Behavior of square footing under eccentric loading on reinforced sand.

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ABSTRACT

The lowermost part of the structure called as Foundation is the important part of the structure; function of foundation is to take loads of superstructure and transferred it to the soil. For the structural stability and to avoid settlement of structure bearing capacity of structure has a important role. We can improve Bearing capacity of soil by various techniques such as dewatering of soil, blending granular material, driving the sand piles & confining the soil. Here we are using geotextiles as reinforcing material, sand is reinforced with geotextiles, and reinforcing material is laid down at various depths along width of the tank. To check behavior of square footing under axial and eccentric loading on reinforced sand we have made one set up i.e. loading frame, tank of dimension 500x500x450 mm, proving ring , dial gauge, mechanical jack etc. behavior of square footing is check for axially and eccentric loading by this set up. Settlement of structure is calculated for axial and eccentric loading, and compared with the standard condition.

Key words: Sand, Proving ring, MS tank, Loading frame, Screw jack, M.S. 10 cm x 10 cm footing. etc

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1.1 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.

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 especially 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.

1.2 Settlement of Foundation

Foundation settlement occurs when there are soil changes below the structure. When the soil is no longer able to bear the weight of the structure above it, it will heave and cause movement in your foundation. Let's take a closer look at the types of soil conditions that can cause your foundation to settle:

- **Weak bearing soil**: This is soil that is not capable of carrying the load of the building sitting on it. The weight and pressure is too much for the soil to bear.
- **Poorly compacted soil:** Sometimes homes and businesses are built on soil that hasn't been properly compacted. If this is the case, the soil will not be able to hold the weight of the foundation, and it will settle.

- **Changes in the level of moisture in the soil**: Excess moisture can lead to weakening of the soil, reducing its ability to support the load of a structure. Loss of moisture will cause it to shrink and decrease in volume. settlement is categorized into three main types, i) Uniform settlement ii)Tilt iii)Angular distortion

1.3 Need of study

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 subsoil's, 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.

1.4 Objective

- To study uniform and differential settlement of foundation.
- To study the different engineering properties of soil by performing various tests.
- Comparative study of stability of foundation with and without Geotextile.
- To provide structural stability and resistivity to the foundation.

1.5 Material Used

- Sand
- MS-tank
- Experimental Frame
- Mechanical jack
- Proving ring
- Dial gauge
- Geotextiles sheet
    - Model footing (100 mm x 100 mm x 10 mm)

1.6 Problem Statement

The model tests will be conduct for embedment ratio D_f/B varying from zero to one, the eccentricity ratio e/B varying from zero to 1.6cm and with relative density and other engineering properties of sand. A square footing of size 10cmX10cmX1cm will be used for all tests. The details of the test and its procedure have been mention in I.S. code 1888-1982. Geotextile will be used for reinforcing the soil in order to improve the bearing capacity. Using the results of laboratory model test, performance of square footing under eccentric loading will be analysed. Medium of soil will be Non Cohesive soil i.e. sand, Test model will be prepared.

1.7 Experimental Model

The experimental model was prepared which consisted of M.S tank, model footing, dial gauge, proving ring, screw jack, geotextile. These are described in following section.

1.7.1 M.S.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 intervals as shown in the Fig.1

Fig 1: Test Tank used for Experimental Investigation

1.7.2 Model Footing

The model footing used was made of a rigid steel plate of dimensions 100 mm x 100 mm and 10 mm thick. The photograph of model footing is as shown in Fig. 3.2.2.1. 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.

