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PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING (F BLOCK) FOR MAX PROPERTIES PVT LTD AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

29.08.2022

N 9°54'57.47832", E 78°4'57.34488"

GEOTECHNICAL INVESTIGATIONS

FINAL REPORT



AUGUST 2022

SASTHA SOIL TESTING SERVICES

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ISO 9001:2015
ISO IEC 17025:2017

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CLIENT : MAX PROPERTIES PVT LTD

PROJECT ADDRESS: 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

FINAL REPORT

AUGUST 2022

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JOB. NO.:	SSTS/LT/290822/21	REPORT. NO.:	SSTS/GT/290822/21

BH No.	Width (m)	Recommended Net SBC (kN/m^2) IS :6403	
		Depth below EGL (m)	
		3.00	
		Shear	Settlement
BH 1	2.00	426.74	860.88

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
ϕ	Phi, Angle of Internal Friction
RL	Reduced Level
γ	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+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

1. INTRODUCTION

Geotechnical investigation of proposed construction of G+3 Max Vidhya Apartment Building at 316/2A - F Block, Periyar Nagar, 4th Street, Madakulam, Madurai – 625003 for Max Properties Pvt Ltd awarded the work of Geotechnical Investigations Work to Sastha Soil Testing Services dated 29th August 2022.

As part of scope of services, Total one boreholes was drilled up to 10.00 m 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 the Client, in our site we have encountered with Medium sand soil up to 4.50 m, Coarse sand from 4.50 m up to 10.00 m, Total 10.00 m. 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 m 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.




CHENNAI
Vellore
Kanchipuram
Krishnagiri
Tiruvannamalai
Dharmapuri
Villupuram
Pondicherry
Salem
Erode
Nilgiris
Cuddalore
Namakkal
Perambalur
Nagapattinam
Coimbatore
Karur
Thiruvarur
Thanjavur
Dindigul
Pudukkottai
Theni
Madurai
Sivaganga
Virudhunagar
Ramanathapuram
Tuticorin
Tirunelveli
Kanniyakumari
CHENNAI
ZONE III
ZONE II

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°4'57.34488"	9°54'57.47832"	10.00 m

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:

$$\% \text{ CR} = \frac{Length\ of\ core}{Length\ of\ run} x100$$

$$\%\text{RQD} = \frac{Length\ of\ core\ in\ pieces\ of\ 101.6mm\ (4inchesandabove)}{Length\ of\ run} x\ 100$$

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

Approximate Ground water table was met in the area at 25.00 m depth below EGL at the time of investigation.

Road level and site level

The Approximate Level of site is same as road Level. Approximate MSL Elevation 139 meters Above Sea level.

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:

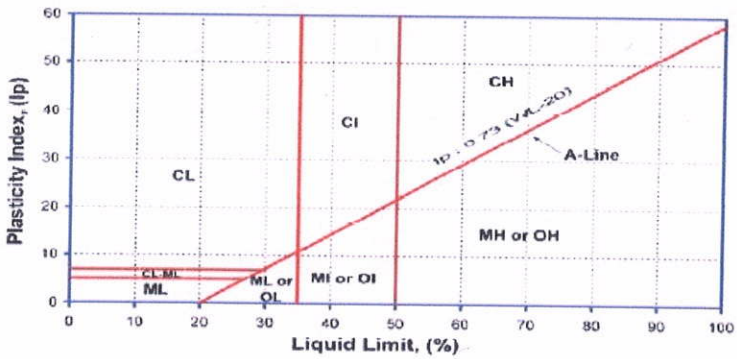
Laboratory Test	IS Code Referred
Bulk Density	By Calculations
Natural Moisture Content (NMC)	IS 2720 Part 2 – 1973 (Reaffirmed 2015)
Specific Gravity	IS 2720 Part 3 Sec 2 – 1980 (Reaffirmed 2016)
Grain Size Analysis	IS 2720 Part 4 – 1985 (Reaffirmed 2015)
Liquid Limit and Plastic Limit	IS 2720 Part 5 – 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 NEPHP 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 II: Medium sand soil up to 4.50 m, Coarse sand from 4.50 m up to 10.00 m, Total 10.00 m. 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
01	0 – 1.50, 1.50 – 3.00, 3.00 – 4.50, 4.50 – 6.00, 6.00 – 7.50, 7.50 – 9.00,9.00 – 10.00	50, >50, >50,>50, >50, >50, >50	DENSE

8.0. FOUNDATION DESIGN CONSIDERATIONS- Foundation Type, Size & Depth

G+3 MAX VIDHYA APARTMENT 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 + 3 Max Vidhya Apartment Building above EGL. Hence Safe Bearing Capacity (SBC) calculations have been made for foundations at 1.5 to 10 m depth below EGL. Based on the structural configuration, designer can consider the design foundation level.

Column foundation

Use Column foundation with wide footing below 3.00 m / 4.50 m from NGL, with connecting Beam all around

(or)

Combined Column foundation / Strip Foundation

Use combined Column foundation with wide footing below 3.00 m / 4.50 m from NGL, with connecting Beam all around

(or)

PILE FOUNDATION

Use Pile Foundation of dia 450 mm /500mm /600 mm to a depth of 10.00 m from NGL.

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 to 6.00 m depth below EGL are as follows:

Borehole No.	N-value			
	Depth (m)			
	1.50	3.00	4.50	6.00
01	50	>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.

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

Where,

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

ϕ= Angle if internal friction of founding strata

S_c, S_q and S_γ=Shape factors referred from IS: 6403

for square foundation =1.3,1.2 and 0.8 Respectively

N_c, N_q and N_γ= Bearing capacity factors referred from IS:6403

d_c, d_q and d_γ= Depth factors referred from IS:6403

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

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

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

i_c, i_q and i_γ= 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)							
		3.00		3.50		4.00		4.50	
		Shear	Settlement	Shear	Settlement	Shear	Settlement	Shear	Settlement
BH 1	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.

