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GEOTECHNICAL SITE INVESTIGATION

BORING 1 THROUGH 12

PROPOSED MARKET OF INDIA PROJECT SITE

"SPR CITY"

NO. 1, COOKS ROAD, PERAMBUR, CHENNAI 600012, TN.

R. S. NO. 222/1, AND 222/2, BLOCK NO. 10 PART, 11 PART, 12 PART OF PERAMBUR TALUK, CHENNAI DISTRICT, TN.

Report to

M/s. SPR Constructions Pvt. Ltd.
No. 1 Cooks Road, **SPR City**
Perambur, Chennai 600 012, TN.

PRASAD ARMSTRONG YEN G E C (P) LTD.
821 (Old No. 439/4) Poonamallee High Road, Arumbakkam, Chennai 600 106.
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CIN: U74210TN1992PTC023645

Report No. 011/GI/18-19
July 25, 2018.

M/s. SPR Constructions Pvt. Ltd.
No. 1 Cooks Road, **SPR City**
Perambur, Chennai 600 012, TN.

Attention: Ms. D R Latha
AGM - Contracts

Geotechnical Site Investigation
Boring 1 through 12
Proposed Market of India Project Site
SPR City
No. 1, Cooks Road, Perambur, Chennai 600 012, TN.
R. S. Nos. 222/1, and 222/2, Block No. 10 Part, 11 Part, 12 Part
Of Perambur Taluk, Chennai District, TN.

The Prasad Armstrong Yen GEC (P) Ltd., Chennai is pleased to submit this report on our geotechnical site investigation conducted at the above location. This work was authorized by your Work Order No. WO0413 dated April 20, 2018.

Estimated capacities of the foundations recommended for the proposed buildings are presented here in final form together with a summary of laboratory and field data.

We appreciate the opportunity to be of service to you on this project. Please call us if you have any questions or when we can be of further assistance.

Sincerely,

PRASAD ARMSTRONG YEN GEC (P) Ltd.

B. Ram Prasad ME, PhD (Texas A&M)
Managing Director

(011brpt)
Copies Submitted: (6)

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SUMMARY

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation at the Proposed "**Market of India**" Site, **SPR City**, No. 1, Cooks Road, Perambur, Chennai 600 012, TN. R. S. Nos. 222/1, and 222/2, Block No. 10 Part, 11 Part, and 12 Part, Perambur Taluk, Chennai District, TN. The primary purpose of our investigation was to obtain data to select suitable foundation type and estimate load carrying capacity of the selected foundation for the proposed building with 2B + 2G + 3 Floors + Part 7 Office Floors. As per the client bottom level of the raft will be at about 12.5-M below the Existing Ground Level (EGL) of the site. Typical expected maximum column loads to be about 1,000 tons. As per the client, in case of combined raft foundation the expected bearing pressure on soil will be about 38 tons/M^2. These details were used only for estimating the preliminary foundation size and type of foundation.

The field investigation was performed from April 22 through May 7, 2018. Number and location of borings was selected to cover half of the proposed site where foundation was yet to start. Boring 1 through 12 were drilled 30-, 30-, 27.85-, 30-, 28.5-, 30-, 29.15, 30-, 30-, 27.5-, 28-, and 30-M, respectively below EGL. Drilling of the borings was terminated after encountering continuous hard strata (SPT N $\geq$ 75) in at least six successive tests and recovery of rock core pieces in weathered rock stratum. NX TC bit and Diamond bit core barrels were used for drilling through the rocky stratum. In the borings minimum of 0 to 71 cms long rock core pieces were recovered in the last 1-M of the boring. Tests were conducted to determine the pertinent index and engineering properties of the soils encountered. We then performed engineering analyses to develop the required design data.

Topography of the site reflects a flat terrain. Visual observation infers site's EGL was about 0.5-M above the Existing Road Level (ERL) of public road in near the site. At present site was a vacant plot with no significant vegetation. Proposed construction will be the first major construction activity of this magnitude to cover this site.

Encountered soil profiles of the borings infer presence of filled up soil, very soft to stiff clay, and very loose silty fine sand and fine sand soil layers with very low SPT "N" values upto 8-M below EGL. In general from 8- to about 25-M was silty fine sand to fine to coarse sand layers with SPT "N" values more than 40 on average with $\geq$ 75 from 16-M. Beyond 25-M was weathered and highly jointed granite rock with low to high rock core recovery in this rocky zone. In all borings hard stratum with SPT "N" $\geq$ 75 was continuously present from about 17.5-M below EGL.

As per client communication bottom level of the raft will be at about 12.5-M below EGL of the site. Therefore, for the proposed building, encountered soil profiles, and expected heavy column loads it was **recommended** providing **Combined Raft foundation at 12.5-M below EGL.** The combined raft should be designed for uplift water pressures as detailed in later sections. From 10-M below EGL it was all sand soils with average SPT "N" value of about 70 between 10- and 24.5-M. A typical raft size of about 40- by 160-M at 12.5-M below EGL was considered in the analysis. For the considered foundation the **estimated ultimate and recommended average allowable capacities were 631 and 40 tons/M^2**, respectively. Estimated total settlements for expected bearing pressure of 38 tons/M^2 was 25 mm, less than 75 mm, IS: 1904 - 2006 code limiting settlement for raft foundations. For any **localized loading condition** the **limiting maximum allowable capacity was 50 tons/M^2**

For central podium area with no floors above the Finished Ground Level (FGL) uplift resistance anchor piles will be required for the raft foundation. Therefore, for the proposed building, encountered soil profiles it was recommend to provide **Direct Mud Circulation (DMC) Bored Cast In-Situ piles foundation.** It was recommended to provide the piles from site's EGL itself before basement floor excavation with pile top cut off at suitable depth below EGL. This approach will reduce time required for completing the basement floor work. For lower bound soil profiles of Boring 5, 26.5-M and 14-M total and effective lengths were recommended with top 12.5-M cutoff was for the basement floors. With this approach pile will be embedded into hard stratum weathered rock to at least 2.5-M depth. Ultimate and allowable pile capacities of various pile diameters are summarized below.

Pile Dia., M	Comp. Capacity, Tons		Uplift Capacity, Tons		Lateral Capacity, Tons	
	Ultimate	Allowable	Ultimate	Allowable	Ultimate	Allowable
0.60	430.86	**172**	181.83	**73**	11.20	**4.48**
0.75	618.13	**247**	229.02	**92**	16.31	**6.53**
0.90	837.22	**335**	276.91	**111**	22.34	**8.94**
1.00	1,000.96	**400**	309.22	**124**	26.17	**10.47**
1.20	1,370.87	**548**	374.76	**150**	33.61	**13.44**

Groundwater was not clearly seen in the borings. In some borings observed groundwater was slushy inferring it may be the bentonite solution water. Therefore, groundwater sample was not collected from the borings. A bore well of unknown depth was present in the site at a distance of about 51.5-M from Boring 1. From this bore well groundwater sample was collected for construction suitability tests as per IS: 456 – 2000. Test results infer that the groundwater from the bore well was **not suitable** for construction purposes due to high alkalinity as inferred by the methyl orange titration test, high chloride content for use in RCC. Groundwater can be used only after suitable treatment. Groundwater from the site should be checked for construction suitability purposes regularly during construction period and adjust the groundwater treatment if necessary.

Site soil profiles infer presence of sandy soil with N_{avg} ~ 70 from 12.5- to 24.5-M EGL and greater than 75 from 16- to 24.5-M. Beyond 24.5-M depths in weathered and highly jointed granite rock had N_{avg} >> 100. Actual "Sub-Grade Modulus" value is influenced by thickness of soil in the influence zone, size and rigidity of foundation. Since it is not possible to estimate the same with variable strata, as a general guideline following sub-grade modulus values as per IS: 2950 - 1998 were presented. As per IS code in case of granular material with SPT "N_{avg}" > 30 and above in **saturated condition** **Sub-Grade Modulus** "**K_s**" was **2.9 to 10.8 kg/cm^3** (**2,900 to 10,800 tons/M^3**.) For the proposed raft design **Sub-Grade Modulus** "**K_s**" of **7.5 kg/cm^3** (**7,500 tons/M^3**) can be adopted.

We do expect construction problems at this site due to groundwater and soil conditions in rainy season and immediately after rainy season when groundwater level can be higher than required foundation level. For the proposed building with two basement floors, excavation has to reach **12.5-M below EGL**. In the top 8-M very soft clay / very loose silty sand and / or very loose sand layers with very low strength were encountered. A 1:2 (V:H) or more slope may be required planned for the basement excavations due to presence of nearly 5- to 6-M thick zone of weak soils. If not feasible then in was recommended to provide designed continuous piles or diaphragm wall with rock anchor tie-back earth retaining structure to protect the soils beyond the basement excavation area. **All the soil retaining structures should be designed with detailed slope stability analysis.**

Raft foundation was planned at 12.5-M below EGL of the site. Since a stream was present near the site and during the heavy seasonal rains groundwater can rise or surface water can accumulate into

the basement floor excavation which can exhort upward water pressure on the raft. Therefore, to avoid uplift of the raft due to groundwater or accumulated rain water suitable counter weight or anchor system should be provided. One option will be to provide anchor piles and raft self weight to provide resistance to 12.5 tons/M^2 upward pressure. Alternatively, relief well points may be provided at the rate of one well per 36-M^2. The provided relief wells should be suitably designed for free water flow and also to avoid pumping out of sand from below due to water pressure. With all these wells the raft floor should be made water tight on all sides to allow water to rise and fill the area above raft to a height of least 2-M. Only the water above this level should be pumped out. With this approach a total combined downward pressure of nearly 5 tons/M^2 can be generated. The net upward water pressure that will be required to be countered by the anchor system will be about 7.5 tons/M^2. Also, if feasible on the finished raft portion excavation soil from adjacent excavation can be stored to increase the downward pressure to counter the upward water pressure.

Groundwater level in the site can raise high in rainy season due to presence of Otteri Nellah near the site. In case of higher groundwater level **dewatering well point system** will be required for this site to a minimum depth of 14-M below EGL. Dewatering will be required for maintain dry working condition. **Groundwater levels in the site should be monitored by developing at least four 0.9-M diameter open wells to confirm the requirement of dewatering activity**, and check the yield of groundwater to select the suitable pump capacities.

Site's EGL was at about 0.5-M above ERL of public road near the site. High Flood Level (HFL) of the Otteri Nellah should be identified, ground and building levels should be suitable selected to minimize flooding of the building and its basement floors. **Bottom of the excavation should be properly cleaned of loose soils after removal of material loosened by the excavation activity for good support for the basement floor slab.**

In case of pile foundation installation "**Pile Necking / Bulging**" can be a potential problem due to presence of thick sand layers with low % of fines. Suitable good quality Bentonite and Bentonite solution of proper density should be used for the piling work. **Pile load test must be performed as the relevant IS code guidelines to confirm the estimated pile capacity and check the quality of pile installation. Hydraulic rotary rig is not recommended for this site soil conditions. For any other reason hydraulic rotary rig has to be considered then it is necessary to** reevaluate pile capacities based on the rig parameters based on input from piling people, evaluate rig operations in the site, install test piles to check feasibility, check test piles for defects by Non-Destructive Tests (NDT), and **perform a few initial load tests** to confirm the load carrying capacity of the piles installed by the hydraulic rotary rig. Also, irrespective of type of pile installation used NDTs should be performed on each and every pile of the planned building to confirm the pile integrity. Required total pile length for some of the piles will be more than the recommended pile length of 26.5-M due to variations in the depth the weathered rock level. Routine pile load tests should be performed on the installed piles as per IS code guidelines.

All structures have to be designed for higher seismic forces (**Zone III**) due to increased seismic activity in peninsular India in the last decade and half. Seismic events of 7.9 magnitude on April 25, 2015, 6.0 magnitude on May 21, 2014, 8.4 magnitude on April 11, 2012, 7.2 magnitude on June 13, 2010, and 7.6 magnitude on August 11, 2009 with epicenters in Himalayas, Bay of Bengal, and near Andaman Islands were felt at Chennai. It is recommended to provide rigid plinth beams in ground level, shear walls in the structure, and continuous lintels in each floor. Lintels must be integrated into

columns of the structure. Plinth beams must be designed to be rigid to allow redistribution of loads in case of differential settlements. The site soil profile infers **"No"** seismic susceptibility. Under a seismic event of **6.5 Richter scale**, and peak ground acceleration of **0.08g** the total estimated vertical settlement was 0.31 cms and total horizontal displacement was about 0 cms. Iwasaki liquefaction potential was 0.0 inferring "**No Liquefaction**." As per IS code for **Zone III** design horizontal acceleration was **0.08g**. Hence, in the analysis peak ground acceleration of **0.08g** was used.

INTRODUCTION

Purpose and Scope

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation at the Proposed "**Market of India**" Site, **SPR City**, No. 1, Cooks Road, Perambur, Chennai 600 012, TN. R. S. Nos. 222/1, and 222/2, Block No. 10 Part, 11 Part, and 12 Part, Perambur Taluk, Chennai District, TN. The primary purpose of our investigation was to obtain data to select suitable foundation type and estimate load carrying capacity of the selected foundation for the proposed building with 2B + 2G + 3 Floors + Part 7 Office Floors. As per the client bottom level of the raft will be at about 12.5-M below EGL of the site. Typical expected maximum column loads to be about 1,000 tons. As per the client, in case of combined raft foundation the expected bearing pressure on soil will be about 38 tons/M^2. These details were used only for estimating the preliminary foundation size and type of foundation. To accomplish these purposes, the following tasks were performed:

(1) Boring 1 through 12 were drilled 30-, 30-, 27.85-, 30-, 28.5-, 30-, 29.15, 30-, 30-, 27.5-, 28-, and 30-M, respectively to explore subsurface stratigraphy to confirmed hard strata and obtain soil and rock samples for lab testing;

(2) Tests were conducted to evaluate the pertinent index and engineering properties of the foundation materials; and

(3) Engineering analyses were performed to develop foundation design information for the proposed building foundation.

Report Format

The initial sections of this report contain brief descriptions of the field and laboratory phases of our study. A general soils description is then presented, followed by discussions of foundation design calculations followed by a brief on construction considerations for this project.

FIELD AND LABORATORY INVESTIGATIONS

Exploratory Borings

Soil conditions at the site for the proposed building area were explored by Boring 1 through 12. Boring location details are presented on Plate 1. Number and location of borings was selected to cover half of the proposed site where foundation was yet to start. Boring 1 through 12 were drilled 30-, 30-, 27.85-, 30-, 28.5-, 30-, 29.15, 30-, 30-, 27.5-, 28-, and 30-M, respectively below EGL. Drilling of the borings was terminated after encountering continuous hard strata (SPT "N" $\geq$ 75) in at least six successive tests and recovery of rock core pieces in weathered rock stratum. NX TC bit and Diamond bit core barrels were used for drilling through the rocky stratum. In the borings minimum of 0 to 71 cms long rock core pieces were recovered in the last 1-M of the boring. Tests were conducted to determine the pertinent index and engineering properties of the soils encountered. Groundwater level was not clearly seen in the borings. Log of Boring is presented on Plate 2 through 13.

Field and Laboratory Tests

Borings were drilled using Calyx drilling unit. In the borings SPT was performed at 0.75-M interval upto 7-M, at 1-M upto 10-M, at 1.5-M interval upto 20.5-M, at 2-M interval beyond 20.5-M. SPT consists of driving a standard split spoon sampler, 51-mm outside diameter and 38-mm inside diameter into soil under the blows of a drop hammer of 63.5 kg falling weight freely through 75-cm. The number of blows required for 30-cm of penetration of sampler in soil is designated as N value and it is termed as SPT blow count. Detailed information regarding SPT can be found in the IS: 2131 code of practice.

The soil-testing program was designed to evaluate pertinent index and engineering properties of the foundation soils. During the field operations soil or rock samples were collected at 0.75-, 1.5-, and 2-M intervals either disturbed or undisturbed as the case may be. All samples were shipped to our Chennai laboratory where pertinent index properties - grain size analyses, natural water content, Atterberg limit tests were performed on collected soil samples. All the test results are tabulated on the Summary of Test Results on Plate 9. Grain size distribution curves of tested soil are presented on Plate 10. Summary of Water Test Results are presented on Plate 11.

GENERAL SOIL CONDITIONS

Topography

Topography of the site reflects a flat terrain. Visual observation infers site's EGL was about 0.5-M above ERL of public road near site. At present site was a vacant plot with no significant vegetation. Proposed construction will be the first major construction activity of this magnitude to cover this site.

Soil Stratigraphy

The soil stratigraphy disclosed by our investigation is presented on the log of boring on Plate 2 through 13. The soil stratigraphy is based on classification of soil samples recovered from the boring, and our observations during drilling operations. A generalized summary of the major soil strata is tabulated below:

Boring – 1:

Stratum	Penetration, M From	To	Description
I	0	1.75	Red Brick Pieces and Rubbish
II	1.75	2.75	Red Sandy Gravel
III	2.75	6.25	Brown Gray Very Soft to Stiff Clay
IV	6.25	7.0	Gray Silty Fine Sand
V	7.0	11.0	Gray Fine to Medium Sand with Silt
VI	11.0	19.0	Gray Silty Fine to Medium Sand
VII	19.0	25.0	Gray Brown Fine to Coarse Sand with Silt
VIII	25.0	30.0+	White Brown Weathered Rock

Boring – 2:

Stratum	Penetration, M From	To	Description
I	0	1.0	Black Silty Fine Sand with Brick Pieces
II	1.0	1.75	Brown Silty Fine Sand

III	1.75	2.75	Brown Stiff Clay
IV	2.75	3.75	Gray Silty Fine to Medium Sand
V	3.75	5.5	Gray Very Soft Clay
VI	5.5	8.0	Gray Silty Fine to Medium Sand
VII	8.0	11.0	Brown Gray Fine to Medium Sand with Silt
VIII	11.0	22.0	Gray and Brown Silty Fine to Medium Sand
IX	22.0	25.0	Brown Fine to Coarse Sand with Silt
X	25.0	30.0+	Brown Gray Weathered Rock

Boring – 3:

	Penetration, M		
Stratum	From	To	Description
I	0	1.0	Open Excavation
II	1.0	2.0	Brown Silty Fine to Medium Sand with Brick Pieces – Filled Up Soil
III	2.0	2.75	Brown Firm Clay
IV	2.75	3.25	Brown Silty Fine to Medium Sand
V	3.25	4.25	Gray Very Soft Clay
VI	4.25	7.25	Gray Silty Fine to Medium Sand
VII	7.25	11.0	Brown Gray Fine to Medium Sand with Silt
VIII	11.0	25.5	Gray and Brown Silty Fine to Medium Sand
IX	25.5	28.85+	Brown Gray Weathered Rock

Boring – 4:

	Penetration, M		
Stratum	From	To	Description
I	0	1.0	White Brown Silty Fine to Medium Sand with Brick Pieces – Filled Up Soil
II	1.0	3.0	Brown Firm Clay
III	3.0	4.75	Gray Very Soft Clay
IV	4.75	6.25	Gray Silty Fine to Medium Sand
V	6.25	11.5	Gray Fine to Medium Sand with Silt
VI	11.5	19.0	Gray and Brown Silty Fine to Medium Sand
VII	19.0	24.5	Brown Fine to Medium Sand with Silt
VIII	24.5	26.5	Brown Gray Weathered Rock
IX	26.5	30.0+	Brown Gray Granite

Boring – 5:

	Penetration, M		
Stratum	From	To	Description
I	0	1.75	Brown Silty Fine to Medium Sand with Brick and Stone Pieces
II	1.75	3.0	Gray Brown Firm Clay
III	3.0	4.0	Gray Very Soft Clay
IV	4.0	8.0	Gray Silty Fine to Medium Sand
V	8.0	11.0	Gray Green Fine to Medium Sand with Silt

VI	11.0	24.5	Brown Gray Green Silty Fine to Medium Sand
VII	24.5	28.5+	Brown White Blue Weathered Rock

Boring – 6:

Stratum	Penetration, M From	To	Description
I	0	1.0	Red Brown Silty Fine to Medium Sand with Brick Pieces and Rubbish
II	1.0	1.75	Brown Soft Clay
III	1.75	2.5	Red Gray Stiff Clay
IV	2.5	3.25	Brown Silty Fine to Medium Sand
V	3.25	4.75	Gray Very Soft Clay
VI	4.75	7.0	Gray Silty Fine to Medium Sand
VII	7.0	11.5	Gray Fine to Medium Sand with Silt
VIII	11.5	24.5	Brown and Gray Silty Fine to Medium Sand with Silt
IX	24.5	30.0+	Brown Gray Weathered Rock

Boring – 7:

Stratum	Penetration, M From	To	Description
I	0	1.5	Brown Silty Fine to Medium Sand with Stone Pieces
II	1.5	3.25	Brown Soft to Firm Clay
III	3.25	4.75	Gray Soft to Firm Clay
IV	4.75	6.0	Brown Red Brick Pieces with Silty Sand
V	6.0	13.0	Gray Fine to Medium Sand with Silt
VI	13.0	16.0	Gray Silty Fine Sand
VII	16.0	20.5	Brown Gray Silty Fine to Medium Sand
VIII	20.5	24.5	Brown Fine to Coarse Sand with Silt
IX	24.5	29.15+	Gray White Brown Weathered Rock

Boring – 8:

Stratum	Penetration, M From	To	Description
I	0	1.0	Red Brown Fine to Medium Sand with Silt, Brick Pieces and Rubbish
II	1.0	2.5	Brown Firm to Stiff Clay
III	2.5	3.75	Brown Silty Fine to Medium Sand
IV	3.75	7.0	Gray Silty Fine to Medium Sand
V	7.0	10.0	Gray Brown Fine to Medium Sand with Silt
VI	10.0	20.0	Gray Brown Silty Fine to Medium Sand
VII	20.0	26.5	Brown Fine to Medium Sand with Silt
VIII	26.5	30.0+	Brown Gray Weathered Rock

Boring – 9:

Stratum	Penetration, M From	To	Description
I	0	1.0	Red Fine to Coarse Sand with Silt and Gravel

II	1.0	4.75	Gray and Brown Very Soft to Firm Clay
III	4.75	5.5	Gray Silty Fine to Medium Sand
IV	5.5	13.0	Gray Fine to Medium Sand with Silt
V	13.0	20.5	Gray and Brown Silty Fine to Medium Sand
VI	20.5	24.5	Brown Fine to Coarse Sand with Silt
VII	24.5	30.0+	White Gray Brown Weathered Rock

Boring – 10:

	Penetration, M		
Stratum	From	To	Description
I	0	1.0	White Brown Silty Fine to Medium Sand with Stone Pieces
II	1.0	1.75	Red Gray Firm Clay
III	1.75	4.75	Brown Fine to Medium Sand with Silt
IV	4.75	13.0	Gray Fine to Medium Sand with Silt
V	13.0	17.5	Brown Gray Silty Fine Sand
VI	17.5	23.5	Brown Silty Fine to Medium Sand
VII	23.5	27.5+	Brown Gray Weathered Rock

Boring – 11:

	Penetration, M		
Stratum	From	To	Description
I	0	1.75	White Red Brown Silty Fine to Medium Sand with Rubbish
II	1.75	3.0	Brown Silty Fine Sand
III	3.0	4.75	Gray Very Soft Clay
IV	4.75	13.0	Gray Fine to Medium Sand with Silt
V	13.0	20.0	Gray Brown Silty Fine to Medium Sand
VI	20.0	24.5	Brown Fine to Medium Sand with Silt
VII	24.5	28.0+	Gray Weathered Rock

Boring – 12:

	Penetration, M		
Stratum	From	To	Description
I	0	1.0	Brown Fine to Coarse Sand with Silt and Rubbish
II	1.0	5.5	Brown Gray Silty Fine to Medium Sand
III	5.5	13.0	Gray Fine to Medium Sand with Silt
IV	13.0	19.0	Gray Silty Fine Sand
V	19.0	24.5	Brown Silty Fine to Medium Sand
VI	24.5	30.0+	Brown Gray Weathered Rock

Detailed soil descriptions that include textural variations and inclusions were noted on log of boring presented on Plate 2 through 13.

Interpretation of Soil Properties

Shear strength parameters for cohesion less soils were selected based on the field SPT results, grain size distribution analyses, and associated correlation. Shear strength parameters for cohesive soils were selected based on the field SPT results, and associated correlation. The unit weight (soil

density) profiles of the soils in the borings were developed from estimated values based on correlations of unit weight with particle size gradation and field test results (Bowles, 1982.)

