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CLIENT	**HANSA ESTATES PVT. LTD., CHENNAI**
PROJECT	**PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (STILT+05 FLOORS) AT PLOT NO: 1, T.S. No: 7/12, GLASS FACTORY ROAD, TIRUVOTTIYUR, CHENNAI-600019**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

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GEOMINES ENGINEERS (P) LTD. GMEPL Chennai

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CHAPTER-1

INTRODUCTION

1.0 Preamble

Hansa Estates Pvt. Ltd., Chennai proposed to construct **Residential Building Blocks (Stilt+05 Floors) at Plot No: 1, T.S. No: 7/12, Glass Factory, Tiruvottiyur, Chennai-600019.**

For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigation was entrusted to **M/s. Geo Mines ENGINEERS Pvt. Ltd., 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 Three Standard Soil investigation bore holes of 150mm diameter up to a depth of 10.50m 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:

Three 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 locations, 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 location is shown in Figs.2.1 to 2.3.

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 2.3.

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 2.3.

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-2.4.

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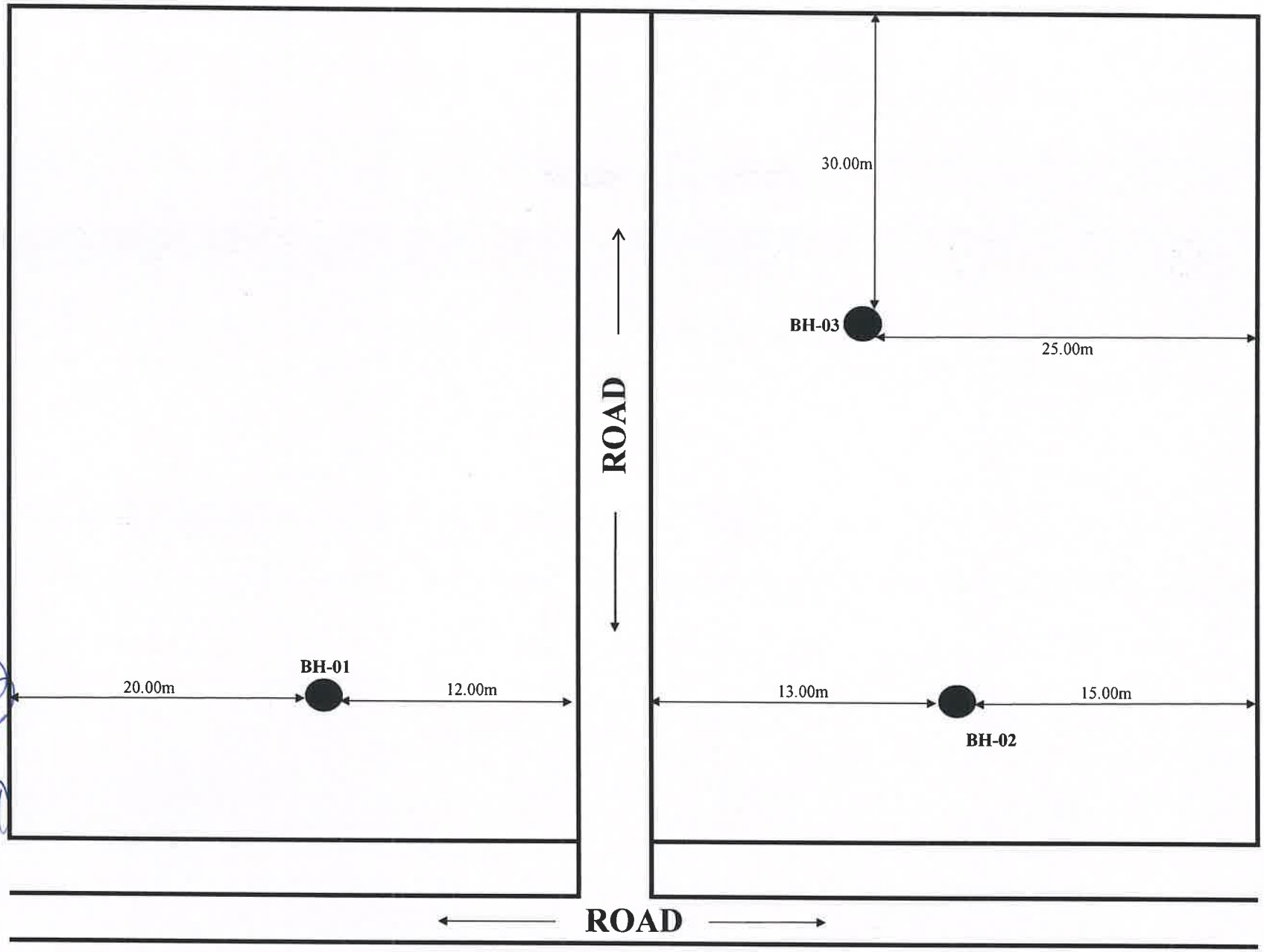


