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EXPERIMENTAL INVESTIGATION TO IMPROVE THE STRENGTH CHARACTERISTICS OF BLACK COTTON SOIL WITH CORCHORUS CAPSULARIS FIBERS & AGAVE SISALANA FIBERS

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***ABSTRACT*---** **Comparative study on strength characteristics of cohesive soil in different percentage of randomly used of natural fibers. Investigation of the strength characteristics of black cotton soil with natural fibers (Corchorus capsularis fibers & Agave sisalana fibers) mixed with the soil at three different ratio of 1% fiber, 2% fiber, 3% fiber. Soil is compacted with standard proctors maximum density with low percentage of reinforcement, Atterberg's limit, CBR test were conducted on reinforced soil to investigate the strength Characteristics of soil. Black cotton soil causing number of damages to the structures particularly light buildings and pavements compare to other natural hazards like earthquake, floods, etc. thus, worldwide these soil is considered to be problematic soil and pose several challenges for engineers Black cotton soil reinforced natural fiber in civil engineering for improving soil properties is advantageous because they are cheap, locally available, bio degradable and eco friendly material.**

Keywords—**, Atterberg's limit, Corchorus capsularis fibers, Agave sisalana fibers**

I. INTRODUCTION

A large part of central India and apportion of south India are covered with black cotton soils. These soils are residual deposits formed from basalt or trap rocks. The black cotton soil is a type of expansive soil with high plasticity and can retain moisture throughout the dry season which is they are valuable for growing crops. They contain essentially the clay mineral montmorillonite which is the most unstable clay minerals, thus the soils have high shrinkage and swelling characteristics. The shearing strength of the soil is extremely low, it highly compressible and has very low bearing capacity. It is very difficult to work with this soil, as do not posses sufficient strength to support the loads imposed upon them either during construction or during the service life of the structure. For better performance of structures build on such soils, the performance characteristics of such soils need to improve. Natural fibers used in the soil because to improve the stability of the soil. These fibers are convenient to use, safe, effective and dramatically improve the black cotton soil

Over the past few decades several factors have led to an increase in the number of people migrating to large cities. Consequently these large cities are getting over populated and quite expectedly necessity of business, residential construction has increased the civil engineering projects located in areas with unsuitable soil is one of the most common problems in many parts of the world.

1.1. CHARACTERISTICS OF BLACK COTTON SOIL UNDER VARIOUS CIRCUMSTANCES

Based on the present investigation it is concluded that CBR value of soil increases with the inclusion of jute fiber. When the jute fiber content is increases, the CBR value of soil is further increases and this increase is substantial at fiber content of 1 %. It was also found that preparation of identical soil samples for CBR test beyond 1 % of fiber content is not possible and optimum fiber content was found to be 1 % by dry weight of soil. It is also concluded that there is significant effects of length and diameter of fiber on the CBR value of soil. The CBR value of the sub grade soil increases up to 250% with the inclusion of bitumen coated jute fiber [1]. The strength behavior of the soil reinforced with randomly included sisal fiber, the reinforced soil samples were subjected to compaction and triaxial compression tests. The results of these tests have clearly shown a significant improvement in the failure deviator stress, Shear strength parameters (C and φ) of the studied soil. It can be concluded that sisal fiber can be considered as a good earth reinforcement material [2]. Investigation of the shear strength of sand reinforced with randomly distributed discrete fibers by carrying out direct shear tests. The effect of the fiber reinforcement content on the shear strength was investigated. The results of the tests

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indicated that peak shear strength and initial stiffness of the sand were not affected significantly by the fiber reinforcement. The horizontal displacements at failure were also found comparable for reinforced and unreinforced sands under the same vertical normal stress. Fiber reinforcements, however, could reduce soil brittleness providing smaller loss of post-peak strength. Thus, there appeared to be an increase in residual shear strength angle of the sand by adding fiber reinforcements [3]. Use of natural fiber in civil engineering for improving soil properties is advantageous because they are cheap, locally available, biodegradable and eco-friendly. The natural fiber reinforcement causes significant improvement in tensile strength, shear strength, and other engineering properties of the soil.

1.2 OBJECTIVES

In the present study, an attempt is made to study how natural fibers may be effectively utilized in black cotton soils to get an improved quality of this material which may be used in various soil structures.

