Research Article Impact Factor: 0.621 ISSN: 2319-507X
AI Dhatrak, IJPRET, 2014; Volume 2 (9): 83-92 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

PERFORMANCE OF FOOTINGS ON PRESTRESED GEOSYNTHETIC REINFORCED SAND

DHATRAK A. I, KHAN FARUKH. A.

1. Associate Professor, Department of Civil Engineering, Government College of Engineering, Amravati, Maharashtra, India.
2. **PG Student, Department of Civil Engineering, Government College of Engineering, Amravati, Maharashtra, India.

Accepted Date: 27/02/2014 ; Published Date: 01/05/2014

Abstract: This paper mainly investigates experimental study from a series of laboratory scale bearing capacity tests carried out on model square footings on single and double layer prestrssed biaxial reinforcement. The improvement in bearing capacity and reduction in settlement of a geogrid reinforced sand bed are due to prestressing the reinforcement. The parameters of experimental study are the bearing capacity improvement, magnitude and direction of prestressing force. The settlements at the interface are also measured. The addition of prestress to Geogrid reinforcement results in significant improvement in the load carrying capacity and settlement response of the prestressed Geogrid sand bed. Improvement in bearing capacity is found to be more with biaxial prestressing than with uniaxial prestressing.

Keywords: Model footing test, Prestress reinforced Bed, ultimate bearing capacity

Corresponding Author: MR. KHANDVE. P. V.

Access Online On:

www.ijpret.com

How to Cite This Article:

AI Dhatrak, IJPRET, 2014; Volume 2 (9): 83-92

PAPER-QR CODE

INTRODUCTION

The systematic layers of reinforcement (e.g. woven geotextile, geogrid, or geocomposite) are often placed beneath foundations to improve the settlement characteristics and load-bearing capacity of the weak foundation soils. In the cases of poor to marginal ground conditions, geosynthetics reinforcement is proved to be a cost-effective solution and in some cases geosynthetics open up the possibility of constructing shallow foundations in lieu of expensive deep foundations.

The work scope focus to study the experimentally the effects of prestressing the single and double layer reinforced sand bed on the load-bearing capacity and settlement response of a reinforced layer at different size of footings and different depth of reinforcement. The parameters of experimental study are the effects of, magnitude of prestress and direction of prestress.

2. Experimental Programme

The experimental program reported herein, that involves small scale load tests, was carried out. Details of the experimental program, test procedures, and analysis of the test results model studies of the settlement behaviour and load-bearing capacity of square footings resting on a prestressed geotextile-reinforced sand bed are presented below.

2.1 Material

The materials used for the study work were Biaxial Geogrid, Kanhan sand and footing of various sizes made up of cast iron.

2.1.1 Test Sand

For the model tests, cohesionless, dry, clean and wash Kanhan sand was used as the foundation material. This sand is available in Nagpur region of Vidharabha, Maharashtra.

2.1.2 Model Footing

The model footings of three different sizes were fabricated by using cast iron material. The model footings used were square plates of dimension75x75mm and 10 mm thick. Every footing has a little groove at the center to facilitate the application of load. The footings were provided with the two flanges on two sides of footings to measure the settlement of footing under the action of load with the help of dial gauges.

2.1.3 Geogrid

The Biaxal Geogrid (SG3030) were used to reinforce sand bed in the model tests. The size of biaxial geogrid reinforcement used was five times the size of the footing. The biaxial geogrid reinforcement were placed at the location of the desired layer of reinforcement i.e. B, B/2 and B/4 from bottom of footing. The physical and mechanical properties, provided by the manufacturer, Strata Geosystems (India) private limited is a joint venture company in India with Strata Systems Inc., U.S.A.

