PRASAD ARMSTRONG YEN G E C (P) LTD.
821 (Old No. 439/4) Poonamallee High Road, Arumbakkam, Chennai 600 106.
Phone: 044 - 2363 7146; e-mail: paygec@yahoo.com
CIN: U74210TN1992PTC023645

GEOTECHNICAL SITE INVESTIGATION

BORING 1 THROUGH 16

PROPOSED HIGH-RISE BUILDING SITE

S. NO. 16/1A1A (PART), 16/1A1B (PART), 16/1A1C (PART), 18/2A (PART), 18/3 (PART) AND 20 (PART), THAIYUR "A" VILLAGE

THIRUPORUR TALUK, CHENGALPATTU DISTRICT, TN.

WITHIN THE LIMITS OF THIRUPORUR PANCHAYAT UNION.

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Report to

M/s. Emerald Haven Housing Pvt. Ltd.
1st Floor Greenways Towers
No. 119, St. Mary's Road
Abhiramapuram, Chennai 600 018, TN.

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Report No. 253/GI/18-19.
February 11, 2019.

M/s. Emerald Haven Housing Pvt. Ltd.
1st Floor Greenways Towers
No. 119, St. Mary's Road
Abhiramapuram, Chennai 600 018, TN.

Geotechnical Site Investigation
Boring 1 through 16
Proposed High-Rise Building Site
S. No. 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) and 20 (Part), Thaiyur "A" Village
Thiruporur Taluk, Chengalpattu District, TN.
Within the Limits of Thiruporur Panchayat Union.

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 Work Order Ref: WO/002/EHR/TYR/20th December 2018 issued on December 21, 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,

For PRASAD ARMSTRONG YEN GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PRASAD ARMSTRONG YEN GEC (P) Ltd.

B. Ram Prasad ME, PhD (Texas A&M)
Managing Director
DTCP Registration No. TVLR/RGTE/2019/06/002

(253brpt)
Copies Submitted: (3)

O/O.THE ASSISTANT DIRECTOR OF TOWN AND COUNTRY PLANNING,
THIRUVALLUR REGION.

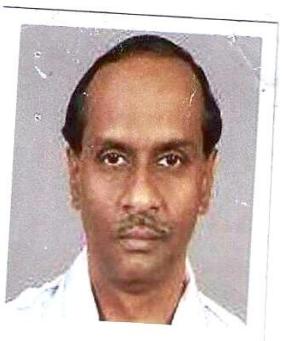
No.43/397A, 2nd Floor, Annai Indira Gandhi Road, Rajajipuram Phase-II, Thiruvallur - 602 001.
E-mail : tvlrregion@gmail.com, Phone : 044-27665657.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that **Dr.B.Ramprasad**, has enrolled as **Geo Tech Engineer (RGTE)** with O/o.The Assistant Director of Town and Country Planning, Thiruvallur Region who has the qualification of **B.E., (Civil Engineering), M.E., (Geotechnical Engineering), Ph.D.,** and experience in the relevant field for **35 Years.**

He has been given the Registration No: **TVLR/RGTE/2019/06/002** Renewed on **18.07.2024.** 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 (MA.1) Dept., Dated:04.02.2019.**

This Registration is valid upto **17.07.2029.**



18/07/24
Assistant Director of
Town and Country Planning,
Thiruvallur Region.

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

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Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

SUMMARY

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation at the Proposed High-Rise Building Site, S. No. 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part), and 20 (Part), **Thaiyur "A" Village**, Thiruporur Taluk, Chengalpattu District, TN. Within the Limits of Thiruporur Panchayat Union. The primary purpose of this investigation was to obtain data to develop foundation design recommendations for the proposed B + Stilt + 19 floors apartment buildings. This investigation was performed to identify variability in soil stratification of the site, and select suitable foundation, and estimate load carrying capacities of the considered foundation. For the proposed buildings typical maximum column load will be about 550 tons. These details were used only for estimating the preliminary foundation size and type of foundation.

The field investigation was performed January 18 through February 8, 2019. Number and location of borings were selected to cover the proposed buildings area as per the layout plan provided by the client. Boring 1 through 16 were drilled between 8- to 12-M penetration below the Existing Ground Level (EGL). Drilling of the borings was terminated after encountering hard stratum with SPT "N" ≥ 75 in at least six successive tests or on high core recovery in the last 2- to 3-M from bore termination depth. NX TC bit and Diamond bit core barrels were used for drilling through the rocky formation. In most of the borings rock core pieces with high core recover (CR) and medium to high Rock Quality Designation (RQD) were recovered at bore termination depth. Tests were conducted to determine the pertinent index and engineering properties of the soils and rock encountered. We then performed engineering analyses to develop the required design data.

Natural topography of the site reflects a relatively flat terrain. Visual observation infers that EGL of the site was about 1-M below the Existing Road Level (ERL) of road in front of the site. At the boring locations and passage from bore to bore were filled with outside material to maintain dry working condition as the site's groundwater was at EGL itself. A few trees and many bushes and shrubs were present in the site. Compound wall, Fencing stones, boundary stones were present along various parts of the site boundaries. Proposed construction will be the first major construction activity to cover this site. Soil stratigraphy at the borings is tabulated below:

Typical Site Soil Profile:

Stratum	Penetration, M From	To	Description
I	0	1.0	Filled Up Soil
II	1.0	2.5-5.25	Silty Sand
III	2.5-5.25	5.25-10	Weathered Rock
IV	5.25-10	10.0-12.0+	Jointed or Hard Granite

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
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Data from borings indicate presence of hard strata weathered rock from shallow depth but with variations in depth to hard stratum level. In the site that appears to be about 1-M below ERL of road in front of the site for proposed buildings with a basement floor bottom of basement floor will be at about 2.25-M below EGL. Site's Finished Ground Level (FGL) should at least 1-M above ERL to maintain proper surface drainage in the site. With the considered levels total height available for basement floor, basement floor slab thickness, and basement roof slab and beam thickness will be 4.25-M. With the said configuration, typical depth to good weathered rock level from bottom of the basement floor

level will be about 2-M. However, in some locations as in Boring 9, 10, 12, and 13 it can be about 3-M. For these soil and building conditions it was **recommended** to provide **Isolated Column Footing** foundation at 4.25-M below EGL with at least 2-M of footing confinement in surrounding soils and **footings should rest in hard stratum weathered rock formation**. A minimum footing width of 2.5-M was considered in analysis. For the considered foundation **estimated ultimate and recommended allowable capacities were 77 and 30 tons/M^2**, respectively. Estimated total settlement was about 11 mm, less than 60 mm, the IS: 1904 - 2006 code limiting settlement for isolated column footings of framed structures with panel walls on granular soil. All the footings should be interconnected in both directions with tie beams at basement floor slab level. It was also recommended to provide continuous lintels in each floor, and sill level beams under openings for better resistance to seismic forces and differential settlements. **In case of footings on or near the filled open wells or locations with loose soils at 4.25-M level then loose soils upto lower level hard layer should be replaced with well compacted lean concrete. Also footings around these areas should be made into "Combined Footings" with a maximum bearing pressure limited to 2/3rd recommended allowable bearing capacity**. In case of weak soils were encountered at 4.25-M in natural state (non-filled up soils) foundation excavation should be taken down to lower level hard stratum at 5-M below EGL in Boring 9 and 5.3-M in Boring 10. In these areas footings should be placed on hard stratum at these deeper levels.

Groundwater was present in the borings at 1-M below EGL of the borings of filled-up level or at the Original Ground Level (OGL). This is very likely due to recent rains and presence of rocky formation in the site. An 10.5-M diameter and unknown depth open well of was present in the site at about 20.5-M from Boring 5 with groundwater at OGL. Groundwater samples were collected from the open well, Boring 2, and 11 for construction suitability test as per IS: 456 - 2000 guidelines. Test results inferred that groundwater from open well, Boring 2 and 11 were **not suitable** for construction purposes due to high alkalinity as inferred by the methyl orange titration test, high inorganic matter, high organic matter, high sulphates, and high chloride content. Groundwater from the site can be used for construction purposes only after suitable treatment. Groundwater from the site should be checked at regular intervals from the beginning and during construction period to confirm suitability of adopted treatment. **All the structural elements of the building upto stilt floor roof level should be provided with steel, and cement capable of resisting sulphates, and chlorides as in the case of seawater facing structures.**

We do expect construction problems at this site due to variable soil profiles and very high groundwater conditions. Visual observation inferred site's EGL was at about 1-M below ERL of road in front of the site. In order to minimize future site and building flooding from road and surface runoff it was recommended to raise FGL of the site by **at least 1-M above ERL** of road in front of the site. The Finished Floor Level (FFL) of **stilt floor** should be 0.15-M above FGL of the site. This will minimize rainwater runoff flooding into the site and building.

Backfilling of the foundation excavations should be done with granular soil, and fill should be compacted properly to achieve proper densification to avoid settlements in flooring. Exposed bottom surface of the foundation excavation must be properly compacted with heavy duty rammer or heavy roller to compact the exposed surface that gets loosened by mechanical excavation activities. This is to minimize the settlements that can arise if the loosened soil in foundation excavation is not removed or compacted. New foundations should rest on virgin soil and not on loose soils or filled up soils.

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Soil profiles of the borings inferred site to have hard strata weathered rock at uneven levels. On top of this uneven weathered rock layer very loose to medium dense silty sand was present upto EGL. Therefore, during construction care must be taken to inspect and confirm that the soil at foundation level was **dense to very dense weathered rock** and not loose material easy to excavate with back-hoe. Excavated sandy soil and weathered rock can be used for back filling and site filling purposes.

Existing groundwater levels was at OGL of the site itself. Site groundwater levels should be monitored by installing a few 0.9-M diameter and 6-M deep open wells. **Open wells should be developed in the areas near Boring 9 and 10 as depth hard stratum was deepest in the site**. Local enquires should be made to understand the level of groundwater fluctuation in this area. In case of perennial high groundwater level in the site then it will be necessary to develop a **Well Point Dewatering System** to complete the foundation and basement work. Recommended open wells may be used for pump out tests to estimate the groundwater yield, and average permeability to the soil to design the well point dewatering system.

Foundation excavation at some locations will be deeper that will require side slope of a minimum 1:0.5 (V:H) to prevent slope failures during foundation installation. **The basement floor slab should be designed for a minimum 2.5 tons/M^2 upward water pressure that will be exerted when groundwater rises to level above OGL as seen just before this investigation.**

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 7.62 cms and total horizontal displacement was about 56.12 cms. Iwasaki liquefaction potential was 1.62 inferring "**Liquefaction Not Probable**." As per IS code for **Zone III** design horizontal acceleration was **0.08g**. **However, from the expected foundation level and below** (from 4-M below EGL and deeper) with very hard weathered rock formation the liquefaction analysis inferred "**No Liquefaction**."

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

INTRODUCTION

Purpose and Scope

Prasad Armstrong Yen GEC (P) Ltd. performed a geotechnical site investigation at the Proposed High-Rise Building Site, S. No. 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part), and 20 (Part), **Thaiyur "A" Village**, Thiruporur Taluk, Chengalpattu District, TN. Within the Limits of Thiruporur Panchayat Union. The primary purpose of this investigation was to obtain data to develop foundation design recommendations for the proposed B + Stilt + 19 floors apartment buildings. This investigation was performed to identify variability in soil stratification of the site, and select suitable foundation, and estimate load carrying capacities of the considered foundation. For the proposed buildings typical maximum column load will be about 550 tons. 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 16 were drilled 8- to 12-M to explore subsurface stratigraphy and obtain soil and rock samples for laboratory testing;

(2) Field and laboratory 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.

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 recommendations followed by a brief on construction considerations for this project.

FIELD AND LABORATORY INVESTIGATIONS

Exploratory Borings

Soil conditions at the site were explored by Boring 1 through 16. Boring location details are presented on Plate 1. Number and location of borings were selected to cover the proposed buildings area as per the layout plan provided by the client. Boring 1 through 16 were drilled between 8- to 12-M penetration below EGL. Drilling of the borings was terminated after encountering hard stratum with SPT "N" $\geq$ 75 in at least six successive tests or on high core recovery in the last 2- to 3-M from bore termination depth. NX TC bit and Diamond bit core barrels were used for drilling through the rocky formation. In most of the borings rock core pieces with high CR and medium to high RQD were recovered at bore termination depth. Groundwater was at 1-M below EGL of borings and at OGL in site's open well, and borings. Log of Boring are presented on Plate 2 through 17.

For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
Managing Director

Field and Laboratory Tests

Boring was drilled using Calyx drilling unit. In the boring SPT was performed at 1-M interval. Soil samples for laboratory tests were collected from SPT split spoon sampler. SPT consists of driving

a standard split spoon sampler, 50.8-mm outside diameter and 35-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.

Soil-testing program was designed to evaluate pertinent index and engineering properties of the foundation soils and rock. During field operations soil samples were collected at 1-M interval either disturbed or undisturbed as the case may be. All soil and rock 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 18. Photos of rock core sample testing were presented on Plate 19. Grain size distribution curves of tested soil are presented on Plate 20. Summary of Water Test Results are presented on Plate 20.

GENERAL SOIL CONDITIONS

Topography

Natural topography of the site reflects a relatively flat terrain. Visual observation infers that EGL of the site was about 1-M below ERL of road in front of the site. At the boring locations and passage from bore to bore were filled with outside material to maintain dry working condition as the site's groundwater was at EGL itself. A few trees and many bushes and shrubs were present in the site. Compound wall, fencing stones, boundary stones were present along various parts of the site boundaries. Proposed construction will be the first major construction activity to cover this site.

Soil Stratigraphy

Soil stratigraphy disclosed by our field and laboratory investigations of the boring are presented on the Log of Boring on Plate 2 through 17. 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:

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GEOTECH ENGINEERING CONSULTANTS (P) LTD.
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Managing Director

Boring – 1:

Stratum	Penetration, M From	To	Description
I	0	1.0	Yellow Brown Weathered Rock – Filled Up Soil
II	1.0	2.5	Gray Brown Silty Fine to Medium Sand
III	2.5	10.0	Gray Brown Weathered Rock
IV	10.0	12.0+	Gray Highly Jointed Granite

Boring – 2:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Weathered Rock – Fill Soil
II	1.0	2.5	White Brown Silty Fine to Medium Sand
III	2.5	8.0	Brown Gray Weathered Rock
IV	8.0	10.0+	Gray Granite

Boring – 3:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Weathered Rock – Fill Soil
II	1.0	2.5	Brown Silty Fine to Medium Sand
III	2.5	7.0	Brown Gray Weathered Rock
IV	7.0	10.0+	Gray Granite

Boring – 4:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt
II	1.0	2.5	Brown Gray Silty Fine to Medium Sand
III	2.5	6.0	Gray Weathered Rock
IV	6.0	8.25+	Gray Granite

Boring – 5:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Stone Pieces
II	1.0	2.5	Gray Brown Silty Fine to Medium Sand
III	2.5	5.0	Brown Gray Weathered Rock
IV	5.0	8.0+	Gray Jointed Granite

Boring – 6:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt - Filled Up Soil
II	1.0	3.25	Brown Silty Fine to Medium Sand
III	3.25	5.0	Brown Gray Weathered Rock
IV	5.0	8.0+	Gray Granite

Boring – 7:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt and Stone Pieces - Filled Up Soil
II	1.0	2.5	Brown Gray Silty Fine to Medium Sand
III	2.5	6.0	Brown Gray Weathered Rock
IV	6.0	9.0+	Gray Granite

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

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Boring – 8:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Weathered Rock – Fill Soil
II	1.0	3.5	Brown Silty Fine to Medium Sand
III	3.5	8.0	Gray Weathered Rock
IV	8.0	10.0+	Gray Granite

Boring – 9:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Stone Pieces - Filled Up Soil
II	1.0	5.0	Gray Brown Silty Fine to Medium Sand
III	5.0	8.0	Brown Gray Weathered Rock
IV	8.0	11.0+	Gray Granite

Boring – 10:

Stratum	Penetration, M From	To	Description
I	0	1.0	White Brown Weathered Rock – Filled Up Soil
II	1.0	5.25	Brown Gray Silty Fine to Medium Sand
III	5.25	9.0	Gray Weathered Rock
IV	9.0	11.0+	Gray Granite

Boring – 11:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt and Stone Pieces - Filled Up Soil
II	1.0	3.25	Brown Gray Silty Fine to Medium Sand
III	3.25	9.0	Gray Weathered Rock
IV	9.0	11.0+	Gray Granite

Boring – 12:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt and Stone Pieces - Filled Up Soil
II	1.0	4.0	Brown Gray Silty Fine to Medium Sand
III	4.0	7.0	Gray Weathered Rock
IV	7.0	12.0+	Gray Granite

Boring – 13:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt and Stone Pieces - Filled Up Soil
II	1.0	3.25	Brown Silty Fine to Medium Sand
III	3.25	8.0	Gray Weathered Rock
IV	8.0	11.0+	Gray Granite

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Managing Director

Boring – 14:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Medium Sand with Silt and Stone Pieces - Filled Up Soil
II	1.0	4.3	Gray Brown Silty Fine to Medium Sand
III	4.3	6.0	Gray Weathered Rock
IV	6.0	9.0+	Gray Granite

Boring – 15:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Coarse Sand with Stone Pieces – Filled Up Soil
II	1.0	3.25	Brown Silty Fine to Medium Sand
III	3.25	7.0	Gray Weathered Rock
IV	7.0	9.5+	Gray Jointed Granite

Boring – 16:

Stratum	Penetration, M From	To	Description
I	0	1.0	Brown Fine to Coarse Sand with Stone Pieces – Filled Up Soil
II	1.0	3.25	Brown Fine to Medium Sand with Silt
III	3.25	4.0	White Green Weathered Rock with Limestone Pieces
IV	4.0	8.0	Gray Weathered Rock
V	8.0	11.0+	Gray Granite

Detailed soil descriptions that include textural variations and inclusions are noted on the log of boring presented on Plate 2 through 17.

Interpretation of Soil Properties

Shear strength parameters for cohesionless soils were selected based on the SPT, and grain size distribution analyses. Shear strength parameters for cohesive soils were selected based on the SPT results. Unit weight (soil density) profiles of 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.)

