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# Review of Studies Conducted On Performance of Reinforced Soil Foundations

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*Abstract*— **The estimation of load carrying capacity of footing is the most important step in the design of foundation. The number of theoretical approaches, in-situ tests and laboratory model tests are available to find out the bearing capacity of footing. However weak soil has always been a problem for geotechnical engineers. In order to increase soil's bearing capacity and to reduce footing settlement, reinforced soil foundations are used to solve engineering problems. Geosynthetics has emerged as one of the best soil reinforcement. By making suitable arrangement of the geosynthetics, the bearing capacity and settlement resistance of the soil can be improved. This paper attempts to review the recent researches that have contributed to the improvement of bearing capacity of soil by using reinforced soil foundations. From the above studies as discussed in this paper we can conclude that layout and configuration of reinforcement play a vital role in bearing capacity improvement rather than the tensile strength of the geosynthetic material. More studies can be conducted on the use of plastic multi-directional reinforcements as for the same area, the multi-directional reinforcing elements provide additional confinement to the soil mass due to the three dimensional projections, compared to the conventional geosynthetic reinforcements such as geogrids**.

***Keywords:*** *Reinforced soil foundations, bearing capacity, geosynthetics.*

## I INTRODUCTION

GEOGRID

GEOCELL

Recent advancements have suggested the use of Geosynthetics as a viable solution in treating soil problems. Geosynthetics products typically used as reinforcement elements are nonwoven geotextiles, woven geotextiles, geogrids, and geocells. Vidal (1966) pioneered the idea of reinforced soil and hence onwards tremendous studies have been conducted to understand the beneficial use of geosynthetics.

## II LITERATURE REVIEW

Reinforced soil foundation has been employed in engineering practice to increase soil's bearing capacity and reduce footing settlement. Binquet and Lee (1975) conducted a study to evaluate the bearing capacity of strip footings on reinforced sandy soil. Since then, substantial research efforts have been focused on investigating the behavior of reinforced soil foundations as well as the effects of the different parameters on its bearing capacity. Among them, the bearing capacity of footings on reinforced sandy soil have been experimentally studied by many researchers (e.g., Akinmusuru and Akinbolade, 1981; Guido et al., 1985, 1986; Huang and Tatsuoka, 1990; Omar et al., 1993a,b; Das and Omar, 1994; Yetimoglu et al., 1994; Adams and Collin, 1997; Gabr et al., 1998; Shin et al., 2002; Basudhar et al., 2007; Ghazavi and Lavasan, 2008; Latha and Somwanshi, 2009a,b; Vinod et al., 2009; Moghaddas Tafreshi and Dawson, in press; Lavasan and Ghazavi, (2012). Later on numerous studies were conducted on natural sand employing reinforcements like geosynthetic.

Madhavi Latha, Amit Somwanshi, [5] studied the bearing capacity of square footing on geosynthetic reinforced sand. The effect of various reinforcement parameters like the type and tensile strength of geosynthetic material, amount of reinforcement, layout and configuration of geosynthetic layers below the footing on the bearing capacity improvement of the footings was studied through systematic model studies A steel tank of size 900 x 900 x 600 mm was used for conducting model tests. Four types of grids, namely strong biaxial geogrid, weak biaxial geogrid, uniaxial geogrid and a geonet, each with different tensile strength, where used in the tests. Influence of all these parameters on the bearing capacity improvement of square footing and its settlement was studied by comparing with the test on unreinforced sand. Test results show that the effective depth of reinforcement is twice the width of the footing and optimum spacing of geosynthetic layers is half the width of the footing. It is observed that the layout and configuration of reinforcement play a vital role in bearing capacity improvement rather than the tensile strength of the geosynthetic material**.**

Elif Cicek, ErolGuler, TemelYetimoglu, [2] conducted laboratory model tests of a surface strip footing on unreinforced and reinforced sand beds to investigate the effects of reinforcement length. Multiples of footing width B was employed in the tests, namely B, 2B, 3B, 5B and, in some tests, even7B. The type and number of reinforcements were also varied to determine whether these parameters had an influence on the optimum reinforcement length. Woven geotextile and different Geogrids were used. The load–settlement and Bearing Ratio values obtained from the model test program were compared. Based on the results, the length of footing required to achieve optimum improvement was determined for different numbers of reinforcement layers and different reinforcement types. It was also observed that the improvement obtained by reinforcing the subgrade was different for low settlement ratio values and large settlement values.

