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Varaha Geotechnical Works

Soil Investigation, SPT Test, Rock Core Drilling

372/1, 2nd Floor, Chinna Suraikkai Patti Street, Rajapalayam, Virudhunagar (Dt), Tamil Nadu-626117

GEOTECHNICAL INVESTIGATION REPORT

CLIENT NAME **BHARATH BLOSSOM TRICHY**

PROJECT NAME: **APARTMENT SOIL INVESTIGATION PUTHUR VILLAGE,WARD NO.L, BLOCK NO.23,TS.NO.42/2.**

PROJECT DONE BY: **M/s VARAHA GEOTECHNICAL WORKS**

REVISION NO	**0**
DATE	**6.08.24**
REPORT NO	**R4/08/24**
REMARKS	**-**

Varaha Geotechnical Works ★ Rajapalayam ★

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CHAPTER-1

INTRODUCTION

1.0 PROEM

BHARATH BLOSSOM SOIL INVESTIGATION, PUTHUR VILLAGE,WARD NO.L, BLOCK NO.23,TS.NO.42/2.

In order to get adequate data required for designing the foundations, proposed to conduct the sub-soil investigation to determine the foundation design parameters.

For the purpose of conducting sub-soil investigation, laboratory testing, designing the foundations and computing the Safe Bearing Capacity, the responsibility of carrying out suitable soil investigation was entrusted to M/s VARAHA GEOTECHNICAL WORKS, RAJAPALAYAM

This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems by M/s VARAHA GEOTECHNICAL WORKS, RAJAPALAYAM

1.1 SCOPE OF WORK

The Scope of Geotechnical work includes the following:

- Making **TWO** standard soil investigations bore holes of 150 mm diameter up to a depth of 10.00 m below existing ground level as directed by the Engineer-in-charge.
- Conducting Standard Penetration Test (SPT) in various depths at regular intervals (1.50 m) or change of soil strata.
- Collection of Disturbed Soil Samples from split spoon samplers.
- Collection of water samples from each bore hole.
- Conducting relevant laboratory tests on collected soil samples.
- Recommending the suitable type and depth of foundation.
- Yielding the Safe Bearing Capacity and Settlement for the recommended foundation.

1.2 LOCATION & DESCRIPTION OF STRUCTUR The proposed site BHARATH BLOSSOM SOIL INVESTIGATION, PUTHUR VILLAGE,WARD NO.L,BLOCK NO.23, TS.NO.42/2 is located in a Urban area and the 2 **boreholes** is made point as specified by the Engineer incharge.

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CHAPTER-2

FIELD INVESTIGATION

2.1 PROEM

The generally adopted field tests on soils are penetration and sounding tests. On the category of penetration tests, the Standard Penetration Test [SPT] is the one implemented as per IS 2131-1981 to study the stratification and characteristics of the sub soil in this project. Two boreholes of depth at 10.00m is made with penetration test done for every 1.50 m.

2.2 EQUIPMENT AND METHODOLOGY

2.2.1 Rotary Boring

The method adapted for drilling the exploratory borehole was rotary drilling technique which was done using Calyx machine with direct mud circulation. The drill mud used was made of Sodium Bentonite. The mud returning upwards though the annular space between the drill rods and the side of the hold bring the cutting to the surface. Borehole was always kept filled with drilling mud to prevent any negative hydrostatic pressure within the borehole.

2.2.2 Standard Penetration Test

The Standard penetration test (SPT) is widely used to get the bearing capacity of soil directly at a certain depth. Standard penetration tests were conducted at the borehole locations, in accordance with IS: 2131. The N-value indicates the relative density, consistency, strength, etc. The tests were conducted at every 1.50 m or change of soil stratum up to the depth of termination of the borehole as directed by the engineer-in-charge.

The test measures the penetration resistance of the split spoon sampler, when it is driven into the soil, at the bottom of a borehole in a standard manner. SPT split spoon sampler of standard size was driven into the soil from borehole bottom using 63.5 kg hammer falling from a standard height of 750 mm. Blow counts for the penetration of every 150 mm for a total of 450 mm penetration were recorded. The initial 150 mm

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penetration is referred to as seating drive and the blows required for this penetration are not considered as this zone is disturbed soil. The next 300 mm of penetration is referred to as the test drive and the number of blows required to achieve this fully is termed the penetration resistance or N-value.

