

Study on Effect of Reinforcement in Planar and Fiber forms on CBR values

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ABSTRACT : An experimental study was conducted on sand reinforced with polypropylene fiber and non woven geo-textile and laboratory CBR values were determined in both soaked and un soaked conditions. Further, these test results were compared with that of unreinforced soil. To address this need, investigations were carried out in this study to determine the CBR value of sand reinforced with a non woven geo-textile in planar form with u/d ratios of 0.6, 0.8 and 1.0 and the same soil reinforced with the fiber used in randomly distributed form with fiber contents of 0.5, 1.0, 1.5, 2.0, and 2.5% by weight of sand. Further, the effect of soaking on reinforcement function was also studied. The results indicated phenomenal improvement in CBR values when reinforcement was used.

Keywords – Black cotton soil, California Bearing Ratio (CBR), Nonwoven Geo-textile, Polypropylene Fiber, Sand

I. INTRODUCTION

The development of transportation infrastructure is the key to overall development of the country. For countries like India, where resources are limited, the importance of rural/unpaved roads is to be highly emphasized. The sub grade, which is the bottom most layer of the pavement, is made up of compacted soil and so also for the highway and railway embankments. The road alignment is decided based on many factors of which one is the availability of good soil strata along the proposed alignment. In early days, areas having weak soil deposits were avoided. These problematic soils have one or more of the short comings as., low shear strength, high compressibility, low hydraulic conductivity, swelling and shrinkage, susceptibility to frost action etc., and therefore are associated with problems such as low bearing capacity, high settlement, high seepage loss, liquefaction during earthquake and instability of foundation excavation. It is often impossible to build a stable base course over soft subgrade, without losing expensive base material which penetrates into the soft subgrade soil and hence a ground improvement method has to be resorted for improvement.

This is a project to investigate the form of reinforcement on improvement of California bearing ratio (CBR) values of reinforced soil. In the present investigation attempt has been made to stabilize black cotton soil. Black cotton soil was collected from Vidyagiri area of Bagalkot city; Karnataka state, which was stabilized with randomly distributed Polypropylene fibers and Nonwoven geo-textile with different u/d ratio and sand content of 5, 10 and 15 percent by weight. The CBR tests were carried out in the laboratory for different mix proportions of fiber and geo-

textile with sand. Considerable improvement has been found in the CBR value of black cotton soil.

In recent years the uses of fibers in various fields have gained much importance. Several researches on soil reinforced fibers have been reported. Fiber-reinforced soils demonstrated that this material might be a practical and cost effective technique for reinforcement of subgrade soils in flexible pavements. In comparison with systematically reinforced soils, randomly distributed fiber reinforced soils exhibit some advantages. Randomly distributed fibers offer strength isotropy and limited potential plane of weakness that can develop parallel to oriented reinforcement. The technique of reinforcing the soil increases the stiffness and load carrying capacity of the soil through frictional interaction between the soil and the reinforcement. Fibers are used to evaluate a methodology for preventing crack developments in soil due to desiccation by the use of short polymeric fibers. The inclusion of randomly distributed, discrete tensile reinforcement elements in soil offers a potential solution to the problem of sloughing instability of levees. Such elements are available as polypropylene fibers.

II. EXPERIMENTAL STUDY

In order to study the effectiveness of reinforcement for improving the CBR value, CBR tests were conducted on samples reinforced with polypropylene fiber and nonwoven geo-textile. The properties of the materials used for the experimental investigation are discussed below.

1. Black Cotton Soil

The different properties of the soil used are summarized in Table 1.

Sl No	Parameters	Value
1	Specific gravity	2.76
2	Atterberg limits	
	Liquid limit (%)	61
	Plastic limit (%)	37.68
	Plasticity index (%)	23.32
3	Free Swelling Index	High
4	I.S classification	CH
5	Compaction characteristics	
	Maximum dry density (gm/cm ³)	1.45
6	Grain size distribution	
	Gravel (%)	1.42
	Sand (%)	20.4
7	Silt and Clay (%)	78.18
	Unconfined compressive strength (Kg/cm ²)	0.9

2. Sand

The sand used in the present study is collected from River Krishna in Bagalkot, Karnataka state. The properties of the sand are determined and summarized in Table II.

Sl No	Parameters	Value
1	Specific gravity (G)	2.65
2	I.S classification	SP

3	Grain size distribution	0.38
	D ₁₀ (mm)	0.54
	D ₃₀ (mm)	0.80
	D ₆₀ (mm)	2.10
	Uniformity coefficient (C _u)	1.00
	Coefficient of curvature (C _c)	

3. Polypropylene Fiber

The properties of these fiber provided by the supplier are given in Table III and the photograph of the polypropylene fiber is shown in Fig.

