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CIN: U74210TN1992PTC023645

GEOTECHNICAL SITE INVESTIGATION
BORING 1 THROUGH 11
PROPOSED RESIDENTIAL APARTMENTS BUILDINGS SITE
O S NO 771/1A & 771/2A, (O S NO 771/1 & 771/2), N S NO 771/2A1
MADAMBAKKAM VILLAGE, TAMBARAM TALUK
CHENGALPATTU TALUK (OLD KANCHEEPURAM TALUK)
CHENNAI (MADRAS 603 202), TN.

Report to

M/s. DRA Aadithya South City Projects Pvt. Ltd.
N. No. 109, 111 & 113 Lloyds Road (Avvai Shanmugan Salai)
Royapettah, Chennai 600 114, TN.

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Report No. 063/GI/23-24.
July 15, 2023.

M/s. DRA Aadithya South City Projects Pvt. Ltd.
N. No. 109, 111 & 113 Lloyds Road (Avvai Shanmugan Salai)
Royapettah, Chennai 600 114, TN.

Geotechnical Site Investigation
Boring 1 through 11
Proposed Residential Apartments Buildings Site
O. S. No. 771/1A & 771/2A, (O. S. No.771/1 & 771/2), N. S. No. 771/2A1
Madambakkam Village, Tambaram Taluk
Chengalpattu Taluk (Old Kancheepuram Taluk)
Chennai (Madras) 603202, 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 study was authorized by your confirmation e-mail received on June 24, 2023.

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

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
CMDA Registration No. GTE/19/02/002

(063brpt)
Copies Submitted: (3)

CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'Thalamuthu Natarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Dr.B.RAM PRASAD** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **B.E.,(Civil Engg.), M.E.,(Geo-Tech.), Ph.D.,** and experience in the relevant field for **30 years**.

He has been given the Registration No.**GTE/19/02/002** on **19.02.2019.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **18.02.2024**.



(R.SHIVAKUMAR)
ASSISTANT PLANNER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
CHENNAI - 600 008

SELF ATTESTED
For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.

Dr. B. Ramprasad
ME, PhD (Texas A&M)
Reg. No.GTE/19/02/002
Managing Director

CONTENTS

	Page
SUMMARY	i
INTRODUCTION	1
Purpose and Scope	1
Report Format	1
FIELD AND LABORATORY INVESTIGATIONS	1
Exploratory Borings	1
Field and Laboratory Tests	1
GENERAL SOIL CONDITIONS	2
Topography	2
Soil Stratigraphy	2
Interpretation of Soil Properties	4
DESIGN INFORMATION	6
GROUNDWATER AND SOIL CHEMICAL ANALYSIS	7
CONSTRUCTION CONSIDERATIONS	7
REFERENCES	9

ILLUSTRATIONS

	Plate
Bore Hole Location Plan	1
Log of Boring 1	2
Log of Boring 2	3
Log of Boring 3	4
Log of Boring 4	5
Log of Boring 5	6
Log of Boring 6	7
Log of Boring 7	8
Log of Boring 8	9
Log of Boring 9	10
Log of Boring 10	11
Log of Boring 11	12
Summary of Test Results	13
Grain Size Distribution Curves	14
Summary of Water Test Results	15
Sample Calculations for Recommended Foundation	16
Liquefaction Analysis Results	17

SUMMARY

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation for the Proposed Residential Apartments Buildings Site, O. S. No. 771/1A & 771/2A, (O. S. No.771/1 & 771/2), N. S. No. 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN. The primary purpose of our investigation was to obtain data to identify foundation type and estimate load carrying capacity of the selected foundation for the proposed Stilt + 5 floors buildings. For the proposed buildings typical maximum column load will be about 140 tons. These load details were used only for estimating the preliminary foundation size and type of foundation.

The field investigation was performed on June 26 through July 3, 2023. Location of the borings was selected to cover the proposed buildings area with 5-M setback from all the boundaries. Boring 1 through 11 were drilled 6-, 5-, 6-, 6-, 7-, 5.6-, 6-, 6-, 6-, 6-, and 5-M below the Existing Ground Level (EGL), respectively. All the borings were terminated with at least 3-M drilling through the hard weathered rock strata with SPT "N" $\geq$ 75 or on recovery of rock core samples. In most of the borings NX Diamond bit core barrel was used for drilling through this stratum in the last 0.75- / 2-M. In some borings highly jointed rock core pieces were recovered in the last 1-M of drilling. Tests were conducted to determine the pertinent index and engineering properties of the soils and weathered rock encountered. We then performed engineering analyses to develop the required design data.

Natural topography of the site reflects a flat terrain. Visual observation inferred EGL of the site to be about 0.3-M below the Existing Road Level (ERL) of road in front of the site. Proposed site was part of a large site with many coconut and mango tress during this investigation field work. Compound walls were present along three boundaries of the site. There was no compound wall along the western boundary. Proposed construction will be the first major construction activity of this magnitude to cover this site. The typical soil stratigraphy at the borings was tabulated below:

Typical Site Soil Profile:

	Penetration, M		
Stratum	From	To	Description
I	0	1.0	Fine to Coarse Sand with Silt and Gravel
II	1.0	5.0 - 7.0+	Weathered Rock

Data from boring infer presence of similar soil profile with some variations in the SPT "N" values in the top 3-M. In the borings beyond 3-M hard stratum weathered rock was encountered continuously. The Finished Ground Level (FGL) of the site should be at least 0.5-M above ERL of road in front of the site for proper surface drainage in the site. Also, the Finished Floor Level (FFL) of the stilt floor should be at least 0.2-M above FGL of the site. For the expected building column loads, and encountered soil profiles "**Isolated Column Footing**" foundation was recommended. **The footing should be located at least 2-M below the EGL of the site and at least 2.5-M below FGL of the site.** A minimum footing size of 1.5-M was considered in the analysis. For the considered foundation the estimated ultimate and recommended allowable bearing capacities were 86 and 30 tons/M^2, respectively. The estimated total settlement was about 8 mm, less than the IS: 1904 - 2006 code limiting settlement of 60 mm for footing foundations for framed structure with brick panel walls. It was recommended to provide shear walls, continuous lintels and sill level beams under openings in each floor for better resistance to differential settlements, and seismic forces.

Groundwater was not clearly seen in the borings. A 9.25-M diameter and unknown depth open well was present in the adjacent plot just at the western boundary of the site. Groundwater was at about 3.25-M below EGL in the open well. Groundwater sample was collected from this open well for construction suitability test purposes. Test results inferred that the groundwater from the open well was **suitable** for construction purposes as per IS: 456 - 2000 guidelines. After installation of open well or bore well in the site, groundwater from the site should be checked for construction suitability purposes at regular intervals from beginning of construction activities. If necessary, suitable treatment should be provided for the groundwater to make the water suitable for construction purposes.

