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PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

FOR

M/S. PRYME PROMOTERS PRIVATE LTD

&

MR. ZAID OMAR

06-12-2023

N 9°55'6.15972'', E 78°8'47.544 "

GEOTECHNICAL INVESTIGATIONS

FINAL REPORT



ISO 9001:2015
ISO IEC 17025:2017

DECEMBER-2023

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DOCUMENT RELEASE SHEET

00	06.12.2023	**Final Report**	12.12.2023		
Rev.	Date	**Description**	Originated	Checked	Approved

CLIENT: M/S. PRYME PROMOTERS PRIVATE LTD & MR. ZAID OMAR

PROJECT ADDRESS: NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

FINAL REPORT

DECEMBER-2023

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JOB. NO.:	**SSTS/LT/061223/04**	**REPORT. NO.:**	**SSTS/GT/061223/04**

FOUNDATION RECOMMENDATION

Use Pile foundation of Dia 450 mm / 500 mm / **600 mm** up to **10 m /15.00 m** from NGL,

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ABBREVIATIONS

EGL / NGL	Existing Ground Level / Natural Ground Level
RL	Reduced Level
BH	Bore Holes
SPT	Standard Penetration Test
GWT	Ground Water Table
TP	Trial Pits
CBR	California Bearing Ratio
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCEER	National Center for Earthquake Engineering Research
BIS	Bureau of Indian Standards
1V: 2H	1 Vertical: 2 Horizontal
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
m	Meter
mm	Milli Meter
m^3	Cubic Meter
MSL	Mean Sea Level
kN/m^3	Kilo Newton per Cubic Meter
Sec/mm	Seconds per Millimeter
SPT 'N'	Standard Penetration Test 'N' value
pH	Hydrogen Ion Concentration
q_a	Allowable Bearing Pressure
IC	In-situ CBR
SBC	Safe Bearing Capacity
SO_4	Sulphate
C	Cohesion
ø	Phi, Angle of Internal Friction
RL	Reduced Level
Y	Gamma, Density
CR	Core Recovery
RQD	Rock Quality Designation
TCR	Total Core Recovery
KPa	Kilo Pascal
D	Depth
Kg	Kilograms
Kg/cm^2	Kilograms per square centimeter
CS	Cross Section

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GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

1.INTRODUCTION

GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF **G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020. f**or **M/S. PRYME PROMOTERS PRIVATE LTD & MR. ZAID OMAR** awarded the work of Geotechnical Investigations Work to Sastha Soil Testing Services dated 06th DECEMBER 2023.

As part of scope of services, Total Three boreholes were drilled up to 10.00m and 15.00m depth below EGL or 3 consecutive N-values are greater than 50 or 1.5 m drilling into Soft rock/ M. rock, H.rock, whichever is earlier at the locations identified by In our site we have Encountered With Fill Up Soil From 1.50 M And Fine Sand From 3.00 M – 6.00 M, Coarse Sand, Kankar Mix Sand From 6.00 M – 10.00, Kankar From 12.00 To 15.00m.N= 50. This final report covers the details of boreholes drilled; sub-soil profile noticed in the boreholes, field and laboratory test results of soil samples collected from the boreholes and interpretation of the same for Safe Bearing Capacity (SBC) and foundation recommendations.

2. SCOPE OF WORK

Conducting Standard Penetration Test (SPT) at every 1.5 m intervals up to 10.00m and 15.00m depth and thereafter at every 1.5 m intervals till refusal (N>50).

- Collection of 100 mm diameter undisturbed soil samples in cohesive soil layers
- Conducting all relevant laboratory tests on soil/rock samples as per IS codes and as per Client's structural requirements.
- Determination of Safe Bearing Capacity (SBC) of Soil/Rock.
- Preparation and submission of reports

3. GEOLOGY OF THE AREA - Regional and Local Geology

Madurai with a total area of 3860 sq.km. is one of the trifurcated districts of the erstwhile composite Madurai and is situated between North latitudes 9° 30' - 10° 16' and east longitudes 77° 15' - 78° 25'. It is bound by Theni district in the west, Dindigul district in the north, Karur and Sivaganga districts in the east and by Virudunagar district in the south. It comprises 10 taluks, viz., Madurai East, Madurai West, Thirupparankundram, Usilampatti, Tirumangalam, Madurai South, Madurai North, Vadipatti, Peraiyur and Melur taluks with Madurai City as the district headquarters.

Madurai district is covered by granulite facies high grade metamorphic rocks and younger intrusives which fall under the following categories: 1. Metasedimentary group comprising quartzite, calc gneiss/crystalline limestone, garnetsillimanite ± biotite ± cordierite ± spinel gneiss, minor garnet-cordierite gneiss and garnetiferrous quartzo-feldspathic gneiss (Khondalites and leptynite), magnetite and quartzite. 2. Charnockite Group consisting of acid charnockite and pyroxene granulite. 3. Older Intrusive rocks consisting of amphibolite, pyroxenite and gabbro (maficsultramafics). 4. Migmatite group made up of banded hornblendebiotite gneiss, grey granitic gneiss, pink granitic gneiss and grey hornblende granite. 5. Younger Acid Intrusives consisting of granite and pegmatite. Metasedimentary group: This consists of rocks of arenaceous, calcareous and argillaceous composition metamorphosed under granulite facies and represented by quartzite, calc gneiss/diopside granulite, marble, garnet sillimanite gneiss (Khondalite) with minor bands of garnetiferrous quartzo-feldspathic gneiss (leptynite), garnet cordierite gneiss. These rocks occur as either individual bands or as 'enclaves' or as tectonic slices within the predominantly charnockite-migmatite country. Quartzite is the important member of the Metasedimentary Group and occupies the crest of the linear ridges in the district. Thickness of the individual quartzite bands varies from less than a metre to 150m. The quartzite is white or dirty white in colour and composed essentially of interlocking grains of quartz and Feldspar which is often kaolinised. Calc gneiss is grayish white, medium grained, granular or gneissose rock with typical ribbed weathering. It consists mainly of green diopside, white calcite and quartz with pinhead size garnets, green apatite and magnetite as accessory minerals. The thickness of calc gneiss varies from 1m to 30m. With the decrease of silicate minerals and increase of carbonates the calc gneiss grades into crystalline limestone at a few places. Garnet-sillimanite gneiss (Khondalite) represents metamorphosed pelitic sediments. This rock shows a thickness varying from 1m to 50m. Development of garnet is very profuse and at times garnet rich layers (1 to 2 cm thick) alternate with quartz-Feldspar rich layers. Sillimanite occurs in varying amounts. Biotite is a common associate mineral. Development of cordierite is noticed in the garnet- 55 sillimanite gneiss in a few places. Minor bands of a few cm to a couple of metres wide, whitish looking quartzo-feldspathic gneiss (leptynite) with unevenly distributed pink garnets occur as inter bands within garnet-sillimanite gneiss.

Younger Acid Intrusives that are noticed in the Madurai District are granite and thin veins of pegmatite. Pegmatite is coarse grained, mostly pink coloured with orthoclase and quartz as the main minerals. Biotite and magnetite occur in small amounts. Pockets of Tertiary marine sandstone, calcareous gritty sandstone and low-level laterite capping with kankary veins are noticed east of Madurai, Quaternary alluvium is found on either side of River Vaigai around Madurai.

Local Seismicity. Madurai falls under Zone II

DISTRICTS LYING IN EARTHQUAKE HAZARD ZONE II SEISMIC ZONE –

Seismic Zone II, Zone factor Z=0.10. Seismic intensity: Low. Importance Factor *I* = 1.5

(Based on the Vulnerability Atlas of India – 2nd Editions, BMTPC

Seismic Zone factor, Z as per IS 1893 (Part 1) – 2016.



4.0. FIELD INVESTIGATIONS.

Location Details

The bore holes have been drilled at the locations identified by the Client. The bore hole Latitude / Longitude is furnished in the below Table.

S.NO	BH NO	EASTING	NORTHING	BORE HOLE TERMINATION DEPTH
1	01	78°8'47.544"	9°55'6.15972"	10.00M
2	02	78°8'46.59144"	9°55'8.02452"	15.00M
3	03	78°8'47.32116"	9°55'8.29704"	15.00M

5.0. METHODOLOGY OF FIELD WORK.

5.1. Boring and Drilling

Boreholes was sunk by deploying heavy duty rotary drilling rig using the conventional rotary drilling process. Methodology followed for boring confirmed to IS: 1892.Boring was affected by the cutting action of rotating bit with Bentonite slurry circulation and by stabilizing the sides of the boreholes using casing pipes/Bentonite slurry up to required depth to prevent side collapse. While this method was adequate to bore through the stiff soil stratum, progress of boring slowed down considerably near the soil-rock interface, including weathered rock formations. In such cases, further drilling work was carried out by using NX size double tube core barrel with TC (Tungsten Carbide) bits. The bore logs are furnished in Appendix A.

5.2. Sampling

Disturbed samples have been collected from split spoon sampler by conducting the standard penetration tests below the existing ground level as presented in the respective field bore logs. Undisturbed samples (UDS) could not be collected in the bore holes since cohesive to semi- cohesive soils was not in the boreholes.

5.3. Rock Coring

Heavy duty rotary drilling rig having the capacity to drill up to 60 m has been used to drill through the rocky stratum. Tungsten Carbide (TC)/Diamond bits were used to drill through weathered rock/hard rock stratum. Recovered cores were measured and percentage CR and RQD has been calculated asunder:

$$\% \text{ CR} = \frac{\textit{Length of core}}{\textit{Length of run}} \times 100$$

$$\%RQD = \frac{Length\ of\ core\ in\ pieces\ of\ 101.6mm\ (4inches and above)}{Length\ of\ run} \times 100$$

The SPT, UDS and rock core samples, core sampling depth percentage, CR and RQD for each core drill run has been mentioned in the bore log.

5.4. Standard Penetration Test (SPT)

Standard Penetration Test (SPT) to determine penetration resistance was conducted in the boreholes generally up to refusal depth using the procedure described in IS: 2131. In this method, driving bit is replaced by split spoon sampler (50.8 mm OD and 35 mm ID) and the sampler is driven by dropping 63.5 kg hammer on the top of the driving collar with free fall of 75 cm. The length of the sampler is 60 cm. The sampler is first driven through15 cm as “Seating Drive”. It is further driven through 30 cm. The number of blows required to drive the sampler for 30 cm beyond seating drive is termed as “Penetration Resistance, N”. Where it was not possible to penetrate the full length of SPT sampler and “refusal” was reached earlier, N values are generally observed to be greater than 100.Recorded ‘N’ values are mentioned in the respective bore log sheet attached.

5.5. Ground Water Table

Ground water table was **Not met at during the drilling depth** at the time of investigation**.**

Note: Approximate Ground water table **30.00M**

Road level and site level

The Approximate Level of site is **0.000m Above** the Nearby Road. Approximate MSL Elevation **134.00 Meters** Above Sea level.

MITIGATION MEASURES

1. Soil stabilization - Soil stabilization **NOT** required for this site.
2.Refilling the excavated soil – the same site soil **CAN** be used for refilling / back filling.
3.Ground water **NOT encountered** within the drilling dept

6.0. LABORATORY INVESTIGATION

Disturbed soil samples recovered from the boreholes at various depths are collected for Laboratory tests to determine their Physical and Engineering properties. The testing procedures were in accordance with current applicable IS Standards.

