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CLIENT	**M/s. CHENNAI LAND HOLDING PVT LTD, CHENNAI**
PROJECT	**PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+ STILT+05) AT SURVEY NO:133/1A, 134/2, 136/1, 136/2A, 136/2B, 137, 138, 139, 140, 141/1A1, 141/1B & 141/2 OF KOLATHUVANCHERRY VILLAGE, KUNDRATHUR TALUK, KANCHEEPURAM DISTRICT, CHENNAI.**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

REV.	DATE	REPORT NUMBER	REMARK
0	20.06.2024	BAG/ M/s. CHENNAI LAND HOLDING PVT LTD / C-1860/24-25	

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For BOOSHNAM ASSOCIATES PVT. LTD.,
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For BOOSHNAM ASSOCIATES PVT. LTD.,
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CHAPTER-1

INTRODUCTION

1.0 Preamble

M/s. Chennai Land Holding Pvt Ltd, Chennai Proposed to Construct a **Residential Building (Basement+ Stilt+05) At Survey No:133/1a, 134/2, 136/1, 136/2a, 136/2b, 137, 138, 139, 140, 141/1a1, 141/1b & 141/2 Of Kolathuvancherry Village, Kundrathur Taluk, Kancheepuram District, Chennai.**

For the purpose of designing the foundations, the responsibility of carrying out suitable soil investigations was entrusted to **M/s. Booshnam Associates 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 Two 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)

For BOOSHNAM ASSOCIATES PVT. LTD.,
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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 were 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.

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 2.2.

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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 2.2.

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 to 2.2.

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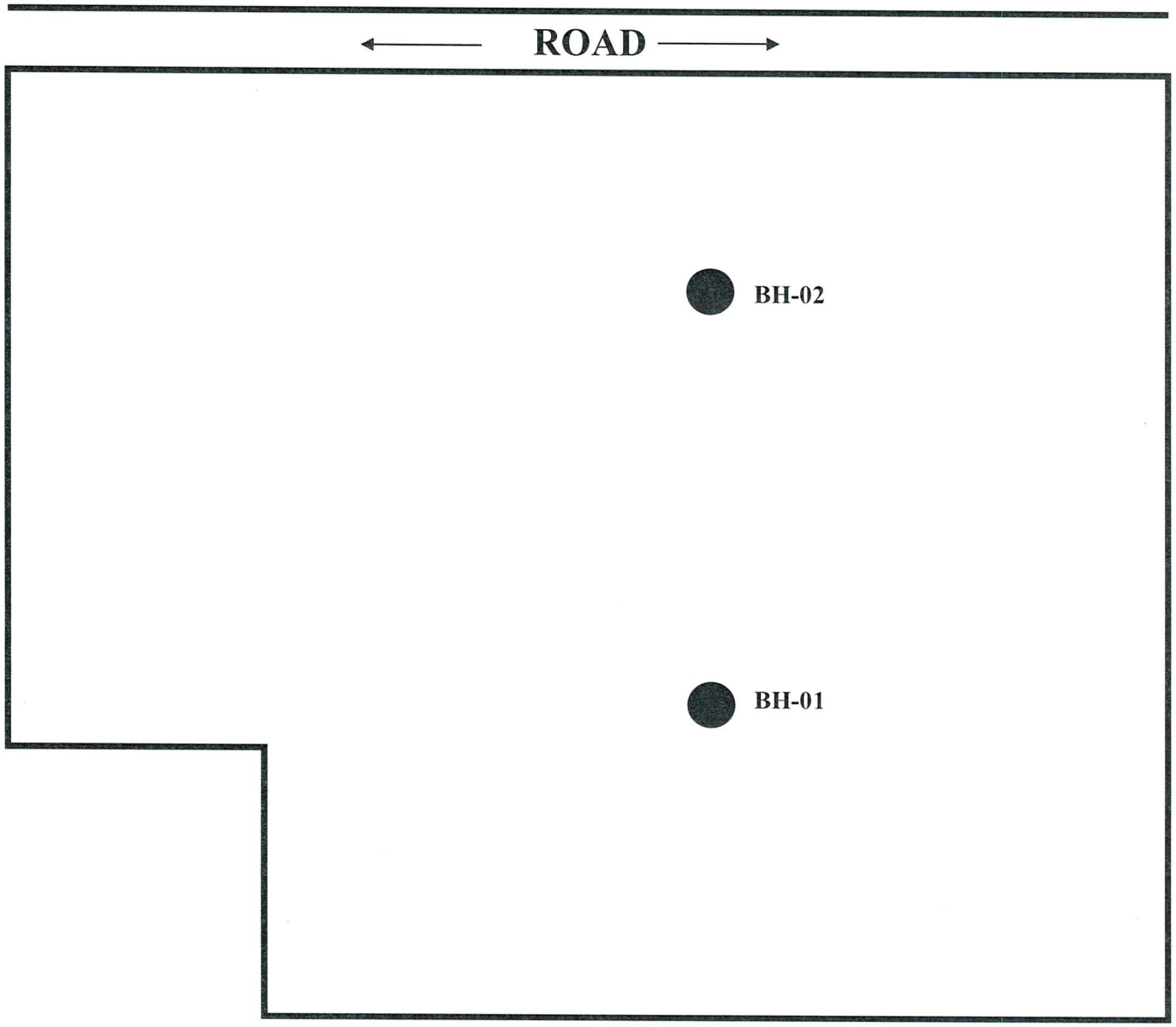


