

Strengthening of soil by using sugarcane fibers with lime

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Abstract : Soil is very important in civil engineering construction. The poor engineering property of local soil provides difficulties for construction and therefore its need to improve their engineering properties. These include soil replacement, preloading, and chemical stabilization. Soils are may classify different types (sandy, silty, loamy, and peaty, clay, chalky) in this present study, we considered sandy red soil; and by using sugarcane fibers, lime admixture to improve the strength of soil. This study was oriented towards improving the strength of soil by using locally available agricultural fibers to reduce the construction cost. The strengthening agent like Sugarcane fibers (SCF) is added in the soil. The addition of sugarcane fibers with lime, increases specific gravity consistently from 2.34 to 2.42, liquid limit consistently from 28.80 to 29.02, plastic limit value has increased from 22.5 to 28.83, the CBR test consistently from 3.34 % to 5.68%. Further research could be carried out on the investigation on the Strength of the Soil under different admixtures such as we can even strengthen the soil by adding different admixtures like fly ash, marble dust, egg shell, quarry dust.

Keywords -agricultural fibers, Sugarcane fibers, specific gravity, plastic limit, liquid limit.

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I. INTRODUCTION

Soil is vital part of nature it provides habitat for a wide range of organisms and distribution for plant species. It is mean of water storage supply and purification Soil provides ecosystem services critical for life: soil acts as a water filter and a growing medium; provides habitat for billions of organisms, contributing to biodiversity; and supplies most of the antibiotics used to fight diseases. Humans use soil as a holding facility for solid waste, filter for wastewater, and foundation for our cities and towns. Finally, soil is the basis of our nation's agro ecosystems which provide us with feed, fiber, food and fuel. Soil may important in the construction of various civil engineering works, some of the important applications are Foundation, Retaining Structures, Stability of Slopes, Underground Structures, Pavement Design, Earth Dam etc., In this test we can use many admixtures to stabilize the soil. There are many type of admixtures some are such as Lime, stone ash, coconut fibers, rice husk ash, sugar cane fibers and Egg shell etc. In all those admixtures we are taking sugarcane fibers as admixture. Sugar cane Fiber is a natural fibre obtained from the fibre-rich parts of the plant. The vegetable parts are physically cleaned, purified. It is generally obtained in market by cheap cost Dietary fiber content of about 99%. It has a good bonding capacity.

California Bearing Ratio Test Machine (CBR) The California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of natural ground, subgrades and base courses beneath new carriageway construction. The CBR was developed for measuring the load-bearing capacity of soils in subgrade in the construction of buildings and roads. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or for soils under paved airstrips. 1.6 Conclusion Soil is a significant part of the construction process. If performed improperly, the settlement of the soil could occur and results in unnecessary maintenance costs or structure failure. For the current project we are carrying the several experiments such as CBR, atterberg's limits, and specific gravity of soil by pycnometer, optimum moisture content (OMC). An attempt has been made to improve the soil strength by using lime.

Scope of Present Investigation In this present investigation the project is done for the increasing of soil strength by adding admixtures to the soil. The various basic tests like plastic limit test, liquid limit test, specific gravity test, proctor test, CBR test were done to know the soil properties.

II. Brief Overview Of Literature

Joyanta Maity, PhD (May 2017) He studied that in many situations, the engineers in road construction face the problem of subgrade soil of loose and soft soil with poor drainage conditions resulting low CBR value when placed at OMC in compacted condition. Huge amount of sub-grade soil is being required for constructing of large amount of road construction. But available strength of soils near road construction sites is not suitable. Such soils need addition of some strengthening elements. Natural fibers from sugarcane are biodegradable, eco-friendly and are available in high amount in many countries at very low cost. The mixing of fibre in soil results

increase in strength and decrease of deformability. In this investigation, Sugarcane fibre was randomly mixed at varying length and percentage with weak clayey soil to improve the compactness and strength of soil. A series of standard Proctor test and un soaked California Bearing Ratio (C.B.R) tests were conducted for each combination of soil fiber mix to study the compaction behavior and changing C.B.R value of the soil- fiber mix combination. From the test results, it was observed that with the increase in percentage of fiber in soils, M.D.D decreases due to its light mass density of fibre, where as O.M.C increases due to its high water absorption capacity. However maximum C.B.R value is achieved at mixing fibers of 2cm length at 1% mixing by weight.