The Following tests were conducted on selected soil samples recovered from the boreholes:

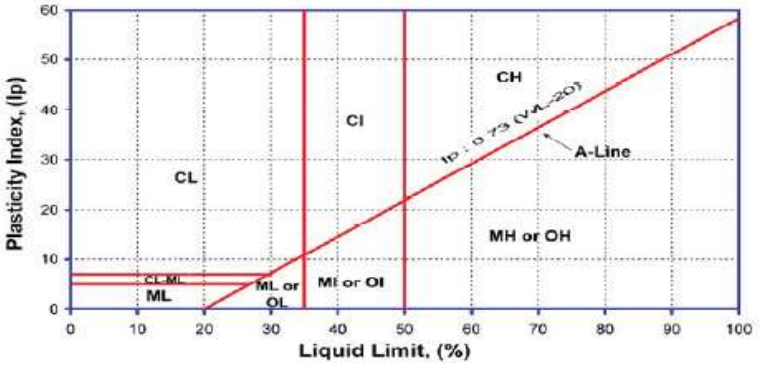
Laboratory Test	IS Code Referred
Bulk Density	By Calculations
Natural Moisture Content (NMC)	IS 2720 Part 2 – 1973 (Reaffirmed 2015)
Specific Gravity	IS 2720 Part 3 Sec 2 – 1980 (Reaffirmed 2016)
Grain Size Analysis	IS 2720 Part 4 – 1985 (Reaffirmed 2015)
Liquid Limit and Plastic Limit	IS 2720 Part 5 – 1985
Free Swell Index	IS 2720 Part 40 – 1977 (Reaffirmed 2002)
Direct Shear Test	IS 2720 Part 13 – 1986 (Reaffirmed 2016)
Unconfined Compressive Strength Test (UCC)	IS 2720 Part 10 – 1991 (Reaffirmed 2015)
Point Load Index Test on Rock	IS 8764 – 1998 (Reaffirmed 2019)

The Laboratory Test Results are furnished in *Appendix B1*. The grain size curves of soil samples are furnished in *Appendix B2.*

Plasticity of Clay

Plasticity	Liquid Limit
Low Plastic	< 35
Medium Plastic	35 to 50
High Plastic	> 50

Plasticity Chart



Consistency of Cohesive Soils		
Consistency	**Cohesion Intercept, Kg/Sq.cm**	**SPT (N) Value**
Very Soft	<0.1	0 to 2
Soft	0.1 to 0.25	2 to 4
Firm / Medium	0.25 to 0.5	4 to 8
Stiff	0.5 to 1.0	8 to 15
Very Stiff	1.0 to 2.0	15 to 30

Hard	> 2.0	> 30

Density Condition of Granular Soil	
Density Descriptor	**SPT (N) Value**
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	> 50

Degree of Expansion of Fine Grained Soils

Liquid Limit	Plasticity Index	Shrinkage Index	Free Swell Percent	Degree of Expansion	Degree of Severity
20 - 35	< 12	< 15	< 50	Low	Non-critical
35 - 50	12 - 23	15 -30	50 -100	Medium	Marginal
50 - 70	23 - 32	30 - 60	100 - 200	High	Critical
70 - 90	> 32	> 60	> 200	Very High	Severe

Test / Parameter		Uncertainty*	Test / Parameter		Uncertainty*
Moisture Content		± 0.28%	Free Swell Index, %		± 0.4%
Bulk & Dry Density		± 0.05 g/cc	Swell Pressure		± 0.43 kg/cm^2
Specific Gravity		± 0.014	Consolidation	Pressure	± 0.03 kg/cm^2
Liquid Limit		± 0.30%		Void Ratio	±0.01
Plastic Limit			Density Index (relative density) of cohesionless soils		± 5 %
Shrinkage Limit		± 0.40%			
Unconfined Compression	c	± 0.052 kg/cm^2	CD Direct Shear Test	ϕ	± 0.52 degrees
UU Triaxial Test	c	± 0.01 kg/cm^2	Soil Gradation		± 0.4% of particle size
	ϕ	± 0.44 degree			
Std/Mod Proctor Compaction	MDD	± 0.03 g/cc	Coefficient of Permeability		± 1.0%
	OMC	± 0.29%	Rock	Crushing Strength	± 2.3 kg/cm^2
Laboratory CBR		± 1.6%		Point Load Strength Index	± 0.017 kg/cm^2

* at 95 percent confidence level for coverage factor of 2

Table 3
Seismic site classification as per NEHRP and Eurocode 8

NEHRP, USA			Eurocode 8	
Site Class or soil profile type	Description	Average shear wave velocity in the top 30 m	Subsoil class	Description of stratigraphic profile
A	Hard Rock	>1500	–	–
B	Rock	760–1500	A	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface
C	Very Dense soil/soft rock	360–760	B	Deposits of very dense sand, gravel or very stiff clay, at least several tens of m in thickness, characterized by a gradual increase of mechanical properties with depth
D	Stiff soil	180–360	C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of m
E	soft soil	<180	D	Deposits of loose to medium cohesionless soil (with or without some soft cohesive layers), or of cohesive soil predominantly soft-to-firm
F	Special soil requiring site-specific evaluation (1. Soils vulnerable to potential failure or collapse under seismic loading e.g., liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils; 2. peats and/or highly organic clays (3 m or thicker layer); 3. very highly plasticity clays (8 m or thicker layer with plasticity index>75); 4. very thick soft/medium stiff clays (36 m or thicker layer)		E	A soil profile consisting of a surface alluvium layer with Vs30 values of class C or D and thickness varying between about 5 m and 20 m, underlain by stiffer material with Vs30 > 800 m/s
			S1	Deposits consisting – or containing a layer at least 10 m thick of soft clays/silts with high plasticity index (PI>40) and high-water content
			S2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in classes A-E or S1

6.3. UNCERTAINTY

- Every Measurement entails an uncertainty. It is well known that no measuring instrument can determine the true value of any measurement. The cumulative effect of factors such as sensitivity of equipment, accuracy in calibration, human factors and environmental conditions will determine the overall uncertainty in the parameter determined from these measurements.

- As a part of our commitment to our clients, we have worked out the uncertainty in the parameters reported by our laboratory. Although this does not form a part of our contract agreement, we present below our statistical estimate of uncertainty of various parameters based on our most recent evaluation.

7.0 SUB-SOIL PROFILE

Generally, one-layer sub-soil profile was noticed in the boreholes, described as under: Layer I – Layer III the With Fill Up Soil From 1.50 M And Fine Sand From 3.00 M – 6.00 M, Coarse Sand, Kankar Mix Sand From 6.00 M – 10.00, Kankar From 12.00 To 15.00m N= 50. This layer was noticed at the top in the boreholes and up to the termination depth of the bore holes. The thickness of this layer and recorded N- values in this layer areas under:

BH. No	Thickness of Layer below EGL (m)	N-values	In-situ Compactness of Soil
BH 1	0.00 - 1.50,3.00 - 4.50-10.00.	50,>50,>50,>50,>50,>50,>50.	LOOSE, DENSE
BH 2	0.00 - 1.50,3.00 - 4.50 10.00 – 15.00.	50,>50,>50,>50,>50,>50,>50,>50,>50,>50.	LOOSE, DENSE
BH 3	0.00 - 1.50,3.00 - 4.50-10.00 – 15.00.	50,>50,>50,>50,>50,>50,>50,>50,>50,>50.	LOOSE, DENSE

8.0. FOUNDATION DESIGN CONSIDERATIONS- Foundation Type, Size & Depth **G + 5 RESIDENIAL BUILDING** Based on sub-soil profile noticed at site and proposed structures, Open **foundations isolated spread** can be considered as suitable foundation system. As per Client's specification, the Structure will have **G + 5 RESIDENIAL BUILDING** above EGL. Hence Safe Bearing Capacity (SBC) calculations have been made for foundations at 1.50 to 15 m depth below EGL. Based on the structural configuration, designer can consider the design foundation level.

Pile Foundation

Use Pile foundation of Dia 450 mm / 500 mm **/ 600 mm up to** 10 m **/15.00 m from NGL,**

(or)

RAFT FOUNDATION

Use Raft foundation below 3.00 m from NGL

(or)

Column foundation

Use Column foundation with wide footing below **4.50M** from NGL, with connecting Beam all around,

(or)

Combined Column foundation / Strip Foundation

Use combined Column foundation with wide footing below **4.50M** from NGL, with connecting Beam all around.

(or)

According to the Structural Engineer's recommendation considering loading conditions.

Minimum and maximum footing widths for isolated spread footings foundations considered in the report are as follows:

8.2. Design N-value

The N-values in the boreholes at 1.50 m,3.0m, 4.50m and 6.00m depth below EGL are as follows:

Borehole No.	N-value			
	Depth (m)			
	1.50	3.00	4.50	6.00
BH 1	10	50	50	50
BH 2	10	50	50	50
BH 3	10	50	50	50

9.0. NET SAFE BEARING CAPACITY (SBC) COMPUTATIONS

Calculations for Net Safe Bearing capacity for the foundations supported in soil layers are recommended based on following approach

- Shear Criteria recommended by IS:6403
- Settlement criteria recommended by IS:8009 (Part I)

Consistent with standard Geotechnical Practices, the lower of values worked out from shear as well as settlement approach is recommended for design.

9.1. Net SBC Computations from Shear Criteria

The calculations are based on equation recommended by Code IS: 6403 which takes care of L/B ratio (shape), foundation depth etc., along with other parameters based on general shear failure. The equation used to calculate net ultimate bearing capacity (UBC) is as under.

$$\text{Net UBC} = c\,N_c\,S_c\,d_c\,i_c + \gamma\,D\,(N_q - 1)\,S_q\,d_q\,i_q + 0.5\,\gamma\,B$$

NS di

Where,

c = Cohesion of founding strata in t/m^2 = 0

ø= Angle if internal friction of founding strata

S_c, S_q and S□=Shape factors referred from IS: 6403 for square foundation =1.3,1.2 and 0.8 Respectively

N_c, N_q and N□= Bearing capacity factors referred from IS:6403 d_c, d_q and d_γ=Depth factors referred from

IS:6403

$\sqrt{N_\gamma} = \tan^2(45 + \phi/2)$

$d_c = 1+0.2(D/B)\sqrt{N_\phi}$

d_q and $d_\phi = 1 + 0.1\,(D/B)\sqrt{N_\phi}$

i_c, i_q and i_ϕ = Inclination factors, all three factors are equal to 1

D = Depth of foundation below existing ground level = 2.0 m & 3.0 m

B = Width of foundation = 2 m, 3 m

γ = Bulk unit weight of founding strata

9.2. Net Allowable Bearing Pressure Computations from Settlement Criteria

Using curve of IS-8009 (Part I), settlements for 10 t/m^2 are inferred for foundations of width 2.0 m, 3.0 m for design SPT 'N' values. For foundations beyond 3.0 m width, Curves become asymptotic and settlements become more or less constant. This settlement inferred is corrected for Ground water table position, embedment and rigidity. Finally, by using this corrected settlement, the net allowable bearing pressure is evaluated for 25 mm immediate settlement.

The calculated Net Safe Bearing Capacity (SBC) values are tabulated below:

BH No.	Width (m)	Recommended Net SBC (kN/m^2) IS :6403							
		Depth below EGL (m)							
		1.50		2.00		2.50		3.00	
		Shear	Settlement	Shear	Settlement	Shear	Settlement	Shear	Settlement
BH 1-3	1.50	36.97	139.61	47.84	139.61	59.55	139.61	428.33	937.37
	2.00	39.17	128.22	49.29	128.22	60.05	128.22	426.74	860.88

BH No.	Width (m)	Recommended Net SBC (kN/m^2) IS :6403							
		Depth below EGL (m)							
		3.00		3.50		4.00		4.50	
		Shear	Settlement	Shear	Settlement	Shear	Settlement	Shear	Settlement
BH 1-3	1.50	428.33	937.37	507.53	937.37	592.33	937.37	682.74	937.37
	2.00	426.74	860.88	496.82	860.88	571.11	860.88	649.61	860.88

Model calculation for estimation of Net SBC is presented in Appendix C.

