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JOSMAR
CONSULTING ENGINEERS
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Client File # 22-I-119

04th January 2023

M/s. Endee Shelters and Properties Pvt Ltd

Site Address:

No. 13/7,
Sadhasiva Apartments,
Thiruvengadam street,
R. A Puram,
Chennai - 600028

Subject: **GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF STILT+5 RESIDENTIAL BUILDING, CHENNAI.**

Dear Sir,

We are pleased to hereby transmit one (01) original and one (01) photocopy of our Geotechnical Investigation Report for the above captioned project.

Should you have any questions, please do not hesitate to contact this office.

Please note that our final report is deemed acceptable to you, if we do not hear from you in writing within 10 calendar days from the date that you received it.

It has been a pleasure being of service to you on this project. Assuring you of our continued co-operation, we remain.

Yours Truly,

FOR JOSMAR CONSULTING ENGINEERS
(Geotechnical, Survey & Materials Consultant)

JOSMAR CONSULTING ENGINEERS Chennai-42

Er.S.RAVICHANDRAN. M.E.,PhD
CEO

No. 9, Officers Colony, 100 Feet By Pass Road, Opp. I.O.B. Bank, Velachery, Chennai - 600 042.
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GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF STILT+5 RESIDENTIAL BUILDING, CHENNAI.

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INTRODUCTION

This report presents the results of the geotechnical investigations carried out by JOSMAR Consulting Engineers, Geotechnical Engineering Division, for the proposed construction of Stilt+5 Residential building located at No. 13/7, Sadhasiva Apartments, Thiruvengadam street, R. A Puram, Chennai - 600028.

.

This work was authorized by the Client, **M/s. Endee Shelters and Properties Pvt Ltd.**
Three bore holes have been requested by the client for the land area measuring about 5750 Sqft. Our recommendations are based on these three bore holes only.

Standard penetration tests were conducted at the bore holes drilled at site, up to a maximum depth of 20.30m below existing ground level.

The investigation consists of drilling one bore hole, soil sampling, field and laboratory testing and preparation of a Geotechnical Report for the proposed construction of Stilt+5 residential building.

SCOPE OF WORK

The scope of this investigation is to:

i) Determine the soil profile at site, with ground water observation.
ii) Recommend a suitable foundation system and safe bearing pressure at foundation level.

Three (3) bore holes were drilled to a maximum depth of 20.30m.
Soil samples were collected for visual identification, classification and laboratory testing.

Key plan & bore hole location plan are presented in Appendix- A.
Bore hole log is presented in Appendix- B.
Laboratory test results are presented in Appendix- C.
Bearing capacity and settlement calculations are presented in Appendix- D, for spread footings.
Pile foundation calculations are presented in Appendix-E.

SITE DESCRIPTION

The site for the proposed construction of Industrial Bulding is located at No. 13/7, Sadhasiva Apartments, Thiruvengadam street, R. A Puram, Chennai - 600028.

The top surface of the site is at the same level of the adjacent road level.

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EXPLORATION PROGRAM & TECHNIQUES

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

Three (3) exploration boreholes were drilled to a maximum depth of 20.30m

BH- 1 was started on 20th December 2022 and completed on 21th December 2022
BH- 2 was started on 21st December 2022 and completed on 22nd December 2022
BH- 3 was started on 22nd December 2022 and completed on 23rd December 2022

Boreholes were drilled at site, in order to obtain an average soil profile of the site. Rotary drilling was performed using water as drilling fluid in the sub soil with casing pipe to stabilize the borehole up to the required depth. Field testing and sampling are conducted in accordance with IS: 2131-1981.

Standard penetration tests (SPTs) were performed on the sub soil. In this test, a standard split spoon (IS:9640-1980) of length about 450mm and external/ internal diameter of 51/35 mm initially penetrates the soil for 15cm to bypass the expected accumulated sludge at the bottom of the hole by means of a 63.5 kg (140 lbs.) hammer falling freely along a guide from a height of 750 mm.

The total number of blows (N) required, to advance the spoon into the bore, for another two successive 15cm (total of 30cm) is recorded as a measure of the soil relative density or consistency.

The field work was carried out under the close supervision of our engineer in accordance with Indian Standard mentioned earlier.

LABORATORY TESTING PROGRAM

All the extracted soil samples were brought to the Geotechnical & Materials Testing Laboratory of JOSMAR *Consulting Engineers* for further examination in accordance with IS:1498-1970.
Soil samples were subjected to the following physical tests.

1. Moisture Content (IS: 2720 Part II- 1973)
2. Sieve Analysis (IS: 2720 Part IV- 1985)
3. Liquid Limit (IS: 2720 Part 5, 1985)
4. Plastic Limit (IS: 2720 Part 5, 1985)
5. Differential free swell Index (IS: 2720 Part 40, 1977)

The laboratory test results are presented in Appendix- C.

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SUBSURFACE SOIL DESCRIPTION

Based on the bore hole information, the sub surface soil profile at the proposed site is given below.

BH-1

Borehole No.	Depth (m)	Soil Description	Relative density / Consistency
01	0.00 to 1.50	Brownish silty sand (SM)	Loose
	1.50 to 4.00	Brownish sandy low plastic clay (CL)	Firm to stiff
	4.00 to 11.00	Brownish silty sand (SM) & Brownish poorly graded sand-silt mixtures (SP-SM)	Medium dense
	11.00 to 17.00	Brown sandy low plastic clay (CL) & Black high plastic clay (CH)	Soft to Hard
	17.00 to 20.00	Brownish silty sand (SM)	Dense to very dense

BH-2

Borehole No.	Depth (m)	Soil Description	Relative density / Consistency
02	0.00 to 1.50	Filling (Bricks and concrete)	-
	1.50 to 4.00	Brownish poorly graded sand-silt mixtures (SP-SM) & Brownish silty sand (SM)	Medium dense
	4.00 to 5.00	Black high plastic clay (CH)	Stiff
	5.00 to 20.00	Brownish silty sand (SM) & (SP-SM)	Medium dense to Very dense