T. Suresh Reddy, Dr. D S V Prasad (June 2017) They have done the experiment with sugarcane fibers and lime. It is used at varying percentages are blending to stabilize the soil. Various geotechnical laboratory tests like compaction, Unconfined Compression Test and California Bearing Test were carried by varying the percentage of sugarcane fibers (10%, 15%, 20% and 25%) and lime (10%) respectively. It is found that 20 % increase in the percentage of sugarcane fibers increases the UCS and CBR values.

R.Oviya, R Manikandan (2016) Described as these soils are found to be highly problematic in constructional activities. It causes severe damages to the structure because of its alternate swelling and shrinkage nature. This happens due to alternate drying and wetting of soil. To avoid these circumstances, soil must be stabilized and strength is to be increased. Soil can be modified or improved by many methods which include mechanical methods, he partially replaced SCF with soil at(0.5% to 1.5%) and addition lime of(10%).The specific gravity of the soil decreases with the addition of SCF to the soil. The liquid limit and plastic limit of the soil increases with the percentage increase of sugarcane fibers. It was also observed that the maximum dry density (MDD) of the soil decreases with the addition of SCF.

Ms.V.Janani (2015) Soil is the foundation material which supports loads from the overlying structure. Soil is the mostly used material in a highway and transportation system, either in its natural form or in a processed form. Also, all pavement structures eventually rest on soil foundation. In the present study the lateritic soil collected by using technique of disturbed sampling with the depth of 1 m. Colour of the soil is reddish brown. Soil will be stabilized by sugarcane fibers with different percentages which is ranging from 2%, 4%, 6% and 8% and as well as using optimum percentage of lime (4%) with variations of bagasse ash percentages like 2%, 4%, 6% and 8% by weight of the dry soil for (0,3,7,14,21) different curing periods. The effect of bagasse (sugarcane foil) ash on the soil will be investigated with respect to California bearing ratio (CBR) test. D. Brett Martinson (June 22nd - 24th 2015) They have performed the effects of sugarcane fibers on the strength properties of soil have been investigated. Laboratory experiments including density, water absorption, compressive strength tests were conducted on soil with 0.25-1% mass of fibers. It was determined that by utilization of an optimum (0.5%) of sugarcane fibers in the soil matrix improved the strength properties of the soil. Furthermore, the study shows that although the soil blocks were of lower density and higher water absorption, they had a better resistance against erosion. In addition, it was found that high clayey soil achieved better strength and durability properties. This research therefore recommends the use of 0.5% fibre content and high clayey soil for production soil with sugarcane fibers.

AshishChhachhia and AnupamMital (2015) They studied the review on improvement of clayey soil stabilized with bagasse ash which showed the effect of stabilized soil and change in its geotechnical properties. Standard Proctor Test and CBR for soil samples mixed with different proportion of sugarcane fibre through which OMC, MDD and CBR value was obtained and had been reviewed, which concludes that by adding the sugarcane fibre to the soil the strength parameters are improved. The chemical composition of sugar cane fibers shows that it has a high amount of silica and has a pozzolonic property which poses economic advantage and environmental enhancing potential. Hence Sugar cane fibers can be used in constructional work to improve the properties of soil. Due to the addition of sugar cane fiber it is observed that the strength parameters are increased upto a certain limit.

PrakashChavan and M.S.Nagakumar (2014) They have studied the effect on soil stabilization by using sugarcane fibers that showed that the soil sampling was done on Kavadamatti village Bagalkote district as per IRC recommendations. This soil was classified as CH as per Indian Standard Classification System (ISCS). Different dosages of blast furnace slag i.e. 3%, 6%, 9% and 12% were used to stabilize the expansive soil. Furthermore California bearing ratio (CBR) value improved from 1.16% to 6.8 %. And the unconfined compressive strength of specimens increased from 93 KN/m² to 429 KN/m².

