FOOTINGS ON GEOSYNTHETIC REINFORCED GRANULAR PADS OVERLAYING WEAK LOCAL SOIL

[1]Eliyas Babu, [2]Merin Abraham, [3]Nikitha Boban, [4] Shifana M. S., [5] Basil Mathai
[1]B Tech Student, [2] B Tech Student, [3] B Tech Student, [4] B Tech Student, [5] Assistant Professor
[1]Department of Civil Engineering,
[1]Muthoot Institute of Technology and Science, Varikoli, India

Abstract: During the past, construction on soft subsoil was considered unsuitable, but nowadays it has become a necessity to do so since the availability of land for construction is decreasing at a rapid rate. Soil reinforcement is an effective and reliable technique for improving the strength and stability of soil. It also reduces the cost of stabilisation. The reinforcement of these soft sub soils with granular fill layers is one of the major soil improvement techniques. Soft soil behaviour can be improved by totally or partially replacing it with layers of compacted granular fill. The plate load tests were done to investigate the settlement of footing over the weak soil which was partially replaced using the replacement soil (granular pad) and reinforced with geogrid. Different tests were conducted for varying depths of the granular pads and also by varying the number of geogrid layers. It is now a common practice to use a layer of a geotextile or geogrid at the base of the fill layer, to separate the fill from soft soil beneath and to improve its load carrying capacity by the structural action of geotextile or geogrid.

***Index Terms* – geosynthetics, granular pad, geogrid, replacing, reinforcement.**

I. INTRODUCTION

A geosynthetic is any synthesised material used for soil improvement. Soil transfers its internal the built up forces to reinforcement by friction resulting in development of tension in reinforcement. Geosynthetics are used in locations where shear stresses are generated because shearing stress between soil and reinforcement restrains the lateral deformation of the soil. Geosynthetics are used for increasing bearing capacity and permeability of soil, reducing settlement of soil. The acceptance of geosynthetics in reinforced soil construction has been triggered by a number of factors including aesthetics, reliability, simple construction techniques, good seismic performance and the ability to tolerate large deformations without structural distress.
The physical behaviour of footings resting on the reinforced granular pads over the weak soil under monotonic loading condition is being investigated in this study.

II. TEST MATERIALS

The materials collected for the study were sea sand, M-sand, geogrids and geotextile. Sea sand was used as the bulk soil (weak soil) for all the experiments and M-sand, due to its proven physical attributes, was selected to be used as the replacement soil. Both the bulk soil and replacement soil were air dried and made ready for conducting experiments. Initial tests to find the physical properties showed that the weak soil is poorly graded and the replacement soil is well graded. The different properties of both the soil is given in Table 2.1.

Table 2.1: Properties of weak soil and replacement soil

Item	Weak Soil	Replacement Soil
Effective grain size, D10	0.17	0.15
Average size of particle, D30	0.2	0.29
Average size of particle, D60	0.31	0.76
Uniformity coefficient, C_u	1.82	5.067
Coefficient of curvature, C_c	1.09	0.737
Specific gravity	2.66	2.60
Cohesion, C	0.03 kg/cm^2	0.04 kg/cm^2
Angle of friction, ϕ	31^o	36^o
Maximum void ratio, e_{max}	0.74	0.566
Minimum void ratio, e_{min}	0.52	0.314

The geosynthetic materials collected for the study were geogrids and geotextile. The geogrid was used as the reinforcing material. Biaxial geogrids of polypropelene material was used. The mesh aperture of the geogrids was 40 mm. The strength of the geogrids was 30 kN/m^2 and was black in colour. Non-woven geotextile of polypropelene material was used for the separation of bulk soil and granular pad. The strength of the geogrids was 20 kN/m^2 and was white in colour.

III. TESTS SET-UP

To investigate the settlement behavior of square footing, a laboratory plate load set-up was made. Plate load test was done in a tank of size 1 m × 1 m × 1.2 m. The static loading was applied on the footing monolithically using a hydraulic jack. To measure the settlement, a dial gauge with an accuracy of 0.01% of full range was used. The test setup can be represented as shown in Fig 3.1.