Foundation calculations presented in this report were based on the lower bound soil proprieties of Boring 5 and 8. A reevaluation of the recommendations in this report may be necessary if variations in the soil profile are encountered during the foundation excavation work. In addition, there may be a need to drill additional borings to investigate soil variability at that location. Based on the field and laboratory test results the following are the properties for soils encountered in the boring.

Boring – 1:

Stratum	Penetration, M From	To	Properties
I	0	1.75	γ_{sat} = 1.6 tons/M^3
II	1.75	2.75	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
IIIa	2.75	3.25	C_u = 6 tons/M^2; γ_{sat} = 1.6 tons/M^3
IIIb	3.25	3.75	$\phi = 27^o$; γ_{sat} = 1.6 tons/M^3
IIIc	3.75	4.5	C_u = 1.2 tons/M^2; γ_{sat} = 1.45 tons/M^3
IIId	4.5	6.25	C_u = 0.5 tons/M^2; γ_{sat} = 1.35 tons/M^3
IV	6.25	7.0	$\phi = 23^o$; γ_{sat} = 1.35 tons/M^3
Va	7.0	8.0	$\phi = 28^o$; γ_{sat} = 1.6 tons/M^3
Vb	8.0	9.0	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
Vc	9.0	11.0	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3
VIa	11.0	13.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
VIb	13.0	14.0	$\phi = 36^o$; γ_{sat} = 2.0 tons/M^3
VIc	14.0	16.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
VId	16.0	17.5	$\phi = 36^o$; γ_{sat} = 2.0 tons/M^3
VIe	17.5	19.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIa	19.0	20.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
VIIb	20.0	25.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIIa	25.0	26.5	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIIb	26.5	28.5	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3
VIIIc	28.5	30.0+	$\phi = 40^o$; γ_{sat} = 2.3 tons/M^3

Boring – 2:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.45 tons/M^3
II	1.0	1.75	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
III	1.75	2.75	C_u = 7.5 tons/M^2; γ_{sat} = 1.65 tons/M^3
IV	2.75	3.75	$\phi = 25^o$; γ_{sat} = 1.4 tons/M^3
V	3.75	5.5	C_u = 0.5 tons/M^2; γ_{sat} = 1.35 tons/M^3
VIa	5.5	7.0	$\phi = 23^o$; γ_{sat} = 1.35 tons/M^3
VIb	7.0	8.0	$\phi = 30^o$; γ_{sat} = 1.65 tons/M^3
VIIa	8.0	10.0	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
VIIb	10.0	11.0	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3
VIIIa	11.0	13.0	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3
VIIIb	13.0	14.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIIc	14.0	17.5	$\phi = 36^o$; γ_{sat} = 2.05 tons/M^3

VIIId	17.5	20.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIIe	20.5	25.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IXa	25.0	26.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IXb	26.5	28.5	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IXc	28.5	30.0+	$\phi = 41^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 3:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	Open Excavation
II	1.0	2.0	$\gamma_{sat} = 1.45$ tons/M^3
III	2.0	2.75	$C_u = 4$ tons/M^2; $\gamma_{sat} = 1.55$ tons/M^3
IV	2.75	3.25	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
V	3.25	4.25	$C_u = 0.5$ tons/M^2; $\gamma_{sat} = 1.35$ tons/M^3
VIa	4.25	7.25	$\phi = 23^o$; $\gamma_{sat} = 1.35$ tons/M^3
VIIa	7.25	8.0	$\phi = 26^o$; $\gamma_{sat} = 1.6$ tons/M^3
VIIb	8.0	10.0	$\phi = 31^o$; $\gamma_{sat} = 1.7$ tons/M^3
VIIc	10.0	11.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
VIIIa	11.0	12.5	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
VIIIb	12.5	13.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIIc	13.5	17.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIIId	17.0	21.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIIe	21.5	25.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IXa	25.5	28.5+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 4:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.45$ tons/M^3
II	1.0	3.0	$C_u = 4$ tons/M^2; $\gamma_{sat} = 1.55$ tons/M^3
III	3.0	4.75	$C_u = 1.25$ tons/M^2; $\gamma_{sat} = 1.4$ tons/M^3
IV	4.75	6.25	$\phi = 24^o$; $\gamma_{sat} = 1.4$ tons/M^3
Va	6.25	7.0	$\phi = 26^o$; $\gamma_{sat} = 1.55$ tons/M^3
Vb	7.0	8.0	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
Vc	8.0	9.0	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
Vd	9.0	9.75	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
Ve	9.75	11.5	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
VIa	11.5	16.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIb	16.0	19.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VII	19.0	24.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIII	24.5	26.5	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IXa	26.5	27.5	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IXb	27.5	30.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 5:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.75	$\gamma_{sat} = 1.55$ tons/M^3
II	1.75	3.0	$C_u = 3$ tons/M^2; $\gamma_{sat} = 1.55$ tons/M^3

III	3.0	4.0	C_u = 0.5 tons/M^2; γ_{sat} = 1.35 tons/M^3
IVa	4.0	5.5	$\phi = 23^o$; γ_{sat} = 1.35 tons/M^3
IVb	5.5	6.25	$\phi = 24^o$; γ_{sat} = 1.45 tons/M^3
IVc	6.25	8.0	$\phi = 30^o$; γ_{sat} = 1.65 tons/M^3
Va	8.0	9.0	$\phi = 33^o$; γ_{sat} = 1.8 tons/M^3
Vb	9.0	11.0	$\phi = 36^o$; γ_{sat} = 2.0 tons/M^3
VIa	11.0	12.5	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3
VIb	12.5	14.5	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
VIc	14.5	16.0	$\phi = 36^o$; γ_{sat} = 2.0 tons/M^3
VId	16.0	19.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIe	19.0	22.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
VIf	22.0	24.5	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIa	24.5	26.5	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
VIIb	26.5	28.5+	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3

Boring – 6:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	γ_{sat} = 1.4 tons/M^3
II	1.0	1.75	C_u = 2 tons/M^2; γ_{sat} = 1.45 tons/M^3
III	1.75	2.5	C_u = 6 tons/M^2; γ_{sat} = 1.6 tons/M^3
IV	2.5	3.25	$\phi = 34^o$; γ_{sat} = 1.8 tons/M^3
Va	3.25	4.75	C_u = 1.25 tons/M^2; γ_{sat} = 1.4 tons/M^3
VIa	4.75	6.25	$\phi = 24^o$; γ_{sat} = 1.4 tons/M^3
VIb	6.25	7.0	$\phi = 26^o$; γ_{sat} = 1.5 tons/M^3
VIIa	7.0	8.0	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
VIIb	8.0	9.75	$\phi = 35^o$; γ_{sat} = 1.9 tons/M^3
VIIc	9.75	11.5	$\phi = 34^o$; γ_{sat} = 1.8 tons/M^3
VIIIa	11.5	13.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
VIIIb	13.0	17.5	$\phi = 36^o$; γ_{sat} = 2.0 tons/M^3
VIIIc	17.5	20.5	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
VIIId	20.5	24.5	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IX	24.5	30.0+	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3

Boring – 7:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.5	γ_{sat} = 1.6 tons/M^3
IIa	1.5	2.5	C_u = 3 tons/M^2; γ_{sat} = 1.5 tons/M^3
IIb	2.5	3.25	C_u = 1.25 tons/M^2; γ_{sat} = 1.45 tons/M^3
IIIa	3.25	4.0	C_u = 3 tons/M^2; γ_{sat} = 1.5 tons/M^3
IIIb	4.0	4.75	C_u = 1.25 tons/M^2; γ_{sat} = 1.45 tons/M^3
IV	4.75	6.0	$\phi = 32^o$; γ_{sat} = 1.75 tons/M^3
Va	6.0	8.0	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
Vb	8.0	9.0	$\phi = 34^o$; γ_{sat} = 1.8 tons/M^3
Vc	9.0	9.75	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
Vd	9.75	13.0	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3

VIa	13.0	14.5	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
VIb	14.5	16.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIIa	16.0	17.5	$\phi = 35^o$; $\gamma_{sat} = 1.95$ tons/M^3
VIIb	17.5	19.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIc	19.0	20.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIIa	20.5	22.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIIb	22.0	24.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IXa	24.5	26.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IXb	26.5	29.15+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 8:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.4$ tons/M^3
II	1.0	2.5	$C_u = 4$ tons/M^2; $\gamma_{sat} = 1.55$ tons/M^3
IIIa	2.5	3.25	$\phi = 27^o$; $\gamma_{sat} = 1.6$ tons/M^3
IIIb	3.25	3.75	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IVa	3.75	6.25	$\phi = 23^o$; $\gamma_{sat} = 1.35$ tons/M^3
IVb	6.25	7.0	$\phi = 24^o$; $\gamma_{sat} = 1.4$ tons/M^3
Va	7.0	8.0	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
Vb	8.0	9.0	$\phi = 33^o$; $\gamma_{sat} = 1.7$ tons/M^3
Vc	9.0	10.0	$\phi = 35^o$; $\gamma_{sat} = 1.95$ tons/M^3
VIa	10.0	11.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIb	11.0	14.0	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
VIc	14.0	16.0	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
VId	16.0	17.5	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIe	17.5	20.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIa	20.0	22.5	$\phi = 36^o$; $\gamma_{sat} = 2.05$ tons/M^3
VIIb	22.5	24.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIc	24.0	26.5	$\phi = 36^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIIa	26.5	28.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIIb	28.5	30.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 9:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.45$ tons/M^3
IIa	1.0	2.5	$C_u = 2.5$ tons/M^2; $\gamma_{sat} = 1.5$ tons/M^3
IIb	2.5	3.25	$C_u = 0.7$ tons/M^2; $\gamma_{sat} = 1.4$ tons/M^3
IIc	3.25	4.75	$C_u = 0.5$ tons/M^2; $\gamma_{sat} = 1.35$ tons/M^3
IIIa	4.75	5.5	$\phi = 23^o$; $\gamma_{sat} = 1.35$ tons/M^3
IVa	5.5	7.0	$\phi = 24^o$; $\gamma_{sat} = 1.4$ tons/M^3
IVb	7.0	8.0	$\phi = 28^o$; $\gamma_{sat} = 1.6$ tons/M^3
IVc	8.0	10.0	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
IVd	10.0	11.5	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
IVe	11.5	13.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
Va	13.0	17.5	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
Vb	17.5	20.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3

VI	20.5	24.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIa	24.5	26.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIb	26.5	30.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 10:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.5$ tons/M^3
II	1.0	1.75	$C_u = 4$ tons/M^2; $\gamma_{sat} = 1.55$ tons/M^3
IIIa	1.75	2.5	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
IIIb	2.5	3.25	$\phi = 30^o$; $\gamma_{sat} = 1.65$ tons/M^3
IIIc	3.25	4.0	$\phi = 27^o$; $\gamma_{sat} = 1.55$ tons/M^3
IIId	4.0	4.75	$\phi = 25^o$; $\gamma_{sat} = 1.5$ tons/M^3
IVa	4.75	9.0	$\phi = 30^o$; $\gamma_{sat} = 1.6$ tons/M^3
IVb	9.0	11.5	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IVc	11.5	13.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
Va	13.0	14.5	$\phi = 35^o$; $\gamma_{sat} = 1.95$ tons/M^3
Vb	14.5	17.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIa	17.5	18.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIb	18.5	22.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIc	22.5	23.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VII	23.5	27.5+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 11:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.75	$\gamma_{sat} = 2.0$ tons/M^3
IIa	1.75	2.5	$\phi = 25^o$; $\gamma_{sat} = 1.5$ tons/M^3
IIb	2.5	3.0	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
III	3.0	4.75	$C_u = 1.0$ tons/M^2; $\gamma_{sat} = 1.4$ tons/M^3
IVa	4.75	6.25	$\phi = 24^o$; $\gamma_{sat} = 1.4$ tons/M^3
IVb	6.25	10.0	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
Va	10.0	11.5	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
Vb	11.5	13.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
VIa	13.0	14.5	$\phi = 35^o$; $\gamma_{sat} = 1.95$ tons/M^3
VIb	14.5	16.0	$\phi = 36^o$; $\gamma_{sat} = 2.0$ tons/M^3
VIc	16.0	17.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VId	17.5	20.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIIa	20.0	22.5	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
VIIb	22.5	24.5	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
VIII	24.5	28.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 12:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.65$ tons/M^3
IIa	1.0	1.75	$\phi = 30^o$; $\gamma_{sat} = 1.6$ tons/M^3
IIb	1.75	4.0	$\phi = 25^o$; $\gamma_{sat} = 1.45$ tons/M^3

IIc	4.0	4.75	$\phi = 28^o$; γ_{sat} = 1.6 tons/M^3
IId	4.75	5.5	$\phi = 24^o$; γ_{sat} = 1.4 tons/M^3
IIIa	5.5	8.0	$\phi = 29^o$; γ_{sat} = 1.6 tons/M^3
IIIb	8.0	11.5	$\phi = 34^o$; γ_{sat} = 1.85 tons/M^3
IIIc	11.5	13.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
IVa	13.0	14.0	$\phi = 36^o$; γ_{sat} = 2.05 tons/M^3
IVb	14.0	16.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
IVc	16.0	17.5	$\phi = 36^o$; γ_{sat} = 2.05 tons/M^3
IVd	17.5	19.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
Va	19.0	22.5	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
Vb	22.5	24.5	$\phi = 38^o$; γ_{sat} = 2.25 tons/M^3
VI	24.5	30.0+	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3

DESIGN INFORMATION

As per client communication bottom level of the raft will be at about 12.5-M below EGL of the site. Therefore, for the proposed building, encountered soil profiles, and expected heavy column loads it was **recommended** providing **Combined Raft foundation at 12.5-M below EGL.** The combined raft should be designed for uplift water pressures as detailed in later sections. From 10-M below EGL it was all sand soils with average SPT "N" value of about 70 between 10- and 24.5-M. A typical raft size of about 40- by 160-M at 12.5-M below EGL was considered in the analysis. The ultimate bearing capacity of the soil was estimated as per IS: 6403 Code of Practice Method using the following equation and soil parameters presented above sections:

$$q_{ult} = CN_c s_c d_c i_c + q(N_q - 1) s_q d_q i_q + 0.5B\gamma' N_\gamma s_\gamma d_\gamma i_{\gamma\delta}$$

Where

B = Width of Footing;
q_{ult} = Ultimate Bearing Capacity of the Soil;
C = Avg. Soil Undrained Shear Strength;
N_c , N_q & N_γ = Bearing Capacity Factors;
q = Eff. Vertical Pressure at Footing Level
γ' = Eff. Unit Weight of Soil;
s_c,s_q,s_γ = Shape Factors;
d_c,d_q,d_γ = Depth Factors;
i_c,i_q,i_γ = Inclination Factors; and

For the considered foundation **estimated ultimate and recommended allowable capacities were 631 and 40 tons/M^2**, respectively. Estimated total settlement was 25 mm, less than 75 mm, the IS: 1904 - 2006 code limiting settlement for raft foundations on granular material. Hence, raft foundation can be used for the proposed building at this site. Sample foundation capacity calculations were presented on Plate 17.

For central podium area with no floors above the Finished Ground Level (FGL) uplift resistance anchor piles will be required for the raft foundation. Therefore, for the proposed building, encountered soil profiles it was recommend to provide **Direct Mud Circulation (DMC) Bored Cast In-Situ piles foundation.** It was recommended to provide the piles from site's EGL itself before basement floor excavation with pile top cut off at suitable depth below EGL. This approach will reduce time required for completing the basement floor work. For lower bound soil profiles of Boring 5, 26.5-M and 14-M total and effective lengths were recommended with top 12.5-M cutoff was for the basement floors.

With this approach pile will be embedded into hard stratum weathered rock to at least 2.5-M depth. Pile capacity was estimated as per the IS: 2911 - 2010 (Part 1 / Section 2) Code guidelines. Ultimate and allowable pile compressive and uplift capacities of various pile diameters were summarized below. Foundation capacity calculations were presented on Plate 17.

Pile Dia., M	Comp. Capacity, Tons		Uplift Capacity, Tons		Lateral Capacity, Tons	
	Ultimate	Allowable	Ultimate	Allowable	Ultimate	Allowable
0.60	430.86	**172**	181.83	**73**	11.20	**4.48**
0.75	618.13	**247**	229.02	**92**	16.31	**6.53**
0.90	837.22	**335**	276.91	**111**	22.34	**8.94**
1.00	1,000.96	**400**	309.22	**124**	26.17	**10.47**
1.20	1,370.87	**548**	374.76	**150**	33.61	**13.44**

GROUND WATER

Groundwater was not clearly seen in the borings. In some borings observed groundwater was slushy inferring it may be the bentonite solution water. Therefore, groundwater sample was not collected from the borings. A bore well of unknown depth was present in the site at a distance of about 51.5-M from Boring 1. From this bore well groundwater sample was collected for construction suitability tests as per IS: 456 – 2000. Test results infer that the groundwater from the bore well was **not suitable** for construction purposes due to high alkalinity as inferred by the methyl orange titration test, high chloride content for use in RCC. Groundwater can be used only after suitable treatment. Groundwater from the site should be checked for construction suitability purposes regularly during construction period and adjust the groundwater treatment if necessary. Summary of Water Test Results are presented on Plate 16.

SUB-GRADE MODULUS OF SOIL

Site soil profiles infer presence of sandy soil with N_{avg} ~ 70 from 12.5- to 24.5-M EGL and greater than 75 from 16- to 24.5-M. Beyond 24.5-M depths in weathered and highly jointed granite rock had N_{avg} >> 100. Actual "Sub-Grade Modulus" value is influenced by thickness of soil in the influence zone, size and rigidity of foundation. Since it is not possible to estimate the same with variable strata, as a general guideline following sub-grade modulus values as per IS: 2950 - 1998 were presented. As per IS code in case of granular material with SPT "N_{avg}" > 30 and above in **saturated condition** **Sub-Grade Modulus** "**K_s**" was **2.9 to 10.8 kg/cm^3** (**2,900 to 10,800 tons/M^3**.) For the proposed raft design **Sub-Grade Modulus** "**K_s**" of **7.5 kg/cm^3** (**7,500 tons/M^3**) can be adopted.

CONSTRUCTION CONSIDERATIONS

We do expect construction problems at this site due to groundwater and soil conditions in rainy season and immediately after rainy season when groundwater level can be higher than required foundation level. For the proposed building with two basement floors, excavation has to reach **12.5-M below EGL**. In the top 8-M very soft clay / very loose silty sand and / or very loose sand layers with very low strength were encountered. A 1:2 (V:H) or more slope may be required planned for the basement excavations due to presence of nearly 5- to 6-M thick zone of weak soils. If not feasible then in was recommended to provide designed continuous piles or diaphragm wall with rock anchor tie-back earth retaining structure to protect the soils beyond the basement excavation area. **All the soil retaining structures should be designed with detailed slope stability analysis.**

Raft foundation was planned at 12.5-M below EGL of the site. Since a stream was present near the site and during the heavy seasonal rains groundwater can rise or surface water can accumulate into the basement floor excavation which can exhort upward water pressure on the raft. Therefore, to avoid uplift of the raft due to groundwater or accumulated rain water suitable counter weight or anchor system should be provided. One option will be to provide anchor piles and raft self weight to provide resistance to 12.5 tons/M^2 upward pressure. Alternatively, relief well points may be provided at the rate of one well per 36-M^2. The provided relief wells should be suitably designed for free water flow and also to avoid pumping out of sand from below due to water pressure. With all these wells the raft floor should be made water tight on all sides to allow water to rise and fill the area above raft to a height of least 2-M. Only the water above this level should be pumped out. With this approach a total combined downward pressure of nearly 5 tons/M^2 can be generated. The net upward water pressure that will be required to be countered by the anchor system will be about 7.5 tons/M^2. Also, if feasible on the finished raft portion excavation soil from adjacent excavation can be stored to increase the downward pressure to counter the upward water pressure.

Groundwater level in the site can raise high in rainy season due to presence of Otteri Nellah near the site. In case of higher groundwater level **dewatering well point system** will be required for this site to a minimum depth of 14-M below EGL. Dewatering will be required for maintain dry working condition. **Groundwater levels in the site should be monitored by developing at least four 0.9-M diameter open wells to confirm the requirement of dewatering activity**, and check the yield of groundwater to select the suitable pump capacities.

Site's EGL was at about 0.5-M above ERL of public road near the site. High Flood Level (HFL) of the Otteri Nellah should be identified, ground and building levels should be suitable selected to minimize flooding of the building and its basement floors. **Bottom of the excavation should be properly cleaned of loose soils after removal of material loosened by the excavation activity for good support for the basement floor slab.**

In case of pile foundation installation "**Pile Necking / Bulging**" can be a potential problem due to presence of thick sand layers with low % of fines. Suitable good quality Bentonite and Bentonite solution of proper density should be used for the piling work. **Pile load test must be performed as the relevant IS code guidelines to confirm the estimated pile capacity and check the quality of pile installation. Hydraulic rotary rig is not recommended for this site soil conditions. For any other reason hydraulic rotary rig has to be considered then it is necessary to** reevaluate pile capacities based on the rig parameters based on input from piling people, evaluate rig operations in the site, install test piles to check feasibility, check test piles for defects by Non-Destructive Tests (NDT), and **perform a few initial load tests** to confirm the load carrying capacity of the piles installed by the hydraulic rotary rig. Also, irrespective of type of pile installation used NDTs should be performed on each and every pile of the planned building to confirm the pile integrity. Required total pile length for some of the piles will be more than the recommended pile length of 26.5-M due to variations in the depth the weathered rock level. Routine pile load tests should be performed on the installed piles as per IS code guidelines.

All structures have to be designed for higher seismic forces (**Zone III**) due to increased seismic activity in peninsular India in the last decade and half. Seismic events of 7.9 magnitude on April 25, 2015, 6.0 magnitude on May 21, 2014, 8.4 magnitude on April 11, 2012, 7.2 magnitude on June 13,

2010, and 7.6 magnitude on August 11, 2009 with epicenters in Himalayas, Bay of Bengal, and near Andaman Islands were felt at Chennai. It is recommended to provide rigid plinth beams in ground level, shear walls in the structure, and continuous lintels in each floor. Lintels must be integrated into columns of the structure. Plinth beams must be designed to be rigid to allow redistribution of loads in case of differential settlements. The site soil profile infers **"No"** seismic susceptibility. Under a seismic event of **6.5 Richter scale**, and peak ground acceleration of **0.08g** the total estimated vertical settlement was 0.31 cms and total horizontal displacement was about 0 cms. Iwasaki liquefaction potential was 0.0 inferring "**No Liquefaction**." As per IS code for **Zone III** design horizontal acceleration was **0.08g**. Hence, in the analysis peak ground acceleration of **0.08g** was used. Liquefaction Analysis results are presented on Plate 18.

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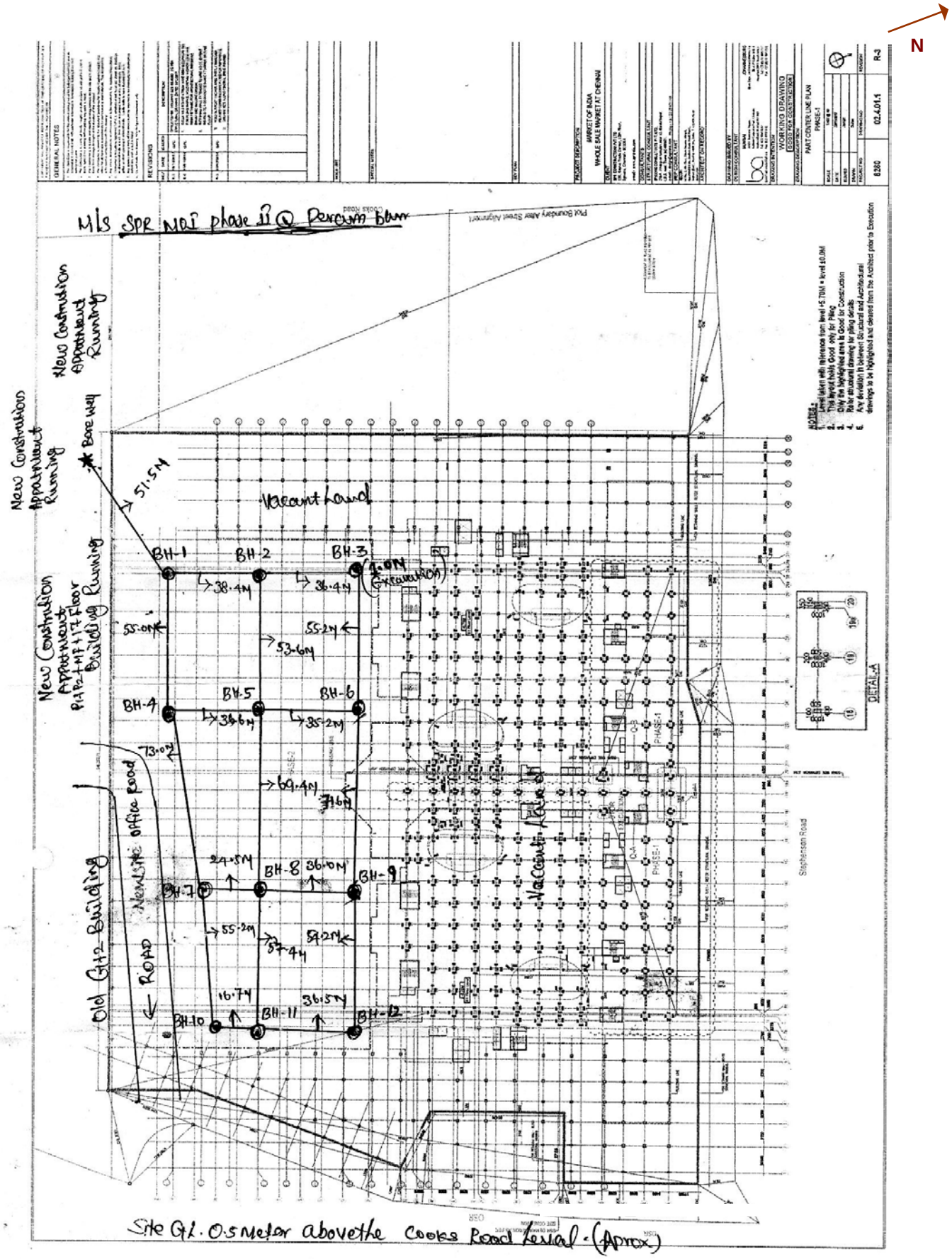
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(Not to Scale)

Site EGL = 0.5-M Below ERL of Road In Front of the Site.