2.3 SAMPLING IN BOREHOLES

The SPT-samples collected were disturbed soil samples and rock samples were collected as core recovery through core drilling on rock strata. Soil collected in the SPT sampler is preserved in polythene covers and transported to laboratory. 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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LABORATORY INVESTIGATION

3.0 PROEM:

The collected soil sample was tested in Laboratory as per relevant procedure in Indian Standard codes. The tests are conducted to determine the index and the engineering properties of the sub soil.

3.1 TESTS ON SAMPLES

The following parameters were conducted on the soil samples:

- **Natural Moisture Content:**
  This test is conducted in all disturbed samples to find the water content in the soil samples as per **IS 2720 (Part 2) : 1973.**

- **Grain size Analysis Tests:**
  On the coarse-grained samples, grain size distribution tests were conducted as per **I.S.2720 (Part 4)-1985**, to know the gradation characteristics and to classify them.

- **Liquid Limit:**
  This test conducted in fine-grained soils to find the liquid Limit of the soil as per **IS 2720 (Part 5) : 1985**

- **Plastic Limit:**
  This test conducted in fine-grained soil to find plastic limit of the soil as per **IS 2720 (Part 5) : 1985**

- **Specific Gravity:**
  This test is conducted in all disturbed soil samples to find Specific gravity of oil as per **IS 2720 (Part 3) : 1980**

- **Direct Shear Test:**
  This test conducted in coarse-grained soil to find the angle of shearing resistance of the soil as per **IS 2720 (Part 13) : 1986**

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- **Unconfined Compression Test:**

  This test conducted in fine-grained soil to find Cohesion of the soil as per **IS 2720 (Part 10) : 1995**

3.2 SUMMARY OF TEST RESULTS:

The laboratory test results were done and the results of the various tests are given the annexure of the report. The test results for each borehole is given in the Annexure and a model results for the tests of a sample is enclosed in the Annexure.

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CHAPTER-4

FOUNDATION ANALYSIS

4.0 PROEM

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.

4.1 SOIL PROFILE

The profile of the area as observed in the bore hole is given in the bore log attached in the annexure. The Ground water table was not observed within the depth of exploration.

The stratigraphy of the sub soil In **BH 1**, is comprised of **SAND MIXED CLAY** [0.00m to 3.00m] further followed by **SAND** [3.00m to 10.00m]

The stratigraphy of the sub soil In **BH 2**, is comprised of **SAND MIXED CLAY** [0.00m to 3.10m] further followed by **SAND** [3.10m to 10.00m]

4.2 SAFE BEARING CAPACITY AND SETTLEMENT

Safe bearing capacity of soil field test is done to check the capacity of the soil to withstand loads. The maximum load per unit area which the soil can bear without any displacement or settlements is designated as the "Safe bearing capacity of the soil. The bearing capacity of granular soil depends upon the unit weight and angle of internal

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friction of the soil. These two properties of granular soils are determined by standard penetration tests.

Safe bearing capacity of the soil is calculated using IS method 6403-1981

$$Q = C\,NC\,SC\,dC\,i_c + q\,(Nq-1)\,Sq\,dq\,i_q + 0.5\,B\gamma Nr\,Sr\,dr\,i_r$$

Where,

Q	= Ultimate bearing capacity	[kN/m²]
C	= Cohesion	[kN/m²]
q	= Effective surcharge at the base level of foundation	[kN/m³]
γ	= Bulk Density of soil	[kN/m³]
B	= Width of the Footing	[m]
Ny, Nq, Nr	= Bearing capacity Factor	
Sc, Sq, Sr	= Shape Factor	
dc, dq, dr	= Depth Factor	
i_C, i_q, i_r	= Inclination Factor	