Chemical tests were performed on 11 soil samples (one sample per boring.) Soil samples were tested for pH, Chlorides, and Sulphates. A 5% soil solution was initially prepared by mixing with distilled water. This solution was allowed to soak and settle for 24 hours. After that soil solution was filtered pH test was performed on the derived solution. Test results infer concentration of tested chemicals were **less than** the acceptable limits as per IS: 456 - 2000 code guideline values for construction water.

We do expect construction problems at this site due to high groundwater conditions in rainy seasons. Site's EGL was about 0.3-M below ERL of road in front of the site. In order to avoid future site flooding from road runoff and for site surface drainage it was recommended to raise site's FGL by **at least 0.5-M above ERL** of road in front of the site, and FFL of stilt floor should be 0.2-M above FGL of the site. Foundation excavation, site, and building basement fillings should be done with granular soils with proper compaction to achieve a minimum unit weight of 2.0 tons/M^3. Backfilling of the foundation excavations should be done with granular soil and it should be compacted properly to achieve proper densification to avoid settlements in flooring. Exposed bottom surface of the foundation excavation must be properly cleaned of loose material and compacted with **heavy duty rammer** to compact the exposed surface that gets loosened by mechanical excavation activities. **New foundation should rest on natural soil and not on top of fill soils or old foundations** to minimize settlements that can arise if the loosened soil in foundation excavation was not removed or compacted. PCC layers can be directly placed on the exposed sandy soil or weathered rock. Excavated sandy soil and weathered rock excavations can be used for site filling proposes. In case any loose soils were encountered at foundation level then the loose soils should be removed till dense soil or weathered rock. This site observation and action was required due to possible presence of filled up open wells or excavations in the large site for previous activities at this site.

People familiar with this land should be enquired to known if any filled up open wells or pits present were in this site. During construction regular inspection of the excavation at planned final depth should be done to physically confirm the absence such filled up or loose pockets. All filled up open wells or any other filled up areas should be identified and at these locations suitable alternative foundation should be provided after evaluation of soil conditions at the specific location.

All structures have to be designed for higher seismic forces (**Zone III**) due to increased seismic activity in peninsular India in the past two decades. Seismic events of 5.1 magnitude on August 24, 2021, 5.1 magnitude on February 12, 2019, 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 was recommended to provide rigid plinth beams in ground level, columns designed for shear forces or 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. Under IS code Zone III guideline seismic event of **6.0 Richter scale**, and peak ground

acceleration of **0.16g** the total estimated vertical settlement was 0.0 cms and total horizontal displacement was about 0.00 cms. Iwasaki liquefaction potential was 0.0 inferring "**No Liquefaction**." The site soil profile infers **"No"** seismic susceptibility.

INTRODUCTION

Purpose and Scope

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation for the Proposed Residential Apartments Buildings Site, O. S. No. 771/1A & 771/2A, (O. S. No.771/1 & 771/2), N. S. No. 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN. The primary purpose of our investigation was to obtain data to identify foundation type and estimate load carrying capacity of the selected foundation for the proposed Stilt + 5 floors buildings. For the proposed buildings typical maximum column load will be about 140 tons. These load details were used only for estimating the preliminary foundation size and type of foundation. To accomplish these purposes, the following tasks were performed:

(1) Eleven detailed boring were drilled to 6-, 5-, 6-, 6-, 7-, 5.6-, 6-, 6-, 6-, 6-, and 5-M depth below EGL, respectively to explore the subsurface stratigraphy and obtain soil and weathered 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 proposed building were explored by Boring 1 through 11. Boring location details are presented on Plate 1. Location of the borings was selected to cover the proposed buildings area with 5-M setback from all the boundaries. Boring 1 through 11 were drilled 6-, 5-, 6-, 6-, 7-, 5.6-, 6-, 6-, 6-, 6-, and 5-M below EGL, respectively. All the borings were terminated with at least 3-M drilling through the hard weathered rock strata with SPT "N" $\geq$ 75 or on recovery of rock core samples. In most of the borings NX Diamond bit core barrel was used for drilling through this stratum in the last 0.75- / 2-M. In some borings highly jointed rock core pieces were recovered in the last 1-M of drilling. Tests were conducted to determine the pertinent index and engineering properties of the soils and weathered rock encountered. We then performed engineering analyses to develop the required design data. Groundwater was at about 3.25-M in the adjacent plot's large open well. Log of Borings are presented on Plate 2 through 12.

Field and Laboratory Tests

Borings were drilled using Calyx drilling unit. In the borings SPT was performed at 1-M intervals. 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 the 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 and rock samples were collected at 1-M intervals either disturbed or undisturbed as the case may be. All soil, rock and water 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 were tabulated on the Summary of Test Results on Plate 13. Grain size distribution curve of tested soil were presented on Plate 14. Summary of Water and Soil Chemical Test Results were presented on Plate 15.

GENERAL SOIL CONDITIONS

Topography

Natural topography of the site reflects a flat terrain. Visual observation inferred EGL of the site to be about 0.3-M below ERL of road in front of the site. Proposed site was part of a large site with many coconut and mango tress during this investigation field work. Compound walls were present along three boundaries of the site. There was no compound wall along the western boundary. Proposed construction will be the first major construction activity of this magnitude to cover this site.

Soil Stratigraphy

Soil stratigraphy disclosed by our investigation is presented on the log of boring on Plate 2 through 12. 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	1.3	Brown Fine to Coarse Sand with Gravel
II	1.3	6.0+	Blue White Gray Brown Weathered Rock

Boring – 2:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Coarse Sand with Silt and Gravel
II	1.0	5.0+	Blue White Gray Brown Weathered Rock

Boring – 3:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Coarse Sand with Silt and Gravel
II	1.0	6.0+	Blue White Gray Brown Weathered Rock

Boring – 4:

Stratum	Penetration, M From	To	Description
I	0	1.0	Gray Brown Fine to Coarse Sand with Silt and Gravel
II	1.0	6.0+	Blue White Gray Brown Weathered Rock

Boring – 5:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Gravely Fine to Coarse Sand
II	1.0	7.0+	Blue White Gray Brown Weathered Rock

Boring – 6:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt
II	1.0	5.6+	Blue White Gray Brown Weathered Rock

Boring – 7:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Gray Fine to Medium Sand with Gravel
II	1.0	6.0+	Blue White Brown Weathered Rock

Boring – 8:

Stratum	Penetration, M From	To	Description
I	0	2.0	Brown Fine to Coarse Sand with Silt And Gravel
II	2.0	6.0+	Blue White Gray Brown Weathered Rock

Boring – 9:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Gray Fine to Medium Sand with Silt and Gravel
II	1.0	3.75	Blue White Brown Weathered Rock
III	3.75	6.0+	Blue Brown Highly Jointed Granite

Boring – 10:

Stratum	Penetration, M From	To	Description
I	0	1.0	Red Brown Fine to Coarse Sand with Silt
II	1.0	6.0+	White Brown Weathered Rock

Boring – 11:

Stratum	Penetration, M From	To	Description
I	0	1.0	Red Yellow Brown Fine to Coarse Sand with Silt And Gravel
II	1.0	5.0+	Blue White Brown Weathered and Jointed Granite Rock

Detailed soil descriptions that include textural variations and inclusions are noted on the log of boring presented on Plate 2 through 12.

