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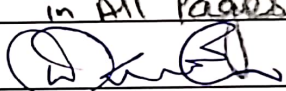
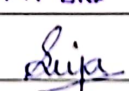
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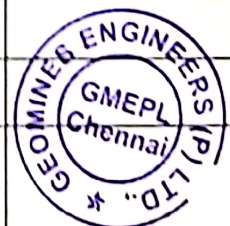
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CLIENT		Mr. VEDAMURTHY, CHENNAI	
PROJECT		PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (STILT+05) AT PADIKUPPAM, CHENNAI	
TITLE		GEOTECHNICAL INVESTIGATION REPORT	
		CMDA Signing	
		in All Pages.	
			
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		For Geo Mines Engineers Pvt Ltd	
			
		Director	
0	17-07-2023	GMEPL/Mr. VEDAMURTHY/214/2023-24	
REV.	DATE	REPORT NUMBER	PREP. BY



DISCLAIMER

We've been asked to look into the ground and identify and quantify everything that mother nature has put there and predict how those materials will react to construction and long-term performance of a facility - and we may fall short of this lofty goal.

We have made reasonable and prudent conclusions but a cloud of uncertainty inherently looms over the project as per the pre and post facilities laid and their elemental behaviour on the mother soil.

Also, the variable nature of soil strata and it's varying characteristics may make the recommended foundation system disqualify and hence it's recommended that special care shall be taken by the owner during and after the construction is complete and during the run period of the building.



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CHAPTER-1

INTRODUCTION

1.0 Preamble

Mr. Vedamurthy, Chennai proposed to construct a **Residential Building (Stilt+05) at Padikuppam, Chennai.**

For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigations was entrusted to **M/s. Geo Mines ENGINEERS, Chennai.**

This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

1.1 Scope of Work

- ❖ Sinking Two Standard Soil investigation bore holes of 150mm diameter up to depth of 29.00m below existing ground level as directed by the engineer-in-charge.
- ❖ Conducting Standard Penetration Test (SPT) at regular depth intervals.
- ❖ Collection of Split Spoon Samples or Disturbed Soil Samples
- ❖ Collection of water samples from each bore hole.
- ❖ Conducting relevant laboratory test results.

1.2 Structure of the Report

- ❖ Contents
- ❖ Introduction
- ❖ Investigation Methodology & Test Results
- ❖ Figures & Tables
- ❖ Sub-Surface Stratification
- ❖ Foundation Systems
- ❖ Recommendations
- ❖ Annexure (Design Computations)



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CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Field Testing:

2.1 Preamble:

Two standard soil investigation boreholes were put. The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.2 Equipment Used and Method of Drilling:

2.2.1 Equipment Used

The equipment used for performing the drilling operations is a Calyx Rotary Drill Rig with direct mud circulation technique. The drill mud used was made out of Sodium Bentonite.

2.2.2 Methodology of drilling

In the soil strata, the drilling operations have been carried out using special drill bits and cutters coupled with direct mud circulation.

2.3 In-Situ Strength Tests:

2.3.1 Standard Penetration Test:

Standard penetration tests were conducted at the borehole location, in accordance with IS: 2131. The tests were conducted at every change of strata up to the depth of termination of the borehole as directed by the engineer-in-charge.

2.4. Collection of Samples:

2.4.1 Disturbed Soil Samples

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.



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2.4.2 Ground Water

For conducting suitable chemical tests, the ground water sample was collected from the respective boreholes.

2.5 Summary of Field Work

The locations of the boreholes are shown in site plan given in Fig. 2.0. The soil profiles obtained at each location is shown in Figs. 2.1 & 2.2.

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

On the coarse-grained soil samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Tables 2.1 & 2.2.

2.6.2 Fine Grained Samples:

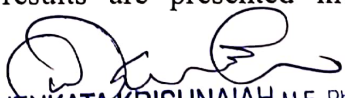
2.6.2.1 Index Property – Free Swell Tests:

