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CLIENT		M/s. M. P. DEVELOPERS, CHENNAI	
PROJECT		PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (STILT+05) AT S.NO. 64/3 & 60/1A, MOONDRAMKATTALAI VILLAGE, KUNDRATHUR TALUK, KANCHEEPURAM DISTRICT	
TITLE		GEOTECHNICAL INVESTIGATION REPORT	
REV.	DATE	REPORT NUMBER	REMARK
0	05.04.2023	BAG/M/s. M.P. DEVELOPERS/M-1727/23-24	

CONTENTS

CHAPTER	SEC. NO.		PAGE NO.
1		INTRODUCTION	
	1.0	Preamble	1
	1.1	Scope of Work	1
	1.2	Structure of the Report	1
2		INVESTIGATION METHODOLOGY & TEST RESULTS	
	2.0	Field Testing	2
	2.1	Preamble	2
	2.2	Equipment Used and Method of Drilling	2
	2.2.1	Equipment Used	2
	2.2.2	Method of Drilling	2
	2.3	In-situ Strength Tests	2
	2.3.1	Standard Penetration Tests	2
	2.4	Collection of Samples	2
	2.4.1	Disturbed Soil Samples	2
	2.4.2	Ground Water	3
	2.5	Summary of Field Work	3
	2.6	Laboratory Testing	3
	2.6.1	Coarse Grained Soil Samples	3
	2.6.1.1	Grain Size Analysis Tests	3
	2.6.2	Fine Grained Soil Samples	3
	2.6.2.1	Index Property & Free Swell Tests	3
	2.6.3	Chemical Analysis Tests	3
	2.6.3.1	Water Samples	3
FIGURES	2.0	Site Plan representing the locations of Field investigation points	4
	2.1	Soil Profile at BH-01 Location	5
	2.2	Soil Profile at BH-02 Location	6
	2.3	Soil Profile at BH-03 Location	7
	2.4	Soil Profile at BH-04 Location	8
	2.5	Soil Profile at BH-05 Location	9
	2.6	Soil Profile at BH-06 Location	10
	2.7	Soil Profile at BH-07 Location	11
TABLES	2.1	Laboratory Test Results on the Soil Samples collected from BH-01 Location	12
	2.2	Laboratory Test Results on the Soil Samples collected from BH-02 Location	13
	2.3	Laboratory Test Results on the Soil Samples collected from BH-03 Location	14
	2.4	Laboratory Test Results on the Soil Samples collected from BH-04 Location	15
	2.5	Laboratory Test Results on the Soil Samples collected from BH-05 Location	16
	2.6	Laboratory Test Results on the Soil Samples collected from BH-06 Location	17

	2.7	Laboratory Test Results on the Soil Samples collected from BH-07 Location	18
	2.8	Chemical Analysis Test Results on the Water Samples collected from borehole Locations	19
3		SUB-SURFACE STRATIFICATION	
	3.0	Preamble	20
	3.1	Sub surface Stratification	20
	3.1.1	Soil Profile at BH-01 Location	20
	3.1.2	Soil Profile at BH-02 Location	21
	3.1.3	Soil Profile at BH-03 Location	22
	3.1.4	Soil Profile at BH-04 Location	23
	3.1.5	Soil Profile at BH-05 Location	24
	3.1.6	Soil Profile at BH-06 Location	25-26
	3.1.7	Soil Profile at BH-07 Location	27-28
4		FOUNDATION SYSTEM	
	4.0	Preamble	29
	4.1	Bearing Strata Characteristics	29
	4.2	Foundation System	30
	4.2.1	Open Foundation System	30
	4.2.2	Deep Foundation System-18.00m Long Bored Cast-in-Situ Friction cum End Bearing Piles	31
5		RECOMMENDATIONS	32-33
ANNEXURE		Design of Open Foundation System (Ref. BH-04)	34-35
		Design of Deep Foundation System (Ref. BH-05)	36-38

CHAPTER-1

INTRODUCTION

1.0 Preamble

M/s. M.P. Developers, Chennai proposed to construct a **Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.**

For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigations was entrusted to **M/s. Booshnam Associates, 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 Seven Standard Soil investigation bore holes of 150mm diameter up to a depth of 18.00m 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)

CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Field Testing:

2.1 Preamble:

Seven 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.

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 to 2.7.

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

On the coarse grained 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 to 2.7.

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 to 2.7.

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-2.8.

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.

Location: BH-01

Started On : 03/04/2023; Ended On : 03/04/2023 G.W.T: 2.00m below existing ground level