BORE HOLE LOCATION DETAILS.

PLATE 1

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 22-04-'18 **Ended on:** 24-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	RED BRICK PIECES AND RUBBISH (To 1.75-M)	DS @ 0.25 M
	0.0- to 1.0-m – γ_t = 1.6 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 8)	4/5/6 = 11 Blows
		SPT @ 1.75M (SNR)
		2/3/3 = 6 Blows
2.0	**RED SANDY GRAVEL (To 2.75-M)**	
	1.75- to 2.75-m – ϕ = 26^o; γ_t = 1.55 tons/M^3	SPT @ 2.5 M
	(N_{avg} = 6)	4/12/20 = 32 Blows
3.0	**BROWN GRAY VERY SOFT TO STIFF CLAY**	SPT @ 3.25 M
	with sand seams (To 6.25-M) (N_{avg} ~ 9)	3/6/3 = 9 Blows
	2.75- to 3.25-m – C_u = 6 tons/M^2; γ_t = 1.6 tons/M^3	
	3.25- to 3.75-m – ϕ = 27^o; γ_t = 1.6 tons/M^3	SPT @ 4 M
4.0	(N_{avg} = 9)	0/1/1 = 2 Blows
	3.75- to 4.5-m – C_u = 1.2 tons/M^2; γ_t = 1.45 tons/M^3	
	(N_{avg} = 2)	SPT @ 4.75 M
		0/0/0 = 0 Blows
5.0		(sunk under hammer weight)
	4.5- to 6.25-m – C_u = 0.5 tons/M^2; γ_t = 1.35 tons/M^3	SPT @ 5.5 M
	(N_{avg} = 0)	0/0/0 = 0 Blows
		(sunk under hammer weight)
6.0		SPT @ 6.25 M
		0/0/0 = 0 Blows
	GRAY SILTY FINE SAND (To 7.0-M)	(sunk under hammer weight)
	6.25- to 7.0-m – ϕ = 23^o; γ_t = 1.35 tons/M^3	SPT @ 7 M
7.0	(N_{avg} = 0)	1/3/6 = 9 Blows
	GRAY FINE TO MEDIUM SAND with silt (To 11.0-M)	
	7.0- to 8.0-m – ϕ = 28^o; γ_t = 1.6 tons/M^3	SPT @ 8 M
8.0	(N_{avg} = 9)	6/8/9 = 17 Blows
	8.0- to 9.0-m – ϕ = 32^o; γ_t = 1.7 tons/M^3	
	(N_{avg} = 17)	SPT @ 9 M
9.0		9/15/17 = 32 Blows
		SPT @ 10 M
10.0	9.0- to 11.0-m – ϕ = 34^o; γ_t = 1.85 tons/M^3	10/15/18 = 33 Blows
	(N_{avg} = 32)	
	-brown gray color at 10-m	
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 2b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 2a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 22-04-'18 **Ended on:** 24-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 2a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY SILTY FINE TO MEDIUM SAND (To 19.0-M)	SPT @ 11.5 M 12/17/19 = 36 Blows		
12.0	11.0- to 13.0-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 36$)			
13.0		SPT @ 13 M 19/20/ 5 cms for 10 Blows		
	13.0- to 14.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} > 50$)	4 cms for 10 Blows		
14.0				
		SPT @ 14.5 M 14/17/20 = 37 Blows		
15.0	14.0- to 16.0-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 37$)			
16.0		SPT @ 16 M 18/20/26 = 46 Blows		
17.0	16.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 46$)			
		SPT @ 17.5M 27/ 4 cms for 10 Blows		
18.0		3 cms for 10 Blows (Hammer Rebound)		
	17.5- to 19.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)			
19.0		SPT @ 19 M 21/ 3 cms for 10 Blows		
	GRAY BROWN FINE TO COARSE SAND with silt (To 25.0-M)	2 cms for 10 Blows (Hammer Rebound)		
20.0	19.0- to 20.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
		SPT @ 20.5M 24/28/ 3 cms for 20 Blows (Hammer Rebound)		
21.0	20.0- to 25.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)			
22.0				

CONTINUED ON PLATE 2c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 2b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 22-04-'18 **Ended on:** 24-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 2b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	GRAY BROWN FINE TO COARSE SAND with silt (To 25.0-M)	SPT @ 22.5 M 31/ 3 cms for 10 Blows
23.0		3 cms for 10 Blows (Hammer Rebound)
	20.0- to 25.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)	
24.0		
		SPT @ 24.5M 27/31/ 1.5 cms for 5 Blows
25.0	-NX Diamond bit drilling from 25-m -5 cms core recovered drilling to 25.1-m	1.5 cms for 5 Blows (Hammer Rebound)
	WHITE BROWN WEATHERED ROCK (Below 25.0-M)	
26.0	25.0- to 26.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)	
	-drilled from 25- to 26.5-m in 75 minutes	SPT @ 26.5 M 2 cms for 10 Blows
27.0		1 cm for 10 Blows (Hammer Rebound)
	-drilled from 26.5- to 27.5-m in 60 minutes	
28.0	26.5- to 28.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	
	-drilled from 27.5- to 28.5-m in 60 minutes	SPT @ 28.5M (SNR) 0.5 cms for 10 Blows
29.0	-8 cms core recovered drilling to 28.5-m	0 cms for 10 Blows (Hammer Rebound)
	28.5- to 30.0-m – $\phi = 40^o$; $\gamma_t = 2.3$ tons/M^3 ($N_{avg} >> 100$)	
30.0	-drilled from 28.5- to 30-m in 145 minutes	SPT @ 30 M (SNR)
	-74 cms core recovered drilling to 30-m -49% CR and 11% RQD	0.5 cms for 10 Blows 0 cms for 10 Blows
31.0	-brownish white color core pieces	(Hammer Rebound)
32.0		
33.0		

SPT / VANE & SAMPLE TYPE — SPT "N" PROFILE: 25 50 75 — INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 2c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 2 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 24-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BLACK SILTY FINE SAND with brick pieces (To 1.0-M)	DS @ 0.25 M		
	0.0- to 1.0-m – γ_t = 1.45 tons/M^3	SPT @ 1 M		
1.0	(N_{avg} ~ 4)	2/3/4 = 7 Blows		
	BROWN SILTY FINE SAND (To 1.75-M)			
	1.0- to 1.75-m – ϕ = 26^o; γ_t = 1.55 tons/M^3	SPT @ 1.75 M		
	(N_{avg} = 7)	3/4/6 = 10 Blows		
2.0	**BROWN STIFF CLAY (To 2.75-M)**			
	1.75- to 2.75-m – C_u = 7.5 tons/M^2; γ_t = 1.65 tons/M^3	SPT @ 2.5 M		
	(N_{avg} = 12)	3/6/9 = 15 Blows		
3.0	**GRAY SILTY FINE TO MEDIUM SAND (To 3.75-M)**	SPT @ 3.25 M		
	2.75- to 3.75-m – ϕ = 25^o; γ_t = 1.4 tons/M^3	2/2/1 = 3 Blows		
	(N_{avg} = 3)	SPT @ 4 M		
4.0	**GRAY VERY SOFT CLAY (To 5.5-M)**	0/0/0 = 0 Blows		
		SPT @ 4.75 M		
	3.75- to 5.5-m – C_u = 0.5 tons/M^2; γ_t = 1.35 tons/M^3	0/0/1 = 1 Blows		
5.0	(N_{avg} < 1)			
		SPT @ 5.5 M		
		0/0/0 = 0 Blows		
	GRAY SILTY FINE TO MEDIUM SAND (To 8.0-M)	(sank under hammer weight)		
6.0		SPT @ 6.25 M		
		0/0/0 = 0 Blows		
	5.5- to 7.0-m – ϕ = 23^o; γ_t = 1.35 tons/M^3	(sank under hammer weight)		
	(N_{avg} = 0)	SPT @ 7 M		
7.0		4/5/6 = 11 Blows		
	7.0- to 8.0-m – ϕ = 30^o; γ_t = 1.65 tons/M^3			
	(N_{avg} = 11)	SPT @ 8 M		
8.0		7/7/8 = 15 Blows		
	BROWN GRAY FINE TO MEDIUM SAND with silt (To 11.0-M)			
		SPT @ 9 M		
9.0	8.0- to 10.0-m – ϕ = 32^o; γ_t = 1.7 tons/M^3	9/10/10 = 20 Blows		
	(N_{avg} = 17)			
		SPT @ 10 M		
10.0		14/15/13 = 28 Blows		
	10.0- to 11.0-m – ϕ = 34^o; γ_t = 1.85 tons/M^3			
	(N_{avg} = 28)			
11.0				

CONTINUED ON PLATE 3b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 3a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 2 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 24-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 3a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN AND GRAY SILTY FINE TO MEDIUM SAND (To 22.0-M)	SPT @ 11.5 M 11/8/22 = 30 Blows
12.0	11.0- to 13.0-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 30$)	
13.0		SPT @ 13 M 29/ 5 cms for 10 Blows
		4 cms for 10 Blows
14.0	13.0- to 14.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	
	-brown color, 14.5- to 22-m	SPT @ 14.5M 18/29/ 5 cms for 10 Blows
15.0		4 cms for 10 Blows
16.0	14.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.05$ tons/M^3 ($N_{avg} \sim 60$)	SPT @ 16 M 18/27/29 = 56 Blows
17.0		
		SPT @ 17.5 M 29/ 4 cms for 10 Blows
18.0		4 cms for 10 Blows
19.0	17.5- to 20.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	SPT @ 19 M 26/ 5 cms for 10 Blows
		4 cms for 10 Blows
20.0		
		SPT @ 20.5 M 29/ 4 cms for 10 Blows
21.0		2 cms for 10 Blows (Hammer Rebound)
	20.5- to 25.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	
22.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 3c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 3b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 2 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 24-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 3b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO COARSE SAND with silt (To 25.0-M)	SPT @ 22.5 M 33/ 3 cms for 10 Blows		■ ♦
23.0		2 cms for 10 Blows (Hammer Rebound)		
	20.5- to 25.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
24.0				
		SPT @ 24.5 M 30/ 3 cms for 10 Blows		■ ♦
25.0	-NX Diamond bit drilling from 25-m	2 cms for 10 Blows (Hammer Rebound)		
	BROWN GRAY WEATHERED ROCK (Below 25.0-M)			
26.0	25.0- to 26.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
	-drilled from 25- to 26.5-m in 75 minutes	SPT @ 26.5M (SNR) 0.5 cms for 10 Blows		
27.0	-stone pieces recovered drilling to 26.5-m	0 cms for 10 Blows (Hammer Rebound)		
	26.5- to 28.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)			
28.0				
	-drilled from 26.5- to 28.5-m in 110 minutes	SPT @ 28.5M (SNR) 0 cms for 10 Blows		
29.0	-48 cms core pieces recovered drilling to 28.5-m -24% CR and 6% RQD	(Hammer Rebound)		
	28.5- to 30.0-m – $\phi = 41^o$; $\gamma_t = 2.35$ tons/M^3 ($N_{avg} >> 100$)			
30.0	-drilled from 28.5- to 30-m in 185 minutes	SPT @ 30 M (SNR)		
	-107 cms core pieces recovered drilling to 30-m -71% CR and 59% RQD	0.5 cms for 10 Blows 0 cms for 10 Blows		
31.0	-brownish gray color core pieces	(Hammer Rebound)		
32.0				
33.0				

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 3c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 3 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 28.85-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	OPEN EXCAVATION (To 1.0-M)			
1.0				
	BROWN SILTY FINE TO MEDIUM SAND with brick pieces – Filled up Soil (To 2.0-M)	DS @ 1.25 M		
	1.0- to 2.0-m – γ_t = 1.45 tons/M^3	SPT @ 2 M		
2.0	(N_{avg} ~ 4)	2/3/4 = 7 Blows		
	BROWN FIRM CLAY (To 2.75-M)	SPT @ 2.75 M		
	2.0- to 2.75-m – C_u = 4 tons/M^2; γ_t = 1.55 tons/M^3	5/8/5 = 13 Blows		
3.0	(N_{avg} = 7)			
	BROWN SILTY FINE TO MEDIUM SAND (To 3.25-M) 2.75- to 3.25-m – ϕ = 31°; γ_t = 1.65 tons/M^3	SPT @ 3.5 M		
	GRAY VERY SOFT CLAY (To 4.25-M)	0/0/0 = 0 Blows		
	3.25- to 4.25-m – C_u = 0.5 tons/M^2; γ_t = 1.35 tons/M^3			
4.0	(N_{avg} = 0)	SPT @ 4.25 M		
		0/0/0 = 0 Blows		
	GRAY SILTY FINE TO MEDIUM SAND (To 7.25-M)			
5.0		SPT @ 5 M		
		0/0/0 = 0 Blows		
		SPT @ 5.75 M		
	4.25- to 7.25-m – ϕ = 23°; γ_t = 1.35 tons/M^3	0/0/0 = 0 Blows		
6.0	(N_{avg} = 0)			
		SPT @ 6.5 M		
		1/0/0 = 0 Blows		
7.0				
		SPT @ 7.25 M		
		1/3/5 = 8 Blows		
	BROWN GRAY FINE TO MEDIUM SAND with silt (To 11.0-M)	SPT @ 8 M		
8.0	7.25- to 8.0-m – ϕ = 26°; γ_t = 1.6 tons/M^3	8/7/7 = 14 Blows		
	(N_{avg} = 8)			
		SPT @ 9 M		
9.0	8.0- to 10.0-m – ϕ = 31°; γ_t = 1.7 tons/M^3	7/9/9 = 18 Blows		
	(N_{avg} = 16)			
10.0		SPT @ 10 M		
		9/15/15 = 30 Blows		
	10.0- to 11.0-m – ϕ = 34°; γ_t = 1.85 tons/M^3			
	(N_{avg} = 30)	SPT @ 11 M		
11.0		11/14/15 = 29 Blows		

CONTINUED ON PLATE 4b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 4a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 3 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 28.85-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 4a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 25.5-M)			
12.0	11.0- to 12.5-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 29$)	SPT @ 12.5 M 32/ 3 cms for 10 Blows		
13.0	12.5- to 13.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	2 cms for 10 Blows		
14.0		SPT @ 14 M 15/25/27 = 52 Blows		
15.0	13.5- to 17.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} \sim 55$)	SPT @ 15.5M 24/25/ 4 cms for 10 Blows (Hammer Rebound)		
16.0				
17.0		SPT @ 17 M 25/29/ 2 cms for 5 Blows 1 cm for 5 Blows (Hammer Rebound)		
18.0				
19.0	-brown color, 18.5- to 25.5-m	SPT @ 18.5 M 30/ 4 cms for 10 Blows (Hammer Rebound)		
20.0	17.0- to 21.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	SPT @ 20 M 35/ 4 cms for 10 Blows (Hammer Rebound)		
21.0				
22.0	21.5- to 25.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 21.5M 36/ 2 cms for 5 Blows 1 cm for 5 Blows (Hammer Rebound)		

CONTINUED ON PLATE 4c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 3 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 28.85-M **Depth to G W S:** Not Clear **Remarks:** **Continued from Plate 4b.**

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 25.5-M)			
23.0				
		SPT @ 23.5 M 37/ 2 cms for 10 Blows		■♦
	21.5- to 25.5-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	(Hammer Rebound)		
24.0	($N_{avg} > 100$)			
25.0				
		SPT @ 25.5M (SNR)		
	-NX Diamond bit drilling from 25.5-m	1 cm for 10 Blows		
	BROWN GRAY WEATHERED ROCK	0.5 cms for 10 Blows		
26.0	**(Below 25.5-M)**	(Hammer Rebound)		
	-drilled from 25.5- to 26.5-m in 60 minutes			
	-25 cms core pieces recovered drilling to 26.5-m			
27.0	-25% CR and 0% RQD			
	-drilled from 26.5- to 27.5-m in 75 minutes	SPT @ 27.5M (SNR)		
	-21 cms core pieces recovered drilling to 27.5-m	0.5 cms for 10 Blows		
	-21% CR and 0% RQD	0 cms for 10 Blows		
28.0	25.5- to 28.85-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3	(Hammer Rebound)		
	($N_{avg} > 100$)			
	-drilled from 27.5- to 28.5-m in 100 minutes	SPT@28.85M (SNR)		
	-29 cms core pieces recovered drilling to 28.5-m	0.5 cms for 10 Blows		
29.0	-29% CR and 16% RQD	0 cms for 10 Blows		
	-drilled from 28.5- to 28.85-m in 60 minutes	(Hammer Rebound)		
	-5 cms core pieces recovered drilling to 28.85-m			
	-14% CR and 0% RQD			
30.0				
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 28.85-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 4c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 4 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 25-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	WHITE BROWN SILTY FINE TO MEDIUM SAND with brick pieces – Filled up Soil (To 1.0-M)	DS @ 0.25 M		
1.0	0.0- to 1.0-m – γ_t = 1.45 tons/M^3 (N_{avg} ~ 4)	SPT @ 1 M 2/3/3 = 6 Blows		
	BROWN FIRM CLAY (To 3.0-M)	SPT @ 1.75 M		
2.0	1.0- to 3.0-m – C_u = 4 tons/M^2; γ_t = 1.55 tons/M^3	2/3/4 = 7 Blows		
	(N_{avg} ~ 6)	SPT @ 2.5 M 3/3/4 = 7 Blows		
3.0		SPT @ 3.25 M		
	GRAY VERY SOFT CLAY (To 4.75-M)	1/1/1 = 2 Blows		
4.0	3.0- to 4.75-m – C_u = 1.25 tons/M^2; γ_t = 1.4 tons/M^3	SPT @ 4 M 0/1/1 = 2 Blows		
	(N_{avg} ~ 2)	SPT @ 4.75 M		
5.0		0/1/1 = 2 Blows		
	GRAY SILTY FINE TO MEDIUM SAND (To 6.25-M)	SPT @ 5.5 M		
	4.75- to 6.25-m – ϕ = 24°; γ_t = 1.4 tons/M^3	1/1/2 = 3 Blows		
6.0	(N_{avg} = 2.5)	SPT @ 6.25 M		
		1/2/4 = 6 Blows		
	GRAY FINE TO MEDIUM SAND with silt (To 11.5-M)	SPT @ 7 M		
7.0	6.25- to 7.0-m – ϕ = 26°; γ_t = 1.55 tons/M^3	5/7/12 = 19 Blows		
	(N_{avg} = 6)			
	7.0- to 8.0-m – ϕ = 32°; γ_t = 1.7 tons/M^3			
	(N_{avg} = 19)	SPT @ 8 M		
8.0		7/10/14 = 24 Blows		
	8.0- to 9.0-m – ϕ = 33°; γ_t = 1.75 tons/M^3			
	(N_{avg} = 24)	SPT @ 9 M		
9.0		13/20/26 = 46 Blows		
	9.0- to 9.75-m – ϕ = 36°; γ_t = 2.0 tons/M^3			
	(N_{avg} = 46)	SPT @ 10 M		
10.0		6/12/15 = 27 Blows		
	9.75- to 11.5-m – ϕ = 34°; γ_t = 1.8 tons/M^3			
	(N_{avg} = 27)			
11.0				

CONTINUED ON PLATE 5b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 5a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 4 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 25-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 5a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	GRAY FINE TO MEDIUM SAND with silt (To 11.5-M)	SPT @ 11.5 M 14/21/27 = 48 Blows
12.0	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 19.0-M)	
13.0		SPT @ 13 M 16/26/29 = 55 Blows
14.0	11.5- to 16.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} \sim 52$)	
	-brown color, 14.5- to 19-m	SPT @ 14.5 M 17/25/30 = 55 Blows
15.0		
16.0		SPT @ 16 M 23/ 4 cms for 10 Blows
		4 cms for 10 Blows
17.0		
	16.0- to 19.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	SPT @ 17.5 M 26/ 4 cms for 10 Blows
18.0		4 cms for 10 Blows
19.0		SPT @ 19 M 30/ 6 cms for 15 Blows
	BROWN FINE TO MEDIUM SAND with silt (To 24.5-M)	1 cm for 5 Blows (Hammer Rebound)
20.0		
	19.0- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 20.5 M 30/ 6 cms for 15 Blows
21.0		1 cm for 5 Blows (Hammer Rebound)
22.0		

SPT / VANE & SAMPLE TYPE — SPT "N" PROFILE: 25 50 75 — INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 5c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 4 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 25-04-'18 **Ended on:** 27-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 5b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO MEDIUM SAND with silt (To 24.5-M)	SPT @ 22.5 M 34/ 3 cms for 10 Blows		■ ♦
23.0		2 cms for 10 Blows (Hammer Rebound)		
	19.0- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5 M 4 cms for 15 Blows		♦ ■
25.0	BROWN GRAY WEATHERED ROCK (To 26.5-M)	0.5 cms for 5 Blows (Hammer Rebound)		
	24.5- to 26.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)			
26.0				
	-drilled from 24.5- to 26.5-m in 40 minutes	SPT @ 26.5M (SNR) 2 cms for 20 Blows		
27.0	BROWN GRAY GRANITE (Below 26.5-M)	(Hammer Rebound)		
	26.5- to 27.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)			
	-drilled from 26.5- to 27.5-m in 60 minutes			
28.0	-50 cms core pieces recovered drilling to 27.5-m -50% CR and 13% RQD			
	-drilled from 27.5- to 28.5-m in 85 minutes -67 cms core pieces recovered drilling to 28.5-m -67% CR and 23% RQD	SPT @ 28.5M (SNR) 0 cms for 10 Blows (Hammer Rebound)		
29.0	27.5- to 30.0-m – $\phi = 42^o$; $\gamma_t = 2.35$ tons/M^3 ($N_{avg} >> 100$)			
	-drilled from 28.5- to 30.0-m in 170 minutes			
30.0	-111 cms core pieces recovered drilling to 30-m -74% CR and 63% RQD	SPT @ 30 M (SNR) 0 cms for 5 Blows (Hammer Rebound)		
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 5c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 5 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 26-04-'18 **Ended on:** 28-04-'18 **Field Work In Charge:** M Munivel

