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CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

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

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

This Registration is valid upto **04.07.2029**.



(A. MEGANATHAN)
Superintendent

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Geotechnical Expert
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This Registration is valid upto **04.07.2024.**



(R.SHIVAKUMAR)

ASSISTANT PLANNER

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CLIENT	**INTOUCH CONSTRUCTION & INFRA STRUCTURE PVT. LTD., CHENNAI**
PROJECT	**PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT (STILT+05) AT PLOT NO: 1, 2, 3, 4 & 5, S.NO: 631/1B, THIRUMULLAIVOYAL VILLAGE, AMBATTUR TALUK, CHENNAI**
TITLE	**GEOTECHNICAL INVESTIGATION REPORT**

All pages

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For Geo Mines Engineers Pvt Ltd

Director

REV.	DATE	REPORT NUMBER	PREP. BY
0	04-02-2020	GMEPL/INTOUCH CONSTRUCTION & INFRA STRUCTURE PVT. LTD./358/2020-21	

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CHAPTER-1

INTRODUCTION

1.0 Preamble

Intouch Construction & Infra Structure Pvt. Ltd., Chennai proposed to construct a **Residential Apartment (Stilt+05) at Plot No: 1, 2, 3, 4 & 5, S. No: 631/1B, Thirumullaivoyal Village, Ambattur Taluk.**

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 One Standard Soil investigation bore hole of 150mm diameter up to a depth of 20.00m below existing ground level as directed by the engineer-in-charge.
- Conducting Standard Penetration Test (SPT) at regular depth intervals.
- Collection of Split Spoon Samples or Disturbed Soil Samples
- Collection of water samples from each bore hole.
- Conducting relevant laboratory test results.

1.2 Structure of the Report

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

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CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Field Testing:

2.1 Preamble:

One standard soil investigation borehole was 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 boreholes 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 samples were collected from the respective borehole.

2.5 Summary of Field Work

The location of the borehole is shown in site plan given in Fig.2.0. The soil profile obtained at location is shown in Figs. 2.1.

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. This result is presented in Table 2.1.

2.6.2 Fine Grained Samples:

2.6.2.1 Index Property – Free Swell Tests:

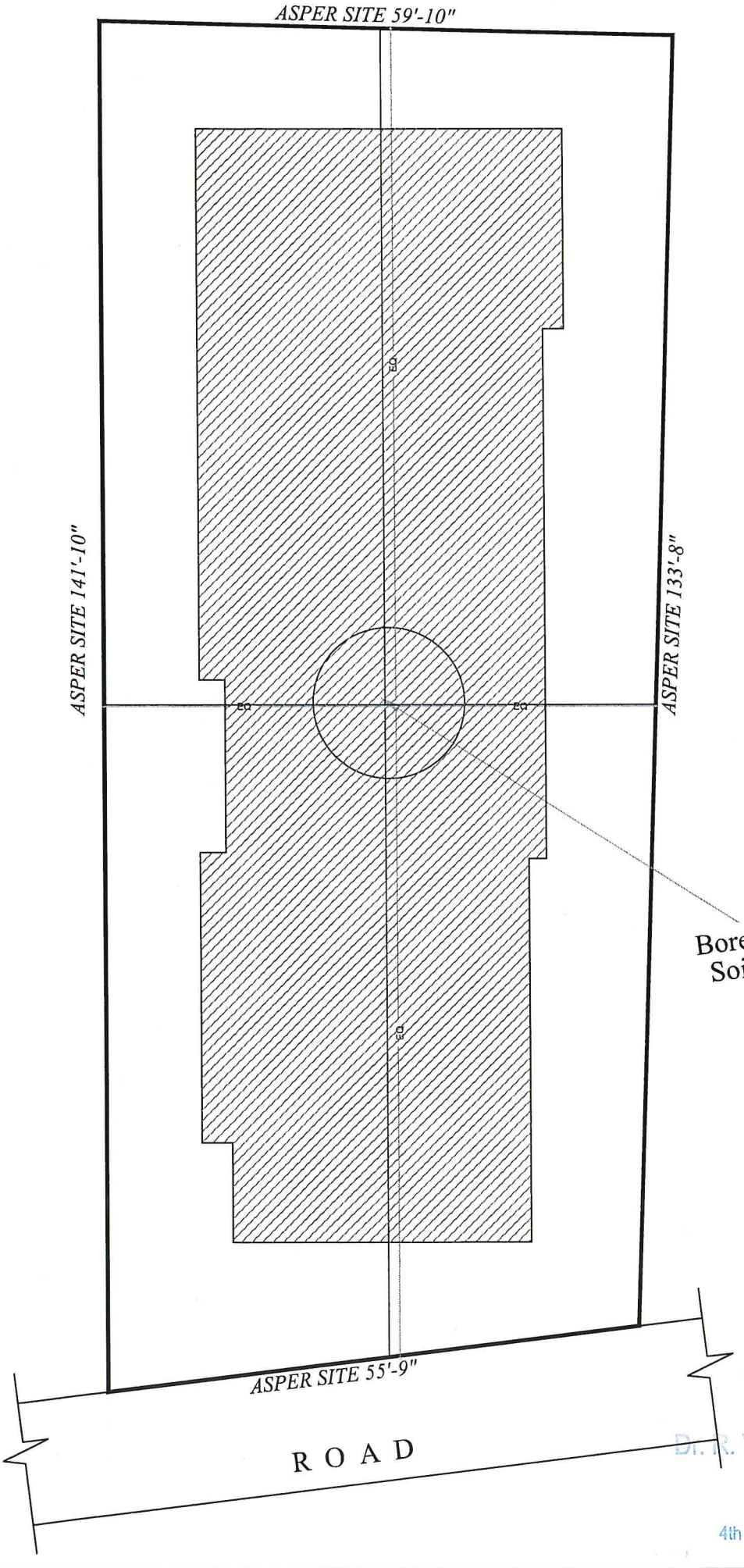
Atterberg Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits and Shrinkage Limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such type of soil strata encountered at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