R.L. of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT												Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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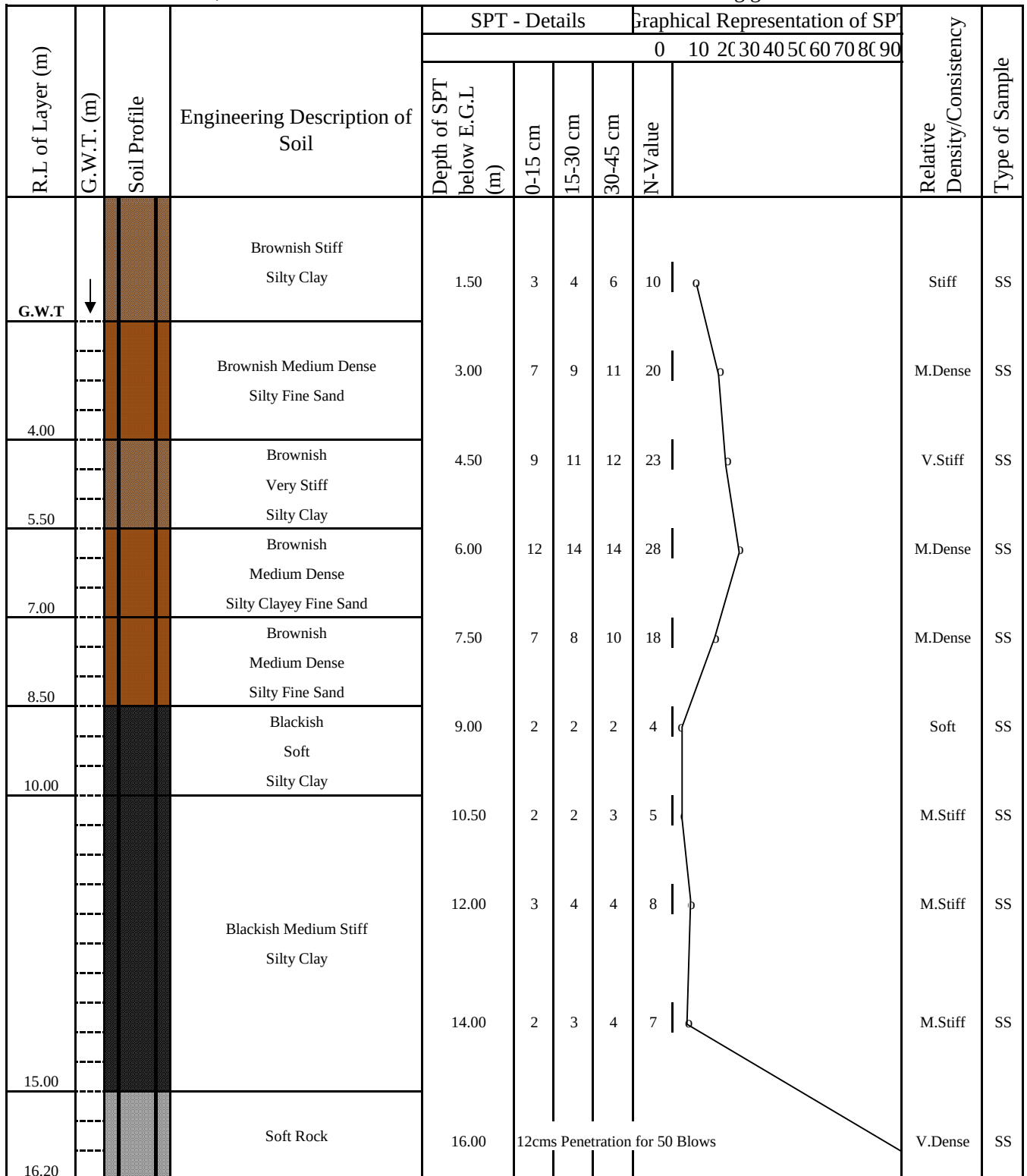
Bore Hole Terminated at a depth of 10.70m below the existing ground level

Fig. 2.1 Soil Profile at BH-01 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kunderathur Taluk, Kancheepuram District.

Location: BH-02

Started On : 01/04/2023; Ended On : 01/04/2023 G.W.T: 2.00m below existing ground level



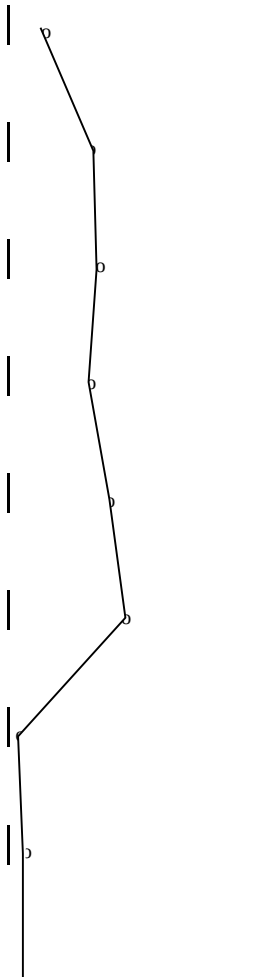
Bore Hole Terminated at a depth of 16.20m below the existing ground level

Fig. 2.2 Soil Profile at BH-02 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.

Location: BH-03

Started On : 01/04/2023; Ended On : 01/04/2023 G.W.T: 2.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details			Graphical Representation of SPT										Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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Bore Hole Terminated at a depth of 16.20m below the existing ground level

Fig. 2.3 Soil Profile at BH-03 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.