Final Depth: 28.5-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN SILTY FINE TO MEDIUM SAND with brick and stone pieces (To 1.75-M)	DS @ 0.25 M
1.0	0.0- to 1.75-m – γ_t = 1.55 tons/M^3 (N_{avg} = 5)	SPT @ 1 M 2/3/2 = 5 Blows
		SPT @ 1.75 M
2.0	**GRAY BROWN FIRM CLAY (To 3.0-M)**	2/3/3 = 6 Blows
	1.75- to 3.0-m – C_u = 3 tons/M^2; γ_t = 1.55 tons/M^3 (N_{avg} = 5.5)	SPT @ 2.5 M 1/2/3 = 5 Blows
3.0		SPT @ 3.25 M
	GRAY VERY SOFT CLAY (To 4.0-M)	0/0/0 = 0 Blows
	3.0- to 4.0-m – C_u = 0.5 tons/M^2; γ_t = 1.35 tons/M^3 (N_{avg} = 0)	(sank under hammer weight) SPT @ 4 M
4.0		0/0/0 = 0 Blows
	GRAY SILTY FINE TO MEDIUM SAND (To 8.0-M)	(sank under hammer weight) SPT @ 4.75 M
	4.0- to 5.5-m – ϕ = 23°; γ_t = 1.35 tons/M^3 (N_{avg} ~ 1)	0/1/1 = 2 Blows
5.0		SPT @ 5.5 M
		0/1/2 = 3 Blows
6.0	5.5- to 6.25-m – ϕ = 24°; γ_t = 1.45 tons/M^3 (N_{avg} ~ 3)	SPT @ 6.25 M
		1/4/6 = 10 Blows
7.0	6.25- to 8.0-m – ϕ = 30°; γ_t = 1.65 tons/M^3 (N_{avg} ~ 12)	SPT @ 7 M 3/6/8 = 14 Blows
8.0	-gray brown color at 8-m	SPT @ 8 M 6/12/14 = 26 Blows
	GRAY GREEN FINE TO MEDIUM SAND with silt (To 11.0-M)	
9.0	8.0- to 9.0-m – ϕ = 33°; γ_t = 1.8 tons/M^3 (N_{avg} = 26)	SPT @ 9 M 12/18/22 = 40 Blows
10.0	9.0- to 11.0-m – ϕ = 36°; γ_t = 2.0 tons/M^3 (N_{avg} = 42)	SPT @ 10 M 14/20/25 = 45 Blows
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 6b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 6a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 5 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 26-04-'18 **Ended on:** 28-04-'18 **Field Work In Charge:** M Munivel

Final Depth: 28.5-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 6a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN GRAY GREEN SILTY FINE TO MEDIUM SAND (To 24.5-M)	SPT @ 11.5 M 12/13/14 = 27 Blows
12.0	11.0- to 12.5-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 27$)	
13.0		SPT @ 13 M 6/8/10 = 18 Blows
14.0	12.5- to 14.5-m – $\phi = 32^o$; $\gamma_t = 1.7$ tons/M^3 ($N_{avg} = 18$)	
15.0	-fine to medium sand at 14.5-m	SPT @ 14.5 M 12/20/26 = 46 Blows
16.0	14.5- to 16.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 46$)	SPT @ 16 M 16/32/ 3 cms for 10 Blows (Hammer Rebound)
17.0		
18.0	16.0- to 19.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)	SPT @ 17.5M 18/28/ 3 cms for 10 Blows (Hammer Rebound)
19.0		SPT @ 19 M 26/ 3 cms for 10 Blows
20.0		2 cms for 10 Blows (Hammer Rebound)
21.0	-gray brown color, 20.5- to 24.5-m 19.0- to 22.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 20.5 M 22/ 3 cms for 10 Blows 2.5 cms for 10 Blows (Hammer Rebound)
22.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 6c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 6b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 5 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 26-04-'18 **Ended on:** 28-04-'18 **Field Work In Charge:** M Munivel

Final Depth: 28.5-M **Depth to G W S:** Not Clear **Remarks:** **Continued from Plate 6b.**

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN GRAY GREEN SILTY FINE TO MEDIUM SAND (To 24.5-M)	SPT @ 22.5 M 24/ 4 cms for 10 Blows		■ ♦
23.0		3 cms for 10 Blows (Hammer Rebound)		
	22.0- to 24.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} > 75$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5M (SNR) 2 cms for 20 Blows		
25.0	BROWN WHITE BLUE WEATHERED ROCK (Below 24.5-M)	(Hammer Rebound)		
	24.5- to 26.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
26.0				
	-drilled from 24.5- to 26.5-m in 275 minutes	SPT @ 26.5M (SNR) 0 cms for 5 Blows		
27.0	-48 cms core pieces recovered drilling to 26.5-m -24% CR and 12% RQD	(Hammer Rebound)		
	26.5- to 28.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)			
28.0				
	-drilled from 26.5- to 28.5-m in 170 minutes	SPT @ 28.5M (SNR) 0 cms for 10 Blows		
29.0	-83.5 cms core pieces recovered drilling to 28.5-m -42% CR and 17% RQD	(Hammer Rebound)		
30.0				
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 28.5-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 6c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 6 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	RED BROWN SILTY FINE TO MEDIUM SAND with brick pieces and rubbish (To 1.0-M)	DS @ 0.25 M		
	0.0- to 1.0-m – γ_t = 1.4 tons/M^3	SPT @ 1 M		
1.0	(N_{avg} ~ 2)	1/1/2 = 3 Blows		
	BROWN SOFT CLAY (To 1.75-M)			
	1.0- to 1.75-m – C_u = 2 tons/M^2; γ_t = 1.45 tons/M^3	SPT @ 1.75 M		
	(N_{avg} = 3)	3/4/6 = 10 Blows		
2.0	**RED GRAY STIFF CLAY (To 2.5-M)**			
	1.75- to 2.5-m – C_u = 6 tons/M^2; γ_t = 1.6 tons/M^3	SPT @ 2.5 M		
	(N_{avg} = 10)	7/12/14 = 26 Blows		
	BROWN SILTY FINE TO MEDIUM SAND			
3.0	**(To 3.25-M)** (N_{avg} = 26)	SPT @ 3.25 M		
	2.5- to 3.25-m – ϕ = 34^o; γ_t = 1.8 tons/M^3	2/1/1 = 2 Blows		
	GRAY VERY SOFT CLAY (To 4.75-M)			
		SPT @ 4 M		
4.0	3.25- to 4.75-m – C_u = 1.25 tons/M^2; γ_t = 1.4 tons/M^3	0/1/1 = 2 Blows		
	(N_{avg} = 2)			
		SPT @ 4.75 M		
		0/0/1 = 1 Blows		
5.0	**GRAY SILTY FINE TO MEDIUM SAND**			
	(To 7.0-M)	SPT @ 5.5 M		
	4.75- to 6.25-m – ϕ = 24^o; γ_t = 1.4 tons/M^3	0/0/1 = 1 Blows		
	(N_{avg} = 1)			
6.0		SPT @ 6.25 M		
		1/2/3 = 5 Blows		
	6.25- to 7.0-m – ϕ = 26^o; γ_t = 1.5 tons/M^3			
	(N_{avg} = 5)	SPT @ 7 M		
7.0		4/6/10 = 16 Blows		
	GRAY FINE TO MEDIUM SAND with silt			
	(To 11.5-M)			
	7.0- to 8.0-m – ϕ = 32^o; γ_t = 1.7 tons/M^3	SPT @ 8 M		
8.0	(N_{avg} = 16)	9/14/18 = 32 Blows		
		SPT @ 9 M		
9.0	8.0- to 9.75-m – ϕ = 35^o; γ_t = 1.9 tons/M^3	12/17/20 = 37 Blows		
	(N_{avg} = 35)			
		SPT @ 10 M		
10.0		10/12/15 = 27 Blows		
	9.75- to 11.5-m – ϕ = 34^o; γ_t = 1.8 tons/M^3			
	(N_{avg} = 27)			
11.0				

CONTINUED ON PLATE 7b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 7a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 6 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 7a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY FINE TO MEDIUM SAND with silt (To 11.5-M)	SPT @ 11.5 M 14/17/20 = 37 Blows		
12.0	BROWN AND GRAY SILTY FINE TO MEDIUM SAND (To 24.5-M)			
	11.5- to 13.0-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 37$)			
13.0		SPT @ 13 M 16/20/24 = 44 Blows		
14.0				
		SPT @ 14.5 M 18/23/24 = 47 Blows		
15.0				
	13.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} \sim 48$)			
16.0		SPT @ 16 M 22/27/ 5 cms for 10 Blows		
		4 cms for 10 Blows		
17.0				
		SPT @ 17.5 M 21/ 4 cms for 10 Blows		
18.0		4 cms for 10 Blows		
19.0	-brown color, 19- to 24.5-m	SPT @ 19 M (SNR) 4 cms for 10 Blows		
	17.5- to 20.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	4 cms for 10 Blows		
20.0				
		SPT @ 20.5M (SNR) 6 cms for 15 Blows		
21.0		1 cm for 5 Blows (Hammer Rebound)		
	20.5- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
22.0				

CONTINUED ON PLATE 7c

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 7b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 6 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 27-04-'18 **Ended on:** 30-04-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 7b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN AND GRAY SILTY FINE TO MEDIUM SAND (To 24.5-M)	SPT @ 22.5 M 27/ 3 cms for 10 Blows		■♦
23.0		2 cms for 10 Blows (Hammer Rebound)		
	20.5- to 24.5-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5 M 4 cms for 15 Blows		■ ♦
25.0	BROWN GRAY WEATHERED ROCK (Below 24.5-M)	0.5 cms for 5 Blows (Hammer Rebound)		
26.0				
	-drilled from 24.5- to 26.5-m in 60 minutes	SPT @ 26.5M (SNR) 1.5 cms for 15 Blows		
27.0	24.5- to 30.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	0 cms for 5 Blows (Hammer Rebound)		
	-drilled from 26.5- to 27.5-m in 110 minutes			
28.0				
	-drilled from 27.5- to 28.5-m in 70 minutes	SPT @ 28.5M (SNR) 0.5 cms for 10 Blows		
29.0	-16 cms core pieces recovered drilling to 28.5-m -8% CR and 0% RQD	0 cms for 5 Blows (Hammer Rebound)		
30.0	-drilled from 28.5- to 30-m in 135 minutes	SPT @ 30 M (SNR) 0 cms for 10 Blows		
	-78 cms core pieces recovered drilling to 30-m -52% CR and 7% RQD	(Hammer Rebound)		
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 7c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 7 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 2-05-'18 **Ended on:** 5-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 29.15-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN SILTY FINE TO MEDIUM SAND with stone pieces (To 1.5-M)	DS @ 0.25 M
1.0	0.0- to 1.5-m – γ_t = 1.6 tons/M^3 (N_{avg} = 7)	SPT @ 1 M 2/3/4 = 7 Blows
		SPT @ 1.75 M
2.0	**BROWN SOFT TO FIRM CLAY (To 3.25-M)** 1.5- to 2.5-m – C_u = 3 tons/M^2; γ_t = 1.5 tons/M^3 (N_{avg} = 5)	2/2/3 = 5 Blows
		SPT @ 2.5 M
3.0	2.5- to 3.25-m – C_u = 1.25 tons/M^2; γ_t = 1.45 tons/M^3 (N_{avg} = 2)	1/1/1 = 2 Blows SPT @ 3.25 M
		1/2/3 = 5 Blows
	GRAY SOFT TO FIRM CLAY (To 4.75-M) 3.25- to 4.0-m – C_u = 3 tons/M^2; γ_t = 1.5 tons/M^3	SPT @ 4 M
4.0	(N_{avg} = 5)	0/1/1 = 2 Blows
	4.0- to 4.75-m – C_u = 1.25 tons/M^2; γ_t = 1.45 tons/M^3 (N_{avg} = 2)	SPT @ 4.75 M 22/
		4 cms for 10 Blows
5.0	**BROWN RED BRICK PIECES with silty sand (To 6.0-M)**	2 cms for 10 Blows SPT @ 5.5 M
	4.75- to 6.0-m – ϕ = 32°; γ_t = 1.75 tons/M^3	24/10/12 = 22 Blows
6.0	(N_{avg} > 25)	SPT @ 6.25 M
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	2/2/3 = 5 Blows
7.0	6.0- to 8.0-m – ϕ = 26°; γ_t = 1.55 tons/M^3 (N_{avg} = 6)	SPT @ 7 M 2/3/4 = 7 Blows
		SPT @ 8 M
8.0		8/12/14 = 26 Blows
	8.0- to 9.0-m – ϕ = 34°; γ_t = 1.8 tons/M^3	
9.0	(N_{avg} = 26)	SPT @ 9 M 13/18/20 = 38 Blows
	9.0- to 9.75-m – ϕ = 35°; γ_t = 1.95 tons/M^3 (N_{avg} = 38)	
10.0		SPT @ 10 M 12/14/18 = 32 Blows
	9.75- to 13.0-m – ϕ = 34°; γ_t = 1.85 tons/M^3	
11.0	(N_{avg} = 31)	

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 8b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 8a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 7 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 2-05-'18 **Ended on:** 5-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 29.15-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 8a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 11.5 M 10/12/18 = 30 Blows		
12.0	9.75- to 13.0-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 31$)			
13.0		SPT @ 13 M 10/14/20 = 34 Blows		
	GRAY SILTY FINE SAND (To 16.0-M)			
14.0	13.0- to 14.5-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 34$)			
		SPT @ 14.5 M 10/12/28 = 50 Blows		
15.0	14.5- to 16.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 50$)			
16.0		SPT @ 16 M 14/18/23 = 41 Blows		
	BROWN GRAY SILTY FINE TO MEDIUM SAND (To 20.5-M)			
17.0	16.0- to 17.5-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 41$)			
		SPT @ 17.5 M 24/ 8 cms for 20 Blows		
18.0	17.5- to 19.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)			
19.0		SPT @ 19 M 28/ 2 cms for 10 Blows		
		2 cms for 10 Blows (Hammer Rebound)		
20.0	19.0- to 20.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
		SPT @ 20.5 M 24/ 5 cms for 15 Blows		
21.0	**BROWN FINE TO COARSE SAND with silt (To 24.5-M)**	1 cm for 5 Blows (Hammer Rebound)		
	20.5- to 22.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
22.0				

CONTINUED ON PLATE 8c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 7 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 2-05-'18 **Ended on:** 5-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 29.15-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 8b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO COARSE SAND with silt (To 24.5-M)	SPT @ 22.5 M 8 cms for 20 Blows		■ ♦
23.0				
	22.0- to 24.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5 M 5 cms for 15 Blows		■♦
25.0	**GRAY WHITE BROWN WEATHERED ROCK (Below 24.5-M)**	1 cm for 5 Blows (Hammer Rebound)		
	24.5- to 26.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
26.0				
	-drilled from 24.5- to 26.5-m in 80 minutes	SPT @ 26.5M (SNR) 3 cms for 15 Blows		
27.0		0.5 cms for 5 Blows (Hammer Rebound)		
	26.5- to 29.15-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)			
28.0				
	-drilled from 26.5- to 28.5-m in 90 minutes	SPT @ 28.5M (SNR) 1 cm for 10 Blows		
29.0	-17 cms core pieces recovered drilling to 28.5-m -11% CR and 7% RQD	0.5 cms for 10 Blows (Hammer Rebound)		
	-drilled from 28.5- to 29.15-m in 80 minutes	SPT@29.15M(SNR)		
	-29 cms core pieces recovered drilling to 29.15-m -45% CR and 26% RQD	0 cms for 10 Blows (Hammer Rebound)		
30.0				
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 29.15-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 8c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 8 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 29-04-'18 **Ended on:** 2-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	RED BROWN FINE TO MEDIUM SAND with silt, brick pieces and rubbish (To 1.0-M)	DS @ 0.25 M
1.0	0.0- to 1.0-m – γ_t = 1.4 tons/M^3 (N_{avg} ~ 2)	SPT @ 1 M 1/2/3 = 5 Blows
	BROWN FIRM TO STIFF CLAY (To 2.5-M)	SPT @ 1.75 M
2.0	1.0- to 2.5-m – C_u = 4 tons/M^2; γ_t = 1.55 tons/M^3 (N_{avg} = 6)	2/3/5 = 8 Blows
		SPT @ 2.5 M 2/3/4 = 7 Blows
3.0	**BROWN SILTY FINE TO MEDIUM SAND (To 3.75-M)** (N_{avg} = 7)	SPT @ 3.25 M
	2.5- to 3.25-m – ϕ = 27°; γ_t = 1.6 tons/M^3	6/10/12 = 22 Blows
	3.25- to 3.75-m – ϕ = 33°; γ_t = 1.75 tons/M^3 (N_{avg} = 22)	SPT @ 4 M
4.0	**GRAY SILTY FINE TO MEDIUM SAND (To 7.0-M)**	0/0/0 = 0 Blows (sank under hammer weight)
		SPT @ 4.75 M
5.0	3.75- to 6.25-m – ϕ = 23°; γ_t = 1.35 tons/M^3 (N_{avg} = 0)	0/0/0 = 0 Blows (sank under hammer weight)
		SPT @ 5.5 M 0/0/1 = 1 Blows
6.0		SPT @ 6.25 M
	6.25- to 7.0-m – ϕ = 24°; γ_t = 1.4 tons/M^3	0/1/1 = 2 Blows
7.0	(N_{avg} = 2)	SPT @ 7 M 4/6/8 = 14 Blows
	GRAY BROWN FINE TO MEDIUM SAND with silt (To 10.0-M)	
8.0	7.0- to 8.0-m – ϕ = 31°; γ_t = 1.65 tons/M^3 (N_{avg} = 14)	SPT @ 8 M 6/10/12 = 22 Blows
	8.0- to 9.0-m – ϕ = 33°; γ_t = 1.7 tons/M^3	
9.0	(N_{avg} = 22)	SPT @ 9 M 13/18/22 = 40 Blows
	9.0- to 10.0-m – ϕ = 35°; γ_t = 1.95 tons/M^3	
10.0	(N_{avg} = 40) -gray color, 10- to 14.5-m	SPT @ 10 M 12/20/24 = 44 Blows
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 20.0-M)	
11.0	10.0- to 11.0-m – ϕ = 36°; γ_t = 2.0 tons/M^3 (N_{avg} = 44)	

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 9b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 9a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 8 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 29-04-'18 **Ended on:** 2-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 17.5-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 9a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 20.0-M)	SPT @ 11.5 M 11/12/14 = 26 Blows		
12.0				
	11.0- to 14.0-m – $\phi = 34^o$; $\gamma_t = 1.8$ tons/M^3 ($N_{avg} = 28$)	SPT @ 13 M 8/14/15 = 29 Blows		
13.0				
14.0				
	-brownish gray color, 14.5- to 20.5-m	SPT @ 14.5 M 7-9/12 = 21 Blows		
15.0	14.0- to 16.0-m – $\phi = 32^o$; $\gamma_t = 1.7$ tons/M^3 ($N_{avg} = 21$)			
		SPT @ 16 M 14/20/24 = 44 Blows		
16.0				
17.0	16.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 44$)			
		SPT @ 17.5 M 24/ 5 cms for 10 Blows 4 cms for 10 Blows		
18.0				
19.0	17.5- to 20.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	SPT @ 19 M 26/ 3 cms for 10 Blows 4 cms for 10 Blows		
20.0				
	BROWN FINE TO MEDIUM SAND with silt (To 26.5-M)	SPT @ 20.5M 18/24/ 4 cms for 10 Blows 4 cms for 10 Blows		
21.0	20.0- to 22.5-m – $\phi = 36^o$; $\gamma_t = 2.05$ tons/M^3 ($N_{avg} \sim 60$)			
22.0				

CONTINUED ON PLATE 9c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 8 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 29-04-'18 **Ended on:** 2-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 9b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO MEDIUM SAND with silt	SPT @ 22.5M 22/30/		
	(To 26.5-M)	3 cms for 10 Blows		
23.0		2 cms for 10 Blows (Hammer Rebound)		
	22.5- to 24.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3			
	($N_{avg} \sim 100$)			
24.0				
		SPT @ 24.5M 24/30/		
		3 cms for 10 Blows		
25.0		4 cms for 10 Blows (Hammer Rebound)		
	24.0- to 26.5-m – $\phi = 36^o$; $\gamma_t = 2.1$ tons/M^3			
	($N_{avg} \sim 70$)			
26.0				
		SPT @ 26.5 M		
	-NX Diamond bit drilling from 26.5-m	5 cms for 15 Blows		
27.0	BROWN GRAY WEATHERED ROCK	1 cm for 5 Blows		
	(Below 26.5-M)	(Hammer Rebound)		
	-drilled from 26.5- to 27.5-m in 80 minutes			
	-19.5 cms core pieces recovered drilling to 27.5-m			
28.0	-19% CR and 0% RQD			
	26.5- to 28.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3			
	($N_{avg} > 100$)	SPT @ 28.5M (SNR)		
	-drilled from 27.5- to 28.5-m in 50 minutes	0.5 cms for 10 Blows		
29.0	-stone pieces recovered drilling to 28.5-m	0 cms for 10 Blows (Hammer Rebound)		
	28.5- to 30-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3			
	($N_{avg} >> 100$)			
30.0		SPT @ 30 M (SNR)		
	-drilled from 28.5- to 30-m in 80 minutes	0 cms for 10 Blows		
	-15 cms core pieces recovered drilling to 30-m	(Hammer Rebound)		
	-10% CR and 0% RQD			
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 20.5-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 9c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 9 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	RED FINE TO COARSE SAND with silt, and gravel (To 1.0-M)	DS @ 0.25 M		
1.0	0.0- to 1.0-m – γ_t = 1.45 tons/M^3 (N_{avg} ~ 2)	SPT @ 1 M 1/1/2 = 3 Blows		
	GRAY AND BROWN VERY SOFT TO FIRM CLAY (To 4.75-M)	SPT @ 1.75 M		
2.0	1.0- to 2.5-m – C_u = 2.5 tons/M^2; γ_t = 1.5 tons/M^3 (N_{avg} = 4)	1/2/3 = 5 Blows		
		SPT @ 2.5 M 1/1/0 = 1 Blows		
3.0	2.5- to 3.25-m – C_u = 0.7 tons/M^2; γ_t = 1.4 tons/M^3 (N_{avg} = 1)	SPT @ 3.25 M		
		0/0/0 = 0 Blows		
4.0	3.25- to 4.75-m – C_u = 0.5 tons/M^2; γ_t = 1.35 tons/M^3 (N_{avg} = 0)	SPT @ 4 M 0/0/0 = 0 Blows		
		SPT @ 4.75 M 0/0/0 = 0 Blows		
5.0	**GRAY SILTY FINE TO MEDIUM SAND (To 5.5-M)** (N_{avg} = 0)	SPT @ 5.5 M		
	4.75- to 5.5-m – ϕ = 23°; γ_t = 1.35 tons/M^3	1/1/1 = 2 Blows		
6.0	**GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)**	SPT @ 6.25 M		
	5.5- to 7.0-m – ϕ = 24°; γ_t = 1.4 tons/M^3 (N_{avg} = 2)	1/1/1 = 2 Blows		
7.0	-brown gray color, 7- to 9-m	SPT @ 7 M 2/3/5 = 8 Blows		
	7.0- to 8.0-m – ϕ = 28°; γ_t = 1.6 tons/M^3 (N_{avg} = 8)			
8.0		SPT @ 8 M 7/9/11 = 20 Blows		
9.0	8.0- to 10.0-m – ϕ = 32°; γ_t = 1.7 tons/M^3 (N_{avg} = 19)	SPT @ 9 M 9/9/10 = 19 Blows		
10.0		SPT @ 10 M 11/14/16 = 30 Blows		
	10.0- to 11.5-m – ϕ = 34°; γ_t = 1.8 tons/M^3 (N_{avg} = 30)			
11.0				

CONTINUED ON PLATE 10b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 10a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 9 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 10a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 11.5 M 17/19/24 = 43 Blows		
12.0				
	11.5- to 13.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 43$)			
13.0		SPT @ 13 M 15/21/26 = 47 Blows		
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 20.5-M)			
14.0				
		SPT @ 14.5 M 16/18/24 = 42 Blows		
15.0				
	13.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 47$)			
16.0		SPT @ 16 M 17/24/28 = 52 Blows		
17.0				
		SPT @ 17.5M 27/32/ 2 cms for 10 Blows (Hammer Rebound)		
18.0				
19.0	17.5- to 20.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 19 M 29/ 4 cms for 10 Blows 2 cms for 10 Blows (Hammer Rebound)		
20.0				
		SPT @ 20.5M (SNR) 4 cms for 10 Blows 2 cms for 10 Blows (Hammer Rebound)		
21.0	BROWN FINE TO COARSE SAND with silt (To 24.5-M)			
	20.5- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
22.0				