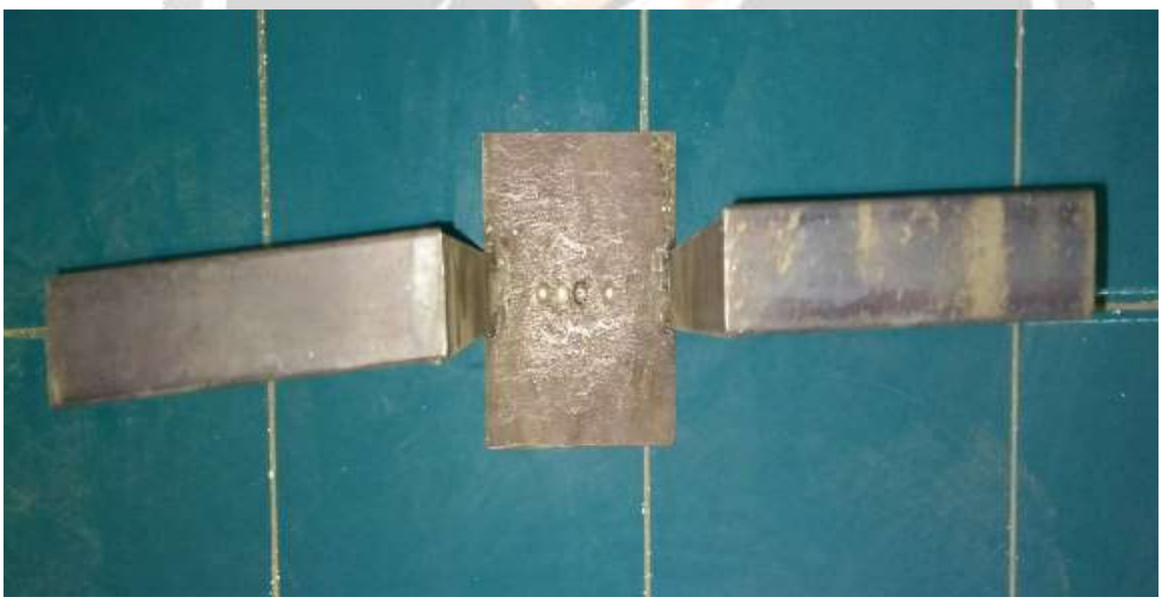

Fig 1.2: Test Tank used for Experimental Investigation

1.7.3 Dial Gauge with Magnetic Base

The dial gauges were used to measure the settlement. Least count of dial gauges was 0.01 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. The purpose of providing two dial gauges on the footing is to record the average vertical settlement of the footing. Fig. 3.2.3.1 shows the dial gauge used for the testing along with a magnetic stand for fixing.

Fig1.3: Dial Gauge with Magnetic Stand used for Experimental Investigation

1.7.4 Proving Ring

For laboratory plate load test, proving rings of 50 kN capacity was used. The proving ring was fixed to bottom plunger to transfer load from proving ring to footing as shown inFig.3.2.4.1.

Fig 1.4: Test Tank used for Experimental Investigation

1.7.5 Screw Jack

The loads are applied on the model footing with the help of a 25 Ton capacity screw jack as shown in Fig.3.2.5.1. The screw jack was fixed at the centre of horizontal member of reaction frame.

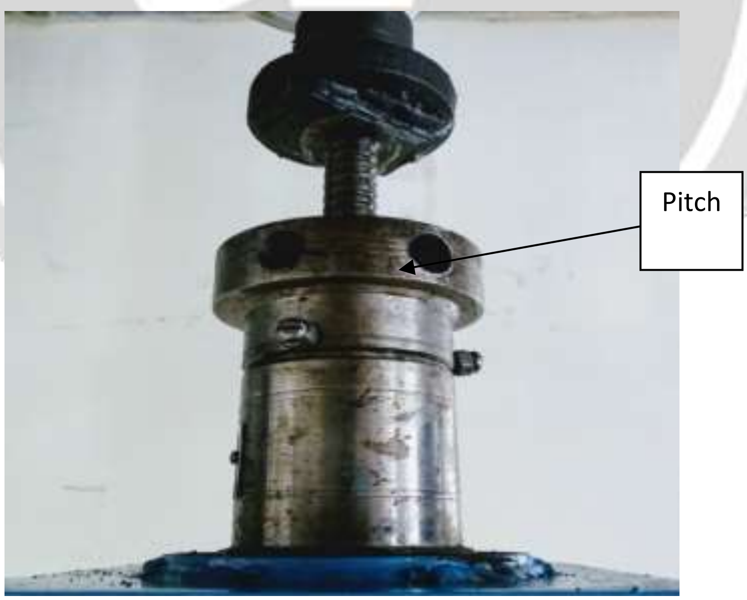

Fig 1.5: Screw jack used for Experimental Investigation

Figure 1.6 Geotextile used for Experimental Investigation

1.8 Materials

The materials used for experimental investigations are described in following section.

