CBR PERFORMANCE OF GEOGRID REINFORCED WEAK SUBGRADES

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Abstract
In this paper, results obtained from a series of CBR load tests are presented. CBR load tests were conducted on geogrid reinforced and unreinforced weak subgrades to understand the general behavior of reinforced subgrades. The geogrid is placed at various heights to find the optimum placement of geogrid reinforcement. The widths of the geogrid with respect to the loading plunger are varied to obtain the optimum amount of reinforcement. The bulk densities and water content of the weak subgrade soil were maintained. The loading was applied through a CBR test apparatus using a 50 kN frame and circular plunger of 50 mm diameter. Results from each case are presented, and different views on the results are discussed with the experimental tests. It was inferred that the performance of the subgrade soil can be improved using geogrid reinforcement. The highest CBR achieved for optimum placement and amount of geogrid reinforcement provided for the subgrade soil improved by about 2.4 times the unreinforced.
Index Terms: CBR, Geogrids, Loading.

I. INTRODUCTION

In pavements, Sub-grade is the native material underneath constructed road, pavement or railway track. It is also called formation level. Sub-grade is commonly compacted before the construction of a road, pavement or railway track.

The sub-grade must be able to support loads transmitted from the pavement structure. This load bearing capacity is often affected by degree of compaction, moisture content, and soil type. A sub-grade that can support a high amount of loading without excessive deformation is considered good.

Most soils undergo some amount of volume change when exposed to excessive moisture or freezing conditions. Clay soils are weak in strength in various parts of the world there is every need to improve the strength by reinforcing the soil.

II BACKGROUND

The reinforcement of soils is a technique used from primitive ages. It started with planar geotextiles, planar polymeric materials and rouse to 3D HDPE reinforcements. Barry R. Christopher (2010) used Geo-grids as reinforcement in permanent paved roadways in two major application areas, base reinforcement and sub-grade stabilization. In sub-grade stabilization application, the Geo-grids are used to build a construction platform over weak sub-grades to carry equipment and facilitate the construction pavement system without excessive deformations of the sub-grade.

Sarika B. Dhule, S.S Valunjkar (2011) In this weaker soils are generally clayey and expansive in nature which are having lesser strength characteristics. In this paper technique of improving the soil with Geo-grid increase the stiffness and load carrying capacity of the soil through fractional interaction between the soil and Geo-grid material improving black cotton soil. Olaniyan O.S., Akolade A. S have discussed basic engineering and geotechnical properties of poor sub-grade soils using geo synthetics like geo-grids to improve its strength Charles Anum Adams, Nana Yaw Amofa, Richter Opoku- Boahen determined the effect of strength of geo grid reinforcement material on the CBR of a sample of relatively poor lateritic subgrade material under soaked and un soaked conditions. The CBR of the soil-geogrid subgrade was used to determine the pavement layer thicknesses for a low volume paved road using the transport research laboratory Road note 31 method of pavement design.

III Materials and Methods

The local soil is reinforced using geogrids which is a geosynthetic material commonly made of polymer materials, such as polyester, Polyvinyl alcohol, polyethylene or polypropylene. Geogrids are mainly used as reinforcing material in subbases or subsoils below pavements, embankments and retaining walls. Soils pull apart under tension. Compared to soil, geogrids are strong in tension.

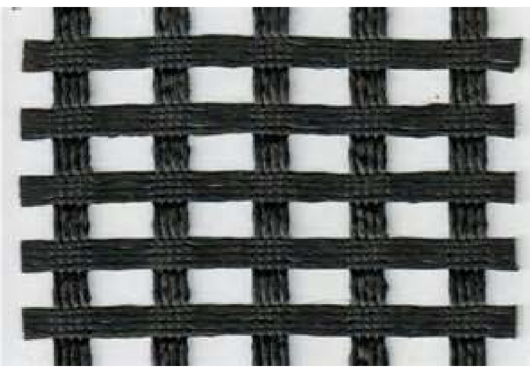

Figure 1. Geogrid Material used in the study

The local soil available is taken for testing purposes. The particle size distribution of the soil was determined by sieve analysis as per IS 2720.