Location: BH-04

Started On : 02/04/2023; Ended On : 02/04/2023 G.W.T: 2.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details			Graphical Representation of SPT												Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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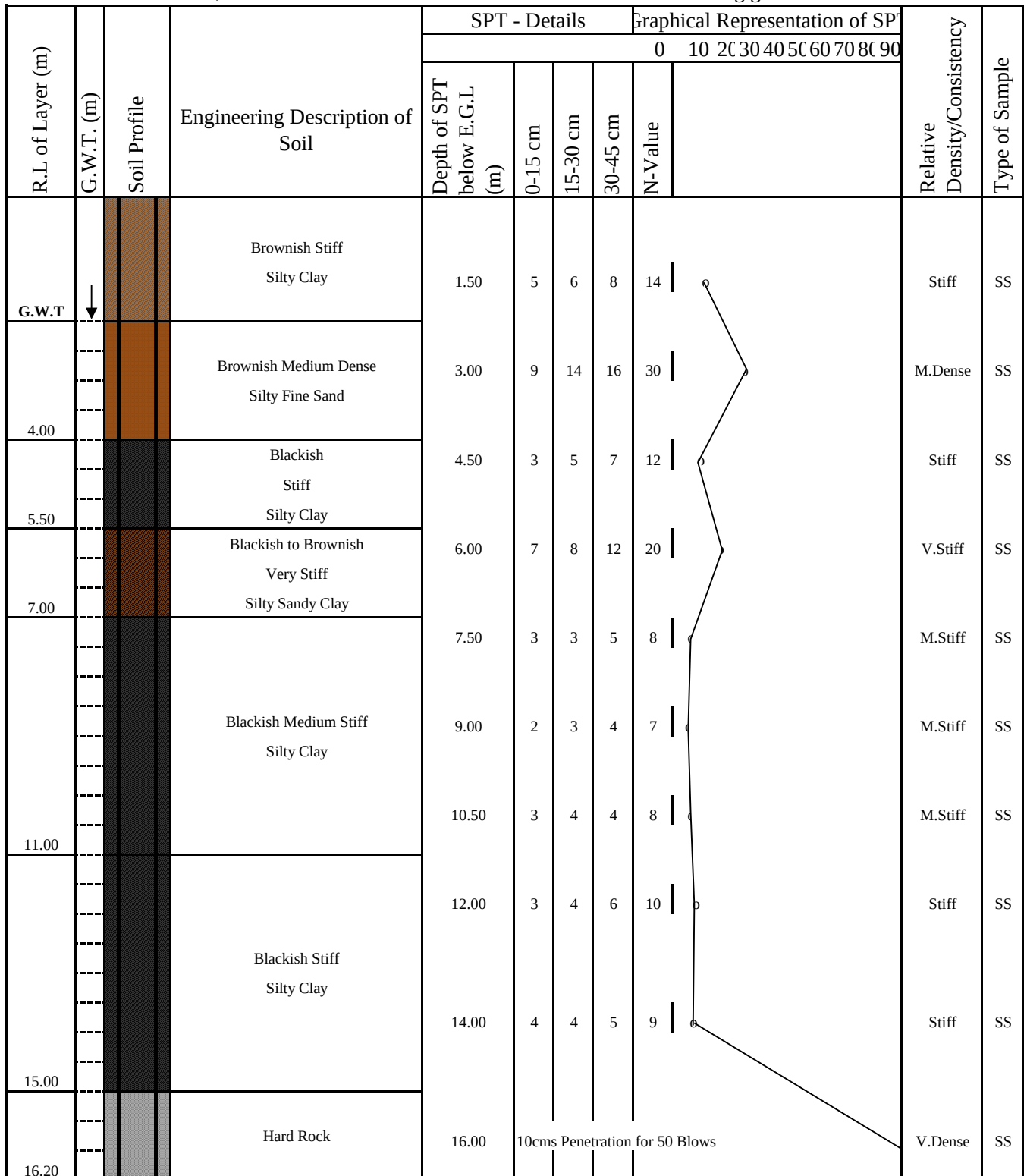
Bore Hole Terminated at a depth of 10.50m below the existing ground level

Fig. 2.4 Soil Profile at BH-04 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kunderathur Taluk, Kancheepuram District.

Location: BH-05

Started On : 30/03/2023; Ended On : 30/03/2023 G.W.T: 2.00m below existing ground level



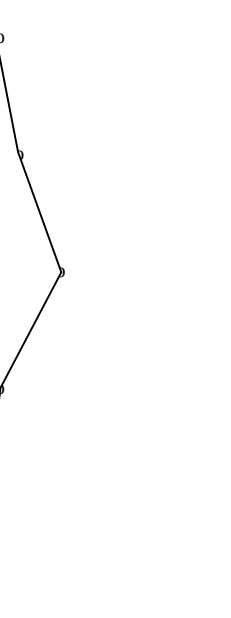
Bore Hole Terminated at a depth of 16.20m below the existing ground level

Fig. 2.5 Soil Profile at BH-05 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.

Location: BH-06

Started On : 02/04/2023; Ended On : 02/04/2023 G.W.T: 2.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details				Graphical Representation of SPT											Relative Density/Consistency	Type of Sample			
				0 10 20 30 40 50 60 70 80 90																			
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value															
G.W.T	↓		Brownish Stiff Silty Clay	1.50	3	4	6	10							Stiff	SS							
			Brownish Very Stiff Silty Clay	3.00	5	7	9	16														V.Stiff	SS
4.00																							
			Brownish Medium Dense Silty Fine Sand	4.50	12	14	15	29														M.Dense	SS
5.50																							
			Blackish to Greyish Stiff Silty Clay	6.00	4	4	6	10														Stiff	SS
7.00																							
			Blackish Medium Stiff Silty Clay	7.50	2	3	3	6								M.Stiff	SS						
8.50																							
			Blackish Soft Silty Clay	9.00	2	2	2	4								Soft	SS						
10.00																							
			Blackish Medium Stiff Silty Clay	10.50	2	3	4	7								M.Stiff	SS						
10.70																							

Bore Hole Terminated at a depth of 10.70m below the existing ground level

Fig. 2.6 Soil Profile at BH-06 Location

Project : Proposed Construction of Residential Building (Stilt+05) At S.No. 64/3 & 60/1a, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District.

