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Improvement of CBR using Geosynthetic Reinforcement

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Abstract - In developing countries like India the biggest drawback is to provide a network of road system, because of limited finances available to built road by conventional methods. The construction cost can be considerably decreased by selecting local materials including local soil for the construction of lower layers of the pavement such as the sub-base course. The term stabilization means the improvement of stability or bearing capacity of the soil by using Geosynthetic materials and also by using controlled compaction. Soil stabilization may increase the stability, change in the properties, density or swelling, change in physical characteristics and also an increase in compressive strength and stiffness. In this experimental study two of the Geosynthetic materials such as Geogrid and Geonet are being used. As per the laboratory tests it is found that the soil has been stabilized by using two to three layers of Geogrid out of which two layers is found to be comparatively improvement in CBR.

Key Words: Soil Stabilization, Geogrid, Geonet, CBR etc…

1. INTRODUCTION

Soil stabilization is the process of altering one or more properties of the soil. It is one of the techniques available to the geotechnical engineer and its choice for any situation should be made only after a comparison with the other techniques which indicate it to be the best solution to the problem. The alternatives available to geotechnical engineer when an unsatisfactory soil is met with are To bypass the bad soil, To improve bad soil and replace with good one, Redesign the structure, To treat the soil to improve its properties. The last alternative is termed as soil stabilization. Although certain techniques of stabilization are of a relatively recent origin, the art is very old. The original objective of soil stabilization is to simply the increase the strength or stability of the soil. Every technique has now been developed to alter almost engineering property of the soil. The primary aim is to alter the strength of the soil.

2. MATERIALS USED

The soil is used in this study collected from nearby site. The properties of Geogrid, Geonet and the index properties of soil are given in table 1 and 2

Table 1. Properties of Geogrid and Geonet

S.No	DESCRIPTION	BIAXIAL GEOGRID	GEONET
1	Colour	Black	Cream
2	Structure	Interwoven	Biplanar
3	Rib Thickness	6mm	2.5mm
4	Mass/unit area	750g/m^2	750g/m^2
5	Tensile strength	29.4 KN/m	5.4 KN/m
6	Aperture Size	2x2 mm	3x3 mm
7	Density	0.923g/cm^3	0.923g/cm^3
8	Polymer	High modulus polyester	-

Table 2: Properties of soil

S.No	DESCRIPTION	RESULT
1	Colour	Black
2	Specific Gravity	2.26
3	Free Swell Index	60%
4	Atterberg Limit	
(i)	Liquid Limit	71%
(ii)	Plastic Limit	35.5%
(iii)	Shrinkage Limit	9.75%
5	Grain size distribution	
I	Gravel	0%
Ii	Sand	16.5%
Iii	Clay and silt	83.5%
Iv	IS Soil classification system	Clay of High compressibility

3. RESULTS AND DISCUSSIONS

3.1 COMPACTION CHARACTERISTICS

Standard Proctor Compaction test is conducted on soil is to determine its compaction characteristics, namely, the Optimum Moisture Content (OMC), and Maximum Dry Density (MDD). The OMC and MDD Values obtained are 16% and 1.420 from figure 1.

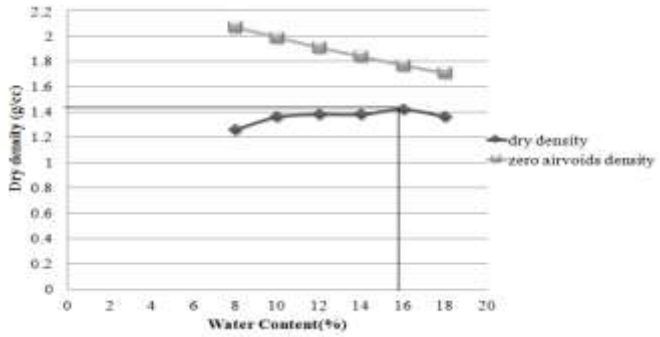

Fig. 1: Compaction curve for soil

3.2 UNCONFINED COMPRESSION STRENGTH TEST

The uniaxial compressive strength of soil that is determined in the absence of cell or confining pressure in the soil. From figure 2, Unconfined compressive strength of the soil is125.4 KN/m^2