Dr. M.S. Dixit, Dr. K.A. Patil, [7] studied the behavior of reinforced sand in improving the bearing capacity and settlement resistance under square footing. Locally available river sand was used along with 'geogrid' as a reinforcing material. The parameters selected were depth of the top layer of reinforcement below the footing and D/B ratio of the reinforcement. Relationships between intensity of loading and settlement have been presented to determine the influence of the above parameters on the bearing capacity and settlement. They concluded that by a suitable arrangement of the reinforcing geogrid, the bearing capacity and settlement resistance of sand is improved as compared to the unreinforced sand. Laboratory model tests on square footings resting on sand with and without reinforcement were conducted to evaluate the effect of bearing capacity of sand below the footing for square plate with variation in size, depth to width ratio and the effect of permissible settlement.

Ehsan Badakhshan, Ali Noorzad, [3] conducted an experimental study for an eccentrically loaded circular footing, resting on a geogrid reinforced sand bed. The effects of depth of first and second geogrid layers and number of reinforcement layers on the settlement-load response and tilt of footing undervarious load eccentricities (0 cm, 0.75 cm, 1.5 cm, 2.25 cm and 3 cm) were investigated. Test results indicate that ultimate bearing capacity increases in comparison with unreinforced condition. It is observed that when the reinforcements are placed in the optimum embedment depth (u/D ¼ 0.42 and h/D ¼ 0.42), the bearing capacity ratio (BCR) increases with increasing load eccentricity to the core boundary of footing, and that with further increase of load eccentricity, the BCR decreases. Besides, the tilt of footing increases linearly with increasing settlement. Finally, by reinforcing the sand bed, the tilt of footing decreases at 2 layers of reinforcement and then increases by increasing the number of reinforcement layers.

Arash AlimardaniLavasann, MahmoudGhazavi, [1] described an experimental investigation conducted to evaluate the ultimate bearing capacity, the settlement and the tilt of two types closely spaced footings, one having square shapes and the other having circular shapes, on unreinforced and reinforced soil. By introducing geogrid layers, the effect of interference on the performance of closely spaced footing was reduced. The ultimate bearing capacity of the interfering footings was increased by about 25–40%, whereas the settlement of the interfering footings at the ultimate load increased in the range of 60–100%. However, the closely spaced footings tilted by approximately 45% and 75% for reinforced sand with one and two layers of geogrid, respectively.

M. Harikumar, N. Sankar, S. Chandrakaran,[8] conducted laboratory plate load tests on a model footing resting on sand bed reinforced with plastic multi-directional reinforcements. The bearing capacity, settlement and heave were evaluated and the effect of depth to first layer, spacing between reinforcements in a layer, number of layers and spacing between layers were investigated. They concluded that the bearing capacity at 25 mm settlement improved by almost 1.3 times for a single layer of reinforcement, placed at an optimum depth of 0.5B. An increase in number of layers beyond four resulted in a reduction in improvement of bearing capacity. Four layers of reinforcement, spaced vertically apart at 0.5B resulted in a maximum increase of 185% in the bearing capacity. For the same area, the multi-directional reinforcing elements provide additional confinement to the soil mass due to the three dimensional projections, compared to the conventional geosynthetic reinforcements such as geogrids

## III CONCLUSION

From the above studies as discussed in this paper we can conclude that layout and configuration of reinforcement play a vital role in bearing capacity improvement rather than the tensile strength of the geosynthetic material. More studies can be conducted on the use of plastic multi-directional reinforcements as for the same area, the multi-directional reinforcing elements provide additional confinement to the soil mass due to the three dimensional projections, compared to the conventional geosynthetic reinforcements such as geogrids.

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