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);

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

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

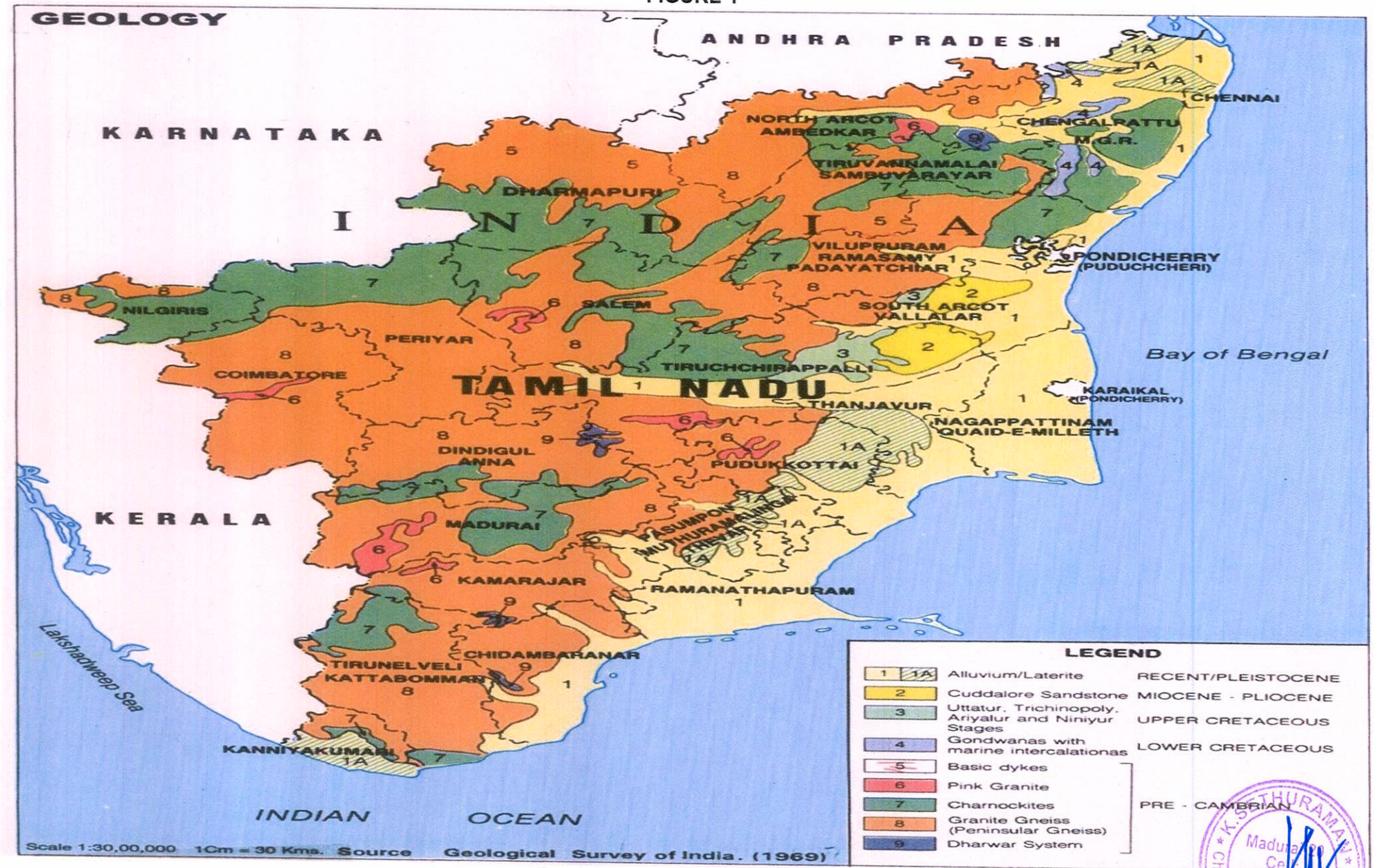
The typical values of modulus of subgrade reaction of different types of soils are given below;

Soil description	Modulus of subgrade reaction (kN/m^2/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

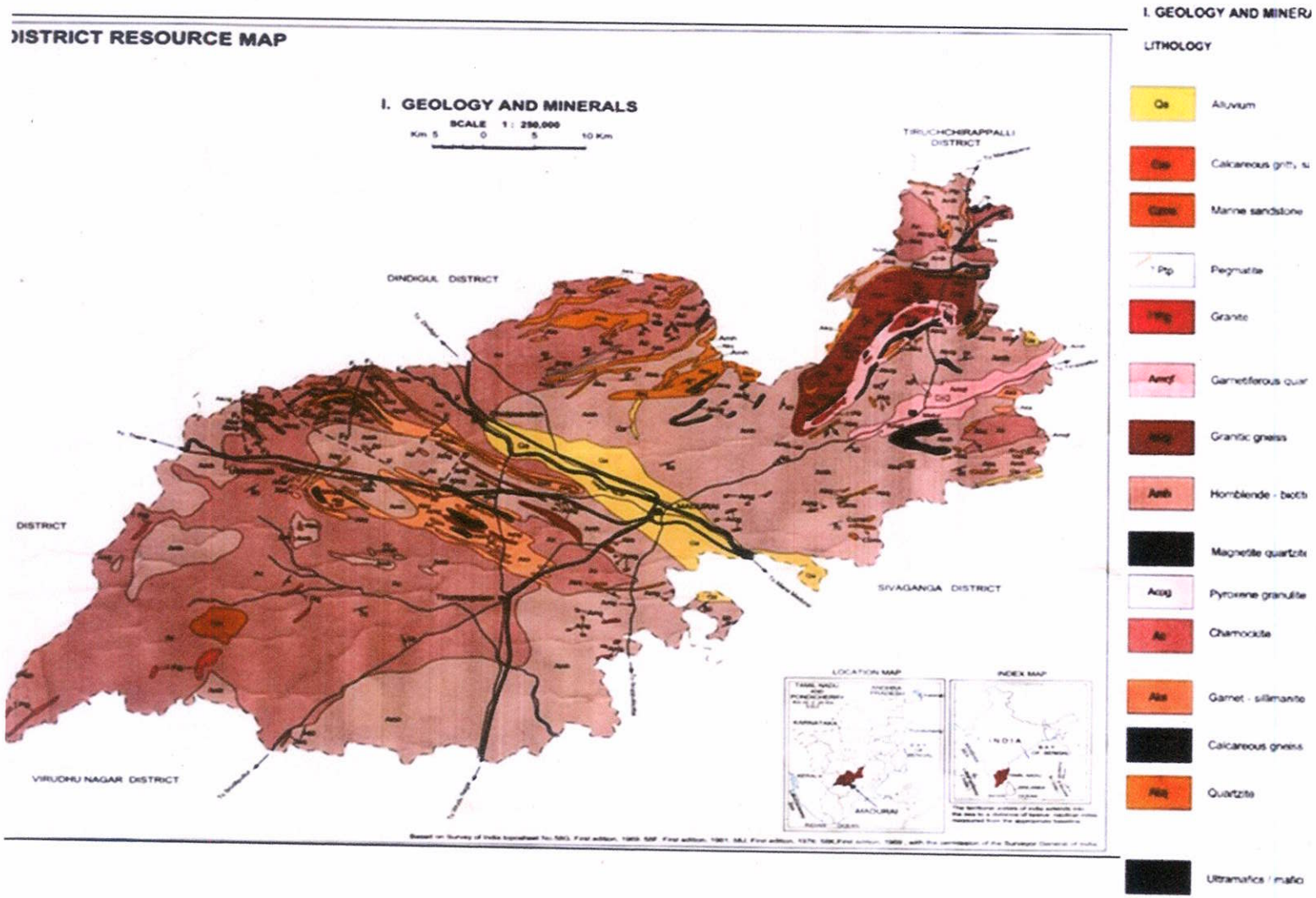
- Boreholes BH 1 was drilled at Site, at the locations identified by the Client.
- The detailed description of soil layers met in the boreholes is mentioned in Sec7.0 above.
- Based on the sub-soil profile noticed, Open foundations isolated spread, shallow foundations such as isolated spread foundations / Pile 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 met in the Area at **25.00 m** depth below EGL 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