The objective is to determine the comparison of strength characteristics of cohesive soil using with natural fibers in various proportions.

- To study the physical properties of soil and identify the soil characteristics
- To reduce the construction cost by making best use of locally available material
- To increase the stability and strength of the black cotton soil.
- To improve the environmental problem and health hazards

II. METHODOLOGY

The initial stage of the research is to review and understand the subject of the research which is the sustainable barrier free design facilities. Then it is followed by formulation of the study aim and objectives .Then the next stage of study focused on the literature review. This stage also includes the legislation and challenges in providing facilities for eco-friendly stabilization .The following tests are being carried out well before the reinforcement is added to properly determine the properties of soil. These tests are used to find out the various characteristics of the soil. The next stage is Collection of materials for Preliminary test has to be conducted and Major test for soil, Strength test with reinforcement .The next step is Test result and discussion

These tests help in determining properties such as size of soil, specific gravity, cohesiveness, Atterberg's limit etc.

2.1 REINFORCEMENT MATERIALS

The Corchorus capsularis fiber used in this study is Natural jute fiber of diameters 1 mm and 2mm. The length of fiber corresponding to each diameter of fiber was taken as 30 mm, 60 mm and 90 mm. Mainly Corchorus capsularis fibers are composed of cellulose, hemi-cellulose and lignin. It is harder than cotton or other fibers. It is for the presence of lignin in its structure. Emulsion is used to make it soft for spinning. It is weaker than other fibers.

Figure 2.1 Corchorus capsularis Fiber

Sisal fiber is one of the most widely used natural fibers and very easily cultivated it is obtained from the sisal plant. The color of the fiber is yellowish. It is decomposes in the salt water.

Figure 2.2 Agave sisalana fiber

2.2 PREPARATION OF SAMPLES

Following steps are carried out while mixing the fiber to the soil,

1. All the soil samples are compacted at their respective maximum dry density
(MDD) and optimum moisture content (OMC), corresponding to the standard Proctor compaction test.
2. The different values adopted in the present study for the percentage of fiber Reinforcement is 0, 1, 2, and 3.
3. If fiber reinforcement was used, the adopted content of fibers was first mixed into the soil in small increment by hand, making sure that all the fibers were mixed thoroughly, so that a fairly homogenous mixture is OBTAINED, AND THEN THE REQUIRED WATER WAS ADDED.

III. EXPERIMENTAL ANALYSIS

The black cotton soil sample which is collected from kovilpatti is experimentally examined for the index properties and engineering properties of the black cotton soil and the results are tabled below. and also the california bearing ratio test is conducted over black cotton soil reinforced with corchorus capsularis fiber and agave sisalana fiber in 1%, 2%, 3% each and tabulated below.

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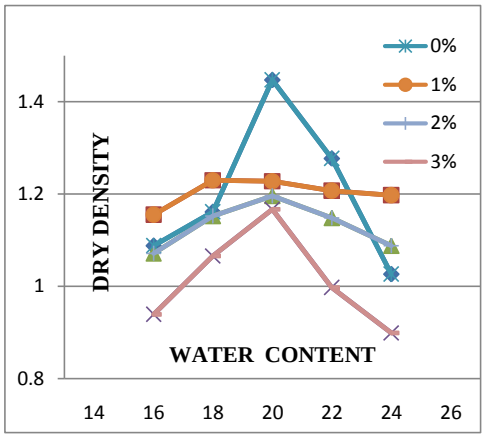
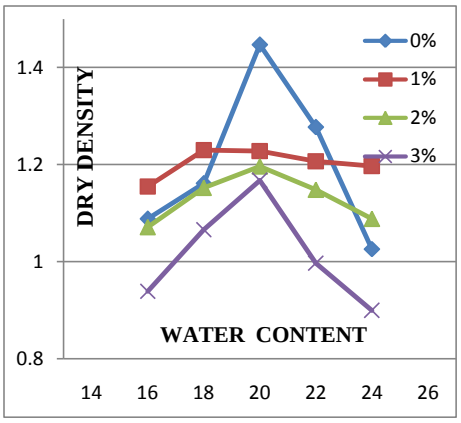
S.No.	Property	Value
1	**Specific gravity**	2.77
2	**Grain size distribution**	
	Clay (%) &silt (%)	24.8
	Gravel (%)	11
	Sand (%)	64.2
3	**Free swell index**	52.6
4	**Atterberg's limits**	
	Plastic limit (%)	19
	Liquid limit (%)	44
	Plasticity index (%)	25
5	Optimum moisture content (%)	14.12