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 8. A reevaluation of the recommendations in this report may be necessary if variations in the soil profile are encountered during the foundation 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 borings.

Boring – 1:

Stratum	Penetration, M From	To	Properties
I	0.0	1.3	$\phi = 30^{o}$; $\gamma_{sat} = 1.6$ tons/M^3
IIa	1.3	2.0	$\phi = 37^{o}$; $\gamma_{sat} = 2.1$ tons/M^3
IIb	2.0	4.0	$\phi = 38^{o}$; $\gamma_{sat} = 2.2$ tons/M^3
IIc	4.0	6.0+	$\phi = 39^{o}$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 2:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 31^{o}$; $\gamma_{sat} = 1.65$ tons/M^3
IIa	1.0	4.0	$\phi = 38^{o}$; $\gamma_{sat} = 2.2$ tons/M^3
IIb	4.0	5.0+	$\phi = 40^{o}$; $\gamma_{sat} = 2.3$ tons/M^3

Boring – 3:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 32^{o}$; $\gamma_{sat} = 1.7$ tons/M^3
IIa	1.0	5.0	$\phi = 38^{o}$; $\gamma_{sat} = 2.2$ tons/M^3
IIb	5.0	6.0+	$\phi = 39^{o}$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 4:

Stratum	Penetration, M From	To	Properties
I	0.0	1.0	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
IIa	1.0	2.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIb	2.0	4.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIc	4.0	6.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 5:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.65$ tons/M^3
IIa	1.0	2.0	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
IIb	2.0	4.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIc	4.0	5.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IId	5.0	6.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IIe	6.0	7.0+	$\phi = 40^o$; $\gamma_{sat} = 2.3$ tons/M^3

Boring – 6:

Stratum	Penetration, M From	To	Properties
Ia	0	1.0	$\phi = 30^o$; $\gamma_{sat} = 1.65$ tons/M^3
Ib	1.0	2.0	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
IIa	2.0	4.6	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIb	4.6	5.6+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 7:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIa	1.0	2.0	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IIb	2.0	3.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIc	3.0	5.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IId	5.0	6.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 8:

Stratum	Penetration, M From	To	Properties
I	0	2.0	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
IIa	2.0	3.0	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
IIb	3.0	4.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIc	4.0	6.0+	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 9:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIa	1.0	2.0	$\phi = 36^o$; $\gamma_{sat} = 2.05$ tons/M^3
IIb	2.0	3.75	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
III	3.75	6.0+	$\phi = 40^o$; $\gamma_{sat} = 2.3$ tons/M^3

Boring – 10:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIa	1.0	2.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIb	2.0	3.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIc	3.0	6.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IId	6.0+		$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3

Boring – 11:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IIa	1.0	2.0	$\phi = 33^o$; $\gamma_{sat} = 1.8$ tons/M^3
IIb	2.0	3.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIc	3.0	5.0+	$\phi = 40^o$; $\gamma_{sat} = 2.3$ tons/M^3

DESIGN INFORMATION

Data from boring infer presence of similar soil profile with some variations in the SPT "N" values in the top 3-M. In the borings beyond 3-M hard stratum weathered rock was encountered continuously. FGL of the site should be at least 0.5-M above ERL of road in front of the site for proper surface drainage in the site. Also, FFL of the stilt floor should be at least 0.2-M above FGL of the site. For the expected building column loads, and encountered soil profiles "**Isolated Column Footing**" foundation was recommended. **The footing should be located at least 2-M below the EGL of the site and at least 2.5-M below FGL of the site.** A minimum footing size of 1.5-M 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:

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

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 bearing capacities were 86 and 30 tons/M^2, respectively. Estimated total settlement was about 8 mm, less than the IS: 1904 - 2006 code limiting settlement of 60 mm for footing foundations for framed structure with brick panel walls. It was recommended to provide shear walls, continuous lintels and sill level beams under openings in each floor for better resistance to differential settlements, and seismic forces. Foundation capacity calculations were presented on Plate 16.

GROUNDWATER AND SOIL CHEMICAL ANALYSIS

Groundwater was not clearly seen in the borings. A 9.25-M diameter and unknown depth open well was present in the adjacent plot just at the western boundary of the site. Groundwater was at about 3.25-M below EGL in the open well. Groundwater sample was collected from this open well for construction suitability test purposes. Test results inferred that the groundwater from the open well was **suitable** for construction purposes as per IS: 456 - 2000 guidelines. After installation of open well or bore well in the site, groundwater from the site should be checked for construction suitability purposes at regular intervals from beginning of construction activities. If necessary, suitable treatment should be provided for the groundwater to make the water suitable for construction purposes.

Chemical tests were performed on 11 soil samples (one sample per boring.) Soil samples were tested for pH, Chlorides, and Sulphates. A 5% soil solution was initially prepared by mixing with distilled water. This solution was allowed to soak and settle for 24 hours. After that soil solution was filtered pH test was performed on the derived solution. Test results infer concentration of tested chemicals were **less than** the acceptable limits as per IS: 456 - 2000 code guideline values for construction water. Summary of groundwater and soil chemical test results were presented on Plate 15.

CONSTRUCTION CONSIDERATIONS

We do expect construction problems at this site due to high groundwater conditions in rainy seasons. Site's EGL was about 0.3-M below ERL of road in front of the site. In order to avoid future site flooding from road runoff and for site surface drainage it was recommended to raise site's FGL by **at least 0.5-M above ERL** of road in front of the site, and FFL of stilt floor should be 0.2-M above FGL of the site. Foundation excavation, site, and building basement fillings should be done with granular soils with proper compaction to achieve a minimum unit weight of 2.0 tons/M^3. Backfilling of the foundation excavations should be done with granular soil and it should be compacted properly to achieve proper densification to avoid settlements in flooring. Exposed bottom surface of the foundation excavation must be properly cleaned of loose material and compacted with **heavy duty rammer** to compact the exposed surface that gets loosened by mechanical excavation activities. **New foundation should rest on natural soil and not on top of fill soils or old foundations** to minimize settlements that can arise if the loosened soil in foundation excavation was not removed or compacted. PCC layers can be directly placed on the exposed sandy soil or weathered rock. Excavated sandy soil and weathered rock excavations can be used for site filling proposes. In case any loose soils were encountered at foundation level then the loose soils should be removed till dense soil or weathered rock. This site observation and action was required due to possible presence of filled up open wells or excavations in the large site for previous activities at this site.