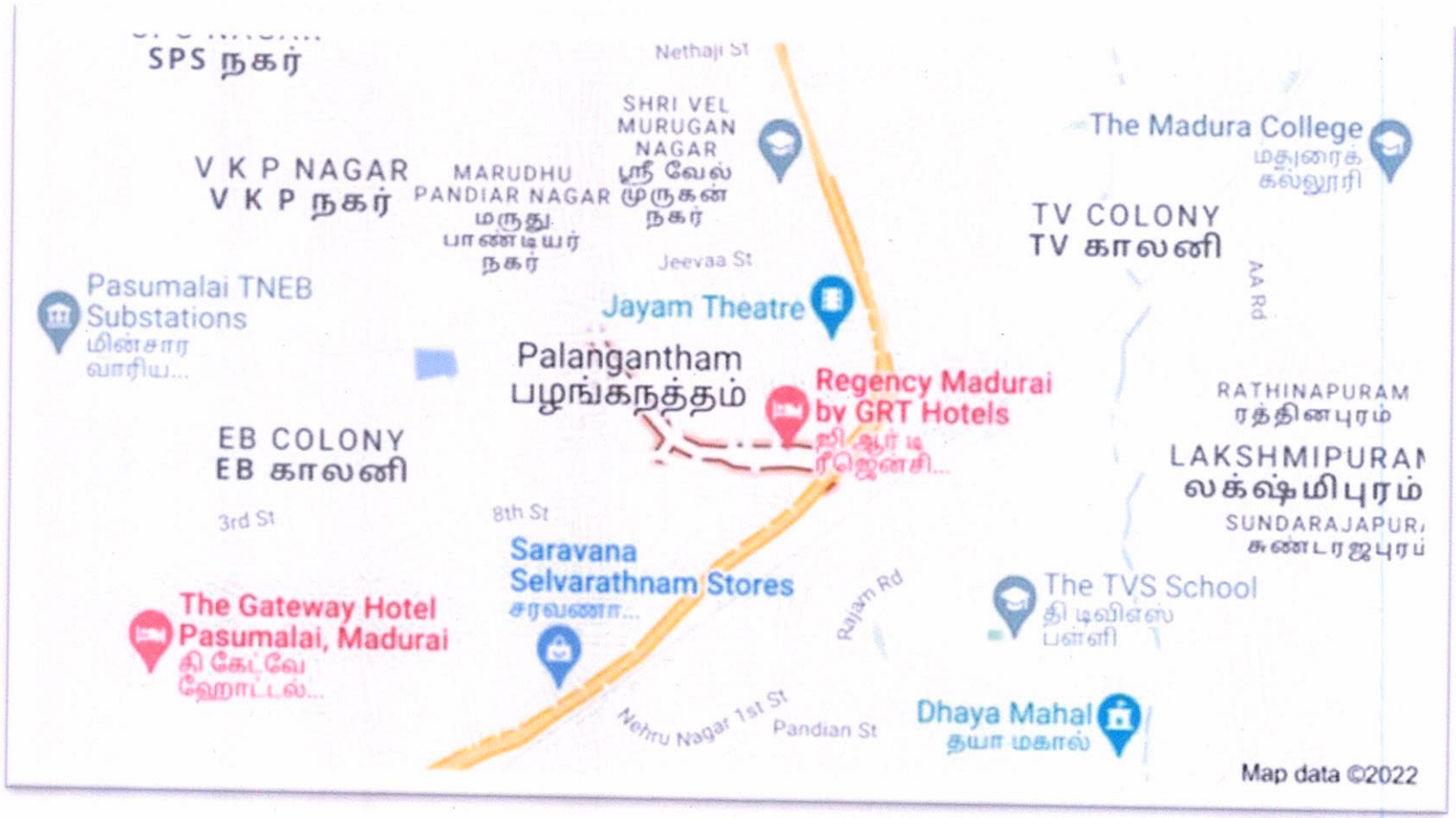


Geology Map of Tamil Nadu

FIGURE 2



Geology Map of Madurai



Location Map

APPENDIX A

BORE LOG – 1

SASTHA SOIL TESTING SERVICES

K. SETHURAMAN, B.E., (Civil), M.E., (Geo Tech), MIE., MIGS., MIIT Arbi., FIV., PEngg 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+3 MAX VIDHYA APPARTMENT BUILDING (F BLOCK) FOR MAX PROPERTIES PVT LTD				
LOCATION	: 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.				
BORE HOLE NUMBER	: BH - 1	DRILLING TYPE MACHINE : FM		DATE COMMENCED	: 29.08.2022
METHOD OF SAMPLING	: Rotary Drilling	CORE TYPE : SINGLE		DATE COMPLETED	: 29.08.2022
COORDINATES N	: 9°54'57.47832"	CORE DIAMETER (mm) : 75		GEOTECH ENGINEER	: Mr. Krishnan Sethuraman
COORDINATES E	: 78°4'57.34488"	WEIGHT OF HAMMER (Kg) : 63.5		DRILL CREW	: SURENDRAN
GROUND WATER DEPTH	: 25.00 m	DIST.FALLING HAMMER (cm) : 75		SUPERVISOR	: VISHNUVARATHAN
TOTAL DEPTH (m)	: 10.00 m	CASSING DIAMETER (mm) : 150		SITE LEVEL	: SAME AS Plot level

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 ϕ 150 mm		S		MEDIUM SAND	SPT-1							1	100
2			S		MEDIUM SAND		DS-1	50/10 cm			>50		2	100
3													3	100
4			S		MEDIUM SAND								4	100
5			S		COARSE SAND								5	100
6													6	100
7			S		COARSE SAND								7	100
8			S		COARSE SAND								8	100
9													9	100
10			S		COARSE SAND								10	100
11													11	100
12													12	100
13													13	100
14													14	100
15													15	90
16													16	90
17													17	90
18													18	100
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)

K. SETHURAMAN Madurai 20 Civil 9344 Chartered Engineer

GEO-TECHNICAL DATA.

TYPE	SEISMIC ZONE	RECOMMENDED SBC (KN/M^2) OF SOIL Terzaghi							RECOMMENDED TYPE OF FOUNDATION		
		1.50 m	3.00 m	4.50 m	6.00 m	7.50 m	9.00 m	10.00 m	Isolated /Combined	Raft	Pile
G+3 Max Vidhya Apartment Building	II	236	300	300	300	300	300	300	YES	NA	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-TC1067722100000038F