Recommendations presented herein for the proposed buildings were based on the soil properties encountered in Boring 12 and 13. **There may be a need to drill additional borings to investigate soil variability if encountered during the foundation work.** 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	1.0	γ_{sat} = 1.45 tons/M^3
IIa	1.0	2.0	$\phi = 26^o$; γ_{sat} = 1.5 tons/M^3
IIb	1.0	2.5	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
IIIa	2.5	3.25	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
IIIb	3.25	4.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IIIc	4.0	10.0	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3
IV	10.0	12.0+	$\phi = 40^o$; γ_{sat} = 2.35 tons/M^3

Boring – 2:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.5 tons/M^3
IIa	1.0	2.0	$\phi = 27^o$; γ_{sat} = 1.6 tons/M^3

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Managing Director

IIb	1.0	2.5	$\phi = 35^o$; $\gamma_{sat} = 1.95$ tons/M^3
IIIa	2.5	4.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIb	4.0	5.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIIc	5.0	8.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	8.0	10.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 3:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.5$ tons/M^3
IIa	1.0	1.75	$\phi = 27^o$; $\gamma_{sat} = 1.6$ tons/M^3
IIb	1.75	2.5	$\phi = 25^o$; $\gamma_{sat} = 1.5$ tons/M^3
IIIa	2.5	3.25	$\phi = 31^o$; $\gamma_{sat} = 1.65$ tons/M^3
IIIb	3.25	4.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIc	4.0	7.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	7.0	10.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 4:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.55$ tons/M^3
IIa	1.0	1.5	$\phi = 29^o$; $\gamma_{sat} = 1.6$ tons/M^3
IIb	1.5	2.5	$\phi = 24^o$; $\gamma_{sat} = 1.45$ tons/M^3
IIIa	2.5	3.25	$\phi = 34^o$; $\gamma_{sat} = 1.8$ tons/M^3
IIIb	3.25	4.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIc	4.0	5.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIId	5.0	6.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	6.0	8.25+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 5:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.55$ tons/M^3
II	1.0	2.5	$\phi = 26^o$; $\gamma_{sat} = 1.55$ tons/M^3
IIIa	2.5	3.25	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IIIb	3.25	4.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIIc	4.0	5.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	5.0	8.0+	$\phi = 40^o$; $\gamma_{sat} = 2.3$ tons/M^3

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Boring – 6:

Stratum	Penetration, M From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.4$ tons/M^3
II	1.0	3.25	$\phi = 25^o$; $\gamma_{sat} = 1.5$ tons/M^3
IIIa	3.25	4.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIIb	4.0	5.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	5.0	8.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 7:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.4 tons/M^3
IIa	1.0	2.5	$\phi = 24^o$; γ_{sat} = 1.45 tons/M^3
IIb	2.5	3.25	$\phi = 27^o$; γ_{sat} = 1.55 tons/M^3
IIIa	3.25	4.0	$\phi = 37^o$; γ_{sat} = 2.1 tons/M^3
IIIb	4.0	6.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IV	6.0	9.0+	$\phi = 42^o$; γ_{sat} = 2.35 tons/M^3

Boring – 8:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.5 tons/M^3
IIa	1.0	2.25	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
IIb	2.25	3.5	$\phi = 24^o$; γ_{sat} = 1.45 tons/M^3
IIIa	3.5	4.0	$\phi = 35^o$; γ_{sat} = 1.95 tons/M^3
IIIb	4.0	8.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IV	8.0	10.0+	$\phi = 42^o$; γ_{sat} = 2.35 tons/M^3

Boring – 9:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.45 tons/M^3
IIa	1.0	2.25	$\phi = 25^o$; γ_{sat} = 1.5 tons/M^3
IIb	2.25	4.0	$\phi = 23^o$; γ_{sat} = 1.4 tons/M^3
IIc	4.0	5.0	$\phi = 27^o$; γ_{sat} = 1.6 tons/M^3
III	5.0	8.0	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3
IV	8.0	11.0+	$\phi = 42^o$; γ_{sat} = 2.35 tons/M^3

Boring – 10:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.45 tons/M^3
IIa	1.0	1.75	$\phi = 24^o$; γ_{sat} = 1.45 tons/M^3
IIb	1.75	2.25	$\phi = 25^o$; γ_{sat} = 1.5 tons/M^3
IIc	2.25	3.25	$\phi = 23^o$; γ_{sat} = 1.4 tons/M^3
IId	3.25	4.0	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
IIe	4.0	5.25	$\phi = 30^o$; γ_{sat} = 1.6 tons/M^3
IIIa	5.25	6.0	$\phi = 34^o$; γ_{sat} = 1.75 tons/M^3
IIIb	6.0	7.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IIIc	7.0	9.0	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3
IV	9.0	11.0+	$\phi = 42^o$; γ_{sat} = 2.35 tons/M^3

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Boring – 11:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.4 tons/M^3
IIa	1.0	1.5	$\phi = 25^o$; γ_{sat} = 1.5 tons/M^3
IIb	1.5	2.5	$\phi = 23^o$; γ_{sat} = 1.4 tons/M^3

IIc	2.5	3.25	$\phi = 25^o$; $\gamma_{sat} = 1.5$ tons/M^3
IIIa	3.25	4.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIb	4.0	8.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIIc	8.0	9.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	9.0	11.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 12:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.45$ tons/M^3
IIa	1.0	2.25	$\phi = 27^o$; $\gamma_{sat} = 1.55$ tons/M^3
IIb	2.25	4.0	$\phi = 24^o$; $\gamma_{sat} = 1.4$ tons/M^3
IIIa	4.0	5.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIIb	5.0	6.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IIIc	6.0	7.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	7.0	12.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 13:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.55$ tons/M^3
II	1.0	3.25	$\phi = 32^o$; $\gamma_{sat} = 1.7$ tons/M^3
IIIa	3.25	4.0	$\phi = 30^o$; $\gamma_{sat} = 1.65$ tons/M^3
IIIb	4.0	4.75	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIc	4.75	6.0	$\phi = 34^o$; $\gamma_{sat} = 1.85$ tons/M^3
IIId	6.0	8.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	8.0	11.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 14:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.45$ tons/M^3
IIa	1.0	1.75	$\phi = 26^o$; $\gamma_{sat} = 1.55$ tons/M^3
IIb	1.75	3.25	$\phi = 24^o$; $\gamma_{sat} = 1.45$ tons/M^3
IIc	3.25	4.3	$\phi = 26^o$; $\gamma_{sat} = 1.55$ tons/M^3
III	4.3	6.0	$\phi = 38^o$; $\gamma_{sat} = 2.2$ tons/M^3
IV	6.0	9.0+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

Boring – 15:

	Penetration, M		
Stratum	From	To	Properties
I	0	1.0	$\gamma_{sat} = 1.45$ tons/M^3
II	1.0	3.25	$\phi = 26^o$; $\gamma_{sat} = 1.55$ tons/M^3
IIIa	3.25	4.0	$\phi = 33^o$; $\gamma_{sat} = 1.75$ tons/M^3
IIIb	4.0	5.0	$\phi = 37^o$; $\gamma_{sat} = 2.1$ tons/M^3
IIIc	5.0	7.0	$\phi = 39^o$; $\gamma_{sat} = 2.25$ tons/M^3
IV	7.0	9.5+	$\phi = 42^o$; $\gamma_{sat} = 2.35$ tons/M^3

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Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Boring – 16:

Stratum	Penetration, M From	To	Properties
I	0	1.0	γ_{sat} = 1.45 tons/M^3
IIa	1.0	3.25	$\phi = 26^o$; γ_{sat} = 1.55 tons/M^3
III	3.25	4.0	$\phi = 32^o$; γ_{sat} = 1.7 tons/M^3
IVa	4.0	6.0	$\phi = 38^o$; γ_{sat} = 2.2 tons/M^3
IVb	6.0	8.0	$\phi = 39^o$; γ_{sat} = 2.25 tons/M^3
V	8.0	11.0+	$\phi = 42^o$; γ_{sat} = 2.35 tons/M^3

DESIGN INFORMATION

Data from borings indicate presence of hard strata weathered rock from shallow depth but with variations in depth to hard stratum level. In the site that appears to be about 1-M below ERL of road in front of the site for proposed buildings with a basement floor bottom of basement floor will be at about 2.25-M below EGL. Site's FGL should at least 1-M above ERL to maintain proper surface drainage in the site. With the considered levels total height available for basement floor, basement floor slab thickness, and basement roof slab and beam thickness will be 4.25-M. With the said configuration, typical depth to good weathered rock level from bottom of the basement floor level will be about 2-M. However, in some locations as in Boring 9, 10, 12, and 13 it can be about 3-M. For these soil and building conditions it was **recommended** to provide **Isolated Column Footing** foundation at 4.25-M below EGL with at least 2-M of footing confinement in surrounding soils and **footings should rest in hard stratum weathered rock formation**. A minimum footing width of 2.5-M was considered in 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:

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

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Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

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 77 and 30 tons/M^2**, respectively. Estimated total settlement was about 11 mm, less than 60 mm, the IS: 1904 - 2006 code limiting settlement for isolated column footings of framed structures with panel walls on granular soil. All the footings should be interconnected in both directions with tie beams at basement floor slab level. It was also recommended to provide continuous lintels in each floor, and sill level beams under openings for better resistance to seismic forces and differential settlements. **In case of footings on or near the filled open wells or locations with loose soils at 4.25-M level then loose soils upto lower level hard layer should be replaced with well compacted lean concrete. Also footings around these areas should be made into "Combined Footings" with a maximum bearing pressure limited to 2/3rd recommended allowable bearing capacity**. In case of weak soils were encountered at 4.25-M in natural state (non-filled up soils) foundation excavation should be taken

down to lower level hard stratum at 5-M below EGL in Boring 9 and 5.3-M in Boring 10. In these areas footings should be placed on hard stratum at these deeper levels. Foundation capacity calculations were presented on Plate 22.

GROUNDWATER

Groundwater was present in the borings at highly variable depths from 1-M below EGL to completely dry borings. This is very likely due to recent rains and presence of rocky formation at variable depth in the site. An 8.25-M diameter and unknown depth open well of was present in the site at about 27.7-M from Boring 7 with groundwater at 2.1-M below EGL. Groundwater sample was collected from this open well for construction suitability test as per IS: 456 - 2000 guidelines. Test results inferred that groundwater from the open well was **suitable** for construction purposes. Groundwater from the site should be checked at regular intervals from the beginning and during construction period to confirm groundwater's construction suitability. Summary of ground water test results is presented on Plate 21.

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GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Managing Director

CONSTRUCTION CONSIDERATIONS

We do expect construction problems at this site due to variable soil profiles and high groundwater conditions. Visual observation inferred site's EGL was at about 1-M below ERL of road in front of the site. In order to minimize future site and building flooding from road and surface runoff it was recommended to raise FGL of the site by **at least 1-M above ERL** of road in front of the site. FFL of **stilt floor** should be 0.15-M above FGL of the site. This will minimize rainwater runoff flooding into the site and building.

Backfilling of the foundation excavations should be done with granular soil, and fill should be compacted properly to achieve proper densification to avoid settlements in flooring. Exposed bottom surface of the foundation excavation must be properly compacted with heavy duty rammer or heavy roller to compact the exposed surface that gets loosened by mechanical excavation activities. This is to minimize the settlements that can arise if the loosened soil in foundation excavation is not removed or compacted. New foundations should rest on virgin soil and not on loose soils or filled up soils.

Soil profiles of the borings inferred site to have hard strata weathered rock at uneven levels. On top of this uneven weathered rock layer very loose to medium dense silty sand was present upto EGL. Therefore, during construction care must be taken to inspect and confirm that the soil at foundation level was **dense to very dense weathered rock** and not loose material easy to excavate with back-hoe. Excavated sandy soil and weathered rock can be used for back filling and site filling purposes.

Existing groundwater levels was at OGL of the site itself. Site groundwater levels should be monitored by installing a few 0.9-M diameter and 6-M deep open wells. **Open wells should be developed in the areas near Boring 9 and 10 as depth hard stratum was deepest in the site**. Local enquires should be made to understand the level of groundwater fluctuation in this area. In case of perennial high groundwater level in the site then it will be necessary to develop a **Well Point Dewatering System** to complete the foundation and basement work. Recommended open wells may be used for pump out tests to estimate the groundwater yield, and average permeability to the soil to design the well point dewatering system.

Foundation excavation at some locations will be deeper that will require side slope of a minimum 1:0.5 (V:H) to prevent slope failures during foundation installation. **The basement floor slab should be designed for a minimum 2.5 tons/M^2 upward water pressure that will be exerted when groundwater rises to level above OGL as seen just before this investigation.**

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 7.62 cms and total horizontal displacement was about 56.12 cms. Iwasaki liquefaction potential was 1.62 inferring "**Liquefaction Not Probable**." As per IS code for **Zone III** design horizontal acceleration was **0.08g**. **However, from the expected foundation level and below** (from 4-M below EGL and deeper) with very hard weathered rock formation the liquefaction analysis inferred "**No Liquefaction**." Liquefaction Analysis results are presented on Plate 23.

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

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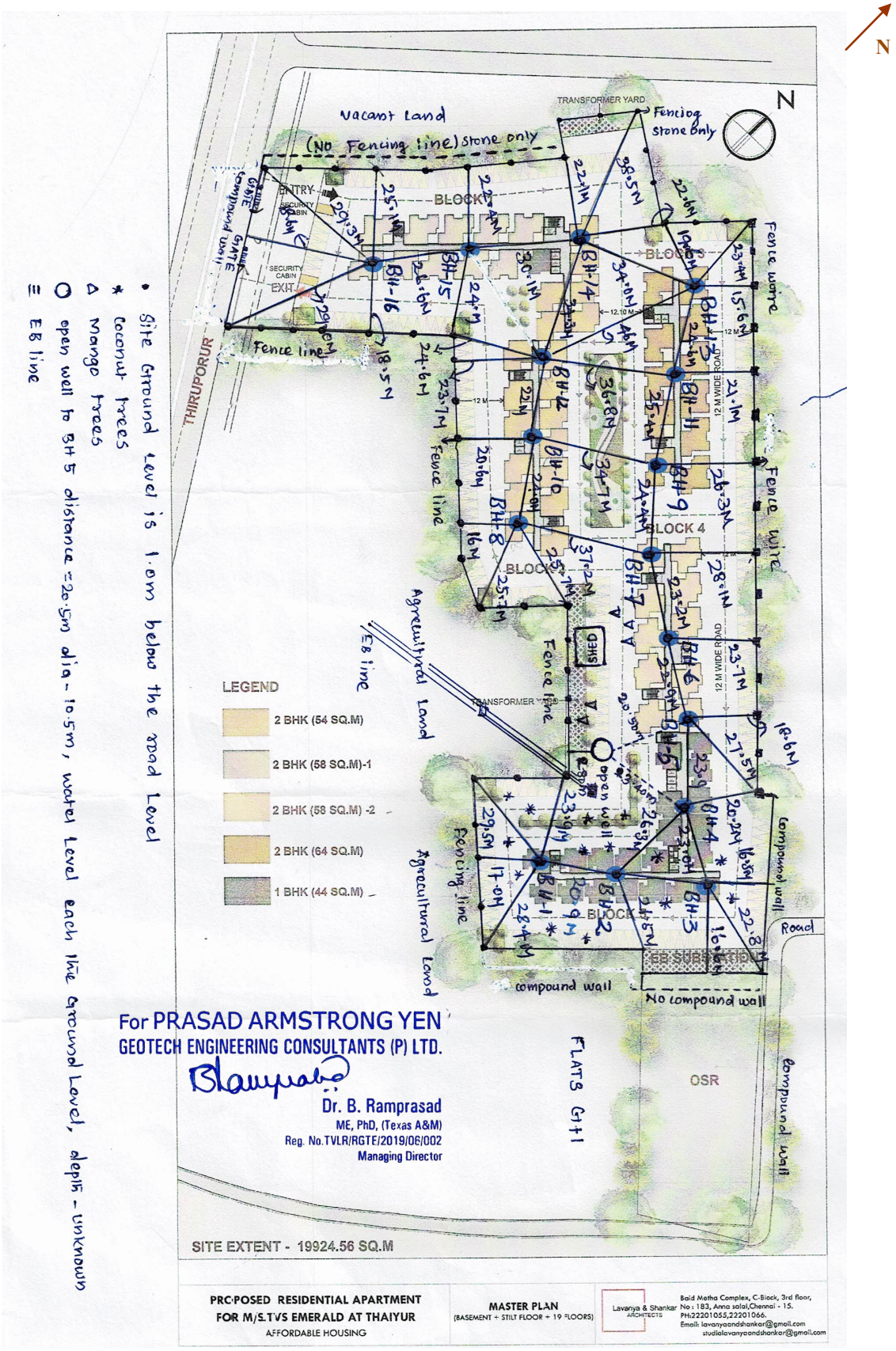
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For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director



(Not To Scale)

Site EGL = 1.0-M Below ERL Road In Front of Site.
SITE PLAN WITH BORE LOCATION DETAILS.

PLATE 1

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 31-01-'19 **Ended on:** 2-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 12.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	YELLOW BROWN WEATHERED ROCK – Filled Up Soil (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} ~ 2)	1/2/2 = 4 Blows
GWL	GRAY BROWN SILTY FINE TO MEDIUM SAND (To 2.5-M)	SPT @ 1.75 M
	1.0- to 2.0-m – ϕ = 26°; γ_t = 1.5 tons/M^3	2/5/10 = 15 Blows
2.0	(N_{avg} ~ 4)	
	2.0- to 2.5-M – ϕ = 32°; γ_t = 1.7 tons/M^3	SPT @ 2.5 M 24/
	(N_{avg} = 20)	4 cms for 10 Blows
	GRAY BROWN WEATHERED ROCK	4 cms for 10 Blows
3.0	(To 10.0-M) (N_{avg} = 75)	SPT @ 3.25 M
	2.5- to 3.25-m – ϕ = 37°; γ_t = 2.1 tons/M^3	5 cms for 15 Blows
	-NX TC bit drilling from 3.25- to 3.5-m in 35 min.	1 cm for 5 Blows
	3.25- to 4.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	SPT @ 4 M (SNR)
4.0	(N_{avg} > 100)	0.5 cms for 10 Blows
	-NX Diamond bit drilling from 3.5-m	0 cms for 5 Blows
	-drilled from 3.5- to 4-m in 30 minutes	(Hammer Rebound)
	-stone pieces recovered drilling to 4-m	SPT @ 5 M (SNR)
5.0	-drilled from 4- to 5-m in 35 minutes	0 cms for 5 Blows
	-15 cms core pieces recovered drilling to 5-m	(Hammer Rebound)
		SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 45 minutes	0 cms for 5 Blows
		(Hammer Rebound)
		SPT @ 7 M
7.0	-drilled from 6- to 7-m in 40 minutes	4 cms for 15 Blows
	4.0- to 10.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	0.5 cms for 5 Blows
	(N_{avg} >> 100)	(Hammer Rebound)
		SPT @ 8 M (SNR)
8.0	-drilled from 7- to 8-m in 40 minutes	0.5 cms for 10 Blows
		0 cms for 5 Blows
		(Hammer Rebound)
	-drilled from 8- to 9-m in 55 minutes	SPT @ 9 M (SNR)
9.0	-31 cms core recovered drilling to 9-m	0 cms for 5 Blows
	-31% CR and 0% RQD at 9-m	(Hammer Rebound)
	-drilled from 9- to 10-m in 70 minutes	
	-22 cms core recovered drilling to 10-m	SPT @ 10 M (SNR)
10.0	-22% CR and 12% RQD at 10-m	0 cms for 5 Blows
	GRAY HIGHLY JOINTED GRANITE	(Hammer Rebound)
	(Below 10.0-M) (N_{avg} >> 100)	SPT @ 11 M (SNR)
	10.0- to 12.0-m – ϕ = 40°; γ_t = 2.35 tons/M^3	0 cms for 5 Blows
11.0	-drilled from 10- to 11-m in 50 minutes	(Hammer Rebound)

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/08/002
Managing Director

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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 1 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 31-01-'19 **Ended on:** 2-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 12.0-M **Depth to G W S:** 1.0-M **Remarks:** Continue from Plate 2a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY HIGHLY JOINTED GRANITE (Below 10.0-M)			
12.0	-stone pieces recovered drilling to 11-m 10.0- to 12.0-m – $\phi = 40^{o}$; $\gamma_t = 2.35$ tons/M^3	SPT @ 12 M (SNR) 0 cms for 5 Blows		
	(N_{avg} >> 100) -drilled from 11- to 12-m in 120 minutes	(Hammer Rebound)		
13.0	-24 cms core recovered drilling to 12-m -24% CR and 21% RQD at 12-m			
14.0				
15.0				
16.0				
17.0				
18.0				
19.0				
20.0				
21.0				
22.0				

For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 12.0-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 2b

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 2 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 2-02-'19 **Ended on:** 3-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 10.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN WEATHERED ROCK - FILL SOIL (To 1.0-M)	DS @ 0.5 M
	0.0- to 1.0-m – γ_t = 1.5 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 4)	2/4/5 = 9 Blows
GWL	**WHITE BROWN SILTY FINE TO MEDIUM SAND (To 2.5-M)**	SPT @ 1.75 M
	1.0- to 2.0-m – ϕ = 27°; γ_t = 1.6 tons/M^3	4/11/20 = 31 Blows
2.0	(N_{avg} = 9)	
	2.0- to 2.5-M – ϕ = 35°; γ_t = 1.95 tons/M^3	SPT @ 2.5 M
	(N_{avg} ~ 40)	4 cms for 10 Blows
	BROWN GRAY WEATHERED ROCK	4 cms for 10 Blows
3.0	**(To 8.0-M)**	SPT @ 3.25 M
	-NX TC bit drilling from 3.25- to 4-m in 25 min.	3 cms for 10 Blows
	2.5- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	4 cms for 10 Blows
	(N_{avg} = 75)	SPT @ 4 M
4.0	-NX Diamond bit drilling from 4-m	3 cms for 10 Blows
		2 cms for 10 Blows
	4.0- to 5.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	(Hammer Rebound)
	(N_{avg} > 100)	SPT @ 5 M (SNR)
5.0	-drilled from 4- to 5-m in 40 minutes	0.5 cms for 10 Blows
		0 cms for 5 Blows
		(Hammer Rebound)
		SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 50 minutes	0 cms for 5 Blows
		(Hammer Rebound)
	5.0- to 8.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	
	(N_{avg} >> 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 65 minutes	0.5 cms for 10 Blows
		0 cms for 5 Blows
		(Hammer Rebound)
	-drilled from 7- to 8-m in 50 minutes	SPT @ 8 M (SNR)
8.0	-17 cms core recovered drilling to 8-m	0 cms for 5 Blows
	GRAY GRANITE (Below 8.0-M)	(Hammer Rebound)
	8.0- to 10.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	SPT @ 9 M (SNR)
9.0	(N_{avg} >> 100)	0 cms for 5 Blows
	-drilled from 8- to 9-m in 80 minutes	(Hammer Rebound)
	-51 cms core recovered drilling to 9-m	
	-51% CR and 40% RQD at 9-m	SPT @ 10 M (SNR)
10.0	-drilled from 9- to 10-m in 120 minutes	0 cms for 5 Blows
	-100 cms core recovered drilling to 10-m	(Hammer Rebound)
	-100% CR and 100% RQD at 10-m	
11.0		