Fig. 2.0: Site Plan Representing the locations of Field Investigation Points

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Location: BH-01

Started On : 16/06/2024; Ended On : 16/06/2024 G.W.T: 2.50m 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 N-Value (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
			Brownish Medium Stiff Silty Clay	1.50	3	4	3	7		M.Stiff	SS
2.00											
G.W.T			Brownish Medium Dense Silty Fine Sand	3.00	8	11	14	25		M.Dense	SS
				4.50	12	15	14	29		M.Dense	SS
5.00											
			Brownish Dense Silty Fine Sand	6.00	14	17	22	39		Dense	SS
7.00											
			Greyish Dense Silty Fine Sand	7.50	18	29	18	47		Dense	SS
				9.00	17	21	28	49		Dense	SS
9.50											
			Greyish Very Dense Silty Fine Sand	10.50	25	32	34	66		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 : 16/06/2024; Ended On : 16/06/2024 G.W.T: 2.50m 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 SP (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
	G.W.T		Brownish Medium Dense Silty Fine Sand	1.50	7	9	12	21		M.Dense	SS
3.50				3.00	10	13	16	29		M.Dense	SS
5.00			Brownish Dense Silty Fine Sand	4.50	14	18	22	40		Dense	SS
6.50			Brownish Very Dense Silty Fine Sand	6.00	18	24	27	51		V.Dense	SS
8.00			Blackish Very Stiff Silty Clay	7.50	6	8	9	17		V.Stiff	SS
9.50			Blackish Medium Dense Silty Fine Sand	9.00	12	15	15	30		M.Dense	SS
10.70			Greyish Very Dense Silty Fine Sand	10.50	20	29	30	59		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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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	7	SS	Silty Clay	34	1.6	77	24	53	0.81	15	M.Stiff	0	0	0	0	17	83	CH
2.00 to 5.00	27	SS	Silty Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	78	22	0	SM
5.00 to 7.00	39	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	82	18	0	SM
7.00 to 9.50	48	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	83	17	0	SM
9.50 to 10.70	66	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	86	14	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 3.50	25	SS	Silty Fine Sand	-	1.7	-	-	-	-	-	M.Dense	0	0	0	79	21	0	SM
3.50 to 5.00	40	SS	Silty Fine Sand	-	1.9	-	-	-	-	-	Dense	0	0	0	83	17	0	SM
5.00 to 6.50	51	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	85	15	0	SM
6.50 to 8.00	17	SS	Silty Clay	28	1.8	59	27	32	0.97	-	V.Stiff	0	0	0	0	22	78	CI
8.00 to 9.50	30	SS	Silty Fine Sand	-	1.8	-	-	-	-	-	M.Dense	0	0	0	80	20	0	SM
9.50 to 10.70	59	SS	Silty Fine Sand	-	2.0	-	-	-	-	-	V.Dense	0	0	0	86	14	0	SM

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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	07
Consistency	Medium Stiff
Un-drained Cohesion, Cu	46.66kPa

* **Layer-2 (from 2.00m to 5.00m depth)**

Type of Strata	Silty 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 7.00m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	2.00m
SPT of the layer	39
Relative Density	Dense
Angle of Shearing Resistance, ϕ	38.475^0

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

Type of Strata	Silty Fine Sand
Colour	Greyish
Thickness of Layer	2.50m

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SPT of the layer	48
Relative Density	Dense
Angle of Shearing Resistance, ϕ	40.55^0

* **Layer-5 (from 9.50m to 10.70m depth)**

Type of Strata	Silty Fine Sand
Colour	Greyish
Thickness of Layer	1.20m
SPT of the layer	66
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50^0

