Performance of square footing under axial and eccentric loading on non-cohesive soil

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ABSTRACT

To improve bearing capacity of soil there are various technique out of which soil reinforcement is well know and mostly used for footing. For this study to integrate the performance of square footing which will be resting on non cohesive soil that is sand for the performance experimental. Set up will be reported as tank of dimension 500X500X450mm, proving ring, dial gauge, mechanical jack is used. The effect of eccentricity with centrally or axially applied loading on square footing resting over non cohesive soil with and without geotextile will be compared and analyzed. To provide structural stability and resistivity, it is very necessary to give rigid support to foundation but it is not possible at every location, because of soil strata. So it is necessary to find settlement of the foundation on different soil before actual construction. Above model can be utilized for the same. Geotextile can be used as a reinforcement in soil to improve their bearing capacity. Test will be performed and result will be compared and analysis with and without geotextile.

Keyword: *- sand, geotextile, MS tank, dial gauge, proving ring, screw jack , model footing.*

1. INTRODUCTION

Foundation are said to be backbone of every civil engineering structures. Foundation is the lower most part of structure that transmits the load coming from beams, columns and wall, equally to the soil beneath them. As the soil below the foundation is weak, it will fail to carry load coming from superstructure. The performance of a structure mostly depends on the performance of foundation. However, the behavior of this foundation has not been well understood. Since it is very important part, it should be designed properly. Further founding of structure of ground with adequate bearing capacity is one of the basic requirements for stability of structure. Footings serving as foundation for retaining walls, abutments, stanchions and portal framed building may be subjected to moments and shears in addition to vertical loads. If the resultant of these loads acting in a line with center of gravity of the footing, then it is said to be centrically but practically there will not be a perfectly centrally loaded footing. That is in certain condition the resultant load may not pass through center of gravity of the footing and thus said to be eccentrically loaded. The horizontal distance to which the load is displaced from the centerof footing can be termed as eccentricity. Footing located at property line, machine foundation are some example where the foundations, experience eccentric loading.

In some situations, structures are required to build on weak or difficult soils. Under such circumstances improvement of bearing capacity of soil is of great importance for the safety and long term stability of the structures. Inclusion of reinforcing layers within the sub soil is an effective and economical method amongst many others. Soil reinforcing technique is a one of the promising field in civil engineering specially for foundation engineering to improve certain characteristics of soil. Many waste materials such as rubber shreds, high density polyethylene strips, polyethylene fiber, geotextiles, geogrids and jute fiber have been used as a fill along with soil in embankment, foundations and retaining walls to improve certain soil characteristics.

Several studies has reported the successful use of sand reinforcement as a cost effective method to increase the strength, ultimate bearing capacity and to decrease settlement value under different types of footings and they are briefly studied in the subsequent chapter.

1.1 NEED OF WORK

One of the most significant components of any structure is its foundation. Foundations are integral to overall structural performance. They help in bearing and transmitting the structural loads to the soil, reducing settlements (total and differential), preventing possible movement of structures due to periodic shrinkage and swelling of subsoils, allow building over water or water-logged grounds, resist uplifting or overturning forces due to wind, and resist lateral forces due to soil movement and control water penetration and dampness. To perform satisfactorily, foundations must have two main characteristics: they have to be safe against overall shear failure in the soil that supports them and they must not undergo excessive settlement.Probably the most difficult of the problems that a soil engineer is asked to solve is the accurate prediction of the settlement of a loaded foundation. The problem is in two distinct parts: the value of the total settlement that will occur and the rate at which this value will be achieved. The design of shallow foundations is generally controlled by settlement rather than bearing capacity. As a consequence, settlement prediction is a major concern and is an essential criterion in the design process of foundations. Consistent and accurate prediction of settlement is yet to be achieved by the use of a variety of analytical methods.

2. MATERIALS AND METHODS

Tank:-The test tank was made of 2 mm thick having internal dimensions 500 mm x 500 mm in plan and 450 mm high. The minimum tank size required to be 5 times the width or breadth of footing whichever is more. The bulging effect counteracts by providing sufficient horizontal and vertical bracings at sufficient interval.

Model Footing :-The model footing used was made of a rigid steel plate of dimensions 100 mm x 100mm and 10 mm thick. The photograph of model footing has little groove to facilitate the application of load at the center and at the point of load eccentricity. The footing was provided with the two Hanges on two sides of footings to measure the settlement of footing under the action of load with the help of dial gauges.

Dial Gauge :-The dial gauges were used to measure the settlement. Least count of dial gauges was0.01 mm and total run was 25 mm. During testing, the two dial gauges were used for the measurement of vertical deformation of the footing and one dial gauge was used to measure the horizontal deflection.