Location: BH-07

Started On : 31/03/2023; Ended On : 31/03/2023 G.W.T: 2.00m below existing ground level

R.L. of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	SPT - Details			Graphical Representation of SPT										Relative Density/Consistency	Type of Sample																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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Bore Hole Terminated at a depth of 18.20m below the existing ground level

Fig. 2.7 Soil Profile at BH-07 Location

Table 2.1: Laboratory Test Result on the Soil Sample 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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	10	SS	Silty Clay	33	1.7	62	22	40	0.73	12	Stiff	0	0	0	0	19	81	CH
2.00 to 3.50	25	SS	Silty Clayey Fine Sand	-	1.7	-	-	-	-	-	M.Dense	0	0	0	78	10	12	SM
3.50 to 5.50	32	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	82	18	0	SM
5.50 to 7.00	10	SS	Silty Clay	32	1.7	64	24	40	0.80	-	Stiff	0	0	0	0	20	80	CH
7.00 to 10.00	6	SS	Silty Clay	35	1.5	70	21	49	0.71	-	M.Stiff	0	0	0	0	17	83	CH
10.00 to 10.70	4	SS	Silty Clay	55	1.4	80	17	63	0.40	-	Soft	0	0	0	0	15	85	CH

Table 2.2: Laboratory Test Result on the Soil Sample Collected from BH-02

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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	10	SS	Silty Clay	32	1.7	60	20	40	0.70	15	Stiff	0	0	0	0	20	80	CH
2.00 to 4.00	20	SS	Silty Fine Sand	-	1.6	-	-	-	-	-	M.Dense	0	0	0	77	23	0	SM
4.00 to 5.50	23	SS	Silty Clay	25	1.9	59	28	31	1.10	-	V.Stiff	0	0	0	0	21	79	CI
5.50 to 7.00	28	SS	Silty Clayey Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	79	10	11	SM
7.00 to 8.50	18	SS	Silty Fine Sand	-	1.6	-	-	-	-	-	M.Dense	0	0	0	76	24	0	SM
8.50 to 10.00	4	SS	Silty Clay	52	1.4	79	21	58	0.47	-	Soft	0	0	0	0	16	84	CH
10.00 to 15.00	6	SS	Silty Clay	44	1.5	78	23	55	0.62	-	M.Stiff	0	0	0	0	18	82	CH
15.00 to 16.20	>100	SS	Soft Rock	-	2.0	-	-	-	-	-	V.Dense	100	0	0	0	0	0	SR

Table 2.3: Laboratory Test Result on the Soil Sample Collected from BH-03

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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	12	SS	Silty Clay	30	1.7	61	21	40	0.78	10	Stiff	0	0	0	0	20	80	CH
2.00 to 5.00	27	SS	Silty Clayey Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	77	11	12	SM
5.00 to 6.50	26	SS	Silty Clay	24	1.9	55	25	30	1.03	-	V.Stiff	0	0	0	0	22	78	CI
6.50 to 10.00	34	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	82	18	0	SM
10.00 to 12.00	4	SS	Silty Clay	50	1.4	77	24	53	0.51	-	Soft	0	0	0	0	16	84	CH
12.00 to 15.00	5	SS	Silty Clay	45	1.5	79	22	57	0.60	-	M.Stiff	0	0	0	0	17	83	CH
15.00 to 16.20	>100	SS	Soft Rock	-	2.0	-	-	-	-	-	V.Dense	100	0	0	0	0	0	SR

Table 2.4: Laboratory Test Result on the Soil Sample Collected from BH-04																		
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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	8	SS	Silty Clay	34	1.6	77	24	53	0.81	18	M.Stiff	0	0	0	0	18	82	CH
2.00 to 4.00	12	SS	Silty Clay	30	1.7	66	24	42	0.86	-	Stiff	0	0	0	0	20	80	CH
4.00 to 5.50	21	SS	Silty Sandy Clay	25	1.9	69	25	44	1.00	-	V.Stiff	0	0	0	11	13	76	CI
5.50 to 8.00	13	SS	Silty Clay	29	1.7	64	22	42	0.83	-	Stiff	0	0	0	0	21	79	CH
8.00 to 10.50	5	SS	Silty Clay	45	1.5	78	21	57	0.58	-	M.Stiff	0	0	0	0	16	84	CH

Table 2.5: Laboratory Test Result on the Soil Sample Collected from BH-05																		
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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	14	SS	Silty Clay	29	1.7	49	34	15	1.33	12	Stiff	0	0	0	0	21	79	CH
2.00 to 4.00	30	SS	Silty Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	80	20	0	SM
4.00 to 5.50	12	SS	Silty Clay	30	1.7	59	28	31	0.94	-	Stiff	0	0	0	0	20	80	CH
5.50 to 7.00	20	SS	Silty Sandy Clay	27	1.8	44	30	14	1.21	-	V.Stiff	0	0	0	12	17	71	CI
7.00 to 11.00	7	SS	Silty Clay	33	1.6	78	22	56	0.80	-	M.Stiff	0	0	0	0	18	82	CH
11.00 to 15.00	9	SS	Silty Clay	31	1.7	69	25	44	0.86	-	Stiff	0	0	0	0	19	81	CH
15.00 to 16.20	>100	SS	Hard Rock	-	2.0	-	-	-	-	-	V.Dense	100	0	0	0	0	0	HR

