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An Experimental Study on Red Laterite Soil by using Composite Geotextilen

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Abstract

This research focuses on the placing of special type of soil reinforcing material called as Composite Geotextile (CGT) in the red laterite soil for the improvement of the strength properties like California bearing ratio. In this study this CGT was placed at different depths from the top of the surface and the CBR values are studied in the soaked and unsoaked conditions. At the depth ratios of 0.25 D, 0.5 D and 0.75 D these CGTs are placed in a CBR mould and Load tests are conducted. The results show that the CGT layer has a significant effect on the behaviour of laterite soil, such as load carrying capacity and the efficiency of the reinforcements. Reinforcing with CGT resulted in a substantial increase in strength of the soaked and unsoaked samples due to confinement of stone dust layer between geotextiles, it act as a strong reinforcing material. In this article, the load-penetration characteristics and CBR values of unreinforced and reinforced lateritic soil during the loading process are examined.

Keywords: Composite geotextile • Soil reinforcing • California bearing ratio • Red laterite soil

Introduction

A lot of the pavement construction fails well before their design life due to the low quality of construction supplies, insufficient compaction, inadequate laying of the subgrade etc. There are two options are available to improve the durability of the pavement. The first alternative is by increasing the thickness of different pavement layers and the other alternative is by escalating the firmness of the layers within the structure so as to diminish the stresses transmitted to the lower layers. Of these two methods it has been extensively observed that increasing the durability and firmness of the pavement layers is a more efficient method to lower the stresses on the pavement layers thereby increasing the life of the pavement. The cost and period of construction are dependent on the availability of aggregate resources for construction. Hence, it is necessary to look at alternatives to accomplish the superior quality of pavements using new materials and reduced usage of natural materials. Adding the materials like baggase ash to stabilize the lateritic soil much not influence on the strength improvement. In the current years, gigantic amount of laboratory and *in-situ* studies have been carried out to comprehend the efficiency of geosynthetics when used in combination with soil or aggregate layers particularly for the applications in paved and unpaved roads. Utilization of geosynthetic materials in road construction has increased significantly in the current years. High tensile strength, filtering and drainage characteristics of geosynthetics have increased its potential in pavement applications. Therefore inclusion of geosynthetics has been proved to be very effective in providing additional support and good ride ability in roads. Since then several laboratory element tests, model tests and field tests has been carried out by several researchers to understand the various parameters that influence the performance of geosynthetic reinforced unpaved roads [1].

The California Bearing Ratio (CBR) test is commonly used to determine the suitability of a soil as a subgrade or subbase for highway and runway design and construction. The CBR test can also be used to get the curve of the load-settlement of the soil in the field which is more or less similar to the plate load test objective. The enhancement in CBR value of soil by using geosynthetics has recommended a laboratory technique for the design of geotextile reinforced unpaved roads by performing modified CBR tests in which lower portion of the CBR mould is filled with soil and the top portion is filled with crushed stone. Modified California bearing ratio tests were also carried out in the laboratory on soil-aggregate systems to understand the effect of size of the mould on the bearing resistance when using geotextile, biaxial geogrid and geonet. From the literature it was evident that the application of geotextile reinforcement in pavement application has not been extensively studied. This present research presents the experimental results from the laboratory model tests and the CBR values are studied in the soaked and unsoaked conditions by placing Composite Geo Textile (CGT) at different depths from the top of the surface [2].

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Materials and Methods

A mixture of materials used in carrying out the model studies are laterite soil, quarry dust (stone dust) and geotextiles.

Laterite soil

In this study the soil was collected from the Gannavaram in Andhra Pradesh, India. The properties of this soil were determined. From the particle size distribution of the soil, it has been shown that it is mainly consists of 64% sand and 36% fines content. As per unified soil classification system it has been seen that the soil is classified as clayey sand and it is chosen (Table 1) [3].

Table 1. Properties of laterite soil.