Ground Water

Ground water table was encountered at a depth of 2.50m below the existing ground level during the third week of June 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 3.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Brownish
Thickness of Layer	3.50m
SPT of the layer	25
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	34.50^0

* **Layer-2 (from 3.50m to 5.00m 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	38.75^0

* **Layer-3 (from 5.00m to 6.50m 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-4 (from 6.50m to 8.00m depth)**

Type of Strata	Silty Clay
Colour	Blackish
Thickness of Layer	1.50m
SPT of the layer	17
Consistency	Very Stiff
Un-drained Cohesion, Cu	113.33kPa

* **Layer-5 (from 8.00m to 9.50m depth)**

Type of Strata	Silty Fine Sand
Colour	Blackish
Thickness of Layer	1.50m

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SPT of the layer	30
Relative Density	Medium Dense
Angle of Shearing Resistance, ϕ	36.00^0

* **Layer-6 (from 9.50m to 10.70m depth)**

Type of Strata	Silty Fine Sand
Colour	Blackish
Thickness of Layer	1.20m
SPT of the layer	59
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.35^0

Ground Water

Ground water table was encountered at a depth of 2.50m below the existing ground level during the third week of June 2024.

For BOOSHNAM ASSOCIATES PVT. LTD.,
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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 coarse-grained type and good from both shear strength characteristics and deformation considerations to act as bearing strata for proposed impending loads form structure.

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 bearing strata.

Considering the above, suitable foundation system is presented below.

4.2 Foundation System

4.2.1 Open Foundation System

Considering the bearing strata characteristics of sub-soil strata encountered at shallow depths, open foundation system of ***Raft*** type located at a least depth of 2.00m below present existing ground level (E.G.L) can be adopted.

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

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S. No.	Type of Open Foundation System	Total Depth of Excavations below Present Existing Ground Level (m)	Observed Thickness of Fill (m)	Depth of Raft below Natural Ground Level (m)	Type of Bearing Strata	Safe Bearing Capacity (MT/m^2)	Elastic Settlements <70mm (mm)
1	**Raft**	2.00	0.00	2.00	Silty Fine Sand	17	52

The computations for above are annexed to this report.

For BOOSHNAM ASSOCIATES PVT. LTD.,
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CHAPTER-5

CONCLUSIONS & RECOMMENDATIONS

1. Open foundation system of Raft footing type located at shallow depths over coarse-grained strata can be adopted for foundation design purposes.
2. Safe bearing capacity presented in Clause 4.2.1; Chapter-IV can be adopted for open foundation design purposes.
3. In no case, the least depth of foundation system can be less than 2.00m below present existing ground.
4. Care shall be taken so that the ultimate bearing strata are none other than coarse-grained **Silty Fine Sand** type.
5. Excavated coarse-grained soil strata encountered at shallow depths can only be used for back filling purposes.
6. Safe bearing capacity presented above is computed considering any rise in the ground water table at or above the level of footing.
7. **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.**
8. Special provisions to contain any lateral collapse of soil from the walls excavated foundation pits are required up to the recommended founding levels.
9. 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.
10. As the chlorides and sulphates present in the water sample are within the permissible limits, no special steel or cement is required to be used for foundation construction purposes.
11. **Consider uplift pressure while designing the foundation of the structure.**

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DESIGN OF OPEN FOUNDATION SYSTEM (Ref. BH-01)

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Raft	
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 Fine Sand	
Design SPT-value of the Bearing Strata :	15	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Angle of Shearing Resistance - Limited to a Maximum of:	31.50	Deg.

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	19.00	kN/m^3
Effective Overburden pressure at foundation level (q)	18.00	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = N/A

N_q = 22.87

N_γ = 30.09

Shape Factors:

S_c = N/A

S_q = 1.61

S_γ = 0.60

Depth Factors :

D_c = N/A

D_q = 1.00

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D_γ = 1.00

Inclination Factor:

I_c = N/A

I_q = 1.00

I_γ = 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*γ*Nγ*Sγ*Dγ*Ig*w'

Q_u = 749.68 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50
Qsafe :	299.87 kPa
Recommended Safe Bearing Capacity:	170.00 kPa

1.6 Settlements

Since, the bearing strata are coarse-grained type, the settlements under the allowable safe bearing pressure 170kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 170kPa and average SPT of 15 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 52mm which is within the permissible limits of 70mm for Raft footing as per I.S:1904.

For BOOSHNAM ASSOCIATES PVT. LTD.,
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