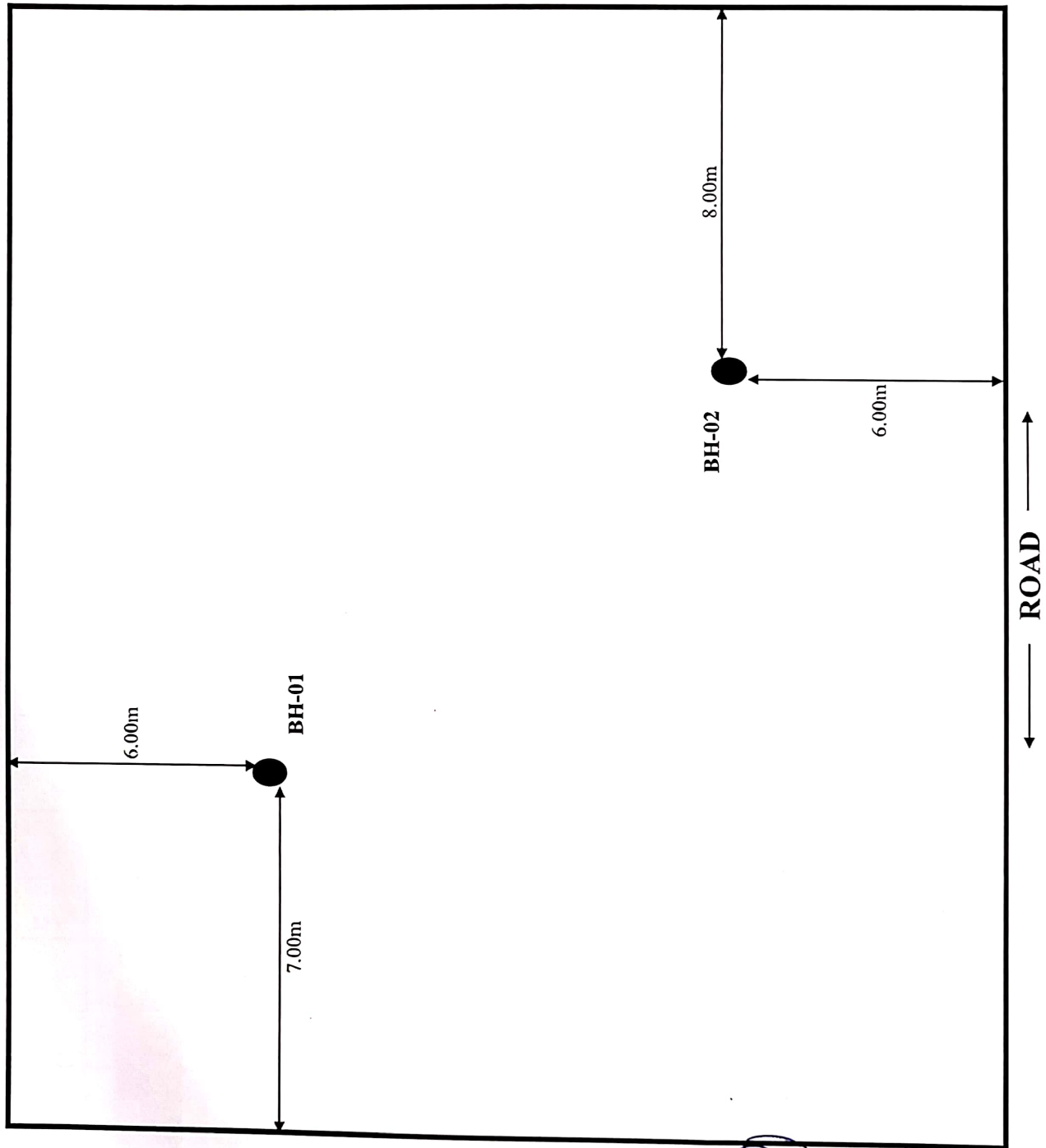
Atterberg Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of soil strata encountered at the investigation locations, such tests were conducted and the test results are presented in Tables 2.1 & 2.2.

2.6.3 Chemical Analysis Tests:

2.6.3.1 Water Samples:

On representative water samples, chemical analysis tests were conducted to estimate pH, Chlorides and Sulphates. These results are presented in Table-2.3.


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Fig. 2.0: Site Plan Representing the locations of Field Investigation Points

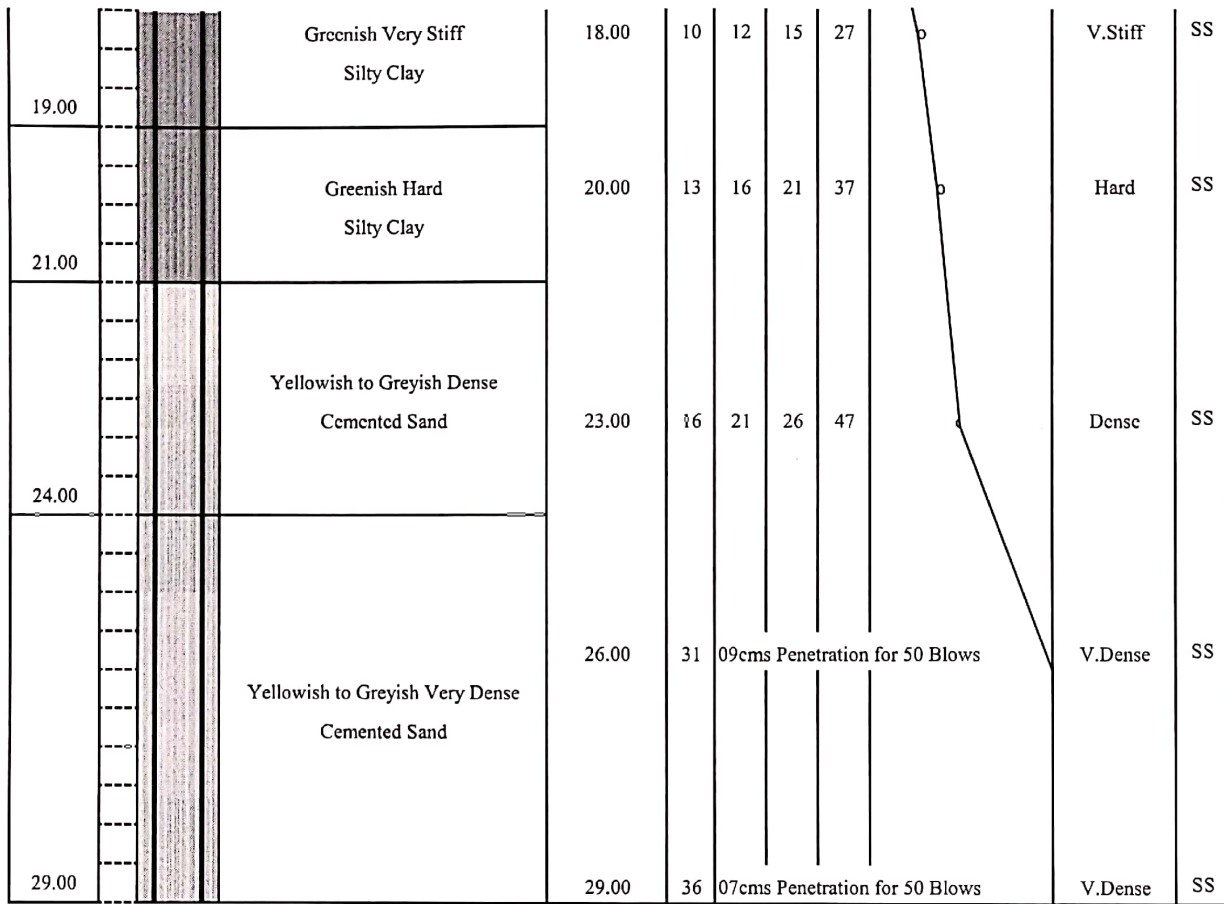
Project : Proposed Construction of Residential Building (Stilt+05) at Padikuppam, Chennai