Achenza, M, &Fenu, L. (2006) Described use of natural fibers as enhancement in soil blocks has attracted much research interest in the past decade. In this paper the effects of sugarcane bagasse fibers on the strength properties of soil blocks have been investigated. Laboratory experiments including density, water absorption, compressive strength, splitting tensile strength and erosion tests were conducted on soil blocks reinforced with 0.25-1% mass of fibers. It was determined that by utilization of an optimum (0.5%) of sugarcane bagasse fibers in the soil matrix improved the strength properties of the soil blocks. Furthermore, the study shows that although the reinforced soil blocks were of lower density and higher water absorption, they had a better resistance against erosion. In addition, it was found that high clayey soil achieved better strength and

durability properties. This research therefore recommends the use of 0.5% fibre content and high clayey soil for production soil blocks reinforced with sugarcane bagasse.

III. RESEARCH DESIGN AND METHODOLOGY

The objective of the experimental work is to find out the effect of red sandy soil in construction. Various tests were performed such as California bearing ratio (CBR), liquid limit, plastic limit, specific gravity, moisture content. The test procedures are followed as per Bureau of Indian standards. 4.2 Brief Steps Involved in the Experiments The laboratory tests carried out first was on the natural soil which includes following tests California bearing ratio (CBR), liquid limit, plastic limit, specific gravity, moisture content. In the second phase soil were mixed with sugarcane fibers with 10% lime in different proportions i.e. 0.5%, 1.0%, 1.5%. Adding of sugarcane fibers to the soil the strength of soil may varies in different tests. The laboratory tests carried out includes following tests California bearing ratio (CBR), liquid limit, plastic limit, specific gravity, moisture content. According to IS-2720 tests for soil sample are as follow.

3.1 Determination of Plastic Limit Test

The plastic limit (PL) is determined by rolling out a thread of the fine portion of a soil on a flat, non-porous surface. The plastic limit is defined as the moisture content where the thread breaks apart at a diameter of 3.2 mm (about 1/8 inch). Plastic Limit (PL or WP) is the water content in percent, of a soil at the boundary between the plastic and semi-solid states. A) Apparatus Required 1. Porcelain dish. 2. Squeeze Bottle and Spatula 3. Balance of capacity 500gm and sensitive to 0.01gm 4. Ground glass plate for rolling the specimen. 5. Containers to determine the moisture content. 6. Oven thermostatically temperature around 1050 and 1100C.

3.2 Determination of Liquid Limit Test

The liquid limit is the moisture content at which the groove, formed by a standard tool into the sample of soil taken in the standard cup, closes for 10 mm on being given 25 blows in a standard manner. This is the limiting moisture content at which the cohesive soil passes from plastic state to liquid state. Liquid limit is significant to know the stress history and general properties of the soil met with construction. From the results of liquid limit the compression index may be estimated. The compression index value will help us in settlement analysis. If the natural moisture content of soil is closer to liquid limit, the soil can be considered as soft. If the moisture content is lesser than liquid limit, the soil is brittle and stiffer.

3.3 Specific Gravity of Soil

The specific gravity of a soil is the ratio of the mass of a given volume of the material at a stated temperature to the mass of an equal volume of de-aired or gas-free distilled water at a stated temperature. The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil.

3.4 Proctor Test

In geotechnical engineering, soil compaction is the process in which a stress applied to a soil causes densification as air is displaced from the pores between the soil grains. It is an instantaneous process and always takes place in partially saturated soil (three phase system). The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. Determination of the relationship between the moisture content and density of soils compacted in a mould of a given size with a 2.5 kg rammer dropped from a height of 30 cm. the results obtained from this test will be helpful in increasing the bearing capacity of foundations, decreasing the undesirable settlement of structures, control undesirable volume changes, reduction in hydraulic conductivity and increasing the stability of slope sand so on.

3.5 Determination of CBR Test

The California bearing ratio test is penetration test meant for the evaluation of the sub-grade strength of roads and pavements. The results obtained by these are used with the empirical curves to determine the thickness of pavement and its component layers. The CBR was developed for measuring the load-bearing capacity of soils in subgrade in the construction of buildings and roads. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or for soils under paved airstrips.

IV. RESULTS AND DISCUSSIONS

The objective of the experimental work is to find out the effect of red sandy soil in construction. Various tests were performed such as California bearing ratio (CBR), liquid limit, plastic limit, specific gravity, moisture content. The test procedures are followed as per Bureau of Indian standards. In this chapter we are discussing about sugarcane fibers were added to the red sandy soil, with the addition of sugarcane fibers with different proportions i.e. 0.5% ,1.0%, 1.5%. and with lime .Here we are taking lime constant as 10 % for each proportion of mixing sugarcane fibers to strengthen the soil.

