

Report on Sub Soil Investigations for the Proposed  
Stadium at Magadh University Bodh Gaya

## 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 sub soil is sandy silty clay [Type CI] up to the depth of about 6.0 m followed by sandy silty clay [type CH] up to the depth of about 7.5 m and sandy silty clay [type CI] up to the investigated depth of 10.5 m bgl. It also gritty up to the investigated depth of 10.5 m bgl.

Ground water table was struck at 6.00 m depth below GL in January, 2020. 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 U/R pile of depth 4.0 m to 10.0 m may be used. Their stem diameters may be taken as 0.25 m, 0.30 m, 0.40 m and 0.50\* m and the bulb diameters may be taken 0.50 m, 0.60 m, 0.80 m and 1.00 m respectively.
- **For 0.5 m stem diameter U/R pile, the depth of pile should be 6 m or more.**

By way of example, the values of safe capacities of

(1) shallow foundations

(2) single or double bulbed u/r piles of the above mentioned sizes and depths have been calculated (vide Samples of Calculations in Appendix F) and are tabulated below.

The value of Modulus of subgrade reaction is given at the bottom of Table 2.

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

Depth (m)	Width (m)	Net allowable bearing pressure (t/m <sup>2</sup> ) for			Maximum expected settlement (mm)
		Strip footing	Square footing	Raft footing	
1.5	2.0	8.6	15.1	...	75
	3.0	6.0	10.5	...	75
	10.0	...	...	8.2	100
2.0	2.0	10.1	17.6	...	75
	3.0	6.8	11.9	...	75
	10.0	...	...	8.7	100
2.5	2.0	11.5	20.0	...	75
	3.0	7.6	13.3	...	75
	10.0	...	...	9.1	100
3.0	2.0	12.9	20.0	...	75
	3.0	8.4	14.7	...	75
	10.0	...	...	9.5	100
3.5	2.0	14.5	20.0	...	75
	3.0	9.3	16.2	...	75
	10.0	...	...	10.1	100
4.0	2.0	15.9	20.0	...	75
	3.0	10.1	17.7	...	75
	10.0	...	...	10.5	100
4.5	2.0	17.8	20.0	...	75
	3.0	11.1	19.5	...	75
	10.0	...	...	11.2	100

Report on Sub Soil Investigations for the Proposed  
Stadium at Magadh University Bodh Gaya

**Table 2. Safe Capacities of U/R Piles [Factor of safety = 2.5]  
[Bulb diameter = 2.0 times the shaft diameter]**

Pile length below pile Cap (m)	Stem diameter (m)	Bulb diameter (m)	[b] Safe Pile Capacity (subject to checking for slenderness ratio) [tonnes]	
			One bulb	Two bulbs
4.0	0.25	0.50	10.2	13.2
	0.30	0.60	13.7	18.1
	0.40	0.80	22.3	30.1
6.0	0.25	0.50	13.1	16.2
	0.30	0.60	17.3	21.7
	0.40	0.80	27.1	35.0
	0.50	1.00	39.0	51.3
8.0	0.25	0.50	16.3	19.5
	0.30	0.60	21.2	25.8
	0.40	0.80	32.6	40.8
	0.50	1.00	46.1	58.9
10.0	0.25	0.50	19.8	23.2
	0.30	0.60	25.5	30.3
	0.40	0.80	38.5	47.1
	0.50	1.00	53.9	67.3

**Modulus of subgrade reaction (k):**

For preliminary estimates in clay soils, the following empirical relation as given in IS: 2950-1981 (Second Revision) Table 1, may be used based on the value of cohesion  $c$  of the soil at the concerned depth:

$$k \text{ (kN/m}^3\text{)} = 240 c, \text{ c being cohesion in kN/m}^2\text{.}$$

**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 concreting of piles is to be done below water table, DMC and tremie method should be adopted.
3. If u/r piles are provided, care should be taken to ensure proper formation of bulbs.
4. Shallow foundations or pile caps should be isolated from the surrounding expansive soil by layers of compacted local sand.
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.**
6. **Bodh Gaya lies in Earthquake Zone III. As the subsoil in the present case is not sand or fine silt it is not vulnerable to liquefaction and the bearing capacity of footings or piles will not be affected by earthquake. The earthquake zone will be taken into consideration by the structural designer.**

For Baidyanath Foundation Consultants Pvt. Ltd.,

(Dr. K.S.P. Singh, FIE, MIGS)  
Senior Consultant.