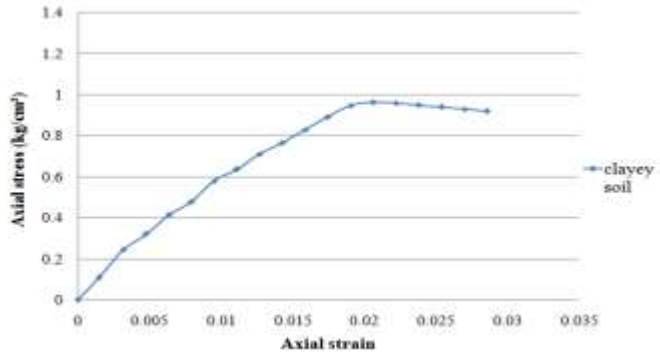

Fig. 2: Unconfined Compressive strength for soil

3.3 CALIFORNIA BEARING RATIO (CBR)TEST FOR REINFORCED & UNREINFORCED SOIL

California bearing ratio is defined as the ratio of the force per unit are required to penetrate to soil mass with a circular plunger. The CBR values for 2.5 mm penetration 5 mm penetration = 1.63%and 1.91% from figure 3.

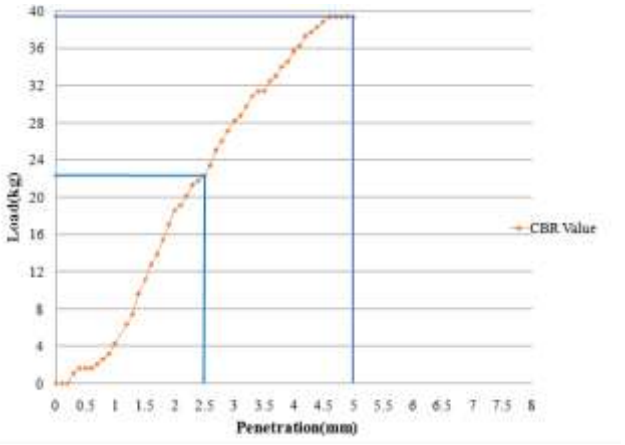

Fig. 3: CBR value for Unreinforced soil

CBR value for reinforced soil at First layer

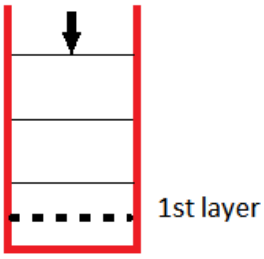

Fig. 4 Reinforcement placed at first layer

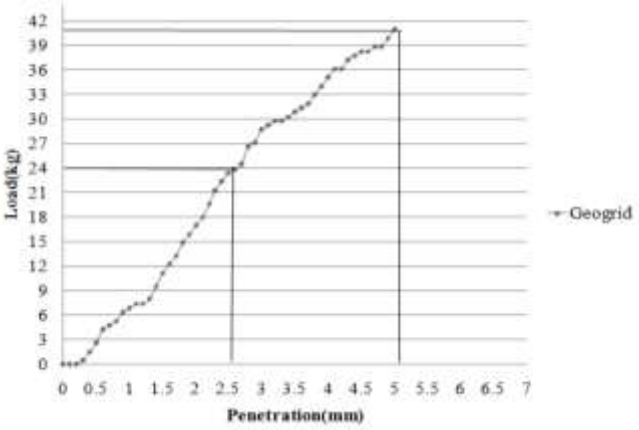

Fig. 5: CBR value by placing Geogrid in firstlayer

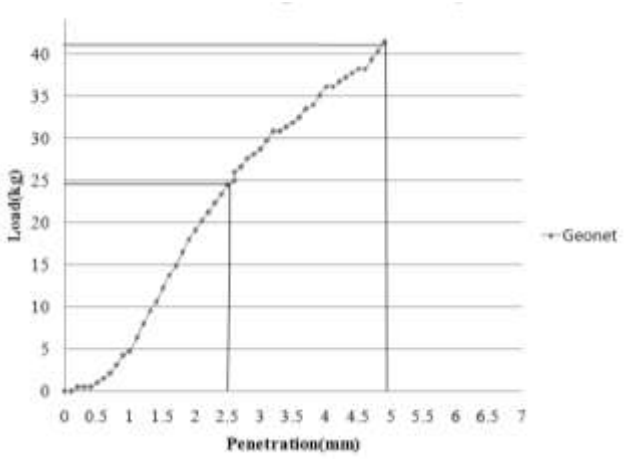

Fig. 6: CBR value by placing Geonet in first layer

From figure 5 and 6,Influence of soil reinforcement at bottom layer by placing Geogrid, the CBR value was found to be 1.99% whereas the CBR value of Geonet was found to be 2.02% which is an increment of 1.5% compared to the Geogrid.

