MODELLING OF SQUARE FOOTING TO STUDY THE ENHANCEMENT OF LOAD CARRYING CAPACITY OF SAND USING GEOGRIDS

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Abstract: Reinforcement in the soil foundations are usually used in the form of reinforcing elements in the form of strips, grids or ties that are placed horizontally. The soil reinforcement enhances the load carrying capacity of soil. The purpose of this research work is to determine the enhancement in the bearing capacity of square footing by conducting the model tests in the laboratory on unreinforced sand and sand reinforced with geogrids. The model tests have been conducted using square model footing made of mild steel plate with dimensions 10×10×2.5 cm. The average relative density to be adopted throughout all the tests is 65%. Distance of first layer of geogrid from bottom of footing and the width of geogrid are varied. The load settlement curve for each tests have been plotted to calculate ultimate bearing capacity and its increase after using the geogrid. In this study triaxial geogrid has been used to investigate the load settlement behavior for model footings reinforced with TX160 polyester geogrids resting on poorly graded medium sand. Depending on the current study, values for optimum depth of 1st layer and optimum width of reinforcement for triaxial type of geogrid have been proposed. It is observed in the present research that addition of reinforcement increased the bearing capacity as well as decreased the settlement of the foundation. The optimum depth of 1st layer obtained from the laboratory testing is 0.45 times the width of square footing and the optimum width of reinforcement used is 5.5 times the width of footing.

Keywords: **Bearing capacity, Geogrids, settlement, reinforcement.**

I. INTRODUCTION

Sandy soils introduce various problems for geotechnical engineers. Usually, their low shear strengths and the magnitude of the proposed loads require the soil to be stabilised. Several techniques are available for ground stabilisation, e.g. grouting, freezing, dewatering, compacting, etc. Most, however, are site specific, often costly and time consuming. One of the fastest growing techniques in the field of geotechnical engineering is reinforcing the soil below shallow foundations with geosynthetic reinforcement like Geogrids etc.

In this paper, attempt is being made to investigate load settlement behavior of square model footings resting on Geogrid reinforced granular soils. In the present study, the load settlement behavior was studied for model footings reinforced with triaxial geogrid resting on sand classified as poorly graded at a relative density equal to 65% and quantum of improvement was observed for each grade. Parameters of the testing program include the depth to the first reinforcement layer and the plan area of the reinforcement. After studying various research papers, the values of depth of 1st layer and the width of the geogrid layers have been adopted in this research work. The increase in bearing capacity was expressed in a non-dimensional form, called Bearing Capacity Ratio.

II. MATERIALS AND METHODOLOGY

The experimental program has been designed to study the bearing capacity of axially loaded square footing on unreinforced and geogrid reinforced sand bed. For this purpose, the laboratory model tests were conducted on square footings at a particular density. All tests were performed in a test tank of dimensions 45cm × 40cm. and the depth of tank is 50cm. The mild steel plate of dimensions 10cm × 10cm × 2.5cm was used as model square footing. All experiments are conducted at same relative density of 65%. The average unit weight of sand at this relative density is 1.59g/cc and internal friction angle is found out to be 34.29 by direct shear test at this relative density. The characteristics of sand used in research work and the grain size distribution is listed in table 1 and figure 1 respectively.

Table 1: Properties of sand

S. No	Property	Value
1.	D_{10}	0.275
2.	D_{30}	0.63
3.	D_{60}	0.915
4.	D_{50}	0.82
5.	Coefficient of curvature (Cc)	1.577
6.	Coefficient of uniformity (Cu)	3.32
7.	Specific gravity (G)	2.67
8.	Maximum dry unit weight (KN/m^3)	16.8
9.	Minimum dry unit weight (KN/m^3)	14.5
10.	Friction angle (ϕ)	34.29
11.	Maximum void ratio (e_{max})	0.84
12.	Minimum void ratio (e_{min})	0.589

