PLATE LOAD TEST ON UNDISTURBED SOIL SAMPLE

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INTRODUCTION

As we know Foundation is that part of the structure which is in direct contact with soil, Which transfers the forces and moments from superstructure to soil below to keep the stresses within limit for maintaining stability of the structure. Bearing capacity is the power of foundation soil to hold the forces from the superstructure without undergoing shear failure or excessive settlement. Bearing capacity is very important while deciding the type of foundation and depth of footing.
There are various methods for determining bearing capacity of foundation. But field methods give more accurate results than that of analytical methods. Standard Penetration Test and Standard Plate Load test are the normally used field methods. Though these methods gives accurate results but they prove to be costlier than analytical methods .Considering the large space requirement and complex loading required for these methods there is need of some other method removing all the faults in old methods.

So we thought of one another test similar to plate load test. For this test we are going to take the undisturbed soil sample of particular size and we are going to test that sample. This test can be performed very easily having loading arrangement very simple one. In our test we are going to test the soil sample by placing it on base plate and applying loading by using reaction frame method .We basically designed the reaction frame for loading of about 300 kN, 150 kN and 50 kN which includes design of beam , design of columns ,design of base plate and design of soil box. This apparatus is similar to California Bearing Ratio test apparatus. This apparatus can be used in lab as well as on site. Loading is applied by using hydraulic jack. We changed the position of bearing plate to achieve good failure surface of soil.

LITERATURE REVIEW

1. **Scale Effect of Plate Load Tests in Unsaturated Soils**
   (Won Taek Oh and Sai K. Vanapalli)

PLT is regarded as the most reliable testing method to estimate the applied stress versus surface settlement (SVS) behavior of shallow foundations. However, there are uncertainties in interpreting the PLT results for soils that are in a state of unsaturated condition. This is mainly attributed to the fact that the SVS behavior from the PLTs is significantly influenced by both the footing size and the capillary stresses.

2. **Small Scale Footing Load Tests on Randomly Distributed Fiber Reinforced Soil Foundations Subjected to Axially Oblique Loading**

Arshdeep Kaur, Arvind Kumar

Footings which serve as foundations for retaining walls and framed structures may getsubjected to other loads also in addition to the vertical load. Also for designing the foundations subjected to earthquake forces appropriate values of horizontal and vertical coefficients should be properly evaluated. The footings which are subjected to these types of loadings are resolved in two parts: (1) An eccentric vertical load and (2) An axially oblique load. In this study we are analyzing the footings which are subjected to only axially oblique load with the help of small
scale footing load tests.

3. **Prediction Of Bearing Capacity Of Granular Layered Soils By Plate Load Test**
   Sanjeev Kumar Verma1, Pradeep Kumar Jain, Rakesh Kumar

From the review of literature, it may be noted that the bearing capacity equations proposed for the homogenous soils by Terzaghi (1943) and Meyerhof (1951) are not applicable to layered soils. Hence it is necessary to develop an equation for predicting the bearing capacity of granular layered soils. In present investigation, plate load test have been conducted in a large tank to observe the load settlement behavior of plates of different sizes resting on layered granular soils. Tests were conducted on two layers of soils. Fine gravel layer overlain sand layer were tested using mild steel plates of square shapes. The effect of the placement of layers on the bearing capacity, settlement characteristics of footing, has been studied and an equation for predicting the bearing capacity of two layered granular soils is developed based on the plate load test data.

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PROPOSED PLATE LOAD TEST ON UNDISTURBED SOIL SAMPLE

This is the test which is proposed to be the test which is same as that of conventional plate load test but having many advantages over conventional plate load test.

In this test a small undisturbed soil sample is taken in a soil box of certain size and it is tested in the same way as that of plate load test. So this test is called a plate load test on undisturbed soil sample. Many times it happens that the area available for testing is very small so it very difficult to go for standard plate load test as it requires a large space. Also sometimes it is not possible to provide the required complex and large loading .also the time required for arranging all the set up is very large taking into consideration the total time for testing. Also manpower required for carrying out this test is also very much .so taking into consideration all these aspects there is need of such test which will overcome all the limitations of standard plate load test. So a plate load test on undisturbed soil sample is designed.

TEST PERFORMED

1) SPT test.

Results obtained from SPT are

1. Penetration resistance = 30
2. Internal angle of friction = 35 deg
3. Type of soil = dense sand.

4.Nc = 57.8 Nq= 41.4 Nγ = 42.4

Bearing capacity of soil considering terzaghis equation and considering square footing of dimension 2 x 2 m2 having depth equal to 2.0 m.

Assuming c=0 , γ = 18

We get bearing capacity of soil = 649.44 KN/m2Safe settlement pressure by using terzaghis empirical relationship.

$$(35\times(N-3)(\frac{B+0.3}{2B})^2 R_w R_d)$$

Here N = Corrected values of penetration resistance by using peck's relation

We get safe settlement pressure = 558.92 KN/m2

Allowable bearing pressure by using terzaghi and peck equation = 330 kN/m2

Allowable bearing pressure by using Meyerhof's Relationship = 500 kN/m2

2) Plate load test on undisturbed soil sample

Test procedure

1.Collecting the undisturbed soil sample
2. Testing the sample in laboratory

1. Collecting the undisturbed soil sample

Steps involved in collecting the sample

Cleaning and leveling the site.