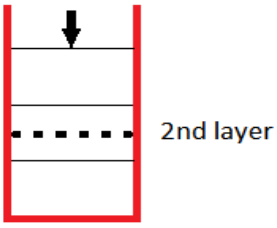

Fig. 7 Reinforcement placed at second layer

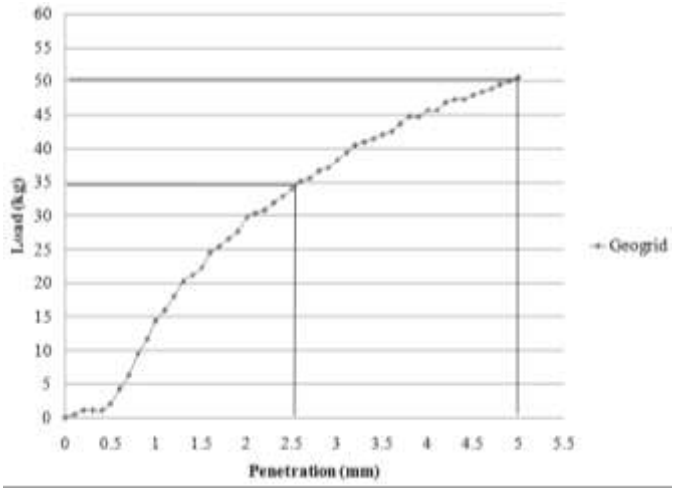

Fig. 8: CBR value by placing Geogrid in second layer

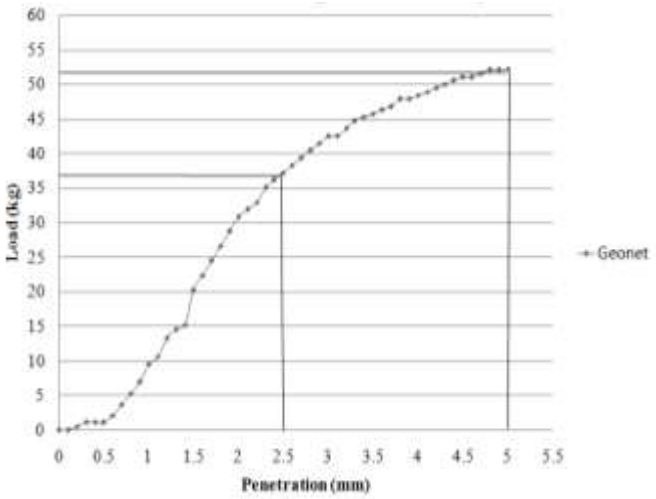

Fig. 9 CBR value by placing Geonet in second layer

From figure 8 and 9, Influence of soil reinforcement at middle layer by placing Geogrid, the CBR value was found to be 2.46% whereas the CBR value of Geonet was found to be 2.53% which is an increment of 2.8% compared to the Geogrid.