BH-3

Borehole No.	Depth (m)	Soil Description	Relative density / Consistency
03	0.00 to 1.50	Filling (Brick and concrete)	-
	1.50 to 2.50	Brownish sandy low plastic clay (CL)	Stiff
	2.50 to 3.50	Brownish poorly graded sand-silt mixtures (SP-SM)	Medium dense
	3.50 to 5.00	Black silty low plastic clay (CL)	Firm
	5.00 to 11.00	Brownish silty sand (SM) & (SP-SM)	Medium to dense

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	11.00 to 19.00	Black silty medium plastic clay (CI) & high plastic clay (CH)	Soft to very stiff
	19.00 to 20.30	Brownish silty sand (SM)	Very dense

GROUND WATER

Depth of ground water table is noted as 2.00m below the existing ground level during the time of field investigation. However, it may fluctuate due to seasonal variations and local sewerage disposal practices.

FOUNDATION ANALYSIS

Shallow foundation system is not feasible for the proposed building, as the estimated settlement for spread foundation is not within the allowable limit. The settlement and allowable bearing pressure calculations were carried out for spread footing. Initially, bearing capacity calculation was carried out using average soil properties of the founding strata. Water table was observed at 4.00m during the time of investigation. However necessary corrections were carried out for N-values. Corrected N-value table is presented in appendix- D. Safety factor for bearing capacity calculation was considered as 2.5 as per IS: 1904. Settlement calculation was carried out by using appropriate corrected N-values for subsoil layer up to a depth of 6.00m below ground level for spread.

By considering borehole-1, allowable bearing pressure is estimated as 180kpa and the corresponding immediate and total settlement is estimated as 177mm which is not within the tolerable limit of settlement of 50mm as per IS: 1904-1986. The analysis of spread footing is presented in appendix- D.

Hence pile foundation is recommended for the proposed structure. Pile depth is fixed as 21.00m where highly weathered rock was encountered. The analysis of pile foundation calculations are presented in appendix-E.

FOUNDATION RECOMMENDATION

Pile foundation

Pile foundation system shall be adopted for the proposed structure by terminating the piles in deep strata. It is a normal practice to adopt same pile length, for better interaction and to achieve uniform settlement. **Pile load tests have to be done in order to confirm the calculated pile capacities.** Under each column, there should be a pile cap to transfer the support load to the carrying piles. The plan and dimensions of pile cap could be estimated according to the required number of piles and

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considered center to center spacing between piles. A pile length of 21.00m depth has been analysed below the existing ground level. The corresponding pile capacities are given. Selection of pile length is estimated according to the soil profile and soil stiffness as obtained from SPT values.

PILE CAPACITIES

The piles utilizing friction and end bearing capacities are adopted for the proposed structure. The pile capacities of the bored, cast in situ piles are worked out considering a depth of 21.00m below the existing ground level as the top of pile level. Estimation of pile capacities are given below with reference to the boreholes drilled at site. Pile design calculations are presented in appendix -E.

PILE LOAD CAPACITIES				
Pile Depth (m)	Pile Diameter (mm)	(Factor of Safety=2.5) Allowable Pile Load Capacity (kN)	Lateral load bearing capacity (kN)	Uplift Resistance (kN)
21.00	600	680	54	350
21.00	750	1080	86	440
21.00	1000	2100	168	590

Note: The above recommendations are given by assuming similar soil strata in the whole site area. In case of any variations in the soil profile, the above recommendations are not applicable and further investigation may be carried out.

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 EFFICIENCY

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 onsite 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 minimize 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.

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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 the pile. Pile load tests should be conducted by loading up to 1.5 times the service load on working pile, while minimum two times the service load on pilot piles. A minimum number of 2% of total number piles can be tested for pile load test for this project.

BACKFILLING AND COMPACTION

Excavated soil is not recommended to be used as general backfill material because the consistency of clayey soil may change once remoulded and becomes more plastic. As per general practice, the backfill material should not contain more than 15% fines passing 0.075mm 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 25cm thickness and each layer shall be compacted to at least 95% of the maximum dry density.

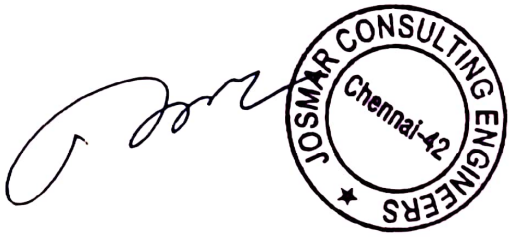
EXCAVATION

Excavation through the overburden soil can be carried out by conventional equipment such as dozers and JCB.

GENERAL COMMENTS

The recommendations for the foundation design and constructions are based on the information obtained from these five 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 the underground conditions revealed by the borehole should be brought to our attention for alternate recommendations, if needed.



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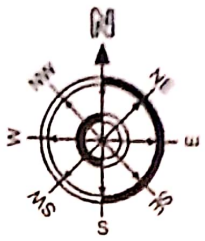
APPENDIX- A