9.3 PILE FOUNDATION

Pile foundations are the part of a structure used to carry and transfer the load of the structure to the bearing ground located at some depth below ground surface. The main components of the foundation are the pile cap and the piles. Piles are long and slender members which transfer the load to deeper soil or rock of high bearing capacity avoiding shallow soil of low bearing capacity The main types of materials used for piles are Wood, steel and concrete. Piles made from these materials are driven, drilled or jacked into the ground and connected to pile caps. Depending upon type of soil, pile material and load transmitting characteristic piles are classified accordingly. In the following chapter we learn about, classifications, functions and pros and cons of piles.

The ultimate bearing capacity of a pile is the maximum load which it can carry without failure or excessive settlement of the ground

The bearing capacity of a pile depends primarily on 3 factors as given below,

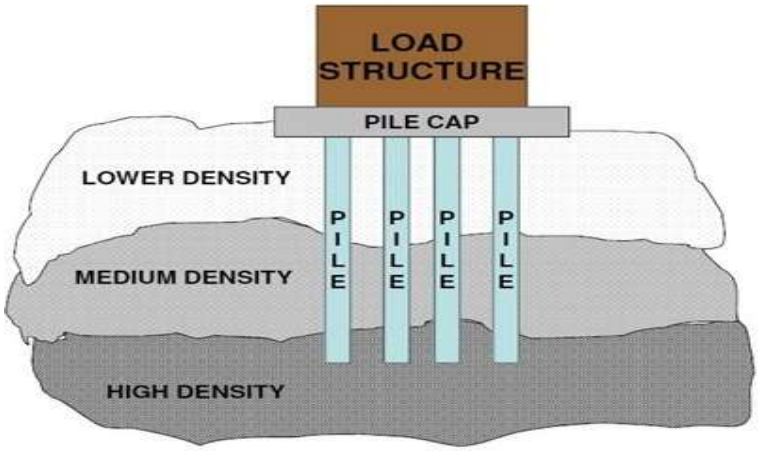
1. Type of soil through which pile is embedded
2. Method of pile installation

3.Pile dimension (cross section & length of pile)

While calculating pile load capacity for cast in situ concrete piles, using static analysis, we need to use soil shear strength parameter and dimension of pile.

Load Carrying Capacity of Pile Using Static Analysis

The pile transfers the load into the soil in two ways. Firstly, through the tip-in compression, termed as *"end-bearing" or "point-bearing";* secondly, by shear along the surface termed as "*skin friction*".



The ultimate load carrying capacity (Q_u) of pile in cohesive soils is given by the formula given below, where the first term represents the *end bearing resistance* (Q_b) and the second term gives the *skin friction resistance* (Q_s).

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

Where,

Q_u = Ultimate load capacity, kN

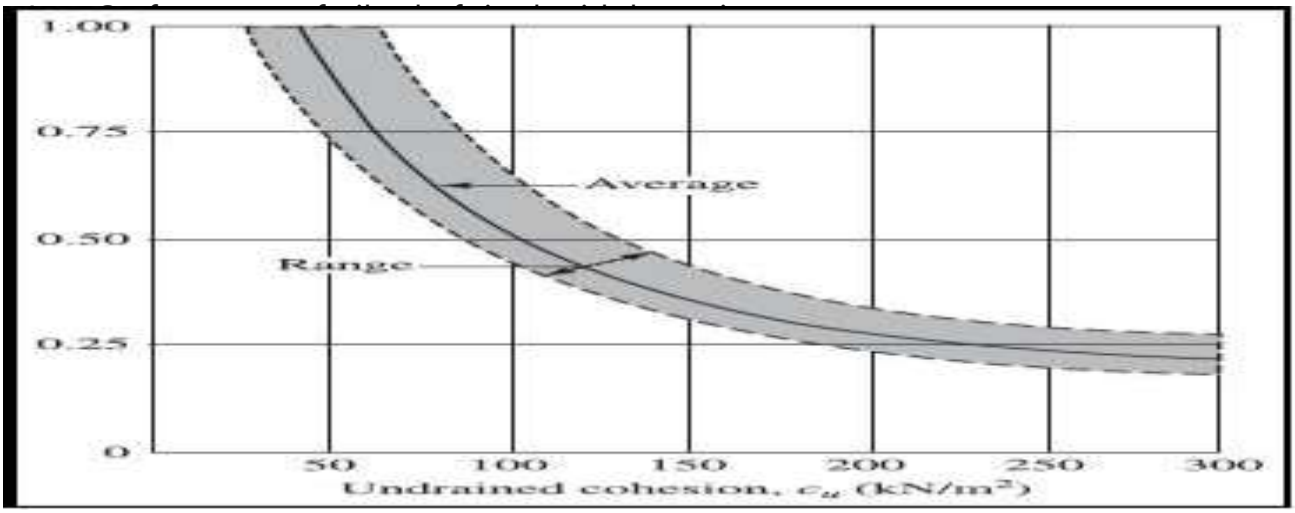
A_p = Cross-sectional area of pile tip, in m^2

N_c = Bearing capacity factor, may be taken as 9

α_i = Adhesion factor for the ith layer depending on the consistency of soil. It depends upon the undrained shear strength of soil and may be obtained from the figure given below.

Variation of alpha with cohesion

c_i = Average cohesion for the ith layer, in kN/m^2



A minimum factor of safety of 2.5 is used to arrive at the safe pile load capacity (Q_{safe}) from ultimate load capacity (Q_u).

$Q_{safe} = Q_u/2.5$

LOAD CARRYING CAPACITY OF CAST IN-SITU PILES IN COHESSIONLESS SOIL

The ultimate load carrying capacity of pile, "Q_u", consists of two parts. One part is due to friction, called *skin friction* or *shaft friction* or *side shear* denoted as "Q_s" and the other is due to *end bearing* at the base or tip of the pile toe, "Q_b".

The equation given below is used to calculate the ultimate load carrying capacity of pile.

$$_u = A_p\left(\frac{1}{2}D\gamma N_\gamma + P_D N_q\right) + \sum_{i=1}^{n} k_i P_{Di} tan\delta A_{si}$$

Where,

A_p = cross-sectional area of pile base, m^2

D = diameter of pile shaft, m

γ = effective unit weight of the soil at pile tip, kN/m^3

N_γ= bearing capacity factor

N_q = bearing capacity factor

Φ = Angle of internal friction at pile tip

P_D = Effective overburden pressure at pile tip, in kN/m^2

K_i = Coefficient of earth pressure applicable for the ith layer

P_{Di} = Effective overburden pressure for the ith layer, in kN/m^2

δ_i = Angle of wall friction between pile and soil for the ith layer

A_{si} = Surface area of pile shaft in the ith layer, in m^2

The first term is the expression for the end bearing capacity of pile (Q_b) and the second term is the expression for the skin friction capacity of pile (Q_s).

A minimum factor of safety of 2.5 is used to arrive at the safe pile capacity (Q_{safe}) from ultimate load capacity (Q_u).

$Q_{safe} = Q_u / 2.5$

10.0. MODULUS OF SUB-GRADE REACTION

One of the most popular relationships between allowable bearing capacity and modulus of subgrade reaction is given in equation (5) according to Bowles (1996);

$$k_s = 40.(FS).(q_a) \quad \text{——-} \ (5)$$

Where q_a is the allowable bearing capacity of the soil, and FS is the factor of safety that was used in converting the ultimate pressure (q_{ult}) to allowable pressure (q_a). It is important to note that in equation (5), the author assumed a 25 mm settlement value for the soil.

Where;
k_s = Coefficient of subgrade reaction
q_a = Allowable bearing capacity = (ultimate bearing capacity/factor of safety)
δ_a = Allowable settlement

Typical values of modulus of subgrade reaction

The typical values of modulus of subgrade reaction of different types of soils are given below;

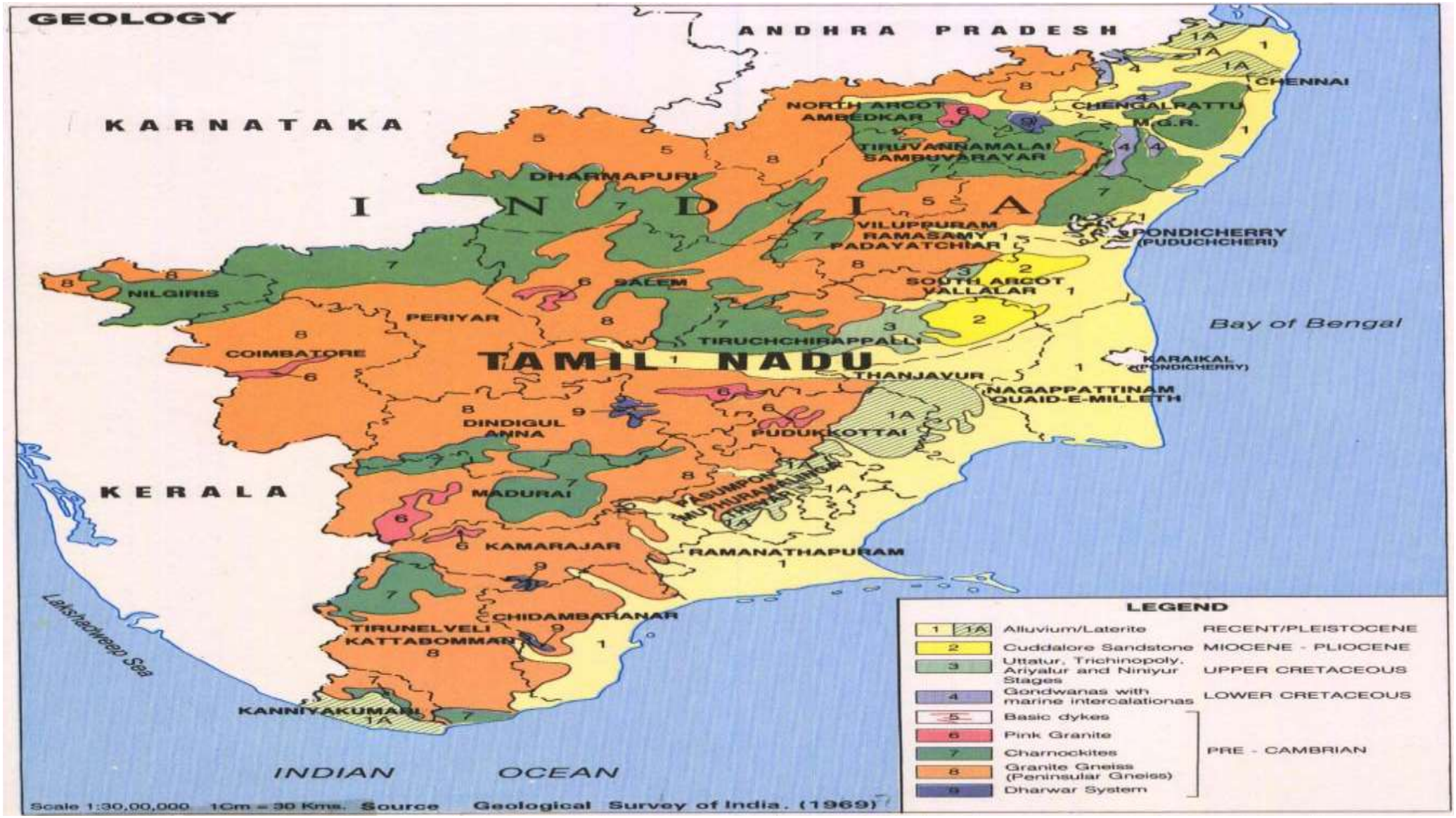
Soil description	Modulus of subgrade reaction (kN/m²/m)
Humus soil or peat	5000 – 15000
Recent embankment	10000 – 20000
Fine or slightly compacted soil	15000 – 30000
Well compacted sand	50000 – 100000
Very well compacted sand	100000 – 150000
Loam or clay (moist)	30000 – 60000
Loam or clay (dry)	80000 – 100000
Clay with sand	80000 – 100000
Crushed stone with sand	100000 – 150000
Coarse crushed stone	200000 – 250000
Well compacted crushed stone	200000 – 300000

11.0. CONCLUSION

- Boreholes BH 1- 3 were drilled at Site, at the locations identified by the Client.
- The detailed description of soil layers met in the boreholes is mentioned in Sec7.0 above.
- Based on the sub-soil profile noticed, **Pile Foundation /** shallow foundations / Raft Foundation can be considered as the suitable foundation system for the proposed structures.
- Stratum at the founding level shall be thoroughly checked before placing the foundations
- on this layer. If any loose soil pockets or cavities are present, the same shall be replaced with lean concrete/ compacted sand pad before placing the foundations.
- Approximate Ground water table was –**NOT MET at during the drilling depth** at the time of investigation. While during construction if water table is encountered at the founding level suggested/higher, proper de watering measures shall be adopted so as to confine the water table to the base level of footing.
- Recommended excavation slopes in this type of soil are 2H: 1V. Any loose soil (unacceptable soil) on the surface below the grubbing depth shall be removed and filled and compacted with good gravelly soil/ lean concrete.