1.8.1 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. The sand used in the test is as shown in Fig. 3.3.1.1.The various laboratory tests were performed as per SP 36(Part 2):1988 to decide the different geotechnical and engineering properties of sand such as grade of sand, specific gravity, density of sand and angle of internal friction of sand.

Fig 1.6: Sand used for Experimental Investigation

Table No: 1 Properties of Sand

Sr no.	Properties	Values
1	Specific Gravity	2.68
2	e_{max}	0.73
3	e_{min}	0.5

4	γ_{max}	17.84
5	γ_{min}	15.53
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

1.9 Experimental 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.

Figure 1.7 Experimental Setup used for Experimental Investigation

1.10 Results & Discussion

I) Load displacement data for square footing under eccentric load on reinforced sand

Sr. No.	e/B = 0.1		e/B = 0.15		e/B = 0.20	
	Load Intensity KN/m^2	Vertical displacement in mm	Load Intensity KN/m^2	Vertical displacement in mm	Load Intensity KN/m^2	Vertical displacement in mm
1	0	0	0	0	0	0
2	20	0.2	10	0.3	5	0.2
3	40	0.5	20	0.6	10	0.5
4	60	1.4	30	1.1	15	0.55
5	80	1.7	40	1.5	20	0.8
6	100	2.1	50	1.7	25	0.95
7	120	2.7	60	2.2	30	1.2
8	116	3.4	70	2.4	35	1.35
9	-	-	62	2.8	40	1.48
10	-	-	-	-	45	1.65
11	-	-	-	-	42	1.88

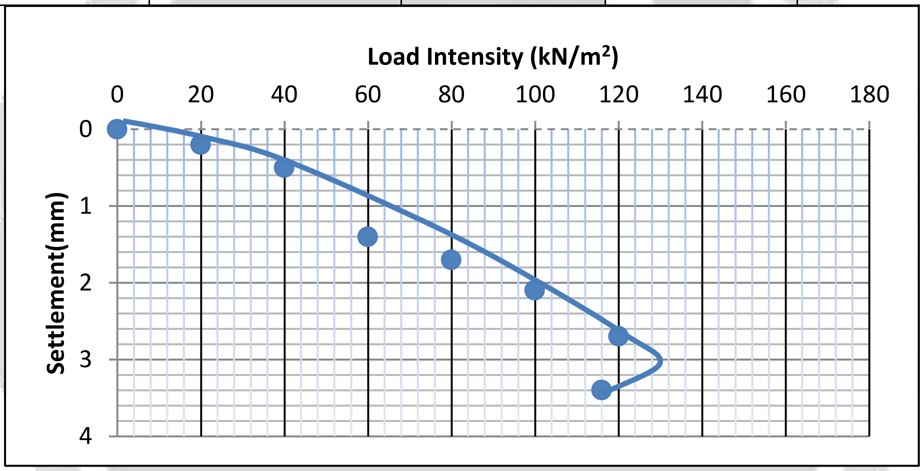

Fig 1.8 Load- Settlement Curve for Footing under Eccentric Load (e/B=0.15) The ultimate bearing capacity of Reinforced sand is 70 kN/m^2.