Then placing the top half portion of soilsampler on plane ground.

Placing the plate on the top surface of soil sampler such that it covers topportion of the sampler.

The sampler is inserted in to the soil by giving blows to top plate by using hammer.

Then the whole portion surrounding the soil sampler is removed so that we can get undisturbed soil sample as shown.

Then this soil box is placed in testing equipment and dial gauges arefixed to the wooden strip placed on bearing plate which is placed onone side of the box as shown.

Then loading is applied with the help of steel ball which is placedon the top of bearing plate load is applied by using reaction frame which uses lever arm arrangement.

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Due to thisarrangement we get increased loading on bearing plate.

Then for each incremental load settlement is noted down for particular time period.

Load is increased till the settlement does not change rapidly. This point is called as failurepoint.

Then graph of loading vs. settlement is drawn. Then allowable bearing pressure is found out from graph by using tangent intersectionmethod.

Also allowable bearing pressure is found out for maximum allowable settlement of plate.

i.e. The relation

$$\frac{S_F}{S_P} = \left(\frac{B_F}{B_P}\frac{[B_P+30]}{[B_F+30]}\right)^2$$

Where Sf = maximum allowable settlement of footing (25 mm)

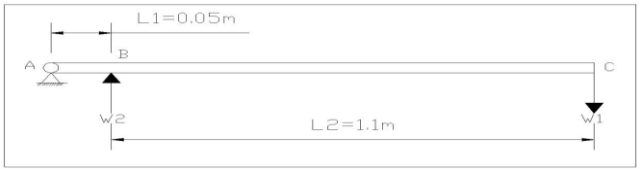
Sp = maximum allowable settlement of plate

So for known value of width of footing and width of plate we get Sp value for which we find out safe settlement pressure.

Also allowable bearing pressure by using 1% B method is found out.

Experimental set up

Lever arm arrangement



Loading detail

Now let the ultimate baring capacity of plate obtained from SPT = *p q* .kN/m2

Incremental bearing pressure = *p q* /5 = p kN/m2

So incremental loading required to applied = p/ (baring plate area) = p/ (0.3 x 0.1) KN = F Kg

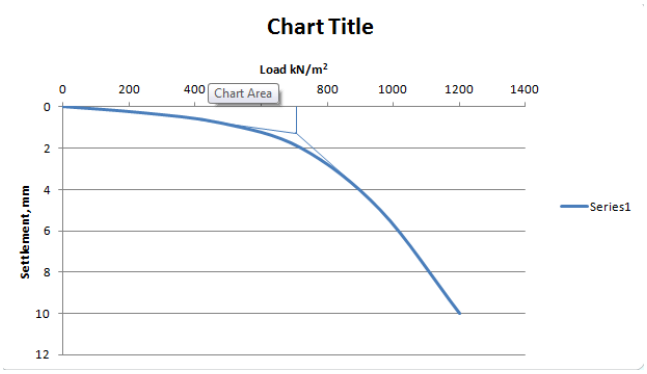
So load required to be attached to lever arm = F/22.5 kg

HereW2 = W1 (L1+L2)/L1

Therefore W2/W1 = 22.5

Results obtained from plate load test are

Allowable bearing pressure by fromgraph by using tangent intersection method.

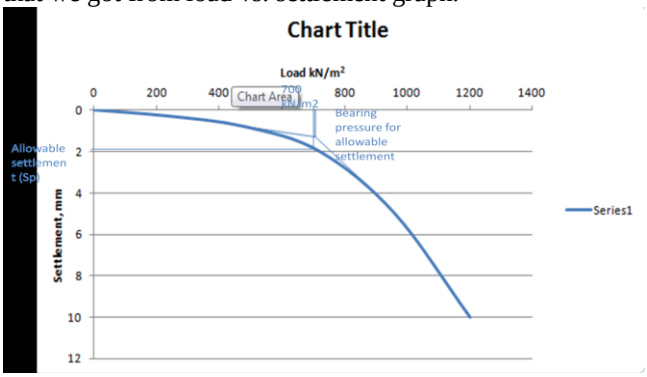


So the allowable bearing pressure is 700 kN/m2

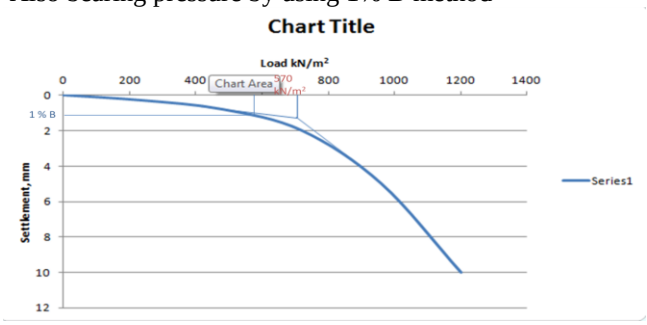
Now allowable bearing pressure considering maximum allowable settlementFrom relation