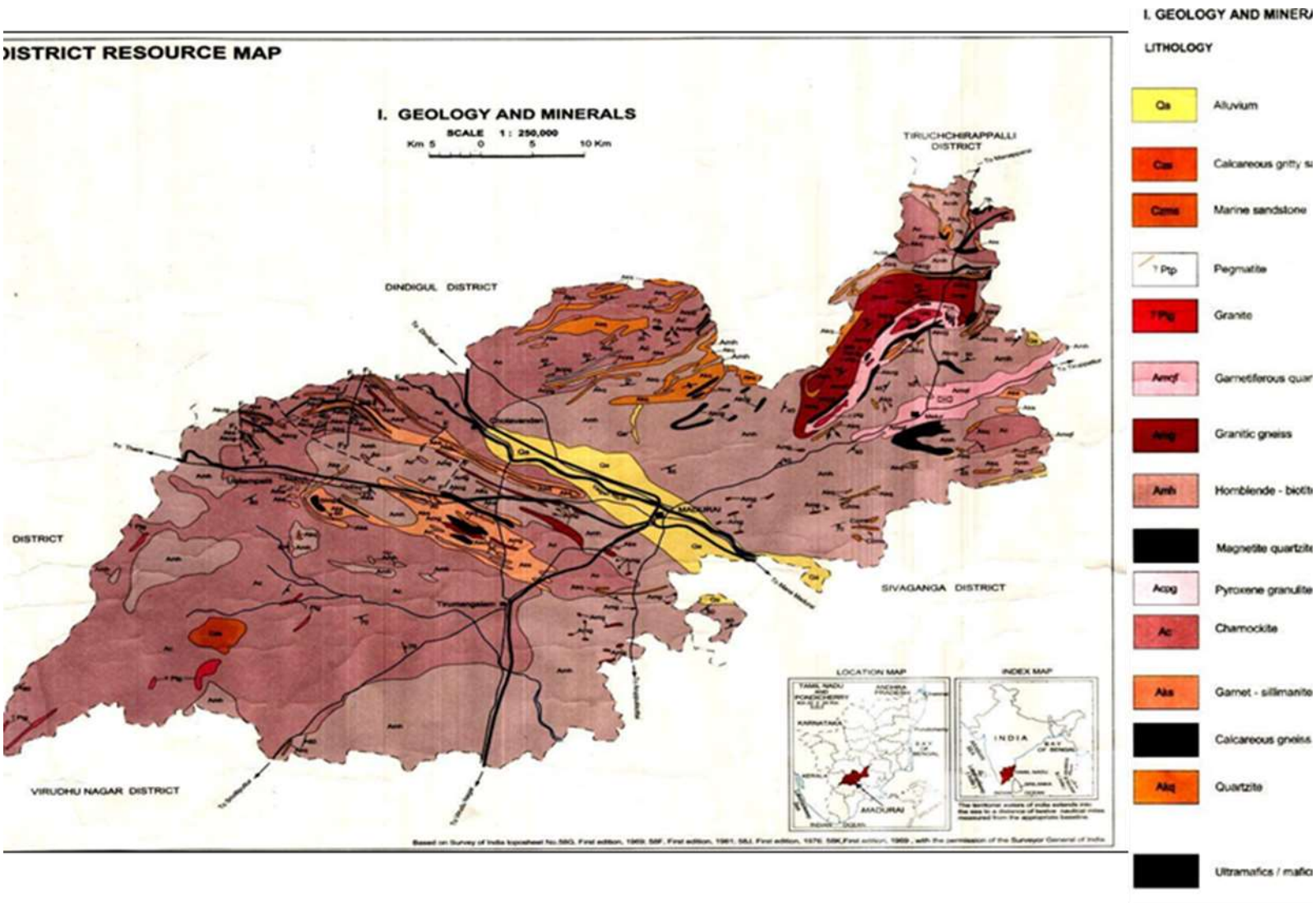


FIGURE 1

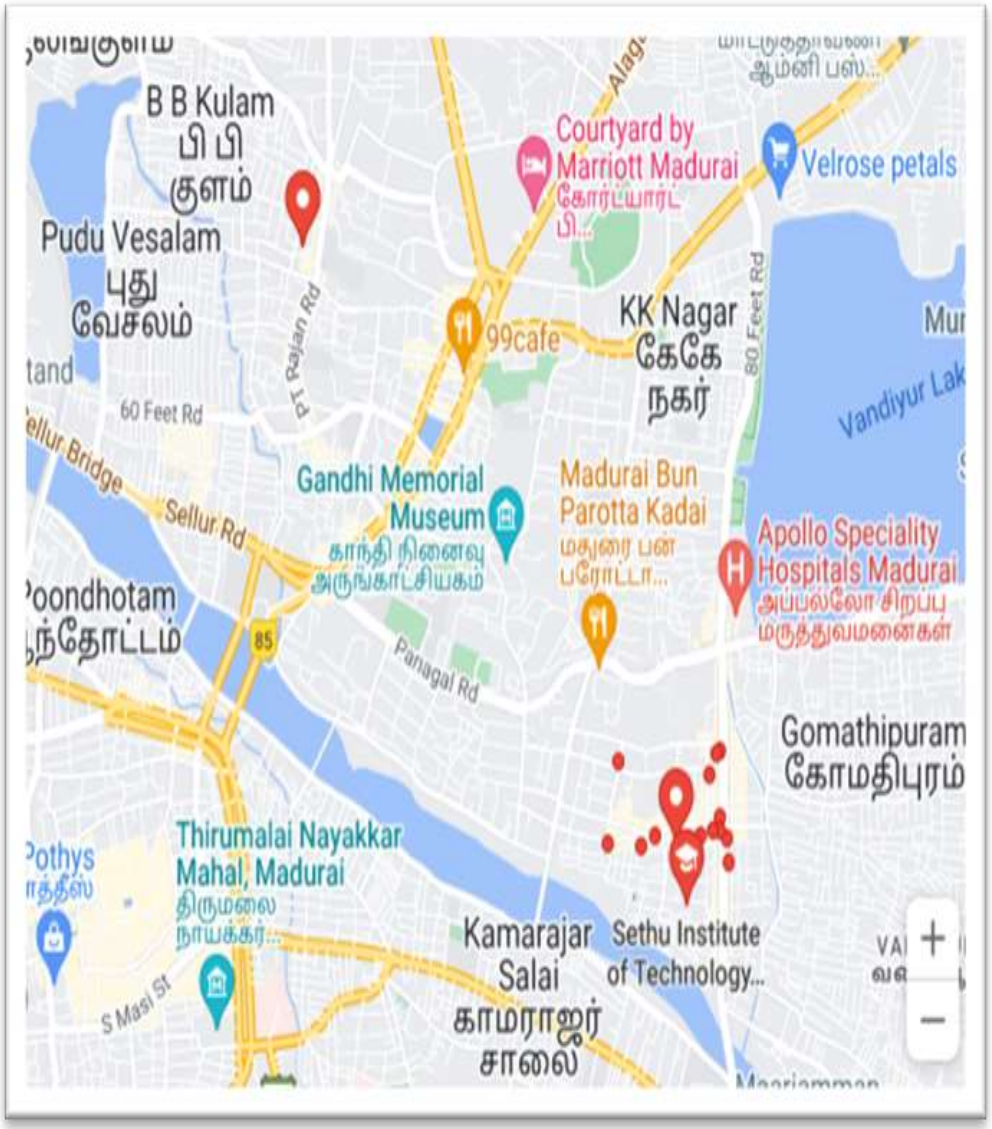


Geology Map of Tamil Nadu

FIGURE 2



Geology Map of Madurai





LOCATION MAP

APPENDIX A

BORE LOG – 1

SASTHA SOIL TESTING SERVICES
K. SETHURAMAN, B.E., (Civil), M.I.E., (Geo Tech), MR., MIGS., MIT Advt., PIV., P.Engg. Chartered Engineer, Govt Approved Valuer
Builders, Technical Valuers, Pile Foundations
Arbitrators, Farms, Geo - Technical Engineering Services

Sastha Soil Testing Services

PROJECT	:	PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
LOCATION	:	NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
BORE HOLE NUMBER	:	BH - 1	DRILLING TYPE MACHINE :	FM	DATE COMMENCED	:	06-12-2023
METHOD OF SAMPLING	:	Rotary Drilling	CORE TYPE :	SINGLE	DATE COMPLETED	:	06-12-2023
COORDINATES Lat	:	9°55'6.15972"	CORE DIAMETER (mm) :	75	GEOTECH ENGINEER	:	Mr. Krishnan Sethuraman
COORDINATES Long	:	78°8'47.544"	WEIGHT OF HAMMER (Kg) :	63.5	DRILL CREW	:	SURENDRAN
GROUND WATER DEPTH	:	30.00 m	DIST.FALLING HAMMER (cm) :	75	SUPERVISOR	:	VISHNUVARTHAN
TOTAL DEPTH (m)	:	10.00 m	CASSING DIAMETER (mm) :	150	SITE LEVEL	:	EQUAL

BORE LOG SHEET

DEPTH (m)	Cassing	G.W.L (m)	LETTER SYMBOL	SOIL PROFILE		SPT TEST	SAMPLE	SPT & N VALUE N1	N2	N3	N	STANDARD PENETRATION TEST NUMBER OF BLOWS 10 20 30 40 50 60 / UNCONF. COMP. TEST COMPRESSIVE STRENGTH 0.4 0.8 1.2 1.6 2.0 4.0	DEPTH (m)	CORE RECOVERY % 25 50 75
0													0	
1	Cassing Of 150 mm		FS		FILL UP SOIL	SPT-1	DS-1	-			10		1	100
2			S		FINE SAND	SPT-2	DS-2	50_{12CM}			>50		2	100
3													3	100
4			S		FINE SAND	SPT-3	DS-3	REBOUND			31		4	100
5			S		FINE SAND	SPT-4	DS-4	REBOUND			45			100
6														100
7			S		COARSE SAND	SPT-5	DS-5	REBOUND			>50		7	100
8			S		COARSE SAND	SPT-6	DS-6	REBOUND			>50		8	100
9													9	100
10			S		COARSE SAND	SPT-7	DS-7	REBOUND			>50		10	100
11													11	100
12													12	100
13													13	100
14													14	100
15													15	100
16													16	90
17													17	90
18													18	90
19													19	100
20													20	100

REMARKS : 10.00 M TEST WAS STOPPED

Drilling done by Viswa Geotech Sevices

Undisturbed Sampel (UDS)

Disturbed Sampel (DS)

BORE LOG – 2

SASTHA SOIL TESTING SERVICES — K. SETHURAMAN, B.E., (Civil), M.I.E., (Geo Tech), MR., MIGS., MIT Advt., PIV., P.Engg. Chartered Engineer, Govt Approved Valuer. Builders, Technical Valuers, Pile Foundations, Arbitrators, Farms, Geo - Technical Engineering Services