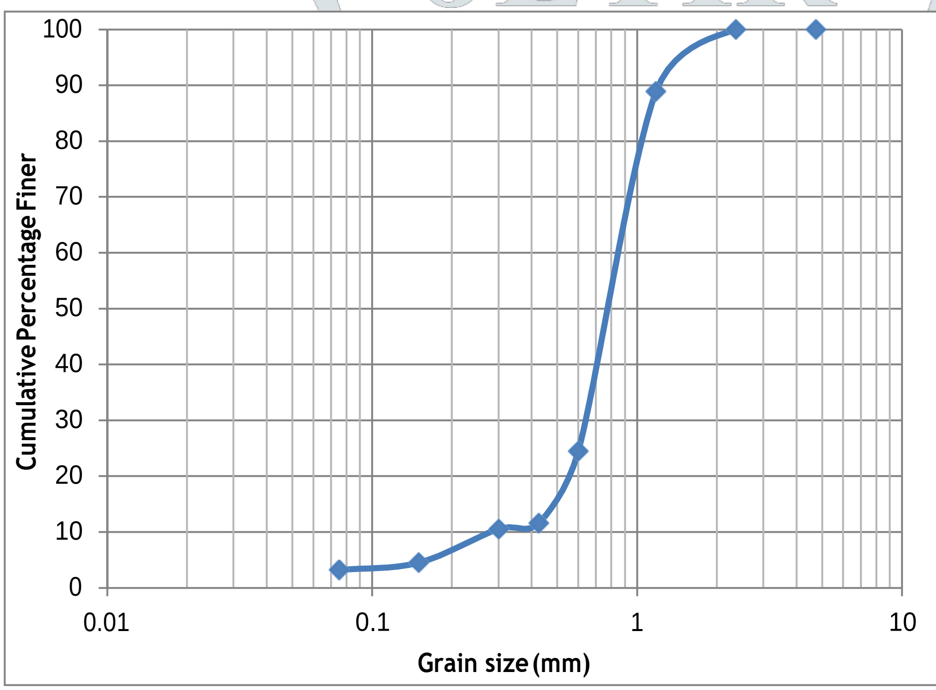

Figure 1: Grain size distribution curve of sand

Based on the stress transfer, triaxial geogrid TriAX (TX160) was used as reinforcement. The properties of geogrid as obtained from Tensar international are tabulated in table 2

Table 2: Properties of triaxial geogrid (TX160)

Properties	**Value**
Rib shape	Rectangular
Aperture shape	Traingular
Radial stiffness at low strain	300 KN/m2
Junction efficiency	93%
Aperture stability	3.6 kg-cm/deg
Tensile strength at low strain	1.5 KN/m2
Resistance to chemical degradation	100%
Resistance to UV lighty and weathering	100%

III. RESULTS AND DISCUSSION

Load tests have been performed on model square footing of size 10cm× 10cm resting over unreinforced as well as reinforced sand bed. For preparing reinforced sand bed, a single layer of geogrid have been introduced. Settlement corresponding to each load increment is noted and the test result is plotted in terms of load-settlement curve. Bearing capacity results are analyzed to determine the optimum values of u/B and b/B. The increase in ultimate bearing capacity of the square footing is generally expressed in a non dimensional form, called Bearing Capacity Ratio, BCR.The various load settlement curves obtained are given in figure 2 and figure 3.