Table 2.6: Laboratory Test Result on the Soil Sample Collected from BH-06

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 _c	FS		Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	
0.00 to 2.00	10	SS	Silty Clay	31	1.7	70	22	48	0.81	15	Stiff	0	0	0	0	20	80	CH
2.00 to 4.00	16	SS	Silty Clay	28	1.8	66	23	43	0.88	-	V.Stiff	0	0	0	0	21	79	CI
4.00 to 5.50	29	SS	Silty Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	79	21	0	SM
5.50 to 7.00	10	SS	Silty Clay	30	1.7	78	24	54	0.89	-	Stiff	0	0	0	0	20	80	CH
7.00 to 8.50	6	SS	Silty Clay	41	1.5	79	21	58	0.66	-	M.Stiff	0	0	0	0	18	82	CH
8.50 to 10.00	4	SS	Silty Clay	55	1.4	80	15	65	0.38	-	Soft	0	0	0	0	15	85	CH
10.00 to 10.70	7	SS	Silty Clay	40	1.6	77	25	52	0.71	-	M.Stiff	0	0	0	0	19	81	CH

Table 2.8: Chemical Analysis Results conducted on Water Samples collected from BH-01 to BH-07				
Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	2.00	7.01	335.69	377.65
BH-02	2.00	7.03	328.44	369.49
BH-03	2.00	7.02	321.52	361.71
BH-04	2.00	7.01	319.08	358.96
BH-05	2.00	7.03	321.29	361.45
BH-06	2.00	7.02	333.61	375.31
BH-07	2.00	7.01	339.15	381.54

CHAPTER-3

SUB-SURFACE STRATIFICATION

3.0 Preamble

The sub surface stratification at borehole location, 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 2.00m depth)**

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
- * **Layer-2 (from 2.00m to 3.50m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	25
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	34.50°
- * **Layer-3 (from 3.50m to 5.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	32
Relative Density	Dense
Angle of Shearing Resistance, ϕ	36.55°
- * **Layer-4 (from 5.50m to 7.00m depth)**

Type of Strata	Silty Clay
Colour	Brownish to Greyish
Thickness of Layer	1.50m

SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-5 (from 7.00m to 10.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	3.00m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa
* Layer-6 (from 10.00m to 10.70m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	0.70m
SPT of the layer	04
Consistency	Soft
Un-drained Cohesion, Cu	26.66kPa

Ground Water

Ground water table was encountered at a depth of 2.00m below the existing ground level during the first week of April 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 2.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-2 (from 2.00m to 4.00m depth)	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	20
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	33.00°
* Layer-3 (from 4.00m to 5.50m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	23
Consistency	Very Stiff
Un-drained Cohesion, Cu	153.33kPa
* Layer-4 (from 5.50m to 7.00m depth)	
Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	1.50m

SPT of the layer	28
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	35.40°
* Layer-5 (from 7.00m to 8.50m depth)	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	18
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	32.40°
* Layer-6 (from 8.50m to 10.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	04
Consistency	Soft
Un-drained Cohesion, Cu	26.66kPa
* Layer-7 (from 10.00m to 15.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	5.00m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa
* Layer-8 (from 15.00m to 16.20m depth)	
Type of Strata	Soft Rock
Colour	-
Thickness of Layer	1.20m
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 2.00m below the existing ground level during the first week of April 2023.

3.1.3 Soil Profile at BH-03 Location (At BH-03 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 2.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	12
Consistency	Stiff
Un-drained Cohesion, Cu	80.00kPa
* Layer-2 (from 2.00m to 5.00m depth)	
Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	3.00m

SPT of the layer	27
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	35.10^0
* Layer-3 (from 5.00m to 6.50m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	26
Consistency	Very Stiff
Un-drained Cohesion, Cu	173.33kPa
* Layer-4 (from 6.50m to 10.00m depth)	
Type of Strata	Silty Fine Sand
Colour	Greyish
Thickness of Layer	3.50m
SPT of the layer	34
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.10^0
* Layer-5 (from 10.00m to 12.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	04
Consistency	Soft
Un-drained Cohesion, Cu	26.66kPa
* Layer-6 (from 12.00m to 15.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	3.00m
SPT of the layer	05
Consistency	Medium Stiff
Un-drained Cohesion, Cu	33.33kPa
* Layer-7 (from 15.00m to 16.20m depth)	
Type of Strata	Soft Rock
Colour	-
Thickness of Layer	1.20m
SPT of the layer	>100
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50^0

Ground Water

Ground water table was encountered at a depth of 2.00m below the existing ground level during the first week of April 2023.

3.1.4 Soil Profile at BH-04 Location (At BH-04 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 2.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m

SPT of the layer	08
Consistency	Medium Stiff
Un-drained Cohesion, Cu	53.33kPa
* Layer-2 (from 2.00m to 4.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	12
Consistency	Stiff
Un-drained Cohesion, Cu	80.00kPa
* Layer-3 (from 4.00m to 5.50m depth)	
Type of Strata	Silty Sandy Clay
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	21
Consistency	Very Stiff
Un-drained Cohesion, Cu	140.00kPa
* Layer-4 (from 5.50m to 8.00m depth)	
Type of Strata	Silty Clay
Colour	Greyish
Thickness of Layer	2.50m
SPT of the layer	13
Consistency	Stiff
Un-drained Cohesion, Cu	86.66kPa
* Layer-5 (from 8.00m to 10.50m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.50m
SPT of the layer	05
Consistency	Medium Stiff
Un-drained Cohesion, Cu	33.33kPa

Ground Water

Ground water table was encountered at a depth of 2.00m below the existing ground level during the first week of April 2023.