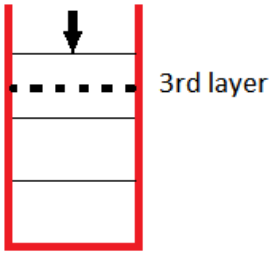

Fig. 10: Reinforcement placed at third layer

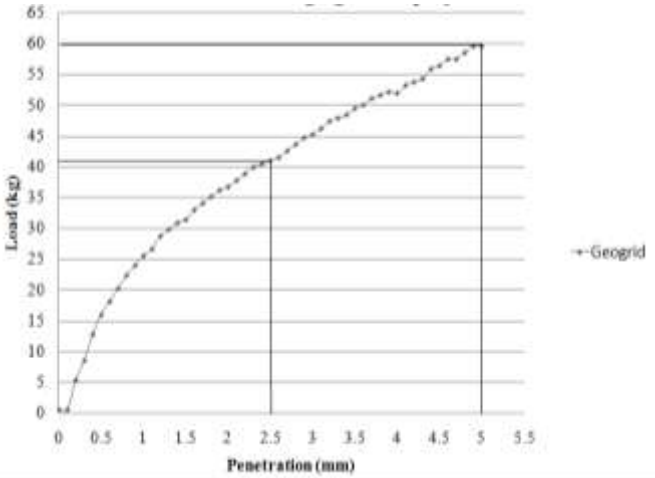

Fig.11: CBR value by placing Geogrid in third layer

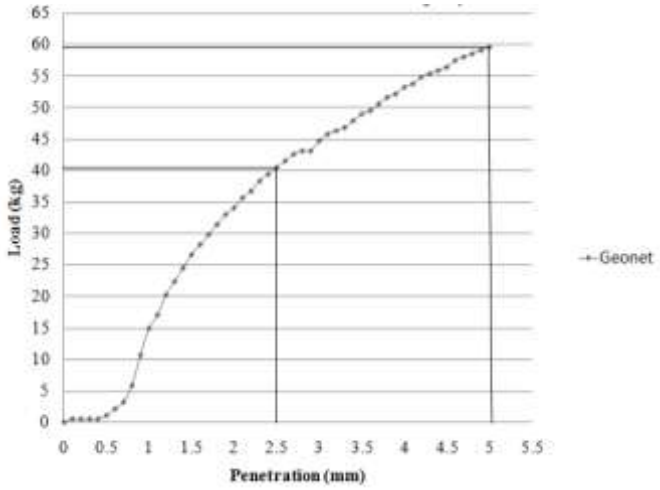

Fig.12: CBR value by placing Geonet in third layer

From the figure 11 and 12, Influence of soil reinforcement at the top layer by placing Geogrid and Geonet the CBR value was found to be 2.89% and hence there was no increment.

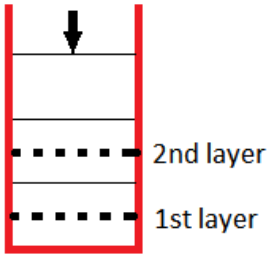

Fig. 13: Reinforcement placed at first and second layer

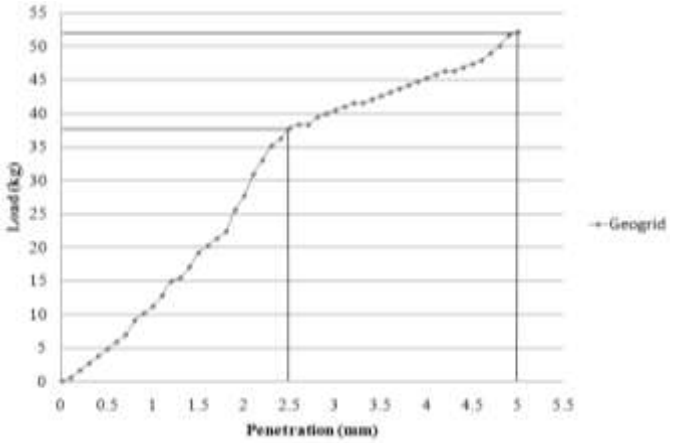

Fig. 14: CBR value by placing Geogrid in first and second layer

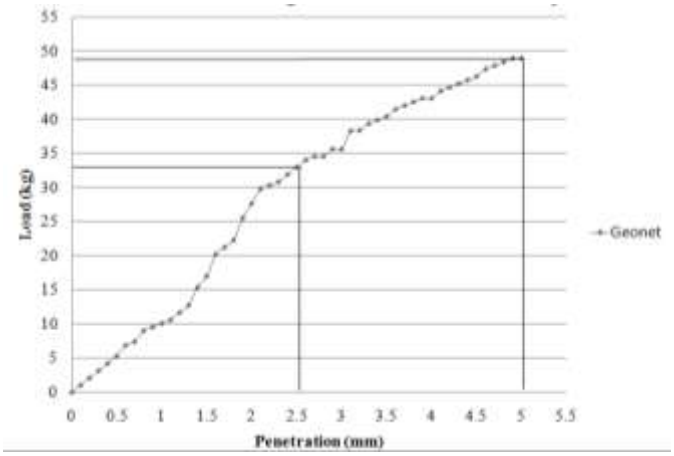

Fig. 15: CBR value by placing Geonet in first and second layer

From figure 14 and 14, Influence of soil reinforcement at bottom and middle layer by placing Geonet, the CBR value was found to be 2.38% whereas the CBR value of Geogrid was found to be 2.53% which is an increment of 6.3% compared to the Geonet.