For PRASAD ARMSTRONG YEN GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 10.0-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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 3 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 31-01-'19 **Ended on:** 1-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 10.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN WEATHERED ROCK - FILL SOIL (To 1.0-M)	DS @ 0.25 M
	0.0- to 1.0-m – γ_t = 1.5 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 4)	2/3/5 = 8 Blows
GWL	BROWN SILTY FINE TO MEDIUM SAND	
	(To 2.5-M) (N_{avg} = 8)	SPT @ 1.75 M
	1.0- to 1.75-m – ϕ = 27°; γ_t = 1.6 tons/M^3	1/2/2 = 4 Blows
2.0	1.75- to 2.5-M – ϕ = 25°; γ_t = 1.5 tons/M^3	
	(N_{avg} = 4)	SPT @ 2.5 M
		5/10/5 = 15 Blows
	BROWN GRAY WEATHERED ROCK	
3.0	(To 7.0-M) (N_{avg} = 15)	SPT @ 3.25 M 17/
	2.5- to 3.25-m – ϕ = 31°; γ_t = 1.65 tons/M^3	4 cms for 10 Blows
	3.25- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	4 cms for 10 Blows
	(N_{avg} = 75)	SPT @ 4 M 32/
4.0	-NX TC bit drilling from 4- to 4.4-m in 30 min.	2 cms for 10 Blows
		1 cm for 10 Blows
	-NX Diamond bit drilling from 4.4-m	(Hammer Rebound)
		SPT @ 5 M (SNR)
5.0	-drilled from 4- to 5-m in 30 minutes	0.5 cms for 10 Blows
		0 cms for 5 Blows
	4.0- to 7.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 65 minutes	0 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 6- to 7-m in 60 minutes	
	-34 cms core recovered drilling to 7-m	SPT @ 7 M (SNR)
7.0	-34% CR and 11% RQD at 7-m	0.5 cms for 10 Blows
	GRAY GRANITE (Below 7.0-M)	0 cms for 5 Blows
	-with joints, 7- to 8-m	(Hammer Rebound)
		SPT @ 8 M (SNR)
8.0	-drilled from 7- to 8-m in 65 minutes	0 cms for 5 Blows
	-40 cms core recovered drilling to 8-m	(Hammer Rebound)
	-40% CR and 26% RQD at 8-m	
	7.0- to 10.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	SPT @ 9 M (SNR)
9.0	(N_{avg} >> 100)	0 cms for 5 Blows
	-drilled from 8- to 9-m in 70 minutes	(Hammer Rebound)
	-72 cms core recovered drilling to 9-m	
	-72% CR and 54% RQD at 9-m	SPT @ 10 M (SNR)
10.0	-drilled from 9- to 10-m in 120 minutes	0 cms for 5 Blows
	-75 cms core recovered drilling to 10-m	(Hammer Rebound)
	-75% CR and 75% RQD at 10-m	
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 10.0-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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 4 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 2-02-'19 **Ended on:** 2-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 8.25-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt (To 1.0-M)	DS @ 0.25 M
	0.0- to 1.0-m – γ_t = 1.55 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 6)	3/5/5 = 10 Blows
GWL	BROWN GRAY SILTY FINE TO MEDIUM SAND (To 2.5-M) (N_{avg} = 10)	SPT @ 1.75 M
	1.0- to 1.5-m – ϕ = 29°; γ_t = 1.6 tons/M^3	1/1/2 = 3 Blows
2.0	1.5- to 2.5-M – ϕ = 24°; γ_t = 1.45 tons/M^3	
	(N_{avg} = 3)	SPT @ 2.5 M
		9/12/16 = 28 Blows
	GRAY WEATHERED ROCK (To 6.0-M)	
3.0	2.5- to 3.25-m – ϕ = 34°; γ_t = 1.8 tons/M^3	SPT @ 3.25 M 24/
	(N_{avg} = 28)	4 cms for 10 Blows
	3.25- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	4 cms for 10 Blows
	(N_{avg} = 75)	SPT @ 4 M
4.0		3 cms for 10 Blows
	4.0- to 5.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	2 cms for 10 Blows
	(N_{avg} > 100)	(Hammer Rebound)
	-NX TC bit drilling from 4.7- to 5-m in 30 minutes	SPT @ 5 M
5.0	-NX Diamond bit drilling from 5-m	2 cms for 10 Blows
	5.0- to 6.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	1 cm for 10 Blows
	(N_{avg} >> 100)	(Hammer Rebound)
	-drilled from 5- to 6-m in 55 minutes	SPT @ 6 M (SNR)
6.0	-10 cms core recovered drilling to 6-m	1 cm for 10 Blows
	GRAY GRANITE (Below 6.0-M)	0.5 cms for 10 Blows
	6.0- to 8.25-m – ϕ = 42°; γ_t = 2.35 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 75 minutes	0 cms for 10 Blows
	-55 cms core recovered drilling to 7-m	(Hammer Rebound)
	-55% CR and 49% RQD at 8-m	
	-drilled from 7- to 8-m in 100 minutes	SPT @ 8 M (SNR)
8.0	-86 cms core recovered drilling to 8-m	0 cms for 10 Blows
	-86% CR and 86% RQD at 8-m	(Hammer Rebound)
	-drilled from 8- to 8.25-m in 25 minutes	
	-14 cms core recovered drilling to 8.25-m	
9.0	-56% CR and 0% RQD at 8.25-m	
10.0		
11.0		

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

For PRASAD ARMSTRONG YEN GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 8.25-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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 5 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 2-02-'19 **Ended on:** 2-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 8.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with stone pieces (To 1.0-M)	DS @ 0.25 M
	0.0- to 1.0-m – γ_t = 1.55 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 6)	3/3/5 = 8 Blows
GWL	GRAY BROWN SILTY FINE TO MEDIUM SAND (To 2.5-M)	SPT @ 1.75 M
	1.0- to 2.5-M – ϕ = 26°; γ_t = 1.55 tons/M^3	2/2/2 = 4 Blows
2.0	(N_{avg} = 6)	
		SPT @ 2.5 M
		3/8/15 = 23 Blows
	BROWN GRAY WEATHERED ROCK	
3.0	(To 5.0-M) (N_{avg} = 23)	SPT @ 3.25 M 26/
	2.5- to 3.25-m – ϕ = 33°; γ_t = 1.75 tons/M^3	3 cms for 10 Blows
	3.25- to 4.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	2 cms for 10 Blows
	(N_{avg} > 100)	SPT @ 4 M (SNR)
4.0	-NX TC bit drilling from 4- to 4.5-m in 40 min.	1 cm for 10 Blows
	-NX Diamond bit drilling from 4.5-m	0.5 cms for 5 Blows
	4.0- to 5.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 5 M (SNR)
5.0	-drilled from 4.5- to 5-m in 20 minutes	0.5 cms for 10 Blows
	GRAY JOINTED GRANITE (Below 5.0-M)	0 cms for 5 Blows
		(Hammer Rebound)
	-drilled from 5- to 6-m in 75 minutes	SPT @ 6 M (SNR)
6.0	-37 cms core recovered drilling to 6-m	0.5 cms for 10 Blows
	-37% CR and 17% RQD at 6-m	0 cms for 10 Blows
	5.0- to 8.0-m – ϕ = 40°; γ_t = 2.3 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 90 minutes	0 cms for 10 Blows
	-37 cms core recovered drilling to 7-m	(Hammer Rebound)
	-37% CR and 17% RQD at 7-m	(Hammer Rebound)
8.0	-drilled from 7- to 8-m in 105 minutes	
	-30 cms core recovered drilling to 8-m	
	-30% CR and 27% RQD at 8-m	
9.0	Note: Bore was terminated at 8-M as rock core bit fell into bore at got stuck at 6-m preventing further drilling and testing activities.	
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 8.0-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

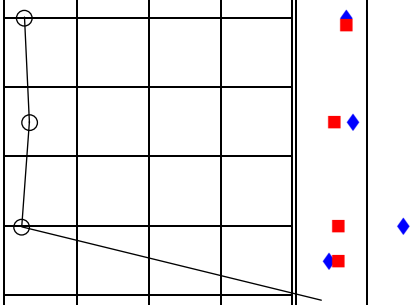
Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 6 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 3-02-'19 **Ended on:** 4-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 8.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt - Filled Up Soil (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)	1/2/3 = 5 Blows
GWL	**BROWN SILTY FINE TO MEDIUM SAND (To 3.25-M)**	
		SPT @ 1.75 M
2.0		3/3/4 = 7 Blows
	1.0- to 3.25-m – ϕ = 25°; γ_t = 1.5 tons/M^3	SPT @ 2.5 M
	(N_{avg} ~ 5)	2/2/2 = 4 Blows
3.0		SPT @ 3.25 M 30/
		2 cms for 10 Blows
	BROWN GRAY WEATHERED ROCK	2 cms for 10 Blows
	(To 5.0-M) (N_{avg} > 100)	SPT @ 4 M (SNR)
4.0	3.25- to 4.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	1 cm for 10 Blows
	-NX TC bit drilling from 4- to 5-m in 35 min.	1 cm for 10 Blows
	4.0- to 5.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 5 M (SNR)
5.0	-NX Diamond bit drilling from 5-m	1 cm for 15 Blows
	GRAY GRANITE (Below 5.0-M)	0 cms for 5 Blows
	-with joints, 5- to 6-m	(Hammer Rebound)
		SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 105 minutes	0 cms for 5 Blows
	-57 cms core recovered drilling to 6-m	(Hammer Rebound)
	-57% CR and 41% RQD at 6-m	
	5.0- to 8.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	SPT @ 7 M (SNR)
7.0	(N_{avg} >> 100)	0 cms for 5 Blows
	-drilled from 6- to 7-m in 80 minutes	(Hammer Rebound)
	-93 cms core recovered drilling to 7-m	
	-93% CR and 93% RQD at 7-m	No SPT @ 8 M
8.0	-drilled from 7- to 8-m in 85 minutes	single rock core
	-93 cms core recovered drilling to 8-m	piece recovered
	-93% CR and 93% RQD at 8-m	
9.0		
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75



For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/003/002
Managing Director

BORE HOLE TERMINATED AT 8.0-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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 7 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 3-02-'19 **Ended on:** 4-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 9.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt, and stone pieces - Filled Up Soil (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)	1/2/3 = 5 Blows
GWL	**BROWN GRAY SILTY FINE TO MEDIUM SAND (To 3.25-M)**	SPT @ 1.75 M
	1.0- to 2.5-M – ϕ = 24°; γ_t = 1.45 tons/M^3	1/2/2 = 4 Blows
2.0	(N_{avg} = 4)	
		SPT @ 2.5 M
	-with shell fragments at 1.0-M	2//3/4 = 7 Blows
	2.5- to 3.25-m – ϕ = 27°; γ_t = 1.55 tons/M^3	
3.0	(N_{avg} = 7)	SPT @ 3.25 M 16/
		4 cms for 10 Blows
	BROWN GRAY WEATHERED ROCK	3 cms for 10 Blows
	(To 6.0-M) (N_{avg} ~ 95)	SPT @ 4 M
4.0	3.25- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	3 cms for 10 Blows
	-NX Diamond bit drilling from 4-m	2 cms for 10 Blows
		(Hammer Rebound)
	4.0- to 6.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	SPT @ 5 M
5.0	(N_{avg} > 100)	3 cms for 10 Blows
	-drilled from 4- to 5-m in 35 minutes	2 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 5- to 6-m in 70 minutes	SPT @ 6 M (SNR)
6.0	-8 cms core recovered drilling to 6-m	0.5 cms for 10 Blows
	GRAY GRANITE (Below 6.0-M)	0 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 6- to 7-m in 75 minutes	SPT @ 7 M (SNR)
7.0	-79 cms core recovered drilling to 7-m	0 cms for 5 Blows
	-79% CR and 53% RQD at 7-m	(Hammer Rebound)
	6.0- to 9.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	No SPT @ 8 M
8.0		solid rock core
	-drilled from 7- to 8-m in 90 minutes	pieces recovered
	-107 cms core recovered drilling to 8-m	
	-100% CR and 100% RQD at 8-m	No SPT @ 9 M
9.0	-drilled from 8- to 9-m in 100 minutes	solid rock core
	-81 cms core recovered drilling to 9-m	pieces recovered
	-81% CR and 72% RQD at 9-m	
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/003/002
Managing Director

BORE HOLE TERMINATED AT 9.0-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

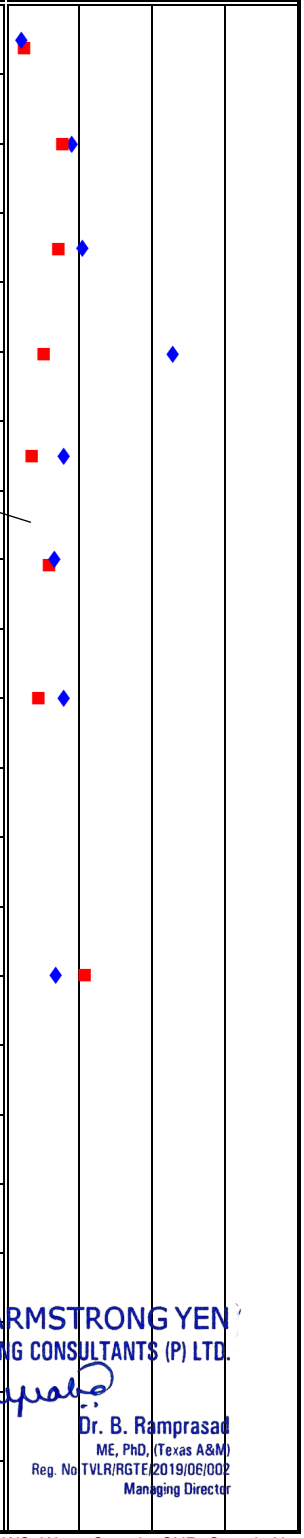
PLATE 8

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 8 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 4-02-'19 **Ended on:** 5-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 10.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN WEATHERED ROCK – Filled Up Soil (To 1.0-M)	DS @ 0.5 M
	0.0- to 1.0-m – γ_t = 1.5 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 4)	2/3/4 = 7 Blows
GWL	**BROWN SILTY FINE TO MEDIUM SAND (To 3.5-M)**	
	1.0- to 2.25-m – ϕ = 26°; γ_t = 1.55 tons/M^3	SPT @ 1.75 M
2.0	(N_{avg} = 6)	2/2/3 = 5 Blows
		SPT @ 2.5 M
		1/1/1 = 2 Blows
3.0	2.25- to 3.5-m – ϕ = 24°; γ_t = 1.45 tons/M^3	SPT @ 3.25 M
	(N_{avg} = 3)	4/13/20 = 33 Blows
	GRAY WEATHERED ROCK (To 8.0-M)	SPT @ 4 M
4.0	3.5- to 4.0-m – ϕ = 35°; γ_t = 1.95 tons/M^3	5 cms for 10 Blows
	(N_{avg} ~ 40)	2 cms for 10 Blows (Hammer Rebound)
		SPT @ 5 M
5.0	-NX TC bit drilling from 5-m	3 cms for 10 Blows
		2 cms for 10 Blows (Hammer Rebound)
	-drilled from 5- to 6-m in 30 minutes	SPT @ 6 M (SNR)
6.0	-NX Diamond bit drilling from 6-m	1 cm for 10 Blows
	4.0- to 8.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	1 cm for 10 Blows
	(N_{avg} > 100)	(Hammer Rebound)
		SPT @ 7 M
7.0	-drilled from 6- to 7-m in 40 minutes	3 cms for 10 Blows
	-brown white color pieces at 7-m	2 cms for 10 Blows (Hammer Rebound)
		SPT @ 8 M (SNR)
8.0	-drilled from 7- to 8-m in 50 minutes	1 cm for 10 Blows
	GRAY GRANITE (Below 8.0-M)	0 cms for 5 Blows
	-drilled from 8- to 9-m in 110 minutes	(Hammer Rebound)
	-102 cms core recovered drilling to 9-m	SPT @ 9 M
9.0	-100% CR and 86% RQD at 8-m	0 cms for 5 Blows
	8.0- to 10.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	
	-drilled from 9- to 10-m in 105 minutes	SPT @ 10 M (SNR)
10.0	-83 cms core recovered drilling to 10-m	0 cms for 5 Blows
	-83% CR and 83% RQD at 10-m	(Hammer Rebound)
11.0		



For PRASAD ARMSTRONG YEN GEOTECH ENGINEERING CONSULTANTS (P) LTD.
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ME, PhD, (Texas A&M)
Reg. No TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 10.0-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

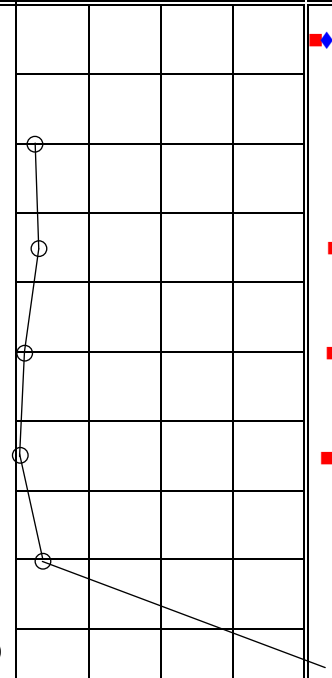
PLATE 9

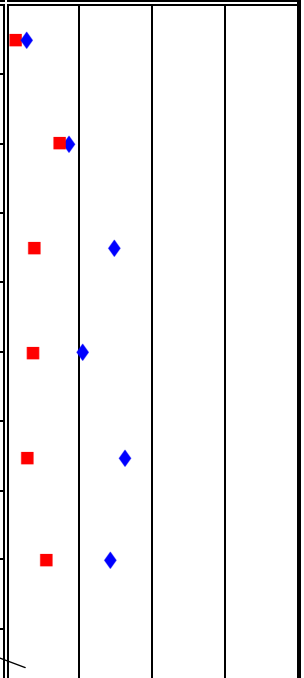
LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 9 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 3-02-'19 **Ended on:** 4-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 11.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with stone pieces – Filled Up Soil (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)	2/2/3 = 5 Blows
GWL	GRAY BROWN SILTY FINE TO MEDIUM SAND (To 5.0-M)	SPT @ 1.75 M
	1.0- to 2.25-m – ϕ = 25°; γ_t = 1.5 tons/M^3	2/3/3 = 6 Blows
2.0	(N_{avg} = 5)	
		SPT @ 2.5 M
		1/1/1 = 2 Blows
3.0	2.25- to 4.0-m – ϕ = 23°; γ_t = 1.4 tons/M^3	SPT @ 3.25 M
	(N_{avg} ~ 1.5)	0/0/1 = 1 Blows
		SPT @ 4 M
4.0		3/4/4 = 8 Blows
	4.0- to 5.0-m – ϕ = 27°; γ_t = 1.6 tons/M^3	
	(N_{avg} = 8)	SPT @ 5 M (SNR)
5.0	-NX Diamond bit drilling from 5-m	1 cm for 10 Blows
	BROWN GRAY WEATHERED ROCK (To 8.0-M)	1 cm for 10 Blows (Hammer Rebound)
	-drilled from 5- to 6-m in 40 minutes	SPT @ 6 M (SNR)
6.0	-21 cms core recovered drilling to 6-m	0.5 cms for 10 Blows
		0 cms for 10 Blows
	5.0- to 8.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 65 minutes	0.5 cms for 10 Blows
	-7 cms core recovered drilling to 7-m	0 cms for 10 Blows (Hammer Rebound)
	-drilled from 7- to 8-m in 60 minutes	SPT @ 8 M (SNR)
8.0	-stone pieces recovered drilling to 8-m	0 cms for 10 Blows
	GRAY GRANITE (Below 8.0-M)	(Hammer Rebound)
	8.0- to 11.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	SPT @ 9 M (SNR)
9.0	-drilled from 8- to 9-m in 80 minutes	0 cms for 10 Blows
	-56 cms core recovered drilling to 9-m	(Hammer Rebound)
	-56% CR and 48% RQD at 9-m	
	-drilled from 9- to 10-m in 85 minutes	No SPT @ 10 M
10.0	-102 cms core recovered drilling to 10-m	solid rock core
	-100% CR and 100% RQD at 10-m	pieces recovered
	-drilled from 10- to 11-m in 100 minutes	No SPT @ 11 M
	-97 cms core recovered drilling to 11-m	solid rock core
11.0	-97% CR and 97% RQD at 11-m	pieces recovered





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Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 11.0-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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 10 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 5-02-'19 **Ended on:** 6-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 11.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	WHITE BROWN WEATHERED ROCK – Filled Up Soil (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} ~ 2)	1/1/1 = 2 Blows
GWL	BROWN GRAY SILTY FINE TO MEDIUM SAND (To 5.25-M) (N_{avg} = 2)	SPT @ 1.75 M
	1.0- to 1.75-m – ϕ = 24°; γ_t = 1.45 tons/M^3	2/2/3 = 5 Blows
2.0	1.75- to 2.25-m – ϕ = 25°; γ_t = 1.5 tons/M^3	
	(N_{avg} ~ 5)	SPT @ 2.5 M
	-with shell fragments at 1.0-M	0/0/1 = 1 Blows
	2.25- to 3.25-m – ϕ = 23°; γ_t = 1.4 tons/M^3	
3.0	(N_{avg} ~ 1)	SPT @ 3.25 M
		2/3/4 = 7 Blows
	3.25- to 4.0-m – ϕ = 26°; γ_t = 1.55 tons/M^3	
	(N_{avg} = 7)	SPT @ 4 M
4.0		3/4/6 = 10 Blows
	4.0- to 5.25-m – ϕ = 30°; γ_t = 1.6 tons/M^3	SPT @ 5 M
5.0	(N_{avg} = 10)	5/15/18 = 33 Blows
	-white gray stone pieces at 5-m	
	GRAY WEATHERED ROCK (To 9.0-M)	
	5.25- to 6.0-m – ϕ = 34°; γ_t = 1.75 tons/M^3	SPT @ 6 M
6.0	(N_{avg} = 33)	3 cms for 10 Blows
	-NX Diamond bit drilling from 6-m	2 cms for 10 Blows
	6.0- to 7.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	(Hammer Rebound)
	(N_{avg} > 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 25 minutes	1 cm for 10 Blows
		0.5 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 7- to 8-m in 35 minutes	SPT @ 8 M (SNR)
8.0	7.0- to 9.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	0.5 cms for 10 Blows
	(N_{avg} >> 100)	0 cm for 10 Blows
		(Hammer Rebound)
		SPT @ 9 M (SNR)
9.0	-drilled from 8- to 9-m in 40 minutes	0 cms for 10 Blows
	GRAY GRANITE (Below 9.0-M)	(Hammer Rebound)
	9.0- to 11.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	No SPT @ 10 M
10.0	-drilled from 9- to 10-m in 125 minutes	solid rock core
	-99 cms core recovered drilling to 10-m	pieces recovered
	-99% CR and 85% RQD at 10-m	No SPT @ 11 M
	-drilled from 10- to 11-m in 120 minutes	rock core
11.0	-93 cms core recovered drilling to 11-m	pieces recovered