Fig. 2.0: Site Plan Representing the locations of Field Investigation Points

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Project : Proposed Construction of Residential Building Blocks (Stilt+05 Floors) at Plot No: 1, T.S. No: 7/12, Glass Factory, Tiruvottiyur, Chennai-600019.

Location: BH-01

Started On : 24/05/2024; Ended On : 24/05/2024 G.W.T: 2.00m below existing ground level

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	Depth of SPT below E.G.L (m)	SPT - Details 0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (## 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
G.W.T	↓		Brownish Dense Silty Fine to Medium Coarse Sand	1.50	15	19	22	41		Dense	SS
				3.00	13	16	21	37		Dense	SS
				4.50	10	17	19	36		Dense	SS
5.50											
			Blackish Medium Stiff Silty Clay	6.00	3	4	4	8		M.Stiff	SS
6.50											
			Blackish Stiff Silty Clay	7.50	7	5	6	11		Stiff	SS
8.00											
			Blackish Very Stiff Silty Clay	9.00	10	13	16	29		V.Stiff	SS
9.50											
			Brownish Very Dense Silty Fine Sand	10.50	11cms Penetration for 50 Blows					V.Dense	SS
10.70											

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

Fig. 2.1 Soil Profile at BH-01 Location

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Location: BH-02

Started On : 25/05/2024; Ended On : 25/05/2024 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: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (## 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
G.W.T	↓		Brownish Dense Silty Fine to Medium Coarse Sand	1.50	10	16	19	35		Dense	SS
				3.00	12	16	27	43		Dense	SS
				4.50	13	15	19	34		Dense	SS
5.50											
6.50			Blackish Stiff Silty Clay	6.00	4	6	9	15		Stiff	SS
			Blackish Very Stiff Silty Clay	7.50	3	6	10	16		V.Stiff	SS
				9.00	8	11	16	27		V.Stiff	SS
9.50											
10.70			Brownish Very Dense Silty Fine Sand	10.50	19	24	32	56		V.Dense	SS

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

Fig. 2.2 Soil Profile at BH-02 Location

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Project : Proposed Construction of Residential Building Blocks (Stilt+05 Floors) at Plot No: 1, T.S. No: 7/12, Glass Factory, Tiruvottiyur, Chennai-600019.

Location: BH-03

Started On : 26/05/2024; Ended On : 26/05/2024 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: Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT (## 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
G.W.T	↓			1.50	10	14	17	31		Dense	SS
			Brownish Dense Silty Fine to Medium Coarse Sand	3.00	8	19	19	38		Dense	SS
				4.50	9	14	19	33		Dense	SS
6.50				6.00	12	18	23	41		Dense	SS
8.00			Brownish Very Dense Silty Fine Sand	7.50	19	24	27	51		V.Dense	SS
9.50			Brownish Dense Silty Fine Sand	9.00	12	16	24	40		Dense	SS
10.70			Brownish Very Dense Silty Fine Sand	10.50	18	27	34	61		V.Dense	SS

Bore Hole Terminated at a depth of 10.50m below the existing ground level

Fig. 2.3Soil Profile at BH-03 Location

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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 5.50	38	SS	Silty Fine to Medium Coarse Sand	-	1.9	-	-	-	-	-	Dense	0	0	33	51	16	0	SM
5.50 to 6.50	8	SS	Silty Clay	33	1.6	82	21	61	0.8	-	M.Stiff	0	0	0	0	19	81	CH
6.50 to 8.00	11	SS	Silty Clay	28	1.7	80	21	59	0.9	-	Stiff	0	0	0	0	21	79	CH
8.00 to 9.50	29	SS	Silty Clay	16	1.9	82	33	49	1.3	-	V.Stiff	0	0	0	0	15	85	CH
9.50 to 10.50	>100	SS	Silty Fine to Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	83	17	0	SM