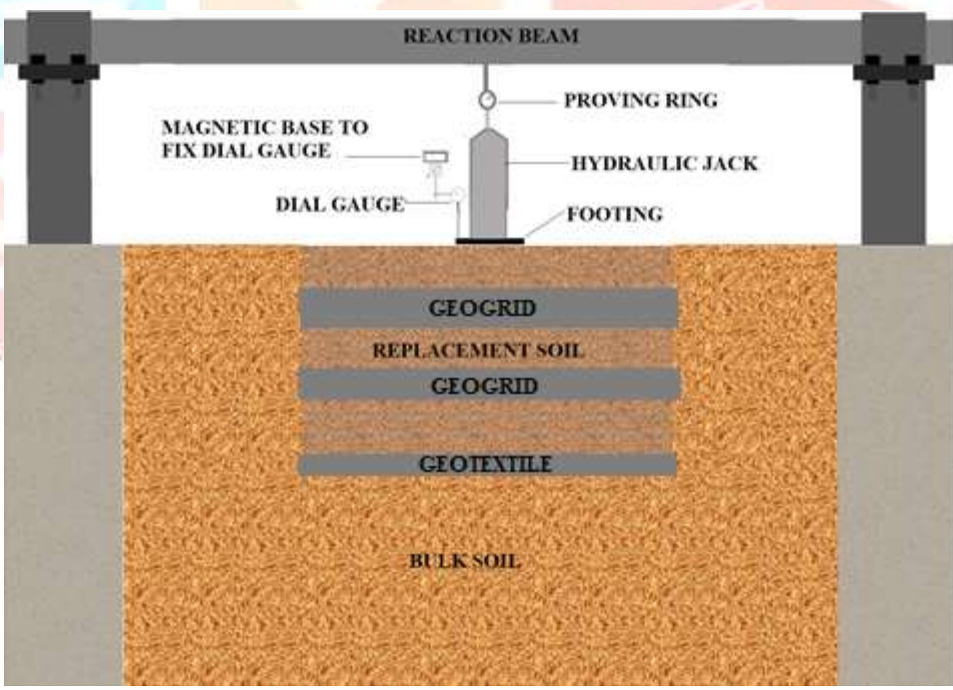

Fig 3.1: Schematic Cross-section of the Test Set-up

IV. TEST PARAMETERS AND TESTING PROGRAM

A square footing of size, B = 15 cm was taken for the tests. Initial test was done for weak soil and the failure load corresponding to standard settlement of 25mm was obtained. Also, test was done for weak soil partially replaced with replacement sand was done. Later, tests were done by replacing the soil at different depths and different layers of geogrid reinforcement. The granular pad replacement was done for two depths (D1 and D2). The increased depth D1 was taken as 2B and the reduced depth D2 as 1.5B. Single layer(G1) and double layer(G2) of geogrid reinforcements were given at both the depths. When one layer of geogrid was used, it was reinforced at one-third of the granular pad from the top. When two layers of geogrids was used, it was reinforced at one-third and two-third of the granular pad from the top.

V. RESULTS AND DISCUSSIONS

The results of the test are presented along with a discussion highlighting the effects of depth of granular pad, depth of reinforcement and number of geogrids layers.

5.1 The Effect of Depth of Granular Pad

The depth of granular pads taken were 2B and 1.5B. The tests were done for both the depths with one layer and two layers of reinforcement. The results obtained from the tests shows that when the depth was reduced, the bearing capacity of the soil increases and the settlement reduces.. This may be due to the increased stiffness because the spacing between footing and the first layer of geogrids is less in reduced depth compared to that of maximum depth. Fig 5.1.1 and 5.1.2 shows that better results in terms of bearing capacity and settlement was obtained when the depth of granular pad was reduced to 1.5B from 2B.

