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Bearing Capacity Analysis of a Square Footing Supported on Geogrid Reinforced Sand

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ABSTRACT: Due to rapid growth in infrastructure activities, the quantity of competent land diminishes slowly. To fulfill the increasing demand, a technique known as soil reinforcement is developed. In this study, laboratory model test were performed for determining ultimate bearing pressure of a square footing on unreinforced and geogrid strengthened sand. A medium to fine sand and geogrid (type SB30-30) were used for carrying out the research on square foundation in medium dense sand having relative density 63.25% in which geogrid is placed at varying depth below footing. In this paper, an experimental approach to carry out bearing capacity analysis is discussed in detail. For preparing sand sample in laboratory, sand raining technique was adopted and due consideration was given to layer-wise compaction. The parameters considered in this study were, the effect of vertical spacing between successive geogrid, number of layers of geogrid and effect of uppermost layer of geogrid on load carrying capacity of a footing. The experimental observations revealed that when four layers of geogrid are used, the ultimate bearing capacity is maximum and Bearing Capacity Ratio (BCR) reached to a maximum value of 6.87. The results obtained also demonstrate that BCR increases as top layer of geogrid and spacing between grogrid decreases from 120mm to 30mm. The most favorable location of top layer of geogrid and the spacing between two adjacent layers of geogrid was observed as 0.25 times width of footing.

Keywords: Bearing Capacity, Footing, geogrid, reinforced soil, settlement.

Abbreviations: BCR, bearing capacity ratio.

I. INTRODUCTION

Since last two decade the use of Geosynthtic Reinforced Soil (GRS) is enhanced, as the competent land is reducing due to of rapid increase in infrastructural development. The foundation soil being weak in tension, the reinforcing technique can significantly improve load carrying capacity. Geosynthetic provides the tensile characteristic to soil as well as it performs other function such as drainage, filtration, separation etc [10]. Soil reinforcement mechanism manifest that geosynthetic provides lateral and vertical confinement of soil also it provides wider stress distribution. The utilization of geogrid has expanded because of it's high rigidity at low pressure, open lattice structure which causes holding among geogrid and establishment soil, long assistance life and small weight [14]. The enormous aperture size of the geogrid material helps in adequate interlocking with the granular material to frame a composite material. Researchers have conducted experiments on geosythetic reinforced soil. Makkar *et al.*, (2017) utilized two sorts of 3 Dimensional geogrids with rectangular and triangular opening. For rectangular opening of 3D geogrids, the improvement in BCR was noticed as 3.05 and for triangular opening it was 2.7. Load improvement in this study was 1.85 times that of single layer of ordinary reinforcement. For rectangular geogrid at a spacing of 0.75B between two progressive layers, surface heave of soil was totally removed [13].

Alawaji (2001) contributed in the domain of sand-geogrid reinforcement over collapsible soil. Laboratory model test were carried out using circular footing of 100 mm diameter plate and tensar geogrid (SS2). The impacts on bearing pressure ratio and collapsible settlement were studied by fluctuating width and depth of geogrid. Consideration of geogrid causes reduction in collapsible settlement and improved the bearing pressure ratio. This study concluded that most ideal depth and width of geogrid were 0.1 times and 4 times diameter footing respectively. The modulus of elasticity increased up to 2000% when geogrid of 4 times diameter of footing were used [2].

Dastpak *et al.*, (2020) determined bearing capacity of a circular footing on geonet reinforced sand subjected to an eccentric loading. The outcomes indicated as eccentric load is more significant compared to axial loading. Also found that irrespective of position of reinforcement, the bearing capacity reduced as amount of eccentricity increases [6].

Deb and Konai (2014) varied percentages of fines in sand from 5% to 30% and ultimate bearing capacities of sand with and without geotextile were determined. The results acquired from load intensity versus displacement chart showed that bearing pressure in both cases enhanced by adding % fines upto 10% fines. The usefulness of geotextile reinforcement was more in presence of 5% fines as the interface friction and adhesion were higher at 5% fines mixed with sand [7].

Das & Omar (1994) analyzed bearing capacity of strip footing on geosynthetic strengthened soil. He identified effect of foundation width and observed a non dimensional parameter; BCR of sand geogrid system reduces with increase in width of footing. This effect was continued for foundation width equal to about 130 mm to 140 mm; afterwards BCR reaches a constant value [5].

Patra *et al.*, (2006) performed laboratory test on a strip footing and load was applied at an eccentricity of zero to 0.15 times width of footing to get maximum load intensity of strip footing on geogrid reinforced sand. The depth of foundation was also altered from 0 to B. The test result demonstrated that the ratio of maximum bearing pressure of eccentrically loaded footing to maximum bearing pressure of axially loaded footing can be correlated by a reduced factor which depends on d_f/B and e/B [17].