Safe Bearing Capacity

Qs = Q / Fs

Qs	= Safe bearing capacity	[kN/m²]
Fs	= Factor of safety	

The factor of safety is considered as 2.5

Settlement calculations done as per IS-8009-(part-1) 1998

$$Si = Q_s B \frac{(1-\mu^2)}{Es} I$$

Si	= Immediate Settlement	[cm]
Qs	= soil Pressure	[kN /m²]
B	= Width of foundation	[m]
μ	= Poisson's ratio	
I	= Influence factor	
Es	= Elastic Modulus	[kN/m²]

(The Safe Bearing Capacity and Settlement Calculations are enclosed at the annexure)

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CHAPTER-5

DESIGN CRITERIA

5.0 PROEM

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.

5.1 BEARING STRATA CHARACTERISTICS

From field investigations, it can be observed that the sub-soil strata encountered at shallow depths i.e. below 3.00 m thick filled up soil strata are uniformly stratified coarse-grained type and good from both shear strength characteristics and deformation consideration to act as bearing strata for proposed impending loads form structure.

If coarse-grained soil strata encountered below 3.00 m depths from existing ground level are considered as bearing strata, the safe bearing capacity of open foundation system will be a function of least width of footing and effective over burden pressure on the bearing strata.

Considering the above, suitable foundation system is presented below.

5.2 Foundation System

The type and the minimum depth of foundations are governed by the following factors:

i. The thickness of the top loose zone.
ii. Adequate depth of soil above founding level, to ensure mobilization of full safe bearing capacity.

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iii. Adequate depth of soil strata below founding level of requisite strength to mobilize the safe bearing capacity and at the same time restricts the total and differential settlements within the allowable limits.

iv. The type and depth of foundation shall be decided by the design engineer according the analyzed load of the super structure.

v. The soil is designed considering the worse case of foundation soil condition. During rain, the water table may rise upto or above the base of the foundation. The water table correction is selected accordingly considering this scenario.

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RECOMMENDATIONS

Based on the SBC and settlement calculations, site investigations the recommendations for foundation are as follows:

i. The Safe bearing capacity is 342.64kN/m² at 4.00 m depth from the Natural Soil Surface.

ii. Recommended foundation is **isolated footing**

iii. Care shall be taken so that the ultimate bearing strata are none other than Soft Disintegrated Rock / Weathered Rock type.

iv. Safe bearing capacity presented is computed considering any rise in the ground water table at or above the level of footing.

v. Special provisions to contain any lateral collapse of soil from the walls excavated foundation pits are required.

vi. 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.

vii. The Design Engineer may choose an alternate foundation and Depth for the building structure and load.

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SAFE BEARING CAPACITY OF SOIL

BH No & CHIANAGE	Safe Bearing Capacity in kN / m² at (1m x 1m) Footing size		
	3.00m Depth	3.50m Depth	4.00m Depth
1	255.32	292.56	342.64
2	258.24	312.2	354.21
Recommended SBC in kN / m²	255.32	292.56	342.64
Settlement in mm	16	16	17

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7 PRECAUTIONS

Entire report should be studied before implementing the recommendations. Loose pockets of soil, if encountered shall be removed and backfilled with a levelling course of concrete shall be laid and construction of foundations with **IS CODE recommends** can be taken up subsequently.

8 LIMITATIONS

The soil investigations have been carried out at locations in the site chosen by the client so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations. However, if there is any change in sub soil conditions and properties at places between or beyond chosen test locations, VARAHA GEOTECHNICAL WORKS may be contacted for further advice.

With passage of time, the recommendations may vary due to manmade and natural environmental changes

REFERENCE

1. IS: 6403-1981
2. IS: 2911-(part1/sec-2 0-1979)
3. IS: 8009 (Part-1) 1976
4. IRC 78:2000
5. Wayne C.Teng (1992) Foundation design, 13th reprint,
6. Prentice - Hall of India Pvt.Ltd,
7. Bowles J.E, (1982) Foundation Analysis and design, 3rd edition, Mc Graw Hill International Book Co.
8. Tomlinson M.J. (1995) Foundation Design and Construction, 6th edition, Longman Group.

