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VELTECH CONSULTING ENGINEERS

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GEOTECHNICAL INVESTIGATION REPORT

PROJECT: **GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF (STILT+5) RESIDENTIAL BUILDING AT ROYAL NATURA PHASE-II, SURVEY NO. 139/1 O, METTU STREET, PILLAIYARMADANTHANGAL ROAD, NOOMBAL, CHENNAI-77.**

CLIENT : M/s. Royal Civil Tech.,

REPORT NO	DATE	REVISION-0
VCE/20/GIR–093	24.03.2023	Submission for Design of Foundation

24.03.2023

To

Client : M/s. Royal Civil Tech.,

SUB: GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF (STILT+5) RESIDENTIAL BUILDING AT ROYAL NATURA PHASE-II, SURVEY NO. 139/1 O, METTU STREET, PILLAIYARMADANTHANGAL ROAD, NOOMBAL, CHENNAI-77.

Dear Sir,

We are glad to submit two copy of our final Geotechnical Investigation Report for the above captioned project.

We look forward to hearing from you at your earliest convenience regarding this report.

We are pleased to work for you in this project. We assure our continual services to our best.

Yours Truly,

FOR VELTECH CONSULTING ENGINEERS

Er.R.VENKATA KRISHNAIAH.M.E.,

Geotechnical Consultant

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INTRODUCTION

This report presents the geotechnical investigations results carried out by **Veltech Consulting Engineers**, for the proposed Construction of (Stilt+5) Residential Building At Royal Natura Phase-II, Survey No. 139/1 O, Mettu Street, Pillaiyarmadanthangal Road, Noombal, Chennai-77.

This work was authorized by the **Client : M/s. Royal Civil Tech.,**

Standard Penetration Testing boreholes were drilled at the site up to a maximum depth of 30.0m below existing ground level.

The investigation consists of drilling one borehole, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the Proposed Construction of (Stilt+5) Residential Building At Royal Natura Phase-II, Survey No. 139/1 O, Mettu Street, Pillaiyarmadanthangal Road, Noombal, Chennai-77.

SCOPE OF WORK

The scope of this investigation is to:

- Conducting Standard Penetration Test (SPT) at regular depth intervals.
- Collecting split spoon samples or disturbed soil samples
- Conducting relevant laboratory tests
- Recommend a suitable foundation system and safe bearing pressure at foundation level.

SITE DESCRIPTION

The site for the proposed construction of (Stilt+5) Residential Building At Royal Natura Phase-II, Survey No. 139/1 O, Mettu Street, Pillaiyarmadanthangal Road, Noombal, Chennai-77.
The elevation of site is same from the nearby road level.

EXPLORATION TECHNIQUES

After the visual inspection of the site, the subsurface investigation was carried out as mentioned below:

One (1) exploration boreholes were drilled to a maximum depth of 30.0m.

BH -1 was started on 20.03.2023 and completed on 21.03.2023.

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.

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.

In-Situ Strength Tests:
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.

Collection of Samples:
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.

LABORATORY TESTING

All the extracted soil samples were brought to our Laboratory for further examination in accordance with IS: 1498-1970. Selected samples were subjected to the following physical tests.

1. **Moisture Content**
2. **Sieve Analysis (IS: 2720 Part IV — 1985)**
3. **Liquid limit (IS: 2720 Part V — 1985)**
4. **Plastic Limit and Plasticity Index (IS: 2720 Part VI — 1972)**
5. **Differential Free Swell Test**

The laboratory test results are given in Appendix "C".

SUBSURFACE SOIL DESCRIPTION

Based on boreholes information, sub surface soil profile for the proposed construction Of Residential building is given below:

BH-1

0.0 - 1.5m	Brownish fine sand
1.5 - 4.0m	Brownish yellow fine sand
4.0 - 15.0m	Blackish high plastic and swelling clay
15.0-16.5m	Greyish black medium to fine sand
16.5- 27.0m	Blackish high plastic and swelling sandy clay
27.0-30.0m	Brownish grey high plastic and swelling clay

GROUND WATER

Ground water table was found at the depth of 5.0m below the ground level at the time of field investigation. However it will fluctuate due to seasonal variations.

FOUNDATION RECOMMENDATIONS

Based on the borehole information and laboratory test results in addition to the nature of structure, the recommendations for the proposed structure are given below.