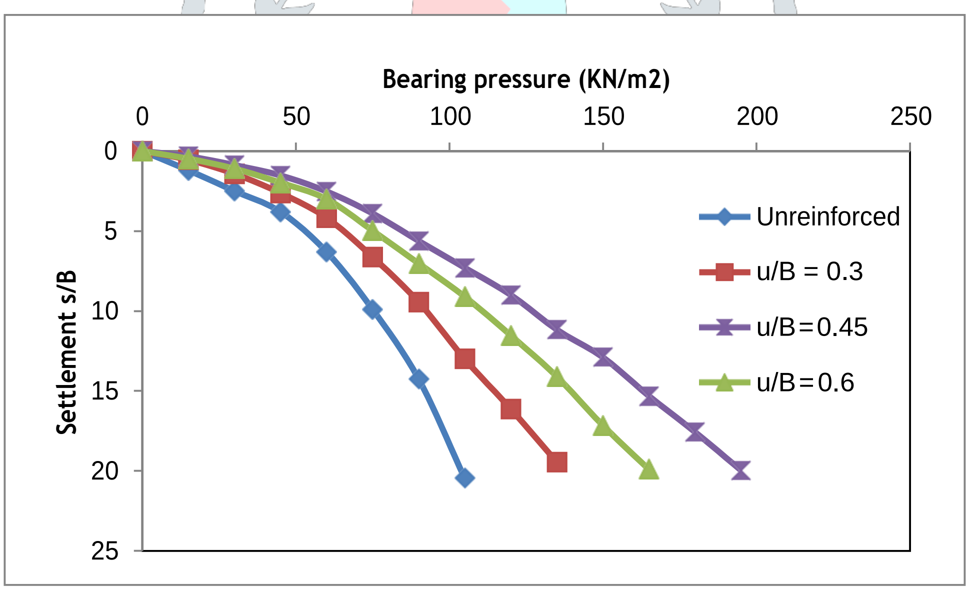

Figure 2 : Plot of Bearing pressure vs settlement ratio at various depths of 1st layer (u/B)

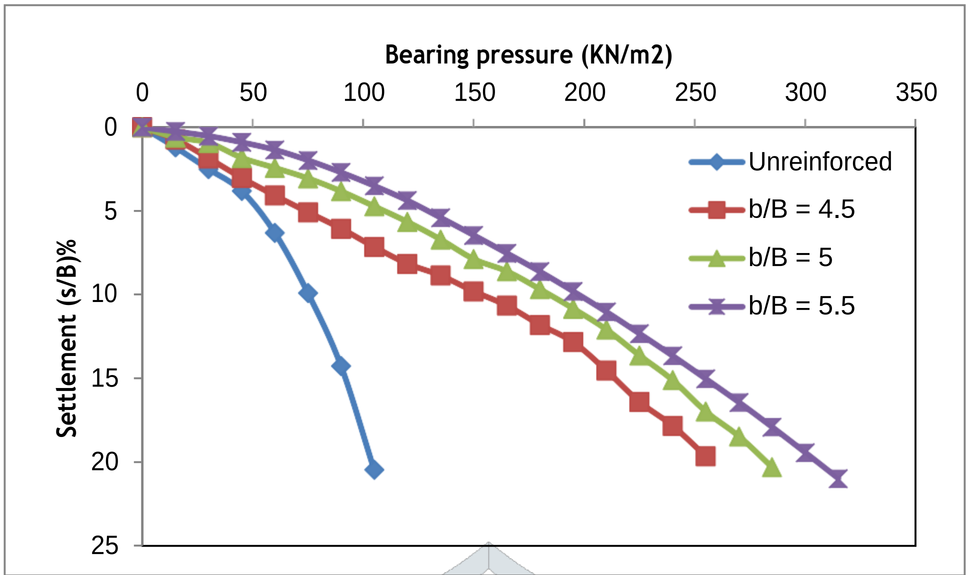

Figure 3: Plot of bearing pressure vs settlement ratio for varying b/B ratios.