TABLE 3.1 INDEX PROPERTIES OF BLACK COTTON SOIL WITHOUT ANY REINFORCEMENT

3.1 COMPACTION TEST ON REINFORCED BLACK SOIL



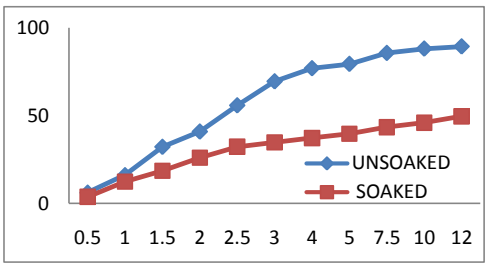
Graph 3.1 Compaction Test Result for Black Cotton Soil with Corchorus capsularis Fiber



Graph 3.2 Compaction Test Result For Black Cotton Soil With Agave Sisalana Fiber

From the graphs we can find that the optimum moisture content and the maximum dry density of the soil samples vary for different values of fibers in percentage .The maximum dry density of soil alone is 1.47 g/cc and optimum moisture content of black cotton soil is 14.12% and in an inclusion of Corchorus capsularis fiber give the maximum dry density and optimum moisture content are variable and gives increasing moisture content at decresing dry density at the same time when Agave sisalana Fiber is added to the black cotton soil in different percentages it give the same values as like the Corchorus capsularis fiber but gives standard values for only 2% of fiber inclusion.

Hence we can add natural fibers as musch as possible to find the effective strength of the soil (black cotton soil) .we can use either Agave sisalena fiber or Corchorus capsularis fiber for our analysis.



GRAPH. 3.3 CBR TEST FOR 0% OF FIBER

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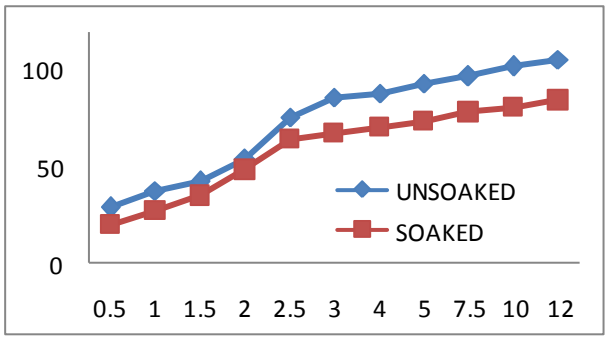
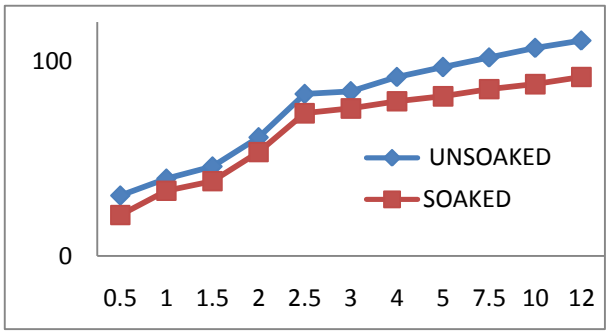
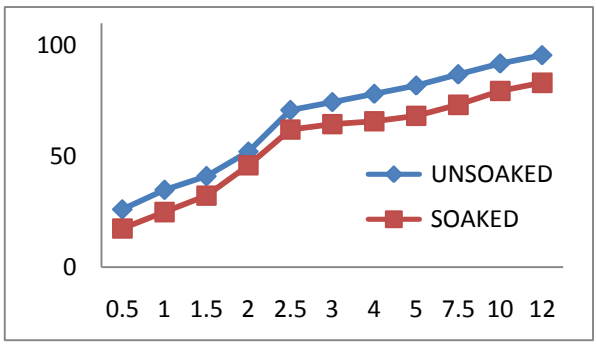