CONTINUED ON PLATE 10c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 10b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 9 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 10b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO COARSE SAND with silt (To 24.5-M)	SPT @ 22.5 M 34/ 4 cms for 10 Blows		■ ♦
23.0		2 cms for 10 Blows (Hammer Rebound)		
	20.5- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5 M 2 cms for 10 Blows		■ ♦
25.0	WHITE GRAY BROWN WEATHERED ROCK (Below 24.5-M)	1.5 cms for 10 Blows (Hammer Rebound)		
	24.5- to 26.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
26.0				
	-drilled from 24.5- to 26.5-m in 75 minutes	SPT @ 26.5 M 2 cms for 10 Blows		♦ ■
27.0		1 cm for 10 Blows (Hammer Rebound)		
28.0				
	-drilled from 26.5- to 28.5-m in 80 minutes	SPT @ 28.5 M 2 cms for 20 Blows		■ ♦
29.0	26.5- to 30.0-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	(Hammer Rebound)		
30.0	-drilled from 28.5- to 30-m in 90 minutes	SPT @ 30 M (SNR)		
	-stone pieces recovered drilling to 30-m	0 cms for 10 Blows (Hammer Rebound)		
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 10c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 10 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 27.5-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	WHITE BROWN SILTY FINE TO MEDIUM SAND with stone pieces (To 1.0-M)	DS @ 0.25 M		
1.0	0.0- to 1.0-m – γ_t = 1.5 tons/M^3 (N_{avg} ~ 4)	SPT @ 1 M 2/3/3 = 6 Blows		
	RED GRAY FIRM CLAY (To 1.75-M) 1.0- to 1.75-m – C_u = 4 tons/M^2; γ_t = 1.55 tons/M^3 (N_{avg} = 6)	SPT @ 1.75 M 4/7/9 = 16 Blows		+-------+
2.0	BROWN FINE TO MEDIUM SAND with silt (To 4.75-M) (N_{avg} = 16) 1.75- to 2.5-m – ϕ = 32°; γ_t = 1.7 tons/M^3	SPT @ 2.5 M 3/4/7 = 11 Blows		
3.0	2.5- to 3.25-m – ϕ = 30°; γ_t = 1.65 tons/M^3 (N_{avg} = 11)	SPT @ 3.25 M 2/3/4 = 7 Blows		
4.0	3.25- to 4.0-m – ϕ = 27°; γ_t = 1.55 tons/M^3 (N_{avg} = 7) -gray color at 4-m	SPT @ 4 M 1/2/2 = 4 Blows		
5.0	4.0- to 4.75-m – ϕ = 25°; γ_t = 1.5 tons/M^3 (N_{avg} = 4) GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 4.75 M 3/4/6 = 10 Blows		
6.0		SPT @ 5.5 M 4/5/7 = 12 Blows		
7.0	4.75- to 9.0-m – ϕ = 30°; γ_t = 1.6 tons/M^3 (N_{avg} = 10)	SPT @ 6.25 M 4/5/6 = 11 Blows SPT @ 7 M 4/4/5 = 9 Blows		
8.0		SPT @ 8 M 5/5/5 = 10 Blows		
9.0		SPT @ 9 M 7/9/12 = 21 Blows		
10.0	9.0- to 11.5-m – ϕ = 33°; γ_t = 1.75 tons/M^3 (N_{avg} = 21)	SPT @ 10 M 7/9/12 = 21 Blows		
11.0				

CONTINUED ON PLATE 11b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 11a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 10 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan
Final Depth: 27.5-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 11a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 11.5 M 13/14/19 = 33 Blows
12.0		
	11.5- to 13.0-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 33$)	
13.0		SPT @ 13 M 15/17/21 = 38 Blows
	BROWN GRAY SILTY FINE SAND (To 17.5-M)	
	13.0- to 14.5-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 38$)	
14.0		
		SPT @ 14.5 M 26/ 8 cms for 20 Blows
15.0		
16.0	14.5- to 17.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)	SPT @ 16 M 28/ 8 cms for 20 Blows
17.0		
		SPT @ 17.5 M 26/ 6 cms for 15 Blows
	BROWN SILTY FINE TO MEDIUM SAND (To 23.5-M)	1 cm for 5 Blows
18.0		
	17.5- to 18.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	
		SPT @ 19 M 28/ 8 cms for 20 Blows
19.0		
20.0		
	18.5- to 22.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)	SPT @ 20.5 M 8 cms for 20 Blows
21.0		
22.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

CONTINUED ON PLATE 11c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 10 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 27.5-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 11b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN SILTY FINE TO MEDIUM SAND	SPT @ 22.5 M		■ ♦
	(To 23.5-M)	6 cms for 15 Blows		
	-fine to coarse sand with silt at 22.5-m	1 cm for 5 Blows		
23.0	22.5- to 23.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3	(Hammer Rebound)		
	($N_{avg} > 100$)			
	-NX Diamond bit drilling from 23.5-m			
24.0	BROWN GRAY WEATHERED ROCK			
	(Below 23.5-M)	SPT @ 24.5M (SNR)		
	-drilled from 23.5- to 24.5-m in 80 minutes	0.5 cms for 10 Blows		
	-12 cms core pieces recovered drilling to 24.5-m	0 cms for 10 Blows		
25.0	-12% CR and 0% RQD	(Hammer Rebound)		
	-drilled from 24.5- to 25.5-m in 105 minutes			
	-21 cms core pieces recovered drilling to 25.5-m			
	-21% CR and 14% RQD			
26.0	23.5- to 27.5-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3			
	($N_{avg} >> 100$)	SPT @ 26.5M (SNR)		
	-drilled from 25.5- to 26.5-m in 110 minutes	0.5 cms for 10 Blows		
	-18 cms core pieces recovered drilling to 26.5-m	0 cms for 10 Blows		
27.0	-drilled from 26.5- to 27-m in 90 minutes	(Hammer Rebound)		
	-stone pieces recovered drilling to 27-m	SPT @ 27.5M (SNR)		
	-drilled from 27- to 27.5-m in 100 minutes	0 cms for 10 Blows		
28.0		(Hammer Rebound)		
29.0				
30.0				
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 27.5-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 11c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 11 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 28.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	WHITE RED BROWN SILTY FINE TO MEDIUM SAND with rubbish (To 1.75-M)	DS @ 0.25 M		
1.0	0.0- to 1.75-m – γ_t = 2.0 tons/M^3 (N_{avg} = 46)	SPT @ 1 M 18/20/26 = 46 Blows		
		SPT @ 1.75 M 2/2/3 = 5 Blows		
2.0	BROWN SILTY FINE SAND (To 3.0-M) 1.75- to 2.5-m – ϕ = 25°; γ_t = 1.5 tons/M^3 (N_{avg} = 5)	SPT @ 2.5 M 5/5/7 = 12 Blows		
3.0	2.5- to 3.0-m – ϕ = 31°; γ_t = 1.65 tons/M^3 (N_{avg} = 12)	SPT @ 3.25 M 1/1/1 = 2 Blows		
	GRAY VERY SOFT CLAY (To 4.75-M)			
4.0	3.0- to 4.75-m – C_u = 1.0 tons/M^2; γ_t = 1.4 tons/M^3 (N_{avg} = 1.5)	SPT @ 4 M 0/0/1 = 1 Blows		
	silty at 4.75-m	SPT @ 4.75 M 0/1/1 = 2 Blows		
5.0	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)			
	4.75- to 6.25-m – ϕ = 24°; γ_t = 1.4 tons/M^3 (N_{avg} ~ 2)	SPT @ 5.5 M 2/1/2 = 3 Blows		
6.0		SPT @ 6.25 M 5/8/10 = 18 Blows		
7.0		SPT @ 7 M 4/5/7 = 12 Blows		
8.0	6.25- to 10.0-m – ϕ = 31°; γ_t = 1.65 tons/M^3 (N_{avg} = 13)	SPT @ 8 M 4/6/7 = 13 Blows		
9.0		SPT @ 9 M 5/6/8 = 14 Blows		
10.0		SPT @ 10 M 7/9/12 = 21 Blows		
	10.0- to 11.5-m – ϕ = 32°; γ_t = 1.7 tons/M^3 (N_{avg} = 21)			
11.0				

CONTINUED ON PLATE 12b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 12a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 11 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 28.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 12a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 11.5 M 10/13/16 = 29 Blows		
12.0				
	11.5- to 13.0-m – $\phi = 34^o$; $\gamma_t = 1.85$ tons/M^3 ($N_{avg} = 29$)			
13.0		SPT @ 13 M 13/17/23 = 40 Blows		
	GRAY AND BROWN SILTY FINE TO MEDIUM SAND (To 20.0-M)			
	13.0- to 14.5-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 40$)			
14.0				
		SPT @ 14.5 M 15/20/26 = 46 Blows		
15.0				
	14.5- to 16.0-m – $\phi = 36^o$; $\gamma_t = 2.0$ tons/M^3 ($N_{avg} = 46$)			
16.0	-brown color, 16- to 20-m	SPT @ 16 M 25/ 4 cms for 10 Blows		
		4 cms for 10 Blows		
	16.0- to 17.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)			
17.0				
		SPT @ 17.5 M 27/ 6 cms for 15 Blows		
		1 cm for 5 Blows (Hammer Rebound)		
18.0				
	17.5- to 20.0-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 19 M 4 cms for 10 Blows		
19.0		2 cms for 10 Blows (Hammer Rebound)		
20.0				
	BROWN FINE TO MEDIUM SAND with silt (To 24.5-M)	SPT @ 20.5 M 26/ 4 cms for 10 Blows		
		4 cms for 10 Blows		
21.0	20.0- to 22.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)			
22.0				

CONTINUED ON PLATE 12c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 12b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 11 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 30-04-'18 **Ended on:** 3-05-'18 **Field Work In Charge:** R Murugesan

Final Depth: 28.0-M **Depth to G W S:** Not Clear **Remarks:** **Continued from Plate 12b.**

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO MEDIUM SAND with silt (To 24.5-M)	SPT @ 22.5 M 31/ 3 cms for 10 Blows		■ ♦
23.0		2 cms for 10 Blows (Hammer Rebound)		
	22.5- to 24.5-m – $\phi = 38^o$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)			
24.0				
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5M (SNR) 1 cm for 10 Blows		
25.0	**GRAY WEATHERED ROCK (Below 24.5-M)**	1 cm for 10 Blows (Hammer Rebound)		
26.0				
	24.5- to 28.0-m – $\phi = 39^o$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} > 100$)	SPT @ 26.5M (SNR) 0.5 cms for 10 Blows		
27.0	-drilled from 24.5- to 26.5-m in 60 minutes -stone pieces recovered drilling to 26.5-m	0 cms for 5 Blows (Hammer Rebound)		
	-drilled from 26.5- to 27.5-m in 50 minutes			
28.0	-stone pieces recovered drilling to 27.5-m	SPT @ 28 M (SNR) 1 cm for 10 Blows		
	-drilled from 27.5- to 28-m in 80 minutes -14 cms core pieces recovered drilling to 28-m	0 cms for 5 Blows (Hammer Rebound)		
29.0	**Note**:- Bore was terminated at 28-M due to rock movement in the boring that obstructed further drilling activity.			
30.0				
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 28.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 12c

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 12 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** None.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN FINE TO COARSE SAND with silt and rubbish (To 1.0-M)	DS @ 0.25 M		
1.0	0.0- to 1.0-m – γ_t = 1.65 tons/M^3 (N_{avg} ~ 12)	SPT @ 1 M 6/6/4 = 10 Blows		
	BROWN GRAY SILTY FINE TO MEDIUM SAND (To 5.5-M) (N_{avg} = 10)	SPT @ 1.75 M		
2.0	1.0- to 1.75-m – ϕ = 30°; γ_t = 1.6 tons/M^3	1/1/2 = 3 Blows		
		SPT @ 2.5 M 1/3/4 = 7 Blows		
3.0	1.75- to 4.0-m – ϕ = 25°; γ_t = 1.45 tons/M^3	SPT @ 3.25 M		
	(N_{avg} ~ 3)	1/1/2 = 3 Blows		
4.0		SPT @ 4 M 2/4/5 = 9 Blows		
	4.0- to 4.75-m – ϕ = 28°; γ_t = 1.6 tons/M^3 (N_{avg} = 9)	SPT @ 4.75 M		
5.0	4.75- to 5.5-m – ϕ = 24°; γ_t = 1.4 tons/M^3	0/0/1 = 1 Blows		
	(N_{avg} = 1)	SPT @ 5.5 M (SNR) 4/5/6 = 11 Blows		
6.0	**GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)**	SPT @ 6.25 M		
		3/4/6 = 10 Blows		
7.0	5.5- to 8.0-m – ϕ = 29°; γ_t = 1.6 tons/M^3 (N_{avg} = 10)	SPT @ 7 M 2/4/5 = 9 Blows		
8.0		SPT @ 8 M 11/14/16 = 30 Blows		
9.0		SPT @ 9 M 12/13/15 = 28 Blows		
10.0	8.0- to 11.5-m – ϕ = 34°; γ_t = 1.85 tons/M^3 (N_{avg} = 29)	SPT @ 10 M 10/14/16 = 30 Blows		
11.0				

CONTINUED ON PLATE 13b

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 13a

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 12 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 13a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY FINE TO MEDIUM SAND with silt (To 13.0-M)	SPT @ 11.5 M 12/17/23 = 40 Blows		
12.0				
	11.5- to 13.0-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 40$)			
13.0		SPT @ 13 M 17/27/ 4 cms for 10 Blows (Hammer Rebound)		
	GRAY SILTY FINE SAND (To 19.0-M) 13.0- to 14.0-m – $\phi = 36^o$; $\gamma_t = 2.05$ tons/M^3 ($N_{avg} = 65$)			
14.0				
		SPT @ 14.5 M 13/16/24 = 40 Blows		
15.0	14.0- to 16.0-m – $\phi = 35^o$; $\gamma_t = 1.95$ tons/M^3 ($N_{avg} = 40$)			
		SPT @ 16 M 18/27/ 4 cms for 10 Blows (Hammer Rebound)		
16.0				
	16.0- to 17.5-m – $\phi = 36^o$; $\gamma_t = 2.05$ tons/M^3 ($N_{avg} = 65$)			
17.0		SPT @ 17.5 M 30/ 4 cms for 10 Blows (Hammer Rebound)		
18.0	17.5- to 19.0-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 75$)			
		SPT @ 19 M 4 cms for 10 Blows 3 cms for 10 Blows (Hammer Rebound)		
19.0	**BROWN SILTY FINE TO MEDIUM SAND (To 24.5-M)**			
20.0				
	19.0- to 22.5-m – $\phi = 37^o$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} = 100$)	SPT @ 20.5 M 4 cms for 10 Blows 3 cms for 10 Blows (Hammer Rebound)		
21.0				
22.0				

CONTINUED ON PLATE 13c.

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 13b

LOG OF BORING

Project: Proposed Market of India Project Site, SPR City, No. 1, Cooks Road, Perambur, Chennai 600 012, TN.

Bore Hole No.: 12 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm

Started on: 4-05-'18 **Ended on:** 7-05-'18 **Field Work In Charge:** Y Saravanan

Final Depth: 30.0-M **Depth to G W S:** Not Clear **Remarks:** Continued from Plate 13b.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN SILTY FINE TO MEDIUM SAND (To 24.5-M)	SPT @ 22.5M (SNR) 1.5 cms for 10 Blows		
23.0		1 cm for 10 Blows (Hammer Rebound)		
	22.5- to 24.5-m – $\phi = 38^{o}$; $\gamma_t = 2.25$ tons/M^3			
24.0	($N_{avg} > 100$)			
	-NX Diamond bit drilling from 24.5-m	SPT @ 24.5M (SNR) 0.5 cms for 10 Blows		
25.0	BROWN GRAY WEATHERED ROCK (Below 24.5-M)	0 cms for 10 Blows (Hammer Rebound)		
	-drilled from 24.5- to 25.5-m in 65 minutes			
26.0	-32 cms core pieces recovered drilling to 25.5-m -32% CR and 10% RQD			
	-drilled from 25.5- to 26.5-m in 100 minutes	SPT @ 26.5M (SNR) 0.5 cms for 10 Blows		
27.0	-stone pieces recovered drilling to 26.5-m	0 cms for 10 Blows (Hammer Rebound)		
	-drilled from 26.5- to 27.5-m in 60 minutes			
28.0	-stone pieces recovered drilling to 27.5-m 24.5- to 30.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3			
	($N_{avg} >> 100$) -drilled from 27.5- to 28.5-m in 75 minutes	SPT @ 28.5M (SNR) 0.5 cms for 10 Blows		
29.0		0 cms for 10 Blows (Hammer Rebound)		
30.0	-drilled from 28.5- to 30-m in 70 minutes	SPT @ 30 M (SNR) 0.5 cms for 10 Blows		
	-stone pieces recovered drilling to 30-m	0 cms for 10 Blows (Hammer Rebound)		
31.0				
32.0				
33.0				

BORE HOLE TERMINATED AT 30.0-M

SPT=Standard Penetration Test; DS=Disturbed Sample; UDS = UnDisturbed Sample; WS=Water Sample; SNR=Sample Not Recovered; LS = Liner Sample; +----+ = Plastic and Liquid Limits; ♦ = N M C; ■ = % -75μ Size

PLATE 13c

SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
1	0.25	5			11					
	1.0	16			6	26	17	9	42	SP
	1.75	SNR								
	2.5a	16			6	60	30	4	0	SP
	2.5b	25	22	58						CH
	3.25	28			25	69	5	1	0	SM
	4.0	47	24	74						CH
	4.75	30	18	45						CL
	5.5	51	36	72						CH
	6.25	30			18	72	1	0	0	SM
	7.0	13			8					
	8.0	11			6	56	35	3	0	SP
	9.0	13			8					
	10.0	14			11	69	20	0	0	SP-SM
	11.5	13			22					
	13.0	16			28	69	3	0	0	SM
	14.5	18			23					
	16.0	19			20	63	16	1	0	SM
	17.5	15			23					
	19.0	13			11	59	26	4	0	SP-SM
	20.5	24			9					
	22.5	11			10	39	41	8	2	SP-SM
	24.5	12			6	32	36	17	9	SP
	26.5	5	stone	pieces						
	28.5	SNR	rock	core						
	30.0	SNR	rock	core						
2	0.25	14			16					
	1.0	16			27	65	8	0	0	SM
	1.75	22	18	47						CL
	2.5a	30	30	69						CH
	2.5b	18			8	73	19	0	0	SP
	3.25	28			19	70	11	0	0	SM
	4.0	68	32	79						CH
	4.75	52	25	78						CH
	5.5	30			18	68	14	0	0	SM
	6.25	36			16	63	20	1	0	SM
	7.0	28			14					
	8.0	14			8	67	25	0	0	SP
	9.0	12			7					
	10.0	11			6	51	39	4	0	SP
	11.5	7			27					
	13.0	13			19	54	8	4	15	SM
	14.5	15			28					
	16.0	16			18	59	20	3	0	SM
	17.5	12			14					
	19.0	13			14	51	31	4	0	SM
	20.5	13			11					
	22.5	12			6	53	34	7	0	SP
	24.5	13			6	54	35	4	1	SP
	26.5	SNR	rock	core						
	28.5	SNR	rock	core						
	30.0	SNR	rock	core						
3	1.25	6			14					
	2.0	38	28	72						CH
	2.75	20			11	73	16	0	0	SP-SM
	3.5	72	38	88						CH

PLATE 14a

SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
3	4.25	45			19	69	12	0	0	SM
	5.0	32			17	66	17	0	0	SM
	5.75	27			15					
	6.5	32			16	68	16	0	0	SM
	7.25	16			14	64	22	0	0	SM
	8.0	16			10					
	9.0	12			10	72	18	0	0	SP-SM
	10.0	12			8					
	11.0	11			12	68	20	0	0	SM
	12.5	14			30					
	14.0	17			28	58	9	1	4	SM
	15.5	15			24					
	17.0	10			19	52	23	3	3	SM
	18.5	14			21					
	20.0	14			7	61	25	5	2	SP
	21.5	14			10					
	23.5	13			9	62	22	3	4	SP-SM
	25.5	SNR								
	27.5	SNR	rock	core						
	28.85	SNR	rock	core						
4	0.25	6			12					
	1.0	28	29	60						CH
	1.75	38	28	71						CH
	2.5	31	21	44						CL
	3.25	59	34	81						CH
	4.0	58	32	70						CH
	4.75	26			16	67	16	1	0	SM
	5.5	25			16					
	6.25	30			9	71	20	0	0	SP-SM
	7.0	16			10					
	8.0	19			8	63	28	1	0	SP
	9.0	12			6					
	10.0	13			7	52	37	4	0	SP
	11.5	14			25					
	13.0	17			20	75	5	0	0	SM
	14.5	16			26					
	16.0	15			15	61	23	1	0	SM
	17.5	14			14					
	19.0	13			8	45	41	5	1	SP
	20.5	15			7					
	22.5	13			7	37	40	9	7	SP
	24.5	13			13	59	25	3	0	SM
	26.5	SNR								
	28.5	SNR	rock	core						
	30.0	SNR	rock	core						
5	0.25	8			11					
	1.0	31			14	73	13	0	0	SM
	1.75	31	23	58						CH
	2.5	29	21	61						CH
	3.25	53	33	83						CH
	4.0	53			14	76	10	0	0	SM
	4.75	21			16					
	5.5	28			11	67	22	0	0	SP-SM
	6.25	16			14	63	22	1	0	SM
	7.0	14			10					
	8.0	13			8	58	32	1	1	SP

PLATE 14b

SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
5	9.0	12			6					
	10.0	12			7	54	37	2	0	SP
	11.5	11			32					
	13.0	22			24	74	2	0	0	SM
	14.5	18			8					
	16.0	15			26	56	16	2	0	SM
	17.5	14			15					
	19.0	12			12	58	26	4	0	SM
	20.5	12			11					
	22.5	13			7	51	36	6	0	SP
	24.5	SNR								
	26.5	SNR	rock	core						
	28.5	SNR	rock	core						
6	0.25	7			8					
	1.0	21	16	50						CH
	1.75	30	26	41						CL
	2.5	12			18	63	17	2	0	SM
	3.25	43	34	77						CH
	4.0	36	30	55						CH
	4.75	25			14	67	19	0	0	SM
	5.5	26			11					
	6.25	29			12	67	21	0	0	SM
	7.0	17			9					
	8.0	18			8	57	33	2	0	SP
	9.0	12			6					
	10.0	13			8	52	38	2	0	SP
	11.5	8			18					
	13.0	19			14	76	10	0	0	SM
	14.5	20			28					
	16.0	20			24	58	8	1	9	SM
	17.5	22			26	60	11	1	2	SM
	19.0	SNR								
	20.5	SNR								
	22.5	14			12	46	33	7	2	SM
	24.5	23			14	62	14	10	0	SM
	26.5	SNR								
	28.5	SNR	rock	core						
	30.0	SNR	rock	core						
7	0.25	4			14					
	1.0	21			16	60	20	4	0	SM
	1.75	34	17	36						CL
	2.5	36	20	49						CL
	3.25	30	28	58						CH
	4.0	46	26	54						CH
	4.75	25			13	49	22	4	12	SM
	5.5	24			23					
	6.25	15			10	67	22	1	0	SP-SM
	7.0	13			8					
	8.0	12			7	51	39	3	0	SP
	9.0	13			3					
	10.0	10			6	41	47	6	0	SP
	11.5	10			7					
	13.0	20			33	61	5	1	0	SM
	14.5	16			27					
	16.0	15			14	66	19	1	0	SM
	17.5	13			14					

PLATE 14c

SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
7	19.0	15			12	61	24	3	0	SM
	20.5	13			6					
	22.5	14			6	54	34	6	0	SP
	24.5	10			10	44	23	11	12	SP-SM
	26.5	SNR								
	28.5	SNR	rock	core	pieces					
	29.15	SNR	rock	core	pieces					
8	0.25	15			7					
	1.0	32	30	73						CH
	1.75	24	20	64						CH
	2.5	23			19	67	11	1	2	SM
	3.25	10			9					
	4.0	19			14	70	16	0	0	SM
	4.75	28			12					
	5.5	53			16	71	13	0	0	SM
	6.25	22			12	76	12	0	0	SM
	7.0	13			7					
	8.0	14			11	62	26	1	0	SP-SM
	9.0	12			8					
	10.0	13			12	61	26	1	0	SM
	11.5	18			17					
	13.0	21			35	60	4	1	0	SM
	14.5	21			27					
	16.0	15			26	56	14	2	2	SM
	17.5	14			13					
	19.0	13			17	57	24	2	0	SM
	20.5	15			8					
	22.5	14			8	55	33	4	0	SP
	24.5	13			8	36	44	9	3	SP
	26.5	13			18	46	24	12	0	SM
	28.5	SNR	stone	pieces						
	30.0	SNR	rock	core	pieces					
9	0.25	2			7					
	1.0	31	16	56						CH
	1.75	31	21	53						CH
	2.5	40	27	67						CH
	3.25	45								
	4.0	68	31	63						CH
	4.75	19			16	69	15	0	0	SM
	5.5	34			10					
	6.25	20			9	70	21	0	0	SP-SM
	7.0	14			9					
	8.0	14			7	65	27	1	0	SP
	9.0	17			9					
	10.0	14			8	69	23	0	0	SP
	11.5	11			8					
	13.0	17			26	56	10	8	0	SM
	14.5	17			27					
	16.0	18			28	55	14	1	2	SM
	17.5	13			16					
	19.0	14			20	58	20	2	0	SM
	20.5	SNR								
	22.5	14			5	30	36	17	12	SP
	24.5	12			7					
	26.5	16			13	50	26	7	4	SM