3.1.5 Soil Profile at BH-05 Location (At BH-05 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 2.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	14
Consistency	Stiff
Un-drained Cohesion, Cu	93.33kPa
* Layer-2 (from 2.00m to 4.00m depth)	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.00m

SPT of the layer	30
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	36.00°
* Layer-3 (from 4.00m to 5.50m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	12
Consistency	Stiff
Un-drained Cohesion, Cu	80.00kPa
* Layer-4 (from 5.50m to 7.00m depth)	
Type of Strata	Silty Sandy Clay
Colour	Blackish to Brownish
Thickness of Layer	1.50m
SPT of the layer	20
Consistency	Very Stiff
Un-drained Cohesion, Cu	133.33kPa
* Layer-5 (from 7.00m to 11.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	4.00m
SPT of the layer	07
Consistency	Medium Stiff
Un-drained Cohesion, Cu	46.66kPa
* Layer-6 (from 11.00m to 15.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	4.00m
SPT of the layer	09
Consistency	Stiff
Un-drained Cohesion, Cu	60.00kPa
* Layer-7 (from 15.00m to 16.20m depth)	
Type of Strata	Hard Rock
Colour	-
Thickness of Layer	1.20m
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 2.00m below the existing ground level during the last week of March 2023.

3.1.6 Soil Profile at BH-06 Location

(At BH-06 Location, as presented in Site plan)

* Layer-1 (from E.G.L to 2.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m

SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-2 (from 2.00m to 4.00m depth)	
Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	16
Consistency	Very Stiff
Un-drained Cohesion, Cu	106.66kPa
* Layer-3 (from 4.00m to 5.50m depth)	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	29
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	35.70°
* Layer-4 (from 5.50m to 7.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish to Greyish
Thickness of Layer	1.50m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa
* Layer-5 (from 7.00m to 8.50m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa
* Layer-6 (from 8.50m to 10.00m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	04
Consistency	Soft
Un-drained Cohesion, Cu	26.66kPa
* Layer-7 (from 10.00m to 10.70m depth)	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	0.70m
SPT of the layer	07
Consistency	Medium Stiff
Un-drained Cohesion, Cu	46.66kPa

Ground Water

Ground water table was encountered at a depth of 2.00m below the existing ground level during the first week of April 2023.

3.1.7 Soil Profile at BH-07 Location**(At BH-07 Location, as presented in Site plan)***** Layer-1 (from E.G.L to 2.00m depth)**

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa

*** Layer-2 (from 2.00m to 4.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	27
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	35.10°

*** Layer-3 (from 4.00m to 7.00m depth)**

Type of Strata	Silty Sandy Clay
Colour	Brownish
Thickness of Layer	3.00m
SPT of the layer	21
Consistency	Very Stiff
Un-drained Cohesion, Cu	140.00kPa

*** Layer-4 (from 7.00m to 8.50m depth)**

Type of Strata	Silty Clayey Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	18
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	32.40°

*** Layer-5 (from 8.50m to 10.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	34
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.10°

*** Layer-6 (from 10.00m to 12.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	06
Consistency	Medium Stiff
Un-drained Cohesion, Cu	40.00kPa

*** Layer-7 (from 12.00m to 14.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	2.00m
SPT of the layer	04
Consistency	Soft

	Un-drained Cohesion, Cu	26.66kPa
*	Layer-8 (from 14.00m to 17.00m depth)	
	Type of Strata	Silty Clay
	Colour	Blackish
	Thickness of Layer	3.00m
	SPT of the layer	07
	Consistency	Medium Stiff
	Un-drained Cohesion, Cu	46.66kPa
*	Layer-9 (from 17.00m to 18.20m depth)	
	Type of Strata	Weathered Rock
	Colour	-
	Thickness of Layer	1.20m
	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 2.00m below the existing ground level during the last week of March 2023.

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 non-uniform shear strength characteristics, BH-04 being relatively weak from deformation considerations and hence shall be considered as design borehole to determine the bearing strata and its safe bearing capacity.

Considering BH-04 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 650kN to 750kN respectively.

If fine-grained 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.

Care shall be taken in locating the foundation system on such type of highly plastic fine-grained strata so that ordinate pressures resulting from its volumetric change phenomenon during variations in seasonal moisture content variations do not impact on the structural system of foundation.

Care shall also be taken in regulating the safe bearing capacity of open foundation system so that the dispersed open foundation stresses on the

underlying relatively weak soil layer encountered at 5.50m depths from present existing ground level (SPT @ 6.00m is 10, Ref. BH-06) are within their safe bearing capacity limits.

However, the refusal soil (SPT>50) strata encountered below 15.00m depths from existing ground level can be considered as end bearing strata for proposed impending loads from structure.

Considering the above, suitable foundation systems are presented below.

4.2 Foundation System

4.2.1 Open Foundation System (BH-04)

*Considering the uniformity in sub-soil stratifications at shallow depths, shear strength, presence of underlying relatively weak soil layer at 5.50m depths from existing ground level, highly plastic characteristics of fine-grained soil strata encountered at shallow depths, open foundation system of **Isolated Column Footing** type located at a design depth of 2.50m below present existing ground level over 0.30m thick well compacted 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 <u>Isolated Column Footing</u> below Existing Ground Level (m)	Safe Bearing Capacity (t/m ²)	Elastic Settlements (mm)
<u>Isolated Column Footing</u>	2.80	0.30	2.50	13	39

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 layer encountered at 5.50m depths from existing ground level i.e. 3.00m distant apart from the bottom level of footing.