Sastha Soil Testing Services

PROJECT	:	PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
LOCATION	:	NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
BORE HOLE NUMBER	:	BH - 2	DRILLING TYPE MACHINE	:	FM	DATE COMMENCED	: 06-12-2023
METHOD OF SAMPLING	:	Rotary Drilling	CORE TYPE	:	SINGLE	DATE COMPLETED	: 06-12-2023
COORDINATES Lat	:	9°55'8.02452"	CORE DIAMETER (mm)	:	75	GEOTECH ENGINEER	: Mr. Krishnan Sethuraman
COORDINATES Long	:	78°8'46.59144"	WEIGHT OF HAMMER (Kg)	:	63.5	DRILL CREW	: SURENDRAN
GROUND WATER DEPTH	:	30.00 m	DIST.FALLING HAMMER (cm)	:	75	SUPERVISOR	: VISHNUVARTHAN
TOTAL DEPTH (m)	:	10.00 m	CASSING DIAMETER (mm)	:	150	SITE LEVEL	: EQUAL

BORE LOG SHEET

DEPTH (m)	Cassing	G.W.L (m)	LETTER SYMBOL	SOIL PROFILE		SPT TEST	SAMPLE	SPT & N VALUE N1	N2	N3	N	STANDARD PENETRATION TEST NUMBER OF BLOWS 10 20 30 40 50 60 / UNCONF. COMP. TEST COMPRESSIVE STRENGTH 0.4 0.8 1.2 1.6 2.0 4.0	DEPTH (m)	CORE RECOVERY % 25 50 75
0													0	
1	Cassing Of 150 mm		FS		FILL UP SOIL	SPT-1	DS-1	-			10		1	100
2			S		FINE SAND	SPT-2	DS-2	50 10CM			>50		2	100
3													3	100
4			S		FINE SAND	SPT-3	DS-3	REBOUND			31		4	100
5			S		COARSE SAND	SPT-4	DS-4	REBOUND			45		5	100
6													6	100
7			S		COARSE SAND	SPT-5	DS-5	REBOUND			>50		7	100
8			S		KANKAR WITH SAND	SPT-6	DS-6	REBOUND			>50		8	100
9													9	100
10			S		KANKAR WITH SAND	SPT-7	DS-6	REBOUND			>50		10	100
11			K		KANKAR	SPT-8	DS-7	REBOUND			>50		11	100
12													12	100
13			K		KANKAR	SPT-9	DS-8	REBOUND			>50		13	100
14			K		KANKAR	SPT-10	DS-9	REBOUND			>50		14	100
15													15	100
16													16	90
17													17	90
18													18	100
19													19	100
20													20	100

REMARKS : 15.00 M TEST WAS STOPPED

Drilling done by Viswa Geotech Sevices

Undisturbed Sampel (UDS)

Disturbed Sampel (DS)

BORE LOG – 3

SASTHA SOIL TESTING SERVICES
K. SETHURAMAN, B.E., (Civil), M.I.E., (Geo Tech), MR., MIGS., MIT Advt., FIV., F.Engg. Chartered Engineer, Govt Approved Valuer
Builders, Technical Valuers, Pile Foundations
Arbitrators, Farms, Geo - Technical Engineering Services

Sastha Soil Testing Services

PROJECT	:	PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
LOCATION	:	NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.					
BORE HOLE NUMBER	:	BH - 3	DRILLING TYPE MACHINE :	FM	DATE COMMENCED	:	06-12-2023
METHOD OF SAMPLING	:	Rotary Drilling	CORE TYPE :	SINGLE	DATE COMPLETED	:	06-12-2023
COORDINATES Lat	:	9°55'8.29704"	CORE DIAMETER (mm) :	75	GEOTECH ENGINEER	:	Mr. Krishnan Sethuraman
COORDINATES Long	:	78°8'47.32116"	WEIGHT OF HAMMER (Kg) :	63.5	DRILL CREW	:	SURENDRAN
GROUND WATER DEPTH	:	30.00 m	DIST.FALLING HAMMER (cm) :	75	SUPERVISOR	:	VISHNUVARTHAN
TOTAL DEPTH (m)	:	10.00 m	CASSING DIAMETER (mm) :	150	SITE LEVEL	:	EQUAL

BORE LOG SHEET

DEPTH (m)	Cassing	G.W.L (m)	LETTER SYMBOL	SOIL PROFILE		SPT TEST	SAMPLE	SPT & N VALUE N1	N2	N3	N	STANDARD PENETRATION TEST NUMBER OF BLOWS 10 20 30 40 50 60 / UNCONF. COMP. TEST COMPRESSIVE STRENGTH 0.4 0.8 1.2 1.6 2.0 4.0	DEPTH (m)	CORE RECOVERY % 25 50 75
0													0	
1	Cassing Of 150 mm		FS		FILL UP SOIL	SPT-1	DS-1	-			10		1	100
2			S		MEDIUM SAND	SPT-2	DS-2	50/14CM			>50		2	100
3													3	100
4			S		MEDIUM SAND	SPT-3	DS-3	REBOUND			31		4	100
5			S		COARSE SAND	SPT-4	DS-4	REBOUND			45		5	100
6													6	100
7			S		COARSE SAND	SPT-5	DS-5	REBOUND			>50		7	100
8			S		COARSE SAND	SPT-6	DS-6	REBOUND			>50		8	100
9													9	100
10			K		KANKAR	SPT-7	DS-6	REBOUND			>50		10	100
11			K		KANKAR	SPT-8	DS-7	REBOUND			>50		11	100
12													12	100
13			K		KANKAR	SPT-9	DS-8	REBOUND			>50		13	100
14			K		KANKAR	SPT-10	DS-9	REBOUND			>50		14	100
15													15	100
16													16	90
17													17	90
18													18	90
19													19	100
20													20	100

REMARKS : 15.00 M TEST WAS STOPPED

Drilling done by Viswa Geotech Sevices

Undisturbed Sampel (UDS)

Disturbed Sampel (DS)

K. SETHURAMAN, Madurai-20, Cell 93441 04870, Chartered Engineer

GEO-TECHNICAL DATA.

TYPE	SEISMIC ZONE	RECOMMENDED SBC (KN/M2) OF SOIL Terzaghi Footing Size (m) 3 x 3 Assumed.							RECOMMENDED TYPE OF FOUNDATION		
		1.5 m	3.00 m	4.50 m	6.00 m	7.50 m	9.00 m	10.00 m	Isolated /Combined	Raft	Pile
G + 5 RESIDENTIAL BUILDING	II	38	200	200	200	250	250	250	YES	YES	YES
		38	200	200	250	250	250	250	YES	YES	YES
		38	200	200	200	250	250	300	YES	YES	YES



APPENDIX B1

SASTHA SOIL TESTING SERVICES
AN ISO-9001:2015 Certified Company
C-128, New HIG Colony, Shenbagathottam, Anna Nagar,
Madurai - 625 020, Ph: 9344104870

TC-10677

ULR-TC1067723100000244F

Issued To	**GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.**	**Test Certificate No**	SSTS/GT/061223/04
		Date of Issue	12-12-2023
		Matrix	Soil Samples
Date of receipt of Soil samples	07-12-2023	**Sampling**	SPL-06.12.2023
Date of Testing	07.12.2023 To 11.12.2023	**Page Nos**	25 of 44

Borehole No	Tested depth (m)	R.L of Layers (m)	N Value	Type of Soil (IS Classification)	Particle size Analysis					Liquid Limit (%)	Plastic Limit (%)	PI (%)	NMC (%)	Specific gravity G	Point Load Index (MN/mm2)
					Gravel (%)	Sand (%)			Silt & Clay (%)						
						Coarse	Medium	Fine							
BH 1	1.5	132.5	10	FILL UP SOIL	46.89	30.42	18.06	3.94	0.69	NON-PLASTIC			10.89	2.73	-
	3	131	50	FINE SAND	-	-		-		-				-	-
	4.5	129.5	50	FINE SAND	2.63	15.69	78.81	8.78	0.09	NON-PLASTIC			17.92	2.76	-
	6	128	50	FINE SAND	-	-			-				-		-
	7.5	126.5	50	COARSE SAND	12.89	58.04	28.93	0.12	0.02	NON-PLASTIC			7.81	2.70	-
	9	125	50	COARSE SAND	-	-			-				-		-
	10	124	50	COARSE SAND	8.33	49.82	40.02	1.81	0.02	NON-PLASTIC			8.19	2.71	-
BH 2	1.5	132.5	10	FILL UP SOIL	-	-			-				-		-
	3	131	50	FINE SAND	4.28	32.73	61.33	1.59	0.07	NON-PLASTIC			17.75	2.72	-
	4.5	129.5	50	FINE SAND	-	-			-				-		-
	6	128	50	COARSE SAND	5.56	48.50	45.17	0.72	0.05	NON-PLASTIC			14.66	2.70	-
	7.5	126.5	50	COARSE SAND	-	-			-				-		-
	9	125	50	KANKAR MIX SAND	15.17	57.60	24.45	2.67	0.11	NON-PLASTIC			12.72	2.67	-
	10	124	50	KANKAR MIX SAND	-	-			-				-		-
	12	122	50	KANKAR	4.63	43.17	44.86	6.90	0.44	NON-PLASTIC			12.14	2.72	-
	13.5	120.5	50	KANKAR	-	-			-				-		-
	15	119	50	KANKAR	12.12	65.07	20.37	2.25	0.19	NON-PLASTIC			12.33	2.68	-

Borehole No	Tested depth (m)	R.L of Layers (m)	N Value	Type of Soil (IS Classification)	Particle size Analysis					Liquid Limit (%)	Plastic Limit (%)	PI (%)	NMC (%)	Specific gravity G	Point Load Index (MN/mm2)
					Gravel (%)	Sand (%)			Silt & Clay (%)						
						Coarse	Medium	Fine							
BH 3	1.5	132.5	10	FILL UP SOIL	17.47	21.40	43.07	16.54	1.52	NON-PLASTIC			7.71	2.66	-
	3	131	50	FINE SAND	-	-			-	-					-
	4.5	129.5	50	FINE SAND	19.16	62.59	15.16	2.88	0.21	NON-PLASTIC			9.45	2.74	-
	6	128	50	FINE SAND	-	-			-	-					-
	7.5	126.5	50	COARSE SAND	38.10	44.63	15.88	1.31	0.08	NON-PLASTIC			8.24	2.70	-
	9	125	50	COARSE SAND	-	-			-	-					-
	10	124	50	KANKAR	20.89	65.21	12.07	1.63	0.20	NON-PLASTIC			8.18	2.67	-
	12	122	50	KANKAR	-	-			-	-					-
	13.5	120.5	50	KANKAR	33.98	49.45	15.32	1.13	0.12	NON-PLASTIC			11.49	2.70	-
	15	119	50	KANKAR	72.30	23.18	3.97	0.44	0.11	NON-PLASTIC			8.84	2.70	-

Authorized Signatory
Mr. K. Sethuraman
Geo-Tech Engineer

APPENDIX B2

Issued To	**GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.**		**Test Certificate No**	SSTS/GT/061223/04
			Date of Issue	12-12-2023
			Matrix	Soil Samples
Date of receipt of Soil samples	07-12-2023		**Sampling**	SPL-06.12.2023
Date of Testing	07.12.2023 To 11.12.2023		**Page Nos**	28 of 44

LAB TEST RESULTS - SOIL SAMPLES

(NON – NABL)