Properties	Values
Color	White
Length (mm)	12
Diameter (microns)	18
Density(gm/cm ³)	0.91
Tensile strength (Mpa)	300-400



Fig. Photographic view of Polypropylene Fiber

4. Nonwoven Geo-textile

Nonwoven geo-textiles are manufactured from high quality polypropylene staple fibers. Nonwoven geo-textile conforms to the following property values. The properties of Geo-textile provided by the supplier MAHARSHEE GEOSYNTHETICS, Vadodara, (IND) PVT.LTD are given in Table IV.

Properties	MG 200
Mass / Unit Area(gms/ sq.mt)	200
Thickness (mm)	1.6
Tensile Strength (kN/m)	6.5
Elongation (%)	55
Opening Size (microns)	150
Permittivity (Sec)	1.8
UV Stability @500hrs (%)	70



Fig. Photographic view of the Nonwoven Geo-textile

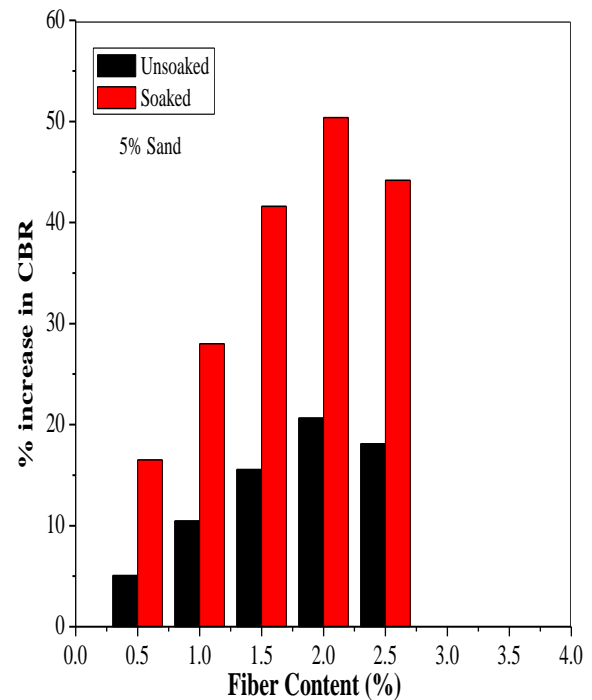
III. RESULTS AND DISCUSSION

A. Percentage increase in CBR Values For Black Cotton Soil with 5%, 10% and 15% Sand and variation of Polypropylene Fiber percentage in both Unsoaked and Soaked condition

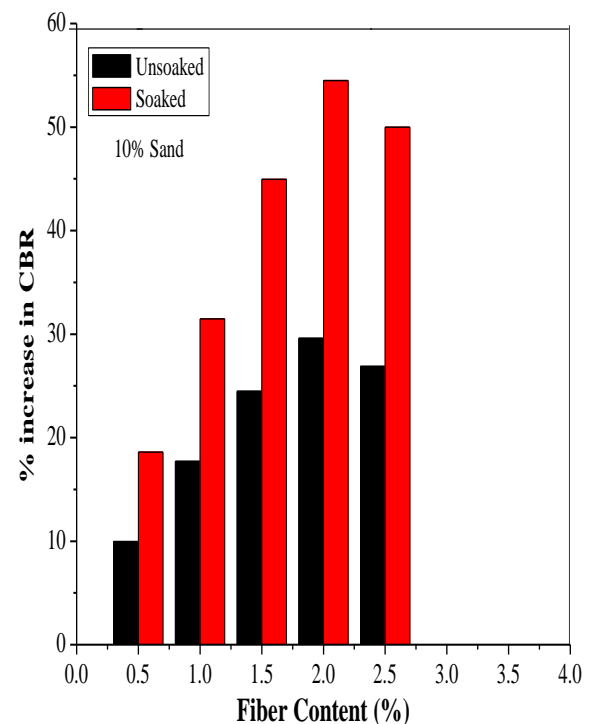
The percentage increase in *CBR* results of 5, 10 and 15% sand with different content of polypropylene fiber is presented in this article.