4.2.2 Deep Foundation System-16.00m Long Bored Cast-in-Situ Friction cum End Bearing Piles

In case, the safe bearing capacity of open foundation system presented above in Clause 4.2.1 is lower than the foundation stresses, deep foundation system consisting of 16.00m long bored cast-in-situ Friction cum End Bearing 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 16.00m long bored cast-in-situ Friction cum End Bearing Piles are computed and presented below which can be adopted for foundation design purposes.

S. No	Type of Installation of Pile	Type of Pile	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 Head Pile	16.00	450	60	25
2				500	75	28
3				550	90	31
4				600	100	34

The computations of safe load carrying capacity for 450mm diameter and 16.00m long bored cast-in-situ Friction cum End Bearing Piles are annexed to this report.

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. The safe bearing capacity of open foundation system is computed considering rise in the ground water table up to or above the level of footing.
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 10, Ref. BH-06) i.e. 3.00m distant apart from the bottom level of footing.

Open Foundation Depths

5. Depth of open excavations below present existing ground level shall be 2.80m.
6. Back-fill Thickness with well compacted CNS soil shall be 0.30m.
7. Depth of Isolated Column Footing below present existing ground level will be 2.50m.

Usage of Excavated Earth

8. **Excavated highly plastic fine-grained soil encountered at shallow depths shall be in no case used for back filling purposes.**
9. **No structural units can be in direct contact of highly plastic fine-grained soil strata encountered at shallow depths. A 0.30m thick well compacted and non-plastic CNS is recommended to be sand-witched in between.**

Deep Foundation System

10. 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 safe load capacity of piles. **(Mandatory)**.
11. *Care shall be taken so that the ultimate end bearing soil strata are none other than recommended “Hard Rock” type. The same shall be reaffirmed by our Geotechnical Engineer during foundation laying works are under progress.*

12. Recommended length of pile shall be taken from its cut-off level.
13. As the sub-soil strata encountered up to the investigated depths are stable, pile liner is not required to be provided while casting the piles.
14. Pile cap can be located over 0.30m thick well compacted existing ground to be replaced soil surface. Ground replacement can be carried out with CNS (cohesive non-swelling) soil.
15. Piles shall be grouped according to the column design load requirements.
16. Safe load carrying capacities of piles shall be limited to their structural capacities.

General

17. **CNS can be well graded coarse-grained soil like quarry dust or clean river sand or sand: gravels mix (1:2) or fly-ash.**
18. 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 foundation construction purposes.

DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-04)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Isolated Column Footing
R.L of the top of Borehole (m):	0.00 m
Total Depth of Excavations below Existing Ground Level (m) :	2.80 m
Recommended Thickness of CNS Back-Fill (m):	0.30 m
Effective Depth of Foundation below existing ground level (D_f):	2.50 m
Design Width of Foundation (B):	1.00 m
Thickness of Foundation (T) :	0.20 m

1.2 Soil Data :

Type of Bearing Strata :	Silty Clay
Design SPT-value of the Bearing Strata : 12 (considered based upon the density of the strata)	
Type of Shear Failure:	General
Undrained Cohesion, C_u :	80.00 kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	17.00 kN/m ³
Effective Overburden pressure at foundation level (q)	17.50 kPa
Water Table Correction Factor (w')	0.50

Bearing Capacity Factors:

$$\begin{aligned} N_c &= 5.14 \\ N_q &= N/A \\ N_\gamma &= N/A \end{aligned}$$

Shape Factors:

$$\begin{aligned} S_c &= 1.00 \\ S_q &= N/A \\ S_\gamma &= N/A \end{aligned}$$

Depth Factors :

$$\begin{aligned} D_c &= 1.00 \\ D_q &= N/A \end{aligned}$$

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

Inclination Factor:

$$I_c = 1.00$$

$$I_q = N/A$$

$$N/A$$

1.4 Ultimate Bearing Capacity (Qu) :

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

$$Q_u = 411.20 \text{ kPa}$$

1.5 Safe Bearing Capacity (Qsafe) :

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

$$Q_{\text{safe}} : 164.48 \text{ kPa}$$

$$\text{Recommended Safe Bearing Capacity} : 130.00 \text{ kPa}$$

Restricted considering the presence of underlying relatively weak soil strata encountered at 5.50m depths from existing ground level i.e. 3.00m distant apart from the bottom level of footing.

1.6 Settlements

Since, the bearing strata are stiff fine-grained type, the settlements under the allowable safe bearing pressure 130kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 130kPa and average SPT of 12 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 39mm which is within the permissible limits of 50mm for isolated column footings as per I.S:1904.

DESIGN OF PILE FOUNDATION (Ref. BH-05)**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):	450.0 mm
Assumed R.L of E.G.L:	0.000 m
Length of pile below E.G.L.(l) :	16.000 m
R.L. of Bot. of Pile	-16.00 m

1.2 Design of Pile for Vertical Compression**1.2.1 Computation of Skin Resistance:****1.2.1.1****Layer-I**

Type of Strata:	Silty Clay
Average SPT of the strata,N:	14
Bulk Density of the strata, γ :	17 kN/m ³
Undrained Cohesion, Cu:	93.33 kPa
R.L of top of Strata:	0.00 m
R.L of bottom of Strata:	-2.00 m
Average Thickness of Strata, I_c :	2.00 m
Effective overburden pressure over the top of strata, σ_{top} :	0.00 kN/m ²
Effective overburden pressure over the bottom of strata, σ_{bottom} :	14.00 kN/m ²
Effective overburden pressure at the middle of the strata, σ_{middle} :	7.00 kN/m ²
Adhesion Factor, α :	0.40
Skin Resistance of the pile, q_s :	105.56 kN
$(q_s: \sigma * k * \tan \phi * \pi() * d * I_c)$	