Issued To	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.	**Test Certificate No**	SSTS/GT/290822/21
		Date of Issue	05.09.2022
		Matrix	Soil Samples
Date of receipt of Soil samples	30.08.2022	**Sampling**	SPL-29.08.2022
Date of Testing	31.08.2022 To 03.09.2022	**Page Nos**	23 of 37

NABL ACCREDITED TESTS

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 (MN/m^2)
					Gravel (%)	Sand (%)									
						Coarse	Medium	Fine	Silt & Clay (%)						
BH 1	1.5	137.5	50	MEDIUM SAND	6.34	43.32	38.50	10.89	0.95	-	-	-	11.97	2.64	-
	3	136	50	MEDIUM SAND	-	-	-	-	-	-	-	-	-	-	-
	4.5	134.5	50	MEDIUM SAND	13.31	21.52	56.65	8.25	0.27	-	-	-	14.53	2.62	-
	6	133	50	COARSE SAND	-	-	-	-	-	-	-	-	-	-	-
	7.5	131.5	50	COARSE SAND	10.23	45.63	37.74	6.06	0.34	-	-	-	16.23	2.63	-
	9	130.5	50	COARSE SAND	-	-	-	-	-	-	-	-	-	-	-
	10	129	50	COARSE SAND	32.03	30.71	32.31	4.81	0.14	-	-	-	12.68	2.71	-

Authorized Signatory
Mr. K. Sethuraman
Geo-Tech Engineer

APPENDIX B2

Issued To	GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.	Test Certificate No	SSTS/GT/290822/21
Date of receipt of Soil samples	30.08.2022	Date of Issue	05.09.2022
Date of Testing	31.08.2022 To 03.09.2022	Matrix	Soil Samples
		Sampling	SPL-29.08.2022
		Page Nos	25 of 37

LAB TEST RESULTS - SOIL SAMPLES

(NON – NABL)

Borehole No	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/m^2)	Direct shear		UCC strength (kPa)	Shear Wave Velocity
									Cohesion (kPa) (t/m^2)	ø (DEG)		
BH 1	1.5	137.5	50	MEDIUM SAND	-	1.76	461.25	236	0	42	>400	340.09
	3	136	50	MEDIUM SAND	-	1.76	461.25	300	0	42	>400	340.09
	4.5	134.5	50	MEDIUM SAND	-	1.76	461.25	300	0	42	>400	340.09
	6	133	50	COARSE SAND	-	1.76	461.25	300	0	42	>400	340.09
	7.5	131.5	50	COARSE SAND	-	1.76	461.25	400	0	42	>400	340.09
	9	130.5	50	COARSE SAND	-	1.76	461.25	300	0	42	>400	340.09
	10	129	50	COARSE SAND	-	1.76	461.25	300	0	42	>400	340.09