Table 1:-Mechanical and Geometric properties of Geosynthetics

Sr. No.	Tests	Values
1	Tensile Strength	30 kN/m
2	Creep Reduction Factor (ASTM D 5262, ASTM D 6992)	1.51 kN/m
3	Creep Limited Strength	19.9 kN/m
4	Partial Factor-Installation Damage In clay, silt or sand In sandy gravel In gravel	1.07 1.07 1.30
5	Partial Factor-Environmental Effects GRI-GG7, GRI-GG8)	1.10
Geometric Properties		
6	Grid Aperture Sizes MD CD	18 (mm) 18 (mm)

2.2. Experimental Analysis

To study the load settlement characteristics of the footings under given parameters, the plate load test required to be conducted. The model plate load tests were performed in laboratory on the model footings of different shapes with different combinations. The tests were conducted on the model footings similar to the prototype under the standard conditions. The various laboratory tests performed to decide the different geotechnical properties of sand and laboratory plate load test conducted on the model footings similar to the prototype under the standard conditions are as discuss below.

2.3 Laboratory Tests

The various laboratory tests were performed to decide the different geotechnical and engineering properties of sand such as grade of sand, specific gravity, density of sand, relative density, height of fall and angle of internal friction of sand. Sieve analysis was then performed on the sand in accordance with IS: 2720- part IV-1985. The relative density test was also conducted as per IS: 2720- part XIV. The specific gravity of the soil sample was determined by Pycnometer method as per IS: 2720 part III-1964.

Table 2: Properties of Sand Used

Sr. No.	Properties	values
1	Specific gravity	2.59
2	emax	0.72
3	emin	0.52
4	γmax	17.04 kN/m3
5	γmin	14.6 kN/m3
6	Relative density (%)	60%
7	Angle of internal friction ϕ	39.5º
8	Average grain size (D60)	0.72
9	Effective grain size (D10)	0.32
10	Coefficient of uniformity (Cu)	2.25
11	Coefficient of curvature (Cc)	0.625
12	I. S. Classification	Medium sand, SP grade

3. Laboratory Set-up

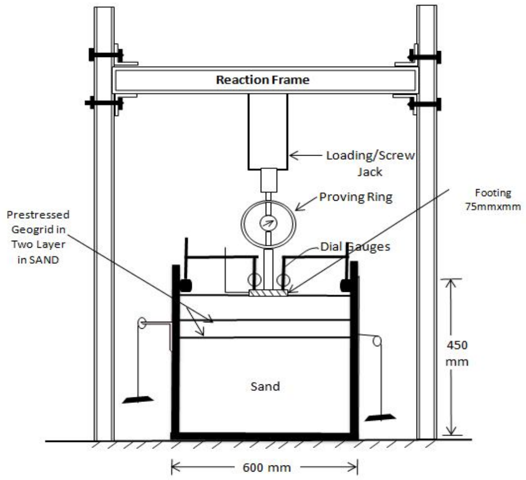
Laboratory set-up consisted of a tank, a reaction frame, a model footing, hydraulic jack, pulleys, proving ring, dial gauges and biaxial geogrid as reinforcement. These are described in following sections.

3.1 Tank

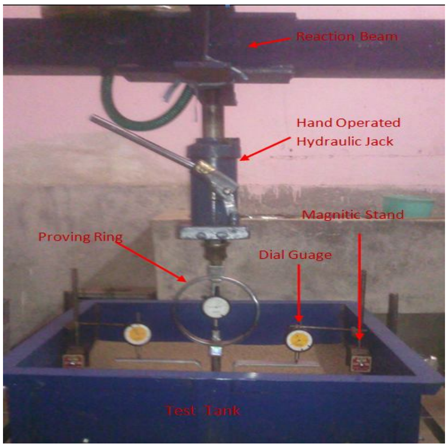
The test tank is made of 2 mm thick having internal dimensions 600mm ×600mm in plan and 450 mm high. The bulging effect counteracts by providing sufficient horizontal and vertical.

3. 2 Reaction Frame

The reaction frame used for applying loads on the model footing, consisted of a horizontal member and two vertical members made of IS channel section.