2.6.3 Chemical Analysis Tests:

2.6.3.1 Water Sample:

On representative water sample, chemical analysis tests were conducted to estimate pH, Chlorides and Sulphates. These results are presented in Table-2.2.

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NOTE:					PROJECT: PROPOSED RESIDENTIAL BUILDING AT THIRUMULLAIVOYAL	PROJ NO: 2101	ARCHITECT: IDAS J5, 3552 6th AVENUE ANNANAGAR, CHENNAI - 102 044-42172999	DWG TITLE: SOIL TEST	
					NOTE: CLIENT			DWG NO:	ISSSUE:
REV NO:	DATE	REVISION DETAILS	DRAWN	CHKD				DATE : 11.01.2021	
								DRAWN : Majeeth	APPVD BY :V.S

Project : Proposed Construction of Residential Apartment (Stilt+05) at Plot No: 1, 2, 3, 4 & 5, S. No: 631/1B, Thirumullaivoyal Village, Ambattur Taluk

Location: BH-01

Started On : 02/02/2021; Ended On : 03/02/2021 G.W.T: 4.80m 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 (0 10 20 30 40 50 60 70 80 90)	Relative Density/Consistency	Type of Sample
			Brownish Stiff Silty Clay	1.50	4	4	6	10		Stiff	SS
2.50				3.00	5	7	9	16		V.Stiff	SS
G.W.T	↓		Brownish Very Stiff Silty Clay	4.50	8	11	12	23		V.Stiff	SS
				6.00	10	13	15	28		V.Stiff	SS
7.00				7.50	15	21	28	49		Hard	SS
				9.00	23	29	33	62		Hard	SS
			Brownish to Greyish Hard Compacted Clay	10.00	25	31	38	69		Hard	SS
12.00				12.00	22	33	41	74		Hard	SS
				14.00	26	37	44	81		Hard	SS
			Greyish Hard Compacted Clay	16.00	29	40	49	89		Hard	SS
				18.00	28	40	57	97		Hard	SS
20.00				20.00	23	42	10cms penetration for 50Blows			Hard	SS