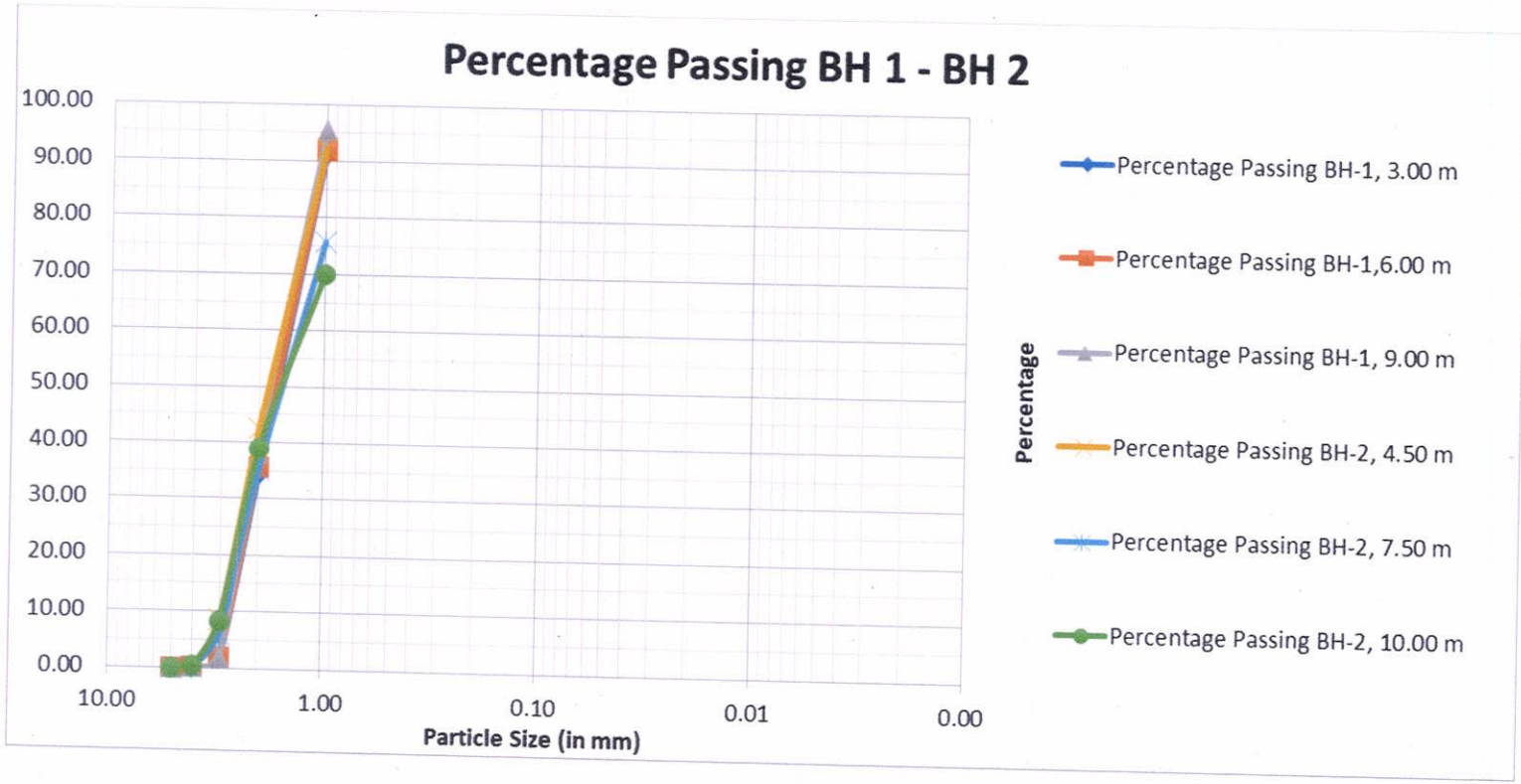
Authorized Signatory
Mr. K. Sethuraman
Geo-Tech Engineer

APPENDIX B3

PARTICLE SIZE ANALYSIS CURVES

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

CLIENT: MAX PROPERTIES PVT LTD.



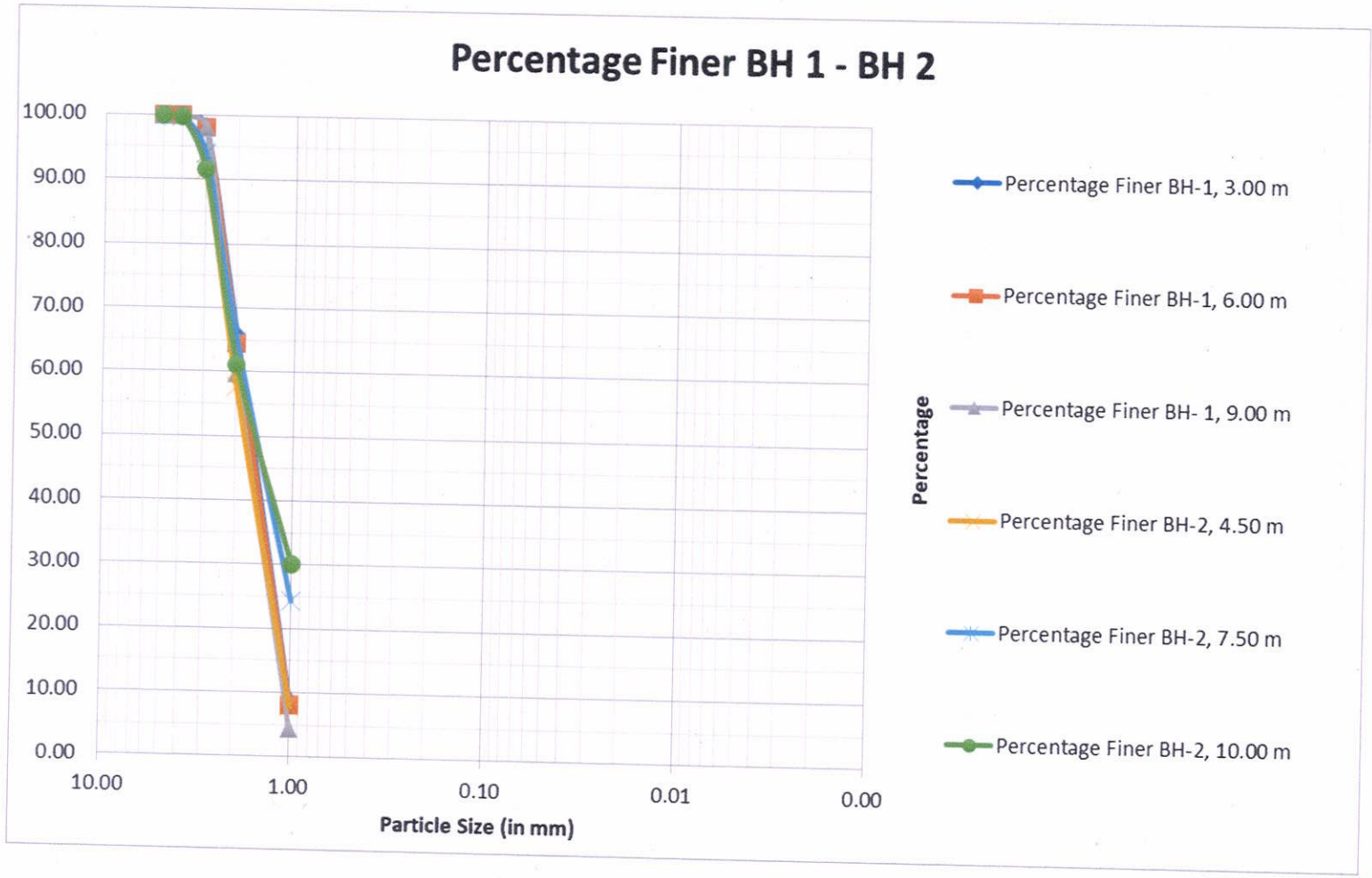
K. SETHURAMAN
Chartered Engineer Approved Valuer
Madurai-20
Cell: 9345194572