(a) Elevation of Laboratory Test Tank



(b) Actual Laboratory Plate load Test Tank

Figure 1: A Schematic Diagram of the Loading Frame and Test set-up

3.3. Filling of Tank and Laying of Geogrid Reinforcement

The tank filled with the dry sand using the sand raining technique using (hopper method). Prior to that, the side walls of the tank were made smooth by coating with a lubricating gel to reduce the boundary effects. The sand was poured in the tank by rainfall technique keeping the height of fall as 35 cm to maintain the constant relative density 60% and bulk density 14.91 kN/m^3 throughout the bed. The location of the desired layer of reinforcement was at B, B/2and B/4 from bottom of footing. The top surface of the sand will be levelled and the biaxial geogrid reinforcement will be placed. Again, the sand will be filled over this geogrid reinforcement layer in the tank up to bottom surface of footing. In case of tests with reinforced sand beds, geosynthetic layers were placed at predetermined depths and prestress is applied while preparing the sand bed. The prestress applied is equal to 1%, 2%, and 3% of the tensile strength of the geogrid and is distributed over three pulleys. In uniaxial prestressing, the prestress is applied only in the *X*-direction, whereas in biaxial prestressing it is applied in both *X* and *Y* directions.

After preparing the bed, the surface was leveled, and the footing was placed exactly at the centre of the loading jack to avoid eccentric loading. The footing was loaded by a hand-operated hydraulic jack supported against a reaction frame. A precalibrated proving ring was used to measure the load transferred to the footing. The load was applied in small increments. Each load increment was maintained constant until the footing settlement was stabilized. The footing settlements and surface deformations were measured through dial gauges (D1, and D2), whose locations are shown in Fig.1

3.4 Test Procedure

The footings were placed at the required position on the test sand bed carefully without disturbing the sand bed. The dial gauges were placed on flanges carefully i.e. both on footing. The loading unit was then lowered with the help of hydraulic jack through proving ring so that the bottom plunger attached to the proving ring just touches the centre of the footing. After just loading the loading unit, the initial readings of dial gauges were recorded. The required load increments were then applied. On increase of each load, the dial gauge reading were noted at frequent interval of time. After reaching deformation or settlement constant, then only next load increment was made. The procedure is then repeated till the failure of the footing. After the failure occurred, the load on footing was released by releasing valve of hydraulic jack. The footings were removed and the test sand bed was again prepared as discussed in above section and next tests were then performed.

4. Experimental results and discussion

The experimental results that the introduction of prestress to the geotextile reinforcement greatly improves the settlement behaviour of the soil.

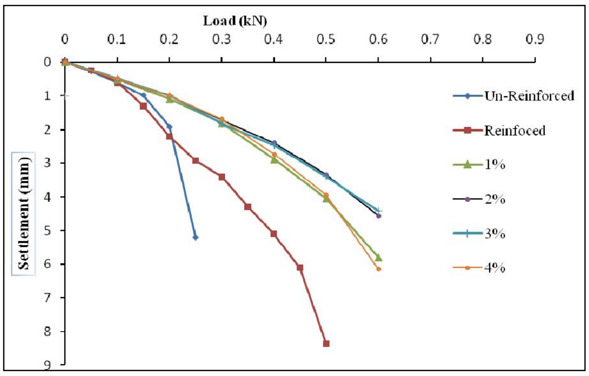


Figure 3: Load intensity versus normalized settlement curves at reinforcement depth B/2 with Uniaxial prestressing force of different magnitude.

The bearing capacity ratio can be analyzed with respect to the ultimate bearing capacity or the allowable bearing capacity at a given settlement level of a foundation. It can be seen that the introduction of prestress generally doubles the load-bearing capacity of the unreinforced soil, in comparison to reinforcement alone, which results in only 1.2–1.7 times the load bearing capacity of the soil. Therefore, the addition of prestress is considered a worthwhile method of reinforcement.