Location: BH-01

Started On : 11/07/2023; Ended On : 12/07/2023 G.W.T: 3.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Semi-logarithmic Representation of SPT Data										Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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Bore Hole Terminated at a depth of 29.00m below the existing grou

Fig. 2.1 Soil Profile at BH-01 Location


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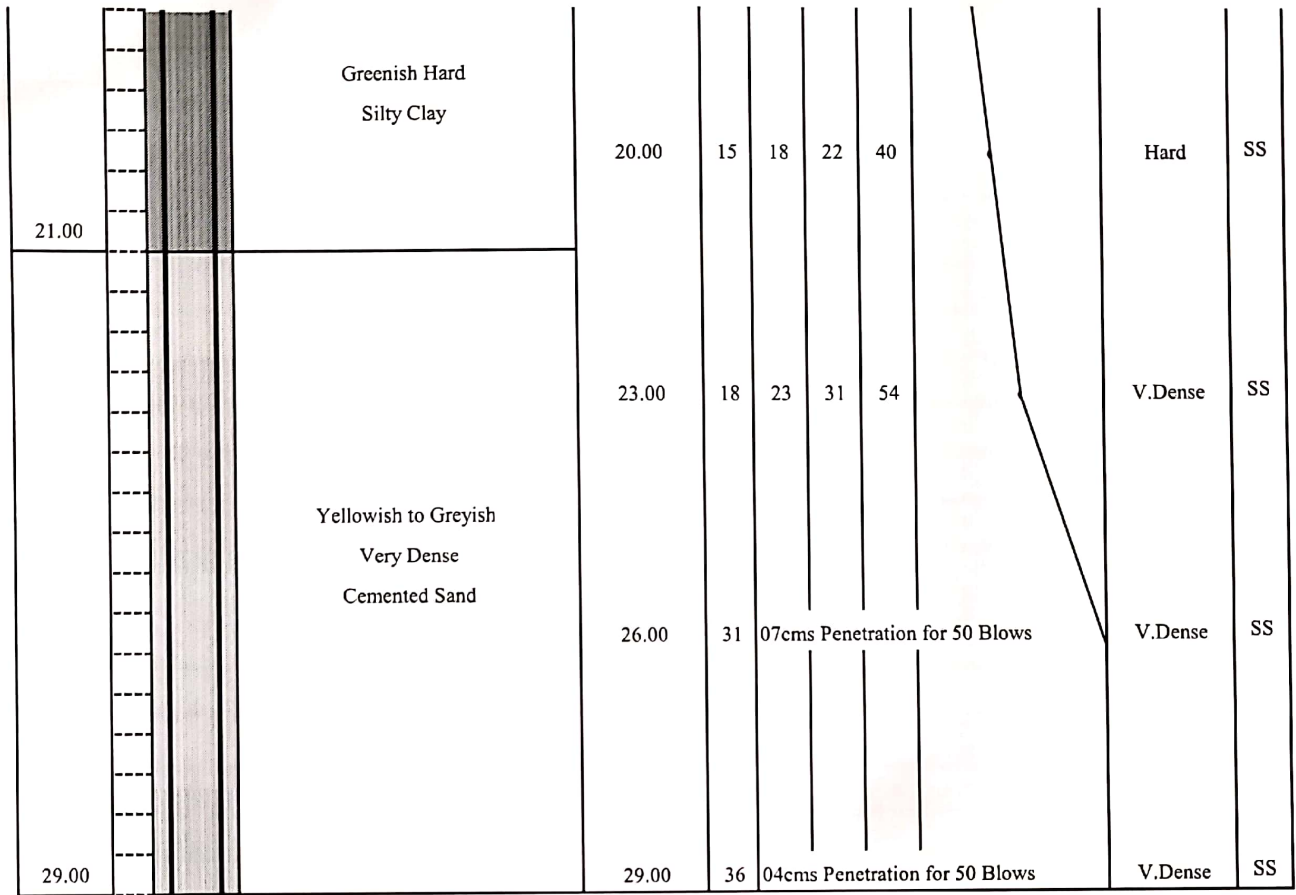
Project : Proposed Construction of Residential Building (Stilt+05) at Padikuppam, Chennai