SASTHA SOIL TESTING SERVICES

PARTICLE SIZE ANALYSIS CURVES

PROJECT: GEOTECHNICAL INVESTIGATION OF PROPOSED CONSTRUCTION OF G+3 MAX VIDHYA APARTMENT BUILDING AT 316/2A - F BLOCK, PERIYAR NAGAR, 4TH STREET, MADAKULAM, MADURAI - 625003.

CLIENT: MAX PROPERTIES PVT LTD .



BH 1 – 2
Composition

SAMPLE	BH - 1 3.00 m	BH - 1 6.00 m	BH - 1 9.00 m	BH - 2 4.50 m	BH -2 7.50 m	BH - 2 10.00 m
% FINE GRAVEL =	8.84	8.15	4.38	7.88	24.23	29.98
% COARSE SAND =	56.96	56.23	55.35	49.67	40.60	31.13
%MEDIUM SAND =	32.48	33.64	38.33	33.85	29.24	30.53
%FINE SAND =	1.72	1.96	1.88	8.37	5.77	8.12
% FINE/ SILT =	0.00	0.02	0.06	0.23	0.16	0.24

SAMPLE	BH - 1 3.00 m	BH - 1 6.00 m	BH - 1 9.00 m	BH - 2 4.50 m	BH -2 7.50 m	BH - 2 10.00 m
% GRAVEL =	8.84	8.15	4.38	7.88	24.23	29.98
% SAND =	91.16	91.83	95.56	91.89	75.61	69.78
% SILT AND CLAY =	0.00	0.02	0.06	0.23	0.16	0.24
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

APPENDIX C

FOUNDATION DESIGN

Subject: F BLOCK G + 3 MAX VIDHYA APARTMENT MADAKULAM SS COLONY, MADURAI -625003 29.08.2022

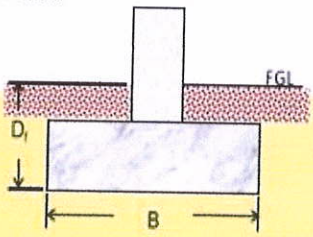
SOIL BEARING CAPACITY BY IS Calculation

Design Code/Ref:	Proj. No.	Location:	Designer:	Date:
IS:6403	SSTS 290822		KSR	03-Sep-22

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 3-Sep-22

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) =	42	deg
gamma(γ) =	1.76	kN/m^3
D_w =	25	m

Factor of Safety

F =	2.5

IS Results

Bearing Capacity

q ult =	604.3	kPa
q a =	242	kPa

Allowable Column Load

P =	825	kN

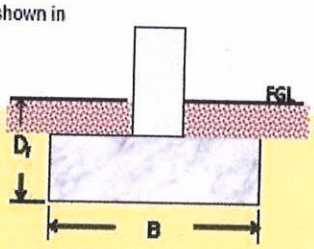
IS Computation

Unit conversion	1	N_c =	98.1952	d_q =	1.16845	q =	26.40
γ_w =	9.8	s_c =	1.3	N_γ =	167.856	W' =	1.00
ϕ (radians)	0.733	d_c =	1.33691	s_γ =	0.8	k =	0.75
W footing	142	N_q =	89.6448	d_γ =	1.16845	σ_{zD}' =	2.64
γ conc	23.6	s_q =	1.2	B/L =	1.0	γ' =	1.76

FOUNDATION DESIGN	Subject:	F BLOCK G + 3 MAX VIDHYA APARTMENT MADAKULAM SS COLONY MADURAI -625003 29.08.2022			
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location:	Designer:	Date:
	IS:6403	SSTS 290822		KSR	03-Sep-22

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: 3-Sep-22
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 =	2	m

Soil Information

c =	0	kPa
phi(Ø) =	42	deg
gamma(γ) =	1.76	kN/m^3
D_w =	25	m

Factor of Safety

F =	2.5

IS Results

Bearing Capacity

q ult =	748	kPa
q a =	299	kPa

Allowable Column Load

P =	1,008	kN

Eq. 4-1

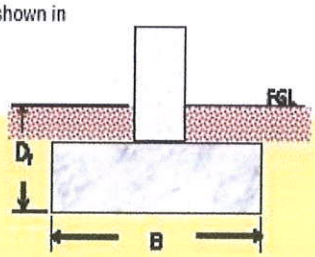
IS Computation

Unit conversion	1	N_c =	98.1952	d_q =	1.2246	q =	35.20
γ_w =	9.8	S_c =	1.3	N_γ =	167.856	W' =	1.00
ϕ (radians)	0.733	d_c =	1.44921	s_γ =	0.8	k =	1
$W_{footing}$	189	N_q =	89.6448	d_γ =	1.2246	σ_{zD}' =	3.52
γ_{conc}	23.6	S_q =	1.2	B/L =	1.0	γ' =	1.76

FOUNDATION DESIGN	Subject: F BLOCK G + 3 MAX VIDHYA APARTMENT MADAKULAM SS COLONY MADURAI -625003 29.08.2022				
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location:	Designer:	Date:
	IS:6403	SSTS 280822		KSR	03-Sep-22