PLATE 14d

SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
9	28.5	9			6	39	31	16	8	SP
	30.0	SNR	stone	pieces						
10	0.25	7			15					
	1.0	20	26	45						CL
	1.75	18			11	71	18	0	0	SP-SM
	2.5	15			10	73	17	0	0	SP-SM
	3.25	17			14					
	4.0	20			11	65	23	1	0	SP-SM
	4.75	21			8					
	5.5	17			7	69	24	0	0	SP
	6.25	17			7	68	25	0	0	SP
	7.0	17			8					
	8.0	17			6	67	27	0	0	SP
	9.0	16			9					
	10.0	15			9	48	37	4	2	SP-SM
	11.5	16			9					
	13.0	14			33	64	3	0	0	SM
	14.5	22			34					
	16.0	25			32	67	1	0	0	SM
	17.5	15			17					
	19.0	21			25	46	23	4	2	SM
	20.5	26			21					
	22.5	14			6	37	43	11	3	SP
	24.5	SNR	rock	core	pieces					
	26.5	SNR	rock	core	pieces					
	27.5	SNR	stone	pieces						
11	0.25	8			14					
	1.0	30			9	40	19	5	27	SP-SM
	1.75	29			17					
	2.5	21			10	87	3	0	0	SP-SM
	3.25	59	32	68						CH
	4.0	46	23	43						CL
	4.75	18			13	68	18	1	0	SM
	5.5	18			7					
	6.25	18			8	60	30	2	0	SP
	7.0	16			7					
	8.0	16			8	60	31	1	0	SP
	9.0	18			7					
	10.0	12			6	58	34	2	0	SP
	11.5	15			6					
	13.0	14			18	74	8	0	0	SM
	14.5	18			18					
	16.0	16			17	64	16	3	0	SM
	17.5	19			21					
	19.0	11			14	58	25	3	0	SM
	20.5	14			5					
	22.5	14			6	35	44	11	4	SP
	24.5	SNR								
	26.5	SNR	stone	pieces						
	28.0	SNR	rock	core	pieces					
12	0.25	7			9					
	1.0	50			19	49	19	4	9	SM
	1.75	25			12					
	2.5	20			11	76	13	0	0	SP-SM
	3.25	7			14					
	4.0	29			14	73	13	0	0	SM

PLATE 14e

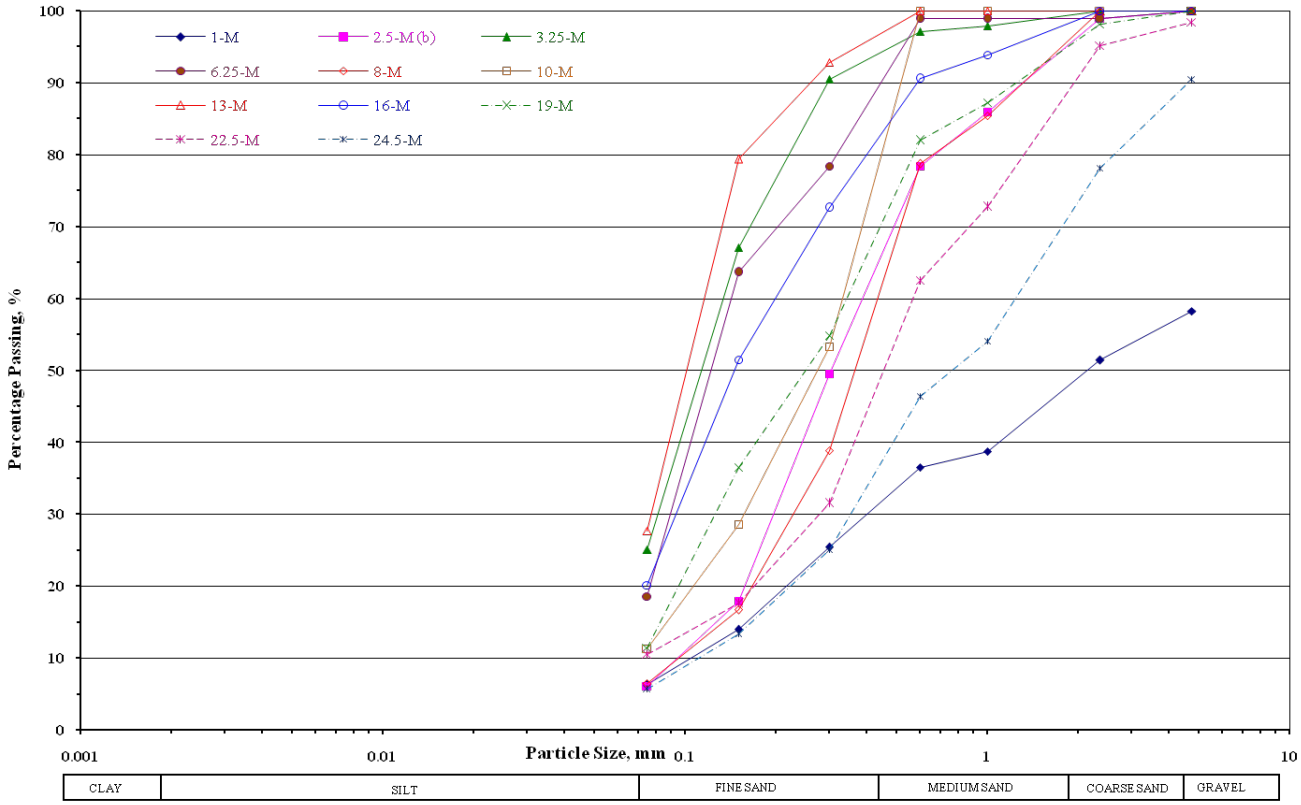
SUMMARY OF TEST RESULTS

Boring	Depth,	w %	PL	LL	-75μ%	SAND			GRAVEL	IS
No.	M					Fine%	Medium%	Coarse%	%	CLASS.
12	4.75	44			15	68	17	0	0	SM
	5.5	SNR								
	6.25	16			9	70	21	0	0	SP-SM
	7.0	17			8					
	8.0	16			7	52	38	3	0	SP
	9.0	14			9					
	10.0	14			7	57	33	3	0	SP
	11.5	13			6					
	13.0	23			27	71	2	0	0	SM
	14.5	21			30					
	16.0	20			27	72	1	0	0	SM
	17.5	20			25					
	19.0	18			16	58	23	3	0	SM
	20.5	14			15	53	27	3	2	SM
	22.5	SNR								
	24.5	SNR								
	26.5	SNR	rock	core	pieces					
	28.5	SNR	stone	pieces						
	30.0	SNR	stone	pieces						

FREE SWELL INDEX TEST RESULTS

BORE NO.	DEPTH, M	FREE SWELL INDEX, %
1	**2.5a**	**183**
	4.0	**143**
2	**1.75**	**107**
	2.5	**157**
	4.0	**78**
3	**1.0**	**217**
	2.5	**144**
4	**1.0**	**125**
	1.75	**138**
	2.5	**150**
	3.25	**113**
5	**1.75**	**100**
	2.5	**240**
	3.25	**125**
6	**1.0**	**100**
	1.75	**190**
	3.25	**83**
7	**1.75**	**191**
	2.5	**150**
	3.25	**230**
8	**1.0**	**171**
	1.75	**100**
9	**1.0**	**167**
	1.75	**143**
	2.5	**150**
	3.25	**183**
10	**1.0**	**133**
11	**3.25**	**138**
	4.0	**143**

Grain Size Distribution Curves
Boring 1



Grain Size Distribution Curves
Boring 2

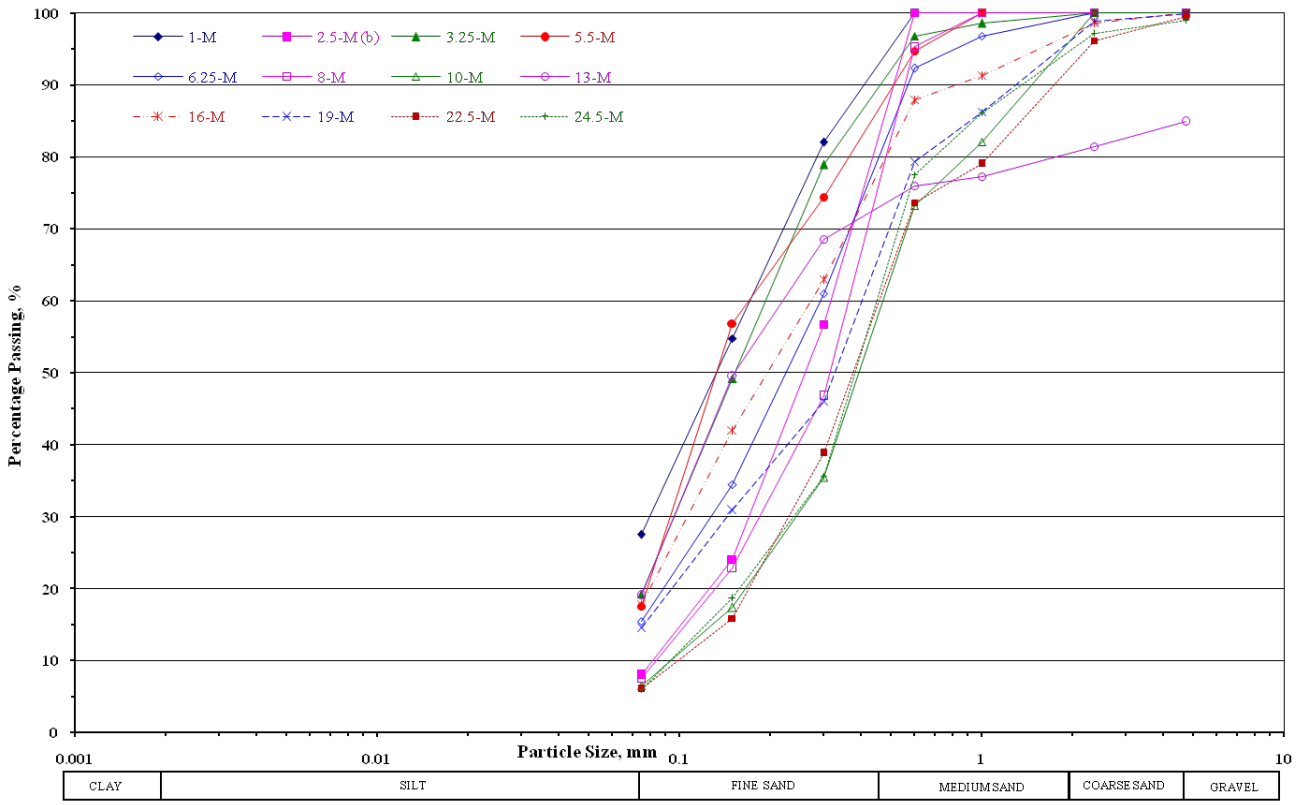
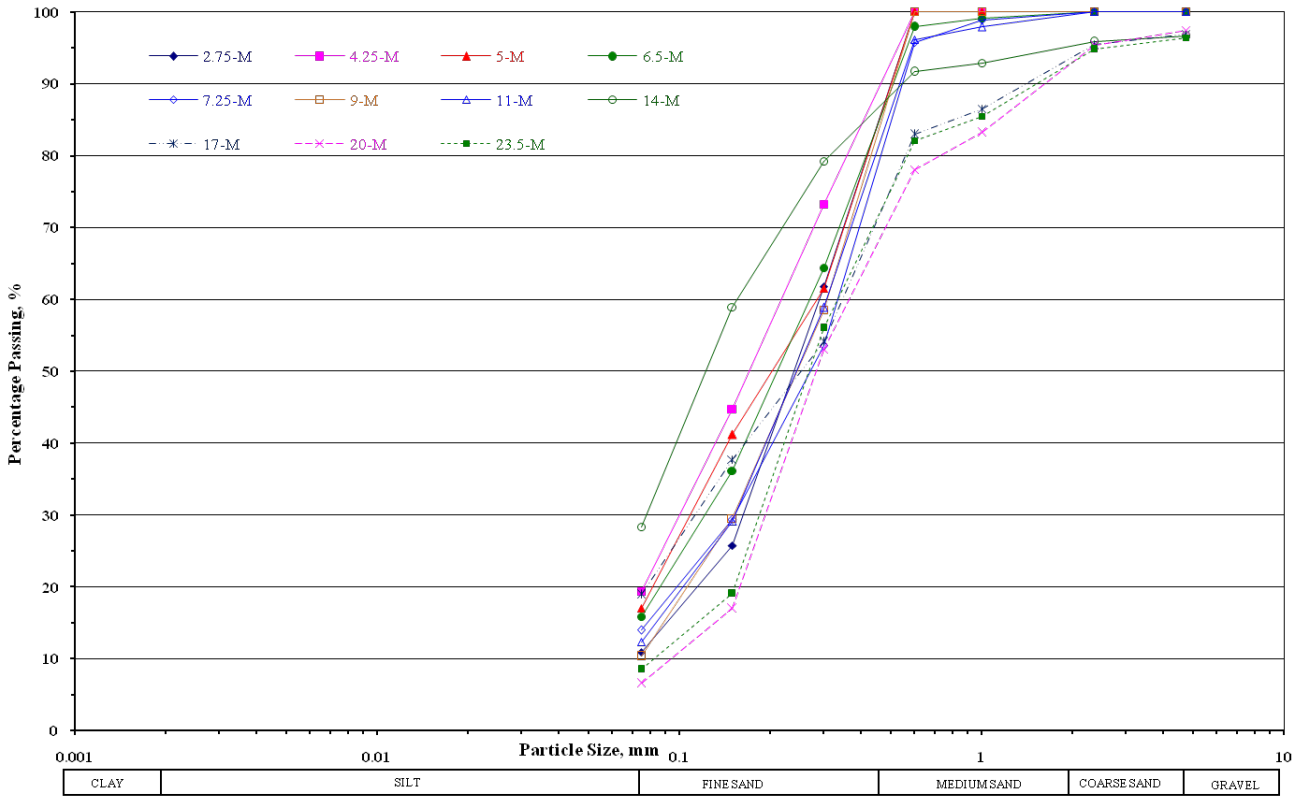


PLATE 15a

Grain Size Distribution Curves
Boring 3



Grain Size Distribution Curves
Boring 4

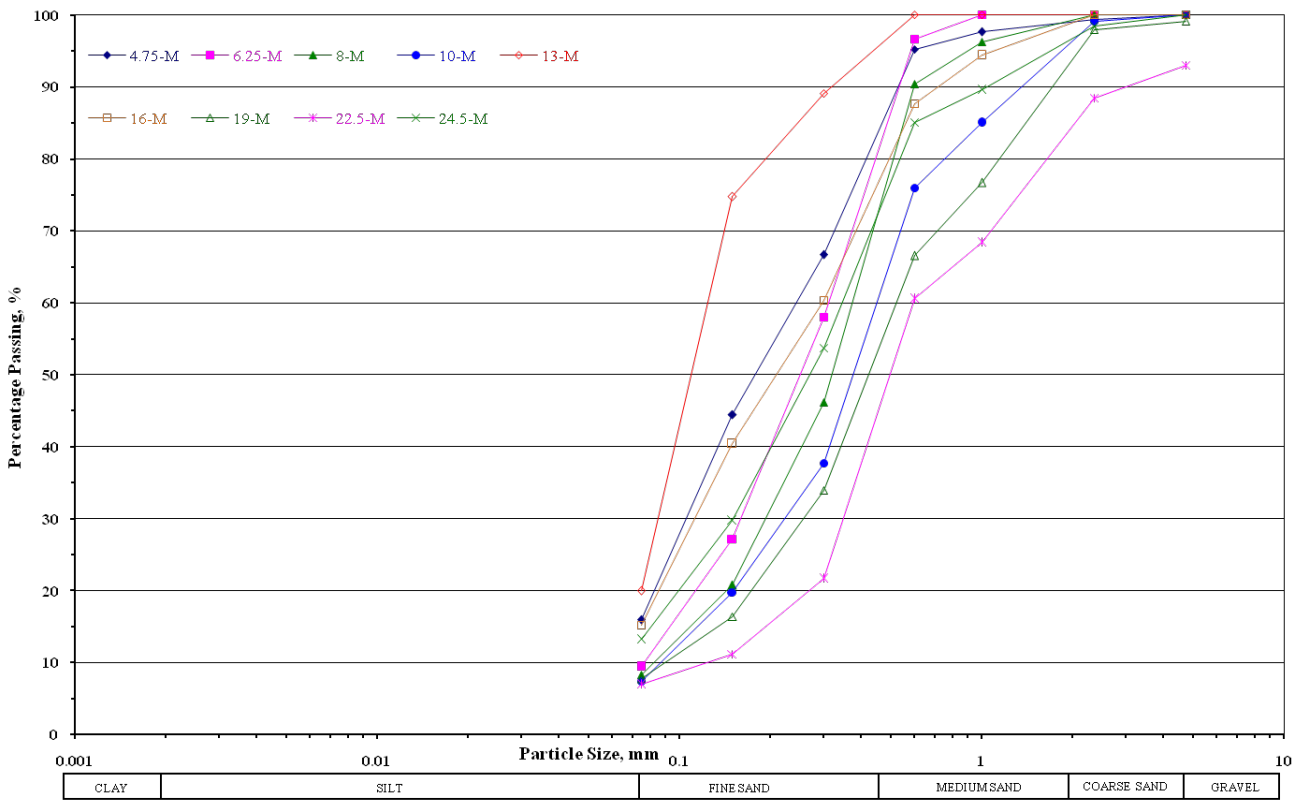
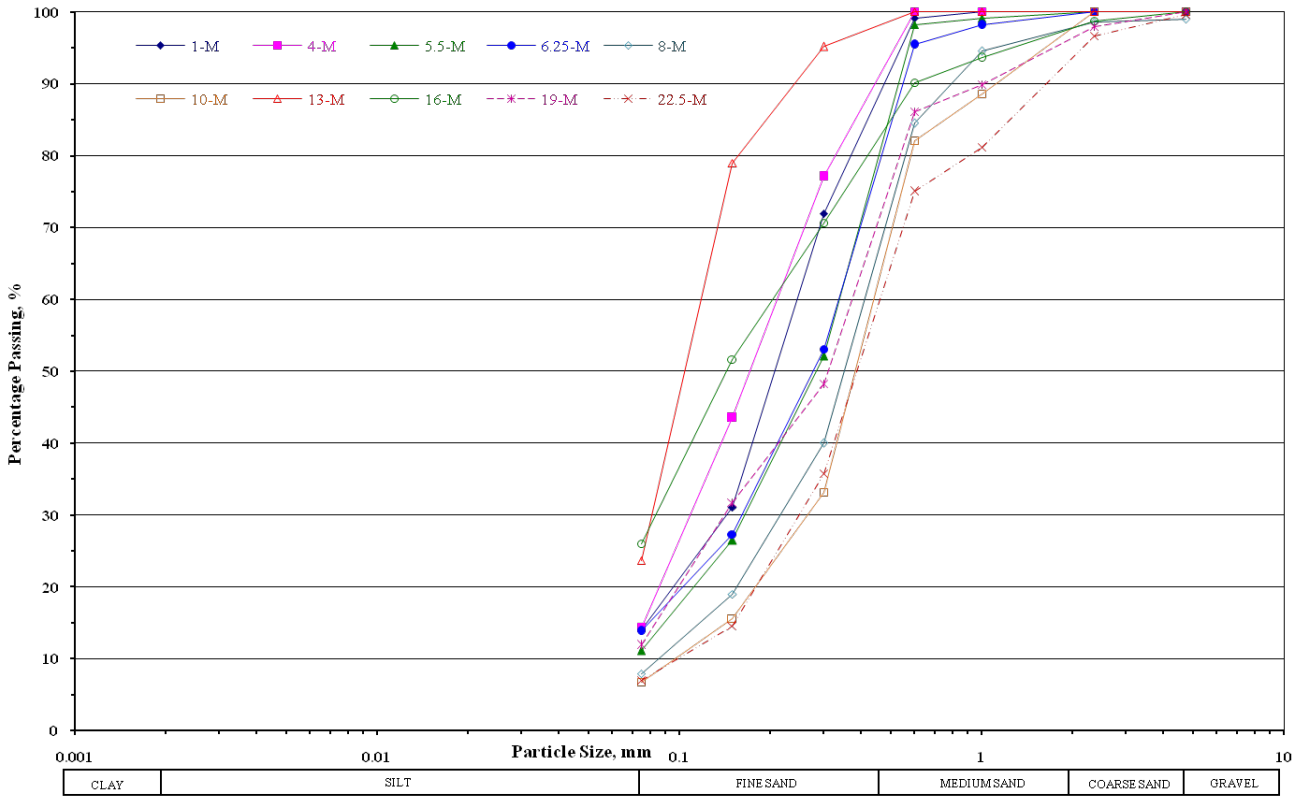