BORED PILE FOUNDATION:

A Pile length of 27.5m has been analyzed below and the corresponding Pile capacities are given. Selection of Pile length was estimated according to soil profile and soil stiffness as obtained from SPT values. In case of bored pile the pile cap shall be placed 1.0m below ground level.

PILE CAPACITIES

Bedrock was not encountered up to a maximum explored depth. Hence, the Piles utilizing friction shall be adopted for the proposed structures. The Pile capacities of the bored piles are worked out considering a depth of 27.5m below ground level as the top of pile level. Estimation of Pile capacities are given below with reference to the boreholes drilled at site

PILE CAPACITY CALCULATIONS				
Pile Length (m)	**Pile Diameter (mm)**	**Factor of Safety = 3.0 Allowable Pile Load Capacity (kN)**	**Lateral load bearing capacity(kN)**	**Uplift Resistance(kN)**
27.5	600	1040	80	850
27.5	750	1350	100	1100

PILE GROUPING

The group efficiency shall be worked out based on number of Piles in a group. Piles shall have a minimum spacing of 2.5 times diameter centre to centre or minimum 1.5 times diameter as clear spacing in order to mobilise frictional resistance, which is a key factor in achieving better Pile capacities. Larger spacing is always preferable, in case of bored piles.

PILE GROUP EFFICENCY

Pile group efficiency will depend on the pattern of arrangement of piles and number of piles in a group. An efficiency of about 60 to 70% shall be considered for the on site soil condition, in general.

However, it shall be decided based on pile load tests. Sequence of casting of Piles shall be such that the adjacent Piles do not get affected during Pile drilling. Tremmie concrete shall be carried out in order to minimise segregation. Water-cement ratio shall also be controlled in order not to be affected by water, existing inside the Pile boring. Gradual pull out of Pile casing is necessary, to avoid necking of Piles.

UPLIFT CAPACITY

Uplift capacity of piles shall be considered as 50% of the ultimate frictional capacity of Piles.

PILE TESTING

The group efficiency shall be worked out based on number of Piles in a group. However, Pile load tests are recommended to observe the performance of the Piles and to re-confirm the theoretical Pile capacities. Load tests to be carried out after a minimum period of 1 week after driving of Pile.

Pile load tests should be conducted by loading up to 1.5 times the service load on working Pile, while minimum two (2) times the service load on Pilot Piles. A minimum of (two) 2 pile load test can be conducted for this project.

FOUNDATION CONSIDERATIONS

A PCC (Plain Cement Concrete) layer of 30cm thickness is recommended below the foundation/pile cap. Any over excavation in the foundation trenches should be re-filled by plain concrete and any disturbed and loose materials found in the foundation trenches should be removed before placement of P.C.C.

Excavated material cannot be used as general backfill material. As per general practice the backfill material should not contain more than 15 % fines passing 0.075 mm sieve, retain 40% on 4.75mm size sieve while the maximum size of gravel allowed is 50mm.

Backfilling materials shall be placed in horizontal layers not exceeding 25 cm thickness and each layer shall be compacted to at least 95% of the maximum dry density.

GENERAL CONSIDERATIONS

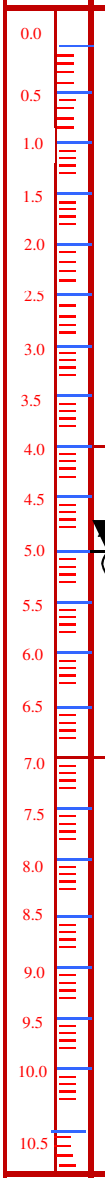
The recommendations for foundation design and construction are based on the information obtained from the boreholes drilled at site. When foundation construction is underway, the recommendations of this report should be checked through field inspection, to validate the information for use during the construction stage. Any variation in underground conditions revealed by the borehole should be brought to our attention for alternate recommendations, if required.