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 3-Sep-22
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) =	1.76	kN/m^3
D_w =	25	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

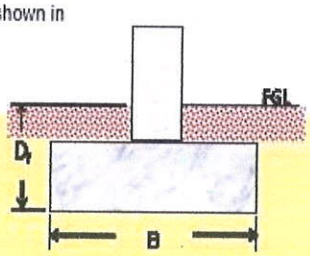
Unit conversion	1	N_c =	98.1952	d_q =	1.33691	q =	52.80
γ_w =	9.8	s_c =	1.3	N_γ =	167.856	W' =	1.00
ϕ (radians)	0.733	d_c =	1.67381	s_γ =	0.8	k =	0.98279
W footing	283	N_q =	89.6448	d_γ =	1.33691	σ_{zD}' =	5.28
γ_{conc}	23.6	s_q =	1.2	B/L =	1.0	γ' =	1.76

K. SETHURAMAN
Chartered Engineer and Valuer

FOUNDATION DESIGN	Subject: F BLOCK G + 3 MAX VIDHYA APARTMENT MADAKULAM SS COLONY MADURAI -625003 29.08.2022				
	SOIL BEARING CAPACITY BY IS Calculation				
	Design Code/Ref:	Proj. No.	Location:	Designer:	Date:
	IS:6403	SSTS 280822		KSR	03-Sep-22

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 3-Sep-22
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) =	1.76	kN/m^3
D_w =	25	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
ϕ (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
γ conc	23.6	s_q =	1.2	B/L =	1.0	γ' =	1.76

DESIGN INFORMATION I

PILE FOUNDATION DESIGN (Pile Dia 450 mm / 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 = 10.00 m 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 = 0.613 Nq = 12 ϕ = 42 Y = 17.6

q'o =Y x L average unit wt of soil along pile length X depth = 176

q'o = ½ x Y x L = 88

D	Ab	As	K̄ s	L
0.45 m	0.159	14.13		
0.50 m	0.196	15.70	1	10.00 m
0.60 m	0.283	18.84		

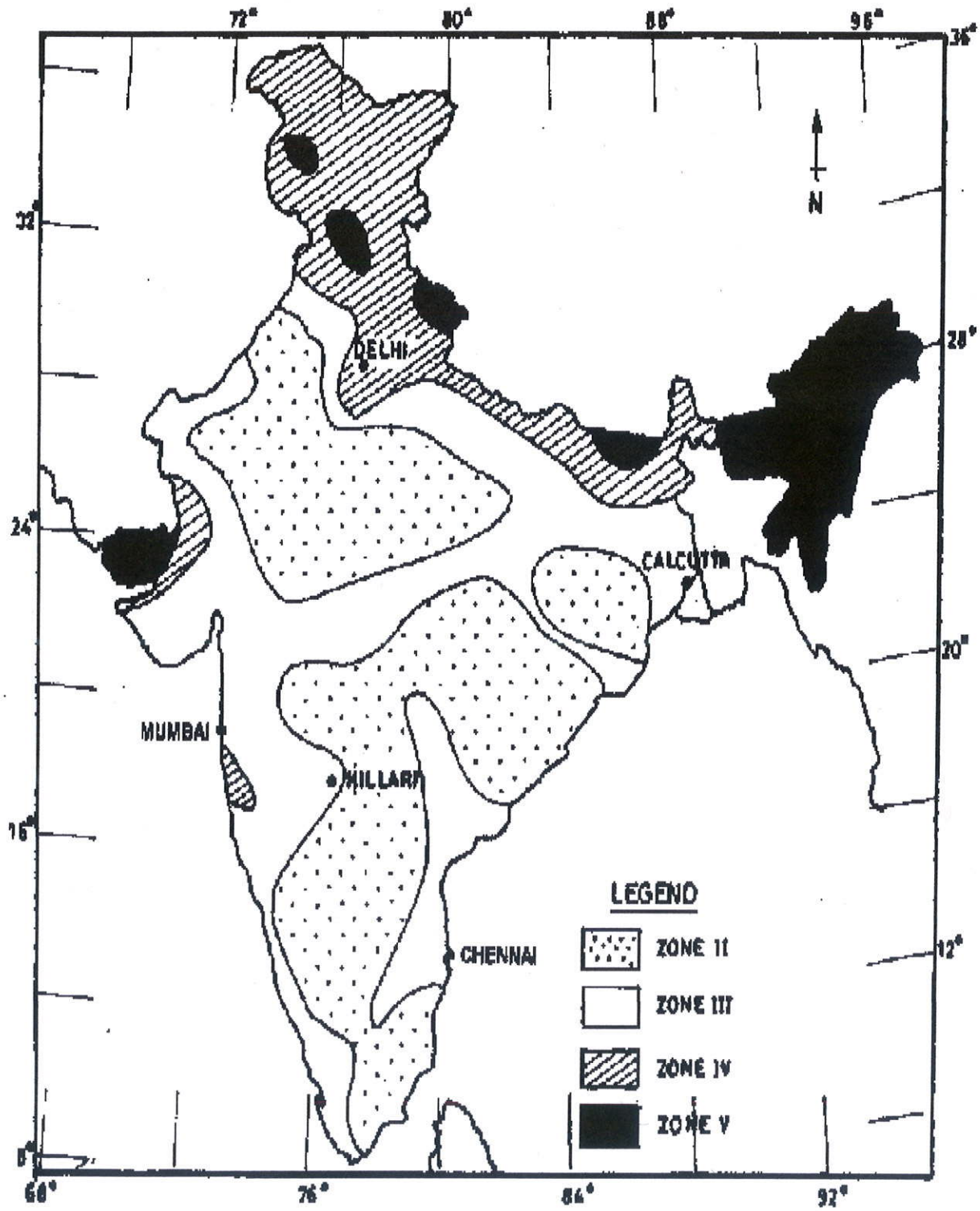
Qb	335.73	414.48	596.85
Qf	761.98	846.64	1015.97
Qu = Qb + Qf	1097.71	1261.12	1612.82
Qa = Qu / 2.50 (kN)	**439.08**	**504.45**	**645.13**
Pile Dia in m	**0.450**	**0.500**	**0.600**
Pile depth in m	**10**	**10**	**10**