Location: BH-02

Started On : 12/07/2023; Ended On : 13/07/2023 G.W.T: 3.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				SPT - Details										Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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Bore Hole Terminated at a depth of 29.00m below the existing grou

Fig. 2.2 Soil Profile at BH-02 Location


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Table 2.1: Laboratory Test Results on the Soil Samples Collected from BH-01

Depth of Sample below E.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I_p	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	11	SS	Silty Clay	31	1.7	58	25	33	0.82	9	Stiff	0	0	0	0	20	80	CH
2.00 to 3.80	9	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	8	69	23	0	SM
3.80 to 5.50	8	SS	Silty Clay	33	1.6	61	23	38	0.74	-	M.Stiff	0	0	0	0	17	83	CH
5.50 to 7.00	10	SS	Silty Clay	31	1.7	59	25	34	0.82	-	Stiff	0	0	0	0	19	81	CH
7.00 to 13.00	14	SS	Silty Sandy Clay	28	1.7	55	27	28	0.96	-	Stiff	0	0	0	11	11	78	CH
13.00 to 15.00	5	SS	Silty Sandy Clay	43	1.5	64	21	43	0.49	-	M.Stiff	0	0	0	2	12	86	CH
15.00 to 20.00	2	SS	Silty Sandy Clay	48	1.2	68	14	54	0.37	-	V.Soft	0	0	0	4	7	89	CH
15.00 to 20.00	9	SS	Silty Sandy Clay	32	1.7	59	24	35	0.77	-	Stiff	0	0	0	10	10	80	CH
15.00 to 20.00	27	SS	Silty Clay	24	1.9	43	33	10	1.90	-	V.Stiff	0	0	0	0	23	77	CI
15.00 to 20.00	37	SS	Silty Clay	19	2.0	34	27	7	2.14	-	Hard	0	0	0	0	26	74	CL
13.00 to 15.00	47	SS	Cemented Sand	-	1.9	-	-	-	-	-	Dense	0	17	17	37	12	17	SM
13.00 to 15.00	>100	SS	Cemented Sand	-	2.0	-	-	-	-	-	V.Dense	0	19	14	31	13	23	SM


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Table 2.2: Laboratory Test Results on the Soil Samples Collected from BH-02

Depth of Sample below F.G.L. (m)	SPT of Sample	Type of Sample	Engineering Description of Soil	NMC(%)	Natural Density (g/cc)	Clay					Relative Density/ Consistency	Sieve Analysis						IS-Classification
						LL (%)	PL (%)	PI	I _p	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 4.00	10	SS	Silty Clay	31	1.7	58	24	34	0.79	9	Stiff	0	0	0	0	20	80	CH
4.00 to 5.50	11	SS	Silty Fine Sand	-	1.5	-	-	-	-	-	Loose	0	0	0	77	23	0	SM
5.50 to 9.50	6	SS	Silty Clay	38	1.6	63	22	41	0.61	-	M.Stiff	0	0	0	0	17	83	CH
9.50 to 11.00	10	SS	Silty Sandy Clay	31	1.7	57	24	33	0.79	-	Stiff	0	0	0	12	8	80	CH
11.00 to 17.00	6	SS	Silty Sandy Clay	39	1.5	63	22	41	0.59	-	M.Stiff	0	0	0	9	12	79	CH
17.00 to 21.00	35	SS	Silty Clay	19	2.0	41	31	10	2.20	-	Hard	0	0	0	0	25	75	CI
21.00 to 29.00	77	SS	Cemented Sand	-	2.0	-	-	-	-	-	V.Dense	0	18	23	33	12	14	SM

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Table 2.3: Chemical Analysis Results conducted on Water Samples collected from BH-01 & BH-02				
Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	3.00	7.01	390.12	300.88
BH-02	3.00	6.98	399.91	310.48


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CHAPTER-3

SUB-SURFACE STRATIFICATION

3.0 Preamble

The sub surface stratification at borehole locations, with respect to foundation/geotechnical engineering application are derived based on the visual identification, laboratory classification tests and field in-situ strength tests. Further, the strength parameters are estimated based on the in-situ strength test results as per the following correlation.

- * For Coarse Grained Samples, Ref. Fig.1, IS: 6403 to estimate Angle of Shearing Resistance.
- * For Fine Grained Samples, Ref. Terzaghi & Peck, 1948, to estimate Unconfined Compressive Strength.