Proving Ring:-For laboratory plate load test, proving rings of 50kN capacity was used. The proving ring was fixed to bottom plunger to transfer load from proving ring to footing

Screw Jack:- The loads are applied on the model footing with the help of a 25 Ton capacity screw jack.The screw jack was fixed at the centre of horizontal member of reaction frame.

Sand:- The sand utilized as a part of experimental program was collected from the bed of Pavana River. By quick washing and cleaning, it is made free from roots, organic matters etc

Geotextile:- Geotextile are permeable fabrics which , when used in association with soil have the ability to separate, filter, reinforce, protect etc.

Sr no.	Properties	Values
1	Specific Gravity	2.69
2	e_{max}	0.60
3	e_{min}	0.52
4	γ_{max}	16.50
5	γ_{min}	15.14
6	Relative Density (%)	43 %
7	Angle of internal friction (φ)	35.35
8	Average grain size (D60)	1.33
9	Effective grain size (D10)	0.6
10	Coefficient of uniformity (Cu)	1.49
11	Coefficient of curvature (Cc)	2.15
12	I.S. Classification	Medium Sand

Table -1 Properties of Sand

2.1 PROCEDURE

To find Basic Properties of soil The model plate load tests will be conducted in a mild steel tank measuring 500(L)X500(B)X450(H) mm. All sides of the tank are made of 2mm thick of MS sheet. All four sides of the tank are braced to avoid bulging during testing. The square footing having dimension 100(L)X100(B)X10(T)mm. These are made from a mild steel plate. The bottom of the footing will be made rough by applying glue and then rolling the model footing over sand. Sand was poured into the test tank in layers of 25mm from a fixed height by raining technique to achieve the desired average unit weight of compaction. The height of fall was fixed by making several trials in the test tank prior to the model test to achieve the desire unit weight. The model foundation will be placed at a desired Df/B ratio at the middle of the tank Load to the model footing will applied by using mechanical jack. The load applied to the model footing is measured by Proving ring settlement of the model foundation is measured by dial gauges placed on two edges along the width side of the model footing.

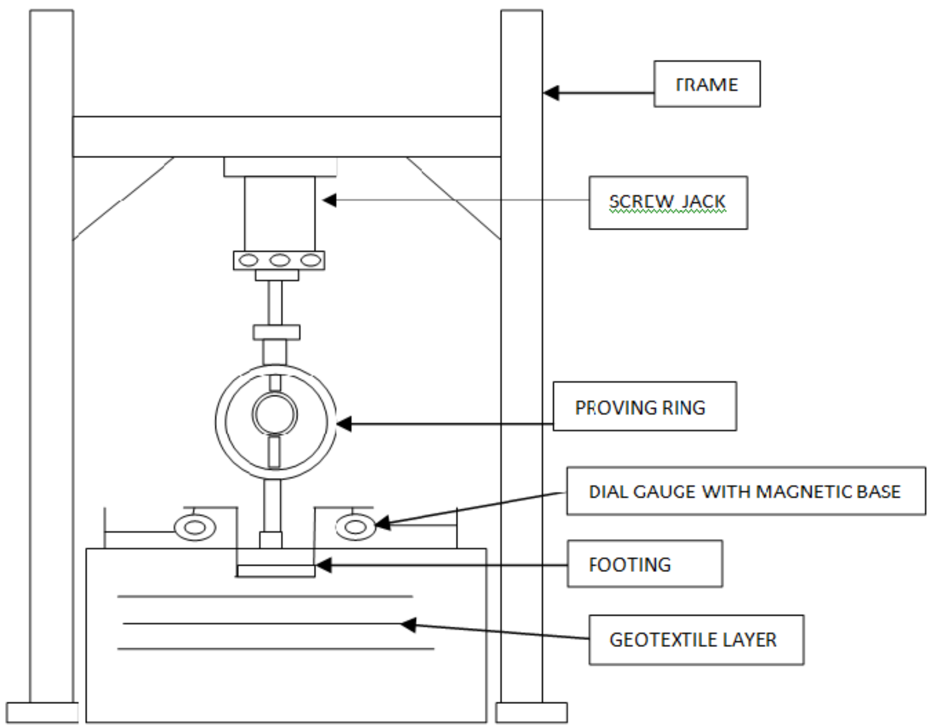


Fig: Experimental Model

3. RESULT

The model plate load tests were conducted on square footing of size 10 cm x 10 cm. The plate load test data for all the tests conducted is given in Appendix 'B' in terms of vertical settlement and horizontal displacement corresponding to the applied load. The load settlement curves were plotted for all tests. The ultimate bearing capacity was determined from these load intensity settlement curve. The results of unreinforced soil and reinforced soil under eccentric load were compared in terms of Bearing Capacity Ratio, which is the ratio of UBC of soil provided with geotextile to that of soil without such provisions.