The percentage increase in *CBR* with sand content and percentage of fiber is shown in Fig 3.10-3.12 respectively,

- For 5% sand and fiber content of 0.5, 1.0, 1.5, 2.0 and 2.5 percent with black cotton soil the observed percentage increase are 5.07%, 10.47%, 15.55%, 20.63% and 18.09% for unsoaked and 16.51%, 28.00%, 41.60%, 50.38% and 44.18% respectively whereas for 10 and 15 percent sand the observed values are (i) 9.96%, 17.22%, 24.47%, 29.60% and 26.88% for unsoaked and 18.60%, 31.46%, 44.94%, 54.49% and 50.00% for soaked (ii) for unsoaked 6.45%, 15.32%, 21.77%, 28.22% and 26.07% and soaked condition 17.87%, 31.00%, 44.18%, 53.28% and 47.44% respectively.



ig. 3.10 Percentage increase in CBR values with 5% sand and fiber content on black cotton soil.



ig. 3.11 Percentage increase in CBR values with 10% sand and fiber content on black cotton soil.

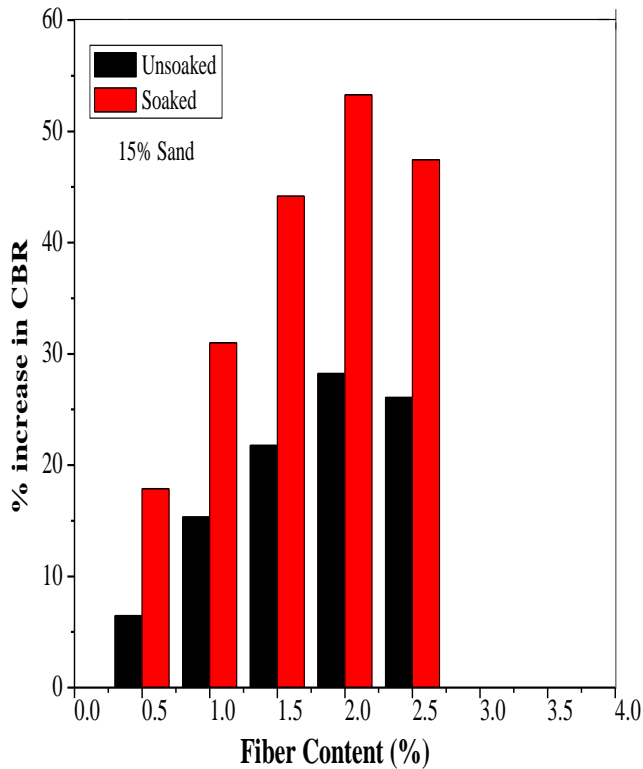


Fig. 3.12 Percentage increase in CBR values with 15% sand and fiber content on black cotton soil.

B. Percentage increase in CBR values for Nonwoven Geo-Textile with 5%, 10% And 15% Sand and U/D Ratio in both Unsoaked and Soaked condition

The percentage increase in CBR results of 5, 10 and 15% sand and u/d ratio of nonwoven geo-textile is presented in this article.

The percentage increase in CBR with sand content and u/d ratio is shown in Fig 3.13-3.15 respectively,

- The observed percentage increase for 5% sand content and u/d ratio of 0.6, 0.8 and 1.0 with black cotton soil are 7.61%, 13.01% and 2.53% for unsoaked and 24.80%, 44.00% and 12.40% for soaked condition respectively whereas for 10 and 15 percent sand the observed values are (i) 12.38%, 22.05% and 7.55% for unsoaked and 29.92%, 50.00% and 23.35% for soaked condition (ii) 8.60%, 17.47%, and 4.30 % for unsoaked and 26.96%, 47.00%, and 13.48 % for soaked condition respectively.

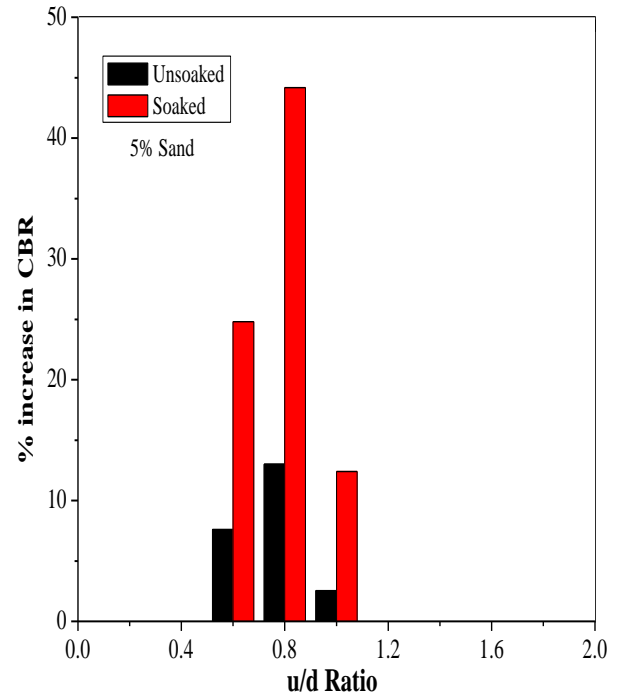


Fig. 3.13 Percentage increase in CBR values with 5% sand and u/d ratio on black cotton soil.