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 11.0-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

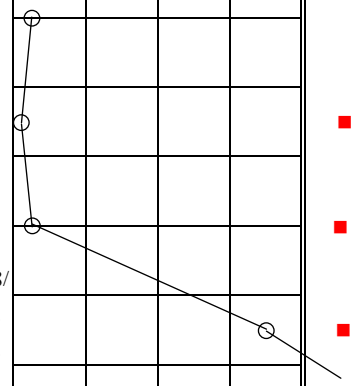
PLATE 11

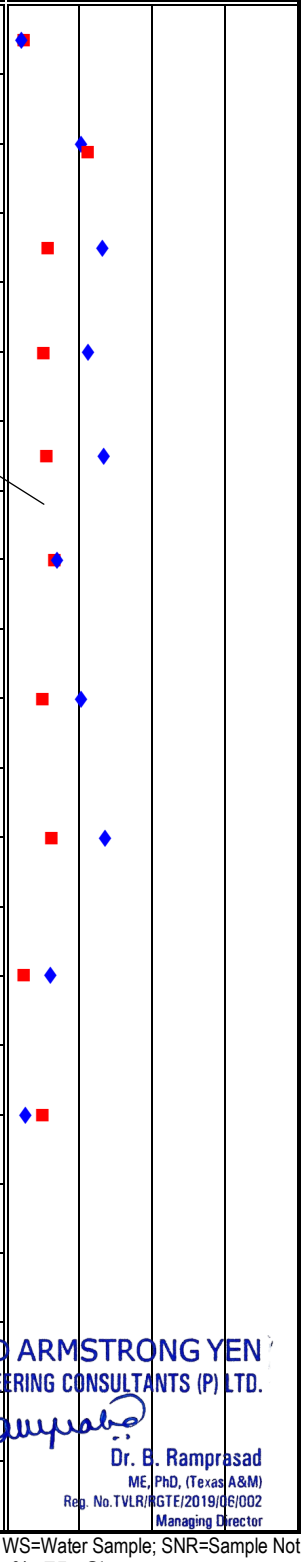
LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 11 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 4-02-'19 **Ended on:** 5-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 11.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt, and stone pieces – Filled Up Soil (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)	1/2/3 = 5 Blows
GWL	**BROWN GRAY SILTY FINE TO MEDIUM SAND (To 3.25-M)** (N_{avg} = 5)	SPT @ 1.75 M
	1.0- to 1.5-m – ϕ = 25°; γ_t = 1.5 tons/M^3	1/1/1 = 2 Blows
2.0	-with clay binder at 1-m	
	1.5- to 2.5-M – ϕ = 23°; γ_t = 1.4 tons/M^3	SPT @ 2.5 M
	(N_{avg} ~ 2)	1/2/3 = 5 Blows
	-with shell fragments at 1.0-M	
3.0	2.5- to 3.25-m – ϕ = 25°; γ_t = 1.5 tons/M^3	SPT @ 3.25M 10/18/
	(N_{avg} ~ 5)	3 cms for 10 Blows
	GRAY WEATHERED ROCK (To 9.0-M)	2 cms for 10 Blows
	3.25- to 4.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	SPT @ 4 M 20/
4.0	(N_{avg} > 75)	3 cms for 10 Blows
		2 cms for 10 Blows
		(Hammer Rebound)
		SPT @ 5 M
5.0		3 cms for 10 Blows
		2 cms for 10 Blows
		(Hammer Rebound)
		SPT @ 6 M
6.0	-NX Diamond bit drilling from 6-m	3 cms for 10 Blows
	4.0- to 8.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	2 cms for 10 Blows
	(N_{avg} > 100)	(Hammer Rebound)
		SPT @ 7 M
7.0	-drilled from 6- to 7-m in 35 minutes	3 cms for 10 Blows
	-brown gray color at 7-m	2 cms for 10 Blows
		(Hammer Rebound)
		SPT @ 8 M
8.0	-drilled from 7- to 8-m in 55 minutes	2 cms for 10 Blows
	8.0- to 9.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	1 cm for 10 Blows
	(N_{avg} >> 100)	(Hammer Rebound)
	-drilled from 8- to 9-m in 110 minutes	SPT @ 9 M (SNR)
9.0	-7 cms core recovered drilling to 9-m	0 cms for 10 Blows
	GRAY GRANITE (Below 9.0-M)	(Hammer Rebound)
	9.0- to 11.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	No SPT @ 10 M
10.0	-drilled from 9- to 10-m in 85 minutes	solid rock core
	-57 cms core recovered drilling to 10-m	pieces recovered
	-57% CR and 44% RQD at 10-m	No SPT @ 11 M
	-drilled from 10- to 11-m in 100 minutes	single rock core
11.0	-90 cms core recovered drilling to 11-m	piece recovered





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

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 11.0-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

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 12 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 7-02-'19 **Ended on:** 8-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 12.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt, and stone pieces – Filled Up Soil (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)	2/2/4 = 6 Blows
GWL	**BROWN GRAY SILTY FINE TO MEDIUM SAND (To 4.0-M)**	SPT @ 1.75 M
	1.0- to 2.25-m – ϕ = 27°; γ_t = 1.55 tons/M^3	3/4/5 = 9 Blows
2.0	(N_{avg} = 7)	
		SPT @ 2.5 M
		1/1/2 = 3 Blows
3.0	2.25- to 4.0-m – ϕ = 24°; γ_t = 1.4 tons/M^3	SPT @ 3.25 M
	(N_{avg} = 2.5)	0/1/1 = 2 Blows
4.0		SPT @ 4 M
		10/12/17 = 29 Blows
	GRAY WEATHERED ROCK (To 7.0-M)	
	4.0- to 5.0-m – ϕ = 34°; γ_t = 1.85 tons/M^3	
	(N_{avg} = 29)	SPT @ 5 M
5.0	-NX TC bit drilling from 5-m	5 cms for 15 Blows
		1 cm for 5 Blows
	5.0- to 6.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	(Hammer Rebound)
	(N_{avg} > 100)	SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 20 minutes	1.5 cms for 15 Blows
	-NX Diamond bit drilling from 6-m	0 cms for 5 Blows
	6.0- to 7.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 55 minutes	0 cms for 5 Blows
	GRAY GRANITE (Below 7.0-M)	(Hammer Rebound)
	-drilled from 7- to 8-m in 70 minutes	SPT @ 8 M (SNR)
8.0	-37 cms core recovered drilling to 8-m	0 cms for 5 Blows
	-37% CR and 37% RQD at 8-m	(Hammer Rebound)
	7.0- to 12.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	SPT @ 9 M (SNR)
9.0	-drilled from 8- to 9-m in 90 minutes	0 cms for 5 Blows
	-84 cms core recovered drilling to 9-m	(Hammer Rebound)
	-84% CR and 84% RQD at 9-m	
	-highly jointed rock, 9- to 10-m	SPT @ 10 M (SNR)
10.0	-drilled from 9- to 10-m in 55 minutes	0 cms for 5 Blows
	-17 cms core recovered drilling to 10-m	(Hammer Rebound)
	-drilled from 10- to 11-m in 45 minutes	SPT @ 11 M (SNR)
	-41 cms core recovered drilling to 11-m	0 cms for 5 Blows
11.0	-41% CR and 33% RQD at 11-m	(Hammer Rebound)

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

For PRASAD ARMSTRONG YEN
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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

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 High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 12 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 7-02-'19 **Ended on:** 8-02-'19 **Field Work In Charge:** R Murugesan
Final Depth: 12.0-M **Depth to G W S:** 1.0-M **Remarks:** Continue from Plate 13a.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE	SPT "N" PROFILE 25 50 75	INDEX TEST DATA 25 50 75
	GRAY GRANITE (Below 7.0-M)			
	7.0- to 12.0-m – $\phi = 42^{o}$; $\gamma_t = 2.35$ tons/M^3			
	(N_{avg} >> 100)	SPT @ 12 M (SNR)		
12.0	-drilled from 11- to 12-m in 105 minutes	0 cms for 5 Blows		
	-78 cms core recovered drilling to 12-m	(Hammer Rebound)		
	-78% CR and 57% RQD at 12-m			
13.0				
14.0				
15.0				
16.0				
17.0				
18.0				
19.0				
20.0				
21.0				
22.0				

For PRASAD ARMSTRONG YEN
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ME, PhD. (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 12.0-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 13b

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 13 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 4-02-'19 **Ended on:** 5-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 11.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt, and stone pieces – Filled Up Soil (To 1.0-M)	DS @ 0.25 M
	0.0- to 1.0-m – γ_t = 1.55 tons/M^3	SPT @ 1 M
1.0	(N_{avg} ~ 6)	3/3/4 = 7 Blows
GWL	BROWN SILTY FINE TO MEDIUM SAND (To 3.25-M)	SPT @ 1.75 M
	1.0- to 1.75-m – ϕ = 27°; γ_t = 1.6 tons/M^3	1/2/2 = 4 Blows
2.0	(N_{avg} = 7)	
		SPT @ 2.5 M
	1.75- to 3.25-m – ϕ = 24°; γ_t = 1.4 tons/M^3	1/1/1 = 2 Blows
	(N_{avg} = 2)	
3.0		SPT @ 3.25 M
		5/5/8 = 13 Blows
	GRAY WEATHERED ROCK (To 8.0-M)	
	3.25- to 4.0-m – ϕ = 30°; γ_t = 1.65 tons/M^3	SPT @ 4 M 24/
4.0	(N_{avg} = 13)	4 cms for 10 Blows
	4.0- to 4.75-m – ϕ = 37°; γ_t = 2.1 tons/M^3	3 cms for 10 Blows
	(N_{avg} ~ 100)	(Hammer Rebound)
		SPT @ 5 M
5.0		10/14/20 = 34 Blows
	4.75- to 6.0-m – ϕ = 34°; γ_t = 1.85 tons/M^3	
	(N_{avg} = 34)	SPT @ 6 M (SNR)
6.0		1 cm for 10 Blows
	-NX Diamond bit drilling from 6.2-m	1 cm for 10 Blows
		(Hammer Rebound)
	-drilled from 6.2- to 7-m in 50 minutes	SPT @ 7 M (SNR)
7.0	6.0- to 8.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	0.5 cms for 10 Blows
	(N_{avg} >> 100)	0 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 7- to 8-m in 75 minutes	SPT @ 8 M (SNR)
8.0	-8 cms core recovered drilling to 8-m	0.5 cms for 10 Blows
	GRAY GRANITE (Below 8.0-M)	0 cms for 10 Blows
	8.0- to 11.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	(Hammer Rebound)
	(N_{avg} >> 100)	No SPT @ 9 M
9.0	-drilled from 8- to 9-m in 105 minutes	solid rock core
	-106 cms core recovered drilling to 9-m	pieces recovered
	-100% CR and 100% RQD at 9-m	
	-drilled from 9- to 10-m in 100 minutes	No SPT @ 10 M
10.0	-76 cms core recovered drilling to 10-m	solid rock core
	-76% CR and 70% RQD at 10-m	pieces recovered
	-drilled from 10- to 11-m in 105 minutes	No SPT @ 11 M
	-115 cms core recovered drilling to 11-m	solid rock core
11.0	-100% CR and 100% RQD at 11-m	pieces recovered

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 11.0-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 14

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 14 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 5-02-'19 **Ended on:** 6-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 9.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO MEDIUM SAND with silt and stone pieces – Filled Up Soil (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)	2/3/3 = 6 Blows
GWL	**GRAY BROWN SILTY FINE TO MEDIUM SAND (To 4.3-M)**	SPT @ 1.75 M
	1.0- to 1.75-m – ϕ = 26°; γ_t = 1.55 tons/M^3	1/2/2 = 4 Blows
2.0	(N_{avg} = 6)	
	1.75- to 3.25-m – ϕ = 24°; γ_t = 1.45 tons/M^3	SPT @ 2.5 M 1/1/2 = 3 Blows
	(N_{avg} = 3.5)	
3.0		SPT @ 3.25 M
	-gray color, 3.25- to 4.3-m	2/3/4 = 7 Blows
	3.25- to 4.3-m – ϕ = 26°; γ_t = 1.55 tons/M^3	SPT @ 4 M 2/3/
4.0	(N_{avg} = 7)	3 cms for 10 Blows
		2 cms for 10 Blows
	GRAY WEATHERED ROCK (To 6.0-M)	(Hammer Rebound)
		SPT @ 5 M
5.0	-NX Diamond bit drilling from 5-m	3 cms for 10 Blows
	4.3- to 6.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3	2 cms for 10 Blows
	(N_{avg} > 100)	(Hammer Rebound)
		SPT @ 6 M (SNR)
6.0	-drilled from 5- to 6-m in 30 minutes	1 cm for 10 Blows
	GRAY GRANITE (Below 6.0-M)	0.5 cms for 10 Blows
		(Hammer Rebound)
	-drilled from 6- to 7-m in 90 minutes	SPT @ 7 M (SNR)
7.0	-78 cms core recovered drilling to 7-m	0 cms for 10 Blows
	-78% CR and 8% RQD at 7-m	(Hammer Rebound)
	6.0- to 9.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	
	(N_{avg} >> 100)	No SPT @ 8 M
8.0	-drilled from 7- to 8-m in 100 minutes	solid rock core
	-85 cms core recovered drilling to 8-m	pieces recovered
	-85% CR and 59% RQD at 8-m	
		No SPT @ 9 M
9.0	-drilled from 8- to 9-m in 110 minutes	solid rock core
	-92 cms core recovered drilling to 9-m	pieces recovered
	-82% CR and 77% RQD at 9-m	
10.0		
11.0		

SPT "N" PROFILE: 25 50 75

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 9.0-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 15

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 15 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 5-02-'19 **Ended on:** 6-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 9.5-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

DEPTH, M	SOIL DESCRIPTION	SPT / VANE & SAMPLE TYPE
	BROWN FINE TO COARSE SAND with stone pieces – Filled Up Soil (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
GWL	**BROWN SILTY FINE TO MEDIUM SAND (To 3.25-M)**	SPT @ 1.75 M
		3/3/3 = 6 Blows
2.0	1.0- to 3.25-m – ϕ = 26°; γ_t = 1.55 tons/M^3	
	(N_{avg} ~ 6.5)	SPT @ 2.5 M
		2/3/4 = 7 Blows
3.0		SPT @ 3.25 M
		7/10/12 = 22 Blows
	GRAY WEATHERED ROCK (To 7.0-M)	
	3.25- to 4.0-m – ϕ = 33°; γ_t = 1.75 tons/M^3	SPT @ 4 M 24/
4.0	(N_{avg} = 22)	4 cms for 10 Blows
		3 cms for 10 Blows
	4.0- to 5.0-m – ϕ = 37°; γ_t = 2.1 tons/M^3	(Hammer Rebound)
	(N_{avg} ~ 95)	SPT @ 5 M (SNR)
5.0	-NX Diamond bit drilling from 5-m	2 cms for 10 Blows
		1 cm for 10 Blows
		(Hammer Rebound)
	-drilled from 5- to 6-m in 35 minutes	SPT @ 6 M (SNR)
6.0	5.0- to 7.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	1 cm for 10 Blows
	(N_{avg} >> 100)	0.5 cms for 10 Blows
		(Hammer Rebound)
		SPT @ 7 M (SNR)
7.0	-drilled from 6- to 7-m in 40 minutes	0.5 cms for 10 Blows
	GRAY JOINTED GRANITE (Below 7.0-M)	0 cms for 10 Blows
	-drilled from 7- to 8-m in 125 minutes	(Hammer Rebound)
	-63 cms core recovered drilling to 8-m	No SPT @ 8 M
8.0	-63% CR and 35% RQD at 8-m	solid rock core
	7.0- to 9.5-m – ϕ = 42°; γ_t = 2.35 tons/M^3	pieces recovered
	(N_{avg} >> 100)	
	-drilled from 8- to 8.7-m in 70 minutes	No SPT @ 9 M
9.0	-66 cms core recovered drilling to 8.7-m	solid rock core
	-94% CR and 94% RQD at 8.7-m	pieces recovered
	-drilled from 8.7- to 9.5-m in 90 minutes	No SPT @ 9.5 M
	-58 cms core recovered drilling to 9.5-m	solid rock core
10.0	-77% CR and 53% RQD at 9.5-m	pieces recovered
11.0		

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

INDEX TEST DATA: 25 50 75

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

BORE HOLE TERMINATED AT 9.5-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 16

LOG OF BORING

Project: Proposed High-Rise Building Site, S No 16/1A1A (Part), 16/1A1B (Part), 16/1A1C (Part), 18/2A (Part), 18/3 (Part) & 20 (Part), Thaiyur "A" Village, Thiruporur Taluk, Chengapattu District, TN. Within the Limits of Thiruporur Panchayat Union.

Bore Hole No.: 16 **Type of Boring:** Calyx Drill **Dia. of Hole:** 150 mm
Started on: 7-02-'19 **Ended on:** 8-02-'19 **Field Work In Charge:** Y Saravanan
Final Depth: 11.0-M **Depth to G W S:** 1.0-M **Remarks:** GWL at Original Ground Level.

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 stone 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 2/4/5 = 9 Blows		
GWL	BROWN FINE TO MEDIUM SAND with silt (To 3.25-M)	SPT @ 1.75 M		
2.0	1.0- to 3.25-m – ϕ = 26°; γ_t = 1.55 tons/M^3 (N_{avg} ~ 7)	1/2/3 = 5 Blows		
		SPT @ 2.5 M 2//34 = 7 Blows		
3.0		SPT @ 3.25 M 4/9/10 = 19 Blows		
	WHITE GREEN WEATHERED ROCK with limestone pieces (To 4.0-M) (N_{avg} = 19)	SPT @ 4 M		
4.0	3.25- to 4.0-m – ϕ = 32°; γ_t = 1.7 tons/M^3	3 cms for 10 Blows		
	GRAY WEATHERED ROCK (To 8.0-M)	2 cms for 10 Blows (Hammer Rebound)		
5.0	-NX Diamond bit drilling from 5-m	SPT @ 5 M 5 cms for 15 Blows		
	4.0- to 6.0-m – ϕ = 38°; γ_t = 2.2 tons/M^3 (N_{avg} > 100)	1 cm for 5 Blows (Hammer Rebound)		
6.0	-drilled from 5- to 6-m in 30 minutes	SPT @ 6 M (SNR) 1 cm for 10 Blows		
		1 cm for 10 Blows (Hammer Rebound)		
7.0	-drilled from 6- to 7-m in 40 minutes 6.0- to 8.0-m – ϕ = 39°; γ_t = 2.25 tons/M^3	SPT @ 7 M (SNR) 0.5 cms for 10 Blows		
	(N_{avg} >> 100)	0 cms for 10 Blows (Hammer Rebound)		
8.0	-drilled from 7- to 8-m in 65 minutes -17 cms core recovered drilling to 8-m	SPT @ 8 M (SNR) 0.5 cms for 5 Blows		
	GRAY GRANITE (Below 8.0-M)	0 cms for 5 Blows (Hammer Rebound)		
9.0	-drilled from 8- to 9-m in 75 minutes -73 cms core recovered drilling to 9-m	No SPT @ 9 M solid rock core		
	-73% CR and 57% RQD at 9-m 8.0- to 11.0-m – ϕ = 42°; γ_t = 2.35 tons/M^3	pieces recovered		
	(N_{avg} >> 100)	No SPT @ 10 M		
10.0	-drilled from 9- to 10-m in 90 minutes -74 cms core recovered drilling to 10-m	solid rock core pieces recovered		
	-74% CR and 56% RQD at 10-m	No SPT @ 11 M		
11.0	-drilled from 10- to 11-m in 95 minutes -78 cms core recovered drilling to 11-m	solid rock core pieces recovered		

For PRASAD ARMSTRONG YEN GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/08/002
Managing Director

BORE HOLE TERMINATED AT 11.0-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 17