Yours Truly,
FOR VELTECH CONSULTING ENGINEERS

Er.R.VENKATA KRISHNAIAH.M.E.,
Geotechnical Consultant

BOREHOLE LOG

Client	**: M/s. Royal Civil Tech.,**	**Water Table**	**: 5.0m**
Type of building	**: (Stilt+5) Residential Building**	**Ele . Of G.L**	**NIL**
Location	**: Iyappanthangal, Chennai**	**Type Of Boring**	**: Rotary**
B.H. No	**: 1**	**Dia of Boring**	**: 150mm**
Final Depth	**: 30.0m**	**Started on**	**: 20.03.2023**
		Ended on	**: 21.03.2023**



Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
0.0 – 0.5			Brownish fine sand					
0.5 – 1.0			Ditto	3	3	5	8	Loose
1.0 – 1.5								
1.5 – 2.0			Brownish yellow fine sand	4	5	7	12	Medium dense
2.0 – 2.5								
2.5 – 3.0								
3.0 – 3.5			Ditto	3	4	4	8	Loose
3.5 – 4.0								
4.0 – 4.5			Blackish high plastic and swelling clay	2	2	2	4	Soft
4.5 – 5.0	▼							
5.0 – 5.5								
5.5 – 6.0								
6.0 – 6.5			Blackish high plastic and swelling clay	2	3	3	6	Firm
6.5 – 7.0								
7.0 – 7.5								
7.5 – 8.0			Blackish grey medium to fine sand	9	9	8	17	Medium dense
8.0 – 8.5								
8.5 – 9.0								
9.0 – 9.5								
9.5 – 10.0			ditto	5	7	8	15	Medium dense
10.0 – 10.5								

BOREHOLE LOG

Client	**: M/s. Royal Civil Tech.,**	**Water Table**	**: 5.0m**
Type of building	**: (Stilt+5) Residential Building**	**Ele . Of G.L**	**NIL**
Location	**: Iyappanthangal, Chennai**	**Type Of Boring**	**: Rotary**
B.H. No	**: 1**	**Dia of Boring**	**: 150mm**
Final Depth	**: 30.0m**	**Started on**	**: 20.03.2023**
		Ended on	**: 21.03.2023**

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
11.0			Blackish grey medium to fine sand					
11.5								
12.0								
12.5			Ditto	9	11	14	25	Medium dense
13.0								
13.5								
14.0								
14.5								
15.0			Greyish black medium to fine sand	10	17	18	35	Dense
15.5								
16.0								
16.5			Blackish high plastic and swelling sandy clay					
17.0								
17.5			Ditto	1	1	2	3	Soft
18.0								
18.5								
19.0								
19.5								
20.0			Blackish high plastic & swelling clay	2	2	2	4	Soft
21.0								

BOREHOLE LOG

		Water Table	**: 5.0m**
Client	**: M/s. Royal Civil Tech.,**	**Ele . Of G.L**	**: NIL**
Type of building	**: (Stilt+5) Residential Building**	**Type Of Boring**	**: Rotary**
Location	**: Iyappanthangal, Chennai**	**Dia of Boring**	**: 150mm**
B.H. No	**: 1**	**Started on**	**: 20.03.2023**
Final Depth	**: 30.0m**	**Ended on**	**: 21.03.2023**

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
22.0								
22.5			Blackish high plastic and swelling clay	2	3	3	6	Firm
23.0								
23.5								
24.0								
24.5			ditto	3	3	4	7	Firm
25.0								
25.5								
26.0								
26.5								
27.0			Brownish grey high plastic and swelling clay	24	29	61/ 25 cm		Hard
27.5								
28.0								
28.5								
29.0								
29.5			ditto	34	50/7 cm			Very dense
30.0								
30.5			Borehole 1 terminated at the depth of 30.0m					
31.0								
31.5								
32.0								

APPENDIX B

LABORATORY TEST RESULTS

GEOTECHNICAL INVESTIGATION REPORT

VELTECH CONSULTING ENGINEERS **CLIENT : Ms. Royal Civil Tech.,**

Project: (Stilt+5) Commercial Building

1- a) PHYSICAL ANALYSIS OF SOIL BH-1

Test results of Moisture content , Atterberg limits

DEPTH M	Moisture Content%	Atterberg limits				IS Classification
		W_L%	W_P%	I_P%	FSI%	
1.0	13.54	Non plastic				**SP**
2.0	13.19	Non Plastic				**SP**
3.0	20.44	Non Plastic				**SM**
4.5	32.78	62	30	32	65	**CH**
6.0	35.22	64	33	31	65	**CH**
8.0	15.43	Non Plastic				**SP**
10.0	11.31	Non Plastic				**SP**
12.5	12.62	Non Plastic				**SP**
15.0	14.35	Non Plastic				**SM**
17.5	21.64	40	19	21	35	**CI**
20.0	37.28	66	32	34	65	**CH**
22.5	33.15	46	20	26	45	**CI**
25.0	31.69	41	19	22	45	**CI**
27.5	24.88	58	25	33	70	**CH**
30.0	25.13	55	24	31	75	**CH**