Property	Value
Specific gravity	2.65
Liquid limit	0.37
Plastic limit	0.0422
Plasticity index	0.3278
Sand	0.64
Silt	0.28
Clay	0.08
Unified soil classification	SC
Optimum moisture content	0.1267
Maximum dry density	1.908 g/cc

Stone dust

Stone dust material is used in this study and it is collected from the nearby stone crusher in Vijayawada. The basic properties of the stone dust. Based on Cu and Cc values from the sieve analysis as per Unified soil classification system the stone dust is classified as poorly graded sand (Table 2) [4].

Table 2. Properties of stone dust.

Property	Value
Specific gravity	2.76
Coarse sand	0.12
Medium sand	0.575
Fine sand	0.302
Silt and clay	0.003
Unified soil classification	SP

Geotextile

Woven geotextile was used in this study as reinforcement. The geotextile used in the experiments is a polypropylene multifilament woven fabric. The properties of these geotextiles, as provided by the manufacturers (Table 3) [5].

Table 3. Properties of woven geotextile.

Properties	Values
Mass per unit area (g/cm^2)	1.65
Aperture opening size (mm)	0.75
Tensile strength (wrap/weft kN/m)	35/30
Elongation at specified strength (wrap/weft %)	25/25
Puncture strength (N)	450

Experimental program

A test setup consisting of a CBR mould, a loading apparatus and measurement devices as per IS code 2720 was used in this study. A special type of reinforcement is provided with a two geotextile layers in between stone dust with a thickness of 1.5 cm. Geotextile is to prevent the mixing of stone dust layer with that of soil so a layer of geotextile was placed at the top and bottom. Normally the geotextile having more flexibility so when heavy loading applied it gets ruptured. This CGT layer act as a rigid member because the confinement of stone dust between the two geotextiles (Figure 1) [6].

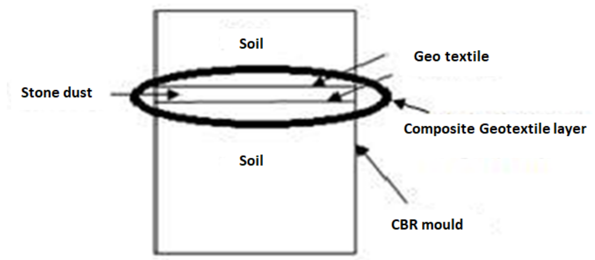

Figure 1. Placing of CGT at depth in CBR mould.

Results and Discussion

Soaked CBR tests

The CBR is lower for unreinforced soil in soaked condition. The CBR value is increased for the reinforced soil at a depth of 0.75D from the 2.20% to 4.37%. Similarly in decreasing the depth of the CGT layer from top, the CBR value is in increasing order. The CBR is for the reinforced soil at a depth of 0.25 D is 11.63% and it is greater than 9.43% when compared to unreinforced soil (Figures 2-4 and Table 4) [7].

Figure 2. Making of CGT layer in CBR mould by placing geotextile.

Figure 3. Making of CGT layer in CBR mould by laying of stone dust layer.

Figure 4. Making of CGT layer in CBR mould by placing geotextile over stone dust.

Table 4. Soaked CBR values for unreinforced and reinforced soil.

Soil condition	Penetration	Load (kg)	CBR (%)
Unreinforced soil	2.5 mm	30.187	2.2
	5.0 mm	42.824	2.08
Reinforcement at 0.25D	2.5 mm	159.36	11.63
	5.0 mm	233.78	11.37
Reinforcement at 0.50D	2.5 mm	97.65	7.12
	5.0 mm	147.56	7.18
Reinforcement at 0.75D	2.5 mm	54.76	3.99
	5.0 mm	89.86	4.37

The Load vs penetration values for the soaked tests on specimens. The Peak load values are observed for the reinforcement provided at a depth 0.25D. These reinforced soils for all different depths have shown a peak curves compared to unreinforced soils (Figure 5) [8].