A significant enhancement in load intensity and tilt of adjacent strip footing were observed for closely spaced strip footing by providing unbroken reinforcement layers in foundation soil [11].

Mirzaeifar and Ghazavi (2010) geometry of footing was considered by different shapes of footing like H, T and + shapes. Numerical investigation of bearing capacity using geogrid on multiedge shallow foundation was carried out. The results of parametric examinations under multi-edged foundation showed that the spacing between geosynthetic layers and first layer of reinforcement depth are 0.33L. The most efficient geometry measurement is B/L=0.6 for +, H, and T shape footings [15].

In the experimental study, Geojute (gunny packs) was utilized as a geotextile and sand was used as soil media. The test results showed that, the maximum bearing capacity on reinforced soil was found as 3.37 times that of soil without geojute. The ideal arrangement position of geotextile was seen as 0.5B from the base of the footing [16].

The numerical examinations indicated that in presence of geogrid, relationship between bearing pressure and displacement of reinforced system was found almost linear till it reaches the failure stage. The strengthened system under dynamic loading appears to have a comparable trend as found in static state. The presence of geogrid becomes practically insignificant when the depth of first layer is equivalent to 0.5 times footing diameter [19].

The researchers in this field carried out bearing capacity analysis by varying width of geosynthetic material, by varying percentage of fines in sand, by applying load at different position, by changing geometry of footing etc.

From the literature, it is found that there is an inadequate study on determining most advantageous depth and optimal spacing between geosynthetic layers. Hence, in this paper an experimental approach has been used to find optimum use of geogrid material considering the parameters like vertical spacing between successive geogrid, range of layers of geogrid and impact of first layer of geogrid on ultimate load bearing intensity of a footing. The parameters remains intact in this study are width of reinforcement (4b), type of geosynthetic reinforcement (geogrid), type of soil (medium to fine sand), load position (at center of footing), relative density (63.25%). In this paper, it is attempted to suggest a best configuration model of geogrid reinforced sand.

II. MATERIAL CHARACTERISTICS

A. Sand

The Godavari river sand which is nearby available in Nanded have used for the test. Specific gravity, Grain Size Distribution (GSD), maximum density, Relative density, Direct shear test were carried out on the test sample in accordance with IS 2720 relevant parts. The shear strength parameters of sand were calculated from direct shear test and cohesion value was found nearly zero. Fig. 1 shows graph of particle size distribution of sand. According to Unified Soil Classification System, the soil is categorized as poorly graded sand denoted by SP. The soil used in present investigation was an oven dried fine to medium sand with rounded and sub rounded particles. The properties of sand are depicted in Table 1.

Table 1: Properties of sand.

Properties	Value
Specific Gravity	2.614
D_{10} (mm)	0.4
D_{30} (mm)	0.48
D_{60} (mm)	0.87
C_u	2.175
C_c	0.662
Bulk density (kN/m^3)	16.58
Dry density (kN/m^3)	15.49
ϕ	36^o
Max void ratio	0.9
Min void ratio	0.48

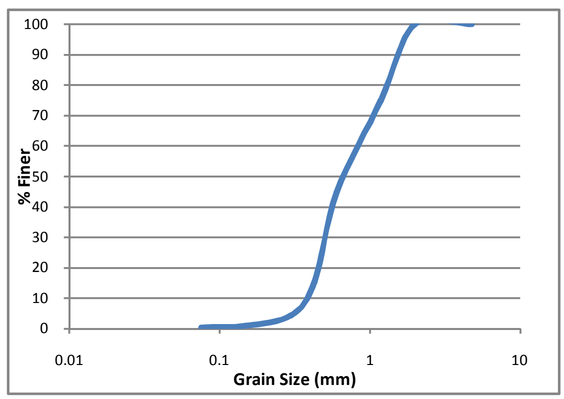


Fig. 1. Particle size distribution of sand.

B. Geogrid

The geogrid utilized in this study is a biaxial extruded polypropylene, manufactured by Strata India pvt limited Mumbai. The geogrid used is denoted by SB 30-30 which has square opening of size 38mm.

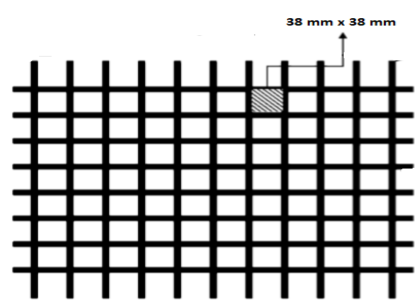


Fig. 2. Schematic diagram of geogrid.

The sample of biaxial geogrid which is used in the test is shown in Fig. 2. The mechanical and physical properties of geogrid were determined as per ASTM D. The geogrid characteristics are mentioned in Table 2.

Table 2: Mechanical, Physical and Dimensional properties of geogrid.