People familiar with this land should be enquired to known if any filled up open wells or pits present were in this site. During construction regular inspection of the excavation at planned final depth should be done to physically confirm the absence such filled up or loose pockets. All filled up open wells or any other filled up areas should be identified and at these locations suitable alternative foundation should be provided after evaluation of soil conditions at the specific location.

All structures have to be designed for higher seismic forces (**Zone III**) due to increased seismic activity in peninsular India in the past two decades. Seismic events of 5.1 magnitude on August 24, 2021, 5.1 magnitude on February 12, 2019, 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 was recommended to provide rigid plinth beams in ground level, columns designed for shear forces or 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. Under IS code Zone III guideline seismic event of **6.0 Richter scale**, and peak ground acceleration of **0.16g** the total estimated vertical settlement was 0.0 cms and total horizontal displacement was about 0.00 cms. Iwasaki liquefaction potential was 0.0 inferring "**No Liquefaction**." The site soil profile infers **"No"** seismic susceptibility. Liquefaction analysis results are presented on Plate 17.

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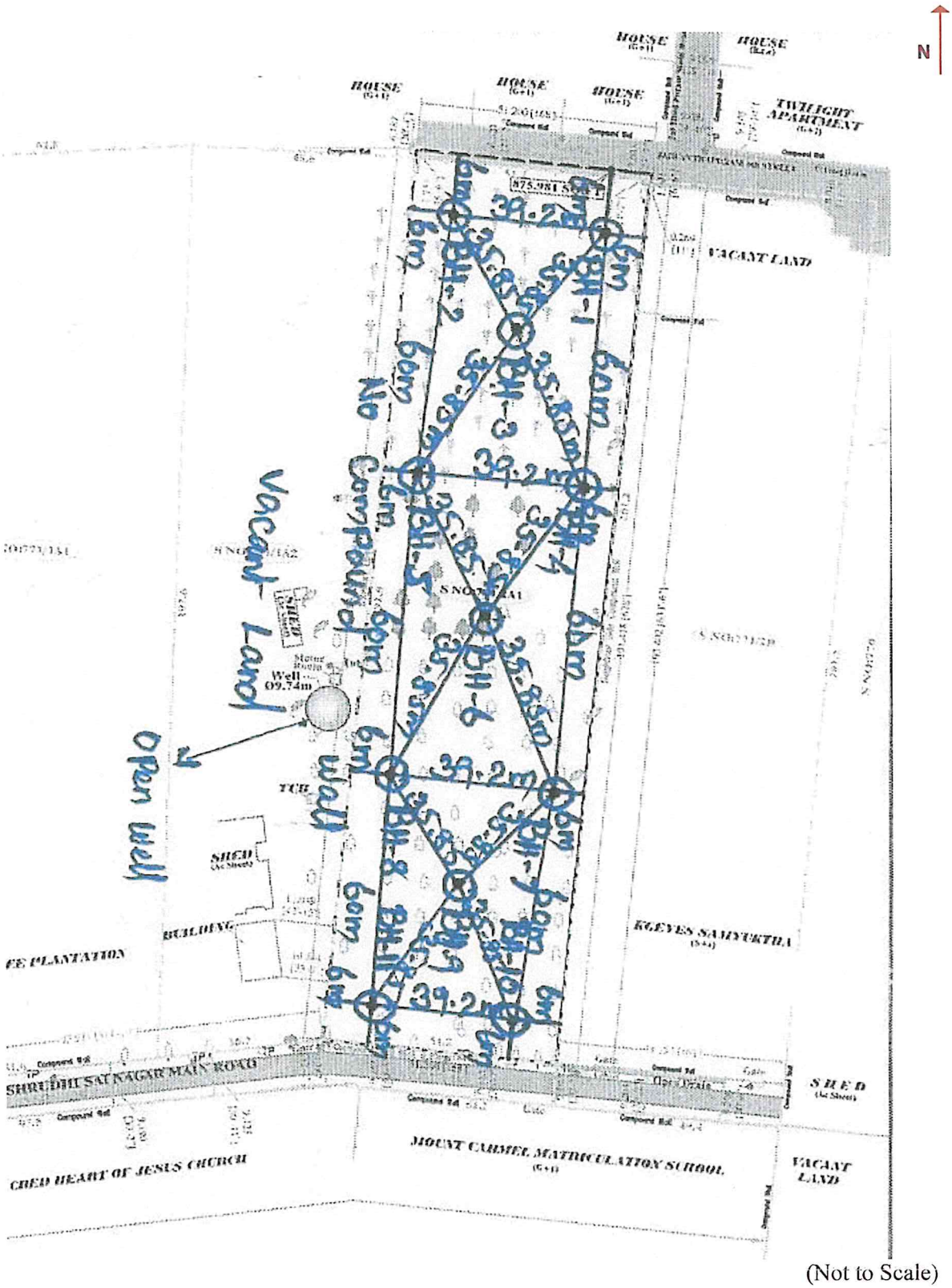
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(Not to Scale)

Site EGL =0.3-M Below ERL of Road In Front of the Site.

BORE HOLE LOCATION DETAILS.

PLATE 1

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 26-06-'23 **Ended on:** 26-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

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 gravel (To 1.3-M)	SPT @ 0.25 M 5/4/4 = 8 Blows		
1.0	0.0- to 1.3-m – $\phi = 30^{o}$; $\gamma_t = 1.6$ tons/M^3 ($N_{avg} \sim 10$)	SPT @ 1 M 8/12/ 4 cms for 10 Blows		
		3 cms for 10 Blows (Hammer Rebound)		
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 1.3-M)	SPT @ 2 M 33/		
2.0	1.3- to 2.0-m – $\phi = 37^{o}$; $\gamma_t = 2.1$ tons/M^3	4 cms for 20 Blows		
	($N_{avg} > 75$)	(Hammer Rebound)		
3.0	2.0- to 4.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	SPT @ 3 M 7 cms for 20 Blows		
GWL	($N_{avg} > 100$)	2 cms for 10 Blows (Hammer Rebound)		
4.0	-NX TC bit drilling from 4-m	SPT @ 4 M 4 cms for 15 Blows		
	-drilled from 4- to 5-m in 15 minutes	0.5 cms for 5 Blows (Hammer Rebound)		
5.0	-drilled from 5- to 5.2-m in 35 minutes -NX Diamond bit drilling from 5.2-m	SPT @ 5 M (SNR) 0.5 cms for 5 Blows		
	4.0- to 6.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	0 cms for 5 Blows (Hammer Rebound)		
6.0	-drilled from 5.2- to 6-m in 35 minutes	SPT @ 6 M (SNR) 0 cms for 10 Blows		
		(Hammer Rebound)		
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 6.0-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 2