2-b) GRAIN SIZE ANALYSIS OF SOIL – BH-2

DEPTH M	GRAVEL SAND %	COARSE SAND %	MEDIUM SAND %	FINE SAND %	SILT + CLAY%
1.0	-	-	25	67	8
2.0	-	-	28	62	10
3.0	2	2	17	33	46
4.5	-	-	-	1	99
6.0	-	-	-	1	99
8.0	-	-	41	48	11
10.0	-	1	53	37	9
12.5	-	1	57	35	7
15.0	-	2	52	33	13
17.5	-	-	10	31	59
20.0	-	-	-	1	99
22.5	-	-	5	28	67
25.0	-	-	7	30	63
27.5	-	1	2	2	95
30.0	-	-	1	1	98

ABBREVIATION :

Note

- W_N = Natural Moisture content (%)
- W_L = Liquid limit (%)
- W_P = Plasticity Limit (%)
- I_P = Plasticity Index (%)
- F.S.I = Free Swell Index (%)
- IS = Indian Standard Classification
- CL = Low compressibility Clay of $W_L < 35\%$
- CI = Inorganic Clay of $35\% < W_L < 50\%$
- CH = High Compressibility Clay of $W_L > 50\%$
- SP = Poorly graded sand
- GP = Poorly graded gravel
- SW = Well graded sand
- SM = Silty sand

APPENDIX A

BOREHOLE LOG

APPENDIX D

PILE CAPACITY CALCULATIONS

APPENDIX C

PHOTOS

GEOTECHNICAL INVESTIGATION REPORT

VELTECH CONSULTING ENGINEERS

CLIENT : Ms. Royal Civil Tech.,

Project: (Stilt+5) Commercial Building



Client : M/s. Royal Civil Tech.,
Project : (Stilt+5) Residential Building
Location : Iyappanthangal, Chennai

DESIGN OF PILE FOUNDATION (Ref BH-1)

1.0 Type of Installation of Pile **Bored pile**

1.1 Geometrical Data

Assumed Diameter of pile(D)	:	600.00	mm
Length of Pile	:	27.50	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

Layer-I

Type of Strata	:	Clay	
Length of strata,lc		14.00	m
Average SPT of the strata,N	:	13	
Bulk Density of the strata, γ	:	16.86	kN/m^3
Undrained Shear Strength (Cu)	:	30.00	kN/m^2
Adhesion, σ	:	0.50	
Skin Resistance of the pile,q_s	:	395.64	kN
(q :σ*Cu*pi*d*Ic)			

1.2.2 Layer-II

Type of Strata	:	sand	
Average SPT of the strata,N	:	9	
Bulk Density of the strata, γ	:	17.50	kN/m^3
Angle of Shearing Resistance - Limited to a Maximum of	:	30.00	Deg
tan phi		0.58	
Top of Strata	:	0.00	m
Bottom of Strata	:	4.00	m
Average Thickness of Strata,I_c	:	4.00	m
Effective overburden pressure at the middle of the strata,σ_{mid}	:	15.00	kN/m^2
Coef. Earth Pressure at Rest		1.00	
Skin Resistance of the pile,q_s	:	65.22	kN
(q_s: σ *k*tanϕ *pi()*d*Ic)			

1.2.2 Layer-III

Type of Strata	:	sand	
Average SPT of the strata,N	:	23	
Bulk Density of the strata, γ	:	18.00	kN/m^3
Angle of Shearing Resistance - Limited to a Maximum of	:	31.00	Deg
tan phi		0.60	
Top of Strata	:	7.00	m
Bottom of Strata	:	16.50	m
Average Thickness of Strata,I_c	:	9.50	m
Effective overburden pressure at the middle of the strata,σ_{mid}	:	164.04	kN/m^2
Coef. Earth Pressure at Rest		1.00	
Skin Resistance of the pile,q_s	:	1763.02	kN
(q_s: σ *k*tanϕ *pi()*d*Ic)			