Properties	Value	
	Machine Direction (MD)	Cross Machine Direction (CMD)
Tensile strength (kN/m)	31.3	29.3
Tensile strength @ 2% elongation (kN/m)	14.2	14.9
Tensile strength @ 5% elongation (kN/m)	22.5	25.9
Maximum Elongation (%)	13.8	7.52
Thickness (mm)	2.7	1.49
Mass (g/m^2)	293	
Single Rib Strength (N)	1188	
Junction Strength (N)	1182	
Junction efficiency (%)	99.5	
Size of aperature (mm^2)	38 x 38	

III. EXPERIMENTAL STUDIES

Experimental set-up consists of a reaction frame, mild steel tank, hydraulic cylinder, power pack, electrical panel and model footing. The actual experimental set-up utilized for the study has been shown in Fig. 3.

Fig. 3. Photograph of test setup.

A reaction frame of 50kN load capacity was installed having a width equal to 1m and height equal to 1.2m. The dimensions of the tank were planned so that width of tank is equal to 6.25 times footing width with the intention of preventing the effect of boundaries. Three sides of tank were made up of M.S. of thickness 8mm and front face of tank were comprised of 18mm thick acrylic sheet to observe the failure surface. Bracing was provided laterally on out surface to avoid yielding during test. A model square footing of size 120mm and thickness of 25mm selected in such a way that width of footing is nearly equal to 3 times aperture size of geogrid. The test footing base was made rough by cementing a thin layer of sand to it with epoxy glue. A hydraulic cylinder of 5 ton capacity and stroke 200mm were provided for applying load on footing. A power pack of 50 Lit capacity was used and pressure can be adjusted from zero to 250 bar. Electric panel was provided for controlling up and down movement of hydraulic cylinder.

Test procedure: Sand raining approach was adopted to prepare the sand beds and the height of fall was maintained as 300 mm from top surface. The sand used in the study was passing through 2mm sieve and retained on 0.075 mm sieve.

The test tank was filled with sand of required constant density to a desired depth, in unreinforced and reinforced sand. The filled surface was compacted by using vibrator. The footing was placed below hydraulic cylinder over sand fill to transfer vertical load. A proving ring and dial gauge were adjusted on footing to record load and settlement values respectively. The load was increased gradually and footing allowed to settle under applied load. The load increment was continued till it reaches ultimate load or maximum permissible settlement. In this way load and settlement values were recorded and plotted on the graph. The schematic representation of test set-up indicating all parts are depicted in Fig. 4.

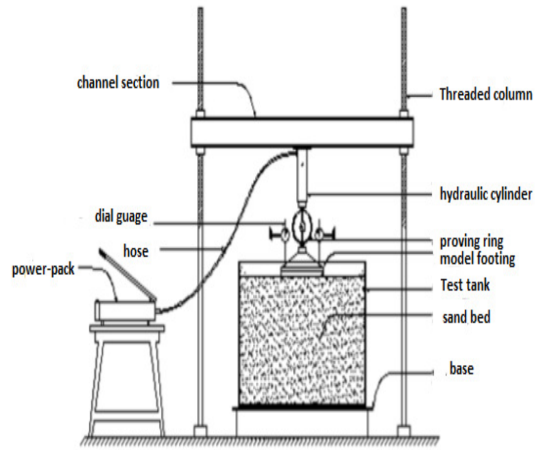


Fig. 4. Schematic diagram of test setup.

Following notations are used in the study, which is shown in Fig. 5.
b = footing width
B = width of geogrid
N = Number of geogrid layers
x = distance of first layer of geogrid below footing
z = vertical distance between two consecutive layers of geogrid.
s = settlement (mm)

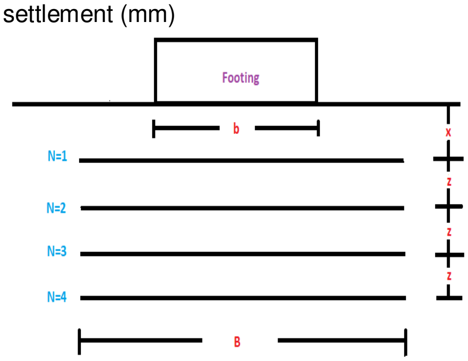


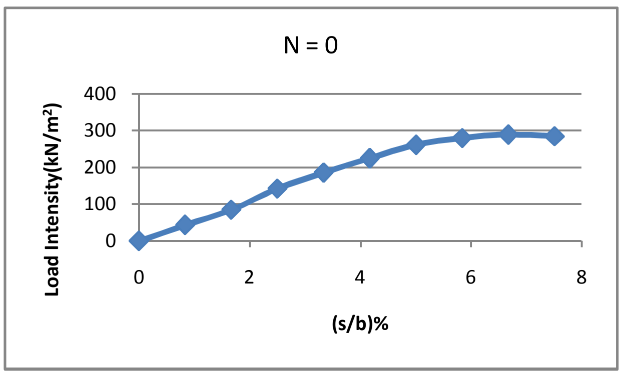
Fig. 5. Layers of geogrid below the footing.