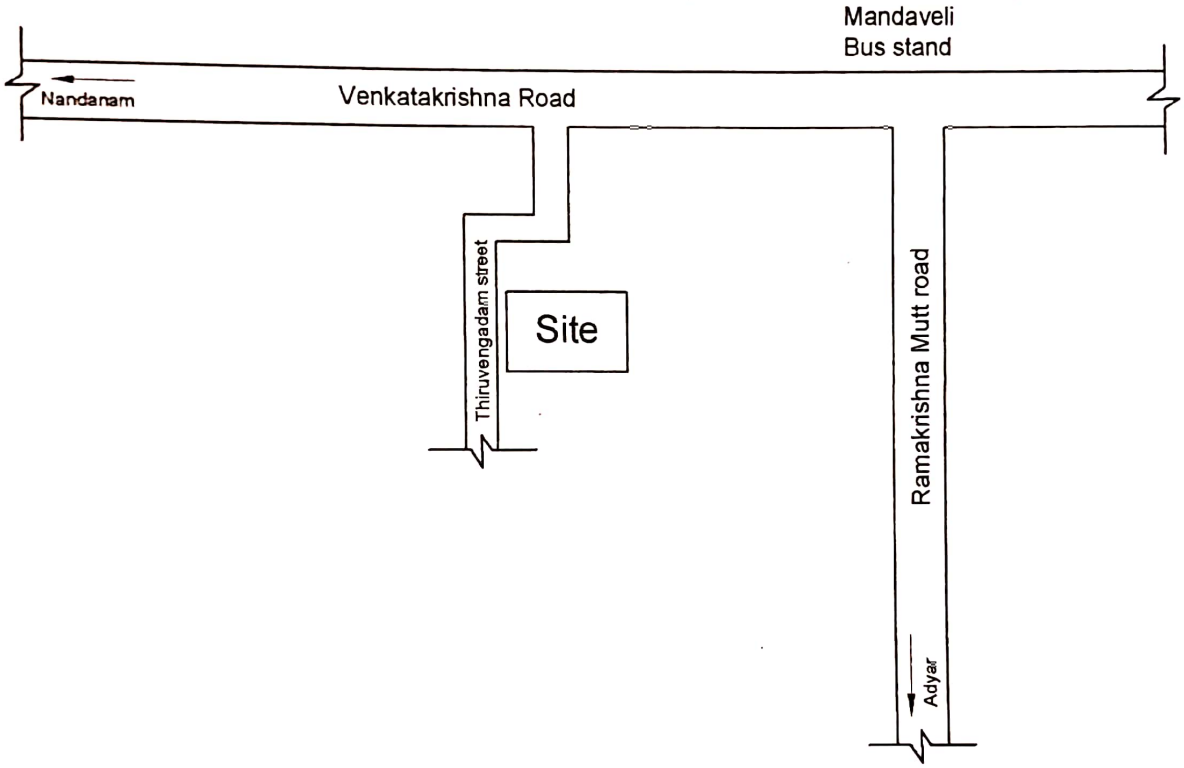
KEY PLAN &
BORE HOLE LOCATION PLAN

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KEY PLAN





Title : **SITE KEY PLAN**	Client: M/s. Endee Shelters and Properties Pvt Ltd	
Site : **No. 13/7, Sadhasiva Apartments, Thiruvengadam street, R. A. Puram, Chennai-600028**	Scale : NTS	File no : 1
	Date :31.12.2022	Drg no : 1
	Drn by: Berlin	Sheet no : 1/2

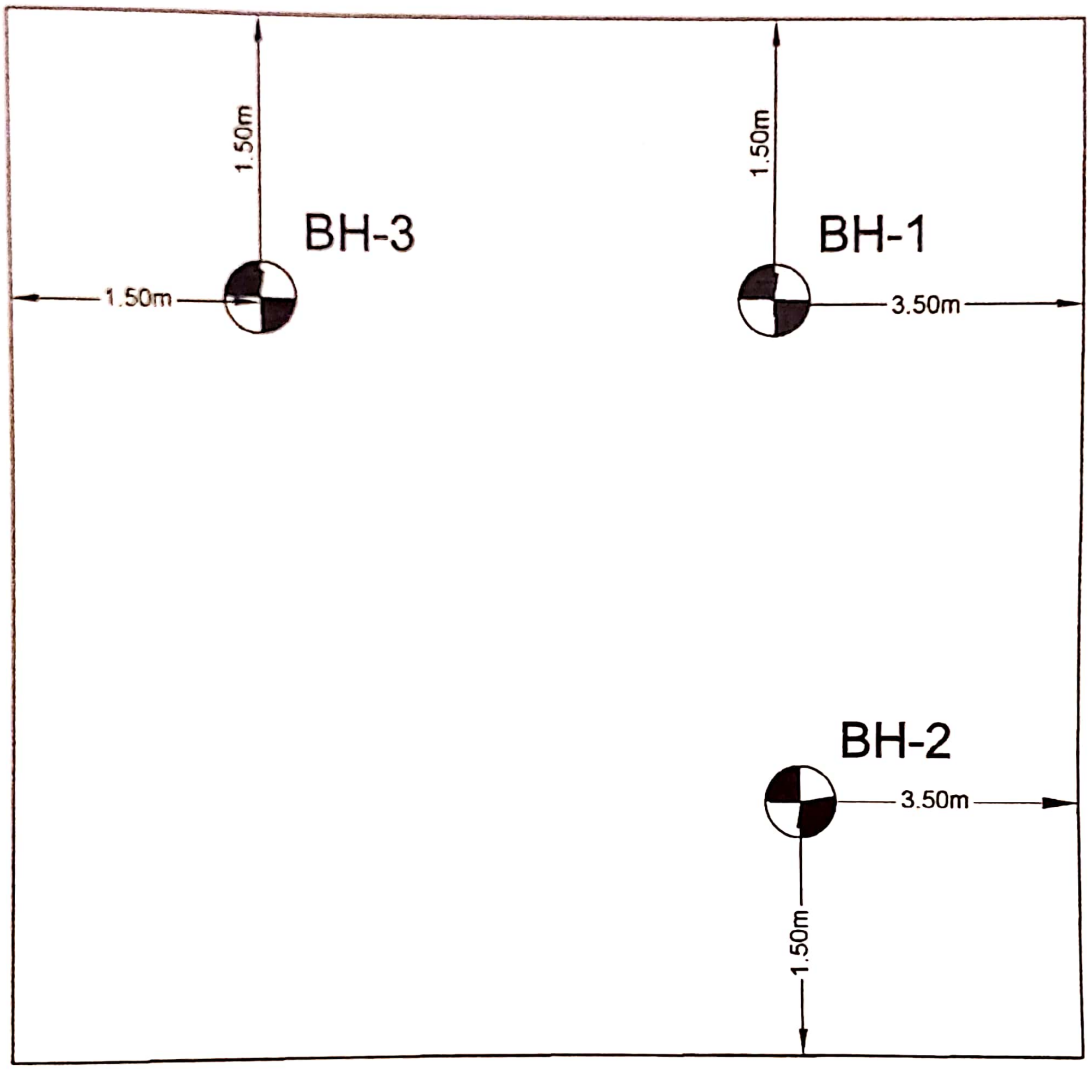
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BORE HOLE LOCATION