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 2 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 26-06-'23 **Ended on:** 27-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 5.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

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 gravel (To 1.0-M)	SPT @ 0.25 M 9/7/5 = 12 Blows		
1.0	0.0- to 1.0-m – $\phi = 31^{o}$; $\gamma_t = 1.65$ tons/M^3 ($N_{avg} \sim 12$)	SPT @ 1 M 18/ 3 cms for 10 Blows		
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 1.0-M)	2 cms for 10 Blows (Hammer Rebound)		
2.0		SPT @ 2 M 3 cms for 10 Blows		
	1.0- to 4.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	2 cms for 10 Blows (Hammer Rebound)		
3.0	-NX TC bit drilling from 3-m	SPT @ 3 M 3 cms for 10 Blows		
GWL		2 cms for 10 Blows (Hammer Rebound)		
4.0	-drilled from 3- to 4-m in 45 minutes	SPT @ 4 M (SNR) 0.5 cms for 5 Blows		
	-NX Diamond bit drilling from 4-m	0 cms for 5 Blows (Hammer Rebound)		
	4.0- to 5.0-m – $\phi = 40^{o}$; $\gamma_t = 2.3$ tons/M^3 ($N_{avg} >> 100$)	SPT @ 5 M (SNR)		
5.0	-drilled from 4- to 5-m in 70 minutes	0 cms for 5 Blows		
	-17 cm core & 2 stone pieces recovered drilling to 5-m	(Hammer Rebound)		
6.0				
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 5.0-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 3

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 3 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 27-06-'23 **Ended on:** 27-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

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 gravel (To 1.0-M)	SPT @ 0.25 M 3/6/9 = 15 Blows		
1.0	0.0- to 1.0-m – $\phi = 32^{o}$; $\gamma_t = 1.7$ tons/M^3 ($N_{avg} \sim 15$)	SPT @ 1 M 16/35/ 4 cms for 20 Blows		
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 1.0-M)	(Hammer Rebound)		
2.0		SPT @ 2 M 4 cms for 10 Blows		
		2 cms for 10 Blows (Hammer Rebound)		
3.0	1.0- to 5.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	SPT @ 3 M 3 cms for 10 Blows		
GWL	($N_{avg} > 100$)	2 cms for 10 Blows (Hammer Rebound)		
4.0		SPT @ 4 M 3 cms for 10 Blows		
		2 cms for 10 Blows (Hammer Rebound)		
5.0	-NX TC bit drilling from 5-m	SPT @ 5 M (SNR) 1.5 cms for 15 Blows		
	-drilled from 5- to 5.4-m in 30 minutes -NX Diamond bit drilling from 5.4-m	0 cms for 5 Blows (Hammer Rebound)		
6.0	5.0- to 6.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	SPT @ 6 M (SNR) 0 cms for 5 Blows		
	-drilled from 5.4- to 6-m in 40 minutes	(Hammer Rebound)		
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 6.0-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 4

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 4 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 28-06-'23 **Ended on:** 28-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY BROWN FINE TO COARSE SAND with silt and gravel (To 1.0-M)	SPT @ 0.25 M 3/5/7 = 12 Blows		
1.0	0.0- to 1.0-m – $\phi = 31^{o}$; $\gamma_t = 1.65$ tons/M^3 ($N_{avg} = 12$)	SPT @ 1 M 15/30/ 4 cms for 10 Blows		
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 1.0-M)	3 cms for 10 Blows (Hammer Rebound)		
2.0	1.0- to 2.0-m – $\phi = 37^{o}$; $\gamma_t = 2.1$ tons/M^3 ($N_{avg} \sim 75$)	SPT @ 2 M 4 cms for 10 Blows		
		2 cms for 10 Blows (Hammer Rebound)		
3.0	2.0- to 4.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	SPT @ 3 M 3 cms for 10 Blows		
GWL	($N_{avg} > 100$)	2 cms for 10 Blows (Hammer Rebound)		
4.0		SPT @ 4 M (SNR) 1.5 cms for 15 Blows		
		0 cms for 5 Blows (Hammer Rebound)		
5.0	-NX TC bit drilling from 5- to 5.1-m in 15 minutes -NX Diamond bit drilling from 5.1-m	SPT @ 5 M (SNR) 0 cms for 5 Blows		
	4.0- to 6.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	(Hammer Rebound)		
6.0	-drilled from 5.1- to 6-m in 45 minutes	SPT @ 6 M (SNR) 0 cms for 5 Blows		
	-3 stone pieces recovered drilling to 6-m	(Hammer Rebound)		
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 6.0-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 5

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 5 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 28-06-'23 **Ended on:** 28-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 7.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN GRAVELY FINE TO COARSE SAND (To 1.0-M)	SPT @ 0.25 M 4/5/6 = 11 Blows
1.0	0.0- to 1.0-m – γ_t = 1.65 tons/M^3 (N_{avg} ~ 14)	SPT @ 1 M 13/11/16 = 27 Blows
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 1.0-M)	
2.0	1.0- to 2.0-m – ϕ = 34°; γ_t = 1.8 tons/M^3 (N_{avg} = 27)	SPT @ 2 M 22/34/ 4 cms for 20 Blows (Hammer Rebound)
3.0	2.0- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3 (N_{avg} ~ 100)	SPT @ 3 M 22/ 4 cms for 10 Blows
GWL		3 cms for 10 Blows (Hammer Rebound)
4.0		SPT @ 4 M 3 cms for 10 Blows
	4.0- to 5.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3 (N_{avg} > 100)	2 cms for 10 Blows (Hammer Rebound)
5.0		SPT @ 5 M 3 cms for 10 Blows
	5.0- to 6.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3 (N_{avg} >> 100)	1 cm for 10 Blows (Hammer Rebound)
6.0	-NX TC bit drilling from 6- to 6.45-m in 40 minutes	SPT @ 6 M (SNR) 0 cms for 5 Blows
	-NX Diamond bit drilling from 6.45-m	(Hammer Rebound)
	6.0- to 7.0-m – ϕ = 40°; γ_t = 2.3 tons/M^3 (N_{avg} >> 100)	
7.0	-drilled from 6.45- to 7-m in 50 minutes	SPT @ 7 M (SNR) 0 cms for 5 Blows
		(Hammer Rebound)
8.0		
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 7.0-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 6