IV. RESULTS AND DISCUSSION

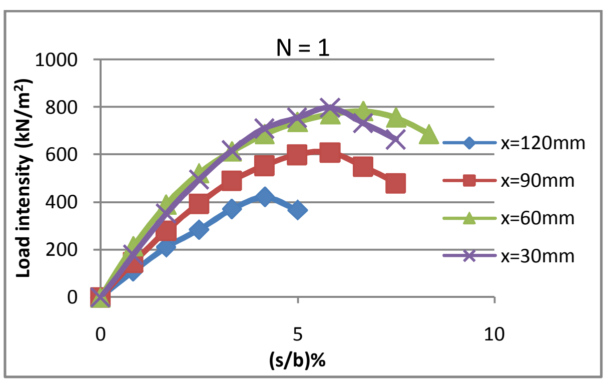
Total 53 tests were performed on model square footing. First test was conducted for unreinforced soil condition. Remaining tests were carried out on geogrid reinforced sand bed by considering the effect of number of layers of geogrid, depth of first layer of geogrid below footing and distance between two successive layers of geogrid. The neat sketch indicating layers of geogrid and notations used in result analysis are shown in Fig. 5. The graph of load intensity versus (s/b) % is plotted. (S/b) is represented in percentage as settlement to width of footing ratio which is a non dimensional parameter plotted on X axis and load intensity on Y axis.

Table 3: Details of experiments conducted.

Test No.	N	(x/b)	(z/b)
1	—	—	—
2-5	1	0.25, 0.5, 0.75, 1.0	—
6-9	2	0.25	0.25, 0.5, 0.75, 1.0
10-13	2	0.5	0.25, 0.5, 0.75, 1.0
14-17	2	0.75	0.25, 0.5, 0.75, 1.0
18-21	2	1.0	0.25, 0.5, 0.75, 1.0
22-37	3	0.25, 0.5, 0.75, 1.0	0.25, 0.5, 0.75, 1.0
38-53	4	0.25, 0.5, 0.75, 1.0	0.25, 0.5, 0.75, 1.0



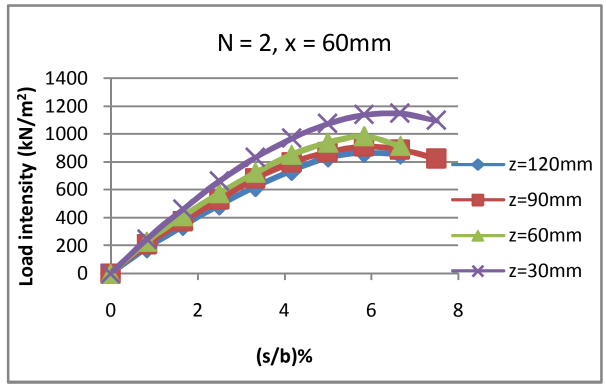
(a)



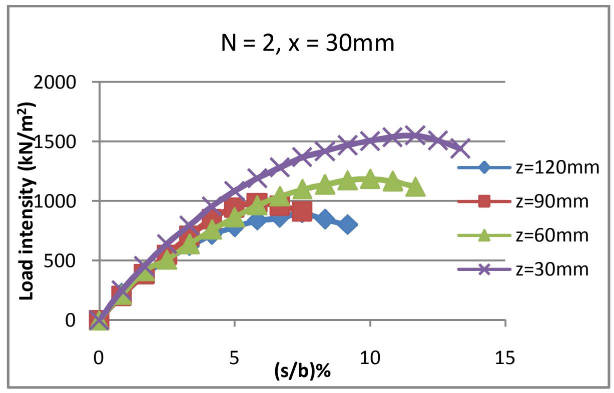
(b)

Fig. 6. Load versus footing settlement for (a) without geogrid (b) Single layer of geogrid.

The first test was carried out in this study was without any reinforcement in soil. The graph of load intensity versus (s/b) % is presented in Fig. 6 (a). The ultimate load intensity was 288 kN/m^2. The improvement factors over bearing capacity in each reinforcement configuration are calculated, in this study by using the ultimate load intensity of unreinforced soil.