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Title : **BORE HOLE LOCATION**	Client: M/s. Endee Shelters and Properties Pvt Ltd	
Site : **No. 13/7, Sadhasiva Apartments, Thiruvengadam street, R. A. Puram, Chennai-600028**	Scale : NTS	File no : 2
	Date :31.12.2022	Drg no : 2
	Drn by: Berlin	Sheet no : 2/2

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APPENDIX- B

BORE HOLE LOG &

CROSS SECTION OF BORE HOLE

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BORE HOLE LOG

Client	: M/s. Endee Shelters and Properties Pvt Ltd	**Elevation Of G.L**	: 0.00m
Project	: Stilt+5 Residential Building	**Water Table**	: 2.00m
Location	: R. A Puram	**Type Of Boring**	: Rotary
Bore hole No	: 1	**Dia of Boring**	: 150mm
Final Depth	: 20.00m	**Started on**	: 20.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.	**Ended on**	: 21.12.2022

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
0.0 – 1.5			Brownish silty sand (SM)	3	4	5	9	Loose
1.5 – 2.0	▼		Brownish sandy low plastic clay (CL)	3	3	4	7	Firm
2.0 – 3.5			Ditto	3	4	5	9	Stiff
4.0 – 4.5			Brownish poorly graded sand-silt mixtures (SP-SM)	5	7	9	16	Medium dense
5.0 – 6.0			Brownish silty sand (SM)	6	9	10	19	Medium dense
6.5 – 7.5			Brownish poorly graded sand-silt mixtures(SP-SM)	8	10	13	23	Medium dense
8.0 – 10.0			Ditto	8	11	15	26	Medium dense

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BORE HOLE LOG

Client	: M/s. Endee Shelters and Properties Pvt Ltd	**Elevation Of G.L** :	0.00m
Project	: Stilt+5 Residential Building	**Water Table** :	2.00m
Location	: R. A Puram	**Type Of Boring** :	Rotary
Bore hole No	: 1	**Dia of Boring** :	150mm
Final Depth	: 20.00m	**Started on** :	20.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.	**Ended on** :	21.12.2022

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
10.5			Ditto	9	12	17	29	Medium dense
11.0								
11.5			Black sandy low plastic clay (CL)	8	13	18	31	Hard
12.0								
12.5								
13.0								
13.5			Black high plastic clay (CH)	7	10	11	21	Very stiff
14.0								
14.5								
15.0								
15.5			Ditto (CH)	1	1	1	2	soft
16.0								
16.5								
17.0								
17.5			Brownish silty sand (SM)	13	12	20	32	Dense
18.0								
18.5								
19.0								
19.5			Brownish silty sand (SM)	50/7cm (P)				Very dense
20.0			Borehole-1 terminated at a depth of 20.00m in very dense strata					

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BORE HOLE LOG

		Elevation Of G.L	: 0.00m
Client	: M/s. Endee Shelters and Properties Pvt Ltd	Water Table	: 2.00m
Project	: Stilt+5 Residential Building	Type Of Boring	: Rotary
Location	: R. A Puram	Dia of Boring	: 150mm
Bore hole No	: 2	Started on	: 21.12.2022
Final Depth	: 20.00m	Ended on	: 22.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.		

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
0.0 – 1.5			Filling (Concrete and bricks)					
1.5 – 3.5	▼		Brownish poorly graded sand-silt mixtures (SP-SM)	4	7	9	16	Medium dense
			Brownish silty sand (SM)	5	7	11	18	Medium dense
4.0 – 4.5			Black high plastic clay (CH)	3	4	4	8	Stiff
5.0 – 6.0			Brownish silty sand (SM)	7	10	12	22	Medium dense
6.5 – 7.5			Ditto (SP)	8	11	15	26	Medium dense
8.0 – 9.0			Ditto (SP-SM)	10	12	17	29	Medium dense
9.5 – 10.0								

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BORE HOLE LOG

Client	: M/s. Endee Shelters and Properties Pvt Ltd	Elevation Of G.L :	0.00m
Project	: Stilt+5 Residential Building	Water Table :	2.00m
Location	: R. A Puram	Type Of Boring :	Rotary
Bore hole No	: 2	Dia of Boring :	150mm
Final Depth	: 20.00m	Started on :	21.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.	Ended on :	22.12.2022

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
10.5			Ditto (SP)	9	14	19	33	Dense
11.0								
11.5								
12.0			Black poorly graded sand-silt mixtures (SP-SM)	11	15	5	20	Medium dense
12.5								
13.0								
13.5								
14.0			Ditto (SP-SM)	16	17	25	42	Dense
14.5								
15.0								
15.5			Ditto (SP-SM)	14	17	22	39	Dense
16.0								
16.5								
17.0								
17.5			Ditto (SM)	50/6cm (P)				Very dense
18.0								
18.5								
19.0								
19.5								
20.0				Drilling rebound				Very dense
			Borehole-2 terminated at a depth of 20.00m in very dense strata					

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BORE HOLE LOG

Client	: M/s. Endee Shelters and Properties Pvt Ltd	**Elevation Of G.L**	: 0.00m
Project	: Stilt+5 Residential Building	**Water Table**	: 2.00m
Location	: R. A Puram	**Type Of Boring**	: Rotary
Bore hole No	: 3	**Dia of Boring**	: 150mm
Final Depth	: 20.30m	**Started on**	: 22.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.	**Ended on**	: 23.12.2022