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 6 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 29-06-'23 **Ended on:** 29-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 5.6-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt (To 2.0-M)	SPT @ 0.25 M 4/5/6 = 11 Blows
1.0	0.0- to 1.0-m – $\phi = 30^{o}$; $\gamma_t = 1.65$ tons/M^3 ($N_{avg} = 11$)	SPT @ 1 M 5/7/9 = 16 Blows
	1.0- to 2.0-m – $\phi = 32^{o}$; $\gamma_t = 1.7$ tons/M^3 ($N_{avg} = 16$)	
2.0		SPT @ 2 M 15/26/ 3 cms for 10 Blows
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 2.0-M)	2 cms for 10 Blows (Hammer Rebound)
3.0		SPT @ 3 M 4 cms for 20 Blows
GWL		(Hammer Rebound)
	2.0- to 4.6-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	
4.0	-NX TC bit drilling from 4- to 4.6-m in 40 minutes	SPT @ 4 M 2.5 cms for 10 Blows
		2 cms for 10 Blows (Hammer Rebound)
	-NX Diamond bit drilling from 4.6-m	SPT @ 5 M (SNR)
5.0	4.6- to 5.6-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	0 cms for 5 Blows (Hammer Rebound)
	-drilled from 4.6- to 5-m in 15 minutes	SPT @ 5.6 M (SNR)
	-3 stone pieces recovered drilling to 5-m	0 cms for 5 Blows
6.0	-drilled from 5- to 5.6-m in 50 minutes	(Hammer Rebound)
	-4 cm core & 7 stone pieces recovered drilling to 5.6-m	
7.0		
8.0		
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 6.0-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 7

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 7 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 30-06-'23 **Ended on:** 30-06-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to GW S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN GRAY FINE TO MEDIUM SAND with gravel (To 1.0-M)	SPT @ 0.25 M 6/12/16 = 28 Blows
	0.0- to 1.0-m – $\phi = 34^{o}$; $\gamma_t = 1.85$ tons/M^3	SPT @ 1 M
1.0	($N_{avg} = 28$)	8/10/12 = 22 Blows
	BLUE WHITE BROWN WEATHERED ROCK (Below 1.0-M)	
	1.0- to 2.0-m – $\phi = 33^{o}$; $\gamma_t = 1.75$ tons/M^3	SPT @ 2 M 16/30/
2.0	($N_{avg} = 22$)	3 cms for 10 Blows
		2 cms for 10 Blows
	2.0- to 3.0-m – $\phi = 37^{o}$; $\gamma_t = 2.1$ tons/M^3	(Hammer Rebound)
	($N_{avg} > 75$)	SPT @ 3 M
3.0	-NX TC bit drilling from 3-m	3 cms for 10 Blows
GWL		2 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 3- to 4-m in 30 minutes	SPT @ 4 M
4.0	-drilled from 4- to 4.4-m in 30 minutes	4 cms for 20 Blows
	-NX Diamond bit drilling from 4.4-m	(Hammer Rebound)
	3.0- to 5.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	
	($N_{avg} > 100$)	SPT @ 5 M (SNR)
5.0	-drilled from 4.4- to 5-m in 30 minutes	0 cms for 5 Blows
		(Hammer Rebound)
	5.0- to 6.0-m – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3	
	($N_{avg} >> 100$)	SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 80 minutes	0 cms for 5 Blows
	-9 stone pieces recovered drilling to 6-m	(Hammer Rebound)
7.0		
8.0		
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 6.0-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 8

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 8 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 30-06-'23 **Ended on:** 1-07-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

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 gravel (To 2.0-M)	SPT @ 0.25 M 6/12/15 = 27 Blows		
1.0	0.0- to 2.0-m – $\phi = 34°$; $\gamma_t = 1.8$ tons/M^3 ($N_{avg} \sim 29$)	SPT @ 1 M 8/12/20 = 32 Blows		
2.0		SPT @ 2 M 5/7/13 = 20 Blows		
	BLUE WHITE GRAY BROWN WEATHERED ROCK (Below 2.0-M)			
3.0	2.0- to 3.0-m – $\phi = 32°$; $\gamma_t = 1.7$ tons/M^3 ($N_{avg} = 20$)	SPT @ 3 M 3 cms for 10 Blows		
GWL	-NX TC bit drilling from 3.35- to 3.8-m in 30 minutes	2 cms for 10 Blows (Hammer Rebound)		
	3.0- to 4.0-m – $\phi = 38°$; $\gamma_t = 2.2$ tons/M^3 ($N_{avg} > 100$)	SPT @ 4 M (SNR)		
4.0	-NX Diamond bit drilling from 3.8-m	0 cms for 5 Blows		
	-drilled from 3.8- to 4-m in 40 minutes	(Hammer Rebound)		
5.0	-drilled from 4- to 5-m in 75 minutes 4.0- to 6.0-m – $\phi = 39°$; $\gamma_t = 2.25$ tons/M^3 ($N_{avg} >> 100$)	SPT @ 5 M (SNR) 0 cms for 5 Blows (Hammer Rebound)		
6.0	-drilled from 5- to 6-m in 80 minutes	SPT @ 6 M (SNR) 0 cms for 5 Blows		
	-5 cms core & 10 stone pieces recovered drilling to 6-m	(Hammer Rebound)		
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 6.0-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 9

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 9 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 1-07-'23 **Ended on:** 2-07-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	BROWN GRAY FINE TO MEDIUM SAND with silt and gravel (To 1.0-M)	SPT @ 0.25 M 11/16/16 = 32 Blows		
	0.0- to 1.0-m – $\phi = 34^{o}$; $\gamma_t = 1.85$ tons/M^3	SPT @ 1 M 17/28/		
1.0	($N_{avg} = 32$)	8 cms for 20 Blows		
	BLUE WHITE BROWN WEATHERED ROCK (To 3.75-M)			
	1.0- to 2.0-m – $\phi = 36^{o}$; $\gamma_t = 2.05$ tons/M^3	SPT @ 2 M 20/33/		
2.0	($N_{avg} = 65$)	3 cms for 10 Blows		
		2 cms for 10 Blows (Hammer Rebound)		
	2.0- to 3.75-m – $\phi = 37^{o}$; $\gamma_t = 2.1$ tons/M^3	SPT @ 3 M 28/32/		
3.0	($N_{avg} \sim 100$)	2 cms for 10 Blows		
GWL		(Hammer Rebound)		
	-NX TC bit drilling from 3.75- to 4-m in 40 minutes			
	-NX Diamond bit drilling from 4-m	SPT @ 4 M (SNR)		
4.0	**BLUE BROWN HIGHLY JOINTED GRANITE (Below 3.75-M)**	0.5 cms for 5 Blows		
		0 cms for 5 Blows (Hammer Rebound)		
	-drilled from 4- to 5-m in 70 minutes	SPT @ 5 M (SNR)		
5.0	-16 cms core & 10 stone pieces recovered drilling to 5-m	0 cms for 5 Blows		
	3.75- to 6.0-m – $\phi = 40^{o}$; $\gamma_t = 2.3$ tons/M^3	(Hammer Rebound)		
	($N_{avg} >> 100$)			
		SPT @ 6 M (SNR)		
6.0	-drilled from 4- to 5-m in 85 minutes	0 cms for 5 Blows		
	-13.5 cms core & 6 stone pieces recovered drilling to 6-m	(Hammer Rebound)		
7.0				
8.0				
9.0				
10.0				
11.0				