Sr No.	e/B=0		e/B=0.1	
	Load Intensity KN/m²	Vertical Displacement mm	Load Intensity KN/m²	Vertical Displacement mm
1	0	0	0	0
2	20	0.3	15	0.4
3	40	0.8	30	0.9
4	60	1.6	45	1.3
5	80	2.4	60	1.9
6	100	3.6	75	2.7
7	87	6.2	67	3.1
8	-	-	-	-

I)Load Displacement Data For Square Footing Under eccentric Load On Unreinforced Sand

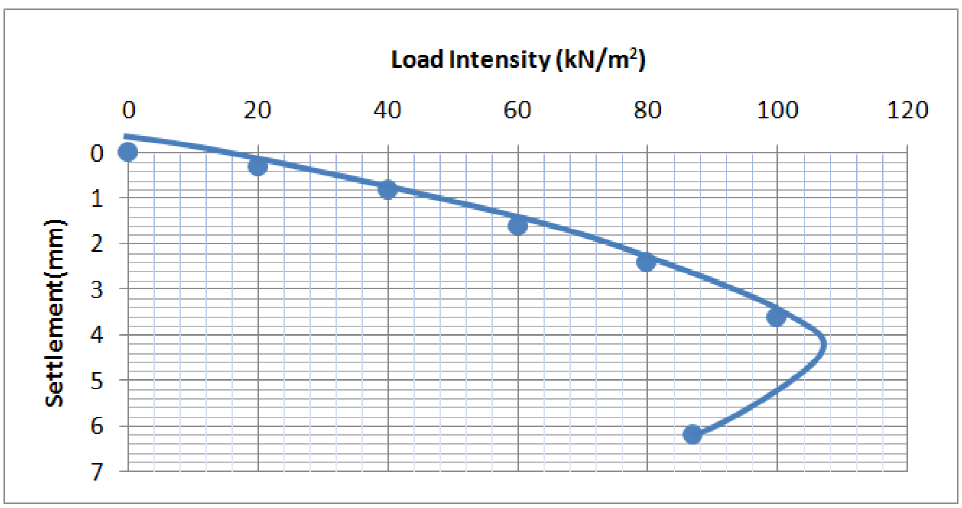


Fig 4.1: Load- Settlement Curve for Footing under unreinforced case.

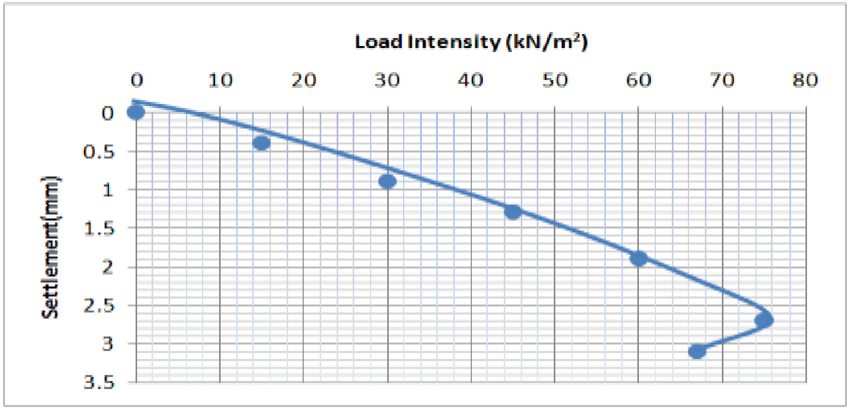


Fig. 4.2: Load- Settlement Curve for Footing under Eccentric Load (e/B=0.1)

Sr No.	e/B=0		e/B=0.1	
	Load Intensity KN/m²	Vertical Displacement mm	Load Intensity KN/m²	Vertical Displacement mm
1	0	0	0	0
2	20	0.4	20	0.2
3	40	1.2	40	0.5
4	60	2	60	1.4
5	80	2.4	80	1.7
6	100	3.2	100	2.1
7	120	4	120	2.7
8	140	4.8	116	3.4
9	160	5.2	-	-
10	154	5.9	-	-
11	-	-	-	-

II) Load Displacement Data For Square Footing Under eccentric Load On Reinforced Sand