(a)



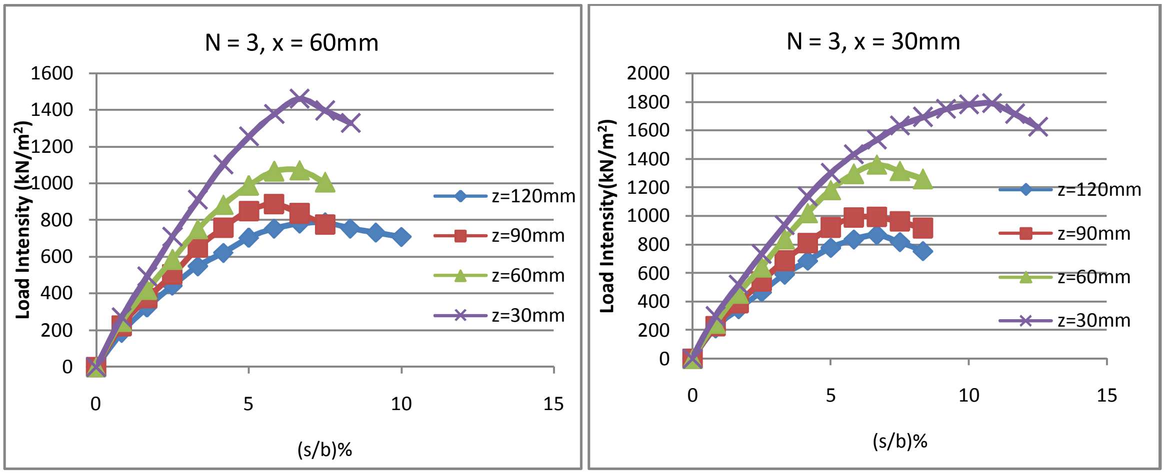
(b)

Fig. 7. Load intensity versus settlement for two layers of geogrid (a) x = 60mm (b) and x = 30mm.

The width of geogrid is remains constant throughout the study i.e. 4 times width of footing which is equal to 480 mm. When only one sheet of geogrid is used at varying distances beneath the base of footing, the nature of variation of load intensities are observed from Fig. 6 (b). Model tests were carried out using one layer of geogrid and it was found that geogrid at 30mm i.e.0.25b from base of footing shows maximum load carrying capacity compared to other depth of insertion of geogrid [9].

For more than one layer of geogrid, the effect of vertical spacing between two layers of reinforcement (z) was taken into account which is observed from Fig. 7. From Fig. (7a & 7b), When x = 60mm at (s/b) = 7 % the ultimate load intensity is about 1148 kN/m^2 and for x = 30mm at same (s/b) % load carrying capacity reached to about 1300 kN/m^2 and the maximum load pressure was reported as 1550 kN/m^2 Similar results were obtained for three layers of geogrid. The results at x = 60 mm and x = 30 mm are presented in Fig. 8 (a) and (b) respectively.

The results of test No 38 to 53 (from Table 3) are presented in Fig. 9. Graph 9a, 9b, 9c, 9d in each case for z = 30mm, the bearing pressure was found maximum and it decreases when spacing between successive geogrid increases. For (s/b) = 4% and x=120mm, utimate load intensity is 553 kN/m^2. This value get increased to 800 kN/m^2, 1050 kN/m^2 and 1125 kN/m^2 for x= 90mm, 60mm and 30mm respectively.



(a) (b)

Fig. 8. Load Intensity versus settlement for three layers of geogrid (a) x = 60mm (b) x = 30 mm.