Field work was executed generally in accordance with IS specification listed below:

IS-1892 : Code of practice for Subsurface Investigation of Foundations.

IS-1498 : Classification and Identification of soils for General Engineering Purposes.

IS-2131 : Method for Standard Penetration Test for Soil

IS-2132 : Code for practice for Thin Walled Tube Sampling of Soil.

IS-5313 : Guide for Core Drilling Observations.

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ANNEXURE

BORELOGS

NAME OF PROJECT: BHARATH BLOSSOM, PUTHUR VILLAGE,WARD NO.L, BLOCK NO.23,TS.NO.42/2.

Bore Hole No	**1**	**Dia of Boring**	**150mm**
Type of Boring	**Rotary**	**Total depth**	**10.00m**
Started on	**24.07.24**	**Depth of Water Table**	**NE**
Ended on	**25.07.24**		

Depth from ground level	Soil Profiles	Description of soil (Visual Identification)	Depth (m)	Type	15	30	45	N	Graphical Representation of SPT(N value)	Type of Samples
0.00		SAND MIXED CLAY	1.50	SPT	10	17	21	38		DS
3.00			3.00	SPT	34	23	21	44		DS
		SAND	4.50	SPT	41	3cm /50	R	>100		DS
			6.00	drill	Rebound			>100		WS
			7.50	drill	Rebound			>100		WS
			9.00	drill	Rebound			>100		WS
10.00			10.00	drill	Rebound			>100		WS

Graphical Representation of SPT(N value): 0 10 20 30 40 50 60 70 80 90 100

Bore Hole is Terminated at a depth of 10.00m Below G.L

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NAME OF PROJECT: BHARATH BLOSSOM, PUTHUR VILLAGE, WARD NO.L, BLOCK NO.23, TS.NO.42/2

Bore Hole No	**2**	**Dia of Boring**	**150mm**
Type of Boring	**Rotary**	**Total depth**	**10.00m**
Started on	**24.07.24**	**Depth of Water Table**	**NE**
Ended on	**25.07.24**		

Depth from ground level	Soil Profiles	Description of soil (Visual Identification)	Depth (m)	Type	15	30	45	N	Graphical Representation of SPT(N value)	Type of Samples
0.00		SAND MIXED CLAY	1.50	SPT	8	13	27	40		DS
3.10			3.00	SPT	12	20	24	44		DS
		SAND	4.50	SPT	4cm/ 50	R	R	>100		DS
			6.00	drill	Rebound			>100		WS
			7.50	drill	Rebound			>100		WS
			9.00	drill	Rebound			>100		WS
10.00			10.00	drill	Rebound			>100		WS

Graphical Representation of SPT(N value): 0 10 20 30 40 50 60 70 80 90 100

Bore Hole is Terminated at a depth of 10.00m Below G.L

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LABORATORY TEST RESULTS

SITE NAME: TS.NO.42/2	BORE HOLE NO: 01	SW-WELL GRADED SAND, SM – SILTY SAND

DEPTH BELOW GROUND LEVEL		SOIL PROFILE	SOIL CLASSIFICATION	DEPTH OF SAMPLE TESTED [m]	INDEX PROPERTIES										ENGINEERING PROPERTIES	
						SIEVE ANALYSIS % OF PARTICLES					ATTERBERG'S LIMITS				SHEAR TEST	
FROM [m]	TO [m]				WATER CONTENT [%]	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT / CLAY	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	SPECIFIC GRAVITY	(C) COHESION [t/m^2]	(φ) ANGLE OF INTERNAL FRICTION [^{0}]
0.00	3.00		SM	1.50	16.36	0	9	24	45	22	NP	NP	NP	2.66	NA	29
				3.00	16.21	0	12	28	42	18	NP	NP	NP	2.63	NA	29.3
3.00	10.00		SW	4.50	13.25	0	27	35	26	12	NP	NP	NP	2.63	NA	29.6
				6.00	15.22	0	31	37	24	8	NP	NP	NP	2.65	NA	-
				7.50	12.21	0	33	35	24	8	NP	NP	NP	2.61	NA	-
				9.00	13.41	0	32	39	22	7	NP	NP	NP	2.62	NA	29.8
				10.00	14.11	0	35	38	20	7	NP	NP	NP	2.64	NA	-