In this project we are showing comparison of natural sandy soil strength and also sandy red soil were mixed with sugarcane fibers in different proportions i.e.0.5%, 1.0%, 1.5%. Adding of lime to the soil, soil strength, soil properties increases.

4.1 Liquid Limit Test

It is seen that as the number of blows increases the moisture content decrease and so the liquid limit also will decrease.

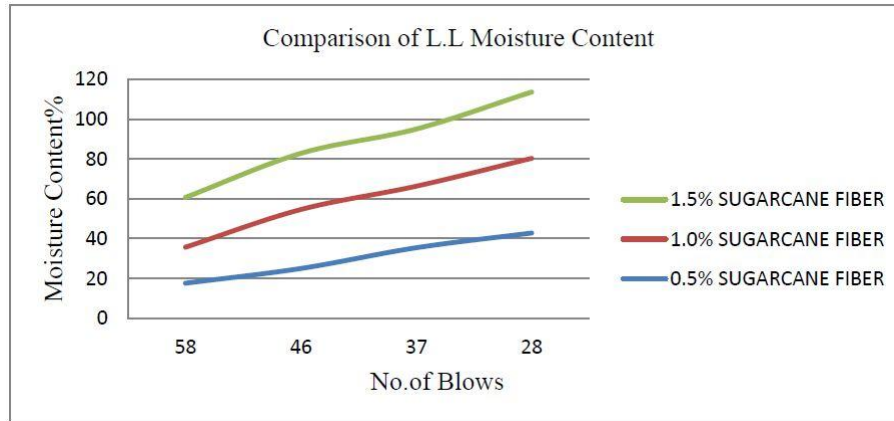


Fig. 1.comparison of moisture content for different proportions of sugarcane fibers

4.2 Plastic Limit Test

In this test the sugarcane fibers mixed in different proportions such as 0.5%, 1.0%,1.5%. The limit lies between plastic and semi-solid state of the soil.It is seen that plastic limit increases as the percentage of sugarcane fibers increases and the maximum plastic limit increases at 1.5% of sugarcane fiber.

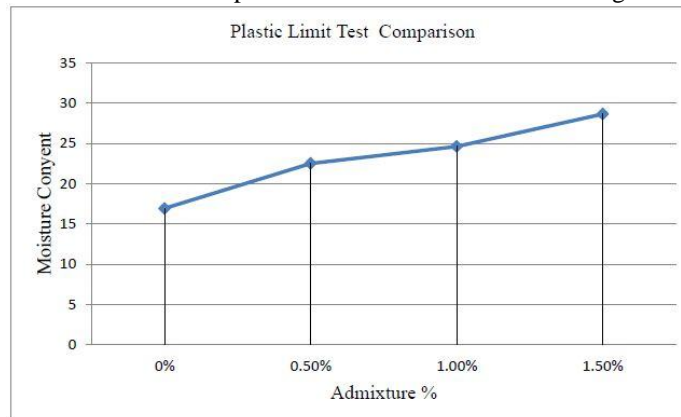


Fig. 2.comparison of plastic limit of normal soil to soil of added admixture.

4.3 Specific Gravity

The specific gravity of a soil is the ratio of the mass of a given volume of the material at a stated temperature to the mass of an equal volume of de-aired or gas-free distilled water at a stated temperature. The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil. The comparison between moisture content and Adding 0.5%, 1.0%, 1.5% Sugarcane fiber with 10% Lime is seen. It is seen that Specific gravity of soil increases as the percentage of sugarcane fibers increases.