3.1 Sub Surface Stratification:

3.1.1 Soil Profile at BH-01 Location

(At BH-01 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 4.00m depth)

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	4.00m
SPT of the layer	11
Consistency	Stiff
Un-drained Cohesion, Cu	73.33kPa

* Layer-2 (from 4.00m to 5.00m depth)

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
SPT of the layer	09
Relative Density	Loose
Angle of Shearing Resistance, ϕ	29.80°

* Layer-3 (from 5.00m to 7.00m depth)

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	08
Consistency	Medium Stiff
Un-drained Cohesion, Cu	53.33kPa

* Layer-4 (from 7.00m to 9.50m depth)

Type of Strata	Silty Clay
----------------	------------


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Colour	Blackish
Thickness of Layer	2.50m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-5 (from 9.50m to 11.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	14
Consistency	Stiff
Un-drained Cohesion, Cu	93.33kPa
* Layer-6 (from 11.00m to 13.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	05
Consistency	Medium Stiff
Un-drained Cohesion, Cu	33.33kPa
* Layer-7 (from 13.00m to 15.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	02
Consistency	Very Soft
Un-drained Cohesion, Cu	13.33kPa
* Layer-8 (from 15.00m to 17.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	09
Consistency	Stiff
Un-drained Cohesion, Cu	60.00kPa
* Layer-9 (from 17.00m to 19.00m depth)	
Type of Strata	Silty Clay
Colour	Greenish
Thickness of Layer	2.00m
SPT of the layer	27
Consistency	Very Stiff
Un-drained Cohesion, Cu	180.00kPa
* Layer-10 (from 19.00m to 21.00m depth)	
Type of Strata	Silty Clay
Colour	Greenish
Thickness of Layer	2.00m
SPT of the layer	37
Consistency	Hard
Un-drained Cohesion, Cu	246.66kPa
* Layer-11 (from 21.00m to 24.00m depth)	
Type of Strata	Cemented Sand
Colour	Yellowish to Greyish

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Thickness of Layer	3.00m
SPT of the layer	47
Relative Density	Dense
Angle of Shearing Resistance, ϕ	40.325°
* Layer-12 (from 24.00m to 29.00m depth)	
Type of Strata	Cemented Sand
Colour	Yellowish to Greyish
Thickness of Layer	5.00m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50°

Ground Water

Ground water table was encountered at a depth of 3.00m below the existing ground level during the second week of July 2023.

3.1.2 Soil Profile at BH-02 Location (At BH-02 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 4.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	4.00m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-2 (from 4.00m to 5.50m depth)	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	11
Relative Density	Loose
Angle of Shearing Resistance, ϕ	30.30°
* Layer-3 (from 5.50m to 9.50m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	4.00m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa
* Layer-4 (from 9.50m to 11.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-5 (from 11.00m to 17.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish


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Thickness of Layer	6.00m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa
* Layer-6 (from 17.00m to 21.00m depth)	
Type of Strata	Silty Clay
Colour	Greenish
Thickness of Layer	4.00m
SPT of the layer	35
Consistency	Hard
Un-drained Cohesion, Cu	233.33kPa
* Layer-7 (from 21.00m to 29.00m depth)	
Type of Strata	Cemented Sand
Colour	Yellowish to Greyish
Thickness of Layer	8.00m
SPT of the layer	77
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50 ⁰

Ground Water

Ground water table was encountered at a depth of 3.00m below the existing ground level during the second week of July 2023.



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CHAPTER-4

FOUNDATION SYSTEM

4.0 Preamble

The foundation system design is an interface between super structure and the sub soil bearing strata characteristics. A sound foundation system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed by the bearing strata deformation response under the super structure load intensity. In addition, as a combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement.

Considering the above aspects of foundation design, the suitable type of foundation system with respect to the sub soil conditions encountered at the borehole locations is presented in the subsequent sections.

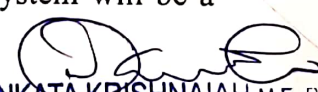
4.1 Bearing Strata Characteristics

From field investigations, it can be observed that the sub-soil strata encountered at shallow depths are uniformly stratified from type but possess varying shear strength characteristics, BH-02 being relatively weak from deformation considerations than that of other borehole location and hence shall be considered as design borehole to determine the bearing strata and its safe bearing capacity.

Considering BH-02 as design borehole, it can be further envisaged that the highly plastic fine-grained soil strata encountered at shallow depths will hold good to act as bearing strata from shear strength characteristics and deformation considerations for nominal column loads in the range of 400kN to 500kN respectively.

If fine-grained soil strata encountered at shallow depths are considered as bearing strata, the safe bearing capacity of open foundation system will be a function of un-drained cohesive strength of the bearing strata.

Foundation system shall be designed to counteract the impact of ordinate pressures which may develop during variations in seasonal moisture content for such type of highly plastic soils.


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Care shall also be taken so that the dispersed foundation stresses on the underlying relatively weak soil strata encountered at 5.50m depths below existing ground level (SPT @ 6.00m is 06, Ref. BH-02) are within its safe bearing capacity limits.

Further, the sub-soil strata encountered up to the depth of investigations can also offer a good frictional resistance against a suitably designed structural member or element if being cast or driven in such soils.

Considering the above, suitable foundation systems are presented below.

4.2 Foundation System

4.2.1 Open Foundation System (BH-02)

*Considering the high plasticity of fine-grained soil strata encountered at shallow depths, their shear strength characteristics and presence of underlying relatively weak soil strata encountered at 5.50m below existing ground level, open foundation system of **Strip Raft** located at a design depth of 2.00m below present existing ground level over 0.40m thick CNS (cohesive non-swelling) soil can be adopted.*

The safe bearing capacity of such type of open foundation system is presented below which can be adopted for foundation design purposes.

