INTRODUCTION

The subsoil investigations reported herein were taken up (vide W.O. No. BSEIDC/Tech/1960/2018-1602 Dated – 10.03.2021 to find out the nature of subsoil at the site of the proposed construction and to recommend the capacity and type of its foundation. After certain tests on the soil, as detailed below, the desired recommendations have been made on **page 3-4** of this Report.

2. FIELD WORK

The fieldwork consisted of sinking bore holes, collecting soil samples and conducting the necessary field tests.

2.1. Boring

Taking guidance from IS: 1892, 150 mm diameter bore holes were sunk at locations shown in the bore hole location map.

2.2 Sampling

2.2.1 Undisturbed Soil Samples

Open drive samplers of 100-mm diameter and about 450-mm length were used for obtaining undisturbed samples of cohesive soils. The collection, sealing, labeling and transportation of the samples to the laboratory were done as per the IS guide-lines.

2.2.2 Disturbed Soil Samples

Disturbed soil samples were collected at suitable intervals of depth (not more than 2.5 m) and at all depths of change in the nature of the subsoil. These samples were sealed in polythene bags with proper identification labels.

2.3 Field Tests

2.3.1 Standard Penetration Tests (SPT)

These tests were conducted as per IS: 2131 – 1963. The depth interval between two consecutive tests was 1 to 1.5 m. The tests were located in between the levels at which undisturbed soil samples were collected.

3. LABORATORY TESTS

Some or all of the following laboratory tests, as necessary, were done on the collected soil samples. Representative soil samples were selected for this from the different soil strata encountered during boring. The tests were performed as per the relevant Indian Standard Codes of Practice.

(a) Natural moisture content

(b) Bulk density

(c) Grain size analysis (using sieves and / or hydrometer)

(d) Specific gravity of soil solids

(e) Atterberg's limit tests (liquid, plastic and shrinkage limits)

(f) Shear Tests :

- [I] Triaxial compression test (unconsolidated – undrained), generally for fine- grained soils
- [II] Unconfined compression tests, only on cohesive soils
- [III] Direct shear tests, generally for coarse-grained soils

(h) Other tests as and when required.

4. PRESENTATION OF TEST RESULTS

The field and laboratory test results are given in the **Appendix B.**

5. SOIL STRATIFICATION

The results of field tests in three bore holes sunk at the site [vide Location Sketch in App. A] and the results of laboratory tests conducted on the collected soil samples indicate that the soil stratification at the site is as describe below.

The subsoil in all BH's is silty sand / sand [type SM-SP/SP/SC-SM] up to in various thicknesses and variable sequence, up to the investigated depth of 10.5 m bgl.

Ground water table was struck at about 2.60 m to 2.70 m depth below GL in April, 2021 It is subject to seasonal variations.

6. FOUNDATION ANALYSIS

The safe capacity of foundation of any type and size may be determined on the basis of the soil data given in this Report by using the standard methods of foundation design and following the relevant Indian Standard Codes.

7. RECOMMENDATIONS

The design of the foundation for the proposed structure depends on the nature of both [a] the subsoil and [b] the structure.

The subsoil in all BH's is silty sand / sand [type SM-SP / SP / SC-SM] up to in various thicknesses and variable sequence, up to the investigated depth of 10.5 m bgl.

Ground water table was struck at about 2.60 m to 2.70 m depth below GL in April, 2021 It is subject to seasonal variations.

Hence,

1. The proposed structure may be provided with shallow foundation at a depth of 1.5 m or more.
2. Alternatively plane piles of lengths 4.0 m to 10.0 m with shaft diameters 0.25 m, 0.30 m, and 0.40 m may be provided. A casing will have to be used during boring for the pile.

By way of example, the values of safe capacities of

[1] Shallow foundations and [2] Plane piles of the above mentioned sizes and depths have been calculated (vide Samples of Calculations in Appendix F) and the safe capacities are given below in Tables 1 and 2 respectively.

Table 1: Allowable Net Bearing Pressures [q_{na}] and Settlements Expected [s]

Depth (m) below Ground Level	Width (m)	Net allowable bearing pressure (t / m²)			Maximum expected settlement (mm)
		Strip footing	Square footing	Raft footing	
1.5	2	7.1	7.1	...	50
	3	5.6	5.6	...	50
	10	...	...	8.0	75
2.0	2	9.3	9.3	...	50
	3	7.1	7.1	...	50
	10	...	...	8.4	75
2.5	2	9.3	9.3	...	50
	3	7.8	7.8	...	50
	10	...	...	8.7	75
3.0	2	10.4	10.4	...	50
	3	9.5	9.5	...	50
	10	...	...	9.1	75
3.5	2	11.6	11.6	...	50
	3	10.6	10.6	...	50
	10	...	...	11.3	75
4.0	2	12.7	12.7	...	50
	3	11.6	11.6	...	50
	10	...	...	11.7	75
4.5	2	13.9	13.9	...	50
	3	12.7	12.7	...	50
	10	...	...	12.1	75

Table 2. Safe Capacities of Plane Piles
[Factor of safety = 2.5 in skin friction and 3 in bearing]

Pile length [m]	Safe Capacities [tonnes] (subject to checking for slenderness ratio*) for Piles of diameters (m):		
	0.25 m	**0.30 m**	**0.40 m**
4.0	2.2	2.8	4.3
6.0	4.0	5.6	8.8
8.0	5.7	8.1	13.6
10.0	7.5	10.7	18.1

*For a preliminary checking of the slenderness ratio, the modulus of subgrade reaction (k) may be estimated from the following empirical relation given in IS: 2950-1981 (Second Revision) Table 1. $k\ (kN/m^3) = 240\ c$, where $c\ (kN/m^2)$ is the value of cohesion of the soil at the concerned depth.**Notes:**

1. If a subsoil condition much different from those reported herein is met with during foundation trenching or piling, suitable steps should be taken.
2. If the depth of a shallow foundation is below the water table, dewatering of the foundation trench has to be done, and its side walls of may have to be suitably supported at the time of the construction of the foundation.
3. In case a basement is being provided, its base and side walls have to be safeguarded against the likely ingress of ground-water.
4. If concreting for a pile has to be done under water, DMC and tremie method of concreting should be adopted.
5. As per the provisions of the IS Code, **an appropriate number of piles must be subjected to routine load tests to check the veracity of the above recommended values of the safe capacities of piles.**

For Bihar Foundation Consultants

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