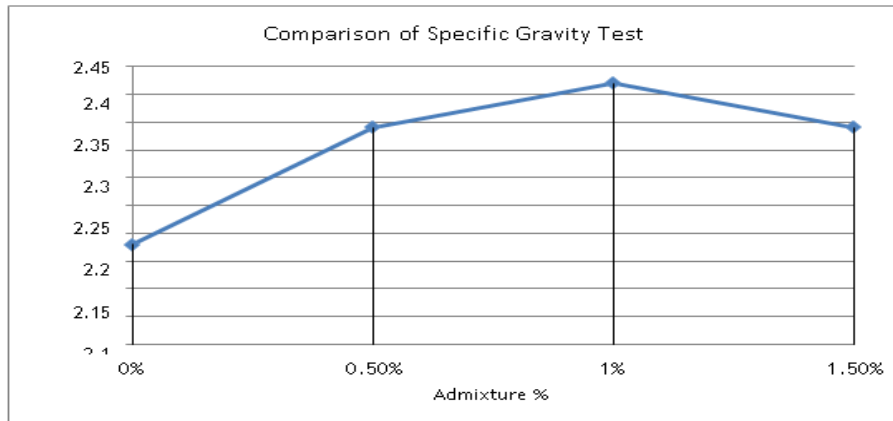


Fig. 3. Comparison of Specific Gravity Test With Normal Soil And Soil Added With Admixtures.

4.4 California Bearing Ratio Test

The California bearing ratio test is penetration test meant for the evaluation of the sub-grade strength of roads and pavements. The results obtained by these are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

4.3.1 Penetration

1. Calibration factor of the proving ring 1div=1.176kg. Surcharge weight used 2.0kg per 6cm construction.
2. Water content after penetration test %, least count of penetration dial 1div=0.01mm.
3. The origins find record load reading corresponding to each concentration.

$$CBR = \frac{PT}{PS} \times 100 \quad (1)$$

Whereas,

PT =corrected test load corresponding to the chosen penetration from the load penetration curve.

PS=standard load for the same penetration.

The comparison between the different proportions of sugarcane fibers and the CBR values. It is seen that as the admixture of 1% sugarcane fibers is showing the higher value when it is added with soil as compared to 0.5% and 1.5% of sugarcane fiber.

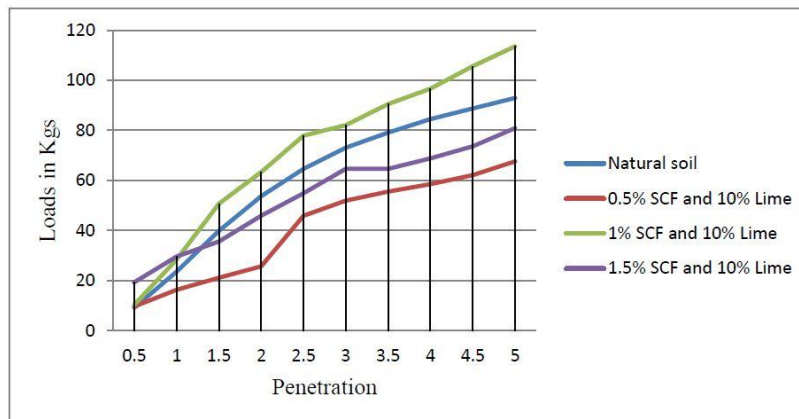


Fig. 4. Comparison of CBR Test on Different Proportions of Sugarcane Fiber With Constant 10% of Lime And Natural Soil Sample.

V. CONCLUSIONS

This study was oriented towards improving the strength of soil by using locally available agricultural fibers to reduce the construction cost. The strengthening agent like Sugarcane fibers (SCF) is added in the soil.

1. Specific Gravity The addition of sugarcane fibers with lime, increases specific gravity consistently from 2.23 to 2.42 the maximum specific gravity value is obtained at adding 1.0% sugarcane fiber with 10% lime and the highest value is 2.42.

2. Liquid Limit The addition of sugarcane fiber with lime, increases liquid limit consistently from 28.80 to 29.02 the maximum liquid limit value is obtained at 1.0% sugarcane fiber with 10% lime and the highest value is 29.02. The liquid limit value is decreased at 1.5% of sugarcane fibers with lime the value is 28.80.
3. Plastic Limit The plastic limit value has increased from 22.5 to 28.83, the maximum plastic limit value is obtained at 1.5% sugarcane fiber with 10% lime and the highest value is 28.83. The plastic limit value is continuously increased, with increasing of sugarcane fibers with lime percentage 0.5% to 1.5%.
4. CBR Test The addition of sugarcane fibers with lime increases the CBR test consistently from 3.34 % to 5.68%. The maximum CBR test value is obtained at 1.0% sugarcane fiber with 10% lime and the highest value is 5.68%.

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