$$\frac{S_F}{S_P} = \left(\frac{B_F}{B_P}\frac{[B_P+30]}{[B_F+30]}\right)^2$$

We get maximum allowable settlement for footing of size 2 x 2 m2 = 2 m .So by drawing horizontal line from to this safe settlement value until it get intersected to curve .Then extending that line upward will intersect to X axis to give us value of bearing pressure .In this case we get bearing pressure = 700 kN/m2 which is equal to bearing pressure that we got from load vs. settlement graph.



Also bearing pressure by using 1% B method



For footings with dimensions of *B=1–3 m, a* settlement of 1% *B* is between 10 and 30mm, which is the range for typical design settlements. In our case B = 10 cm , so 1% of Bis equal to 1 mm .so for the settlement of 1 mm we have calculated the bearing pressureby using graph of bearing pressure vs. settlement as shown above

We got bearing pressure = 570 kN/m2

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Bearing capacity by using terzaghis equation

$$q_f = cN_c + \gamma DN_q + 0.5\gamma BN_\gamma$$

For this we requireNc, Nq ,$N\gamma$ which we can get from internal angle of friction which we got by direct shear.
Cohesion which is found out by using direct shear test.
Assumptions
1) At first we have taken the width of footing equal to width of plate and since weare performing the test on surface, so depth is considered as zero.
2) we assumed the footing of size 2 x 2 m2 and having depth equal to 2 then the results obtained by considering both the assumptions are compared and if required corrections are required to apply to first case considering type of soil. Means if soil is non-cohesive one then the relation between bearing capacity offooting and bearing capacity of plate are as follows.

$$\frac{q_{up}}{q_{uf}} = \frac{B_p}{B_f}$$

So the bearing capacity goes on increasing with width of footing. But in case of cohesivesoil width of footing doesn't matter.

COMPARISON OF RESULTS

Bearing pressure of footing
By SPT test = 330 kN/m2
By plate load test
From graph = 700 kN/m2
Now as we can see the results that we got from plate load test by using three different methods are comparable to each other. But these results are varying from the results of spt .

By 1 % B method =570 k N/m2
For maximum allowable settlement = 700 kN/m2

CORRECTIONS THAT MAY BE REQUIRED

If the results are not varying much (i.e. < 5%).then there is no need of applying corrections for given test.
If it is not the case then the corrections are needed to be applied.
Those corrections are as given below
Correction considering change in soil behavior due to change in the stiffness of walls of soil box, which restricts the soil movement.
Since this test gives 2-D failure of soil sample and the standard formulas available are based on 3-D failure of soil sample. So if there is drastic change in soil behavior in both of these cases, then there is need of corrections.

ADVANTAGES OF PLATE LOAD TEST ON UNDISTURBED SOIL SAMPLE OVER STANDARD PLATE LOAD TEST….

Space required is very small.
Total loading required is very small and loading arrangement is also simple one.
Cost of operation is also very less.
After considering required corrections in this method, it can prove superior to all other methods because of its enormous advantages.
The value of ultimate bearing capacity of footing that we got from plate load test on undisturbed soil sample is compared with the values that we got from standard plate load test.

FUTURE SCOPE

Now a day's many tall buildings are built due to lack of space. The load of whole building is basically taken by foundation which rest on soil. So it's bearing capacity of soil which decides the amount of load that soil can take. There are many cases of building failure happening due to soil failure and many times this happens due to improper calculation of bearing capacity. Many times the builder avoids to do the testing on soil due to lack of space and considers the properties of surrounding soil are same as that of soil on site of construction. But this not the case always. So we should always perform the loading tests on soil
Our proposed test basically eliminates many drawbacks of standard plate load test. This test can either performed in laboratory or on site. Space, time and money required for carrying out this test is also very small. And the most important thing is that it gives results comparable with standard plate load test. So this new method can prove very useful in future if we can eliminate small drawbacks that occur while removing the undisturbed sample and performing the test.

References

1. Bowles J.E. (1988). Foundation analysis and design, 4th Ed., McGraw-Hill, New York, N.Y.

2. DIN 18134 (2001). Determining the deformation and strength characteristics of soil by plate loading test. Deutsches Institute fürNormung.

3. ASTM D1195-93, Standard test method for repetitive static plate load tests of soils and flexible pavement components, for use in evaluation and design of airport and highway pavements: American Society for Testing Materials, Philadelphia, USA, 2004.
[15]
4. ASTM D1196-93, Standard test method forNonrepetitive static plate load tests of soils and flexible pavement components, for use in evaluation and design of airport and highway pavements: American Society for Testing Materials, Philadelphia, USA, 2004.

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