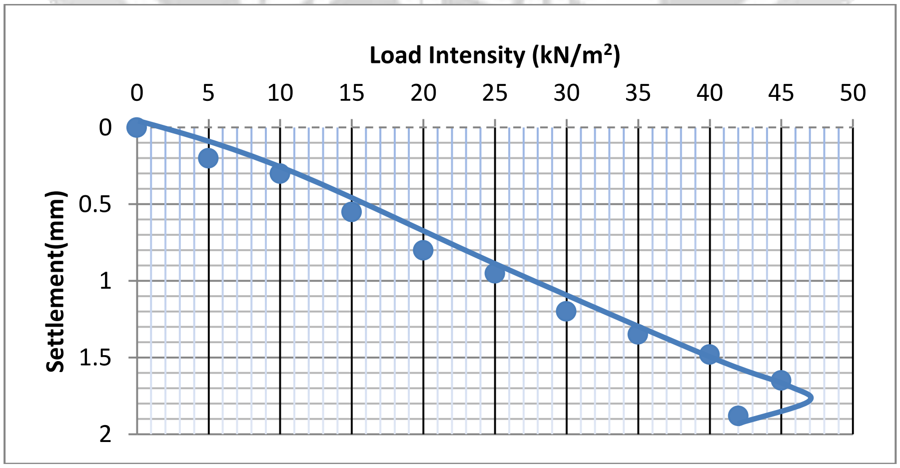

Fig. 1.9 Load- Settlement Curve for Footing under Eccentric Load (e/B=0.2) The ultimate bearing capacity of Reinforced sand is 47 kN/m^2**.**

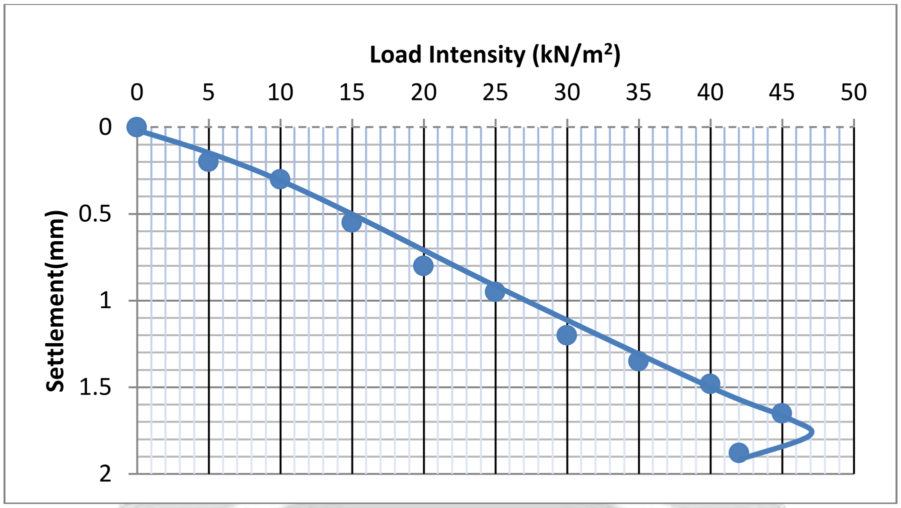

Fig. 1.10 Load- Settlement Curve for Footing under Eccentric Load (e/B=0.2) The ultimate bearing capacity of Reinforced sand is 47 kN/m^2.

1.10 Conclusion

The present work studied the Behavior of square footing under eccentric loading on reinforced sand. The geotextile was used as reinforced material for sand. The geotextile was used in three layers having length of four times the width of footing. The reinforcement was placed at u/B=0.2 and u/B=0.4 for studying the effects of position of reinforcement. The model plate load test were conducted to understand the performance. The performance was presented in terms of bearing capacity ratio, settlement and horizontal displacement. The following conclusion are drawn from the work.

• The bearing capacity of square footing decreases as load eccentricity increases for reinforced soil.
• The bearing capacity ratios for eccentric load is minimum at load eccentricity of 0.15 (e/B=0.15).
• The bearing capacity ratios for eccentric-inclined load increases with inclination and The bearing capacity ratios for inclined, eccentric and eccentric-inclined load is maximum when reinforcement is placed at u/B=0.2.

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