Bore Hole Terminated at a depth of 20.00m below the existing ground level

Fig. 2.1 Soil Profile at BH-01 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 2.50	10	SS	Silty Clay	29	1.7	59	22	34	0.9	55	Stiff	0	0	0	0	19	79	CH
2.50 to 7.00	22	SS	Silty Clay	24	1.9	50	26	24	1.1	-	V.Stiff	0	0	0	0	22	78	CI
7.00 to 12.00	60	SS	Compacted Clay	18	2.0	47	33	14	2.1	-	Hard	0	0	0	0	19	81	CI
12.00 to 20.00	85	SS	Compacted Clay	14	2.0	40	28	12	2.2	-	Hard	0	0	0	0	18	82	CI

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Table 2.2: Chemical Analysis Results conducted on Water Sample collected from BH-01

Location	Depth of Sample below E.G.L. (m)	pH	Chlorides (ppm)	Sulphates (ppm)
BH-01	6.00	7.66	321.14	361.28

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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 2.50m depth)**

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	2.50m
SPT of the layer	10
Consistency	Stiff
Un-drained Cohesion, Cu	66.66kPa

* **Layer-2 (from 2.50m to 7.00m depth)**

Type of Strata	Silty Clay
Colour	Brownish
Thickness of Layer	4.50m
SPT of the layer	22
Consistency	Very Stiff
Un-drained Cohesion, Cu	146.66kPa

* **Layer-3 (from 7.00m to 12.00m depth)**

Type of Strata	Compacted Clay
Colour	Brownish to Greyish
Thickness of Layer	5.00m
SPT of the layer	60
Consistency	Hard
Un-drained Cohesion, Cu	400.00kPa

* **Layer-4 (from 12.00m to 20.00m depth)**

Type of Strata	Compacted Clay

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Colour	Greyish
Thickness of Layer	8.00m
SPT of the layer	85
Consistency	Hard
Un-drained Cohesion, Cu	566.66kPa

Ground Water

Ground water table was encountered at a depth of 4.80m below the existing ground level during the first week of February 2020.

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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 weak from both shear strength characteristics and deformation considerations and hence cannot be considered as bearing strata for proposed impending loads form structure.

Further, the refusal soil strata (SPT>60) encountered below a uniform depth of 12.00m below existing ground level can be considered as good end bearing strata for proposed impending loads from structure.

Considering the above, suitable foundation system is presented below.

4.2 Foundation System

4.2.1 Deep Foundation System-15.00m Long Bored Cast-in-Situ Friction cum End Bearing Piles

Considering the weak shear strength characteristics of the sub-soil strata encountered at the investigation locations @ shallow depths, deep foundation system consisting of 15.00m long bored cast-in-situ Friction cum End Bearing Piles can be adopted.

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

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For four different diameters, the safe load carrying capacities of 15.00m 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	15.00	450	100	90
2				500	120	100
3				550	140	110
4				600	160	120

The computations of safe load carrying capacity for 450mm diameter and 15.00m long bored cast-in-situ Friction cum End Bearing pile are annexed to this report.

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CHAPTER-5

CONCLUSIONS & RECOMMENDATIONS

DEEP FOUNDATION SYSTEM

1. Deep foundation system presented in Clause 4.2.1, Chapter-IV can be adopted for foundation design purposes.
2. Suitable pile load tests (as per I.S: 2911, part-IV) shall be performed to confirm the presented safe load carrying capacities.
3. **Pile cap can be located on 0.30m thick ground replaced surface. Ground replacement can be done with well compacted CNS (Cohesive Non-Swelling) Soil.**
4. **Piles shall be grouped according to the column design load requirements.**
5. Safe load carrying capacities of piles shall be limited to their structural capacities.
6. Care shall be taken so that the ultimate end bearing strata are none other than recommended **Compacted Clay** type encountered below 15.50m depths from existing ground level. (Note)

OPEN FOUNDATION SYSTEM

7. For lightly loaded structures with column loads in the range of 400kN to 500kN, open foundation system of isolated column footing type located at a depth of 1.90m over 0.30m thick well compacted CNS (cohesive non-swelling) soil cushion is recommended. For permissible settlements of 50mm for isolated column footing type, the safe bearing Capacity of such type of open foundation system can be taken as 10MT/m^2.