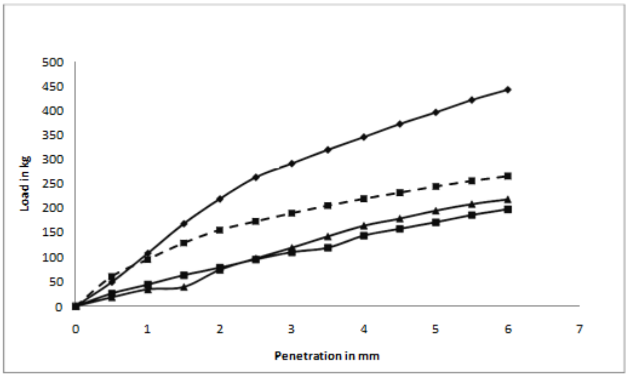

Figure 5. Load vs penetration graph for unsoaked CBR tests. Note: Reinforcement 0.25D Unreinforced Reinforcement Reinforcement 0.5D. 0.75D

The variation in CBR values at different depths of CGT layer in soaked and unsoaked condition is presented. In this, it shown that the variation of results in both the conditions is linearly.

By using the equation provided in the figure it will be useful to estimate the CBR values for the remaining depths also (Figures 6 and 7) [9,10].

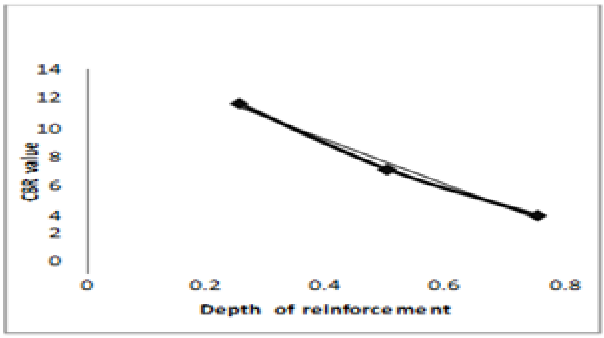

Figure 6. CBR values for the various depths of reinforcement CBR values at different depths (Soaked). Note: CBR at 2.5 mm penetration.

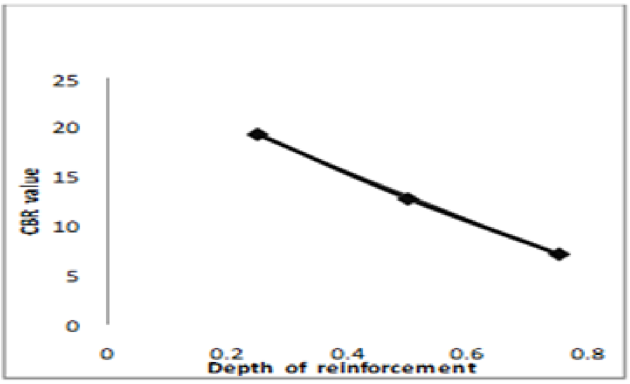

Figure 7. CBR values for the various depths of reinforcement CBR values at different depths (unsoaked). Note: CBR at 2.5 mm penetration.

Conclusion

A series of laboratory CBR tests were performed on composite geotextile reinforced laterite soil. In this study to explore the prospective benefits of using CGT as reinforcement in laterite soil were studied. The CBR test results showed

- The CGT reinforced Laterite soil has shown increased values of CBR in both soaked and unsoaked condition.
- In soaked condition the CBR value is increased for the reinforced soil at a depth of 0.75 D from the 2.20% to 4.37% and for the reinforced soil at a depth of 0.25 D is 11.63%. It is nearly equal to 5.3 times the unreinforced soil.
- In unsoaked condition CBR value is increased for the reinforced soil at a depth of 0.75 D from the 8.33% to 9.49% and for the reinforced soil at a depth of 0.25 D is 19.26%. It is nearly equal to 2.3 times the unreinforced soil.
- The influence of CGT is more in the CBR test in soaked condition compared to unsoaked condition. It will represent that the CGT works better also in worst condition.
- In decreasing the depth of CGT layer the CBR values increasing linearly so for the all depths we can estimate the CBR.

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