	Tested depth (m)	R.L of Layers (m)	N Value	Type of Soil (IS Classification)	Water Absorption %	Bulk density (g/cm3)	Allowable Bearing Pressure (kPa)	qu=SBC (kN/m²) Footing Size (m) 3 x 3 Assumed	Direct shear		UCC strength (kPa)	Shear Wave Velocity
									Cohesion (kPa) (t/m²)	ø (DEG)		
BH 1	1.5	132.5	10	FILL UP SOIL	-	1.76	92.25	38	0	30	128.57	197.72
	3	131	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	4.5	129.5	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	6	128	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	7.5	126.5	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	9	125	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	10	124	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
BH 2	1.5	132.5	10	FILL UP SOIL	-	1.76	92.25	38	0	30	128.57	197.72
	3	131	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	4.5	129.5	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	6	128	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	7.5	126.5	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	9	125	50	KANKAR MIX SAND	-	1.76	461.25	250	0	42	>400	340.09
	10	124	50	KANKAR MIX SAND	-	1.76	461.25	250	0	42	>400	340.09
	12	122	50	KANKAR		1.92	461.25	300	0	42	>400	340.09
	13.5	120.5	50	KANKAR		1.92	461.25	300	0	42	>400	340.09
	15	119	50	KANKAR		1.92	461.25	300	0	42	>400	340.09

	Tested depth (m)	R.L of Layers (m)	N Value	Type of Soil (IS Classification)	Water Absorption %	Bulk density (g/cm3)	Allowable Bearing Pressure (kPa)	qu=SBC (kN/m²) Footing Size (m) 3 x 3 Assumed	Direct shear		UCC strength (kPa)	Shear Wave Velocity
									Cohesion (kPa) (t/m²)	ø (DEG)		
BH 3	1.5	132.5	10	FILL UP SOIL	-	1.76	92.25	38	0	30	128.57	197.72
	3	131	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	4.5	129.5	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	6	128	50	FINE SAND	-	1.76	461.25	200	0	42	>400	340.09
	7.5	126.5	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	9	125	50	COARSE SAND	-	1.76	461.25	250	0	42	>400	340.09
	10	124	50	KANKAR	-	1.92	461.25	300	0	42	>400	340.09
	12	122	50	KANKAR		1.92	461.25	300	0	42	>400	340.09
	13.5	120.5	50	KANKAR		1.92	461.25	300	0	42	>400	340.09
	15	119	50	KANKAR		1.92	461.25	300	0	42	>400	340.09

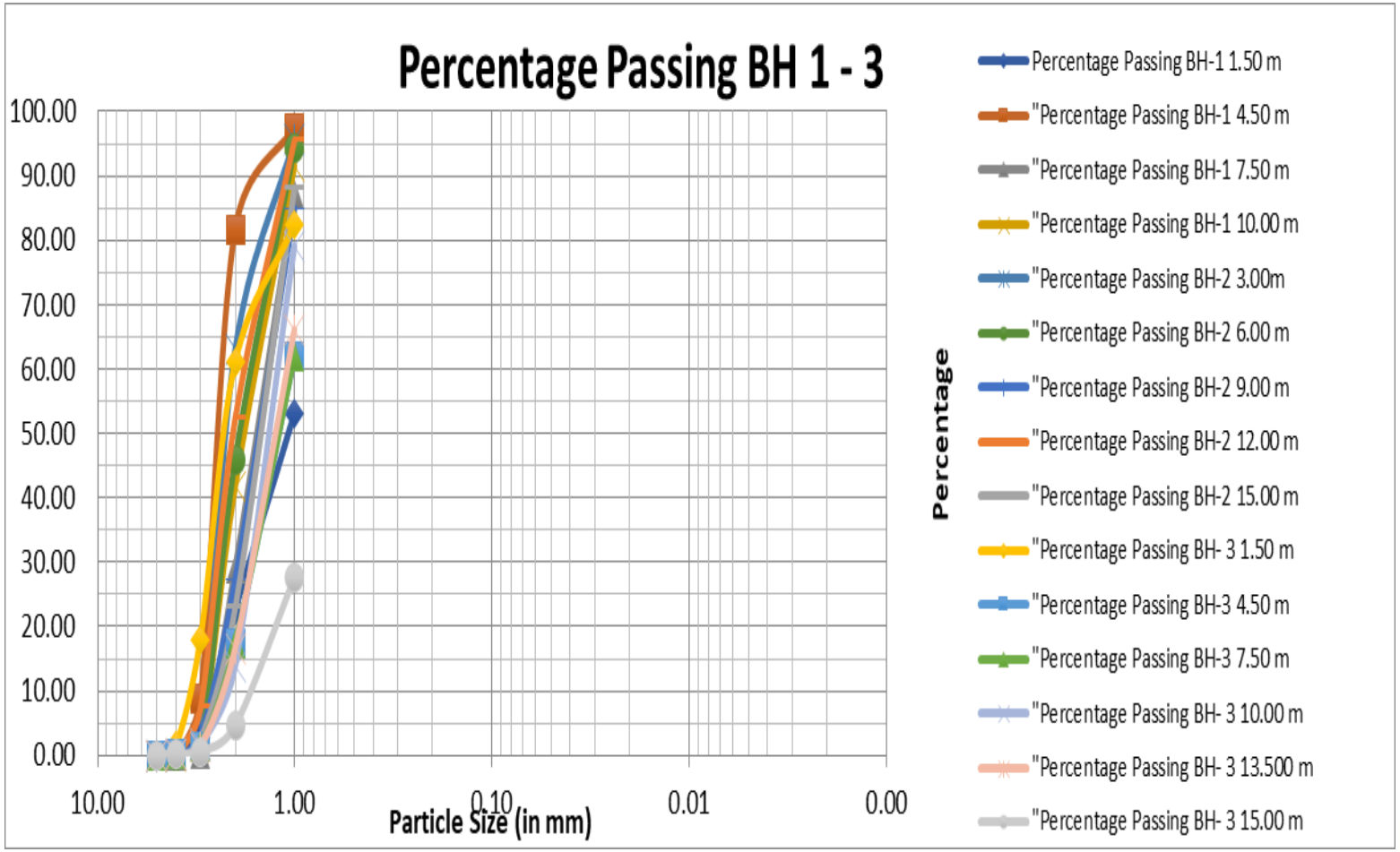
Authorized Signatory
Mr. K. Sethuraman
Geo-Tech Engineer

APPENDIX B3

PARTICLE SIZE ANALYSIS CURVES

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

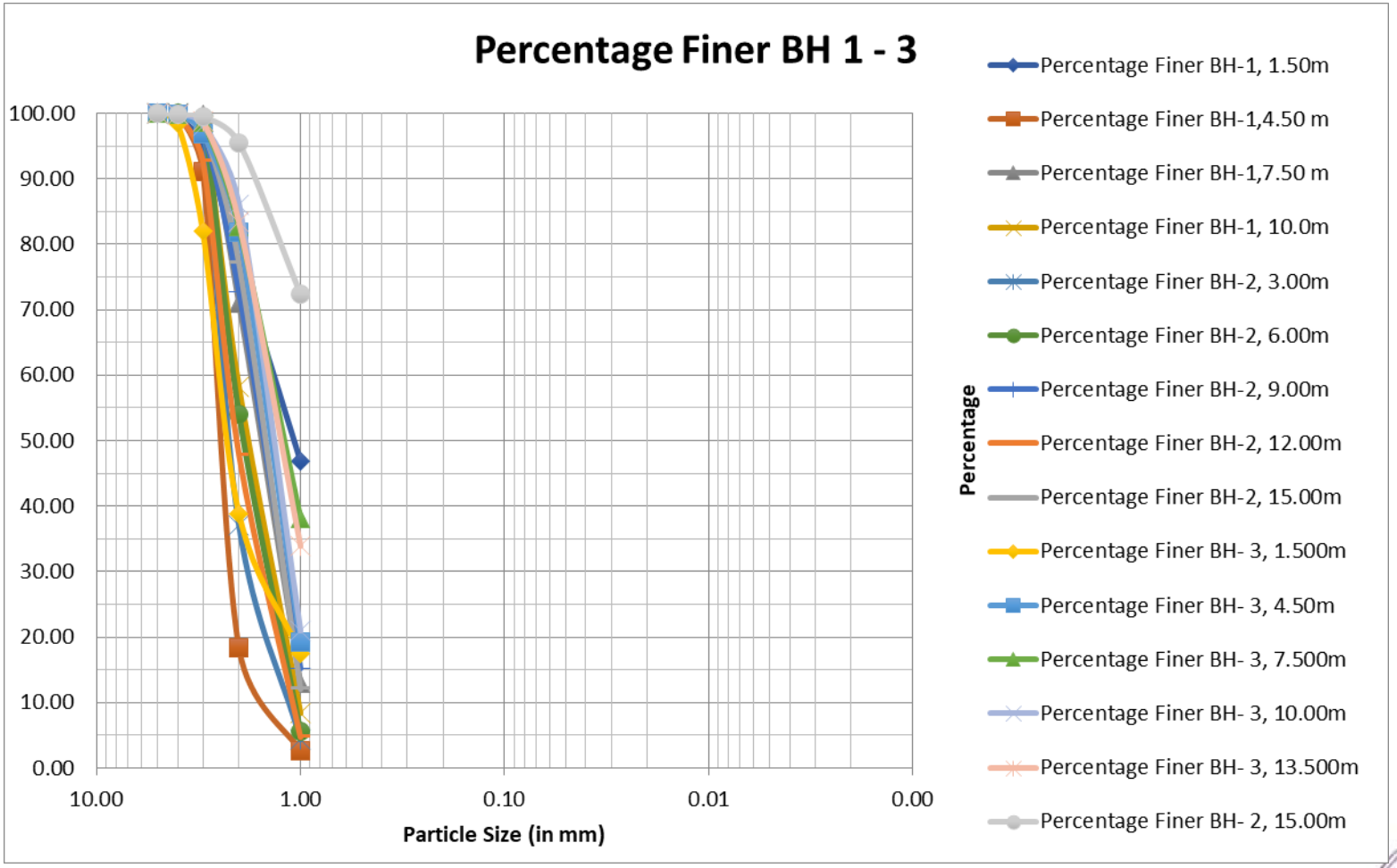
CLIENT : M/S. PRYME PROMOTERS PRIVATE LTD & MR. ZAID OMAR



PARTICLE SIZE ANALYSIS CURVES

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.

CLIENT : M/S. PRYME PROMOTERS PRIVATE LTD & MR. ZAID OMAR



BH 1 - 3

Composition

SAMPLE	BH - 1 1.50m	BH - 1 4.50m	BH - 1 7.50m	BH - 1 10.00m	BH - 2 3.00m	BH - 2 6.00m	BH - 2 9.00m	BH - 2 12.00m	BH - 2 15.00m	BH - 3 1.50m	BH - 3 4.50m	BH - 3 7.50m	BH - 3 10.00m	BH - 3 13.50m	BH - 3 15.00m
% FINE GRAVEL =	46.89	2.63	12.89	8.33	4.28	5.56	15.17	4.63	12.12	17.47	19.16	38.10	20.89	33.98	72.30
% COARSE SAND =	30.42	15.69	58.04	49.82	32.73	48.50	57.60	43.17	65.07	21.40	62.59	44.63	65.21	49.45	23.18
%MEDIUM SAND =	18.06	72.81	28.93	40.02	61.33	45.17	24.45	44.86	20.37	43.07	15.16	15.88	12.07	15.32	3.97
%FINE SAND =	3.94	8.78	0.12	1.81	1.59	0.72	2.67	6.90	2.25	16.54	2.88	1.31	1.63	1.13	0.44
% FINE/ SILT =	0.69	0.09	0.02	0.02	0.07	0.05	0.11	0.44	0.19	1.52	0.21	0.08	0.20	0.12	0.11
SAMPLE	BH - 1 1.50m	BH - 1 4.50m	BH - 1 7.50m	BH - 1 10.00m	BH - 2 3.00m	BH - 2 6.00m	BH - 2 9.00m	BH - 2 12.00m	BH - 2 15.00m	BH - 3 1.50m	BH - 3 4.50m	BH - 3 7.50m	BH - 3 10.00m	BH - 3 13.50m	BH - 3 15.00m
% GRAVEL =	46.89	2.63	12.89	8.33	4.28	5.56	15.17	4.63	12.12	17.47	19.16	38.10	20.89	33.98	72.30
% SAND =	52.42	97.28	87.09	91.65	95.65	94.39	84.72	94.93	87.69	81.01	80.63	61.82	78.91	65.90	27.59
% SILT AND CLAY =	0.69	0.09	0.02	0.02	0.07	0.05	0.11	0.44	0.19	1.52	0.21	0.08	0.20	0.12	0.11
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



APPENDIX C

DESIGN INFORMATION I

Drilling pile from NGL.