PLATE 15b

Grain Size Distribution Curves
Boring 5



Grain Size Distribution Curves
Boring 6

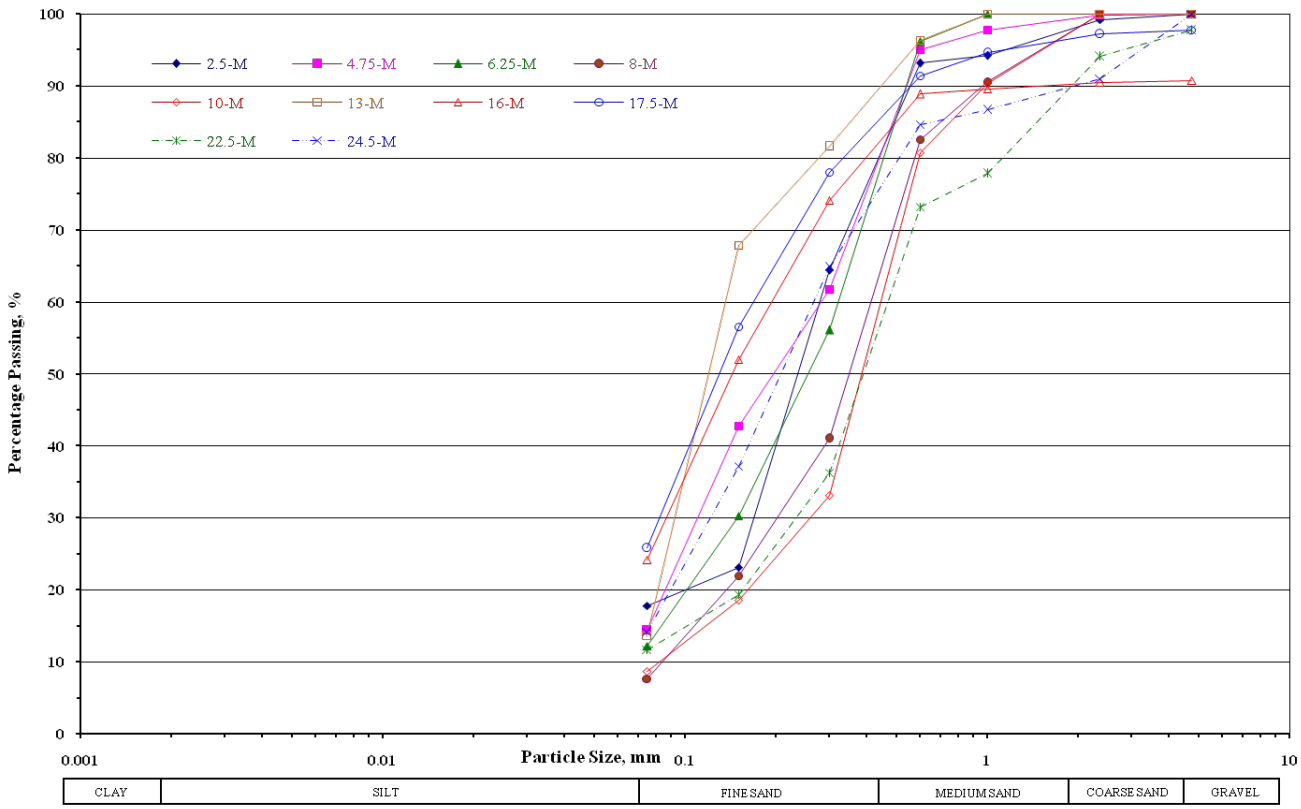
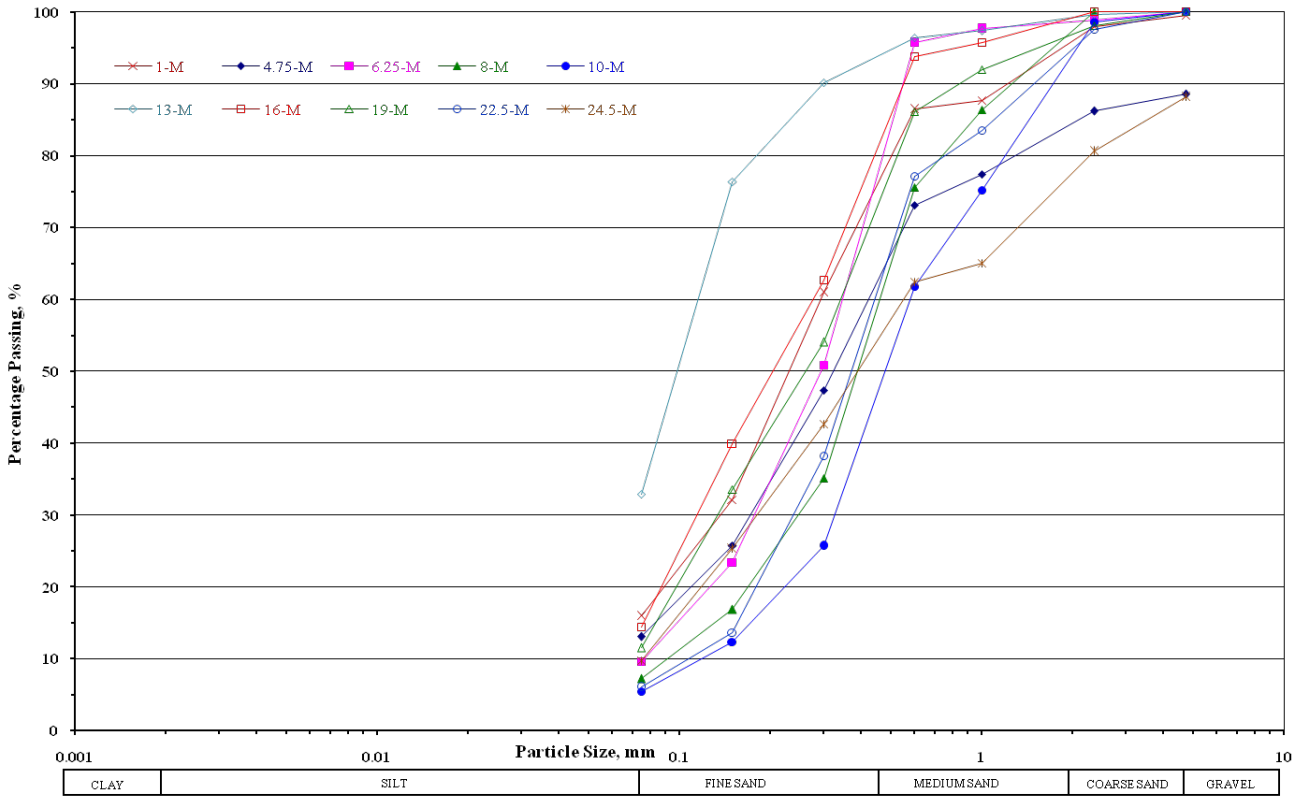


PLATE 15c

Grain Size Distribution Curves
Boring 7



Grain Size Distribution Curves
Boring 8

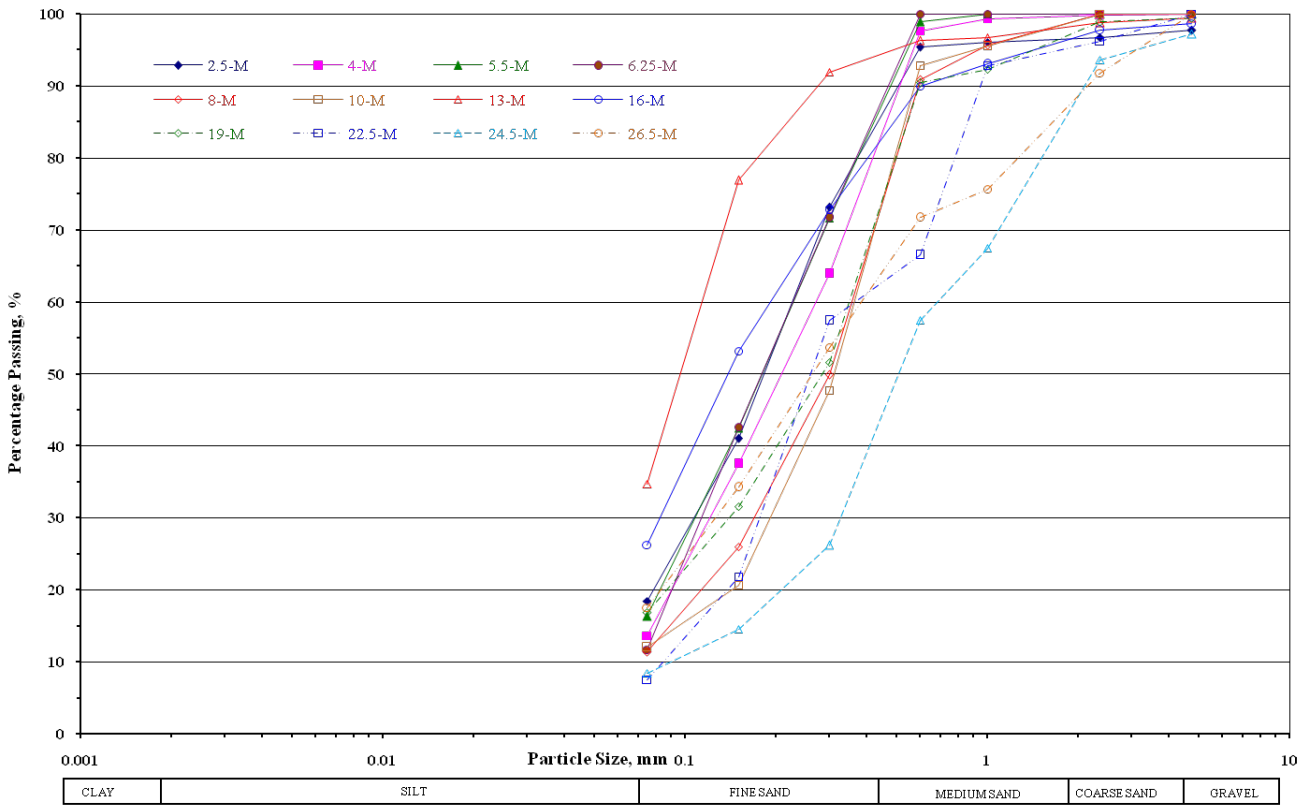
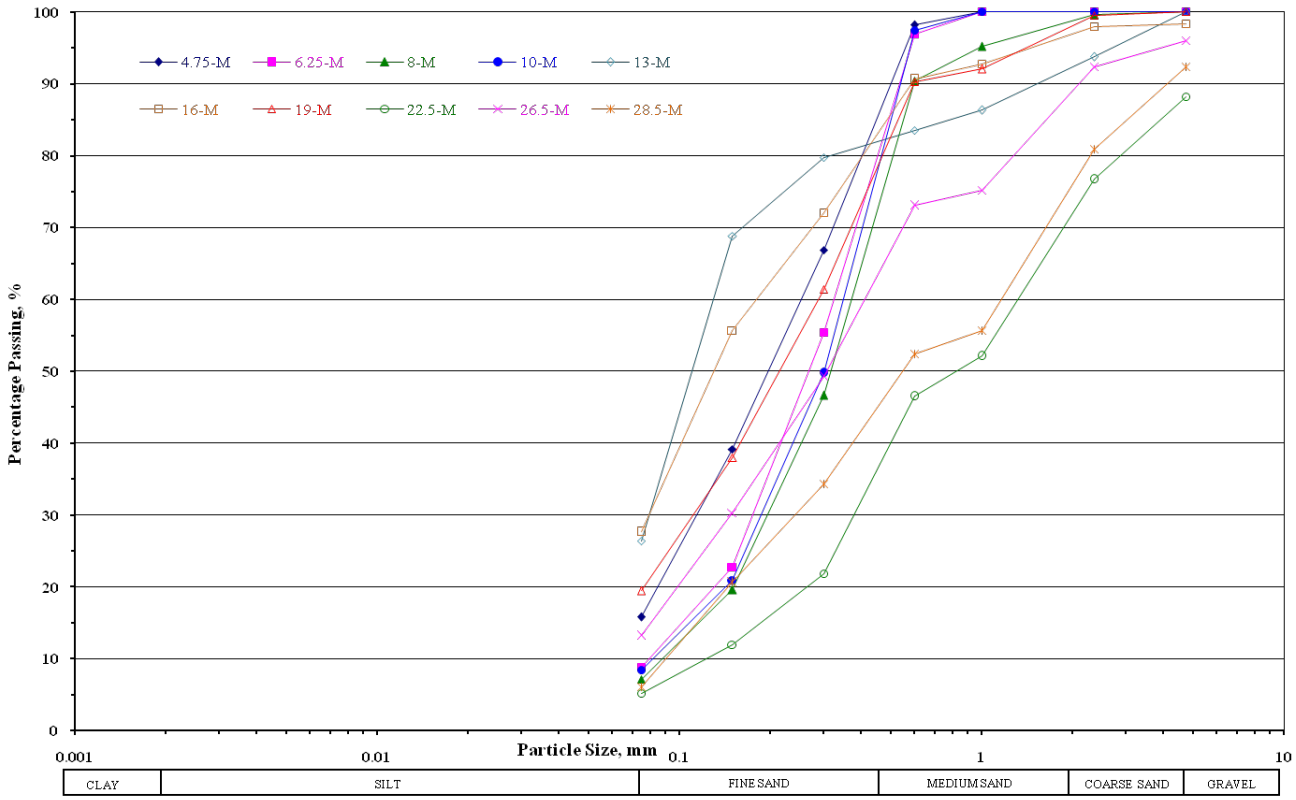


PLATE 15d

Grain Size Distribution Curves
Boring 9



Grain Size Distribution Curves
Boring 10

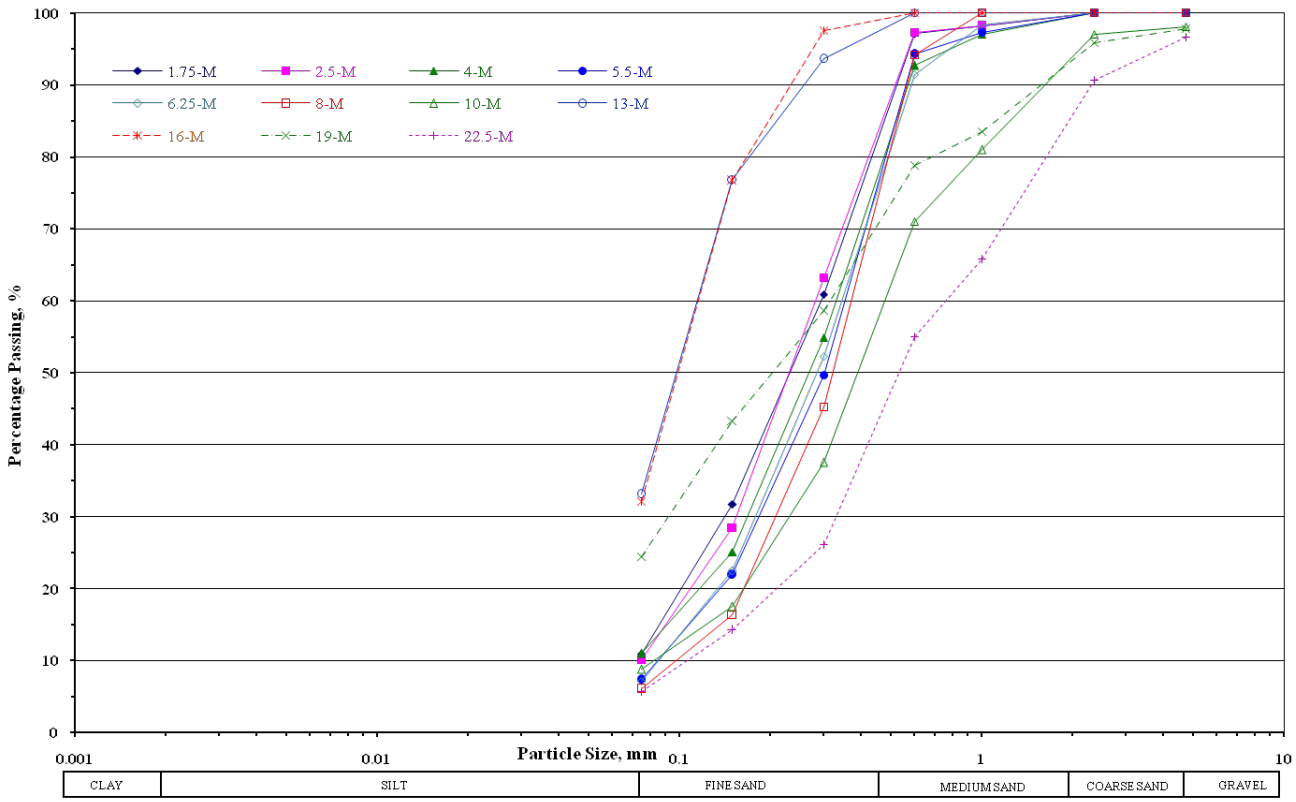
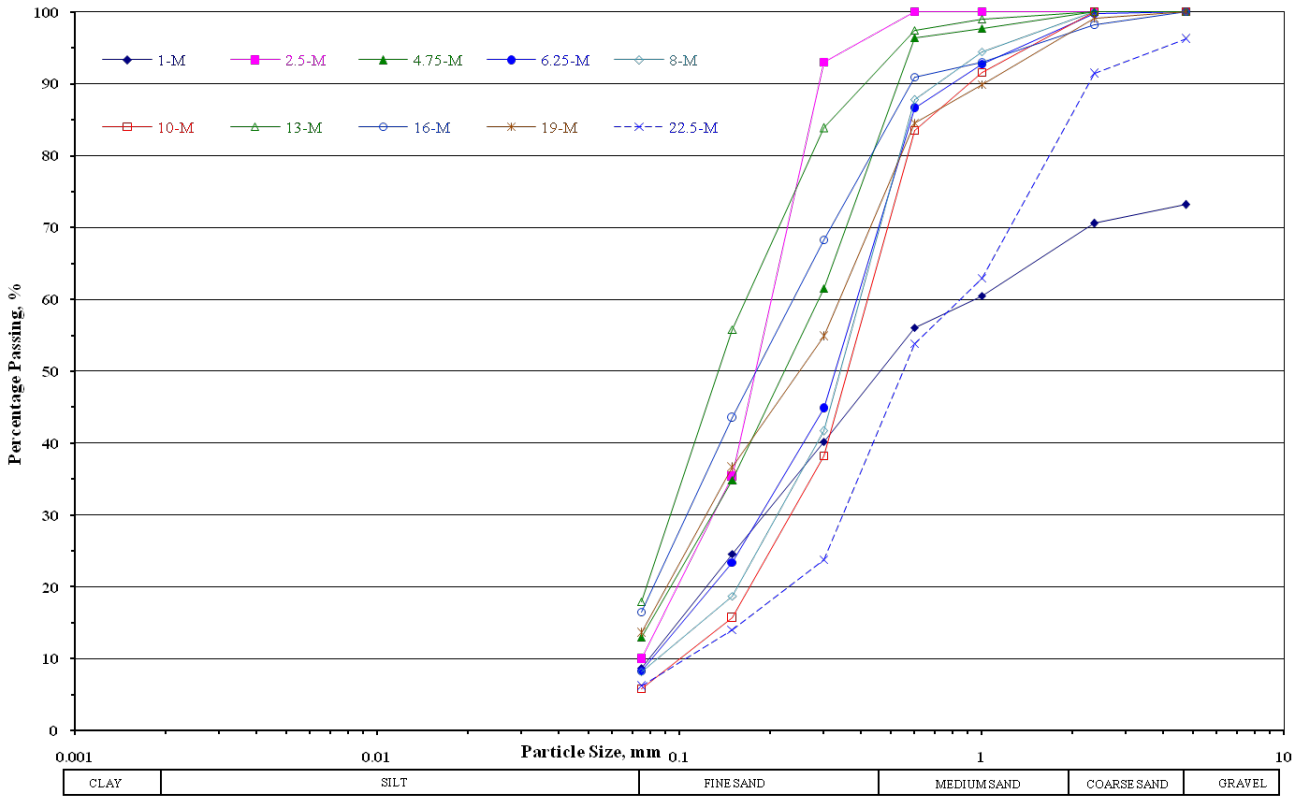


PLATE 15e

Grain Size Distribution Curves
Boring 11



Grain Size Distribution Curves
Boring 12

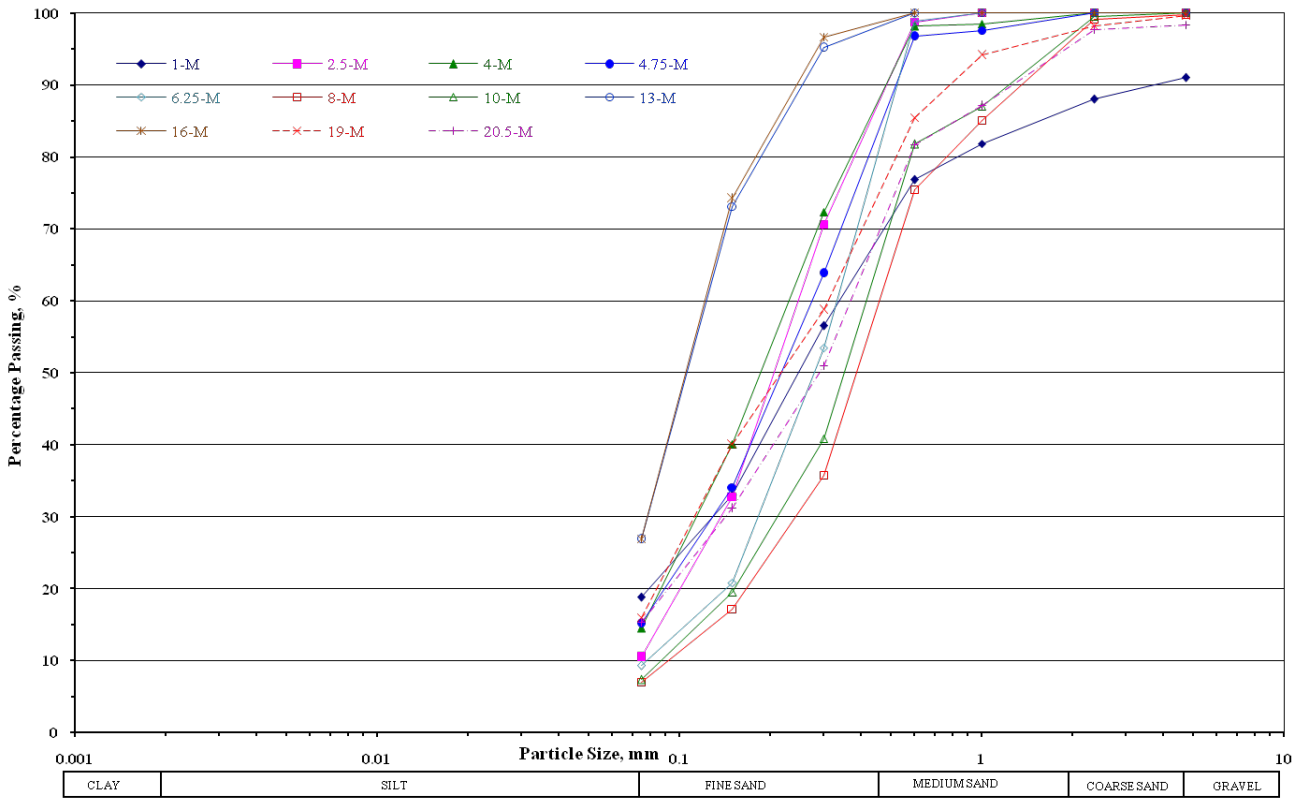


PLATE 15f

SUMMARY OF WATER TEST RESULTS

NEAR BY BORE WELL; DEPTH = UNKNOWN

DISATNCE FROM BORING 1 = 51.5-M; WATER LEVEL = UNKNOWN.

S. No.		Description	Results Obtained	As per IS:456 – 2000
1		To neutralize 100 cc of water using phenolphthalein as indicator	0.4 ml	Not more than 5 ml of 0.02N NaOH
2		To neutralize 100 cc of water using methyl orange as indicator	42.5 ml	Not more than 25 ml of 0.02N H_2SO_4
3	a	Organic Solids, mg/liter	120	200 Max.
	b	Inorganic Solids, mg/liter	3,102	3,000 Max.
	c	Sulphates as SO_3, mg/liter	342	400 Max.
	d	Chlorides as Cl, mg/liter	1,092	2,000 Max. - Plain Concrete 500 Max. RCC
	e	Suspended Solids, mg/liter	0	2,000 Max.
	f	Ph	7.33	6 Min.

Remarks: The sample does not meet the requirements of above clauses 2 and 3d (for used in RCC). Water cannot be used for construction purposes as per IS 456 - 2000.

SAMPLE CALCULATIONS FOR DMC BORED CAST IN SITU PILES.

PILE CAPACITY CALCULATIONS - By IS : 2911 (Part I / Sec. 2) - 2010 Method.

PROPOSED "MARKET OF INDIA PHASE - II" SITE

No. 1, Cooks Road, Old Binny Mills, Perambur, Chennai 600 012, TN.

Bored Cast In-Situ Pile Details:

Total Pile Length = **26.50 M** below EGL

Top Pile Cutoff Length = 12.50 M Top pile cutoff length for basement floor and pilecaps

Pile Effective Concreting Length = 14.00 M

Pile Diameters Considered: **0.60 0.75 0.90 1.00 1.20 -M.**

Design Soil Profile Used in the Pile Capacity Calculations (Boring 5 Data)

S.No.	Soil Description	From	To	N_{avg}	C_u, T/M^2	ϕ^0	γ_T, T/M^3
1	Brown Silty F to M Sand with ….	0.00	1.75	5			1.55
2	Gray Brown Firm Clay	1.75	3.00	5.5	3.00		1.55
3	Gray Very Soft Clay	3.00	4.50	0	0.50		1.35
4a	Gray Silty F to M Sand	4.50	5.50	1		23	1.35
4b	Gray Silty F to M Sand	5.50	6.25	3		24	1.45
4c	Gray Silty F to M Sand	6.25	8.00	12		30	1.65
5a	Gray Green F to M Sand with Silt	8.00	9.00	26		33	1.80
5b	Gray Green F to M Sand with Silt	9.00	11.00	42		36	2.00
6a	Brown Gray Green Silty F to M Sand	11.00	12.50	27		34	1.85
6b	Brown Gray Green Silty F to M Sand	12.50	14.50	18		32	1.70
6c	Brown Gray Green Silty F to M Sand	14.50	16.00	46		36	2.00
6d	Brown Gray Green Silty F to M Sand	16.00	19.00	> 75		37	2.10
6e	Brown Gray Green Silty F to M Sand	19.00	22.00	> 100		38	2.20
6f	Brown Gray Green Silty F to M Sand	22.00	24.50	> 75		37	2.10
7a	Brown White Bluw Weathered Rock	24.50	26.50	> 100		38	2.20

For Cohesive Soils :-

C_u	α
0.50	1.00
3.00	1.00

Pile Capacity Calculations by IS : 2911 (Part I / Sec. 2) Method.