Type of Open Foundation System	Total Depth of Excavations below existing ground level (m)	Backfill with well compacted CNS (m)	Depth of Strip Raft below Present Existing Ground Level (m)	Safe Bearing Capacity (MT/m ²)	Elastic Settlements (mm)
Strip Raft	2.40	0.40	2.00	10	56

The computations for above are annexed to this report.

Notes

Safe Bearing Capacity of open foundation system is restricted considering the presence of underlying relatively weak soil strata encountered at 5.50m depths below existing ground level (SPT @ 6.00m is 06, Ref. BH-02) i.e. 3.50m distant apart from the bottom level of footing.

4.2.2 Deep Foundation System-26.00m Long Bored Cast-in-Situ Friction Piles

In case, the safe bearing capacity of open foundation system as presented above in Clause 4.2.1 is lower than the anticipated of proposed open


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foundation stresses, deep foundation system consisting of 26.00m long bored cast-in-situ Friction Piles can also be adopted.

Piles shall be drilled through DMC (direct mud circulation) technique.

For four different diameters, the safe load carrying capacities of 26.00m long bored cast-in-situ Friction Piles are computed and presented below which can be adopted for foundation design purposes.

S. No	Type of Installation of Pile	Type of Pile Head Group	Length of Pile below Existing Ground Level (m)	Diameter of Pile (mm)	Safe Load Carrying Capacity (MT)	Safe Pull Out Capacity (MT)
1	Bored Cast-in-Situ	Fixed	26.00	500	150	150
2				550	170	170
3				600	190	190
4				650	210	210

The computations of safe load carrying capacity for 500mm diameter and 26.00m long bored cast-in-situ Friction Pile are annexed to this report.


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CHAPTER 5

CONCLUSIONS & RECOMMENDATIONS

1. Foundation systems presented in Clause 4.2.1 & 4.2.2, Chapter-IV can be adopted for foundation design purposes.

Open Foundation System

2. Safe bearing capacity of open foundation system is computed considering any rise in the ground water table up to or above the level of strip raft .
3. In case, ground water table is encountered within recommended depth of foundation system, provision shall be made to continuously bail the water out of the foundation pits to keep the surfaces of pit consolidated dry.
4. Safe Bearing Capacity of open foundation system is restricted considering the presence of underlying relatively weak soil strata encountered at 5.50m depths below existing ground level (SPT @ 6.00m is 06, Ref. BH-02) i.e. 3.50m distant apart from the bottom level of strip raft.

Open Foundation Depths & Foundation Dimensional Restrictions

5. Depth of open excavations below present existing ground level shall be 2.40m.
6. Recommended Thickness of CNS Back-Fill @ Site is 0.40m.
7. Depth of Strip Raft below existing ground level will be 2.00m.
8. For the recommended safe bearing capacity of 10MT/sq.m., the least dimension of strip shall be in no case more than 2.00m.

Usage of Excavated Earth

9. **Excavated highly plastic fine-grained soil encountered at shallow depths shall be in no case used for back filling purposes.**
10. **No structural units can be in direct contact of highly plastic fine-grained soil strata encountered at shallow depths. 0.40m thick well compacted CNS is recommended to be sand-witched in between.**


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Other Recommendations

11. It is recommended to connect the grade beams so that the entire structure can act as a single unit against any differential settlements in between the individual strips.
12. Suitable arrangements to contain the lateral soil collapse from the walls of excavated open foundation pits are recommended.

IMPORTANT RECOMMENDATIONS

13. Open foundation system presented above will be conducive only if proper drainage arrangements are made to channel the run-off into the drains and hence containing any water seepage into the ground. Also, there shall not be any underground plumbing line leakages which may lead to softening of highly plastic fine-grained soil recommended as bearing strata.

Deep Foundation System

14. Suitable pile load tests (as per I.S: 2911, part-IV) shall be performed to confirm the presented theoretical safe load carrying capacities and arrive at the design/allowable load carrying capacity of piles under considerations.
(Mandatory)
15. Pile cap can be located over 0.40m thick well compacted ground replaced CNS (Cohesive Non-Swelling) soil surface.
16. Piles shall be grouped according to the column design load requirements.
17. Safe load carrying capacities of piles shall be limited to their structural capacities.

General

18. CNS can be well graded coarse-grained M-Sand or quarry dust or clean river sand or sand: gravels mix (1:2) or fly-ash.
19. As the chlorides and sulphates present in the collected water samples are within the permissible limits, no special steel or cement is recommended to be used for open foundation construction purposes.
20. Water shall also be sampled at deeper levels and tested to determine the chemicals parameters to understand the usage of cement and steel for deep foundation purposes. (IMPORTANT)

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DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-02)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System: Strip Raft
R.L of the top of Borehole (m): 0.00 m
Depth of Foundation excavations below existing ground level (D_f): 2.40 m
Recommended Thickness of CNS Back-Fill below Footing: 0.40 m
Effective Depth of Foundation below existing ground level (D_f): 2.00 m
Design Width of Foundation (B): 1.00 m
Thickness of Foundation (T) : 0.25 m

1.2 Soil Data :

Type of Bearing Strata : Silty Clay
Design SPT-value of the Bearing Strata : 9
(considered based upon the density of the strata)
Type of Shear Failure: General
Undrained Cohesion, C_u : 60.00 kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk}) 17.00 kN/m³
Effective Overburden pressure at foundation level (q) 14.00 kPa
Water Table Correction Factor (w') 0.50