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N-Value	Relative Density /Consistency
0.0 – 1.5			Filling (Bricks and Concrete)					
1.5 – 2.5	▼		Brownish sandy low plastic clay (CL)	3	5	6	11	Stiff
2.5 – 3.5			Brownish poorly graded sand-silt mixtures (SP-SM)	6	9	11	20	Medium dense
3.5 – 4.5			Black silty low plastic clay (CL)	2	2	2	4	Firm
5.0 – 6.0			Brownish silty sand (SM)	8	12	17	29	Medium dense
6.5 – 7.5			Ditto (SP-SM)	11	14	18	32	Dense
8.5 – 9.0			Ditto (SP-SM)	10	13	17	30	Dense
9.5 – 10.0								

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BORE HOLE LOG

Client	: M/s. Endee Shelters and Properties Pvt Ltd	**Elevation Of G.L**	: 0.00m
Project	: Stilt+5 Residential Building	**Water Table**	: 2.00m
Location	: R. A Puram	**Type Of Boring**	: Rotary
Bore hole No	: 3	**Dia of Boring**	: 150mm
Final Depth	: 20.30m	**Started on**	: 22.12.2022
Site Address	: Thiruvengadam street, R. A Puram, Chennai-600028.	**Ended on**	: 23.12.2022

Depth (m)	GWL	SYMBOL	DESCRIPTION	SPT COUNT 0 -15 cm	15 -30 cm	30 -45 cm	N- Value	Relative Density /Consistency
10.5			Ditto (SP-SM)	12	14	19	33	Hard
11.0			Brownish silty low plastic clay (CL)	7	10	14	24	Very stiff
12.0								
12.5								
13.0								
13.5			Black silty medium plastic clay (CI)	1	2	1	3	Soft
14.0								
14.5								
15.0								
15.5			Black high plastic clay (CH)	3	3	3	6	Firm
16.0								
16.5								
17.0								
17.5			Black medium plastic clay (CI)	2	2	3	5	Firm
18.0								
18.5								
19.0								
19.5			Brownish silty sand (SM)	50/8cm (P)				Very dense
20.0				50/0cm (P)				Very dense
			Borehole-3 terminated at a depth of 20.30m in very dense strata					

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CROSS SECTION OF BORE HOLES

Client : M/s. Endee Shelters and Properties Pvt Ltd
Project : Stilt+5 Residential Building
Location : R. A Puram
Water Table : 2.00m

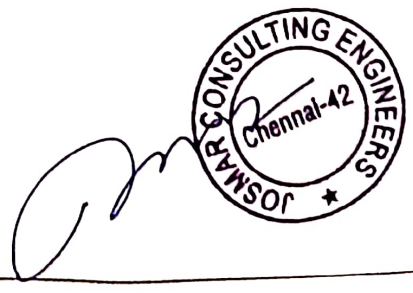
Depth (m)	BH-1		BH-2		BH-3	
	SPT	SYM	SPT	SYM	SPT	SYM
0.5						
1.0	9					
1.5						
2.0	7		16		11	
2.5						
3.0	9		18		20	
3.5						
4.0					4	
4.5	16		8			
5.0						
5.5						
6.0	19		22		29	
6.5						
7.0						
7.5	23		26		32	
8.0						
8.5						
9.0	26		29		30	
9.5						
10.0						
10.5	29		33		33	
11.0						
11.5					24	
12.0	31		20			
12.5						
13.0						
13.5					3	
14.0	21		42			
15.0					6	
16.0	2		39			
17.0					5	
18.0	32		>50			
19.0					>50	
20.0	>50		>50			
21.0						
22.0						

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APPENDIX- C

LABORATORY TEST RESULTS



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PHYSICAL ANALYSIS OF SOIL- BH- 1

DEPTH M	W_N %	W_L %	W_P %	I_P %	FSI %	IS	GRAVEL %	COARSE SAND %	MEDIUM SAND %	FINE SAND %	SILT+ CLAY %
1.00	18	Non Plastic				SM	23	3	35	22	17
2.00	22	33	17	16	33	CL	6	0	2	27	64
3.00	21	37	18	19	20	CL	2	2	4	4	88
4.50	21	Non Plastic				SP-SM	0	0	19	75	6
6.00	20					SM	1	1	24	59	15
7.50	22					SP-SM	0	0	20	75	5
9.00	22					SP-SM	0	0	13	80	6
10.50	18					SP-SM	0	0	23	73	4
12.00	24	28	14	14	10	CL	0	0	1	26	73
14.00	53	68	32	36	50	CH	0	0	6	17	76
16.00	57	85	40	45	77	CH	0	0	1	1	97
18.00	14	Non Plastic				SM	0	1	10	43	45
20.00	12					SM	3	6	33	33	26

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PHYSICAL ANALYSIS OF SOIL- BH- 2

DEPTH M	W_N %	W_L %	W_P %	I_P %	FSI %	IS	GRAVEL %	COARSE SAND %	MEDIUM SAND %	FINE SAND %	SILT+ CLAY %
2.00	20	Non Plastic				SP-SM	0	0	51	41	8
3.00	19					SM	0	0	55	31	14
4.50	29	65	28	32	50	CH	0	0	1	2	96
6.00	24	Non Plastic				SM	0	0	0	77	22
7.50	18					SP	0	0	34	62	4
9.00	16					SP-SM	0	0	43	51	5
10.50	20					SP	1	3	65	27	4
12.00	19					SP-SM	1	1	64	30	5
14.00	16					SP-SM	0	0	51	43	6
16.00	16					SP-SM	0	0	54	39	7
18.00	16					SM	1	2	31	33	33

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PHYSICAL ANALYSIS OF SOIL- BH- 3