Unit Skin Friction in Clay Soils, f_s = αC_u

Unit Skin Friction in Sand Soils, f_s = $\sigma' K_o \tan\delta$ K_o = 1.25

Skin Friction of the Each Strata, Q_{si} = $f_s * \pi D L_i$

Total Ult. Skin Frition, $Q_{s\ ult}$ = ΣQ_{si}

Unit End Bearing in Clay Soils, q_{ult} = $9C_u$

Unit End bearing in Sand Soils, q_{ult} = $\sigma' N_q + 0.5 D \gamma N_\gamma$

Ultimate End Bearing, $Q_{p\ ult}$ = $q_{ult} * \pi D^2/4$

Total Ultmate Pile Capacity, Q_{ult} = $Q_{s\ ult} + Q_{p\ ult}$

Allowable Pile Capacity, Q_{all} = Q_{ult}/FS FS = Factor of Safety = **2.50**

COMPRESSIVE PILE CAPACITY CALCULATIONS

Skin Friction Calculations

S.No.	Soil Description	From	To	ϕ^0 / C_u	$\delta = \phi$	γ'_s, T/M^3	σ'_{Mid},T/M^2	f_s,T/M^2	Pile Dia 0.60 Q_s, T	0.75 Q_s, T	0.90 Q_s, T	1.00 Q_s, T	1.20 Q_s, T	-M.
1	Brown Silty F to M Sand with ….	0.00	1.75	0	0	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Cutoff for
2	Gray Brown Firm Clay	1.75	3.00	3.00	3	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Basement
3	Gray Very Soft Clay	3.00	4.50	0.50		0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Floors
4a	Gray Silty F to M Sand	4.50	5.50	23	23	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4b	Gray Silty F to M Sand	5.50	6.25	24	24	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4c	Gray Silty F to M Sand	6.25	8.00	30	30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5a	Gray Green F to M Sand with Silt	8.00	9.00	33	33	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5b	Gray Green F to M Sand with Silt	9.00	11.00	36	36	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6a	Brown Gray Green Silty F to M Sand	11.00	12.50	34	34	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6b	Brown Gray Green Silty F to M Sand	12.50	14.50	32	32	0.70	0.70	0.55	2.06	2.58	3.09	3.44	4.12	
6c	Brown Gray Green Silty F to M Sand	14.50	16.00	36	36	1.00	2.15	1.95	5.52	6.90	8.28	9.20	11.05	
6d	Brown Gray Green Silty F to M Sand	16.00	19.00	37	37	1.10	4.55	4.29	24.24	30.31	36.37	40.41	48.49	
6e	Brown Gray Green Silty F to M Sand	19.00	22.00	38	38	1.20	8.00	7.81	44.20	55.25	66.29	73.66	88.39	
6f	Brown Gray Green Silty F to M Sand	22.00	24.50	37	37	1.10	11.18	10.53	49.62	62.03	74.43	82.70	99.24	
7a	Brown White Bluw Weathered Rock	24.50	26.50	38	38	1.20	13.75	13.43	50.64	63.30	75.96	84.40	101.28	
								Net Total Ultimate Skin Friction, $Q_{s\,ult}$=	176.29	220.36	264.43	293.82	352.58	

@ 25-M below Existing G. L. Soil
Formation - Weathered Rock
L/D of Pile = 20.5/0.60 > 20
L/D of Pile = 20.5/0.75 > 20
L/D of Pile = 20.5/0.90 < 20
L/D of Pile = 20.5/1.00 < 20
L/D of Pile = 20.5/1.20 < 20
Use Lim. Value or Actual σ'_{base}

N = > 100
N_q = 72
N_γ = 68

		0.60	0.75	0.90	1.00	1.20	-M
	Base A=	0.2829	0.4420	0.6364	0.7857	1.1314	-M^2
	σ'_{base} =	12.55	14.95	14.95	14.95	14.95	T/M^2
	$q_{b\,ult}$ =	928.08	1107.00	1113.12	1117.20	1125.36	T/M^2
Limited to	**$q_{b\,ult}$ =**	**900.00**	**900.00**	**900.00**	**900.00**	**900.00**	**T/M^2**
	$Q_{b\,ult}$ =	254.57	397.77	572.79	707.14	1018.29	Tons
	$Q_{s\,ult}$ =	176.29	220.36	264.43	293.82	352.58	Tons
	$Q_{tot\,ult}$=	430.86	618.13	837.22	1000.96	1370.87	Tons
	F.S. =	2.5	2.5	2.5	2.5	2.5	
Allowable Compressive Capacity =	**Q_{All} =**	**172.34**	**247.25**	**334.89**	**400.38**	**548.35**	Tons
Use	**Q_{All} =**	**172**	**247**	**335**	**400**	**548**	**Tons**

Note:-

1 Pile Load Test must be conducted as per relavant IS Code to confirm the above estimated pile capacities before completion of installtion of all piles.
2 Pile installation must be done with extreme care to prevent "Necking" and "Buldging" problems due to presence of thick layers of sand soils;
3 Ground water level was assumed to rise to ground level in worst case conditions.
4 Limiting All. End Bearing Pressure in "**Hard Rock**" as per IS code was 330 tons/M^2. Therefore, q_b (all) is limited to 300 tons/M^2 in the weathered rock.
5 **Hydraulic Rotary Rig is not suitabel** for encounerted sand profile. If used piles may have to reach lower level rocky layer where NX tools were used.

PLATE 17 - 2

UPLIFT PILE CAPACITY CALCULATIONS

Skin Friction Calculations

S.No.	Soil Description	From	To	ϕ^0 / C_u	$\delta = \phi$	γ'_s, T/M^3	σ'_{Mid},T/M^2	f_s,T/M^2	Pile Dia 0.60 Q_s, T	0.75 Q_s, T	0.90 Q_s, T	1.00 Q_s, T	1.20 Q_s, T	-M.
1	Brown Silty F to M Sand with ….	0.00	1.75	0	0	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Cutoff for
2	Gray Brown Firm Clay	1.75	3.00	3.00	3	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Basement
3	Gray Very Soft Clay	3.00	4.50	0.50		0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Floors
4a	Gray Silty F to M Sand	4.50	5.50	23	23	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4b	Gray Silty F to M Sand	5.50	6.25	24	24	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
4c	Gray Silty F to M Sand	6.25	8.00	30	30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5a	Gray Green F to M Sand with Silt	8.00	9.00	33	33	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
5b	Gray Green F to M Sand with Silt	9.00	11.00	36	36	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6a	Brown Gray Green Silty F to M Sand	11.00	12.50	34	34	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
6b	Brown Gray Green Silty F to M Sand	12.50	14.50	32	32	0.70	0.70	0.55	2.06	2.58	3.09	3.44	4.12	
6c	Brown Gray Green Silty F to M Sand	14.50	16.00	36	36	1.00	2.15	1.95	5.52	6.90	8.28	9.20	11.05	
6d	Brown Gray Green Silty F to M Sand	16.00	19.00	37	37	1.10	4.55	4.29	24.24	30.31	36.37	40.41	48.49	
6e	Brown Gray Green Silty F to M Sand	19.00	22.00	38	38	1.20	8.00	7.81	44.20	55.25	66.29	73.66	88.39	
6f	Brown Gray Green Silty F to M Sand	22.00	24.50	37	37	1.10	11.18	10.53	49.62	62.03	74.43	82.70	99.24	
7a	Brown White Bluw Weathered Rock	24.50	26.50	38	38	1.20	13.75	13.43	50.64	63.30	75.96	84.40	101.28	
								Net Total Ultimate Skin Friction, $Q_{s\,ult}$=	176.29	220.36	264.43	293.82	352.58	

Unit Weight of Pile RCC = γ_{conc} 2.40 T/M^3

	0.60	0.75	0.90	1.00	1.20	
Base A=	0.2829	0.4420	0.6364	0.7857	1.1314	-M^2
Pile Length, L =	14.00	14.00	14.00	14.00	14.00	-M
Pile Volume, V =	3.96	6.19	8.91	11.00	15.84	-M^3
Submerged Pile Weight W =	5.54	8.66	12.47	15.40	22.18	Tons
$Q_{s\,ult}$ =	176.29	220.36	264.43	293.82	352.58	Tons
$Q_{tot\,ult}$=	**181.83**	**229.02**	**276.91**	**309.22**	**374.76**	Tons
F.S. =	2.5	2.5	2.5	2.5	2.5	
Allowable Uplift Capacity = **Q_{All} =**	**72.73**	**91.61**	**110.76**	**123.69**	**149.90**	Tons
Use Q_{All} =	**73**	**92**	**111**	**124**	**150**	**Tons**

Note:-

1 Pile Load Test must be conducted as per relavant IS Code to confirm the above estimated pile capacities before completion of installtion of all piles.
2 Pile installation must be done with extreme care to prevent "Necking" and "Buldging" problems due to presence of Very Loose Sand / Very Soft Clay Strata;
3 Ground water level was assumed to rise to ground level in worst case conditions.

SAMPLE CALCULATIONS FOR LATERAL LOAD CAPACITY OF PILES.

BY BROMS (1964) METHOD.

PROPOSED "MARKET OF INDIA PHASE - II" SITE

No. 1, Cooks Road, Old Binny Mills, Perambur, Chennai 600 012, TN.

BORING 5 SOIL PROFILE

Pile Dia. 0.60 0.75 0.90 1.00 1.20 -M

Pile Type Bored Cast In-Situ Concrete Piles

Concrete Grade = M30 Max. Comp. Stress in Bending f_c = 700 Tons/M^2 = 70 Kg/cm^2

Min. % of Reinforcement Content = 0.40%

Modulus of Pile, E_c = 200000 Kg/cm^2 = 2000000 Tons/M^2

Soil's ϕ = 34 ^{0} For N_{avg} ~ 30 (from 12.5- and 16-M)

Soil's γ' = 0.80 Tons/M^3

K_p = 3.54 Passive Co-Efficient of Earth Pressure

Factor of Safety = 2.50

Dia., D M	(I) Mom. of Inertia, M^4	y = D/2 M	f_c Tons/M^2	M_{yield} Tons-M $\frac{f_c * I}{y}$	$\frac{M_{yield}}{D^4 \gamma' K_p}$	Broms Factor $\frac{P_{ult}}{K_p \gamma' D^3}$	P_{ult} Tons	P_{all} Tons
0.60	0.00636	0.30	700	14.84	40.48	11.00	11.20	4.48
0.75	0.01553	0.38	700	28.99	32.39	10.25	16.31	6.53
0.90	0.03221	0.45	700	50.10	26.99	9.75	22.34	8.94
1.00	0.04909	0.50	700	68.72	24.29	9.25	26.17	10.47
1.20	0.10178	0.60	700	118.75	20.24	8.25	33.61	13.44

Note:-

1.) Pile Load Test must be conducted as per relavant IS Code to confirm the above estimated pile capacities before completion of installtion of all piles.

2.) Pile is assumed to be "Fixed Head" type than "Free Head" due to provision of pile cap with a minimum 20 tons axial pile load with pile caps and tie beams.

SAMPLE CALCULATIONS FOR RECOMMENDED FOUNDATION

Bearing capacity was estimated using lower bound soil properties from drilled borings. Following is a list of design assumptions:

Type of Foundation	=	Combined Raft Foundation;
Foundation Depth below EGL	=	12.5-M below EGL;
Worst Case Ground Water Level	=	At EGL;
Minimum Raft Size	=	40- by 160-M;
Expected Max. Column Load	=	1000 tons; and
Expected Bearing Pressure	=	38 tons/M^2.

Bearing Capacity Calculations:

Ultimate Bearing Pressure $q_{ult} = C_u*N_c*S_c*D_c + q'(N_q - 1)*S_q*d_q + 0.5*B*\gamma'*N_\gamma* S_\gamma*d_\gamma$

ϕ	=	32^o
C_u (Undrained Shear Strength)	=	0 tons/M^2
N_c (Bearing Capacity Factor)	=	N/A
N_q (Bearing Capacity Factor)	=	24.36
N_γ (Bearing Capacity Factor)	=	32.65
S_c (Shape Factor)	=	1 + 0.2*(B/L) = 1.0 + 0.2*(40.0/160.0) = 1.05;
D_c (Depth Factor)	=	1 + 0.2*D_f/B*tan (45 + ϕ/2) = 1.11
S_q (Shape Factor)	=	1 + 0.2*(B/L) = 1.0 + 0.2*(40.0/160.0) = 1.05;
d_q (Depth Factor)	=	1 + 0.1*D_f/B*tan (45 + ϕ/2) = 1.06
S_γ (Shape Factor)	=	1 - 0.4*(B/L) = 1.0 - 0.4*(40.0/160.0) = 0.90;
d_γ (Depth Factor)	=	1 + 0.1*D_f/B*tan (45 + ϕ/2) = 1.06
q'(O B @ Footing)	=	~ (1.6-1)*12.5 = 7.5 tons/M^2

Note: Ground water is assumed to rise to EGL of the site.

q_{ult} = 0 + 7.5*(24.36-1)*1.05*1.06 + 0.5*0.7*40*32.65*0.90*1.06 = 631.07 ~ 631 tons/M^2

$q_{all} = q_{ult} / 2.5 = 631 / 2.5$ = 252.4 tons/M^2 **Use and Limit q_{all} = 40 tons/M^2 > 38 tons/M^2**

Settlement Calculations:

In case of raft foundation the "Zone of Influence" will extend to "2B" depth below raft, i.e., 2*40 = 80-M below raft or upto hard stratum level, whichever is earlier. There will be only elastic (immediate) settlement and no consolidation (long term) settlements as soil profile had weathered rock and jointed granite in the zone of influence.

Elastic or Immediate Settlement:-

1. 12.5- to 14.5-M = H_1 = 2.0-M; SPT "N" = 18 (Sand); E_s = 3,000 tons/M^2
2. 14.5- to 16.0-M = H_2 = 1.5-M; SPT "N" = 46 (Sand); E_s = 5,500 tons/M^2
3. 16.0- to 17.5-M = H_3 = 1.5-M; SPT "N" ~ 75 (Sand); E_s = 7,500 tons/M^2

$E_{s\ avg}$ = (3000*2 + 5500*1.5 + 7500*1.5)/5.0 = 5,100 tons/M^2

q_0 = 38 tons/M^2; H/B' = 5.0/20.0 = 0.25; L/B = 160.0/40.0 = 4; μ = 0.2; E_s = 5,100 tons/M^2

I_f = 0.90; I_1 = 0.010; I_2 = 0.052; I_s = 0.049;

$\Delta H_E = 4*20.0*38.0*(1-0.2^2)/5100*0.90*0.049*1000$ = **25.24 mm**

Total Elastic Settlement ΔH_E = 25.24 mm.

Consolidation Settlement: None.

Total Consolidation Settlement ΔH_C = 0.00 mm.

Total Combined Settlement **ΔH** = $\Delta H_E + \Delta H_C$ = 25.24 + 0.00 = **25.24 ~ 25 mm**.

Estimated total settlement for a 40- by 160-M combined raft foundation at 12.5-M below EGL was about 25 mm. The estimated total settlement was less than 75 mm – allowable limits for the total settlements for raft foundations on granular material as per IS: 1904 - 2006 code. Therefore, combined raft foundations can be used for the proposed building.

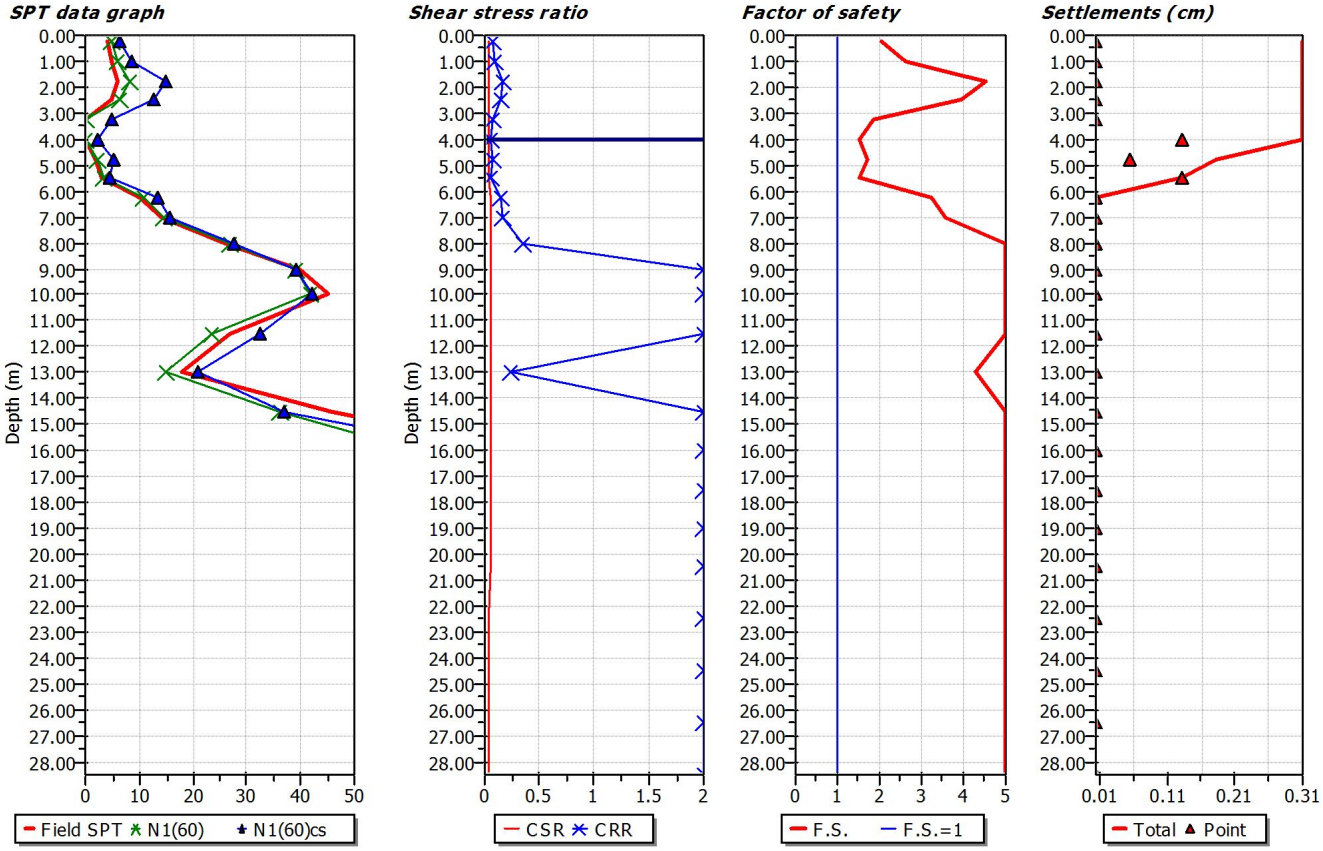
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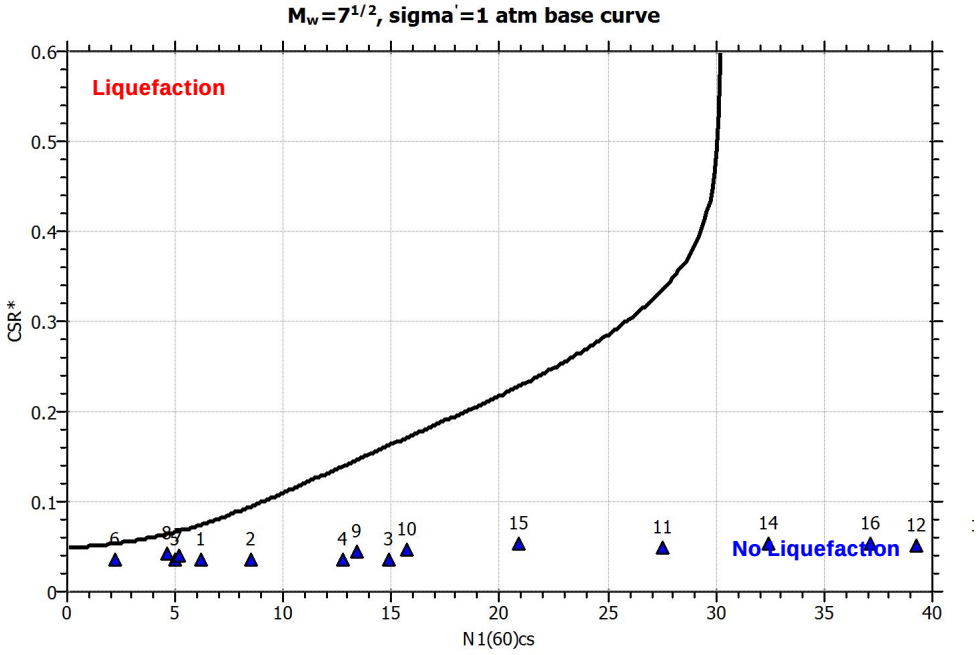
Project title : Market of India Phase - II Project Site, SPR City, No. 1, Cooks Road, Binny Mills, Perambur, Chennai 600 012, TN

Project subtitle : Boring 5 Soil Profile

Input parameters and analysis data

In-situ data type:	Standard Penetration Test	Depth to water table:	4.00 m
Analysis type:	Deterministic	Earthquake magnitude M_w:	6.50
Analysis method:	NCEER 1998	Peak ground accelaration:	0.08 g
Fines correction method:	Idriss & Seed	User defined F.S.:	1.00





Boring 5 Soil Profile
Horizontal Acceleration, $\mathbf{A_h = 0.08g}$

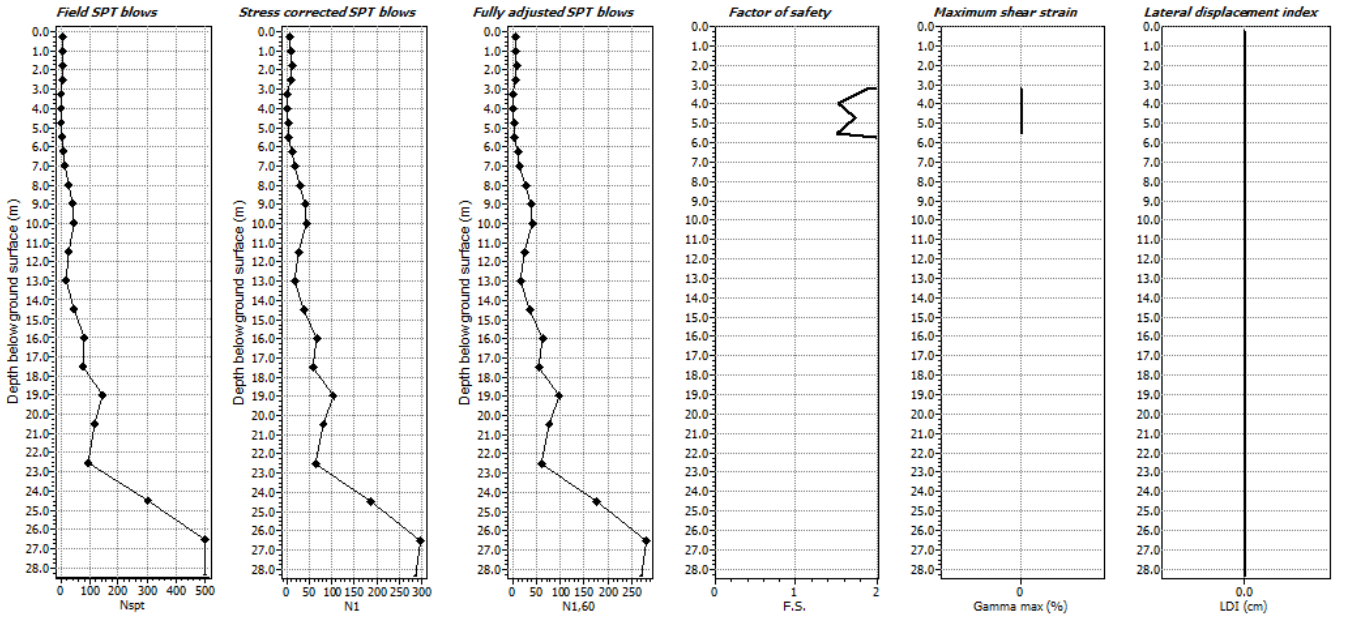
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GeoLogismiki - Merarchias 56, 621 25 Serres, Greece
Url : http://www.geologismiki.gr - Email : info@geologismiki.gr

LiqIT software v.4.6
Assessment of soil liquefaction potential from SPT, CPT or Vs data

LATERAL DISPLACEMENTS ESTIMATION DUE TO SOIL LIQUEFACTION[1]

Geometric parameters: Gently sloping ground without free face
Total lateral displacement estimation: 0.00 cm



N_{spt}: Measured SPT blows
N_1: Stress adjusted SPT blows
$N_{1,60}$: Fully adjusted SPT blows

F.S.: Factor of safety
Gamma max: Maximum cyclic shear strain
LDI: Lateral displacement index

[1] This method was developed using the NCEER methods (SPT and CPT) and other methods will produce slightly different results

PLATE 18b

PRASAD ARMSTRONG YEN G E C (P) LTD.
821 (Old # 439/4) Poonamallee High Road
Arumbakkam, Chennai 600 106.
Phone: 044 - 2363 7146; e-mail: paygec@gmail.com



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Ownership, Compliance & Legal Verification

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

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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