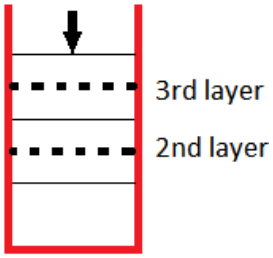

Fig. 16: Reinforcement placed at second and third layer

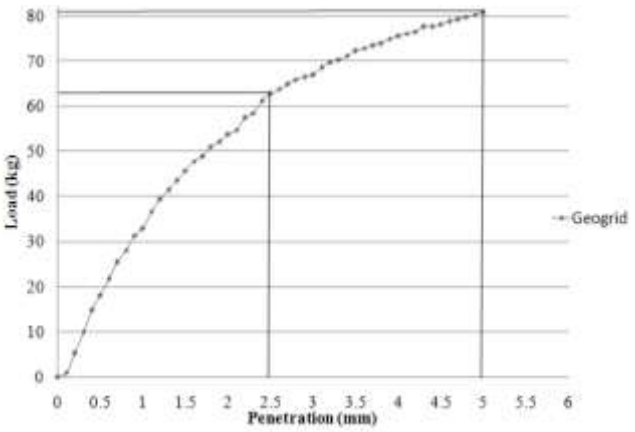

Fig. 17: CBR value by placing Geogrid in second and third layer

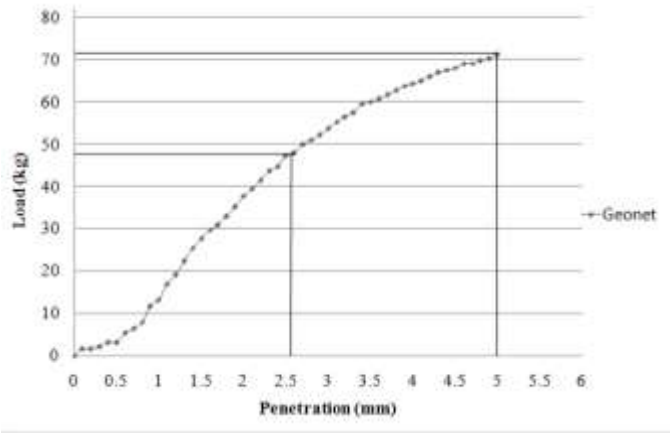

Fig. 18: CBR value by placing Geogrid in second and third layer

From figure 17 and 18, Influence of soil reinforcement at top and middle layer by placing Geonet, the CBR value was found to be 3.94% whereas the CBR value of Geogrid was found to be 3.47% which is an increment of 13.5% compared to the Geonet.

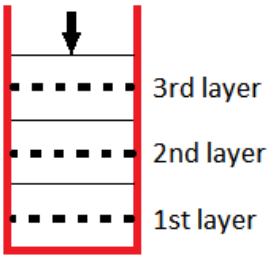

Fig. 19: Reinforcement placed at first, second and third layer

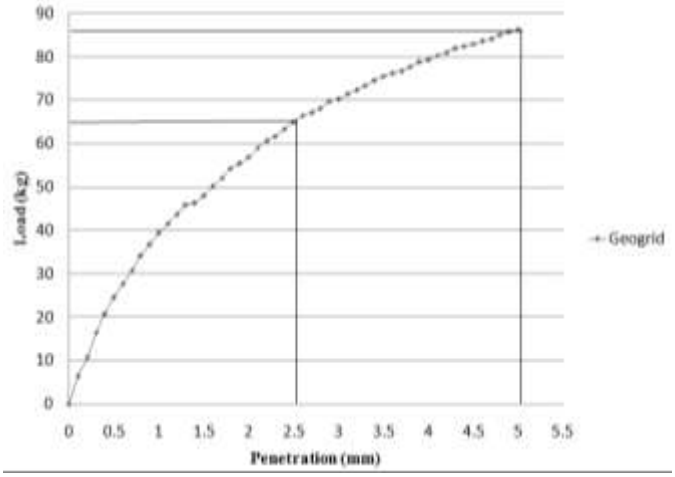

Fig. 20: CBR value by placing Geogrid in first, second and third layer

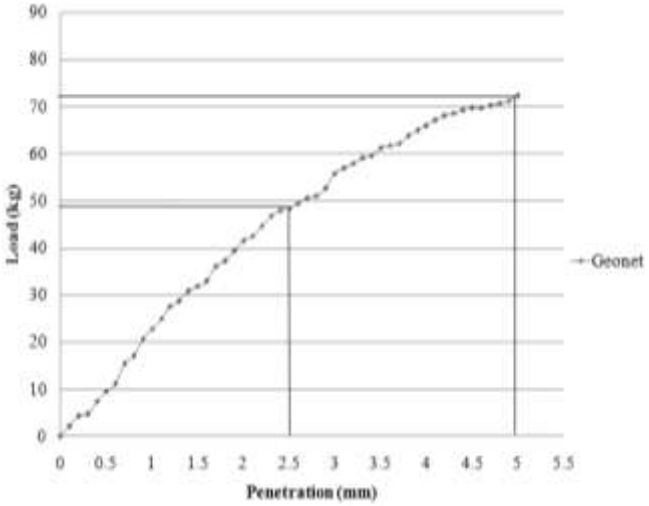

Fig. 21: CBR value by placing Geonet in first, second and third layer

From figure 20 and 21, Influence of soil reinforcement at top and middle layer by placing Geonet, the CBR value was found to be 4.19% whereas the CBR value of Geogrid was found to be 3.52% which is an increment of 19% compared to the Geonet.