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL	IS CLASS.
						Fine%	Medium%	Coarse%	%	
1	0.25	5			7					
	1.0	20			13	59	26	2	0	SM
	1.75	19			13					
	2.5	13			5	49	27	11	5	SP
	3.25	10			5	21	7	2	65	GW
	4.0	SNR	stone	pieces						
	5.0	SNR	rock	core	pieces					
	6.0	SNR								
	7.0	12			8	43	32	10	7	SP
	8.0	SNR								
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
	11.0	SNR	stone	pieces						
	12.0	SNR	rock	core	pieces					
2	0.25	1			9					
	1.0	22			17	57	21	4	1	SM
	1.75	14			18					
	2.5	9			10	53	32	4	1	SP-SM
	3.25	13			11					
	4.0	18			12	54	23	6	5	SM
	5.0	SNR								
	6.0	SNR								
	7.0	SNR								
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
3	0.25	6			7					
	1.0	18			14	68	17	1	0	SM
	1.75	27			16					
	2.5	17			20	51	19	3	7	SM
	3.25	13			16					
	4.0	13			11	52	30	5	2	SP-SM
	5.0	SNR								
	6.0	SNR								
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
4	0.25	4			5					
	1.0	37			11	66	22	1	0	SP-SM
	1.75	30			16					
	2.5	18			14	66	18	1	1	SM
	3.25	11			8					
	4.0	12			7	44	35	10	4	SP
	5.0	14			8	42	31	19	0	SP
	6.0	SNR	rock	core	pieces					
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
	8.25	SNR	rock	core	pieces					
5	0.25	5			2					
	1.0	23			17	62	19	2	0	SM
	1.75	26			11					

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVR/RGTE/2019/06/002
Managing Director

PLATE 18a

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL %	IS CLASS.
						Fine%	Medium%	Coarse%		
5	2.5	15			16	68	12	2	2	SM
	3.25	10			16	64	19	1	0	SM
	4.0	SNR								
	5.0	SNR								
	6.0	SNR	rock	core	pieces					
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
6	0.5	10			9					
	1.0	19			19	61	16	3	1	SM
	1.75	21			15					
	2.5a	38			16	66	12	3	3	SM
	2.5b	12			15					
	3.25	17			20	59	13	5	3	SM
	4.0	SNR								
	5.0	SNR								
	6.0	SNR	rock	core	pieces					
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
7	0.25	7			10					
	1.0	25			12	57	27	3	1	SM
	1.75	30			15					
	2.5	31			10	44	36	10	0	SP-SM
	3.25	16			8					
	4.0	10			9	21	26	20	24	SW
	5.0	15			11	57	19	4	9	SP-SM
	6.0	SNR	rock	core	pieces					
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
8	0.25	4			5					
	1.0	24			21	54	23	2	0	SM
	1.75	26			20					
	2.5	57			14	53	29	4	0	SM
	3.25	21			7					
	4.0	16			15	53	19	7	6	SM
	5.0	21			12	55	27	6	0	SM
	6.0	SNR								
	7.0	18			27	57	13	3	0	SM
	8.0	SNR								
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
9	0.25	7			4					
	1.0	22			19	57	22	2	0	SM
	1.75	39			10					
	2.5	26			9	60	28	3	0	SP-SM
	3.25	41			7					
	4.0	36			14	74	12	0	0	SM
	5.0	SNR								
	6.0	SNR	rock	core	pieces					
	7.0	SNR	rock	core	piece					
	8.0	SNR	stone	pieces						
	9.0	SNR	rock	core	pieces					

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 18b

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL	IS CLASS.
						Fine%	Medium%	Coarse%	%	
9	10.0	SNR	rock	core	pieces					
	11.0	SNR	rock	core	pieces					
10	0.25	5			4					
	1.0	22			21	62	14	2	1	SM
	1.75	24			24					
	2.5	30			17	68	14	1	0	SM
	3.25	37			17					
	4.0	14			8	55	29	6	2	SP
	5.0a	19			19					
	5.0b	14			16	52	20	2	10	SM
	6.0	18			14	46	20	6	14	SM
	7.0	SNR								
	8.0	SNR								
	9.0	SNR								
	10.0	SNR	rock	core	pieces					
	11.0	SNR	rock	core	pieces					
11	0.25	5			6					
	1.0	26			27	58	13	2	0	SM
	1.75	34			14					
	2.5	28			13	57	27	3	0	SM
	3.25	33			13					
	4.0	18			17	66	16	1	0	SM
	5.0	26			12					
	6.0	34			17	65	15	3	0	SM
	7.0	15			7					
	8.0	7			12	17	14	18	39	SM
	9.0	SNR	rock	core	piece					
	10.0	SNR	rock	core	pieces					
	11.0	SNR	rock	core	piece					
12	0.25	13			8					
	1.0	17			14	48	24	7	7	SM
	1.75	22			20					
	2.5	41			11	59	27	3	0	SP-SM
	3.25	22			17					
	4.0	20			19	66	14	1	0	SM
	5.0	13			11	48	30	9	2	SP-SM
	6.0	SNR								
	7.0	SNR								
	8.0	SNR	rock	core	piece					
	9.0	SNR	rock	core	piece					
	10.0	SNR	rock	core	piece					
	11.0	SNR	rock	core	piece					
	12.0	SNR	rock	core	piece					
13	0.25	10			8					
	1.0	26			21	65	13	1	0	SM
	1.75	31			18					
	2.5	35			25	61	12	1	1	SM
	3.25	38			19					
	4.0	19			12	59	23	5	1	SM
	5.0	24			21	56	18	5	0	SM
	6.0	SNR								
	7.0	SNR								

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 18c

SUMMARY OF TEST RESULTS

Boring No.	Depth, M	w %	PL	LL	-75μ%	SAND			GRAVEL	IS CLASS.
						Fine%	Medium%	Coarse%	%	
13	8.0	SNR	rock	core	piece					
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
	11.0	SNR	rock	core	pieces					
14	0.25	5			5					
	1.0	21			17	64	15	2	2	SM
	1.75	24			20					
	2.5	27			15	67	15	2	1	SM
	3.25	36			13					
	4.0a	34			15	59	20	3	3	SM
	4.0b	18			10					
	5.0	18			10	61	24	4	1	SP-SM
	6.0	SNR								
	7.0	SNR	rock	core	pieces					
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
15	0.25	6			2					
	1.0	21			15	62	22	1	0	SM
	1.75	24			15					
	2.5	25			18	65	15	2	0	SM
	3.25	17			14					
	4.0	18			14	54	24	4	4	SM
	5.0	SNR								
	6.0	SNR								
	7.0	SNR								
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
	9.5	SNR	rock	core	pieces					
16	0.25	7			3					
	1.0	16			7	44	35	13	1	SP
	1.75	18			10					
	2.5	20			11	66	22	1	0	SP-SM
	3.25	18			5					
	4.0	15			13	60	22	3	2	SM
	5.0	16			8	75	16	1	0	SP
	6.0	SNR								
	7.0	SNR								
	8.0	SNR	rock	core	pieces					
	9.0	SNR	rock	core	pieces					
	10.0	SNR	rock	core	pieces					
	11.0	SNR	rock	core	pieces					

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 18d

Rock Sample Point Load Test Result Analysis

Client: **M/s. Emerald Haven Residences Pvt. Ltd.**

Site: High-Rise Building Location, Thaiyur, Kanchipuram Dist., TN.

For PRASAD ARMSTRONG YEN
GEOTECH ENGINEERING CONSULTANTS (P) LTD.
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

D = Sample Diameter, mm

D_e = Effective Diameter of non-cylindrical rock sample, mm

P = Point Load, Newtons, N

I_{L50} = Point Load Index for 50 mm Dia. Sample, N/mm^2

$$I_{L50} = \frac{P\,[D/50]^{0.45}}{D^2} \quad \text{OR} \quad I_{L50} = \frac{P\,[D_e/2500]^{0.45}}{D_e^{\,2}}$$

UCS = Unconfined Comp. Strength = **20 to 24 x I_{L50}** (Use Avg. of 22)

S. No.	Bore No.	Sample Depth, M	Dia. D mm	Rock Type	"P" kN	Pt. Load Test Index, I_{L50} MN/M^2	UCS MPa	UCS Kg/cm^2
1.	1	4.0 - 5.0	54.5	Gray Jointed Granite	5.5	1.92	42.3	423.5
2.		5.0 - 6.0	54.4	Gray Jointed Granite	12.5	4.39	96.5	965.2
3.		8.0 - 9.0	53.1	Gray Jointed Granite	0.2	0.07	1.6	16.0
4.		9.0 - 10.0	53.4	Gray Jointed Granite	0.5	0.18	4.0	39.7
5.		11.0 - 12.0	54.2	Gray Jointed Granite	5.5	1.94	42.7	427.1
6.	2	7.0 - 8.0	52.1	Green Wea. Rock	0.5	0.19	4.1	41.3
7.		8.0 - 9.0	55.5	Gray Granite	34	11.57	254.5	2545.1
8.		9.0 - 10.0	55.3	Gray Granite	24	8.21	180.7	1806.6
9.	3	7.0 - 8.0	54.3	Gray Jointed Granite	30	10.56	232.3	2323.1
10.		8.0 - 9.0	54.5	Gray Jointed Granite	27	9.45	207.9	2078.9
11.	4	6.0 - 7.0	54.6	Gray Jointed Granite	13	4.54	99.8	998.1
12.		7.0 - 8.0	54.5	Gray Granite	43	15.05	331.1	3310.9
13.		8.0 - 9.0	54.7	Gray Granite	22	7.66	168.4	1684.3
14.	5	6.0 - 7.0	54.6	Gray Jointed Granite	14	4.89	107.5	1074.9
15.		7.0 - 8.0	54.5	Gray Granite	27	9.45	207.9	2078.9
16.	6	5.0 - 6.0	55.7	Gray Jointed Granite	1	0.34	7.4	74.4
17.		6.0 - 7.0	56.9	Gray Granite	28.5	9.33	205.3	2052.6
18.	7	6.0 - 7.0	54.6	Gray Granite	33	11.52	253.4	2533.7
19.		7.0 - 8.0	54.9	Gray Granite	23	7.96	175.1	1751.0
20.		8.0 - 9.0	54.7	Gray Granite	20.5	7.13	156.9	1569.5
21.	8	8.0 - 9.0	53.1	Gray Granite	25	9.11	200.4	2004.1
22.		9.0 - 10.0	56.2	Gray Granite	19.5	6.51	143.2	1431.6
23.	9	5.0 - 6.0	52.2	Gray Jointed Granite	20	7.48	164.6	1646.4
24.		8.0 - 9.0	54.8	Gray Granite	18.5	6.42	141.2	1412.4
25.		9.0 - 10.0	54.6	Gray Jointed Granite	4	1.40	30.7	307.1
26.		10.0 - 11.0	55.3	Gray Jointed Granite	24	8.21	180.7	1806.6

PLATE 18e

Rock Sample Point Load Test Result Analysis

Client: **M/s. Emerald Haven Residences Pvt. Ltd.**
Site: High-Rise Building Location, Thaiyur, Kanchipuram Dist., TN.

D = Sample Diameter, mm

D_e = Effective Diameter of non-cylindrical rock sample, mm

P = Point Load, Newtons, N

I_{L50} = Point Load Index for 50 mm Dia. Sample, N/mm^2

$$I_{L50} = \frac{P\,[D/50]^{0.45}}{D^2} \quad \text{OR} \quad I_{L50} = \frac{P\,[D_e/2500]^{0.45}}{D_e^{\,2}}$$

UCS = Unconfined Comp. Strength = **20 to 24 x I_{L50}** (Use Avg. of 22)

S. No.	Bore No.	Sample Depth, M	Dia. D mm	Rock Type	"P" kN	Pt. Load Test Index, I_{L50} MN/M^2	UCS MPa	UCS Kg/cm^2
1.	10	9.0 - 10.0	53.7	Gray Granite	15	5.37	118.2	1181.7
2.		10.0 - 11.0	55.4	Gray Granite	29.5	10.07	221.4	2214.5
3.	11	9.0 - 10.0	54.5	Gray Granite	24	8.40	184.8	1847.9
4.		10.0 - 11.0	54.6	Gray Granite	22	7.68	168.9	1689.1
5.	12	7.0 - 8.0	54.9	Gray Granite	25	8.65	190.3	1903.2
6.		8.0 - 9.0	54.5	Gray Granite	28	9.80	215.6	2155.9
7.		9.0 - 10.0	56.7	Gray Granite	28	9.22	202.8	2027.6
8.		10.0 - 11.0	57.9	Gray Granite	27	8.60	189.3	1892.8
9.		11.0 - 12.0	54.2	Gray Granite	22	7.77	170.8	1708.5
10.	13	8.2 - 9.0	55.9	Gray Granite	24.5	8.24	181.4	1813.7
11.		9.0 - 10.0	55.3	Gray Granite	40	13.69	301.1	3011.1
12.		10.0 - 11.0	55.3	Gray Granite	28	9.58	210.8	2107.8
13.	14	6.0 - 7.0	54.2	Gray Granite	19.5	6.88	151.4	1514.3
14.		7.0 - 8.0	54.5	Gray Granite	14	4.90	107.8	1078.0
15.		8.0 - 9.0	54.6	Gray Granite	20	6.98	153.6	1535.6
16.	15	7.0 - 8.0	54.2	Gray Granite	12	4.24	93.2	931.9
17.		8.0 - 8.7	54.1	Gray Granite	46	16.28	358.3	3582.5
18.		8.7 - 9.5	55.2	Gray Granite	35.5	12.18	268.0	2679.8

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 18f





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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

Photos of the Rock Core Samples & Rock Testing.

PLATE 19a





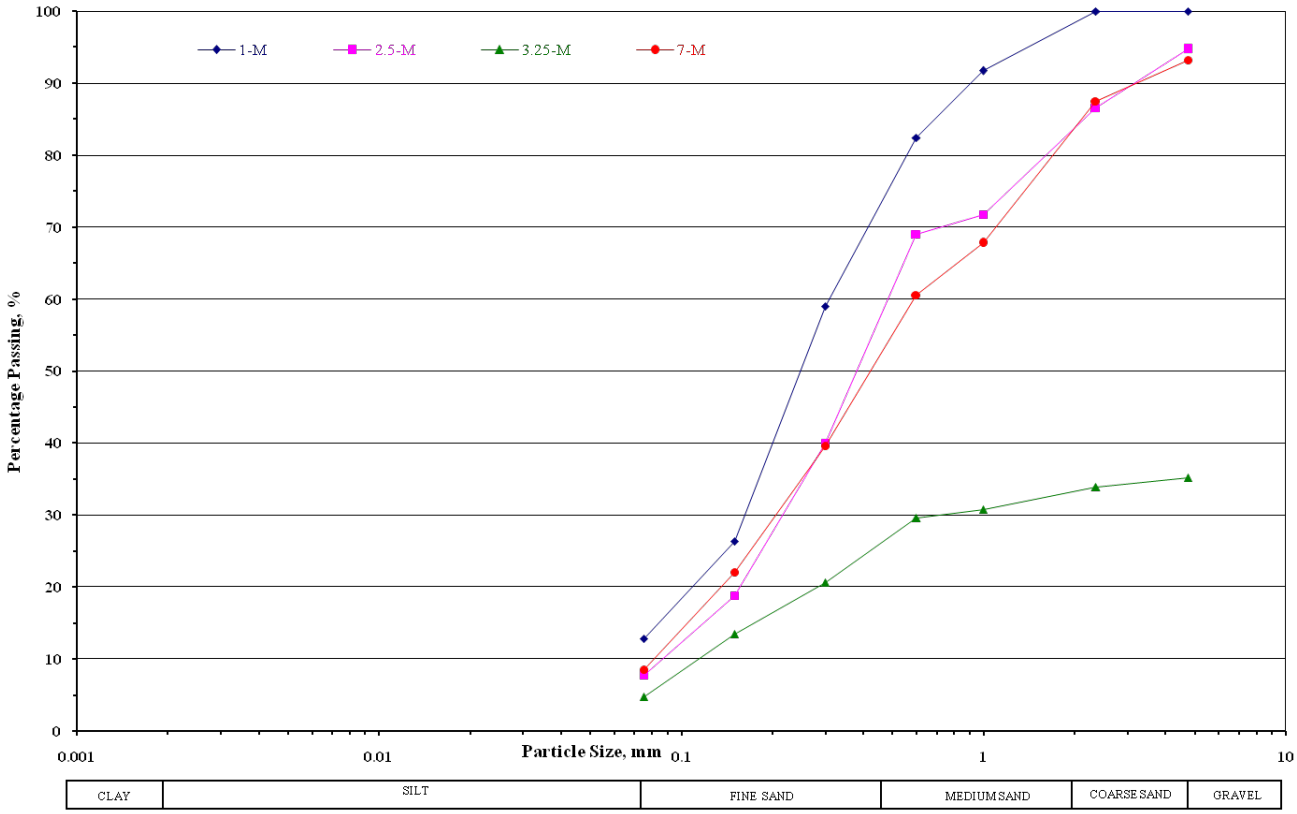
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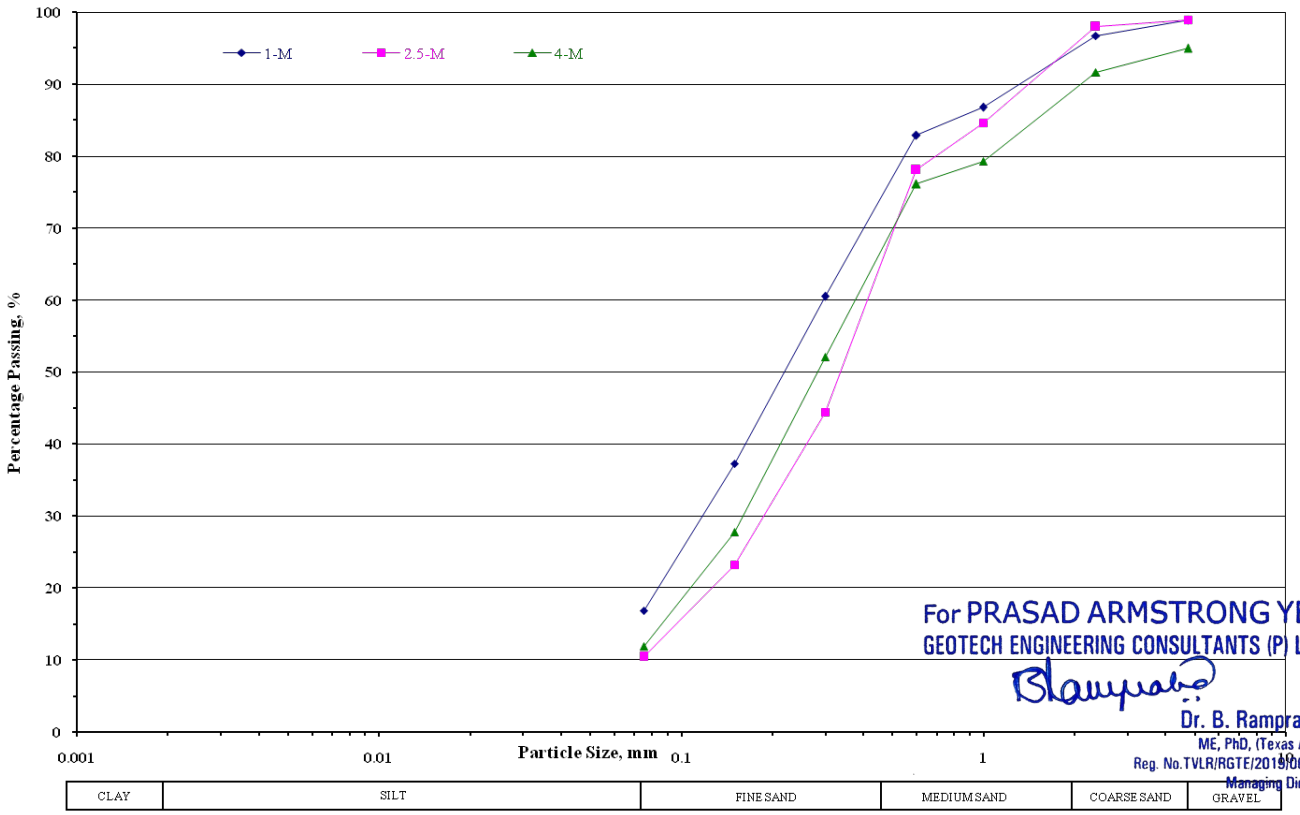
Photos of the Rock Core Samples & Rock Testing.