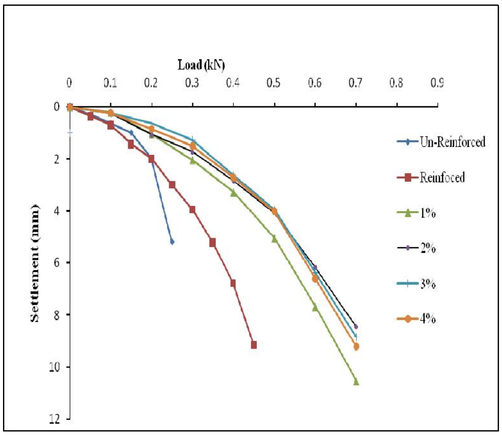


Figure 4: Load intensity versus normalized settlement curves at reinforcement depth B/4 with Uniaxial prestressing force of different magnitude.

The load-carrying capacity of reinforced soil without prestress in relation to unreinforced soil, however, appears to be independent of footing embedment depth for lowstrains (i.e. small displacements).

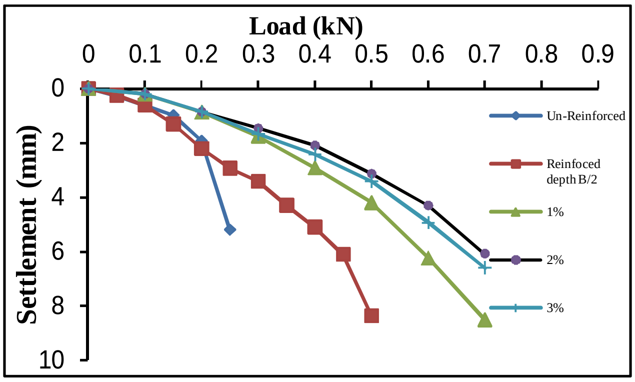


Figure 5: Load intensity versus normalized settlement curves at reinforcement depth B/2 with Biaxial prestressing force of different magnitude.

The settlement behaviour of unreinforced and reinforced (without prestress) soil for a footing for reinforcement depth B, B/2 and B/4 having size of square footing 75mm. However, the effect of prestress in the Biaxial geotextile reinforcement

is more effective for the footing depth of B/4.

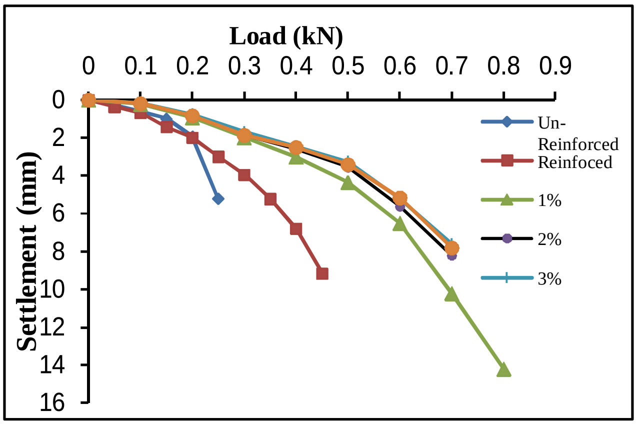


Figure 6: Load intensity versus normalized settlement curves at reinforcement depth B/4 with Biaxial prestressing force of different magnitude.

5. Concluding remarks

The improvements in settlement behavior and load-bearing capacity of a geotextile-reinforced sand foundation were investigated using experimental methods. The physical model test with single and double layer of prestressed geotextile as reinforcement was developed and simulate field effect.

The beneficial effects of geotextile reinforcement without prestress were insignificant beyond a footing embedment depth of B/2 for low strains. The addition of prestress to the geotextile reinforcement significantly improved the settlement response and load bearing capacity of the soil.The improvement in bearing capacity depends on the reinforcement depth, magnitude of prestress, and the direction of prestress. The improvement in bearing capacity is found to be more with biaxial prestressing than uniaxial prestressing. Settlements are also less with biaxial prestressing at reinforcement depth B/4. The improvement in bearing capacity increases with the placement depth of reinforcement.

