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# "GEOTECHNICAL INVESTIGATION FOR SUGGESTING S.B.C. OF SOIL FOR PROPOSED BUILDING AT G.P. AMRAVATI CAMPUS, MAHARASHTRA, INDIA"

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**ABSTRACT**:

*This paper described the preliminary geotechnical investigation undertaken and summarizes the subsurface conditions encountered. It includes the details of methodology of investigation, field test results, and laboratory test results including their analysis, recommendation of Bearing Capacity of existing soil where proposed structure is going to be constructed.*

*In this project the method of conducting the load test on soils and the evaluation of bearing capacities and settlement are carried out. The paper presents the compiled data of test results of geotechnical investigation. The observed data of field investigations and laboratory tests are presented and used to access the nature of subsoil strata and to evaluate the soil parameters.*

*The paperalso includes results obtained by performing standard penetration test (S.P.T.) which was carried out at regular interval in order allow the assessment of the relative in-site density or stiffness of the ground also to determine safe bearing capacity of soil. Also by using the formulas provided by Terzaghi, Tense and I.S.6403:1981(Reaffirmed 2002) the S.B.C. of the sub soil is determined and at last all the S.B.C.'s of the soil are compared so as to suggest the safe bearing capacity of the soil.*

***KEY WORDS:***

*Safe Bearing Capacity, Plate Load Test, Ultimate Bearing Capacity, Amravati, I.S. (Indian Standards).*

## I. INTRODUCTION:

The S.B.C. (Safe Bearing Capacity) of the soil itself indicates that the supporting power of the soil which can sustain the maximum load coming on it without introducing any shear failure within the soil body. Also the foundation of the any structure is directly resting upon the sub soil which is situated below it. Therefore it is necessary to find out the load that the soil can support safely without causing any shear failure and unequal settlement of the structure. Hence, this study is carried out so as to find out the S.B.C. of the soil by conducting the field test and by using the equations provided by Terzaghi, Tense and I.S.6403:1981(Reaffirmed 2002).

By conducting P.L.T.(Plate Load Test) on the soil at G.P.Amravati, it gives an idea about the behavior of the soil under the applied loading which can be understand from the load-settlement curve and helps in finding the ultimate as well as safe bearing capacity of the soil.

***Setup for P.L.T***

Also the Standard Penetration Test (S.P.T.) is currently the most popular in-situ test in obtaining subsurface information.It gives an idea about the denseness of the soil and also the bearing capacity of the soil is determined by counting the number of blows required to penetrate the split spoon sampler for every 15cm depth. Also the S.B.C. calculated by performing S.P.T. somewhat is same in magnitude as the S.B.C. calculated by using P.L.T.

***Spilt Spoon Sampler***

The research has shown that the most significant factor affecting the measured N values is the amount of energy delivered to the drill rods. In order to reduce the significant variability of the SPT N-values due to the large variation in energy delivered, it has been recommended that the N value be standardized to a specific energy level through the use of correction factors. The purpose of this research is to summarize all available correction factors and, with the guidance of a limited field-testing program, determine the most appropriate correction factor and bearing capacity of existing soil for girl's hostel at G.P.Amravati.

The S.B.C. of the soil is also calculated by using the geotechnical parameters of the soil which are obtained by lab tests conducted on the soil samples collected from the site. By using the equations provided by Terzaghi, Tense and I.S.6403:1981(Reaffirmed 2002) , the S.B.C. of the soil is find out on the basis of the geotechnical parameters of the soil. Then an overall comparison of all the values of the S.B.C.'s obtained by different ways gives an value of the S.B.C.'s that can be suggested for designing the foundation of the structure.

## II. TESTS CARRIED OUT ON THE SOIL:

1. Determination of water content as per I.S.: 2720 (part ii) - 1173(reaffirmed 2010)
2. bulk density of soil by sand replacement method as per I.S.: 2720 (part xxviii) – 1974
3. Direct shear test as per I.S.: 2720(part 13) - 1986
4. Plate load testas per I.S.: 1888-1982
5. Standard penetration testas per I.S.:2131 – 1981

## III. BACKGROUND AND SITE DESCRIPTION:

**Location:** The site for project is situated on behind library building of Government Polytechnic Amravati. The map showing the location of the site.