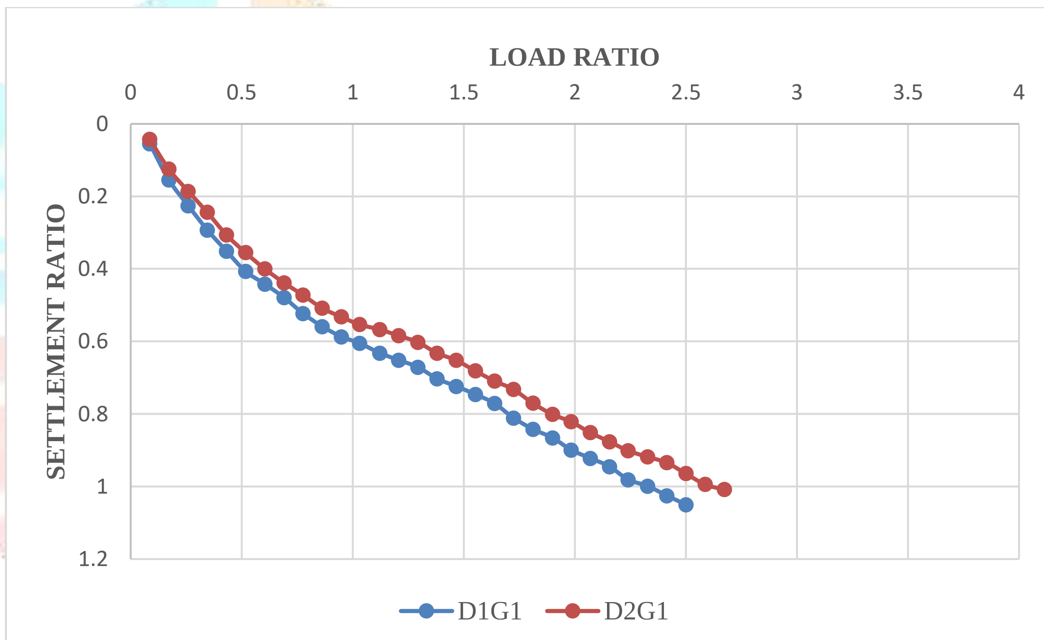

Fig 5.1.1: Depth Effect for Single Layer Reinforcement

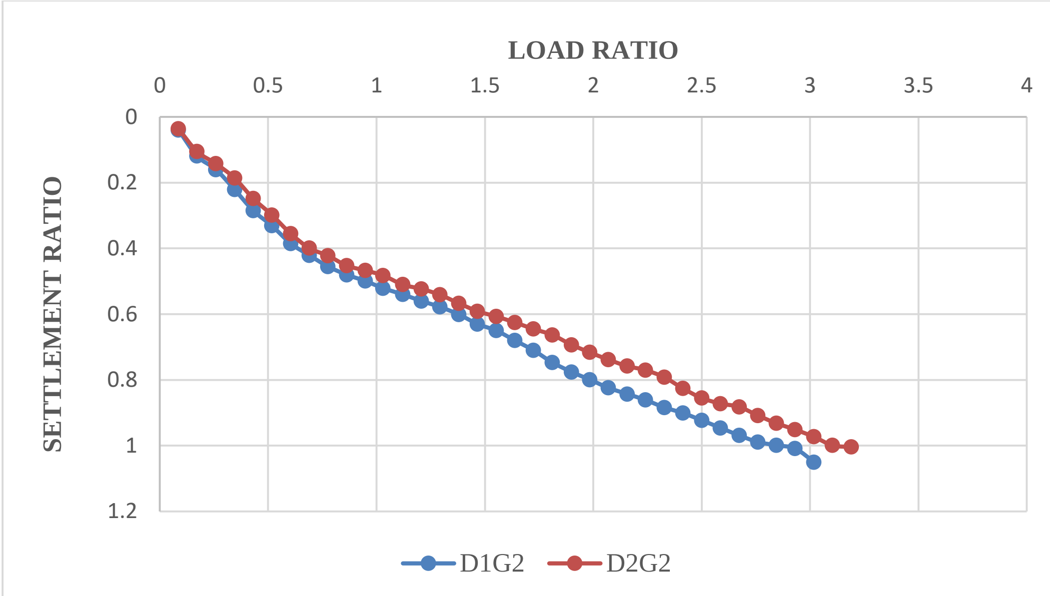

Fig 5.1.2: Depth Effect for Double Layer Reinforcement

5.2 The Effect of Number of Geogrid Layers

The tests were done for two depths with single layer of reinforcement and two layers of reinforcements. For single layer of reinforcement the geogrid was placed at 1/3rd of the depth of replacement soil from top. For two layers of reinforcement the geogrids were placed at 1/3rd and 2/3rd of the depth of reinforcement soil depth from top. The spacing between the geogrid layers were kept constant. From the load ratio vs. settlement ratio graphs it was observed that the settlement has reduced when it was doubly reinforced in both the cases. Fig 5.2.1 and 5.2.2 also shows that there is a significant improvement in the load carrying capacity as it is doubly reinforced compared to that of singly reinforced. This shows that as the number of layer increases the load carrying capacity of soil is increases and settlement reduces.