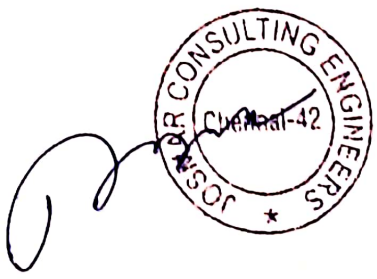
DEPTH M	W_N %	W_L %	W_P %	I_P %	FSI %	IS	GRAVEL %	COARSE SAND %	MEDIUM SAND %	FINE SAND %	SILT+ CLAY %
1.00	21	33	15	18	24	CL	0	0	4	44	51
2.00	15	Non Plastic				SP-SM	0	1	30	61	9
3.00	53	35	17	18	25	CL	0	0	1	12	87
4.50	21	Non Plastic				SM	0	0	1	69	31
6.00	15					SP-SM	0	0	28	64	8
7.50	14					SP-SM	0	0	33	58	9
9.00	17					SP-SM	0	1	69	23	6
10.50	7	35	18	17	28	CL	0	0	46	50	72
12.00	5	38	21	17	30	CI	0	0	0	1	78
14.00	50	52	25	27	37	CH	0	0	2	8	90
16.00	49	35	16	19	30	CI	0	0	2	5	74
18.00	14	Non Plastic				SM	2	3	27	33	35

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ABBREVIATION:

W_N	=	Natural Moisture content (%)
W_L	=	Liquid limit (%)
W_P	=	Plastic Limit (%)
I_P	=	Plasticity Index (%)
FSI	=	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 $W_L > 50\%$
SM	=	Silty sand
SP-SM	=	Poorly graded sand-silt mixtures
SP	=	Poorly graded sand



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Correlations of SPT N values with Common properties of soils

A) Granular Soil

Standard Penetration No., SPT N	Description	Relative Density, Dr %	Approx. Angle of Internal Friction, Φ°	Approx. Rang of Most. Unit Wt.,ɣ kN/m^3
< 4	Very loose	< 20	< 29	11-16
4-10	Loose	20-40	29-30	14-18
10-30	Medium Dense	40-60	30-36	17-20
30-50	Dense	60-80	36-41	17-22
> 50	Very Dense	> 80	> 41	20-29

B) Cohesive Soil

Standard Penetration No., SPT N	Description	Unconfined Compressive Strength, kPa	Approx. Rang of Most. Unit Wt., , ɣkN/m^3
< 2	Very Soft	0-25	14.4-16
2-4	Soft	25-50	16-17.4
4-8	Firm (medium)	50-100	17.6-19.2
8-15	Stiff	100-200	19.2-20.8
15-30	Very Stiff	200-400	20.8-22.4
> 30	Hard	> 400	> 20

Note: These values are most appropriate values in general. However, the soil properties vary between sites to site and hence it shall be used only for guidance

Keeping Samples:

1. Soil samples will be kept up to 15 days from the date of submission of report.
2. Sample disposal will be carried out for every 15 days.

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APPENDIX- D

SPREAD DESIGN AND SETTLEMENT CALCULATION



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Settlement Calculation as per IS 8009- Part-1 for BH-1

Immediate settlement = q x B x (1-m²) x If / Es

q - Allowable bearing pressure =	180	kPa
B - width of foundation =	2.00	m
m - poisson's ratio of soil =	0.50	
If - Influence factor (Centre) =	1.12	
Es-Modulus of Elasticity of Soil =	6368	kPa
Immediate settlement = q x B x (1-m²) x If / Es =	0.04749	
Immediate Settlement =	**47**	**mm**

SAFE BEARING CAPACITY BASED ON SETTLEMENT

DEPTH	WIDTH	ALLOWABLE SETTLEMENT	SAFE BEARING CAPACITY
2.00m	2.00m	47mm	180 kPa

Pressure influence up to 6.00m due to foundation loads has been considered. An immediate maximum settlement of 47mm and consolidation settlement of 130mm under the centre of foundation has been estimated which is not within the total maximum allowable limit of settlement 50mm. Hence spread foundation shall not be adopted.

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COMPUTATION OF BEARING CAPACITY AS PER IS: 6403:1981 FOR BH-1

1 Geometrical Data :

Shape of the Foundation	Square	
Shape considered for bearing capacity design	Square	
Size of Foundation (B)	**2.00**	m
Length to Breadth Ratio of Foundation (L/B)	1	
Depth of Foundation below E G L. (D_f):	**2.00**	m
Inclination of Vertical Load with the Vertical (α)	0.00	Deg.

2 Soil Data :

Type of Bearing Strata :	Clay	
Design SPT "N" value of the Bearing Strata:	12	
Type of Shear Failure:	General	
Undrained Shear Strength (Su):	**60**	kPa

3 Design Parameters:

Saturated Density of Soil above the foundation detph (γ_{bulk})	17.00	kN/m^3
Effective Overburden pressure at foundation level (q)	14.40	kPa
Water Table Correction Factor (w')	0.50	

Bearing Capacity Factors:

N_c = 5.140
N_q = N/A
N_γ = N/A

Shape Factors:

S_c = 1.300
S_q = N/A
S_γ = N/A

Depth Factors :

D_c = 1.200
D_q = N/A
D_γ = N/A

Inclination Factor:

I_c = 1.0000
I_q = N/A
I_γ = N/A

4 Ultimate Bearing Capacity (Qu) :

Qu=Cu*Nc*Sc*Dc*Ic 481.1 kPa

5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50
Qsafe : 192.44 kPa

$Q_{safe\ limited\ to}$ 180 kPa

This value of bearing capacity 180kpa has to fulfill the settlement limit 50mm

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TABLE FOR CORRECTION OF SPT VALUES as per IS :2131-1981

CLIENT : M/s. Endee Shelters and Properties Pvt Ltd

PROJECT : Stilt+5 Residential Building

LOCATION : R. A Puram

Depth (m)	Field SPT N- Values	Over burden pressure (t/m^2)	Over burden correction factor (C_n)	Over burden Correction (N')	Dilatancy correction (N'')	Corrected N Values
	BH-1					
2.00	7	6.0	1.15	N/A	N/A	7
3.00	9	7.0	1.12	N/A	N/A	9
4.50	16	8.5	1.04	17	16	16
6.00	19	10.0	1.00	19	17	17