1.2.1.2**Layer-II**

Type of Strata:	Silty Fine Sand
Average SPT of the strata,N:	30
Bulk Density of the strata, γ :	18 kN/m ³
Angle of Shearing Resistance, ϕ :	36 Deg.
R.L of top of Strata:	-2.00 m
R.L of bottom of Strata:	-4.00 m
Average Thickness of Strata, I_c :	2.00 m
Effective overburden pressure over the top of strata, σ_{top} :	14.00 kN/m ²
Effective overburden pressure over the bottom of strata, σ_{bottom} :	30.00 kN/m ²
Effective overburden pressure at the middle of the strata, σ_{middle} :	22.00 kN/m ²
Coeff. Of Earth Pressure, k:	1.50
Skin Resistance of the pile, q_s :	67.79 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:	12
Bulk Density of the strata, γ :	17 kN/m ³
Undrained Cohesion, Cu:	80.00 kPa
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} : 30.00 kN/m^2
 Effective overburden pressure over the bottom of strata, σ_{bottom} : 40.50 kN/m^2
 Effective overburden pressure at the middle of the strata, σ_{middle} : 35.25 kN/m^2
 Adhesion Factor, α : 0.40
 Skin Resistance of the pile, q_s : 67.86 kN
 $(q_s: \sigma^* k * \tan \phi * \pi() * d * I_c)$

1.2.1.4**Layer-IV**

Type of Strata: Silty Sandy Clay
 Average SPT of the strata, N : 20
 Bulk Density of the strata, γ : 18 kN/m^3
 Undrained Cohesion, C_u : 133.33 kPa
 R.L of top of Strata: -5.50 m
 R.L of bottom of Strata: -7.00 m
 Average Thickness of Strata, I_c : 1.50 m
 Effective overburden pressure over the top of strata, σ_{top} : 40.50 kN/m^2
 Effective overburden pressure over the bottom of strata, σ_{bottom} : 52.50 kN/m^2
 Effective overburden pressure at the middle of the strata, σ_{middle} : 46.50 kN/m^2
 Adhesion Factor, α : 0.40
 Skin Resistance of the pile, q_s : 113.10 kN
 $(q_s: \sigma^* k * \tan \phi * \pi() * d * I_c)$

1.2.1.5**Layer-V**

Type of Strata: Silty Clay
 Average SPT of the strata, N : 7
 Bulk Density of the strata, γ : 16 kN/m^3
 Undrained Cohesion, C_u : 46.67 kPa
 R.L of top of Strata: -7.00 m
 R.L of bottom of Strata: -11.00 m
 Average Thickness of Strata, I_c : 4.00 m
 Effective overburden pressure over the top of strata, σ_{top} : 52.50 kN/m^2
 Effective overburden pressure over the bottom of strata, σ_{bottom} : 76.50 kN/m^2
 Effective overburden pressure at the middle of the strata, σ_{middle} : 64.50 kN/m^2
 Adhesion Factor, α : 0.60
 Skin Resistance of the pile, q_s : 158.34 kN
 $(q_s: \sigma^* k * \tan \phi * \pi() * d * I_c)$

1.2.1.6**Layer-VI**

Type of Strata: Silty Clay
 Average SPT of the strata, N : 9
 Bulk Density of the strata, γ : 17 kN/m^3
 Undrained Cohesion, C_u : 60.00 kPa
 R.L of top of Strata: -11.00 m
 R.L of bottom of Strata: -15.00 m
 Average Thickness of Strata, I_c : 4.00 m
 Effective overburden pressure over the top of strata, σ_{top} : 76.50 kN/m^2

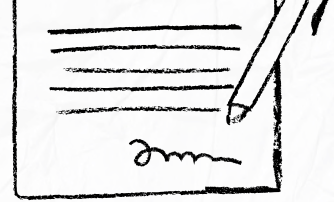
Effective overburden pressure over the bottom of strata, σ_{bottom} : 104.50 kN/m²
 Effective overburden pressure at the middle of the strata, σ_{middle} : 90.50 kN/m²
 Adhesion Factor, α : 0.40
 Skin Resistance of the pile, q_s : 135.72 kN
 $(q_s: \sigma * k * \tan \phi * \pi() * d * l_c)$

Ultimate Skin Resistance, q_s : 648.36 kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata Hard Rock
 Cross-Sectional Area of pile, A_p : 0.159 m²
 R.L of bottom of pile: -16.00
 Minimum SPT-value of the Bearing Strata 60
 Angle of Shearing Resistance(ASR) 42.50 Degrees
 Bearing Capacity Factor(N_q) 220.00
 Effective Over Burden Pressure at the bottom of pile (q) 30.00 kPa
Ultimate End Bearing Resistance (Q_p) 1049.7 kN
 $(Q_p = A_p * q * N_q)$

1.3.0 Ultimate Load Carrying Capacity ($Q_u = Q_s + Q_p$) 1698.0 kN
Safe Load Carrying Capacity ($Q_{\text{safe}} = Q_u / 2.50$) 679.2 kN
However, limit Q_{safe} to the structural capacity of pile: 600.0 kN



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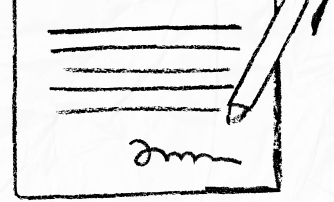
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