*NP – Non Plastic, NA – Not Applicable

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SITE NAME: TS.NO.42/2	BORE HOLE NO: 02	SW-WELL GRADED SAND, SM – SILTY SAND

DEPTH BELOW GROUND LEVEL		SOIL PROFILE	SOIL CLASSIFICATION	DEPTH OF SAMPLE TESTED [m]	INDEX PROPERTIES										ENGINEERING PROPERTIES	
						SIEVE ANALYSIS % OF PARTICLES					ATTERBERG'S LIMITS				SHEAR TEST	
FROM [m]	TO [m]				W ATER CONTENT [%]	GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	SILT / CLAY	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	SPECIFIC GRAVITY	(C) COHESION [t/m^2]	(φ) ANGLE OF INTERNAL FRICTION [^{0}]
0.00	3.10		SM	1.50	15.24	0	10	25	44	21	NP	NP	NP	2.61	NA	29.1
				3.00	16.25	0	11	26	45	18	NP	NP	NP	2.62	NA	29.3
3.10	10.00		SW	4.50	13.65	0	27	37	25	11	NP	NP	NP	2.62	NA	29.5
				6.00	13.98	0	31	35	25	9	NP	NP	NP	2.65	NA	-
				7.50	14.15	0	32	36	24	8	NP	NP	NP	2.64	NA	29.6
				9.00	14.58	0	33	38	20	9	NP	NP	NP	2.65	NA	29.8
				10.00	14.76	0	35	36	23	6	NP	NP	NP	2.62	NA	-

*NP – Non Plastic, NA – Not Applicable

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SAFE BEARING CAPACITY CALCULATION

COMPUTATION OF BEARING CAPACITY AS PER IS: 6403:1981

1 Geometrical Data : **BH 1**

Shape of the Foundation	Square	
Shape considered for bearing capacity design	Square	
Size of Footing (B)	1.00	m
Breadth to Length Ratio of Foundation (B/L)	1.00	
Depth of Foundation below E.G.L. (D_f):	3.00	m
Inclination of Vertical Load with the Vertical (α)	0.00	Deg.

2 Soil Data :

Type of Bearing Strata :	SM	
Design SPT "**N**" value of the Bearing Strata:	44	
Type of Shear Failure:	General	
Angle of Shearing Resistance - Limited to a Maximum of:	29.30	Deg.

3 Design Parameters:

Saturated Density of Soil above the foundation depth (γ_{sat})	19.40	kN/m^3
Effective Overburden pressure at foundation level (q)	28.80	kPa
Water Table Correction Factor (w')	0.50	
Bearing Capacity Factors:		
N_c =	N/A	
N_q =	17.16	
N_γ =	20.56	
Shape Factors:		
S_c =	N/A	
S_q =	1.20	
S_γ =	0.80	
Depth Factors :		
D_c =	N/A	
D_q =	1.000	
D_γ =	1.000	
Inclination Factor:		
I_c =	N/A	
I_q =	1.00	
I_γ =	1.00	

4 Ultimate Bearing Capacity (Qu) :

$Qu=q*(Nq-1)*Sq*Dq*Iq + 0.5*B*g*Ng*Sg*Dg*Ig*w'$ 638.305 kPa

5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50

Qsafe : 255.32 kPa

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SETTLEMENT CALCULATION

Settlement Calculation as per IS 8009-part1

BH 1

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

q - Safe bearing pressure	255.32	kPa
B - width of foundation	1.00	m
D - Depth of Foundation	3.00	m
m - poisson's ratio of soil	0.3	
If - Influence factor (Square centre)	1.12	
Es-Modulus of Elasticity of Soil	16251	
Immediate settlement = q x B x (1-m2)x If / Es =	0.01601	
Settlement	16.01	mm

K. Shkr.

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SAMPLE PHOTOS



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