BORE HOLE TERMINATED AT 6.0-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 10

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 10 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 2-07-'23 **Ended on:** 3-07-'23 **Field Work In Charge:** M Munivel
Final Depth: 6.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	RED BROWN FINE TO COARSE SAND with silt (To 1.0-M)	DS @ 0.25 M
		12/18/10 = 28 Blows
	0.0- to 1.0-m – $\phi = 34^{o}$; $\gamma_t = 1.85$ tons/M^3	SPT @ 1 M
1.0	($N_{avg} = 28$)	6/12/18 = 30 Blows
	WHITE BROWN WEATHERED ROCK (Below 1.0-M)	
	1.0- to 2.0-m – $\phi = 34^{o}$; $\gamma_t = 1.85$ tons/M^3	SPT @ 2 M 20/
2.0	($N_{avg} = 30$)	8 cms for 20 Blows
	2.0- to 3.0-m – $\phi = 37^{o}$; $\gamma_t = 2.1$ tons/M^3	
	($N_{avg} = 75$)	SPT @ 3 M 26/
3.0		3 cms for 10 Blows
GWL		2 cms for 10 Blows
		(Hammer Rebound)
		SPT @ 4 M
4.0		4 cms for 15 Blows
		0.5 cms for 5 Blows
	3.0- to 6.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	(Hammer Rebound)
	($N_{avg} > 100$)	SPT @ 5 M
5.0		4 cms for 20 Blows
		(Hammer Rebound)
		SPT @ 6 M (SNR)
6.0		1.5 cms for 15 Blows
	6.0-m+ – $\phi = 39^{o}$; $\gamma_t = 2.25$ tons/M^3	0 cms for 5 Blows
	($N_{avg} >> 100$)	(Hammer Rebound)
7.0		
8.0		
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 6.0-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 11

LOG OF BORING

Project: Proposed Residential Apartments Buildings Site, O S No 771/1A & 771/2A, (O S No771/1 & 771/2), N S No 771/2A1, Madambakkam Village, Tambaram Taluk, Chengalpattu Taluk (Old Kancheepuram Taluk), Chennai (Madras) 603202, TN.

Bore Hole No.: 11 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 3-07-'23 **Ended on:** 3-07-'23 **Field Work In Charge:** M Munivel
Final Depth: 5.0-M **Depth to G W S:** 3.25-M **Remarks:** GWL from Adj. Site's Open Well.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	RED YELLOW BROWN FINE TO COARSE SAND with silt and gravel (To 1.0-M)	SPT @ 0.25 M 5/8/16 = 24 Blows
	0.0- to 1.0-m – $\phi = 33^{o}$; $\gamma_t = 1.75$ tons/M^3	SPT @ 1 M
1.0	($N_{avg} = 24$)	10/14/12 = 26 Blows
	BLUE WHITE BROWN WEATHERED AND JOINTED GRANITE ROCK (Below 1.0-M)	
	1.0- to 2.0-m – $\phi = 33^{o}$; $\gamma_t = 1.8$ tons/M^3	SPT @ 2 M 35/
2.0	($N_{avg} = 26$)	3 cms for 10 Blows
		2 cms for 10 Blows
	2.0- to 3.0-m – $\phi = 38^{o}$; $\gamma_t = 2.2$ tons/M^3	(Hammer Rebound)
	($N_{avg} > 100$)	SPT @ 3 M (SNR)
3.0		1.5 cms for 15 Blows
GWL		0 cms for 5 Blows (Hammer Rebound)
	-NX TC bit drilling from 4- to 4.1-m in 20 minutes	SPT @ 4 M (SNR)
4.0	-NX Diamond bit drilling from 4.1-m	0.5 cms for 5 Blows
	3.0- to 5.0-m – $\phi = 40^{o}$; $\gamma_t = 2.3$ tons/M^3	0 cms for 5 Blows
	($N_{avg} >> 100$)	(Hammer Rebound)
		SPT @ 5 M (SNR)
5.0	-drilled from 4.1- to 5-m in 95 minutes	0 cms for 5 Blows
	-25.5 cms core & 11 stone pieces recovered drilling to 5-m	(Hammer Rebound)
6.0		
7.0		
8.0		
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

BORE HOLE TERMINATED AT 5.0-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 12

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL	IS CLASS.
						Fine%	Medium%	Coarse%	%	
1	0.25	8			3					
	1.0	19			6					
	2.0	18			9	32	33	16	10	SP-SM
	3.0	18			9	53	32	5	1	SP-SM
	4.0	12			10	29	33	17	11	SP-SM
	5.0	SNR								
	6.0	SNR								
2	0.25	11			5					
	1.0	22			11	38	33	10	8	SP-SM
	2.0	17			12	33	27	15	13	SM
	3.0	17			15	56	23	4	2	SM
	4.0	SNR								
	5.0	SNR	core pieces							
3	0.25	14			6					
	1.0	18			11					
	2.0	15			14	30	25	16	15	
	3.0	16			11	31	33	17	8	SP-SM
	4.0	16			11	46	25	5	13	SP-SM
	5.0	SNR								
	6.0	SNR								
4	0.25	10			5					
	1.0	17			11					
	2.0	21			14	39	26	13	8	SM
	3.0	17			7	28	22	10	33	SW
	4.0	SNR								
	5.0	SNR								
	6.0	SNR	stone pieces							
5	0.25	12			6					
	1.0	20			2					
	2.0	12			13	26	16	13	32	SM
	3.0	17			18					
	4.0	24			28	28	21	13	9	SM
	5.0	14			8	31	31	14	16	SP
	6.0	SNR								
	7.0	SNR								
6	0.25	10			6					
	1.0	20			7					
	2.0	20			14	32	23	18	13	SM
	3.0	15			9	23	24	15	29	SP-SM
	4.0	19			7	28	30	20	15	SW
	5.0	SNR	stone pieces							
	5.6	SNR	stone pieces							
7	0.25	11			3					
	1.0	17			8					
	2.0	14			13	42	30	10	5	SM
	3.0	11			8	24	28	19	21	SW
	4.0	12			10	33	30	16	11	SP-SM
	5.0	SNR								
	6.0	SNR	stone pieces							