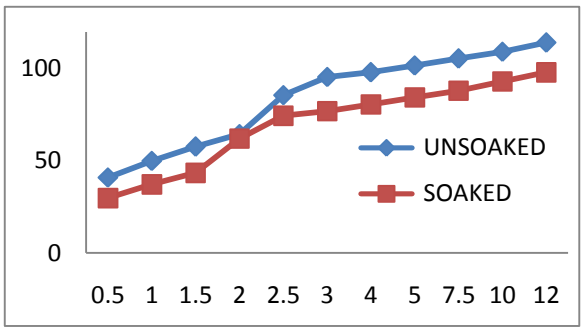
GRAPH 3.4 CBR TEST FOR 1% OF CORCHORUS CAPSULARIS FIBER



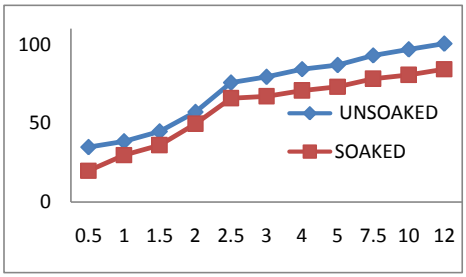
GRAPH 3.5 CBR TEST FOR 2% OF CORCHORUS CAPSULARIS FIBER



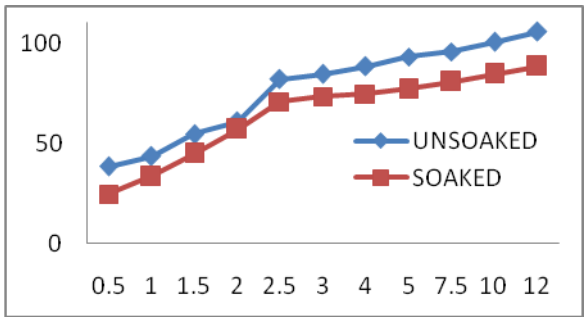
GRAPH. 3.7 CBR TEST FOR 1% OF AGAVE SISALANA FIBER



GRAPH 3.6 CBR TEST FOR 3% OF CORCHORUS CAPSULARIS FIBER



GRAPH.3.8 CBR TEST FOR 2% OF AGAVE SISALANA FIBER



GRAPH. 3.9 CBR TEST FOR 3% OF AGAVE SISALANA FIBER

From the above graphs we can find the values of California bearing capacity test results for the Corchorus capsularis fiber and Agave sisalana Fiber gives higher bearing capacity for 2% of fiber inclusion and it starts reduces if more fiber added to it in soaked condition.

FIBER LENGTH	**% OF FIBER**	**TEST RESULT FOR REINFORCED BLACK COTTON SOIL**	
		MDD in gms/cc	**OMC in %**
Black cotton soil with no fiber	0%	1.47	14.12
Corchorus capsularis fiber 5mm	1%	1.37	14.10
	2%	1.32	14.21
	3%	1.31	14.23

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Agave sisalana fiber 5mm	1%	1.31	13.98
	2%	1.19	14.12
	3%	1.16	14.40

Table 3.1 Tabulation For moisture content Fiber Reinforced Black Cotton Soil

FIBER LENGTH	**% OF FIBER**	**TEST RESULT FOR REINFORCED BLACK COTTON SOIL**	
		CBR UNSOAKED	**SOAKED**
Black cotton soil with no fiber	0%	4.07	2.35
Corchorus capsularis fiber 5mm	1%	5.16	4.22
	2%	5.52	5.16
	3%	5.97	3.98
Agave sisalana fiber 5mm	1%	5.52	5.52
	2%	6.07	5.61
	3%	6.25	4.71

Table 3.2 Tabulation For CBR value of Fiber Reinforced Black Cotton Soil

IV. CONCLUSION

With the increase of the percentage of all types of fibers with the used soil within the range tested in this investigation, MDD decreases and OMC increases. There is a considerable increase in unsoaked and decrease in soaked CBR value for black cotton soil when mixing with the increasing of percentage of randomly distributed 5mm length of natural fibers up to 2% of the dry weight of soil, where after the value decreases. There is improvement in CBR value when natural fibers mixed with the soil sample. The increasing fiber content was to increase the CBR value of the soil. The maximum CBR value is 5.61% which is achieved by Agave Sisalana fibers with in 2%.The increase in CBR value with addition of fibers would mean that the thickness of the sub grade flexible pavement road would also be reduced. From our project the sisal fiber will give the better engineering properties on the addition of admixture

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