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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 5.50	37	SS	Silty Fine to Medium Coarse Sand	-	1.9	-	-	-	-	-	Dense	0	0	39	51	10	0	SM
5.50 to 6.50	15	SS	Silty Clay	27	1.7	82	28	54	1.0	-	Stiff	0	0	0	0	21	79	CH
6.50 to 9.50	21	SS	Silty Clay	24	1.9	85	31	54	1.1	-	V.Stiff	0	0	0	0	17	83	CH
9.50 to 10.50	56	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	85	15	0	SM

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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 6.50	36	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	77	23	0	SM
6.50 to 8.00	51	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	82	18	0	SM
8.00 to 9.50	40	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	80	20	0	SM
9.50 to 10.50	61	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	85	15	0	SM

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Table 2.4: Chemical Analysis Results conducted on Water Samples collected from BH-01 to BH-03

Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	3.00	7.76	340.18	382.70
BH-02	3.00	7.76	339.43	381.85
BH-03	3.00	7.76	343.91	386.89

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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 5.50m depth)**

Type of Strata	Silty Fine to Medium Coarse Sand
Colour	Brownish
Thickness of Layer	5.50m
SPT of the layer	38
Relative Density	Dense
Angle of Shearing Resistance, ϕ	38.20^0

* **Layer-2 (from 5.50m to 6.50m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.00m
SPT of the layer	08
Consistency	Medium Stiff
Un-drained Cohesion, Cu	53.33kPa

* **Layer-3 (from 6.50m to 8.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	11
Consistency	Stiff
Un-drained Cohesion, Cu	73.33kPa

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* **Layer-4 (from 8.00m to 9.50m depth)**	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	29
Consistency	Very Stiff
Un-drained Cohesion, Cu	193.33kPa
* **Layer-5 (from 9.50m to 10.50m depth)**	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
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 last week of May 2024.

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 5.50m depth)**	
Type of Strata	Silty Fine to Medium Coarse Sand
Colour	Brownish
Thickness of Layer	5.50m
SPT of the layer	37
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.925^0
* **Layer-2 (from 5.50m to 6.50m depth)**	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.00m
SPT of the layer	15
Consistency	Stiff
Un-drained Cohesion, Cu	100.00kPa
* **Layer-3 (from 6.50m to 9.50m depth)**	
Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	3.00m
SPT of the layer	21
Consistency	Very Stiff
Un-drained Cohesion, Cu	140.00kPa
* **Layer-4 (from 9.50m to 10.50m depth)**	
Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
SPT of the layer	56
Relative Density	Very Dense

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Angle of Shearing Resistance, ϕ	41.90^0

Ground Water

Ground water table was encountered at a depth of 2.00m below the existing ground level during the last week of May 2024.

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 6.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	5.50m
SPT of the layer	36
Relative Density	Dense
Angle of Shearing Resistance, ϕ	37.65^0

* **Layer-2 (from 6.50m to 8.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	51
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	41.15^0

* **Layer-3 (from 8.00m to 9.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.50m
SPT of the layer	40
Relative Density	Dense
Angle of Shearing Resistance, ϕ	41.15^0

* **Layer-4 (from 9.50m to 10.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	1.00m
SPT of the layer	61
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 last week of May 2024.

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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 non-uniform shear strength characteristics, BH-01 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-01 as design borehole, it can be envisaged that the coarse-grained soil strata encountered at shallow depths can be considered as bearing strata for nominal column loads in the range of 400kN to 500kN respectively.

If coarse-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 least dimension of footing and effective surcharge over the proposed bearing strata.

Care shall also be taken so that the dispersed open foundation stresses on the underlying relatively weak soil layer encountered at 5.50m depths from existing ground level (SPT @ 6.00m is 08, Ref. BH-01) are within its safe bearing capacity limits.

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Further, refusal strata (SPT>60) encountered below a uniform depth of 9.50m below existing ground level can also be considered as good end bearing strata for proposed structure.

Considering the above, suitable foundation systems are presented below.

4.2 Foundation System

(FOR NOMINAL COLUMN LOADS IN THE RANGE OF 400kN to 500kN)

4.2.1 Open Foundation System –Isolated Column Footing

Considering the shear strength characteristics of coarse-grained soil strata encountered uniformly at shallow depths and presence of underlying relatively weak soil layer encountered @ 5.50m depths from existing ground level, open foundation system of ***Isolated Column Footing*** *type located at a design depth of 2.00m below present existing ground level (EGL) 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)	Observed Thickness of Fill at Site (m)	Depth of **Isolated Column Footing** below Present Existing Ground Level (m)	Safe Bearing Capacity (t/m^2)	Elastic Settlements (mm)
Isolated Column Footing	**2.00**	**0.00**	**2.00**	**20**	**25**

The computations for above are annexed to this report.