N/A Not Applicable

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CONSOLIDATION SETTLEMENT CALCULATION

Considering BH-1, at a depth 3.00m

P_o = 2.00x18 + 1x8 = 44.0 kN/m^2 **Refer Fig. A**

e_o = 0.58

C_c = 0.18

Mid Depth (Z/B) = 0.50

Factor (σz/q) = 0.70

Applied Pressure = 126 kN/m^2

Change in pressure @depth of layer - $\triangle p$

P = Factor x SBC of soil (Refer book Donald P. Coduto, From 10.9 pressure bulb

= 126.0 kN/m^2

$$S_c = \frac{0.18}{1+\ 0.58} \times 200 \times \log \left\{ \frac{44.0 + 126.00}{44.0} \right\}$$

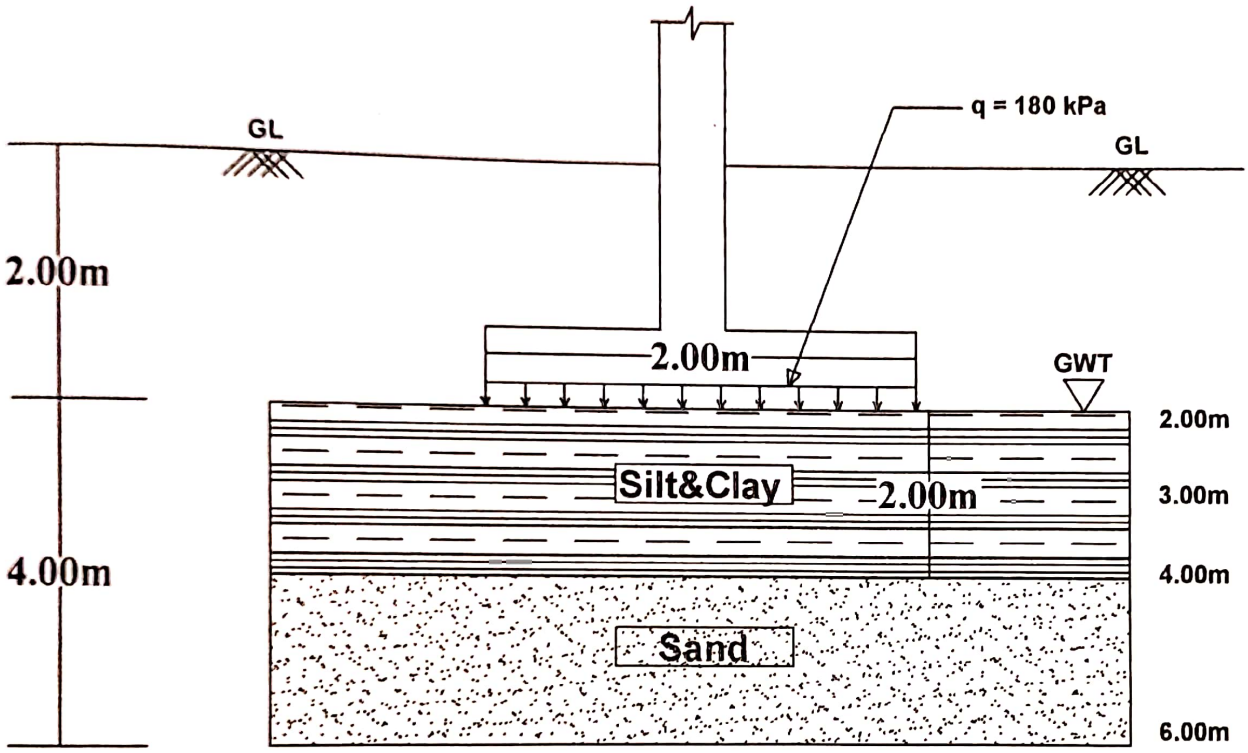
= 129.99 mm

Sc = 130 mm

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FIGURE - A



Title : Cross Section of BH-1	Client: M/s. Endee Shelters and Properties Pvt Ltd	
Site : No. 13/7, Sadhasiva Apartments, Thiruvengadam street, R. A. Puram, Chennai-600028	Scale : NTS	File no : 3
	Date :03.01.2023	Drg no : 3
	Drn by: Berlin	Sheet no : 3

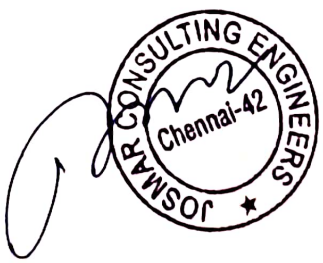
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E-mail : josmar.consultants@gmail.com

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APPENDIX- E

PILE FOUNDATION DESIGN CALCULATION



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Client : M/s. Endee Shelters and Properties Pvt Ltd
Project : Stilt+5 Residential Building
Site : R.A Puram

DESIGN OF PILE FOUNDATION (Ref BH-2)

1.0 Type of Installation of Pile — **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile (D)	:	600 mm
Length of Pile	:	21.00 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	:	Black high plastic clay (CH)
Length of strata, lc		1.00 m
Average SPT of the strata,N	:	8
Bulk Density of the strata, γ	:	18.00 kN/m^3
Undrained Shear Strength (Cu)	:	40 kN/m^2
Adhesion, σ	:	1.00
Skin Resistance of the pile,q_s	:	**75.36 kN**
(q: σ*Cu*pi*d*lc)		

1.2.1.2 **Layer- II**

Type of Strata	:	Brownish and blackish poorly graded sand-silt mixtures (SP-SM) and silty sand (SM)
Average SPT of the strata,N	:	31
Bulk density of the strata, γ	:	18.00 kN/m^3
Angle of shearing resistance - limited to	:	30 Deg
tan phi		0.58
Top of strata	:	1.50 m
Bottom of strata	:	21.00 m
Average thickness of strata, l_c	:	18.50 m
Effective overburden pressure at the middle of the strata,σ_{middle}	:	82.00 kN/m^2
Coef. Earth pressure , k		0.50
Skin resistance of the pile, q_s	:	**824.54 kN**
(q_s: σ *k*tanϕ *pi()*d*lc)		