PLATE 19b

Grain Size Distribution Curves
Boring 1



Grain Size Distribution Curves
Boring 2

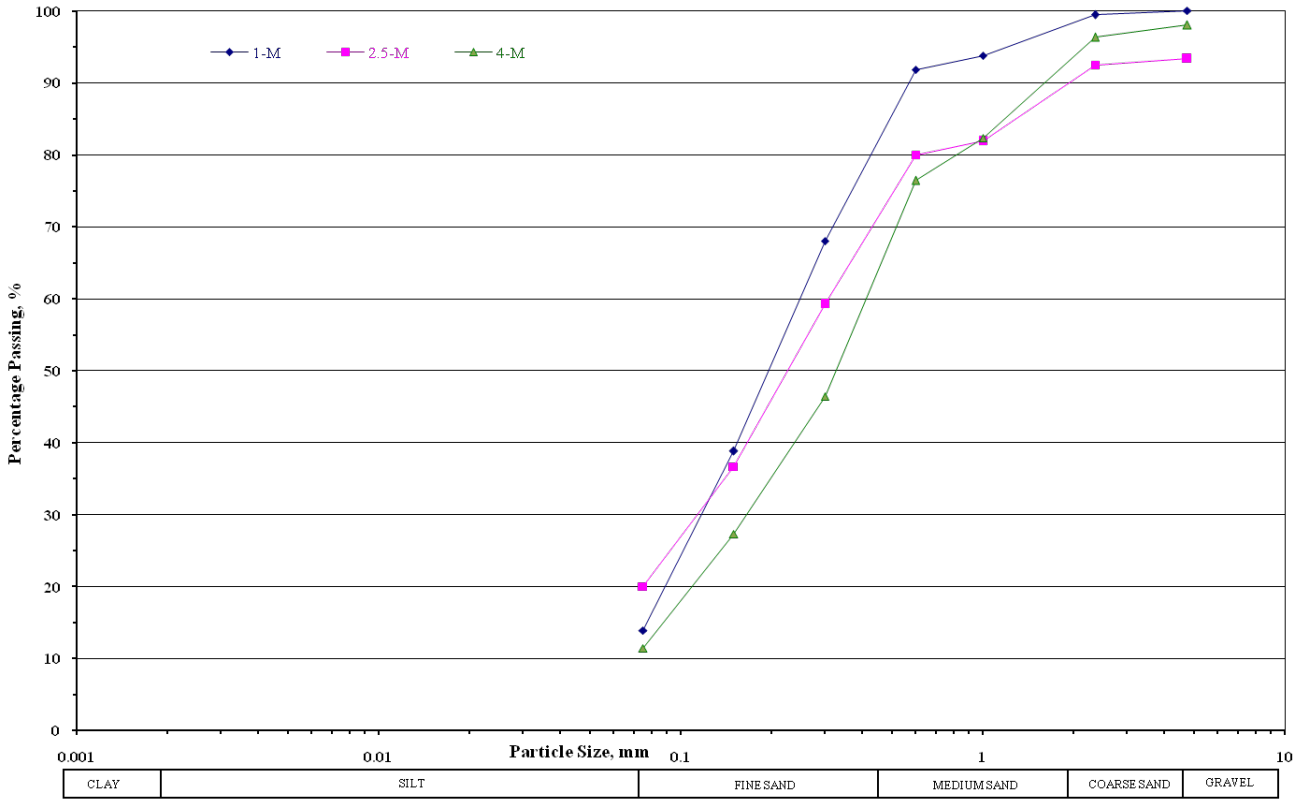


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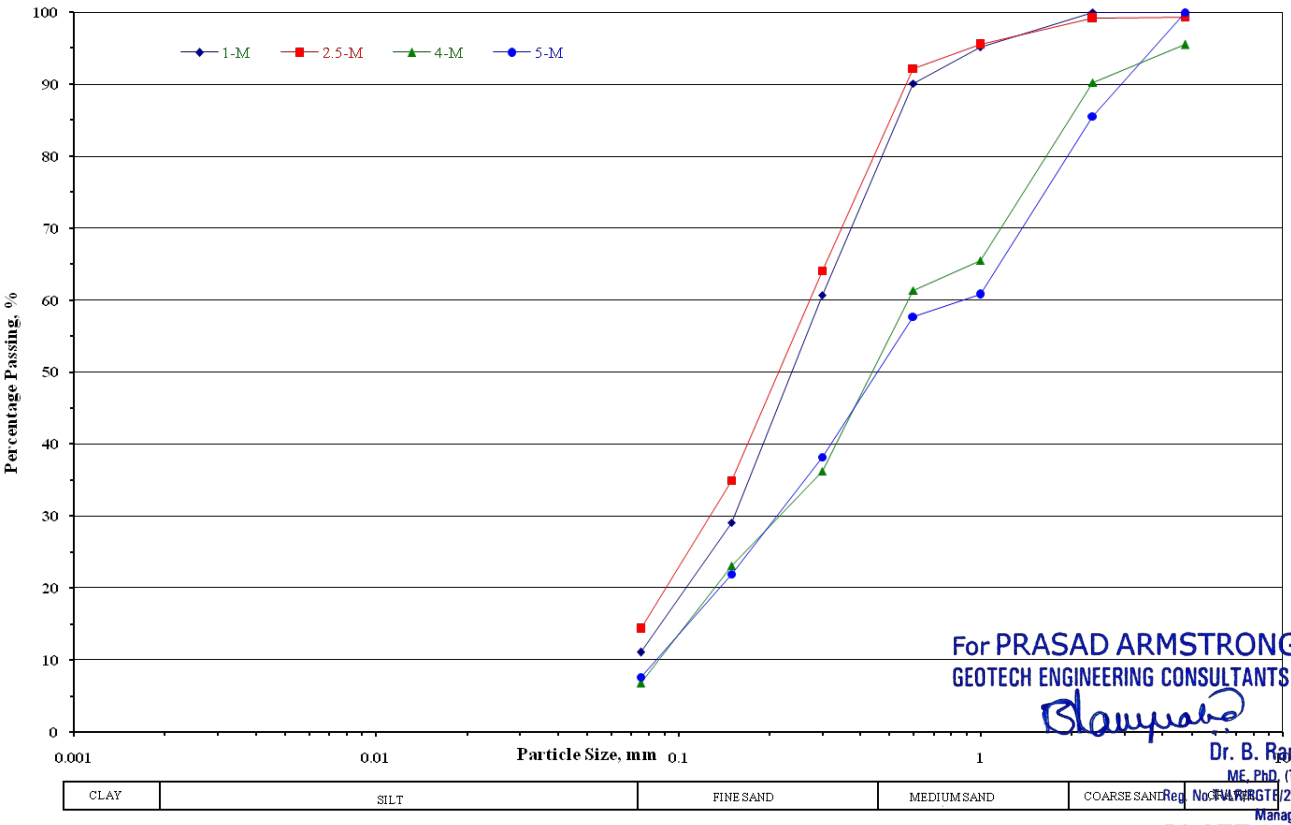
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ME, PhD, (Texas A&M)
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PLATE 20a

Grain Size Distribution Curves
Boring 3



Grain Size Distribution Curves
Boring 4

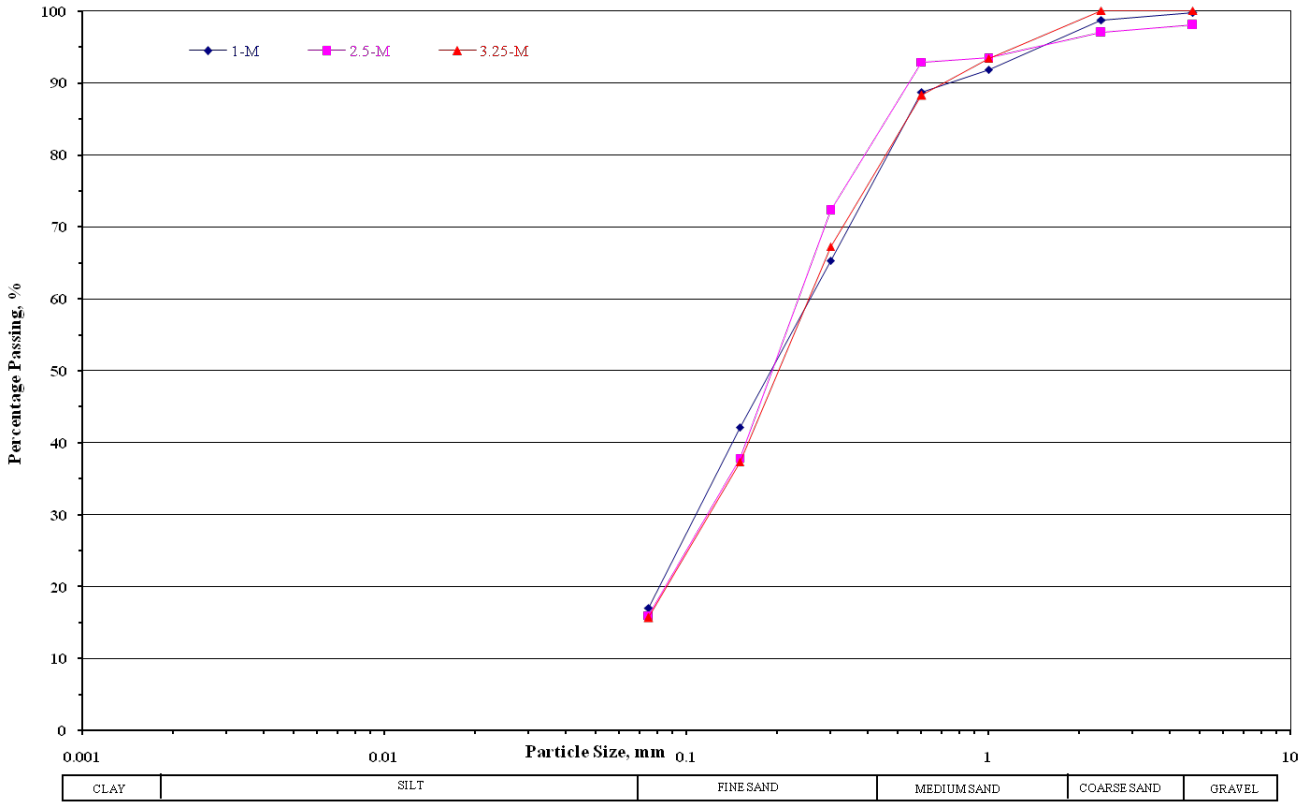


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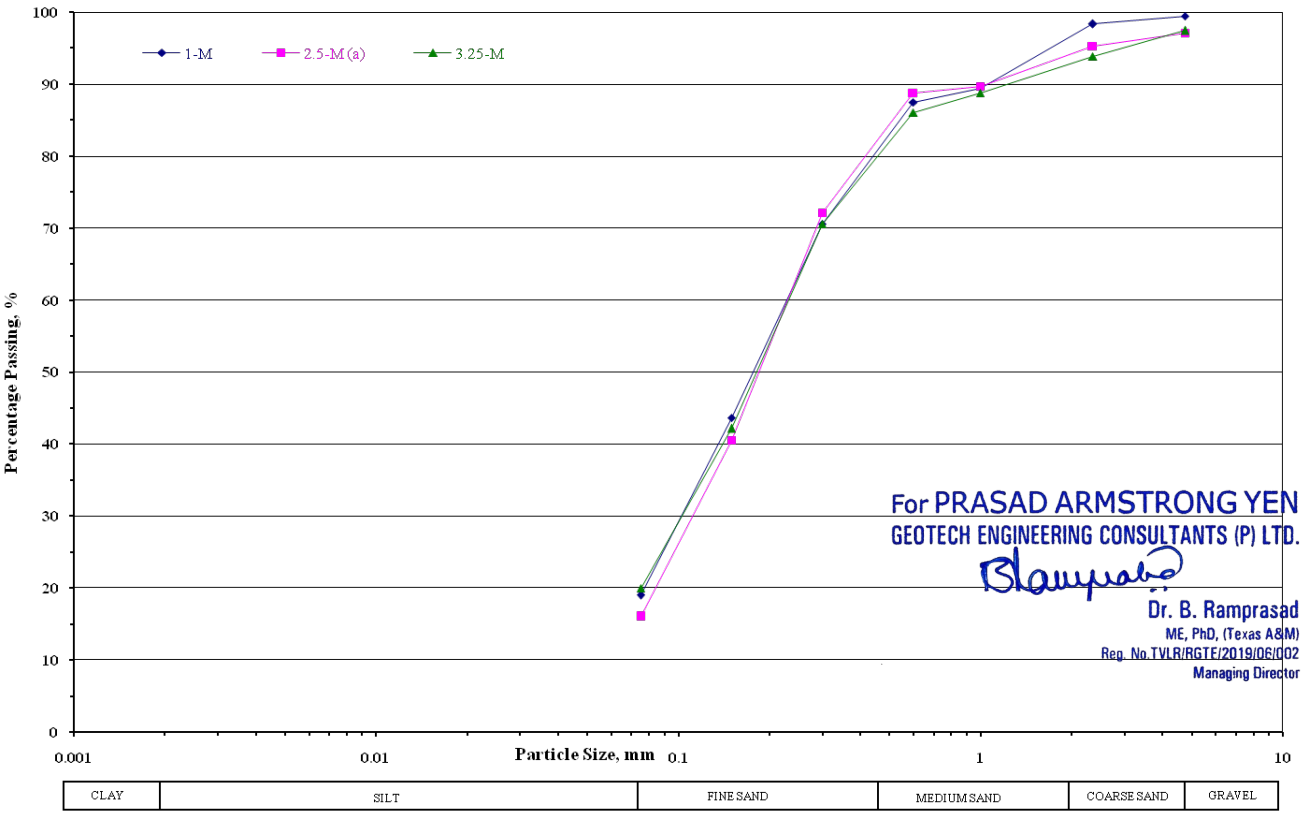
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No. TN/RGTE/2019/06/002
Managing Director

PLATE 20b

Grain Size Distribution Curves
Boring 5



Grain Size Distribution Curves
Boring 6

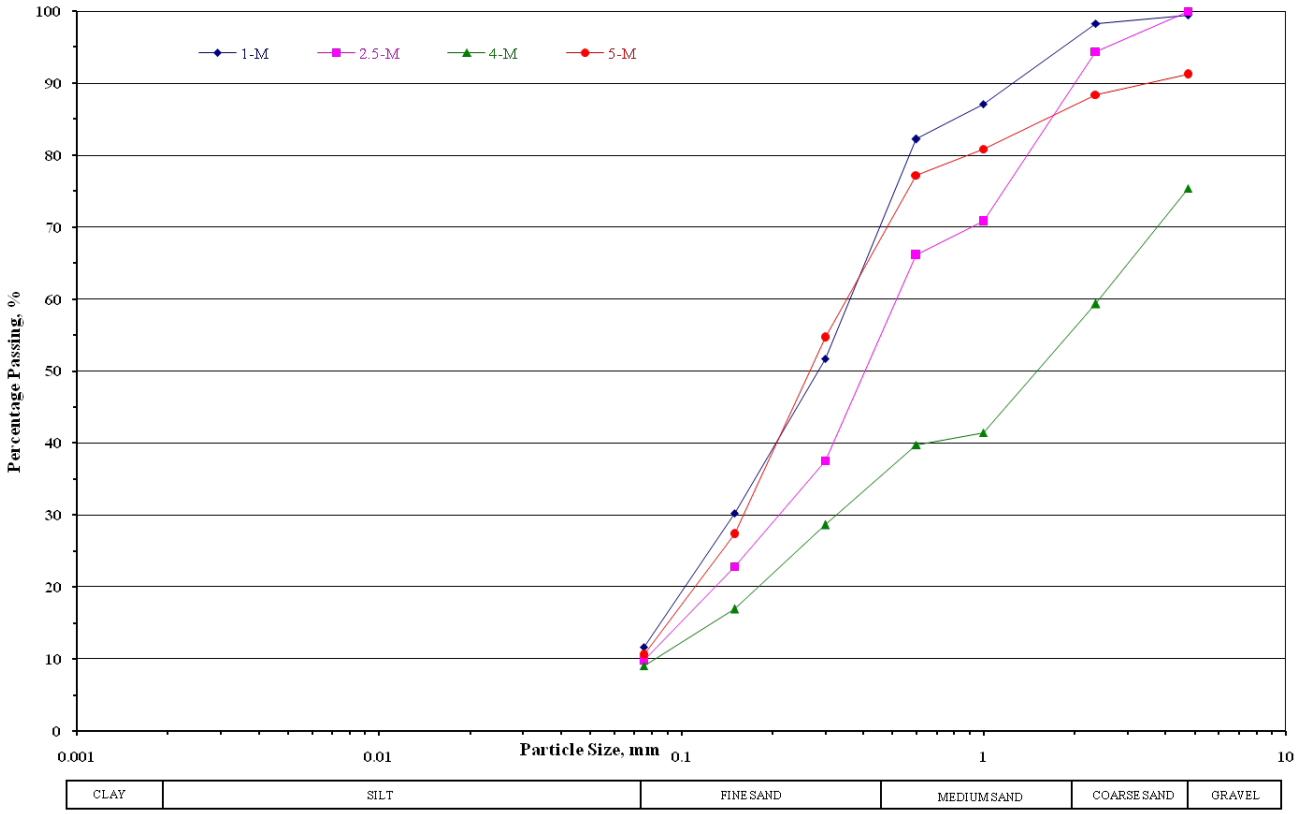


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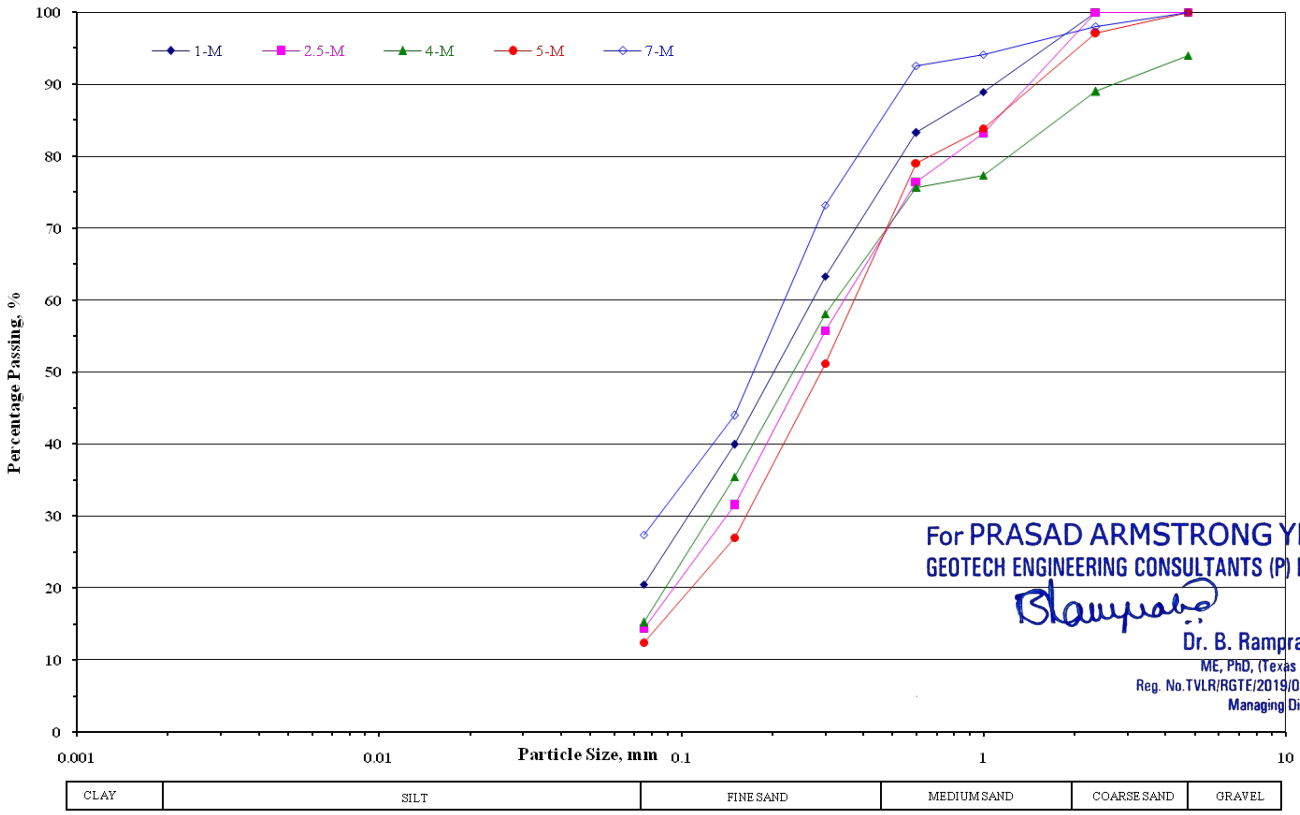
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ME, PhD, (Texas A&M)
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PLATE 20c