Notes

Safe Bearing Capacity of open foundation is restricted considering the presence of underlying relatively weak soil layer encountered at a depth of 5.50m below existing ground level i.e. 3.50m distant apart from the bottom level of footing.

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(FOR COLUMN LOADS IN HIGHER THAN 500kN)

4.2.2 Deep Foundation System–10.50m long Bored Cast-in-Situ Friction cum End Bearing Piles

In case, the impending foundation stresses are more than the recommended safe bearing capacity of the recommended soil strata, deep foundation system consisting of 10.50m 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 10.50m 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	Length of Pile below Existing Ground Level (m)	Diameter of Pile (mm)	Safe Load Carrying Capacity (t)	Safe Pull Out Capacity (t)
1	Bored Cast-in-Situ	10.50	400	60	18
2			450	70	21
3			500	80	23
4			550	90	25

The computations of safe load carrying capacity for 400mm diameter and 10.50m long bored cast-in-situ Friction cum End Bearing Pile are annexed to this report

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CHAPTER-5

CONCLUSIONS & RECOMMENDATIONS

OPEN FOUNDATION SYSTEM

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 footing.
3. **It is recommended to connect the grade beams to contain any differential settlements in between the individual footings.**
4. **In no case, least depth of footing shall be less than 2.00m below existing ground level.**
5. Care shall be taken so that the ultimate bearing strata are none other than coarse-grained **Silty Fine to Medium Coarse Sand** type.
6. Excavated coarse-grained soil encountered at shallow depths shall be in no case used for back filling purposes.
7. Safe bearing capacity presented above is computed considering any rise in the ground water table at or above the level of footing.
8. **It is recommended to connect the grade beams so that the structure can act as a single unit against any differential settlements in between the individual footings.**

DEEP FOUNDATION SYSTEM

9. Deep foundation system presented in Clause 4.2.2, Chapter-IV can be adopted for foundation design purposes.
10. Suitable pile load tests (as per I.S: 2911, part-IV) shall be performed to confirm the presented safe load carrying capacities **(provisional)**.
11. Pile cap can be located over well compacted existing ground surface.

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12. Piles shall be grouped according to the column design load requirements.

13. Safe load carrying capacities of piles shall be limited to their structural capacities.

Additional Recommendations

14. In case, the ground water table is encountered within the recommended depths of foundation system, the same shall be bailed out continuously to keep the sub-grade well consolidated.

15. As the chlorides and sulphates present in the water samples are within the permissible limits, no special steel or cement is required to be used for foundation construction purposes.

For Geo Mines Engineers Pvt Ltd

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DESIGN OF OPEN FOUNDATION SYSTEM

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
Depth of Foundation below existing ground level (D_f):	2.00	m
Observed Thickness of fill at site:	0.00	m
Effective Depth of Foundation below natural 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 Sand	
Design SPT-value of the Bearing Strata :	31	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Angle of Shearing Resistance - Limited to a Maximum of:	36.28	Deg.

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.50	kN/m^3
Effective Overburden pressure at foundation level (q)	17.00	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = N/A

N_q = 41.18

N_γ = 63.68

Shape Factors:

S_c = N/A

S_q = 1.73

S_γ = 0.60

Depth Factors :

D_c = N/A

D_q = 1.00

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$D_\gamma = 1.00$

Inclination Factor:

I_c = N/A

$I_q = 1.00$

$I_\gamma = 1.00$

1.4 Ultimate Bearing Capacity (Qu) :

$Qu = Cu*Nc*Sc*D_C*I_C+q*(Nq-1)*Sq*Dq*Iq + 0.5*B*\gamma*N\gamma*S\gamma*D\gamma*Ig*w'$

$Q_u =$ 1390.54 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50

Qsafe : 556.22 kPa

Recommended Safe Bearing Capacity: 200.00 kPa

Restricted considering the presence of underlying relatively weak soil layer encountered at a depth of 5.50m below existing ground level i.e. 3.50m distant apart from the bottom level of footing.