PILE FOUNDATION DESIGN (Pile Dia mm 450/ 500 mm / 600 mm with 10.00 m Depth

DEEP FOUNDATIONS: R.C. BORED PILE — DR.K.R. ARORA

The load carrying capacities of R.C. bored piles, for various dia., are calculated on the basis of I.S. code, Berezontzev's

Using the Berezantsev's method formula, Pile Dia = 0.45 m, Pile depth = 10.00m NGL

The Ultimate bearing capacity of the pile, Pile Dia = 0.50 m, Pile depth = 10.00 m NGL

The Ultimate bearing capacity of the pile, Pile Dia = 0.60 m, Pile depth = 10.00 m NGL

$Q_u = Q_b + Q_f = q'_o A_b N_q + \bar{q}'_o A_s \bar{K}_s \tan \delta$

F. S = 2.5	tan δ = 0.582	Nq = 10	ϕ = 40.29	ϒ = 17.6	D	Ab	As	K̄ s	L
					0.45 m	0.159	14.13		
q'o =ϒ x L average unit wt of soil along pile length X depth =		176			0.50 m	0.196	15.7	1	10.0 M
					0.60 m	0.283	18.84		
q'o = ½ x ϒ x L =		88							

Qb	279.77	345.40	497.38
Qf	724.18	804.64	965.57
Qu	1003.95	1150.04	1462.95
Qa kN	**401.58**	**460.02**	**585.18**
Pile Dia in m	**0.450**	**0.500**	**0.600**
Pile depth in m	**10.00**	**10.00**	**10.00**



Drilling pile from NGL.

PILE FOUNDATION DESIGN (Pile Dia mm 450/ 500 mm / 600 mm with 15.00 m Depth

DEEP FOUNDATIONS: R.C. BORED PILE

DR.K.R. ARORA

The load carrying capacities of R.C. bored piles, for various dia., are calculated on the basis of I.S. code, Berezontzev's

Using the Berezantsev's method formula,

Pile Dia = 0.45 m, Pile depth = 15.00m NGL

The Ultimate bearing capacity of the pile,

Pile Dia = 0.50 m, Pile depth = 15.00 m NGL

The Ultimate bearing capacity of the pile,

Pile Dia = 0.60 m, Pile depth = 15.00 m NGL

$$Q_u = Q_b + Q_f = q'_o A_b N_q + \bar{q}'_o A_s \bar{\kappa}_s \tan \delta$$

F. S = 2.5 tan δ = 0.598 Nq = 10 ϕ = 40.8 Y = 18.08

D	Ab	As	$\bar{\kappa}_s$	L
0.45 m	0.159	21.195		
0.50 m	0.196	23.55	1	15.00 M
0.60 m	0.283	28.26		

q'o =Y x L average unit wt of soil along pile length X depth = 271.2

q'o = ½ x Y x L = 135.6

Qb	294.08	363.06	522.81
Qf	735.12	816.80	980.16
Qu	1029.20	1179.86	1502.97
Qa kN	**411.68**	**471.94**	**601.19**
Pile Dia in m	**0.450**	**0.500**	**0.600**
Pile depth in m	**15.00**	**15.00**	**15.00**



DESIGN INFORMATION II

Raft Foundation

In case, higher bearing capacities are required and to avoid differential settlement, rigid raft foundation can be considered at the proposed founding level.

Borehole No.	N-value $Q_{a\text{-}net}$ = 0.088 X Cw X N X S_a in t/sq.m Where,$Q_{a\text{-}net}$ =Net allowable bearing pressure in t/sq.m	
	N-value Depth (m) 3.00	**$Q_{a\text{-}net}$ Net allowable bearing pressure in t/sq.m**
BH 1 - 3	50	55
Average	50	**55**

Net Safe Bearing Pressure for a raft foundation is given by,

$Q_{a\text{-}net}$ = 0.088 X Cw X N X S_a in t/sq.m

Where,$Q_{a\text{-}net}$ =Net allowable bearing pressure in t/sq.m

C_w=correction factor for water table = 0.5

N = SPT 'N' value

SBC at 3.00 m depth, N value = 50

$Q_{a\text{-}net}$= 0.088 x 0.5 x 50 x25 = 55 t/sq.m x 9.80665, SBC = 539.37 kN/m2

Hence net SBC of **55 t/sq.m** or **539.37 kN/m2** can be considered for raft foundations (B ≥ 6m) at **3.00 m depth** below EGL.

.

Depth in Metre	SBC (t/m^2)	SBC (KN/m^2)
3.00 m	**55**	**539.37**

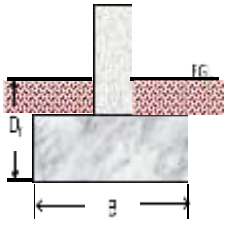


DESIGN INFORMATION III

FOUNDATION DESIGN	Subject:	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.			
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location:	Designer :	Date:
	IS:6403	SSTS 061223		KSR	07.12.23

CODE REF.	CALCULATIONS & SKECTHES

Allowable bearing pressure using IS equation for the footing and soil parameters shown in
Figure 1.



BEARING CAPACITY OF SHALLOW FOUNDATIONS

IS Method

Date 07-DEC-2023
Identification BH-1

INPUT

Units of Measurement
SI SI or E

Foundation Information
Shape SQ SQ, CI, CO, or RE
B = 2 m
L = 2 m
D = 1.5 m

Soil Information
c = 0 kPa
phi(Ø) = 30 deg
gamma(γ) = 17.6 kN/m^3
D_w = 30 m

Factor of Safety
F = 2.5

IS Results

Bearing Capacity
q ult = 97.92 kPa
q a = 39 kPa

Allowable Column Load
P = 15 kN

Eq. 4-1

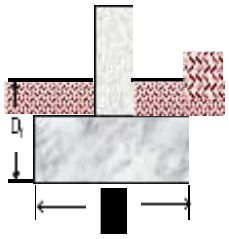
IS Computation

Unit conversion	1	N_c =	30.14	d_q =	1.1299	q =	26.40
γ_w =	9.8	s_c =	1.3	N_γ =	22.4	W' =	1.00
ø(radians)	0.5236	d_c =	1.25981	s_γ =	0.8	k =	0.75
W footing	142	N_q =	18.4	d_γ =	1.1299	σ_{zD}' =	2.64
γ conc	23.6	s_q =	1.2	B/L =	1.0	γ ' =	1.76

FOUNDATION DESIGN	Subject:	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.			
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location :	Design:	Date:
	IS:6403	SSTS 061223		KSR	07.12.23

CODE REF.	CALCULATIONS & SKECTHES

Allowable bearing pressure using IS equation for the footing and soil parameters shown in
Figure 1.



BEARING CAPACITY OF SHALLOW FOUNDATIONS

IS Method

Date 07-DEC-23
Identification BH-1

INPUT

Units of Measurement
SI SI or E

Foundation Information
Shap e SQ SQ, CI, CO, or RE
B = 2 m
L = 2 m
D = 2 m

Soil Information
c = 0 kPa
phi(Ø) = 30 deg
gamma(γ) = 17.6 kN/m^3
D_w = 30 m

Factor of Safety
F = 2.5

IS Results

Bearing Capacity
q ult = 123.2 kPa
q a = 49 kPa

Allowable Column Load
P = 8 kN

Eq. 4-1

IS Computation

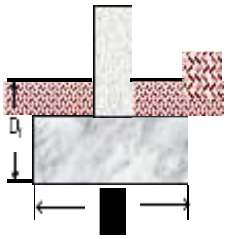
Unit conversion	1	N_c =	30.14	d_q =	1.17321	q =	35.20
γ_w =	9.8	s_c =	1.3	N_γ =	22.4	W' =	1.00
γ(radians)	0.5236	d_c =	1.34641	s_γ =	0.8	k =	1
W footing	189	N_q =	18.4	d_γ =	1.17321	σ_{zD}' =	3.52
γconc	23.6	s_q =	1.2	B/L =	1.0	γ ' =	1.76

FOUNDATION DESIGN

Subject:	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.			
SOIL BEARING CAPACITY BY IS Calculation				
Design Code/Ref:	Proj. No.	Location:	Designer :	Date:
IS:6403	SSTS 061223		KSR	07.12.23

CODE REF.	CALCULATIONS & SKECTHES

Allowable bearing pressure using IS equation for the footing and soil parameters shown in
Figure 1.



BEARING CAPACITY OF SHALLOW FOUNDATIONS

IS Method

Date 07-DEC-23
Identification BH-1

INPUT

Units of Measurement
SI SI or E

Foundation Information
Shape SQ SQ, CI, CO, or RE
B = 2 m
L = 2 m
D = 3 m

Soil Information
c = 0 kPa
phi(Ø) = 42 deg
gamma(γ) = 17.6 kN/m^3
D_w = 30 m

Factor of Safety
F = 2.5

IS Results

Bearing Capacity
q ult = 1067 kPa
q a = 427 kPa

Allowable Column Load
P = 1,424 kN

Eq. 4-1

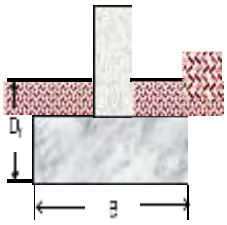
IS Computation

Unit conversion	1	N_c =	98.1952	d_q =	1.33691	q =	52.80
γ_w =	9.8	s_c =	1.3	N_γ =	167.856	W' =	1.00
ø (radians)	0.733	d_c =	1.67381	s_γ =	0.8	k =	0.98279
$W_{footing}$	283	N_q =	89.6448	d_γ =	1.33691	σ_{zD}' =	5.28
	23.6	s_q =	1.2	B/L =	1.0		
γ_{conc}						γ' =	1.76

FOUNDATION DESIGN	Subject:	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G + 5 PRYME GIO RESIDENTIAL BUILDING NO 474 10TH EAST CROSS STREET ANNANAGAR MADURAI NORTH MADURAI-625020.			
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location:	Designer :	Date:
	IS:6403	SSTS 061223		KSR	07.12.23

CODE REF.	CALCULATIONS & SKECTHES

Allowable bearing pressure using IS equation for the footing and soil parameters shown in
Figure 1.