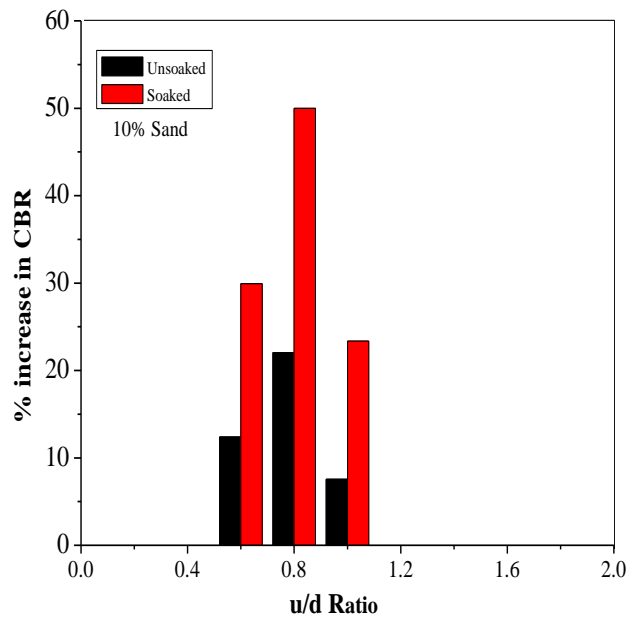


Fig 3.14 Percentage increase in CBR values with 10% sand and u/d ratio on black cotton soil.

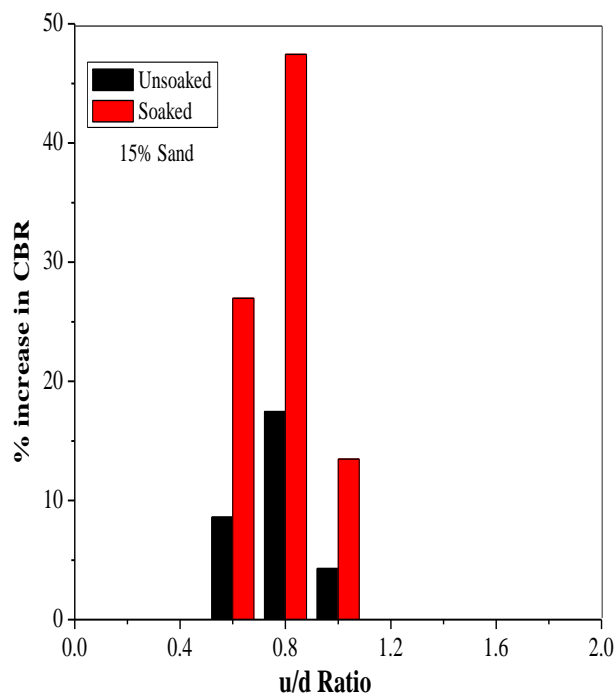


Fig 3.15 Percentage increase in CBR values with 15% sand and u/d ratio on black cotton soil.

IV. CONCLUSION

Laboratory results for polypropylene fiber and nonwoven geo-textile with different sand contents of 5% , 10% and 15% have been presented. Based on the investigations the following conclusions were made;

- The California bearing ratio value can be improved phenomenally by reinforcing the material in both planar and fiber forms.
- The CBR increases with the increase in sand content at an optimum polypropylene fiber content of 2.0% and geo-textile at u/d =0.8.
- The improvement in CBR values of fiber form has increased from 1.05% to 2.75% with a percentage increase of 55% in soaked condition and 3% to 4.77% with a percentage increase of 30% in unsoaked condition is achieved when 2.0% polypropylene fiber content is used.
- The maximum improvement in CBR value of geo-textile has increased from 1.05% to 2.67% with a percentage increase of 50% in soaked condition and 2.99% to 4.37% with a percentage increase of 20% in unsoaked condition is achieved when the layer of geo-textile is placed at u/d=0.8.

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