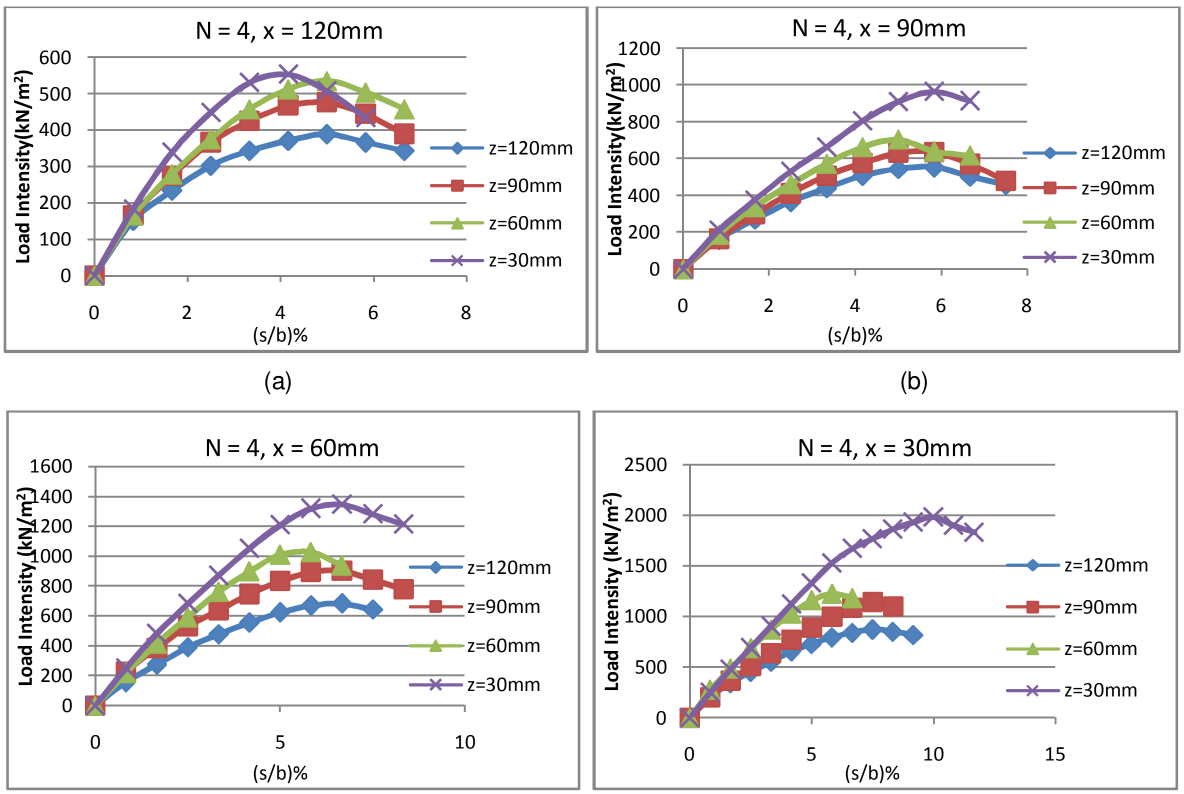


Fig. 9. Load intensity versus (s/b) % for N = 4 and (a) x = 120mm (b) x = 90mm (c) x = 60mm (d) x = 30mm.

The ultiate bearing capacity of soil without reinforcement and with reinforcement have been computed and it is related with a non dimesional parameter, which is an improvement in bearing capacity due to provision of reinforcement in soil, called as Bearing Capacity Ratio. (BCR). Fig. 10 shows BCR for single layer of geogrid. The trend of increasing BCR was found as depth of geogrid reduced from 120mm to 30mm and the values of BCR calculated as 1.46 and 2.76 respectively.

In case of two, three and four layers of geogrid, the depth of first layer of geogrid plays vital role similar to single layer of geogrid which can be clearly understood from Fig. 11 (a, b & c). Also the spacing between successive layers of geogrid needs to be considered. Fig. 11 (a, b and c) clearly demonstrates that, BCR found to be increased if spacing between two successive geogrid layers and depth of top layer of geogrid decreased from 120mm to 30mm. The calculated BCR values are mentioned in Table 4.

Table 4 : BCR for all reinforced soil configuartion.

Test No.	N	(x/b)	(z/b)	BCR
2-5	1	0.25	—	2.76
		0.5		2.71
		0.75		2.11
		1.0		1.46
6-9	2	0.25	0.25	5.38
			0.5	4.11
			0.75	3.41
			1.0	3.12
10-13	2	0.5	0.25	3.98
			0.5	3.41
			0.75	3.15
			1.0	2.96
14-17	2	0.75	0.25	3.63
			0.5	3.24
			0.75	2.96
			1.0	2.58
18-21	2	1.0	0.25	2.25
			0.5	2.15
			0.75	1.99
			1.0	1.85
22-25	3	0.25	0.25	6.21
			0.5	4.74
			0.75	3.44
			1.0	3.01
26-29	3	0.5	0.25	5.06
			0.5	3.71
			0.75	3.07
			1.0	2.73
30-33	3	0.75	0.25	3.0
			0.5	2.68
			0.75	2.57
			1.0	1.90
34-37	3	1.0	0.25	2.33
			0.5	2.16
			0.75	1.94
			1.0	1.74
38-41	4	0.25	0.25	6.87
			0.5	4.23
			0.75	3.95
			1.0	3.01
42-45	4	0.5	0.25	4.66
			0.5	3.55
			0.75	3.12
			1.0	2.36
46-49	4	0.75	0.25	3.34
			0.5	2.44
			0.75	2.20
			1.0	1.92
50-53	4	1.0	0.25	1.92
			0.5	1.85
			0.75	1.65
			1.0	1.34