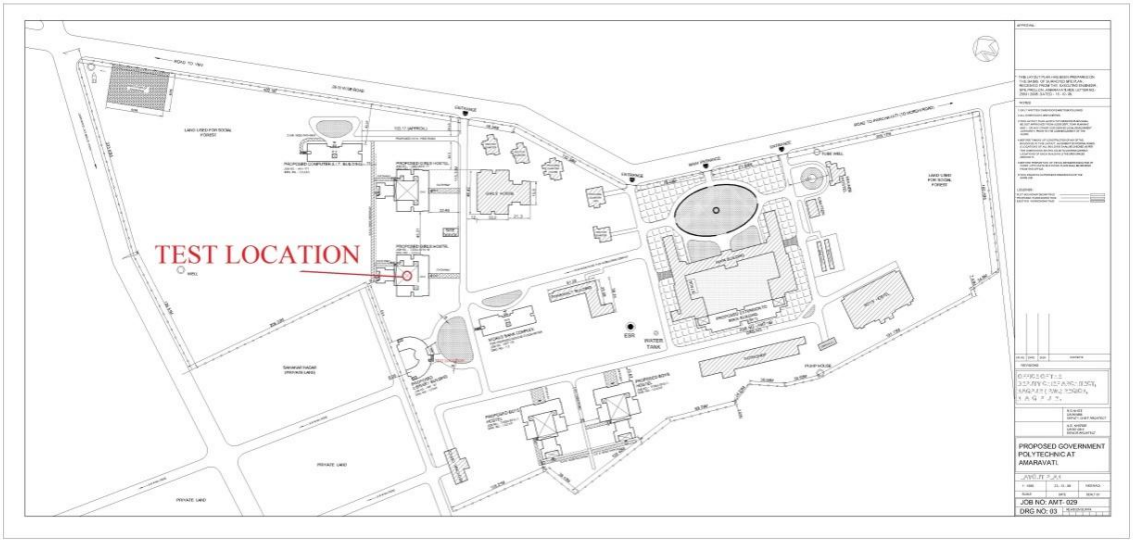
**Site Layout and Topography:** The site has irregular shape. The site is open in all side. Vegetation in the form of grass was observed at the site during the period of field investigation.

**Type of Soil:** The soil type is disintegrated soft rock (murum).The colour of expose soil was light brown.

**The Structure:** As per the information, the proposed structure was girls hostel comprising of a ground floor and two upper floors. The square shape footing is assumed for bearing capacity calculations.

**Seismic Zone:** Site for the proposed project is situated in campus of Government Polytechnic Amravati, Maharashtra, India which falls under Seismic Zone III as per IS 1893 (Part 1) – 2002.

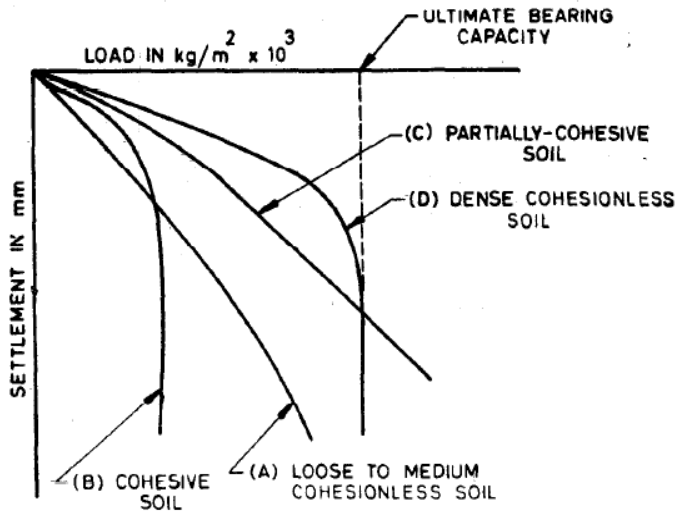



## IV. GEOTECHNICAL PARAMETERS OF SOIL:

1. Water content w = 2.3 %
2. Angle of shearing resistance, $\emptyset = 40^0$
3. Bulk Density of Soil, $\gamma_b$= 17.3 KN/$m^2$
4. Dry Density of Soil, $\gamma_d$=16.91 KN/$m^2$

## V. LITERATURE REVIEW:

Determination of Ultimate bearing capacity of the soil which is located at shallow depth involves the carrying out in-situ test i.e. Plate load test **[Methods Of Load Test On Soil (Is: 1888 – 1982)]**which gives an idea about the behaviour of soil within the shallow depth and provides a layout for determination of Safe bearing capacity of soil for recommending type of foundation to be used and design of foundation of structure. The typical Load-settlement curves for different soil types are shown below.