Grain Size Distribution Curves
Boring 7



Grain Size Distribution Curves
Boring 8

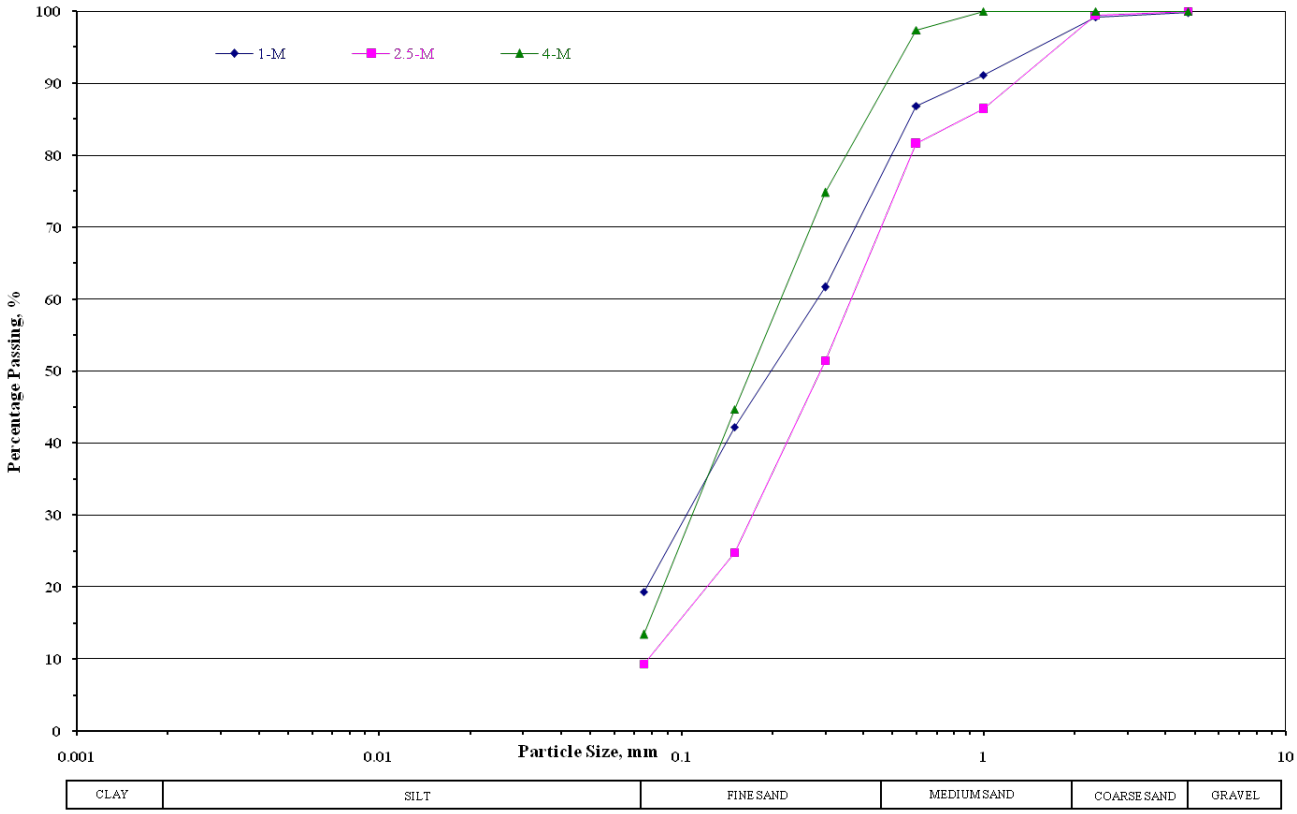


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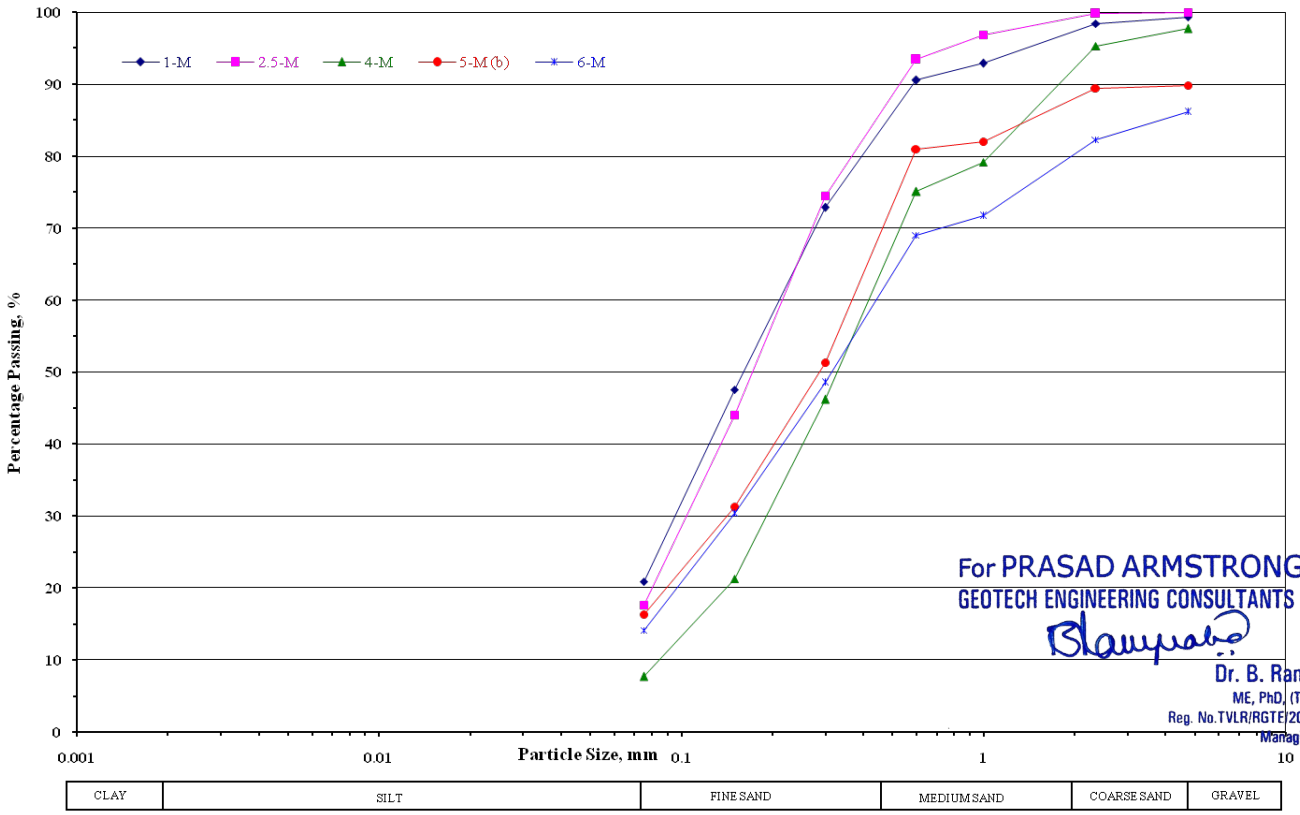
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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 20d

Grain Size Distribution Curves
Boring 9



Grain Size Distribution Curves
Boring 10

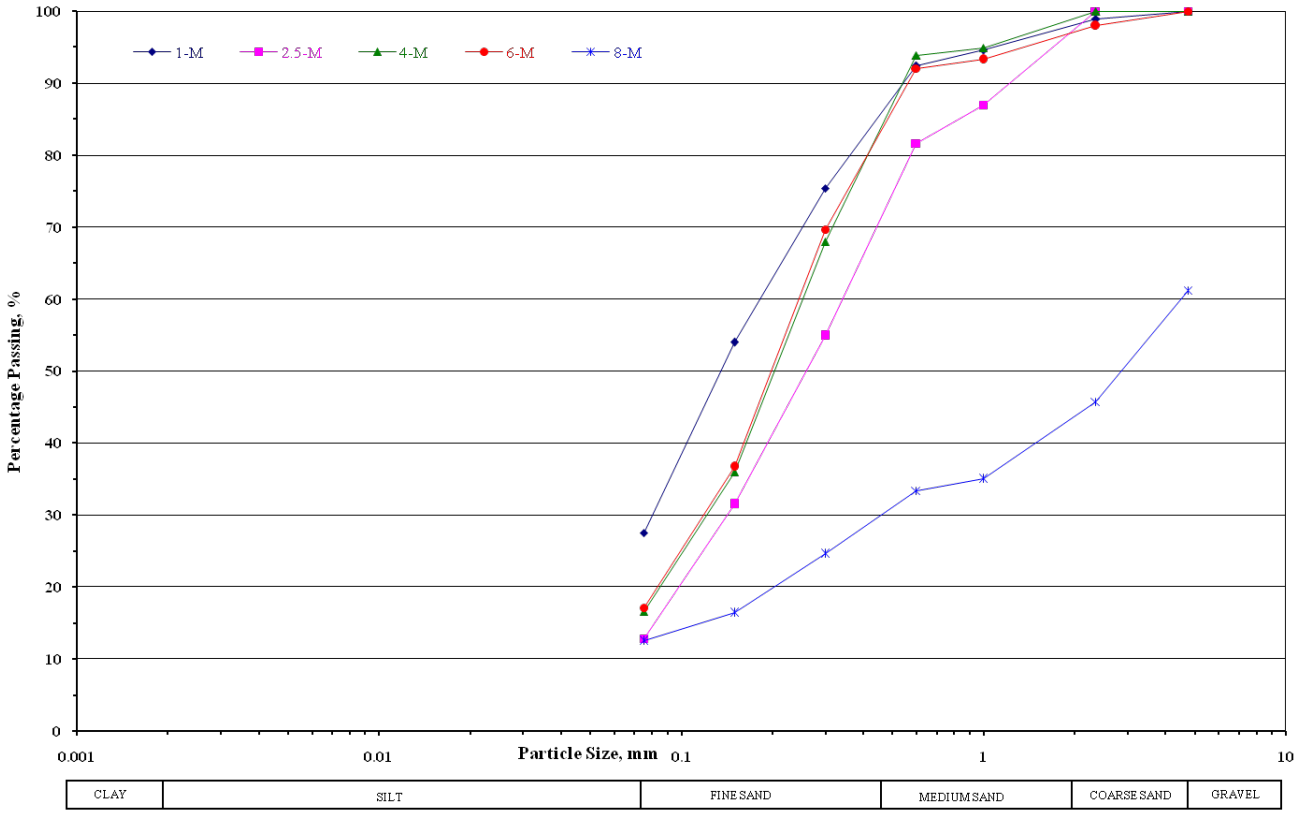


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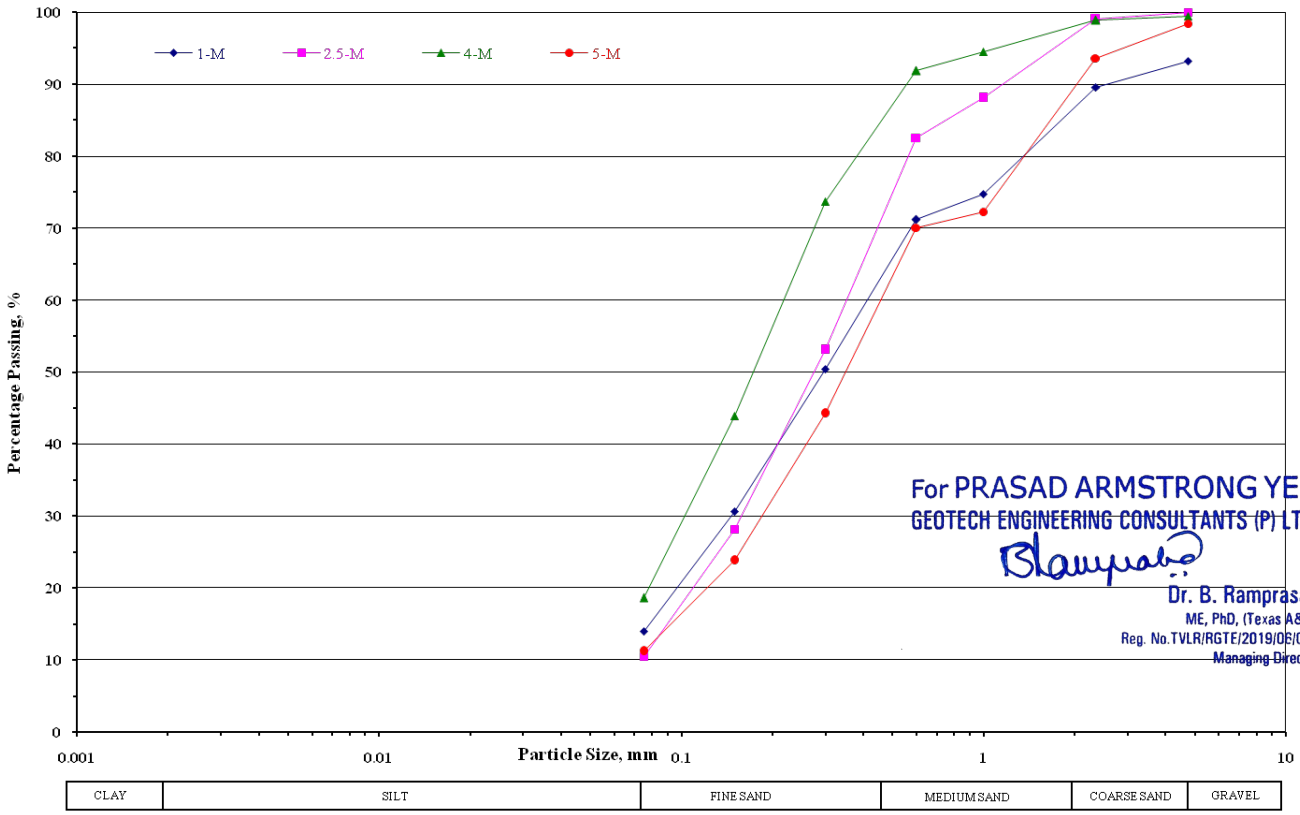
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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 20e

Grain Size Distribution Curves
Boring 11



Grain Size Distribution Curves
Boring 12

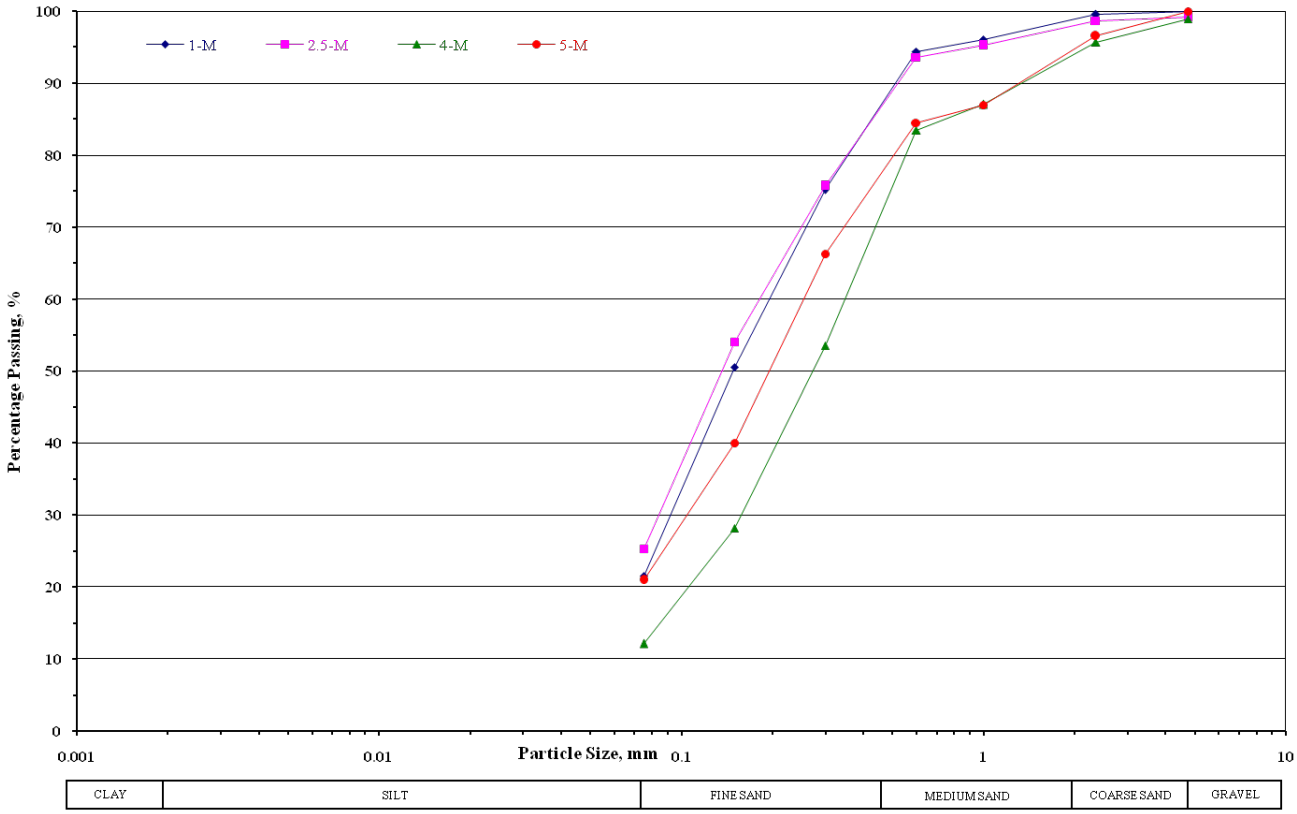


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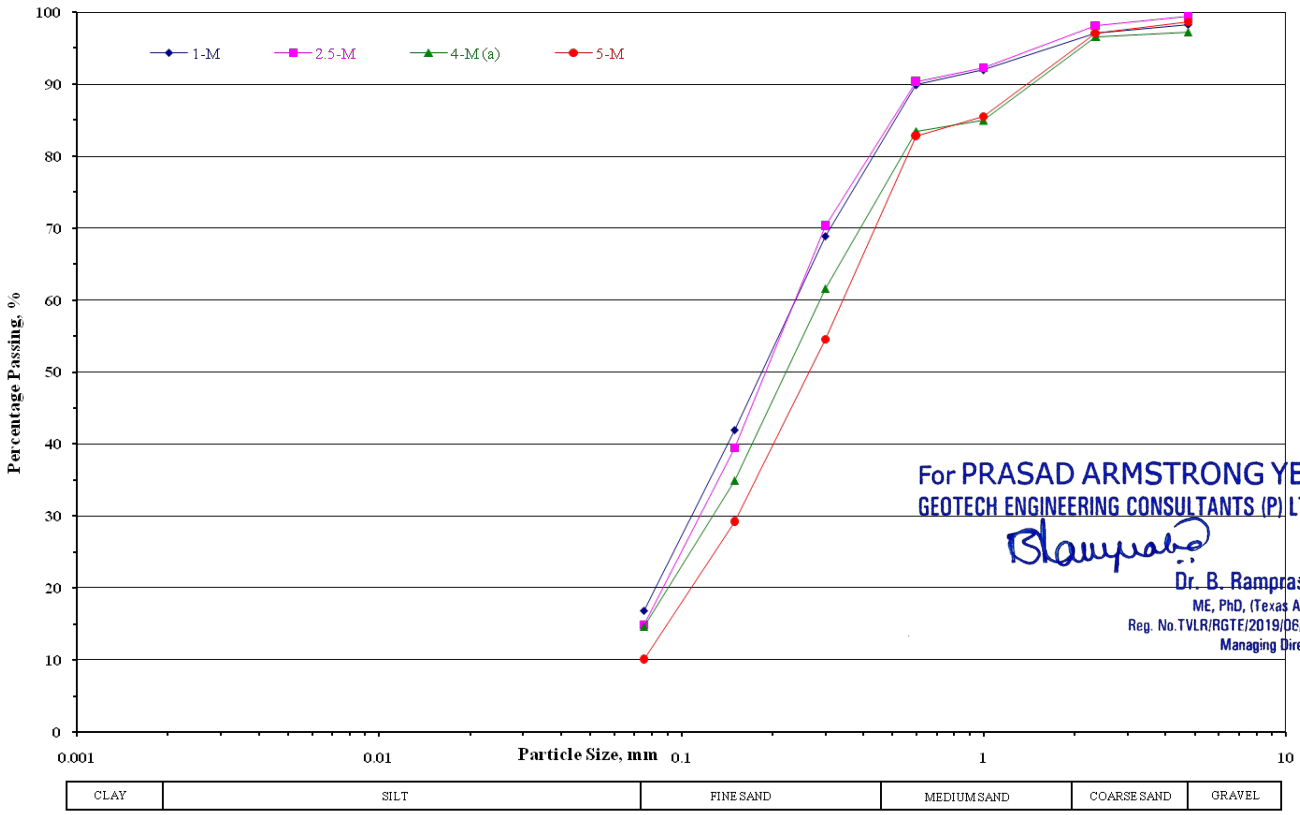
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/08/002
Managing Director