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	Highly Weathered rock
Dia of pile	:	0.60 m
Cross-Sectional Area of pile,Ap	:	0.28 m^2
R.L of bottom of pile	:	21.00 m
SPT-value of the Bearing Strata	:	60
Angle of internal friction (ϕ)	:	34
Bearing Capacity Factor(Nq)	:	40
Effective overburden pressure at pile tip, Qef	:	72
Ultimate End Bearing Resistance (Qp)	:	**814.30 kN**
(Qp=Ap*Nq*Qef)		

1.3.0

Ultimate Load Carrying Capacity (Qs+Qp)	:	1714.20 kN
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	:	685.68 kN
	Say :	**680 kN**
Lateral Load Bearing Capacity	:	**54.40 kN**
Ultimate uplift resistance	:	899.90 kN
Safe Uplift resistance	:	359.96 kN
	Say :	**350 kN**

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Client : M/s. Endee Shelters and Properties Pvt Ltd
Project : Stilt+5 Residential Building
Site : R.A Puram

DESIGN OF PILE FOUNDATION (Ref BH-2)

1.0 Type of Installation of Pile — **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile (D)	:	750 mm
Length of Pile	:	21.00 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	:	Black high plastic clay (CH)
Length of strata, lc		1.00 m
Average SPT of the strata,N	:	8
Bulk Density of the strata, γ	:	18.00 kN/m^3
Undrained Shear Strength (Cu)	:	40 kN/m^2
Adhesion, σ	:	1.00
Skin Resistance of the pile,q_s	:	**94.20 kN**
(q: σ*Cu*pi*d*lc)		

1.2.1.2 Layer- II

Type of Strata	:	Brownish and blackish poorly graded sand-silt mixtures (SP-SM) and silty sand (SM)
Average SPT of the strata,N	:	31
Bulk density of the strata, γ	:	18.00 kN/m^3
Angle of shearing resistance - limited to	:	30 Deg
tan phi		0.58
Top of strata	:	1.50 m
Bottom of strata	:	21.00 m
Average thickness of strata, l_c	:	18.50 m
Effective overburden pressure at the middle of the strata,σ_{middle}	:	82.00 kN/m^2
Coef. Earth pressure , k		0.50
Skin resistance of the pile, q_s	:	**1030.67 kN**
(q_s: σ *k*tanϕ *pi()*d*lc)		

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	Highly Weathered rock
Dia of pile	:	0.75 m
Cross-Sectional Area of pile,Ap	:	0.44 m^2
R.L of bottom of pile	:	21.00 m
SPT-value of the Bearing Strata	:	60
Angle of internal friction (ϕ)	:	34
Bearing Capacity Factor(Nq)	:	40
Effective overburden pressure at pile tip, Qef	:	90
Ultimate End Bearing Resistance (Qp)	:	**1590.44 kN**
(Qp=Ap*Nq*Qef)		

1.3.0

Ultimate Load Carrying Capacity (Qs+Qp)	:	2715.30 kN
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	:	1086.12 kN
	Say :	**1080 kN**
Lateral Load Bearing Capacity	:	**86.40 kN**
Ultimate uplift resistance	:	1124.87 kN
Safe Uplift resistance	:	449.95 kN
	Say :	**440 kN**

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Client : M/s Endee Shelters and Properties Pvt Ltd
Project : Stilt+5 Residential Building
Site : R.A Puram

DESIGN OF PILE FOUNDATION (Ref BH-2)

1.0 Type of Installation of Pile — **Bored Cast in Situ**

1.1 Geometrical Data

Assumed Diameter of pile (D)	:	1000 mm
Length of Pile	:	21.00 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	:	Black high plastic clay (CH)
Length of strata, lc		1.00 m
Average SPT of the strata,N	:	8
Bulk Density of the strata, γ	:	18.00 kN/m^3
Undrained Shear Strength (Cu)	:	40 kN/m^2
Adhesion, σ	:	1.00
Skin Resistance of the pile,q_s	:	**125.60 kN**
(q: σ*Cu*pi*d*lc)		

1.2.1.2 **Layer- II**

Type of Strata	:	Brownish and blackish poorly graded sand-silt mixtures (SP-SM) and silty sand (SM)
Average SPT of the strata,N	:	31
Bulk density of the strata, γ	:	18.00 kN/m^3
Angle of shearing resistance - limited to	:	30 Deg
tan phi		0.58
Top of strata	:	1.50 m
Bottom of strata	:	21.00 m
Average thickness of strata, l_c	:	18.50 m
Effective overburden pressure at the middle of the strata,σ_{middle}	:	82.00 kN/m^2
Coef. Earth pressure , k		0.50
Skin resistance of the pile, q_s	:	**1374.23 kN**
(q_s: σ *k*tanϕ *pi()*d*lc)		

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	Highly Weathered rock
Dia of pile	:	1.00 m
Cross-Sectional Area of pile,Ap	:	0.79 m^2
R.L of bottom of pile	:	21.00 m
SPT-value of the Bearing Strata	:	60
Angle of internal friction (ϕ)	:	34
Bearing Capacity Factor(Nq)	:	40
Effective overburden pressure at pile tip, Qef	:	120
Ultimate End Bearing Resistance (Qp)	:	**3769.92 kN**
(Qp=Ap*Nq*Qef)		

1.3.0

Ultimate Load Carrying Capacity (Qs+Qp)	:	5269.75 kN
Safe Load Carrying Capacity (Qsafe =Qu/2.5)	:	2107.90 kN
	Say :	**2100 kN**
Lateral Load Bearing Capacity	:	**168.00 kN**
Ultimate uplift resistance	:	1499.83 kN
Safe Uplift resistance	:	599.93 kN
	Say :	**590 kN**

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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

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Vastu & Property Management Tools

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