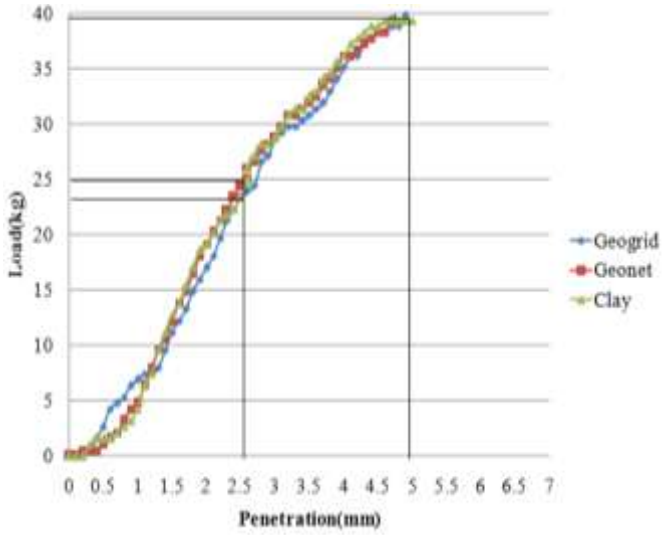

Fig. 22: Variation of CBR values with and without specimens at first layer

From figure 22, it was observed that, the CBR value obtained for natural soil was 1.91%. By placing Geogrid at first layer the CBR value was increased to 1.99% which is an increment of 4.1% compared to the natural soil. By placing Geonet at first layer the CBR value was increased to 2.02% which is an increment of 5.7% compared to the natural soil. When comparing the values of Geonet and Geogrid it was found that Geonet had an increase of 1.5% when reinforced with soil.

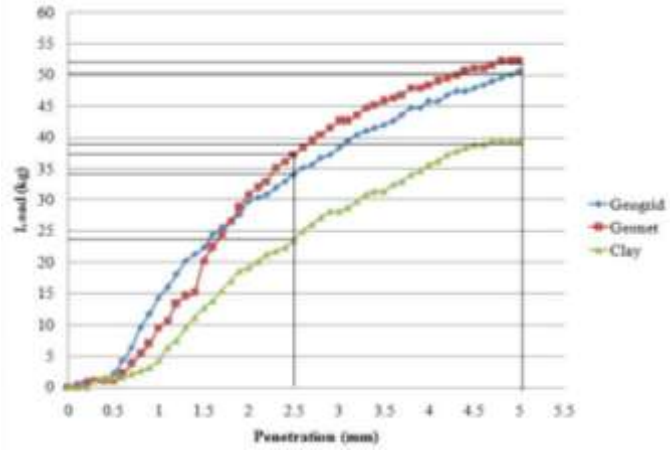

Fig. 23: Variation of CBR values with and without specimens at second layer

It was observed from figure 23, the CBR value obtained for natural soil was 1.91%. By placing Geogrid at second layer the CBR value was increased to 2.46% which is an increment of 29% compared to the natural soil. By placing Geonet at second layer the CBR value was increased to 2.53% which is an increment of 32% compared to the natural soil. When comparing the values of Geonet and Geogrid it was found that Geonet had an increase of 2.8%.