***Load settlement curve for different types of soil as per [Methods of Load Test on Soil (IS: 1888 – 1982)]***

The code **[Methods of Load Test on Soil (IS: 1888 – 1982)]**has given following equation based on settlement consideration for a intensity of load, $q_o$

$$s_f = s_p \times \left[\frac{B_f(B_p + 0.3)}{B_p(B_f + 0.3)}\right]^2$$

Terzaghi and Peck (1967) proposed the Following equation based on settlement consideration for intensity of load, $q_o$

$s_f = s_p \times \frac{B_f}{B_p}$ ……for clayey Soils

$s_f = s_p \times \left(\frac{B_f}{B_p}\right)^2 \times \left(\frac{3.28\times B_p+1}{3.28\times B_f+1}\right)^2$ …….for Sandy soils

where

$S_f$= settlement of Foundation $S_p$= Settlement of Plate

$B_f$= width of Foundation$B_p$= width of Plate

Also based on the Ultimate Bearing Capacity

$q_{uf} = q_{up}$ ……..for clayey Soils

$q_{uf} = q_{up} \times \frac{B_f}{B_p}$ ……for Sandy soils

Where,

$q_{uf}$=Ultimate bearing capacity for the proposed foundation

$q_{up}$= Ultimate bearing capacity of the test plate

Also Terzaghi has given the formula for ultimate bearing capacity for square footing,

$$q = 1.3\ c.N_c + \gamma.D_f.N_q + 0.4.\ \gamma.\ B.N_\gamma$$

Tense formula for ultimate bearing capacity on the basis of total number of blows required for penetration of split spoon sampler to a depth of 30cm,

$$q = 0.314N^2BW_\gamma + 0.943(100 + N^2)D_fW_q$$

I.S.6403:1981(Reaffirmed 2002) has given the formula for bearing capacity for general shear failure,

$$q_d = q\ x\ (N_q - 1)s_q\ d_q i_q + 0.5\ B\ \gamma\ N_\gamma s_\gamma d_\gamma i_\gamma$$

$$d_q = d\gamma = 1 + 0.1\ x\ \left(\frac{D_f}{B}\right)\ x\sqrt{N_\emptyset} \quad \ldots\ldots\ldots (For\ \emptyset\ > 10^0)$$

$$N_\emptyset = \tan^2\left(\frac{\pi}{4} + \frac{\emptyset}{2}\right)$$

Where,

$N_c$ ,$N_q$,$N_\gamma$ = Bearing capacity factors

$D_f$ = Depth of the footing

γ= Bulk Density of Soil

C = Cohesion

B = Width of the footing

$W_\gamma$,$W_q$ = Water table correction factors

N = Number of blows required for penetration of split spoon sampler to a depth of 30cm

q= Effective surcharge at foundation level

$s_q$ , $d_q$ , $i_q$ = Shape factors

### *A.* METHODOLOGY TEST SETUP FOR P.L.T.:

Test Pit was dug at the Proposed Foundation Level, with width at least 5 times the width of the Test Plate. A square Steel Plate, 0.3m X 0.3m with thickness not less than 25mm was used. A reaction load was placed over a 500KN/m$^2$capacity hydraulic Jack, which lies on a Test Plate. The sitting load of 7KN/m2 was applied after the placement of hydraulic Jack on the plate. After thateach load increment was kept for not less than one hour or when the settlement gets appreciable reduced (a value of 0.2mm per hour). The next Increment was then applied and observation repeated. The Test was continued till a settlement of 25mm reaches or till soil fails in shear whichever is earlier occurred.

