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CLIENT	**ASSET TREE HOMES, CHENNAI**
PROJECT	**PROPOSED CONSTRUCTION OF STILT FLOOR+3 FLOORS+4TH FLOOR(PART)+5TH FLOOR(PART), (HEIGHT-18.00M) RESIDENTIAL BUILDING WITH 32 DWELLING UNITS (GYM & ASSOCIATION ROOM AT 4TH FLOOR) AFFORDABLE HOUSING AT SHANKAR NAGAR 8TH STREET 9TH STREET & 10TH STREET, PAMMAL, CHENNAI. COMPRRISED IN S.NO.143/604, T.S.NO. 1, BLOCK NO. 8, WARD K OF PAMMAL VILLAGE WITHIN THE LIMIT OF TAMBARAM MUNICIPAL CORPORATION.**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

		For Geo Mines Engineers Pvt Ltd	
		Director	
0	16-12-2022	GMEPL/ASSET TREE HOMES/421/2022-23	
REV.	**DATE**	**REPORT NUMBER**	**PREP. BY**

DISCLAIMER

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

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

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

GEO MINES ENGINEERS (P) LTD.
GMEPL
Chennai

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CHAPTER-1

INTRODUCTION

1.0 Preamble

Asset Tree Homes, Chennai proposed to construct a **Stilt Floor+3Floors+4th Floor(Part)+5th Floor (Part) (Height-18.00m) Residential Building with 32 Dwelling units (Gym & Association Room at 4th Floor) Affordable Housing at Shankar Nagar 8th Street, 9th Street & 10th Street, Pammal, Chennai. Comprised in S.No. 143/604, T.S.No. 1, Block No. 8, Ward K of Pammal Village, within the limit of Tambaram Municipal Corporation.** 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 Two Standard Soil investigation bore holes of 150mm diameter up to depth below existing ground level where SPT>100 or 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:

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

2.2 Equipment Used and Method of Drilling:

2.2.1 Equipment Used

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

2.2.2 Methodology of drilling

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

2.3 In-Situ Strength Tests:

2.3.1 Standard Penetration Test:

Standard penetration tests were conducted at the borehole 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.

2.4.2 Ground Water

For conducting suitable chemical tests, the ground water samples were collected from the respective boreholes.

2.5 Summary of Field Work

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

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

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

2.6.2 Fine Grained Samples:

2.6.2.1 Index Property – Free Swell Tests:

Atterberg Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. As no such type of soil strata encountered at the investigation locations, no such tests could be conducted.