Bearing Capacity Factors:

$$N_c = 5.14$$

$$N_q = N/A$$

$$N_\gamma = N/A$$

Shape Factors:

$$S_c = 1.30$$

$$S_q = N/A$$

$$S_\gamma = N/A$$

Depth Factors :

$$D_c = 1.00$$

$$D_q = N/A$$

$$D_\gamma = N/A$$


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$$D_{\gamma} = N/A$$

Inclination Factor:

$$I_c = 1.00$$

$$I_q = N/A$$

$$I_{\gamma} = N/A$$

1.4 Ultimate Bearing Capacity (Q_u) :

$$Q_u = C_u * N_c * S_c * D_c * I_{c+q} * (N_q - 1) * S_q * D_q * I_q + 0.5 * B * \gamma * N_{\gamma} * S_{\gamma} * D_{\gamma} * I_{\gamma} * w'$$

$$Q_u = 400.92 \text{ kPa}$$

1.5 Safe Bearing Capacity (Q_{safe}) :

$$\text{Factor of Safety (F.S.) : } 2.50$$

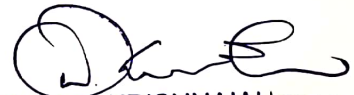
$$Q_{safe} : 160.37 \text{ kPa}$$

$$\text{Recommended Safe Bearing Capacity: } 100.00 \text{ kPa}$$

Restricted considering the presence of underlying relatively weak soil layer encountered at 5.50m depths from existing ground level i.e. 3.50m distant apart from the bottom level of strip raft.

1.6 Settlements

Since, the bearing strata are stiff fine-grained type, the settlements under the allowable safe bearing pressure 100kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 100kPa and average SPT of 09 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 56mm which is within the permissible limits of 70mm for strip raft as per I.S:1904.



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DESIGN OF PILE FOUNDATION (Ref. BH-02)

Refer, IS:2911(Part I/Sec 2)-1979, Reaffirmed 1997

1.0 Type of Installation of Pile

Bored Cast in Situ

1.1 Geometrical Data

Assumed Diameter of pile(D):	500.0 mm
Assumed R.L of E.G.L:	0.000 m
Length of pile below E.G.L.(l) :	26.000 m
R.L. of Bot. of Pile	-26.00 m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.21.1

Layer-I

Type of Strata: Silty Clay

Average SPT of the strata,N: 10

Bulk Density of the strata, γ : 17 kN/m³

Undrained Cohesion, Cu: 66.67 kPa

R.L of top of Strata: 0.00 m

R.L of bottom of Strata: -4.00 m

Average Thickness of Strata, I_c : 4.00 m

Effective overburden pressure over the top of strata, σ_{top} : 0.00 kN/m²

Effective overburden pressure over the bottom of strata, σ_{bottom} : 28.00 kN/m²

Effective overburden pressure at the middle of the strata, σ_{middle} : 14.00 kN/m²

Adhesion Factor, α : 0.40

Skin Resistance of the pile, q_s : 167.55 kN

$$(q_s: \alpha * Cu * \pi() * d * I_c)$$

1.2.1.2

Layer-II

Type of Strata: Silty Fine Sand

Average SPT of the strata,N: 11

Bulk Density of the strata, γ : 15 kN/m³

Angle of Shearing Resistance, ϕ : 30.3 Deg.

R.L of top of Strata: -4.00 m

R.L of bottom of Strata: -5.50 m

Average Thickness of Strata, I_c : 1.50 m

Effective overburden pressure over the top of strata, σ_{top} : 28.00 kN/m²

Effective overburden pressure over the bottom of strata, σ_{bottom} : 35.50 kN/m²

Effective overburden pressure at the middle of the strata, σ_{middle} : 31.75 kN/m²

Coeff. Of Earth Pressure, k: 1.00

Skin Resistance of the pile, q_s : 43.71 kN

$$(q_s: \sigma * k * \tan \phi * \pi() * d * I_c)$$

1.2.1.3

Layer-III

Type of Strata: Silty Clay

Average SPT of the strata,N: 6

Bulk Density of the strata, γ : 15 kN/m³

Undrained Cohesion, Cu: 40.00 kPa

R.L of top of Strata: -5.50 m

R.L of bottom of Strata: -9.50 m

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Average Thickness of Strata, I_c : 4.00 m
Effective overburden pressure over the top of strata, σ_{top} : 35.50 kN/m²
Effective overburden pressure over the bottom of strata, σ_{bottom} : 55.50 kN/m²
Effective overburden pressure at the middle of the strata, σ_{middle} : 45.50 kN/m²
Adhesion Factor, α : 0.70
Skin Resistance of the pile, q_s : 175.93 kN
($q_s: \alpha * Cu * \pi() * d * I_c$)