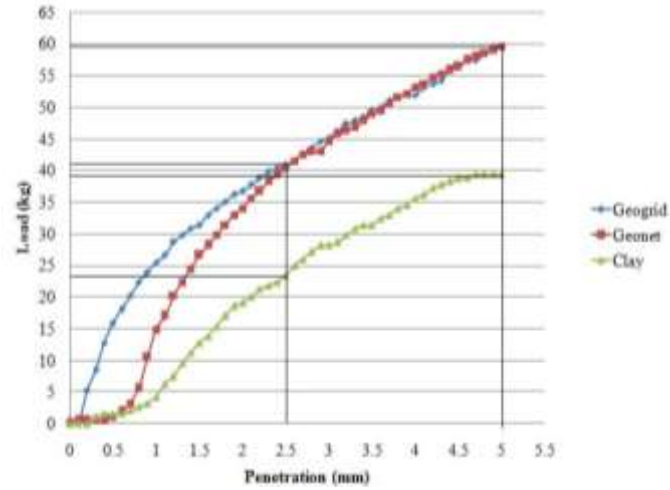

Fig. 24: Variation of CBR values with and without specimens at third layer

From figure 24, The CBR value obtained for natural soil was 1.91%. By placing Geogrid at second layer the CBR value was increased to 2.89% which is an increment of 51% compared to the natural soil. By placing Geonet at second layer the CBR value was increased to 2.89% which is an increment of 51% compared to the natural soil. The values were found to be equal for both Geonet and Geogrid.

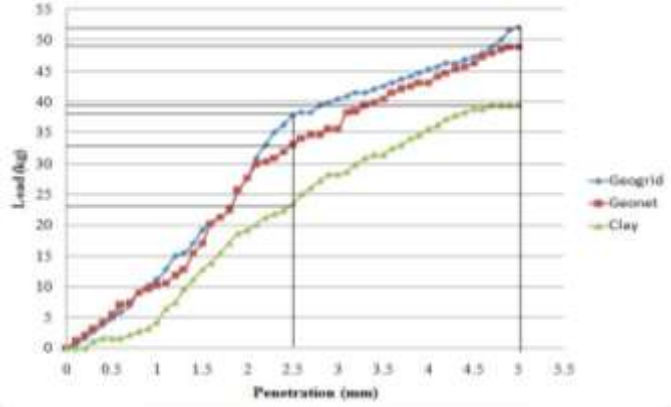

Fig. 25: Variation of CBR values with and without specimens at first & second layer

From figure 25, The CBR value obtained for natural soil was 1.91%. By placing Geonet at first and second layer the CBR value was increased to 2.38% which is an increment of 24% compared to the natural soil. By placing Geogrid at first and second layer the CBR value was increased to 2.53% which is an increment of 32% compared to the natural soil. When comparing the values of Geonet and Geogrid it was found that Geogrid had an increase of 6%.

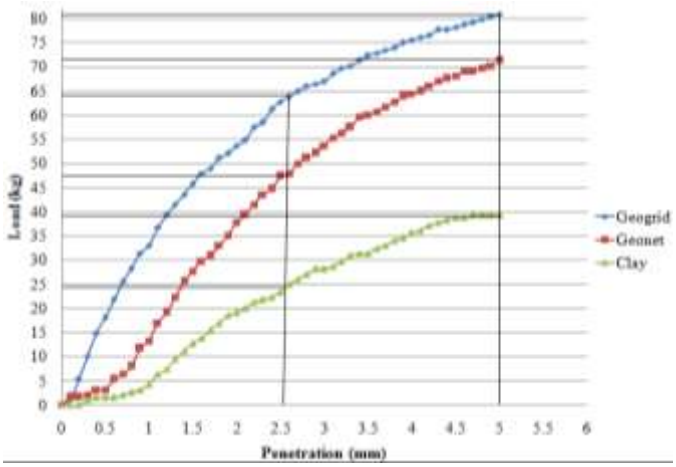

Fig. 26: Variation of CBR values with and without specimens at second & third layer

From figure 26, The CBR value obtained for natural soil was 1.91%. By placing Geonet at second and third layer the CBR value was increased to 3.47% which is an increment of 81% compared to the natural soil. By placing Geogrid at second layer and third the CBR value was increased to 3.94% which is an increment of 106% compared to the natural soil. When comparing the values of Geonet and Geogrid, it was found that Geogrid has an increase of 13%.

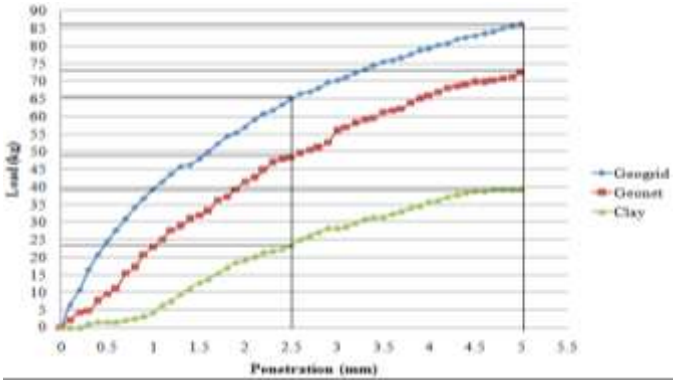

Fig. 27: Variation of CBR values with and without specimens in all the three layer

From figure 27, The CBR value obtained for natural soil was 1.91%. By placing Geonet at first and second layer the CBR value was increased to 3.52% which is an increment of 84% compared to the natural soil. By placing Geogrid at first and second layer the CBR value was increased to 4.19% which is an increment of 119% compared to the natural soil. When comparing the values of Geonet and Geogrid, it was found that Geogrid has an increase of 19%.