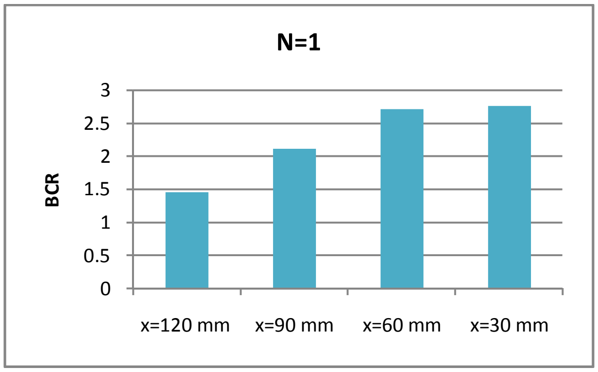
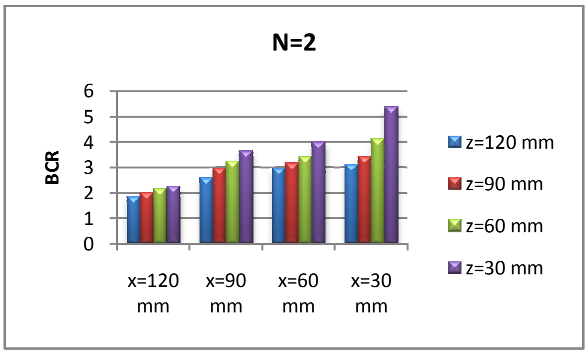
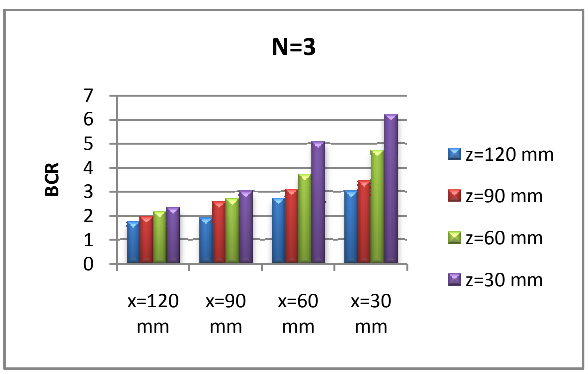


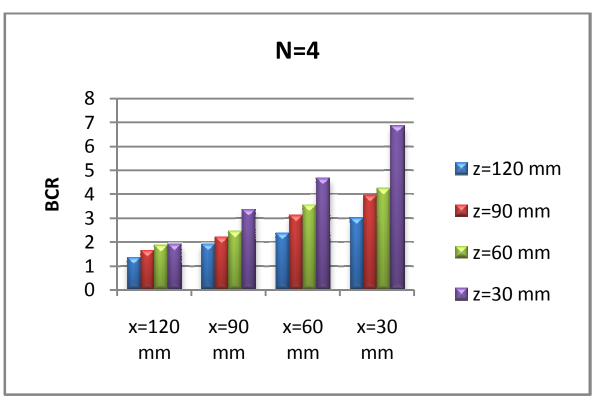
Fig. 10. BCR for single layer of geogrid.



(a)



(b)



(c)

Fig. 11. BCR for (a) N = 2, (b) N = 3, (c) N = 4.

V. SUMMARY AND CONCLUSION

In this paper an effective use of geogrid reinforced sand foundation has explained by conducting laboratory model test on square footing and studied the effect of number of reinforcement layers (N), effect of first layer depth (x) and vertical spacing between the geogrid (z). From the outcomes obtained on this, the consequences of various parameters are summarized below

The number of reinforcement layers (N): Number of laboratory model footing tests were conducted on reinforced sand by varying N =1 to N=4. For single layer of geogrid maximum load intensity reported as 796 kN/m^2 and for four layers of geogrid the ultimate load intensity was enhanced from 796 kN/m^2 to 1981 kN/m^2. However finest range of geogrid layers is also reliant on the vertical spacing between two geogrid layers and the embedded depth of the top layer. This is because the location of soil reinforcement would be noteworthy if it is placed in the effective zone below the footing.

The impact of first layer depth (x): The ultimate loads were compared by varying depth of first layer of geogrid from 0.25b to 1.0b. Maximum load carrying capacity for x = 30mm, 60mm, 90mm and 120mm were determined. For single layer, when geogrid was placed at a distance 0.25b below the base of footing, ultimate load carried by footing observed to be nearly 26% more as compared to other depth of insertion of geogrid. The graphical representation of fig 10 and fig 11 clearly indicated that when x is reduced from 120mm to 30mm, the BCR in each case was certainly enhanced. The calculated values of BCR for different ratios of (x/b) are summarized in Table 4.

Vertical spacing between the reinforcements (z): The spacing between two successive geogrid layers was varied from 0.25b to 1.0b i.e. 30mm, 60mm, 90mm and 120mm. From the results of BCR for two, three and four layers of geogrid (Fig. 11), it is observed that BCR raised by (15% to 20%) if spacing between two consecutive geogrid layers decreased from z=120mm to z=30mm. The calculated BCR values are mentioned in Table 4. Also the ultimate bearing pressure in each case for z =30mm was reported as maximum compared to other values of z mentioned in this study. This is because more amount of soil gets confined vertically and laterally for lesser spacing between two geogrids.

The results achieved in the present study can lead to following conclusions

– The load settlement response of a square footing resting on geogrid reinforced sand is approximately linear upto (s/b) = 5%.

– To get maximum advantage of geosynthetic material, the top layer of geogrid should be placed at a space of 0.25b from base of footing.