Sample Area	BVRIT, Narsapur
Gravel	0
Sand	45.91
Fines	54.09
Liquid limit	41%
Plastic limit	28%
Specific gravity	2.62
Differential Free Swell	75%(Very High)

Table 1. Properties of the soil used

Various tests for characterising the soil are performed and are the properties are given below in Table 1. The soil has about around 55% fines, Liquid limit of 41 %, Plastic limit of 28 %, Specific gravity of 2.62 and a differential free swell of 75% making the clay a highly compressible clay which is denoted by CH.
Compaction tests are done to assess the amount of compaction and water content required in the field. The optimum water content and maximum dry density.The water content at which the maximum dry density is attained is obtained from the relationships provided by the tests.

A compaction curve is plotted between the water content as absicca and corresponding dry density as ordinate. The optimum water content of 21% and the maximum dry density of 1.51 gm/cc are used from the compaction curve of Figure 2.

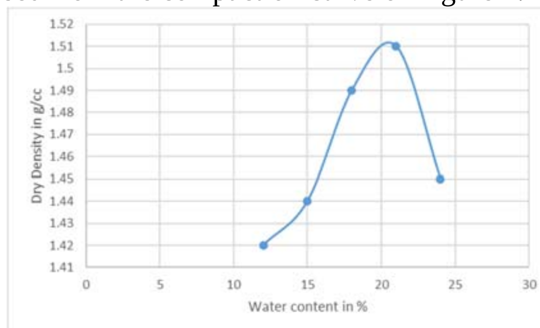

Figure 2. Compaction Curve for the soil

II. Test Setup and Testing methodology

For testing the material, the CBR test set up having a load frame of capacity 50 kN is used. It has a plunger diameter of 50 mm. The plunger in the CBR test penetrates the specimen in the mould at the rate of 1.25mm per minute.The loads required for the penetration of 2.5mm and 5.0mm are determined.The penetration load is expressed as a percentage of the standard loads at the respective penetration level of 2.5mm or 5.0mm.

Figure 3. CBR Experimental Setup

The load-Penetration curve is plotted and then the corrected loads, after zero correction, corresponding to penetration of 2.5mm and 5.0mm are determined. The loads required for the penetration of 2.5mm and 5.0mm are determined. The penetration load is expressed as a percentage of the standard loads at the respective penetration level of 2.5mm or 5.0mm. The CBR value is determined corresponding to penetration of 2.5mm and 5.0mm.

Geogrid widths are increased with b/D= 1, 2, 3 and placed at u/D= 0.1 i.e. 5 mm depth from top and CBR tests are conducted. The values of Penetration and Load are tabulated from each test by maintaining dry density 1.51 g/cc and water content 21%. The various tests conducted are shown in Table 2 and schematic of the tests performed is shown in Figure 4.

Table 2. Tests Conducted with variation of b/D's

Tests Performed	Constant Parameters
Unreinforced	1.51 g/cc, water content 21%.
u/D= 0.1, b/D =1	1.51 g/cc, water content 21%.
u/D= 0.1, b/D =2	1.51 g/cc, water content 21%.
u/D= 0.1, b/D =3	1.51 g/cc, water content 21%.

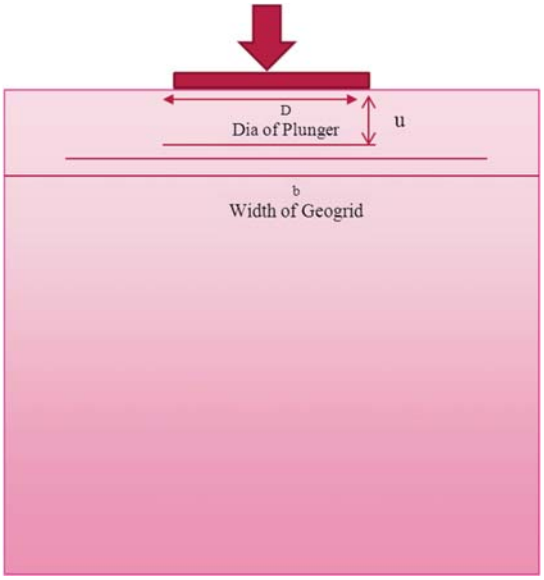

Figure 4. Testing Schematic

The next series of testing is done by varying the placement depths of geogrid at u/D= 0.1, 0.2, 0.3, 0.4 i.e. 5, 10, 15 and 20 mm depth from top and CBR tests are conducted. The tests conducted are shown in Table 3.