GENERAL

8. CNS can be non-plastic/coarse-grained soil like clean river sand or sand-gravels mix.
9. As the chlorides and sulphates present in water sample are within the permissible limits, non-special steel and or cement is recommended to be used for foundation construction purposes.

For Geo Mines Engineers Pvt Ltd.

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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):	**450.0**	mm
Assumed R.L of E.G.L:	0.000	m
Length of pile below E.G.L.(l) :	**15.000**	m
R.L. of Bot. of Pile	-15.00	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:	10	
Bulk Density of the strata,γ:	17	kN/m^3
Undrained Cohesion, Cu:	66.67	kPa
R.L of top of Strata:	0.00	m
R.L of bottom of Strata:	-2.50	m
Average Thickness of Strata,I_c:	2.50	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}:	17.50	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	8.75	kN/m^2
Adhesion Factor, α:	0.40	
Skin Resistance of the pile,q_s:	94.25	kN
(q_s:α*Cu*pi()*d*Ic)		

1.2.1.2 **Layer-II**

Type of Strata:	Silty Clay	
Average SPT of the strata,N:	22	
Bulk Density of the strata,γ:	19	kN/m^3
Undrained Cohesion, Cu:	146.67	kPa
R.L of top of Strata:	-2.50	m
R.L of bottom of Strata:	-7.00	m
Average Thickness of Strata,I_c:	4.50	m
Effective overburden pressure over the top of strata,σ_{top}:	17.50	kN/m^2
Effective overburden pressure over the bottom of strata,σ_{bottom}:	58.00	kN/m^2
Effective overburden pressure at the middle of the strata,σ_{middle}:	37.75	kN/m^2
Adhesion Factor, α:	0.40	

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Skin Resistance of the pile,q_s: 373.22 kN

(q_s:α*Cu*pi()*d*Ic)

1.2.1.3 **Layer-III**

Type of Strata: Compacted Clay

Average SPT of the strata,N: 60

Bulk Density of the strata,γ: 20 kN/m^3

Undrained Cohesion, Cu: 400.00 kPa

R.L of top of Strata: -7.00 m

R.L of bottom of Strata: -12.00 m

Average Thickness of Strata,I_c: 5.00 m

Effective overburden pressure over the top of strata,σ_{top}: 58.00 kN/m^2

Effective overburden pressure over the bottom of strata,σ_{bottom}: 108.00 kN/m^2

Effective overburden pressure at the middle of the strata,σ_{middle}: 83.00 kN/m^2

Adhesion Factor, α: 0.40

Skin Resistance of the pile,q_s: 1130.97 kN

(q_s:α*Cu*pi()*d*Ic)

1.2.1.4 **Layer-IV**

Type of Strata: Compacted Clay

Average SPT of the strata,N: 60

Bulk Density of the strata,γ: 20 kN/m^3

Undrained Cohesion, Cu: 400.00 kPa

R.L of top of Strata: -12.00 m

R.L of bottom of Strata: -15.00 m

Average Thickness of Strata,I_c: 3.00 m

Effective overburden pressure over the top of strata,σ_{top}: 108.00 kN/m^2

Effective overburden pressure over the bottom of strata,σ_{bottom}: 138.00 kN/m^2

Effective overburden pressure at the middle of the strata,σ_{middle}: 123.00 kN/m^2

Adhesion Factor, α: 0.40

Skin Resistance of the pile,q_s: 678.58 kN

(q_s:α*Cu*pi()*d*Ic)

Ultimate Skin Resistance,q_s: 2277.03 kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata Compacted Clay

Cross-Sectional Area of pile,Ap: 0.159 m^2

R.L of bottom of pile: -15.00

Minimum SPT-value of the Bearing Strata 60

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Undrained Cohesion, Cu=(q_u/2):	400.00	kPa
Bearing Capacity Factor(Nc)	9.00	
Ultimate End Bearing Resistance (Qp)	**572.6**	**kN**
(Qp=Ap*Cu*Nc)		

1.3.0	**Ultimate Load Carrying Capacity (Qu=Qp+Qs**	**2849.6**	**kN**
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	**1139.8**	**kN**
	However, limit Q_{safe} to the structural capacity of pile:	**1000.0**	**kN**

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Our services go beyond

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.

Smarter Tools, Stronger Decisions

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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