– The ultimate bearing pressure has found maximum value when two adjacent geogrids are kept at a distance of 0.25b.

– If top layer of geogrid is located at 0.25b beneath the footing and number of geogrid layers increased from two to three and from three to four, the ultimate loads are increased by 10% and 8% respectively.

– BCR are increases as x and z values reduce from 120mm upto 30mm.

– The maximum BCR for N = 2, N = 3 and N = 4 are 5.38, 6.21 and 6.87 respectively.

VI. FUTURE SCOPE

In present study, load on footing is applied at the center. This study can be extended by applying load at different eccentricities within core of footing and effect of eccentricity on load carrying capacity of footing can be calculated.

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Conflict of Interest. No.

REFERENCES

[1]. Abu-Farsakh M., Chen Q., & Sharma R. (2013). An experimental evaluation of the behavior of footings on geosynthetic-reinforced sand. *Soils Found, 53,* 335–348.

[2]. Alawaji, H. A. (2001). Settlement and bearing capacity of geogrid-reinforced sand over collapsible soil. *Geotextiles and Geomembranes, 19*(2), 75–88.

[3]. Badakhshan, E., & Noorzad A. (2017). Effect of footing shape and load eccentricity on behavior of geosynthetic reinforced sand bed. Geotextitle. *Geomembranes, 45* 58–67.

[4]. Chakraborty, D., & Kumar, J. (2015). Bearing capacity of circular footings on reinforced soils. *Inernational Journal. Geomech, 15*, 1–9.

[5]. Das, B. M., & Omar, M. T. (1994). The effects of foundation width on model tests for the bearing capacity of sand with geogrid reinforcement. *Geotechnical and Geological Engineering, 12*(2), 133–141.

[6]. Dastpak, P., Abrishami, S., Sharifi, S., & Tabaroei, A. (2020). Experimental study on the behavior of eccentrically loaded circular footing model resting on reinforced sand. *Geotextiles and Geomembranes,* 20 (3), 1-8

[7]. Deb, K., & Konai, S. (2014). Bearing capacity of geotextile-reinforced sand with varying fine fraction. *Geomechanics and Engineering, 6*(1), 33–45.

[8]. Demir, A., Yildiz, A., Laman, M., & Ornek, M. (2014). Experimental and numerical analyses of circular footing on geogrid-reinforced granular fill underlain by soft clay. *Acta Geotechnica*, *9*(4), 711-723.

[9]. Hariprasad, C., & Umashankar B. (2015). Load-settlement response of circular footing resting on reinforced layered system. 15th Asian Reg. Conf. Soil Mech. Geotech. Engineering ARC 2015 New Innov. *Sustain,* 2170–2173.

[10]. Jorge, G., Delleur, E. J. W., Zornberg, J. G., & Christopher, B. R. (1999). Zornberg, Jorge G. et al. Geosynthetics. The Handbook of Groundwater Engineering CRC Press LLC, *27*(3), 1-32.

[11]. Kumar, A., & Saran, S. (2003). Closely spaced strip footings on reinforced sand. *Geotechnical Engineering, 34*(3), 177–186.

[12]. Latha, M. G., & Somwanshi, A. (2009). Bearing Capacity of square footings on geosynthetic reinforced sand. *Geotextitle. and Geomembranes, 27*, 281-294.

[13]. Makkar, F. M., Chandrakaran, S., & Sankar, N. (2017). Behaviour of Model Square Footing Resting on Sand Reinforced with Three-Dimensional Geogrid. *International Journal of Geosynthetics and Ground Engineering, 3*(1), 1–10.

[14]. Marto, A., Oghabi, M., & Eisazadeh, A. (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 Q*, 3501–3516.

[15]. Ghazavi, M., & Mirzaeifar, H. (2010). Bearing capacity of multi-edge shallow foundations on geogrid-reinforced sand. In *Proceedings of the 4th International Conference on Geotechnical Engineering and Soil Mechanics*, 1-9.

[16]. Panigrahi, B., & Pradhan, P. K. (2019). Improvement of bearing capacity of soil by using natural geotextile. *International Journal of Geo-Engineering*, *10*(1), 1-12.

[17]. Patra, C. R., Das, B. M., Bhoi, M., & Shin, E. C. (2006). Eccentrically loaded strip foundation on geogrid-reinforced sand. *Geotextiles and Geomembranes, 24*(4), 254–259.

[18]. Rowshanzamir, M. A., & Karimian M. (2016). Bearing capacity of square footings on sand reinforced with dissimilar geogrid layers. *Scientia Iranica A 23-1,* 36-44.

[19]. Zidan, A. F. (2012). Numerical Study of Behavior of Circular Footing on Geogrid-Reinforced Sand under Static and Dynamic Loading. *Geotechnical and Geological Engineering, 30*(2), 499–510.

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