2.6.3 Chemical Analysis Tests:

2.6.3.1 Water Samples:

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

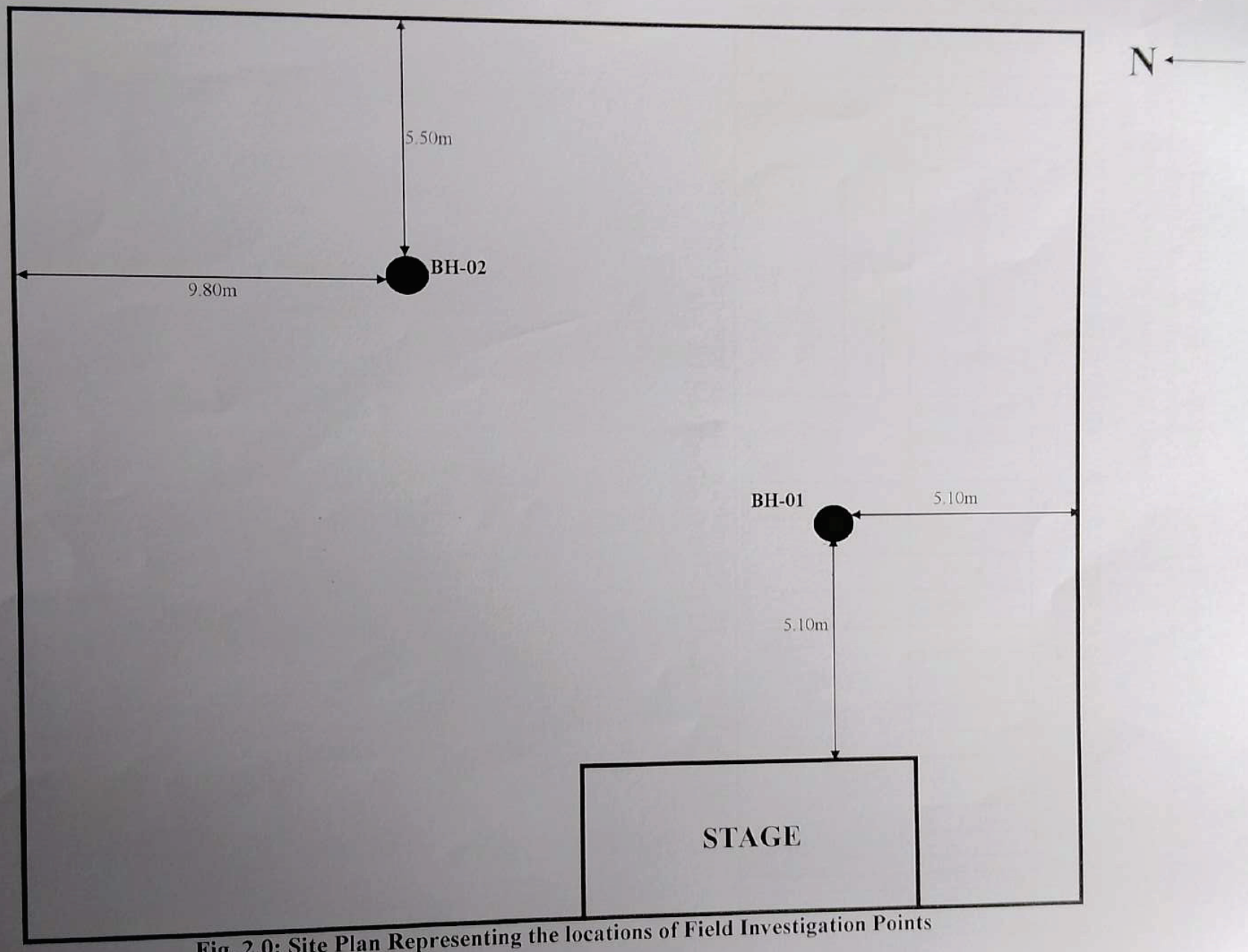


Fig. 2.0: Site Plan Representing the locations of Field Investigation Points

Project : Proposed Construction of Stilt Floor+3Floors+4th Floor(Part)+5th Floor (Part) (Height-18.00m) Residential Building with 32 Dwelling units (Gym & Association Room at 4th Floor) Affordable Housing at Shankar Nagar 8th Street, 9th Street & 10th Street, Pammal, Chennai. Comprised in S.No. 143/604, T.S.No. 1, Block No. 8, Ward K of Pammal Village, within the limit of Tambaram Municipal Corporation.

Location: BH-01

Started On : 16/12/2022; Ended On : 16/12/2022 G.W.T: 0.30m 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)	SPT - Details: 0-15 cm	SPT - Details: 15-30 cm	SPT - Details: 30-45 cm	SPT - Details: N-Value	Graphical Representation of SPT (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
0.30	▼		Filled Up Soil							-	DS
1.00			Brownish Loose Sity Clayey Sandy Gravels							Loose	DS
			Weathered Rock	1.50	12	28	35	63		V.Dense	SS
3.00				3.00	08cms Penetration for 50 Blows					V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.1 Soil Profile at BH-01 Location

Project : Proposed Construction of Stilt Floor+3Floors+4th Floor(Part)+5th Floor (Part) (Height-18.00m) Residential Building with 32 Dwelling units (Gym & Association Room at 4th Floor) Affordable Housing at Shankar Nagar 8th Street, 9th Street & 10th Street, Pammal, Chennai. Comprised in S.No. 143/604, T.S.No. 1, Block No. 8, Ward K of Pammal Village, within the limit of Tambaram Municipal Corporation.

Location: BH-02

Started On : 16/12/2022; Ended On : 16/12/2022 G.W.T: 0.30m 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 (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
				Depth of SPT below E.G.L (m)	0-15 cm	15-30 cm	30-45 cm	N-Value			
0.30	▼		Filled Up Soil							-	DS
1.00			Brownish Loose Sity Clayey Sandy Gravels							Loose	DS
			Weathered Rock	1.50	9	25	36	61		V.Dense	SS
3.00				3.00	07cms Penetration for 50 Blows					V.Dense	SS

Bore Hole Terminated at a depth of 3.00m below the existing ground level

Fig. 2.2 Soil Profile at BH-02 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 0.30	-	DS	Filled Up Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.30 to 1.00	-	DS	Silty Clayey Sandy Gravels	-	1.5	-	-	-	-	-	Loose	43	5	13	14	9	16	GP
1.00 to 3.00	63	SS	Weathered Rock	-	2.0	-	-	-	-	-	V.Dense	36	27	11	16	10	0	SDR

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 0.30	-	DS	Filled Up Soil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.30 to 1.00	-	DS	Silty Clayey Sandy Gravels	-	1.5	-	-	-	-	-	Loose	40	17	12	9	10	12	GP
1.00 to 3.00	61	SS	Weathered Rock	-	2.0	-	-	-	-	-	V.Dense	37	21	18	14	10	0	SDR

Table 2.3: Chemical Analysis Results conducted on Water Samples collected from BH-01 & BH-02

Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	1.50	6.97	300.58	338.15
BH-02	1.50	6.99	295.83	332.80

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 0.30m depth)**

Type of Strata	Filled Up Soil
Colour	-
Thickness of Layer	0.30m

* **Layer-2 (from 0.30m to 1.00m depth)**

Type of Strata	Silty Clayey Sandy Gravels
Colour	Brownish
Thickness of Layer	0.70m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-3 (from 1.00m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.00m
SPT of the layer	63
Relative Density	Very Dense
Angle of Shearing Resistance, ϕ	42.50^0

Ground Water

Ground water table was encountered at a depth of 0.30m below the existing ground level during the third week of December 2022.