### B. OBSERVATIONS FOR PLATE LOAD TEST AS PER I.S.: 1888-1982

Size of test plate = 0.3m X 0.3m

Shape of test plate = Square

Depth of foundation = 0.67m

Least count of dial gauges = 0.01mm

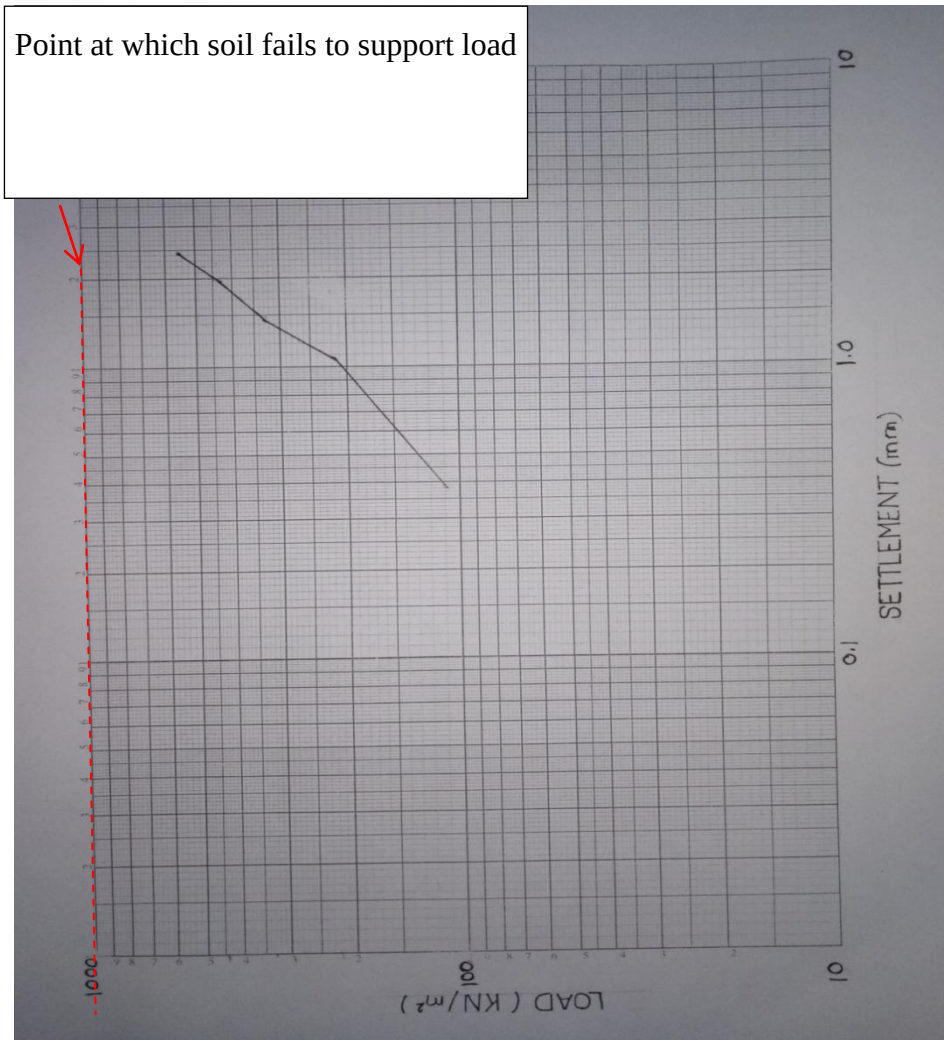
Least count of pressure gauge = 2 KN

**C. OBSERVATION TABLE:**

| Sr.No. | Pressure ($KN/m^2$) | Time | Dial Gauge Reading(mm) | | Avg. Displacement (mm) | Cumulative Settlement (mm) |
|---|---|---|---|---|---|---|
| | | | DG1 | DG2 | | |
| 1. | 111.11 | 0 | 00 | 00 | | |
| | | 1 | 0.59 | 0.06 | | |
| | | 2 | 0.61 | 0.09 | | |
| | | 4 | 0.62 | 0.11 | | |
| | | 10 | 0.66 | 0.11 | 0.385 | 0.385 |
| 2. | 222.22 | 0 | 00 | 00 | | |
| | | 1 | 0.32 | 0.51 | | |
| | | 2 | 0.32 | 0.54 | | |
| | | 4 | 0.32 | 0.56 | | |
| | | 10 | 0.45 | 0.65 | | |
| | | 20 | 0.45 | 0.65 | | |
| | | 40 | 0.60 | 0.66 | | |
| | | 60 | 0.70 | 0.67 | 0.685 | 1.07 |
| 3. | 333.33 | 0 | 0.14 | 0.36 | | |
| | | 1 | 0.14 | 0.38 | | |
| | | 2 | 0.18 | 0.39 | | |
| | | 4 | 0.19 | 0.42 | | |
| | | 10 | 0.19 | 0.44 | | |
| | | 20 | 0.19 | 0.48 | | |
| | | 40 | 0.24 | 0.48 | | |
| | | 60 | 0.24 | 0.52 | 0.38 | 1.45 |
| 4. | 444.44 | 0 | 0.17 | 0.27 | | |
| | | 1 | 0.18 | 0.3 | | |
| | | 2 | 0.20 | 0.32 | | |
| | | 4 | 0.24 | 0.36 | | |
| | | 10 | 0.31 | 0.41 | | |
| | | 20 | 0.37 | 0.49 | | |
| | | 40 | 0.38 | 0.62 | | |
| | | 60 | 0.43 | 0.65 | 0.54 | 1.99 |
| 5. | 555.55 | 0 | 0.18 | 0.20 | | |
| | | 1 | 0.22 | 0.24 | | |
| | | 2 | 0.24 | 0.27 | | |
| | | 4 | 0.26 | 0.3 | | |
| | | 10 | 0.32 | 0.37 | | |
| | | 20 | 0.36 | 0.4 | | |
| | | 40 | 0.40 | 0.47 | | |
| | | 60 | 0.43 | 0.55 | 0.43 | 2.48 |




***LOAD-SETTLEMENT CURVE PLOTTED ON LOG-LOG SCALE***

**D. OBSERVATIONS FORSTANDARD PENETRATION TESTAS PER I.S.:2131 – 1981:**

| Sr.No. | Depth In m. | No. of blows for every 150mm penetration of sampler | Observed SPT value | Overburden Corrected Value | Dilatancy Corrected Value | Ø from N value. |
|---|---|---|---|---|---|---|
| 1. | 0.15 | 15 | 58 | 58 | No correction is required | $40^0$ |
| 2. | 0.15 | 20 | | | | |
| 3. | 0.15 | 38 | | | | |