BEARING CAPACITY OF SHALLOW FOUNDATIONS

IS Method

Date 07-DEC-23
Identification BH-1

INPUT

Units of Measurement
SI SI or E

Foundation Information
Shape SQ SQ, CI, CO, or RE
B = 2 m
L = 2 m
D = 4.5 m

Soil Information
c = 0 kPa
phi(Ø) = 42 deg
gamma(γ) = 17.6 kN/m^3
D_w = 30 m

Factor of Safety
F = 2.5

IS Results

Bearing Capacity
q ult = 1624 kPa
q a = 650 kPa

Allowable Column Load
P = 2174 kN

Eq. 4-1

IS Computation

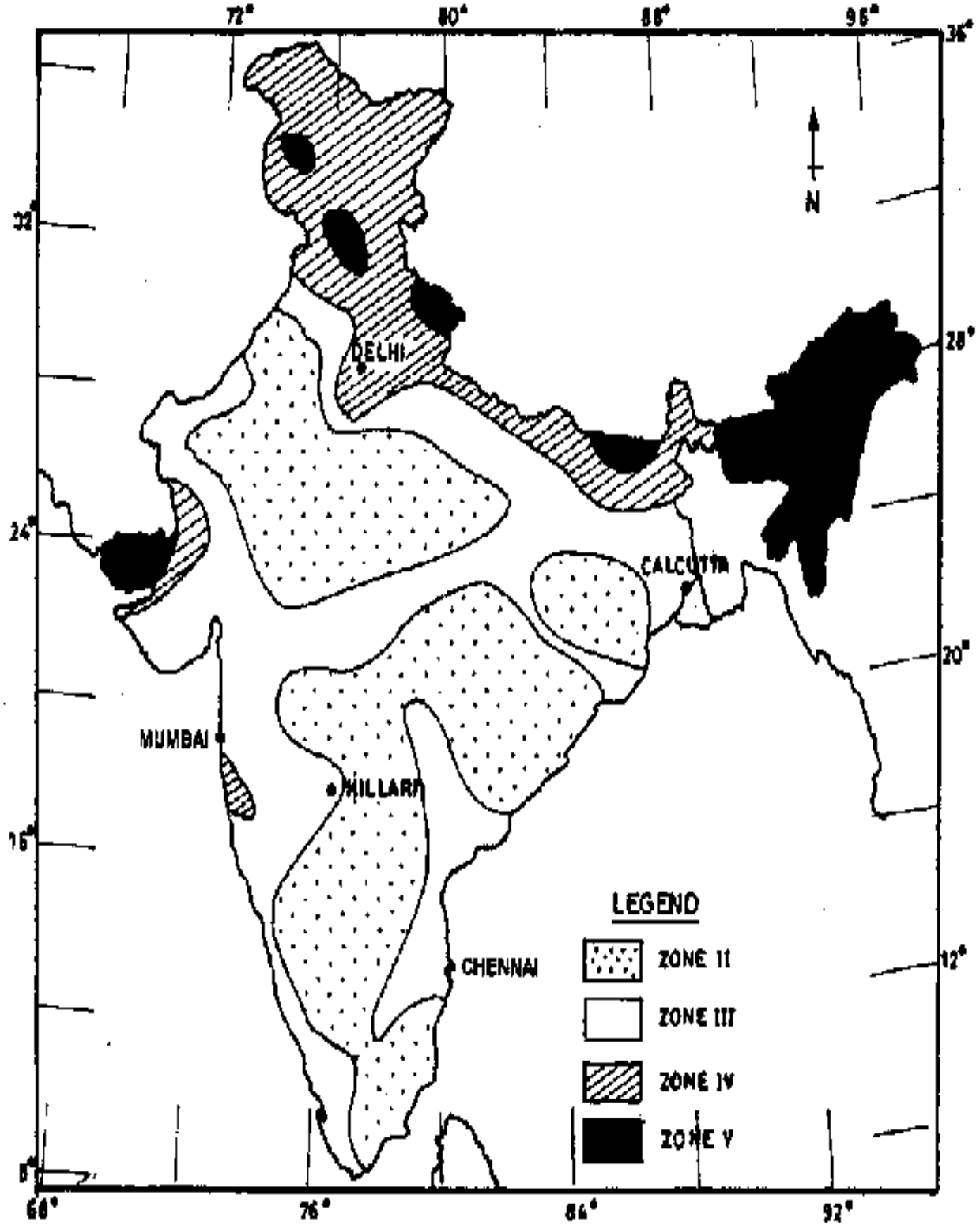
Unit conversion	1	N_c =	98.1952	d_q =	1.50536	q =	79.20
γ_w =	9.8	s_c =	1.3	N_γ =	167.856	W' =	1.00
ø (radians)	0.733	d_c =	2.01072	s_γ =	0.8	k =	1.15257
$W_{footing}$	425	N_q =	89.6448	d_γ =	1.50536	σ_{zD}' =	7.92
		s_q =	1.2	B/L =	1.0		
γ_{conc}	23.6					γ' =	1.76

ADDITIONAL INFORMATION

Bore Hole	D	g	Ø	c	B	L	q_{nu}		qa		P	qnp
	Footing Embedment depth (m)	Soil Density (g/cm^3)	Angle of internal friction (rad)	Cohesion of Soil (kPa)	Footing Size (m)	Footing Size (m)	Net Ultimate Bearing Capacity (kPa)	Factor of Safety SF	Allowable Bearing Capacity (kPa)	W footing	Allowable Column Load (kN)	Safe Settlement Pressure (kPa)
BH 1 - 3	1.5	1.76	30	0	1.5	1.5	92.42	2.5	36.97	79.65	3.53	139.61
	1.5	1.76	30	0	2	2	97.92	2.5	39.17	141.6	15.07	128.22
	2	1.76	30	0	1.5	1.5	119.59	2.5	47.84	106.2	1.43	139.61
	2	1.76	30	0	2	2	123.23	2.5	49.29	188.8	8.37	128.22
	2.5	1.76	30	0	1.5	1.5	148.88	2.5	59.55	132.75	1.24	139.61
	2.5	1.76	30	0	2	2	150.13	2.5	60.05	236	4.21	128.22
	3	1.76	42	0	1.5	1.5	1070.83	2.5	428.33	159.3	804.45	937.37
	3	1.76	42	0	2	2	1066.84	2.5	426.74	283.2	1423.75	860.88
	3.5	1.76	42	0	1.5	1.5	1268.82	2.5	507.53	185.85	956.09	937.37
	3.5	1.76	42	0	2	2	1242.05	2.5	496.82	330.4	1656.89	860.88
	4	1.76	42	0	1.5	1.5	1480.82	2.5	592.33	212.4	1120.34	937.37
	4	1.76	42	0	2	2	1427.78	2.5	571.11	377.6	1906.84	860.88
	4.5	1.76	42	0	1.5	1.5	1706.85	2.5	682.74	238.95	1297.21	937.37
	4.5	1.76	42	0	2	2	1624.01	2.5	649.61	424.8	2173.62	860.88



SEISIMIC MAP OF INDIA



APPENDIX C1
PHOTOGRAPHS

Drilling Under Progress

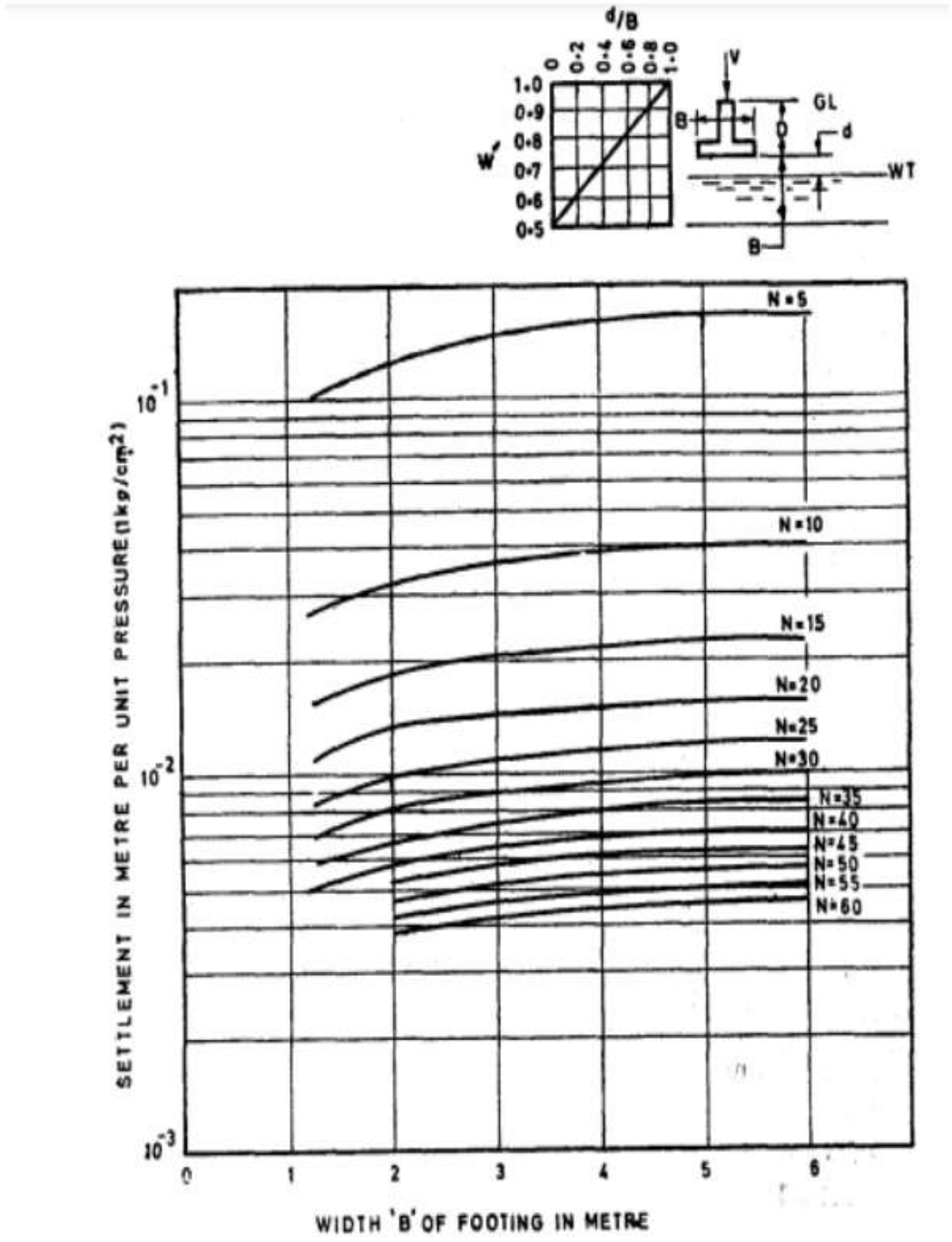








STANDARD PENETRATION RESISTANCE CURVE



GL = Ground level. WT = Water table.

FIG. 9 SETTLEMENT PER UNIT PRESSURE FROM STANDARD PENETRATION RESISTANCE

END OF REPORT

GEOTECHNICAL ENGINEER DETAILS:

Name	:	KRISHNAN SETHU RAMAN
Address	:	C-128, New Hig Colony, Shenbaga Thottam, Near Mela Madai Apollo Signal, Anna Nagar, Madurai-20.
Branch	:	Chennai. 2, 94 Th Street 21st Avenue, Ashok Nagar, Duraisamy Road, Near JRK Metric School Vadapalani, Chennai-600083.
Mobile no	:	09344104870, 06382534513
Test report number	:	**SSTS/GT/061223/04**
Register no	:	GTE001/2019.30.08.2019
Office no	:	0452 - 4295151
Email id	:	sasthageotechengineers@gmail.com



MLPA

GOVERNMENT OF TAMILNADU
TOWN AND COUNTRY PLANNING DEPARTMENT

MADURAI LOCAL PLANNING AUTHORITY
Anna Maligai, 3rd Floor, Corporation Building, Madurai – 625 002.
Phone: 0452-2530544, E.mail –ID : mlpa_ctcp@yahoo.in

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that **Thiru. K.Sethuraman** has enrolled as **GEO TECH ENGINEER - (GTE)** with Madurai Local Planning Authority **(MLPA)**, who has the qualification of **Degree of Master of Engineering (Geotechnical)** and experience in the relevant field for **24 years.**

He has been given the **Registration No.GTE 001/2019 on 30.08.2019.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide **G.O.(Ms)No.18, MAWS (MA1) Department, Dated: 04.02.2019.**

This Registration is valid upto **29.08.2024.**

MEMBER SECRETARY (I/C),
MADURAI LOCAL PLANNING AUTHORITY,
MADURAI.

30/8/2019





our services doesn't just end there

Buying & Selling Services

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

Legal & Documentation Services

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

Property Development & Approvals

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

NRI & Investment Services

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

Compliance & Special Services

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



empowering your real estate decisions with smart tools

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

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

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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