PLATE 20f

Grain Size Distribution Curves
Boring 13



Grain Size Distribution Curves
Boring 14

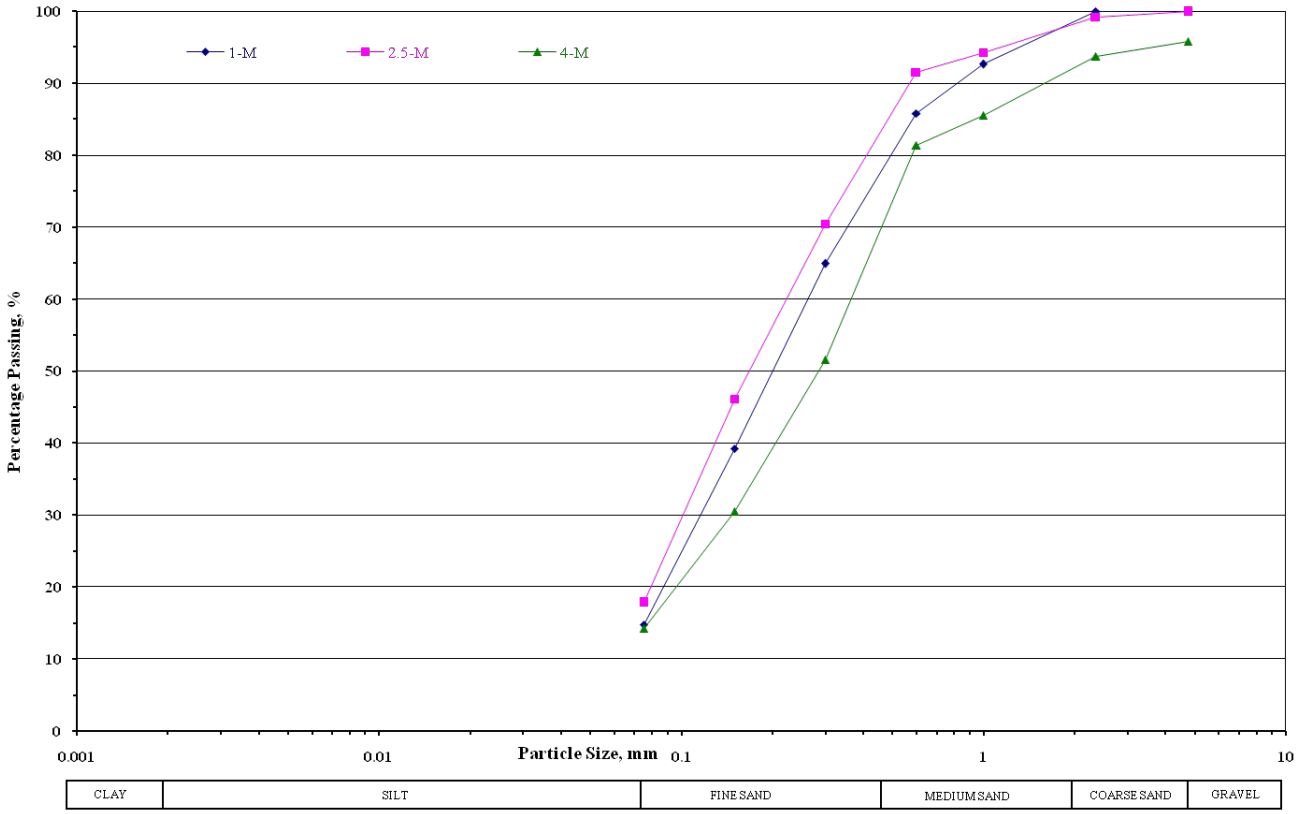


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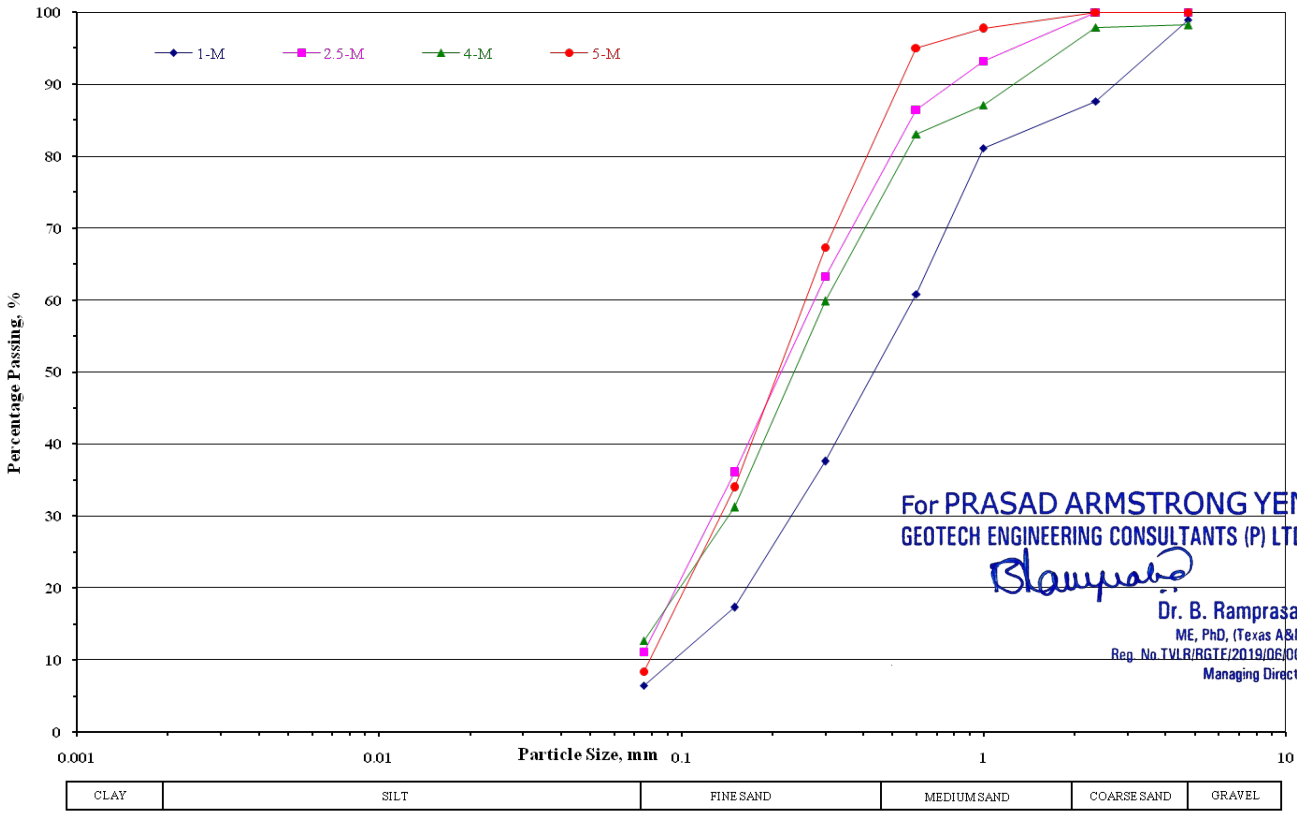
Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 20g

Grain Size Distribution Curves
Boring 15



Grain Size Distribution Curves
Boring 16



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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06002
Managing Director

PLATE 20h

SUMMARY OF WATER TEST RESULTS

PLOT'S OPEN WELL; DIAMETER = 10.5-M;

WATER LEVEL = 0.0-M; DISTANCE FROM BORING 5 ~ 20.5-M.

S. No.		Description	Results Obtained	As per IS:456 – 2000
1		To neutralize 100 cc of water using phenolphthalein as indicator	0.5 ml	Not more than 5 ml of 0.02N NaOH
2		To neutralize 100 cc of water using methyl orange as indicator	50.0 ml	Not more than 25 ml of 0.02N H_2SO_4
3	a	Organic Solids, mg/liter	80	200 Max.
	b	Inorganic Solids, mg/liter	1,748	3,000 Max.
	c	Sulphates as SO_3, mg/liter	199	400 Max.
	d	Chlorides as Cl, mg/liter	496	2,000 Max. - Plain Concrete 500 Max. RCC
	e	Suspended Solids, mg/liter	0	2,000 Max.
	f	pH	7.08	6 Min.

Remarks: Sample does not meet the requirements of all above clause 2.
Hence water cannot be used for construction purposes as per IS 456 - 2000.

BORING 2; WATER LEVEL = 0.0-M BELOW ORIGINAL GROUND LEVEL.

S. No.		Description	Results Obtained	As per IS:456 – 2000
1		To neutralize 100 cc of water using phenolphthalein as indicator	0.6 ml	Not more than 5 ml of 0.02N NaOH
2		To neutralize 100 cc of water using methyl orange as indicator	45.0 ml	Not more than 25 ml of 0.02N H_2SO_4
3	a	Organic Solids, mg/liter	290	200 Max.
	b	Inorganic Solids, mg/liter	4,312	3,000 Max.
	c	Sulphates as SO_3, mg/liter	580	400 Max.
	d	Chlorides as Cl, mg/liter	1,596	2,000 Max. - Plain Concrete 500 Max. RCC
	e	Suspended Solids, mg/liter	0	2,000 Max.
	f	pH	7.11	6 Min.

Remarks: Sample does not meet the requirements of all above clauses 2, 3a, 3b, 3c, and 3d.
Hence water cannot be used for construction purposes as per IS 456 - 2000.

BORING 11; WATER LEVEL = 0.0-M BELOW ORIGINAL GROUND LEVEL.

S. No.		Description	Results Obtained	As per IS:456 – 2000
1		To neutralize 100 cc of water using phenolphthalein as indicator	0.7 ml	Not more than 5 ml of 0.02N NaOH
2		To neutralize 100 cc of water using methyl orange as indicator	60.0 ml	Not more than 25 ml of 0.02N H_2SO_4
3	a	Organic Solids, mg/liter	312	200 Max.
	b	Inorganic Solids, mg/liter	6,008	3,000 Max.
	c	Sulphates as SO_3, mg/liter	840	400 Max.
	d	Chlorides as Cl, mg/liter	3,191	2,000 Max. - Plain Concrete 500 Max. RCC
	e	Suspended Solids, mg/liter	0	2,000 Max.
	f	pH	7.08	6 Min.

Remarks: Sample does not meet the requirements of all above clauses 2, 3a, 3b, 3c, and 3d.
Hence water cannot be used for construction purposes as per IS 456 - 2000.

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

SAMPLE CALCULATIONS FOR RECOMMENDED FOUNDATION

For the existing footings with short pile below load carrying capacity was estimated using soil properties from Boring 12 and 13. Following is a list of design assumptions:

Type of Foundation	=	Isolated Column Footing Foundation;
Foundation Depth below EGL	=	4.25-M below EGL;
Depth of Basement Floor below EGL	=	2.25-M;
Foundation Depth below Basement	=	2-M (4.25 – 2.0);
Worst Case Ground Water Level	=	At EGL;
Minimum Footing Size	=	2.5- by 2.5-M;
Expected Max. Column Load	=	550 tons.

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	=	34^o
C_u (Undrained Shear Strength)	=	0 tons/M^2
N_c (Bearing Capacity Factor)	=	N/A
N_q (Bearing Capacity Factor)	=	30.42
N_γ (Bearing Capacity Factor)	=	42.90
S_c (Shape Factor)	=	1 + 0.2*(B/L) = 1.0 + 0.2*(2.5/2.5) = 1.2;
D_c (Depth Factor)	=	1 + 0.2*D_f/B*tan (45 + ϕ/2) = 1.30
S_q (Shape Factor)	=	1 + 0.2*(B/L) = 1.0 + 0.2*(2.5/2.5) = 1.2;
d_q (Depth Factor)	=	1 + 0.1*D_f/B*tan (45 + ϕ/2) = 1.15
S_γ (Shape Factor)	=	1 - 0.4*(B/L) = 1.0 - 0.4*(2.5/2.5) = 0.60;
d_γ (Depth Factor)	=	1 + 0.1*D_f/B*tan (45 + ϕ/2) = 1.15
q'(O B @ Footing)	=	(1.4-1)*2.0 = 0.80 tons/M^2

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

q_{ult} = 0 + 0.80*(30.42-1)*1.20*1.15 + 0.5*1.2*2.5*42.90*0.60*1.15 = 76.88 ~ 77 tons/M^2

$q_{all} = q_{ult} / 2.5 = 77 / 2.5$ = 30.8 tons/M^2 **Use and Limit q_{all} = 30 tons/M^2**

Footing Size required for 550 tons = 550/30 = 18.33-M^2 or L = B = 4.28- Say 4.3-M.

Settlement Calculations:

In case of isolated column footing foundation the "Zone of Influence" will extend to "2B" depth below footing, i.e., 2*4.3 = 8.6-M below footing or 12.85-M below EGL or upto hard stratum level, whichever is earlier. There will be only elastic (immediate) settlement and no consolidation (long term) settlements as profile had only weathered rock and hard rock in the zone of influence.

Elastic or Immediate Settlement:- (Boring 12 and 13 Soil Profile)

1. 4.25- to 6.0-M = H_1 = 1.75-M; SPT "N" = 29; (Wea. Rock); E_s = 3,750 tons/M^2
2. 6.0- to 8.0-M = H_2 = 2.0-M; SPT "N" >> 100; (Wea. Rock); E_s = 8,500 tons/M^2

E_{savg} = (1.75*3750 + 2.0*8500)/3.75 = 6,283.33 ~ 6,250 tons/M^2

q_0 = 30 tons/M^2; H/B' = 3.75/2.15 = 1.74; L/B = 4.3/4.3 = 1.0; μ = 0.2; E_s = 6,250 tons/M^2

I_f = 0.90; I_1 = 0.26; I_2 = 0.07; I_s = 0.313;

$\Delta H_E = 4*30.0*2.15*(1-0.2^2)/6250*0.90*0.313*1000$ = **11.16 mm**

Total Elastic Settlement ΔH_E = 11.16 mm.

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

Dr. B. Ramprasad
ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 22a

Consolidation Settlement: None.

Total Consolidation Settlement $\Delta H_C = 0.00$ mm.

Total Combined Settlement $\mathbf{\Delta H} = \Delta H_E + \Delta H_C = 11.16 + 0.00 = \mathbf{11.16 \sim 11\ mm}$.

Estimated total settlement for a 4.3- by 4.3-M isolated column footing foundation at 4.25-M below EGL and minimum 2-M below basement bottom level was about 11 mm for a bearing pressure of 30 tons/M^2. The estimated total settlement was less than 60 mm – allowable limits for the total settlements for isolated column footing foundations on granular soils for framed structures with panel walls as per IS: 1904 - 2006 code.

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Managing Director

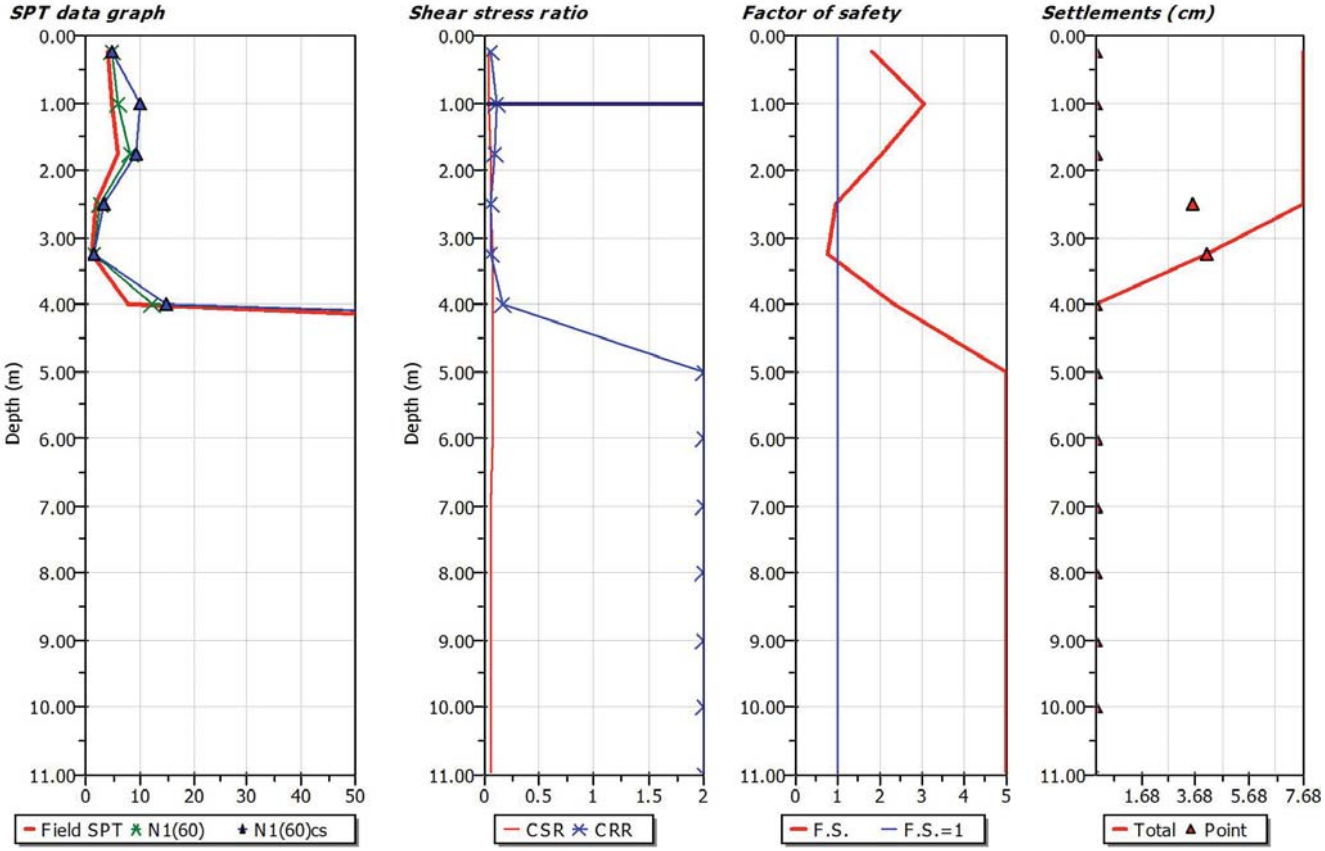
LIQUEFACTION ANALYSIS REPORT

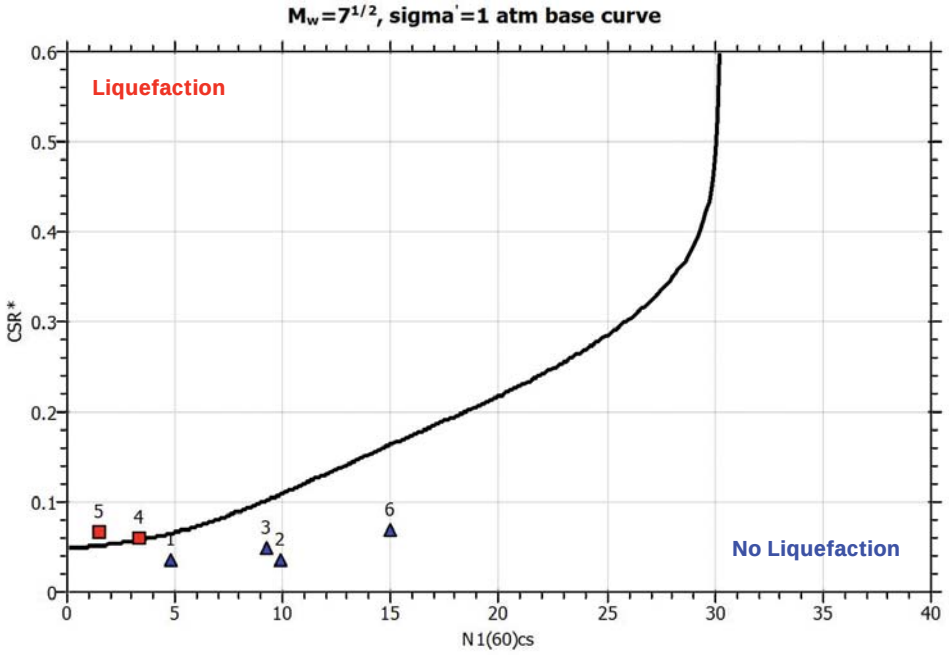
Project title : S No 16/1A1A, 16/1A1B, 16/1A1C, 17/2, 18/2A, 18/3 & 20, Thaiyur - A & 1401/2 at Thaiyur - B, Thiruporur Tlk., Kanchipuram Dist., TN

Project subtitle : Boring 9 Soil Profile

Input parameters and analysis data

In-situ data type:	Standard Penetration Test	Depth to water table:	1.00 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





Horizontal Acceleration, A_h = 0.08g

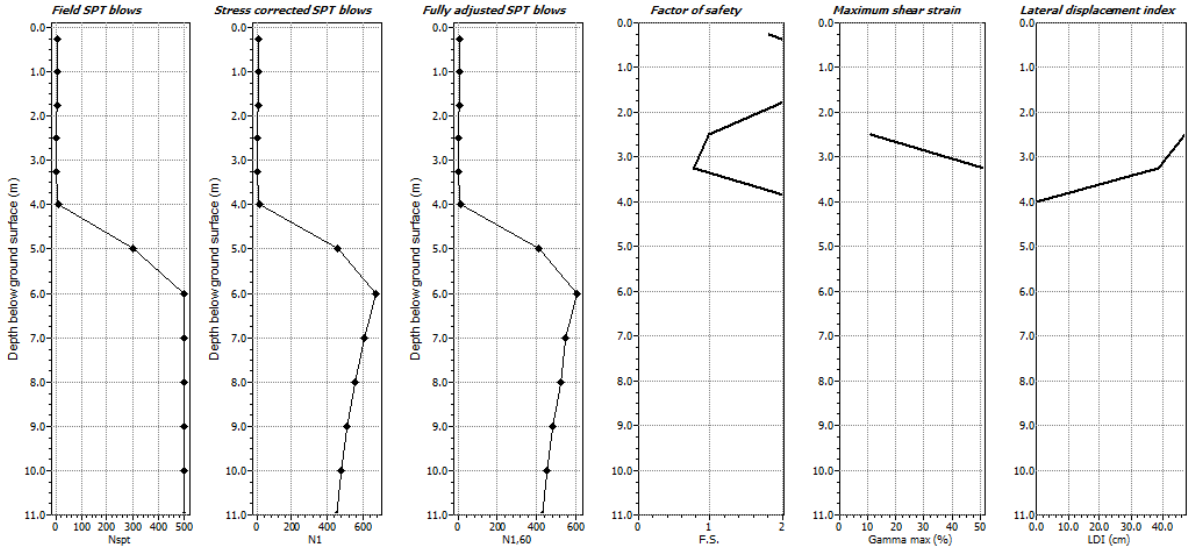
This software is licensed to : TRIAL VERSION

GeoLogismiki - Merarhias 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: 56.12 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

LiqIT v.4.6 - Soil Liquefaction Assesment Software

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ME, PhD, (Texas A&M)
Reg. No.TVLR/RGTE/2019/06/002
Managing Director

PLATE 23b

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