1.2.1.4

Layer-IV

Type of Strata: Silty Sandy Clay
Average SPT of the strata, N : 10
Bulk Density of the strata, γ : 17 kN/m³
Undrained Cohesion, C_u : 66.67 kPa
R.L of top of Strata: -9.50 m
R.L of bottom of Strata: -11.00 m
Average Thickness of Strata, I_c : 1.50 m
Effective overburden pressure over the top of strata, σ_{top} : 55.50 kN/m²
Effective overburden pressure over the bottom of strata, σ_{bottom} : 66.00 kN/m²
Effective overburden pressure at the middle of the strata, σ_{middle} : 60.75 kN/m²
Adhesion Factor, α : 0.40
Skin Resistance of the pile, q_s : 62.83 kN
($q_s: \alpha * Cu * \pi() * d * I_c$)

1.2.1.5

Layer-V

Type of Strata: Silty Sandy Clay
Average SPT of the strata, N : 6
Bulk Density of the strata, γ : 15 kN/m³
Undrained Cohesion, C_u : 40.00 kPa
R.L of top of Strata: -11.00 m
R.L of bottom of Strata: -17.00 m
Average Thickness of Strata, I_c : 6.00 m
Effective overburden pressure over the top of strata, σ_{top} : 66.00 kN/m²
Effective overburden pressure over the bottom of strata, σ_{bottom} : 96.00 kN/m²
Effective overburden pressure at the middle of the strata, σ_{middle} : 81.00 kN/m²
Adhesion Factor, α : 0.70
Skin Resistance of the pile, q_s : 263.89 kN
($q_s: \alpha * Cu * \pi() * d * I_c$)

1.2.1.6

Layer-VI

Type of Strata: Silty Clay
Average SPT of the strata, N : 35
Bulk Density of the strata, γ : 20 kN/m³
Undrained Cohesion, C_u : 233.33 kPa
R.L of top of Strata: -17.00 m
R.L of bottom of Strata: -21.00 m
Average Thickness of Strata, I_c : 4.00 m
Effective overburden pressure over the top of strata, σ_{top} : 96.00 kN/m²
Effective overburden pressure over the bottom of strata, σ_{bottom} : 136.00 kN/m²


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Effective overburden pressure at the middle of the strata, σ_{middle} : 116.00 kN/m²
Adhesion Factor, α : 0.40
Skin Resistance of the pile, q_s : 586.43 kN
($q_s: \alpha * C_u * \pi() * d * l_c$)

1.2.1.7

Layer-VII

Type of Strata: Cemented Sand
Average SPT of the strata, N : 60
Bulk Density of the strata, γ : 20 kN/m³
Angle of Shearing Resistance, ϕ : 42.5 Deg.
R.L of top of Strata: -21.00 m
R.L of bottom of Strata: -26.00 m
Average Thickness of Strata, I_c : 5.00 m
Effective overburden pressure over the top of strata, σ_{top} : 136.00 kN/m²
Effective overburden pressure over the bottom of strata, σ_{bottom} : 186.00 kN/m²
Effective overburden pressure at the middle of the strata, σ_{middle} : 161.00 kN/m²
Coeff. Of Earth Pressure, k : 2.50
Skin Resistance of the pile, q_s : 2896.73 kN
($q_s: \sigma * k * \tan \phi * \pi() * d * l_c$)
Ultimate Skin Resistance, q_s : 4197.08 kN

1.2.2 Computation of End Bearing Resistance:

Ultimate End Bearing Resistance (Q_p) Neglected for Friction

1.3.0 Ultimate Load Carrying Capacity ($Q_u = Q_s + Q_p$) 4197.1 kN
Safe Load Carrying Capacity ($Q_{safe} = Q_u / 2.50$) 1678.8 kN
However, limit Q_{safe} to the structural capacity of pile: 1500.0 kN


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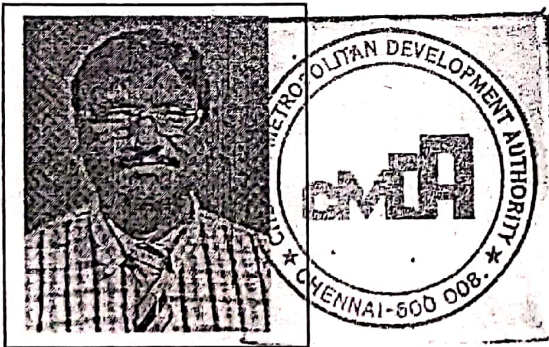
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PROFESSIONAL REGISTRATION CERTIFICATE

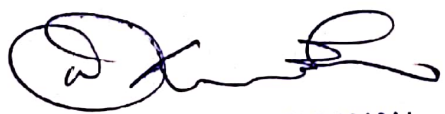
This is to certify that the **Thiru. R. VENKATA KRISHNAIAH** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Civil) (Geo-Technical Engg.)** and experience in the relevant field for **10 years.**

He has been given the Registration No.**GTE/2019/07/032** Renewed on **05.07.2024**. He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

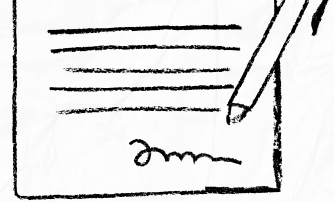
This Registration is valid upto **04.07.2029**.




(A. MEGANATHAN)
Superintendent


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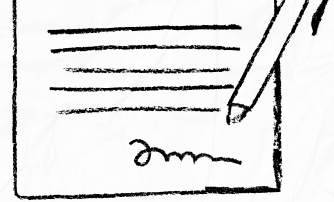
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