**EVALUATION OF THE BEARING CAPACITIES OBTAINED BY DIFFERENT METHODS:**

| Sr. No. | Methods | Safe Bearing Capacity ($KN/m^2$) |
|---|---|---|
| **1.** | Plate Load Test | 1111.12 |
| **2.** | SPT | 1520.8 |
| **3.** | Terzaghi's Formula | 800.754 |
| **4.** | IS Code Method | 830.38 |

**This Safe Baring Capacities are for Square Footings 1.2x1.2**

## VI. DISCUSSION:

The load-settlement curve, potted for P.L.T. shows the definite point which indicates that at that point the soil under the load corresponding to the definite point, the soil supports becomes incapable of supporting the load at that definite point, which means the soil cannot support the load more than the load at the point of failure and hence, in this case the load corresponding to the point of failure is taken as the ultimate load and corresponding load per unit area is calculated. Then by using the relations provided byIS : 1888 – 1982 ultimate bearing capacity for footing is obtained.

Also the safe bearing capacity of the soil is obtained by different methods and has its magnitude somewhat nearer to the S.B.C. as computed by P.L.T. These values of S.B.C. also help in deciding that which value should be the S.B.C. of the soil that can be suggested for further designs which can be decided by comparing these values with each other and the minimum value of the S.B.C. can be suggested as the safe bearing capacity of the soil from safety point of view.

## VII. CONCLUSION:

As the minimum value of the S.B.C. from the S.B.C. computed by using different methods is 800.754 KN/$m^2$which can be the value of the S.B.C. that can be suggested for further design of the foundation of the structure that will be constructed at that site and also this value of the S.B.C. indicates that the soil has good load supporting power and also form the type of soil i.e. murum, it can be realize that it can have good bearing capacity and it proves to be good soil for resting the foundation of the structure safely over it.

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