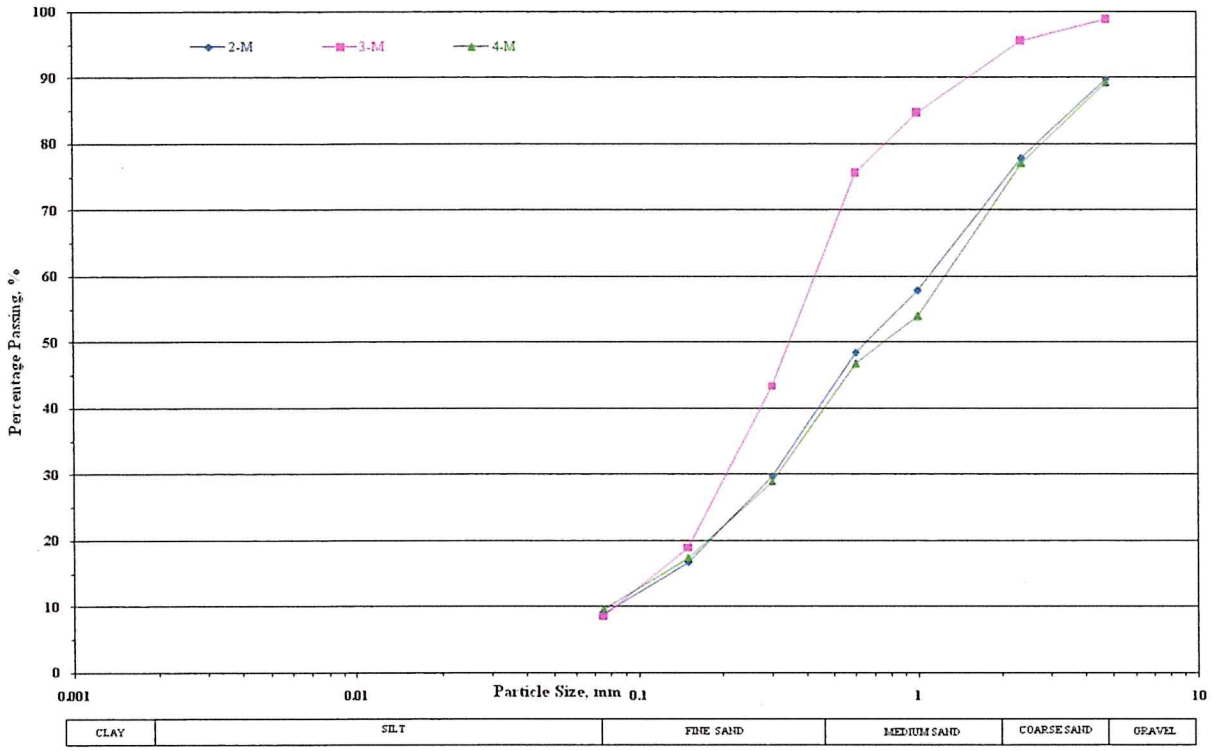
PLATE 13a

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL %	IS CLASS.
						Fine%	Medium%	Coarse%		
8	0.25	13			6					
	1.0	18			6	28	34	23	8	SW
	2.0	14			6	33	31	18	12	SW
	3.0	10			5	13	15	14	53	GW
	4.0	SNR								
	5.0	SNR								
	6.0	SNR	stone	pieces						
9	0.25	13			5					
	1.0	14			9	40	31	10	10	SP-SM
	2.0	14			4	18	20	19	39	SW
	3.0	16			4	17	26	26	37	SW
	4.0	SNR								
	5.0	SNR	core	pieces						
	6.0	SNR	core	pieces						
10	0.25	10			5					
	1.0	18			16					
	2.0	18			13	35	35	12	5	SM
	3.0	15			7	24	27	19	23	SW
	4.0	18			8	29	31	17	15	SW
	5.0	9	stone	pieces						
	6.0	SNR								
11	0.25	18			9					
	1.0	13			5	29	33	15	18	SW
	2.0	14			10	29	30	15	16	SP-SM
	3.0	SNR								
	4.0	SNR								
	5.0	SNR	core	pieces						

PLATE 13b

Grain Size Distribution Curves
Boring 1



Grain Size Distribution Curves
Boring 2

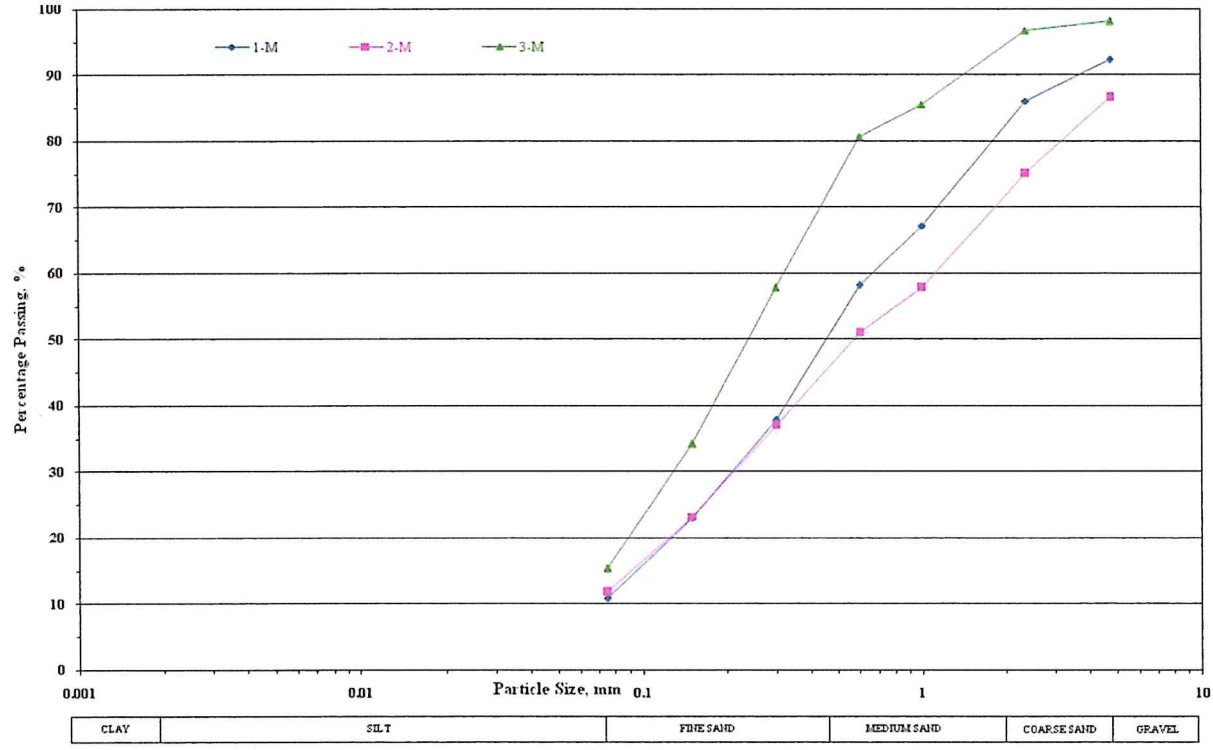


PLATE 14a

Our services go beyond

Buying & Selling Services

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

Legal & Documentation Services

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

Property Development & Approvals

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

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.

Smarter Tools, Stronger Decisions

Property Valuation & Cost Estimation

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

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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