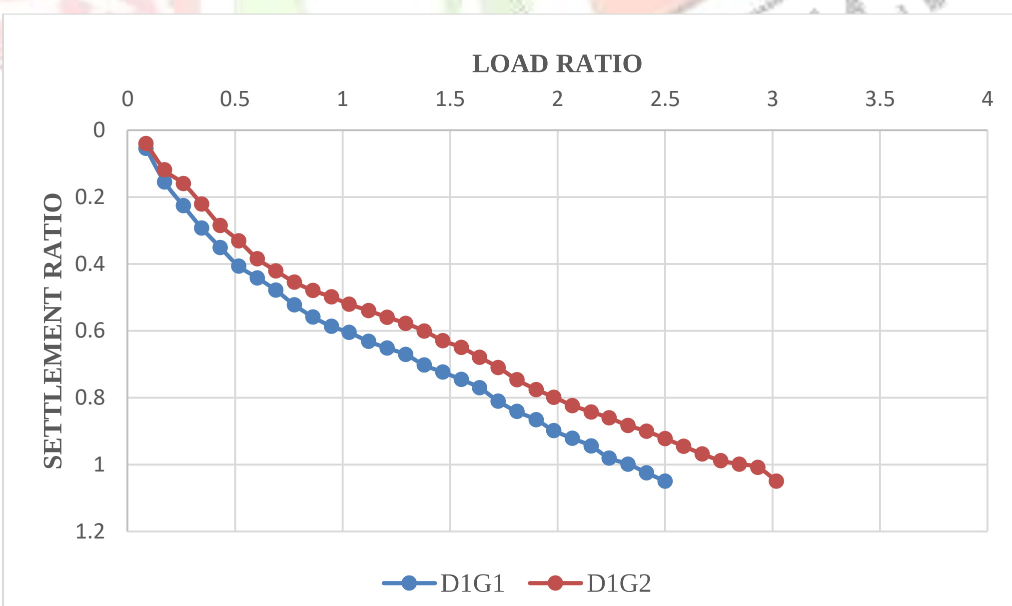

Fig 5.2.1: Layer Effect for Reduced Depth D1

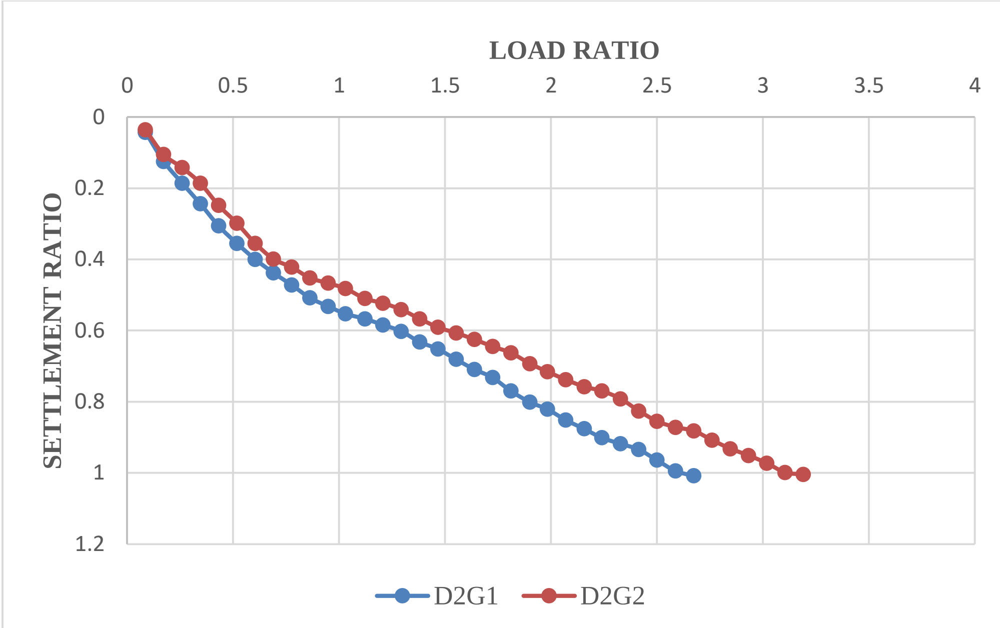

Fig 5.2.2: Layer Effect for Reduced Depth D2

VI. CONCLUSIONS

This paper presents model tests on a square embedded footing supported on geogrids reinforced granular pad. The effect of geogrid reinforced granular pad over weak local soil was investigated. The weak soil was partially replaced by replacement soil along with the inclusion of geogrid. The following conclusions can be drawn from the results obtained.