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	Clay	

	Cross-Sectional Area of pile,Ap	:	0.2826	m^2
	R.L of bottom of pile	:	27.50	m
	Minimum SPT-value of the Bearing Strata	:	50	
	Unconfined compression strength (c)	:	150.00	Kn/m2
	Bearing Capacity Factor(Nc)	:	9.00	
	Ultimate End Bearing Resistance (Qp)	:	**381.51**	kN
	(Qp=Ap*c*Nc)			
1.3.0	**Ultimate Load Carrying Capacity (Qs+Qp)**	:	**2605.40**	kN
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	:	**1042.2**	kN
	say		**1040**	**kN**
	Lateral Load Bearing Capacity		**83.2**	**kN**
	Ultimate uplift resistance		**2223.89**	**kN**
	Safe Uplift resistance		**741.30**	**kN**
	Self wt. of pile	**:**	**116.57**	
	Say		**857.87**	**kN**

Client : M/s. Royal Civil Tech.,
Project : (Stilt+5) Residential Building
Location : Iyappanthangal, Chennai

DESIGN OF PILE FOUNDATION (Ref BH-1)

1.0 Type of Installation of Pile **Bored pile**

1.1 Geometrical Data

Assumed Diameter of pile(D)	:	750.00	mm
Length of Pile	:	27.50	m

1.2 Design of Pile for Vertical Compression

1.2.1 Computation of Skin Resistance:

Layer-I

Type of Strata	:	Clay	
Length of strata,lc		14.00	m
Average SPT of the strata,N	:	13	
Bulk Density of the strata, γ	:	16.86	kN/m^3
Undrained Shear Strength (Cu)	:	30.00	kN/m^2
Adhesion, σ	:	0.50	
Skin Resistance of the pile,q_s	:	494.55	kN
(q :σ*Cu*pi*d*Ic)			

1.2.2 Layer-II

Type of Strata	:	sand	
Average SPT of the strata,N	:	9	
Bulk Density of the strata, γ	:	17.50	kN/m^3
Angle of Shearing Resistance - Limited to a Maximum of	:	30.00	Deg
tan phi		0.58	
Top of Strata	:	0.00	m
Bottom of Strata	:	4.00	m
Average Thickness of Strata,I_c	:	4.00	m
Effective overburden pressure at the middle of the strata,σ_{mid}	:	15.00	kN/m^2
Coef. Earth Pressure at Rest		1.00	
Skin Resistance of the pile,q_s	:	81.53	kN
(q_s: σ *k*tanϕ *pi()*d*Ic)			

1.2.2 Layer-III

Type of Strata	:	sand	
Average SPT of the strata,N	:	23	
Bulk Density of the strata, γ	:	18.00	kN/m^3
Angle of Shearing Resistance - Limited to a Maximum of	:	31.00	Deg
tan phi		0.60	
Top of Strata	:	7.00	m
Bottom of Strata	:	16.50	m
Average Thickness of Strata,I_c	:	9.50	m
Effective overburden pressure at the middle of the strata,σ_{mid}	:	164.04	kN/m^2
Coef. Earth Pressure at Rest		1.00	
Skin Resistance of the pile,q_s	:	2203.78	kN
(q_s: σ *k*tanϕ *pi()*d*Ic)			

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	Clay

	Cross-Sectional Area of pile,Ap	:	0.4415625	m^2
	R.L of bottom of pile	:	27.50	m
	Minimum SPT-value of the Bearing Strata	:	50	
	Unconfined compression strength (c)	:	150.00	Kn/m2
	Bearing Capacity Factor(Nc)	:	9.00	
	Ultimate End Bearing Resistance (Qp)	:	**596.11**	kN
	(Qp=Ap*c*Nc)			
1.3.0	**Ultimate Load Carrying Capacity (Qs+Qp)**	:	**3375.97**	kN
	Safe Load Carrying Capacity (Qsafe =Qu/2.5)	:	**1350.4**	kN
	say		**1350**	**kN**
	Lateral Load Bearing Capacity		**108**	**kN**
	Ultimate uplift resistance		**2779.86**	**kN**
	Safe Uplift resistance		**926.62**	**kN**
	Self wt. of pile	**:**	**182.14**	
	Say		**1108.76**	**kN**



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