Table 3: Bearing capacity ratios at various u/B ratios for 6% settlement

u/B	Bearing pressure for unreinforced soil, q_u (KN/m^2)	Bearing pressure for reinforced soil, q_r (KN/m^2)	Bearing capacity ratio (BCR)	Increase in bearing capacity (%)
0.3	58.2	66.78	1.15	14.7
0.45	58.2	93.4	1.6	60.5
0.6	58.2	82.5	1.4	41.7

Table 4: Bearing capacity ratios at various b/B ratios for 6% settlement

b/B	Bearing pressure for unreinforced soil ,qu (KN/m2)	Bearing pressure for reinforced soil ,qr (KN/m2)	Bearing capacity ratio (BCR)	Increase in bearing capacity (%)
4.5	58.2	89.23	1.53	53.3
5	58.2	125	2.14	114.7
5.5	58.2	143.57	2.47	146.7

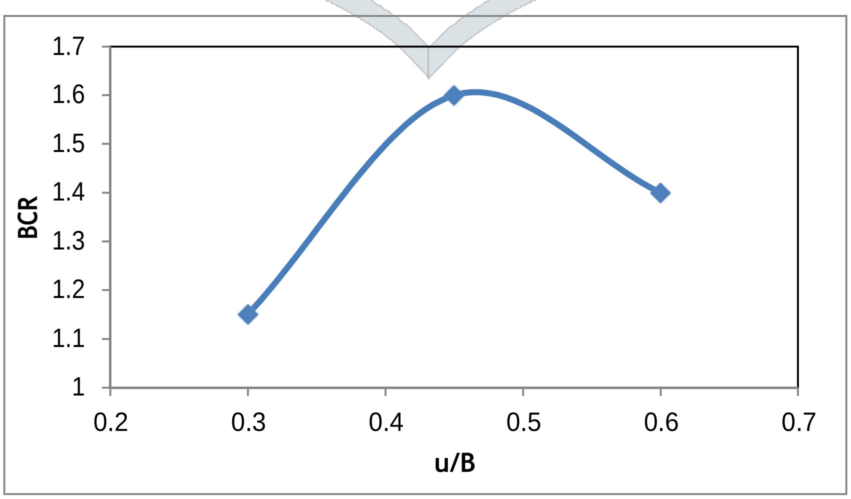

Figure 4 : Variation of bearing capacity ratio with u/B.

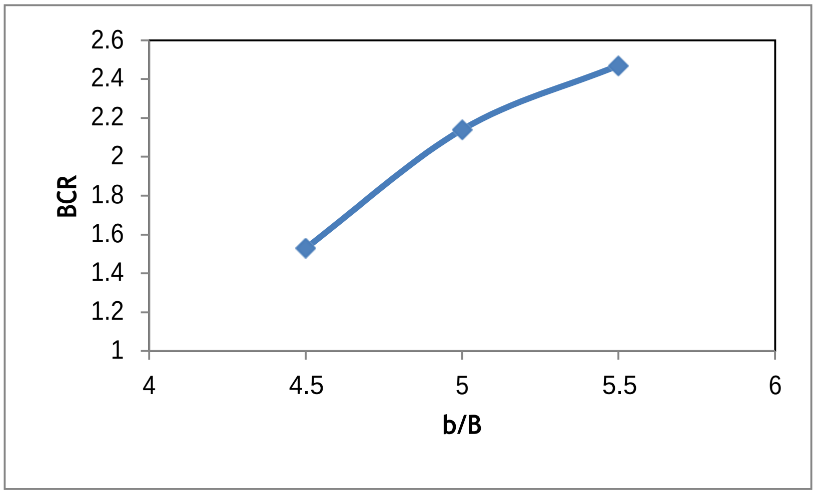

Figure 5 : Variation of BCR with changing b/B ratio.

IV. CONCLUSIONS

Laboratory model test results for the ultimate bearing capacity of square foundations supported by sand with triaxial geogrid reinforcement have been presented. Based on the model test results, the following conclusions can be drawn.

- The bearing capacity of sand reinforced with triaxial geogrid is more as compared to the unreinforced sand and the settlement of sand decreases on addition of support in the form of geogrids.
- For development of maximum bearing capacity, the effective depth of 1st layer of geogrid reinforcement is about 0.45B for square foundations.
- Maximum width of reinforcement layers required for mobilization of maximum bearing-capacity ratio is about 5.5B for square foundations.

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