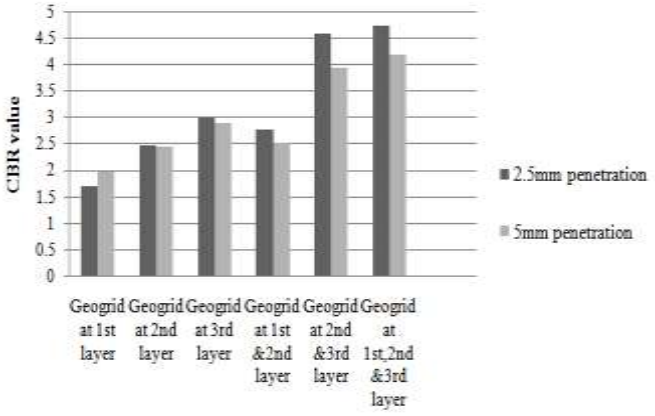

Fig. 28: Variation of CBR values by placing Geogrid in different layers

From figure 28, The CBR values of Geogrid when plotted, was found that when the specimen placed at all the three layers was increased by 119% when compared to the unreinforced soil

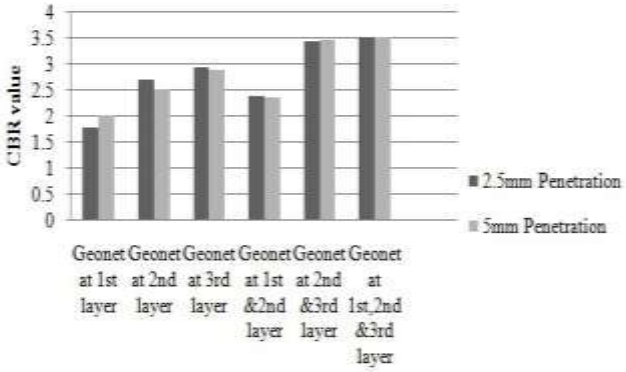

Fig. 29: Variation of CBR values by placing Geonet in different layers

From figure 29, The CBR values of Geonet when plotted, was found that when the specimen placed at all the three layers was increased by 84% when compared to the unreinforced soil.

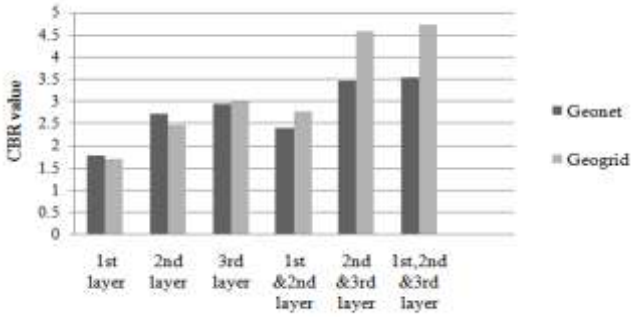

Fig. 30: Variation of CBR values by placing Geonet & Geogrid in different layers

From figure 30, The CBR value obtained for natural soil was 1.91%. By placing Geonet and Geogrid at different layers respective results were obtained. The CBR value obtained by placing three layers of Geogrid was found to be the highest of 4.19% at 5mm penetration which showed an increment of 119% when compared to the unreinforced soil.

4. CONCLUSIONS

Based on the Experiments carried out on soil and Geosynthetic materials, the following observations and conclusions are drawn:

i. Compared to the unreinforced soil it was found that the settlement was decreased by the use of both Geonet and Geogrid from which Geogrid was more efficient.

ii. Placing three layers of Geogrid had effective performance in unsoaked condition using CBR results.

iii. The unconfined compressive strength of soil was found to be more when Geogrid was placed in three layers compared to Geonet.

iv. It was found economical to place Geogrid in two layers (3rd layer and 2nd layer) rather than placing three layers since the CBR value was found to be relatively close.

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