K.SETHURAMAN Madurai Civil Engineer & Valuer 9344 84

ADDITIONAL INFORMATION

Bore Hole	D	γ	Ø	c	B	L	q_{nu}		q_a		P	q_{np}
	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	1.5	1.76	42	0	1.5	1.5	560.97	2.5	224.39	79.65	425.22	937.37
	1.5	1.76	42	0	2	2	604.29	2.5	241.71	141.6	825.26	860.88
	2	1.76	42	0	1.5	1.5	716.91	2.5	286.76	106.2	539.02	937.37
	2	1.76	42	0	2	2	747.96	2.5	299.18	188.8	1007.94	860.88
	2.5	1.76	42	0	1.5	1.5	886.86	2.5	354.74	132.75	665.43	937.37
	2.5	1.76	42	0	2	2	902.15	2.5	360.86	236	1207.43	860.88
	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

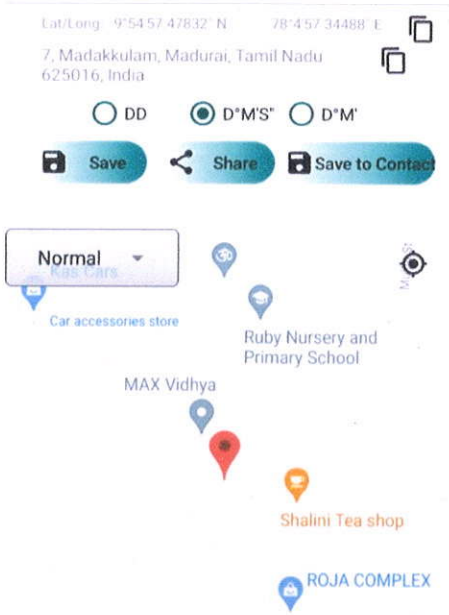


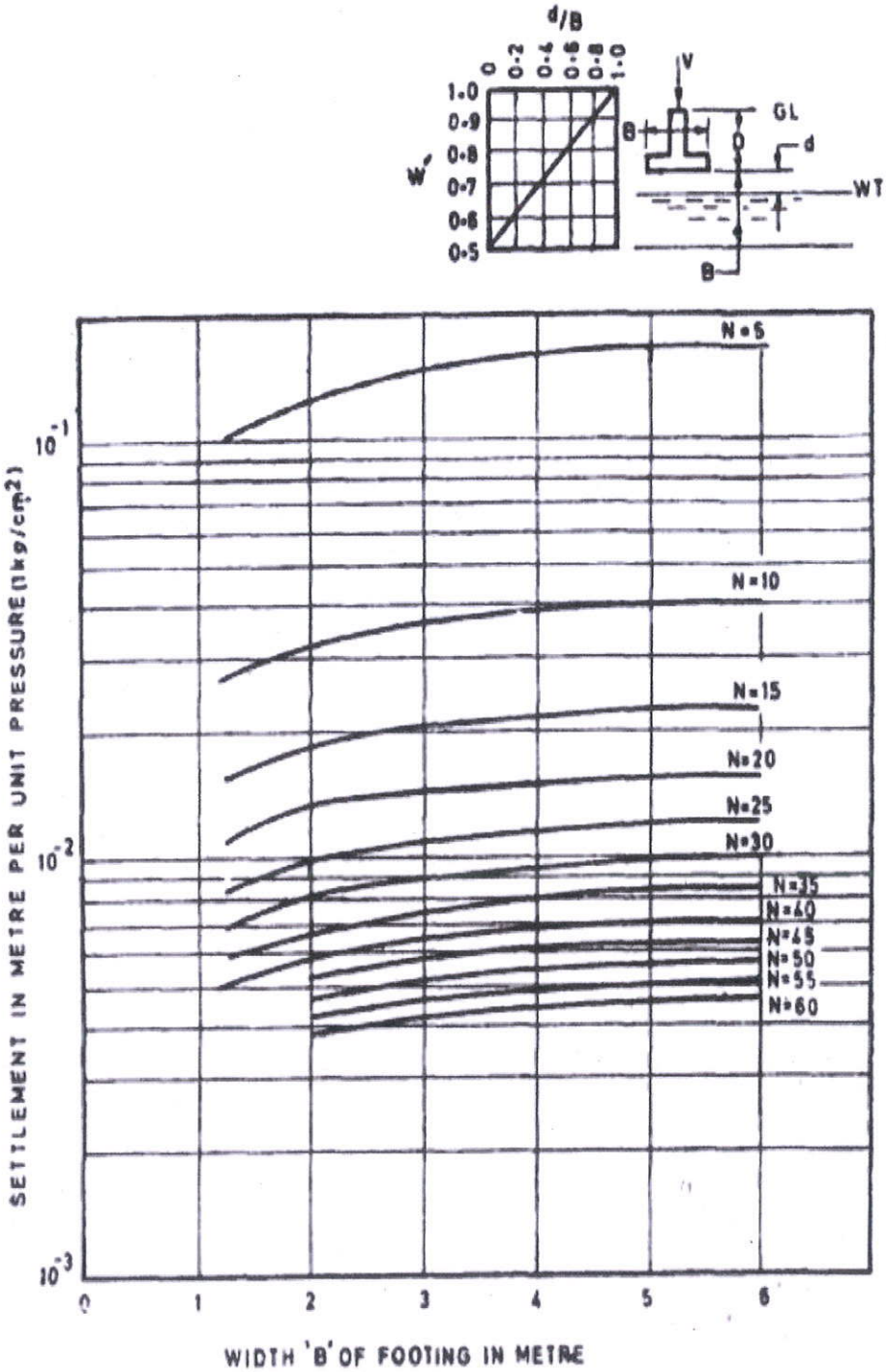
APPENDIX C1
PHOTOGRAPHS

Drilling Under Progress

BH 01







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/290822/21**
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

K.SETHURAMAN Madurai Cell: 93441 Chartered Engineer



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