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 0.30m depth)**

Type of Strata	Filled Up Soil
Colour	-
Thickness of Layer	0.30m

* **Layer-2 (from 0.30m to 1.00m depth)**

Type of Strata	Silty Clayey Sandy Gravels
Colour	Brownish
Thickness of Layer	0.70m
SPT of the layer	-
Relative Density	Loose
Angle of Shearing Resistance, ϕ	-

* **Layer-3 (from 1.00m to 3.00m depth)**

Type of Strata	Weathered Rock
Colour	-
Thickness of Layer	2.00m
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 0.30m below the existing ground level during the third week of December 2022.

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 i.e. below 0.30m thick filled up soil strata are coarse-grained type and good from both shear strength characteristics and deformation considerations to act as bearing strata for proposed impending loads from structure.

If coarse-grained soil strata encountered below 0.30m depths from existing ground level 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 (BH-02)

Considering the bearing strata characteristics of sub-soil strata encountered at shallow depths, open foundation system of isolated column footing type located at a least depth of 1.80m below existing ground level (E.G.L) can be adopted.

The safe bearing capacity of open foundation at least recommended depth of 1.80m below E.G.L is computed and presented below which can be adopted for foundation design purposes.

S. No.	Type of Open Foundation System	Depth of Footing below Existing Ground Level (m)	Observed Thickness of Fill (m)	Depth of Footing below Natural Ground Level (m)	Type of Bearing Strata	Safe Bearing Capacity (MT/m^2)	Elastic Settlements <50mm (mm)
1	Isolated Column Footing	1.80	0.30	1.50	Weathered Rock	30	15

The computations for above are annexed to this report.

CHAPTER5

CONCLUSIONS & RECOMMENDATIONS

1. Open Foundation system presented in Clause 4.2.1, Chapter-IV can be adopted for foundation design purposes.
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. **For the presented safe bearing capacity of 30MT/sq.m., the least depth of Isolated Column Footing shall be in no case less than 1.80m below existing ground level i.e. 1.50m below natural ground level considering 0.30m thick fill observed at site.**
4. Care shall be taken so that the ultimate bearing strata are none other than coarse-grained **Weathered Rock** type.
5. Excavated coarse-grained soil encountered below 0.30m thick filled up soil strata can only be used for back-filling purposes.
6. **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.**
7. Special provisions to contain any lateral collapse of soil from the walls excavated foundation pits are required up to the recommended depths of open foundation system.
8. 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.
9. As the chlorides and sulphates present in the collected water sample are within the permissible limits, no special steel or cement is recommended to be used for foundation construction purposes.

For Geo Mines Engineers Pvt Ltd

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

1 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Type of Foundation System:	Isolated Col. Footing	
R.L of the top of Borehole (m):	0.00	m
Depth of Foundation below existing ground level (D_f):	1.80	m
Observed Thickness of fill at site:	0.30	m
Effective Depth of Foundation below natural ground level (D_f):	1.50	m
Design Width of Foundation (B):	1.00	m
Thickness of Foundation (T) :	0.25	m

1.2 Soil Data :

Type of Bearing Strata :	Weathered Rock	
Design SPT-value of the Bearing Strata :	60	
(considered based upon the density of the strata)		
Type of Shear Failure:	General	
Angle of Shearing Resistance - Limited to a Maximum of:	42.50	Deg.

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	20.00	kN/m^3
Effective Overburden pressure at foundation level (q)	15.00	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = N/A

N_q = 99.54

N_γ = 190.59

Shape Factors:

S_c = N/A

S_q = 1.92

S_γ = 0.60

Depth Factors :

D_c = N/A

D_q = 1.00

$D_\gamma = 1.00$

Inclination Factor:

$I_c = N/A$

$I_q = 1.00$

$I_\gamma = 1.00$

1.4 Ultimate Bearing Capacity (Qu) :

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

$Q_u =$ 3433.03 kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50
Qsafe :	1373.21 kPa
Recommended Safe Bearing Capacity:	300.00 kPa

1.6 Settlements

Since, the bearing strata are coarse-grained type, the settlements under the allowable safe bearing pressure 300kPa will be of immediate elastic nature. The elastic settlements corresponding to a safe bearing pressure of 300kPa and average SPT of 60 considering extent of pressure bulb below bottom level of footing are computed to be in the order of 15mm which is within the permissible limits of 50mm for isolated column footing as per I.S:1904.



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