1.6 Settlements

Since, the bearing strata are coarse-grained type, the settlements under the allowable safe bearing pressure 200kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 200kPa and average SPT of 31 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 25mm which is within the permissible limits of 50mm for isolated column footings as per I.S:1904.

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DESIGN OF PILE FOUNDATION (Ref.BH-01)

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):	**400.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**10.500**	m
R.L. of Bot. of Pile	-10.50	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

1.2.1.1 **Layer-II**

Type of Strata:	Silty Sand	
Average SPT of the strata,N:	38	
Bulk Density of the strata,γ:	19	kN/m^3
Angle of Shearing Resistance,ϕ:	38.2	Deg.
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	-5.50	m
Average Thickness of Strata,I_c:	5.50	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}:	49.50	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	24.75	kN/m^2
Coeff. Of Earth Pressure, k:	2.00	
Skin Resistance of the pile,q_s:	269.22	kN

(q_s:σ*k*tanϕ*pi()*d*Ic)

1.2.1.2 **Layer-III**

Type of Strata:	Silty Clay	
Average SPT of the strata,N:	8	
Bulk Density of the strata,γ:	16	kN/m^3
Undrained Cohesion, Cu:	53.33	kPa
R.L of top of Strata:	-5.50	m
R.L of bottom of Strata:	-6.50	m
Average Thickness of Strata,I_c:	1.00	m
Effective overburden pressure over the top of strata,σ_{top}:	49.50	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	55.50	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	52.50	kN/m^2
Adhesion Factor, α:	0.60	
Skin Resistance of the pile,q_s:	40.21	kN

(q_s:α*Cu*pi()*d*Ic)

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1.2.1.3 **Layer-IV**

Type of Strata:	Silty Clay	
Average SPT of the strata,N:	11	
Bulk Density of the strata,γ:	17	kN/m^3
Undrained Cohesion, Cu:	73.33	kPa
R.L of top of Strata:	-6.50	m
R.L of bottom of Strata:	-8.00	m
Average Thickness of Strata,I_c:	1.50	m
Effective overburden pressure over the top of strata,σ_{top}:	55.50	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	66.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	60.75	kN/m^2
Adhesion Factor, α:	0.40	
Skin Resistance of the pile,q_s:	55.29	kN

(q_s:α*Cu*pi()*d*Ic)

1.2.1.4 **Layer-V**

Type of Strata:	Silty Clay	
Average SPT of the strata,N:	29	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	193.33	kPa
R.L of top of Strata:	-8.00	m
R.L of bottom of Strata:	-9.50	m
Average Thickness of Strata,I_c:	1.50	m
Effective overburden pressure over the top of strata,σ_{top}:	66.00	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	79.50	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	72.75	kN/m^2
Adhesion Factor, α:	0.40	
Skin Resistance of the pile,q_s:	145.77	kN

(q_s:α*Cu*pi()*d*Ic)

1.2.1.5 **Layer-VI**

Type of Strata:	Silty Sand	
Average SPT of the strata,N:	60	
Bulk Density of the strata,γ:	20	kN/m^3
Angle of Shearing Resistance,ϕ:	42.5	Deg.
R.L of top of Strata:	-9.50	m
R.L of bottom of Strata:	-10.50	m
Average Thickness of Strata,I_c:	1.00	m
Effective overburden pressure over the top of strata,σ_{top}:	79.50	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	89.50	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	84.50	kN/m^2
Coeff. Of Earth Pressure, k:	2.50	
Skin Resistance of the pile,q_s:	243.25	kN

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(q_s:σ*k*tanϕ*pi()*d*Ic)

Ultimate Skin Resistance,q_s: 753.75 kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	Silty Sand	
Cross-Sectional Area of pile,Ap:	0.126	m^2
R.L of bottom of pile:	-10.50	
Minimum SPT-value of the Bearing Strata	60	
Angle of Shear Resistance, ϕ:	42.50	Deg.
Effective Overburden Pressure, q:	40.00	kPa
Bearing Capacity Factor(Nq)	220.00	
Ultimate End Bearing Resistance (Qp)	**1105.8**	**kN**
(Qp=Ap*q*Nq)		

1.3.0 Ultimate Load Carrying Capacity (Qu=Qs+Q_p) 1859.6 kN

Safe Load Carrying Capacity (Qsafe =Qp/2.50+qs/4.0) 630.8 kN

However, limit Q_{safe} to the structural capacity of pile: 600.0 kN

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