- By the inclusion of geogrid the settlement reduces.
- By the inclusion of geogrid the soil become stiffer and it helps to reduce settlement.
- As the number of layers of geogrid increases the load bearing capacity of soil also increases.
- It was observed that by replacing the weak soil to an optimum depth of 1.5B and reinforcing it with two layers of geogrid we obtained a higher bearing capacity of soil compared to other tests.
- By the inclusion of geogrid it not only reduced settlement but also the amount of replacement soil used.
- It is more effective when the geogrid was placed at 1/3rd and 2/3rd of the replacement depth.

Construction of an engineering pad of reinforced granular fill above layers of relatively weak, compressible fill and native soil has enabled the foundation to undergo only moderate differential settlement, which is well within tolerable limits.

REFERENCES

[1] Ahmet Demir, Mustafa Laman, Abdulazim Yildiz and Murat Ornek 2012. Large Scale Field Tests on Geogrid-Reinforcement Granular Fill Underlain by Clay Soil. Geotextiles and Geomembranes, 38(8):1-15.

[2] Alston C., Lowry D. K. and Lister A. 2015. Geogrid Reinforced Granular Pad Foundation Resting on Loose and Soft Soils, Hamilton Harbour, Ontario. International Journal of Geosynthetics and Ground Engineering, 1(21):15-26.

[3] Aminaton Marto, Mohsen Oghabi, Amin Eisazade 2013. Effect of Geocell Reinforcement in Sand and its Effect on the Bearing Capacity With Experimental Test: A Review. Electronic Journal of Geotechnical Engineering, 18(6) :3501-3516.

[4] Banerjee, L., Biswas, S., Bhandari, G. and Sahu, R. B. 2015. Ground Improvement of Soft Clay Bed Using Geocell Mattress at Foundation of an Earthen Embankment. Indian Journal of Geosynthetics and Ground Improvement, 4(2):18-22.

[5] Chen X., Zhang J. and Li Z. 2014. Shear Behaviour Of A Geogrid-Reinforced Coarse-Grained Soil Based On Large-Scale Triaxial Tests. Geotextiles and Geomembranes, 42(4): 312-328.

[6] El Mahallawy, N. A. and Rashed, A. S. 2012. Experimental Study for The Behaviour of Footings On Reinforced Sand Beds Overlying Soft Clay Zone. Journal of American Science, 8(1):427-434.

[7] Elleboudy A. M., Saleh N. M. and Salama A. G. 2016. Assessment of Geogrids in Gravel Roads Under Cyclic Loading. Alexandria Engineering Journal, 8(6): 14-23.

[8] Ling, H.I.,Liu, H.,Kaliakin,V.N. and Leshchinsky D. 2004. Analyzing Dynamic Behavior of Geosynthetic-Reinforced Soil Retaining Walls. American Society of Civil Engineering, 12(9):911-920.

[9] Madhavi Latha G. and Amit Somwanshi 2009. Effect of Reinforcement Form on the Bearing Capacity of Square Footings on Sand. Geotextiles and Geomembranes, 27(6):409-422.

[10] Mitra Ashis 2015. Application of Geotextiles in Coastal Protection and Coastal Engineering Works: An Overview. International Research Journal of Environment Sciences, 17(5):1-16.

[11] Mostafa A. El Sawwa 2006. Behaviour Of Strip Foundation On Geogrid-Reinforced Sand Over A Soft Clay Slope. Canadian Geotechnical Journal, 13(5):23-38.

[12] Olaniyan O. S. and Akolade A. S. 2014. Reinforcement of Subgrade Soils with the Use of Geogrids. International Journal of Science and Research, 11(8):43-78.

[13] P. K. Kolay, Kumar S., and D. Tiwari 2013. Improvement of Bearing Capacity of Shallow Foundation on Geogrid Reinforced Silty Clay and Soil. Journal of Construction Engineering, 8(5):1-10.

[14] Ramteke N., Saxena A. and Arora T.R. 2014. Review: Effect Of Geo-Grid Reinforcement On Soil. International Journal of Core Engineering and Management, 7(3):33-57.

[15] Tarun Kumar 2015. Geosynthetics Materials: Recent Advancements for Ground Improvements. International Journal of Research & Development Organisation, 1(7):7-12.

[16] Thirumalai, R., Dr. Babu, S. S., Gobinath, S. and Deebika, P. 2016. Influence Of Geosynthetics On Different Types Of Soils. International Journal of Civil Engineering and Technology (IJCIET), 7(4):149–155.

[17] Zornberg, J. G. 2007. New Concepts in Geosynthetic-Reinforced Soil. Proceedings of the Fifth Brazilian Symposium on Geosynthetics, Geossinteticos, 8(14):1-26.