It is also observed that the bearing capacity will not be increased by increasing the percentage of prestressing force after 3%.

Further study is required to determine the effects of any losses in prestress due to anchorage slip, stress relaxation in reinforcement, shrinkage of soil, and so forth.

Acknowledgement

I wish to express my deep sense of gratitude and indebtedness to Prof. A. I. Dhatrak**,** Associate Professor, Department of Civil Engineering, for introducing the present topic and for his inspiring guidance, constructive and valuable suggestions throughout the project work.

I am also thankful to Dr. S. S. Pusadkar sir, Prof S.W.Thakare sir, Dr. S. P. Tatewar sir, H. O. D., Department of Civil Engineering, for extending their valuable guidance and support to complete the report within stipulated time-line.

Lastly, I would like to thank and express my gratitude towards everybody who at various stages had lent a helping hand.

REFERENCE:

1. G. L. Sivakumar Babu, An introduction to Soil Reinforcement and Geosynthetics, Universities Press, 2006.

2. G. Madhavilatha and A. Somwanshi, “Bearing capacity of square footings on geosynthetic reinforced sand,” Geotextiles and Geomembranes, vol. 27, no. 4, pp. 281–294, 2009.

3. G. Madhavilatha and A. Somwanshi, “Effect of reinforcement form on the bearing capacity of square footings on sand,” Geotextiles and Geomembranes, vol. 27, no. 6, pp. 409–422,2009.

4. J. Binquet and K. L. Lee, "Bearing capacity tests on reinforced earth slabs," Journal of Geotechnical Engineering, vol. 101, no.12, pp. 1241–1255, 1975.

5. J. Jayamohan and R. Shivashankar, "Some Studies on Prestressed Reinforced Granular Beds OverlyingWeak Soil" International Scholarly Research Network ISRN Civil Engineering, Volume 2012, Article ID 436327, 12 September 2012.

6. J. Lovisa, S. K. Shukla, and N. Sivakugan, "Behaviour of prestressed geotextile-reinforced sand bed supporting a loaded circular footing," Geotextiles and Geomembranes, vol. 28, no. 1, pp. 23–32, 2010.

7. K. Deb, N. Sivakugan, S. Chandra, and P. K. Basudhar, "Numerical analysis of multi layer geosynthetic-reinforced granular bed over soft fill," Geotechnical and Geological Engineering, vol. 25, no. 6, pp. 639–646, 2007.

8. K. Deb, S. Chandra, and P. K. Basudhar, "Nonlinear analysis of multilayer extensible geosynthetic-reinforced granular bed on soft soil," Geotechnical and Geological Engineering, vol. 25, no.1, pp. 11–23, 2007.

9. M.Balamaheswari and K. Ilamparuthi, "Performance of Footing on Reinforced soil Bed" Proceedings of Indian Geotechnical Conference,Kochi (Paper No. D-089) pp.15-17, 2011.

10. N. P. Kurian, K. S. Beena, and R. Krishna Kumar, "Settlement of reinforced sand in foundations," Journal of Geotechnical and Geoenvironmental Engineering, vol. 123, no. 9, pp. 818–827, 1997.

11. P. Vinod, A. B. Bhaskar, and S. Sreehari, "Behaviour of a square model footing on loose sand reinforced with braided coir rope," Geotextiles and Geomembranes, vol. 27, no. 6, pp.464–474, 2009.

12. R. Sharma, Q. Chen, M. A. Farsakh, and S. Yoon, "Analytical modeling of geogrid reinforced soil foundation," Geotextiles and Geomembranes, vol. 27, no. 1, pp. 63–72, 2009.

13. R. Shivashankar, M. R. Madhav, and N. Miura, "Reinforced granular beds overlying soft clay," in Proceedings of the 11th South East Asian Geotechnical Conference, pp. 409–414, Singapore, 1993.