Table 3. Tests Conducted with variation of u/D's

Tests Performed	Constant Parameters
Unreinforced	1.51 g/cc, water content 21%.
b/D =3, u/D= 0.1	1.51 g/cc, water content 21%.
b/D =3, u/D= 0.2	1.51 g/cc, water content 21%.
b/D =3, u/D= 0.3	1.51 g/cc, water content 21%.
b/D =3, u/D= 0.4	1.51 g/cc, water content 21%.

IV. RESULTS AND DISCUSSIONS

The California bearing ratio tests are conducted for evaluating the suitability of the sub grade and the materials used in the sub base and base of a flexible pavements. The variation of the penetration and load resistance is obtained for varied widths of the geogrids and shown in figure 5. The results have shown that the maximum value is obtained at u/D = 0.1 and b/D = 3 as the amount of reinforcement is higher it resulted in higher perfomance.

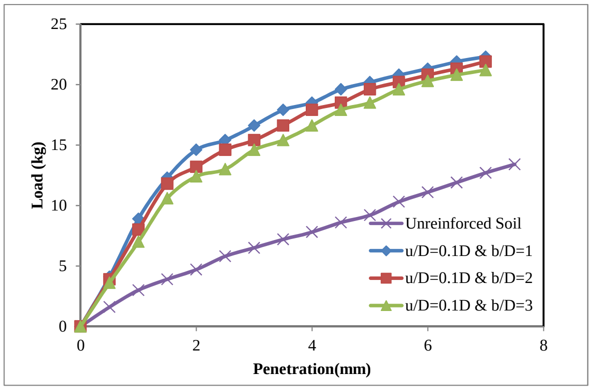

Figure 5. Variation of Penetration with load for varying widths of geogrid

The results obtained for varying widths of geogrids are shown below in Table 4.

The variation of the penetration and load resistance is obtained for varied widths of the geogrids and shown in figure 6.

Table 4. Results with variation of b/D's

Tests Performed	CBR Value
Unreinforced	2.90
b/D =3,u/D = 0.1	5.96
u/D = 0.2	5.62
u/D = 0.3	5.37
u/D = 0.4	5.15

The results have shown that the maximum value is obtained at b/D = 3 and u/D = 1 and this also agrees with the studies done earlier with reinforement placed at u/D = 0.1 as the reinforcement at that depth is showing higher performance compared to the other reinforcements placed below it. The results obtained for varying placement depths of geogrids are shown below in Table 5.

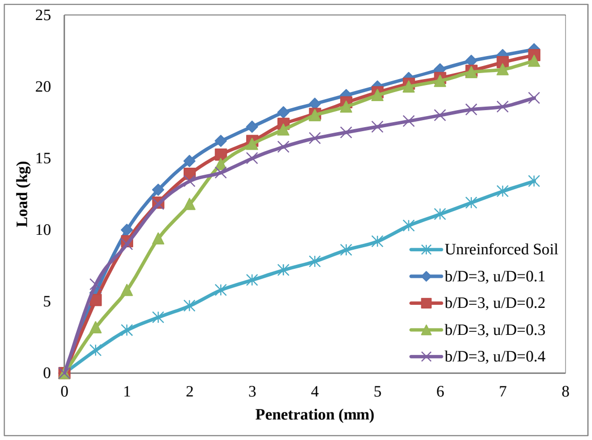

Figure 6. Variation of Penetration with load for varying widths of geogrid

The results obtained for varying widths of geogrids are shown below in Table 5.

Table 5. Results with variation of b/D's

Tests Performed	CBR Value
Unreinforced	2.90
u/D= 0.1, b/D =1	4.78
u/D= 0.1, b/D =2	5.37
u/D= 0.1, b/D =3	5.96

V. CONCLUSIONS

From the series testings performed, it can be concluded that

- Geogrid can be used to improve the strength of the subgrade.
- From the analysis of results when geogrid is placed with different placement heights, the maximum strength is achieved for b/D=3 and u/D= 0.1.
- The optimum placement of the geogrid in subgrade is given as u/D= 0.1.
- The geogrid reinforcement improved the CBR of the subgrades compared to unreinforced.
- The maximum CBR obtained for optimum placement and amount of reinforcement is 5.96%.
- The strength of soil increased and the CBR values of the reinforced increased by 2.4 times when compared to unreinforced and reinforced.
- The local soil reinforced with geogrid is suitable for laying embankments.

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