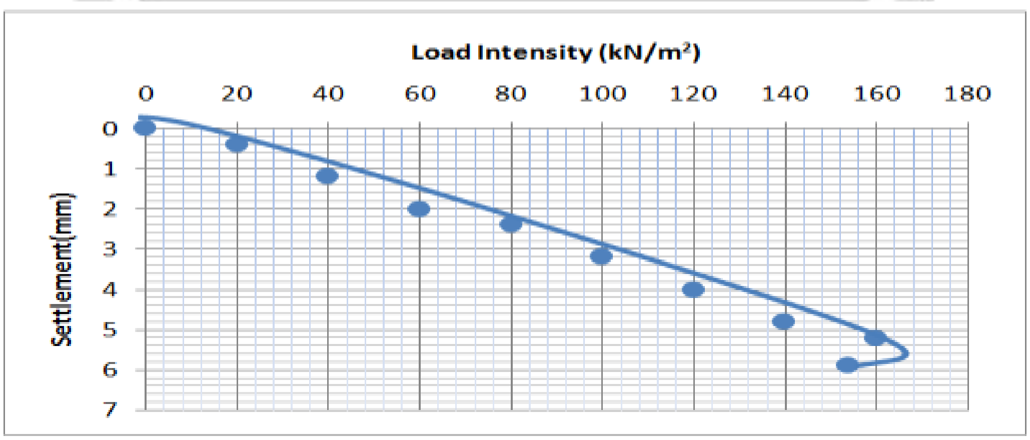
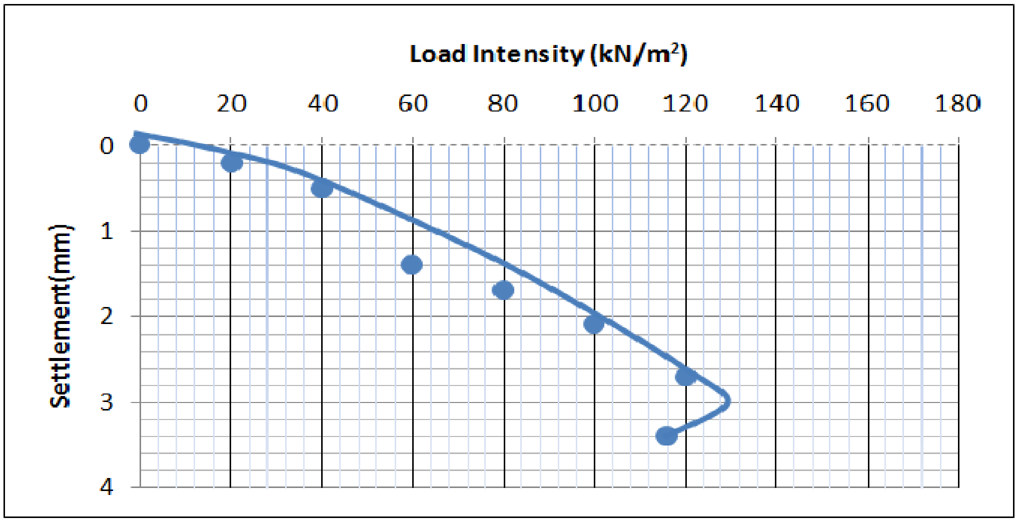


Fig. 4.5: Load- Settlement Curve for Footing on Reinforced Sand Bed.



4.6: Load -Settlement Curve for Footing on Reinforced Sand Bed (at u/B-0.2 and e/B=0.1)

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4. CONCLUSIONS

The present work studied the performance of square footing under axial and eccentric loading on unreinforced and reinforced sand. The geotextile wasused as reinforced material for sand. The geotextile was used in three layers having length of fourtimes the width of footing. The reinforcement was placed at u/B=0.2 for studyingthe effects of position of reinforcement. The model plate load test were conducted to understandthe performance. The performance was presented in terms of bearing capacity ratio, settlementand horizontal displacement. The following conclusion are drawn from the work.

- The bearing capacity of square footing decreases as load eccentricity increases forunreinforced and reinforced sand.
- The settlement is reduced by using geotextile as reinforcing material.
- Ultimate bearing capacity of sand is improved by using geotextile as reinforcing material by 65%.
- Ultimate bearing capacity of sand at e/B=0.1 is improved by 58% as compared to unreinforced sand.
- Ultimate bearing capacity of sand at e/B=0.15 is improved by 76%.
- Ultimate bearing capacity of sand at e/B=0.2 is improved by 70%.

5. APPLICATIONS

- This study for eccentric load can be used in the design and construction of structuressuch as foundations of retaining walls, abutments, columns, stanchions, portal framed building,footing located at property line, machine foundation, portal frame buildings.
- Geotextiles can be used in soil stabilization.
- Geotextiles are used in civil engineering earthworks to reinforce vertical and steep banks of soil , to construct firm bases for temporary and permanent roads and highways.
- Geotextiles are used to protect river bank from erosion due to currents.

5.1 Future scope

The following points can be used for the further studies of axial-eccentric load on soil.
(i) The Earthquake Analysis is necessary.
(ii) Study for the others types of soil.
(iii) Analytical simulations for axial-eccentric load.
(iv) Study for different type of footing.

6. REFERENCES

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