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EXPERIMENTAL STUDY ON STABILIZATION OF SOIL USING COCONUT COIR FIBRE

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Abstract: The development of any country mainly depends on the transport system, trading etc. One of the major transport systems to connect all the villages and cities are roads. The construction of roads in most of the places across the world faces major problems due to weak sub grade soil. Due to the presence of mineral called montmorillonite in the clay, it exhibits large swelling and shrinkage under the wet and dry conditions and due to which the vertical movement is experienced in the pavement and there by the failure of pavement takes place. The total load coming on to the pavement should be properly dispersed through the sub grade. The poor performances of the subgrade soil can be improved by adding some materials or fibres in it. Use of waste material and natural fibre for improving soil property is advantageous because they are cheap, locally available and eco-friendly. In this study, the stabilizing effect of Natural fibre (coconut coir) on soil properties has been studied. An experimental study is conducted on locally available i.e. clayey soil mixed with varying percentage of coir fibre. The percentage of coir fibre by dry weight of soil is taken as 0%, 0.50%, 0.75%and 1% and corresponding to each coir fibre content, Standard Proctor and Unconfined compression tests are conducted in the laboratory. Tests result indicates that shear strength value determined from unconfined compression Test of soil increases with the increase in fibre content. The addition of 0%, 0.5%, 0.75% and 1% by dry weight of soil of randomly distributed coconut fibre increases the shearing strength of the soil sample respectively. Adding of coconut coir fibre results in less thickness of pavement due to increase in strength of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of natural fibre changes the brittle behavior of the soil to ductile behavior.

Index Terms **- stabilization, clay soil, coir fiber, bearing capacity.**

I. Introduction

Soils generally have low tensile and shear strength, and their characteristics may strongly be influenced by environmental conditions (eg. dry versus wet). Soil reinforcement involves the incorporation of certain materials with some desired properties into soils which lack those properties. Therefore, soil reinforcement is defined as a technique to improve the engineering characteristics of soil. The primary purpose of reinforcing soil mass is to improve its stability, to increase its bearing capacity, and to reduce settlements and lateral deformations. Initial developments in soil reinforcement led to the use of plant roots and straws in walls made from soil bricks to improve their mechanical properties. Coir geotextiles are made from coconut fibre extracted from the husk of coconut. This biodegradable and environment friendly material is virtually irreplaceable by any of the modern synthetic substitutes. Coir geotextiles can be easily blended with man-made fibres and other natural fibres to get wide range of products. Its low cost makes it attractive for geotechnical applications. The major drawback is its biodegradability. However this very fact can be used to advantage in creating environmental friendly applications. The potential application areas of coir geotextile in civil engineering are erosion control, slope protection, embankments, wasteland development, road underlays, road edge drains, ground improvement, reinforcements etc. Studies conducted in geo-textiles have indicated that coir is better preferred, as compared to jute or other natural material owing to certain characteristics like durability, strength, hairy surface, etc. It enables vegetation to take root on the applied area thus making 6 the bonding of the soil very strong. They are application on hill slopes, road and rail embankments.

II. LITERATURE REVIEW

R.R Singh, Er.et.al Improvement of local subgrade soil for road construction by the use of coconut coir fibre' International Journal of Research in Engineering and Technology. In this paper, the stabilizing effect of Natural fibre (coconut coir) on soil properties has been studied. An experimental study is conducted on locally available i.e. clayey soil mixed with varying percentages of coir fibre. Soil samples for unconfined compression strength (UCS) and California bearing ratio (CBR) tests are prepared and percentage of coir fibre by dry weight of soil is taken as 0.25%, 0.50%, 0.75% and 1%. Test results indicate

that both un soaked and soaked CBR value of soil increases with the increase in fibre content. Adding coconut coir fibre results in less thickness of pavement due to an increase in CBR of mix and reduces the cost of construction. Composite effect of natural fibre changes the brittle behaviour of the soil to ductile behaviour.

Chaple and Dhatrak (2013) et.al studied effect of coir fibre on bearing capacity and settlement of footing with 0.25%, 0.50%, 0.75% and 1% of coir fibre using the laboratory model test on square footing which were supported on compressible clayey soil reinforced with coir fibre which were randomly distributed in soil. it was observed that there is an increase in bearing capacity of soil by coir fibre. the bearing capacity for reinforced soil with 0.50% coir for 100mm, 50mm, 25mm were 425KN/m2, 495KN/m2 and 665KN/m2 respectively which were quite higher than unreinforced soil having a valve of 250KN/m2. The bearing capacity increases only up to a fibre content of 0.50% and there after start decreasing with further addition of coir fibre in it.

T.Subramani, D.Udayakumar (2016) et.al, in paper Experimental Study on Stabilization of Clay Soil Using Coir Fibre, conclude that the coir fibre is a waste material which could be utilized in a stabilization of clay soil. The strength of soil-coir mix increases with increasing the percentage of coir Fibre. CBR and UCS values of soil-coir Fibre mix increases with increasing percentage of fibre. Maximum improvement in U.C.S. and C.B.R. values are observed when 0.5% of coir is mixed with the soil. It is concluded that proportion of 0.5% coir Fibre in a soil is optimum percentage of materials having maximum soaked CBR value. Hence, this proportion may be economically used in stabilization of clay soil.

R.R. Singh et.al represents a study to analyze both un soaked and soaked CBR value of soil increases with the increase in fibre content. Soaked CBR value increases from 4.75% to 9.22% and un soaked CBR value increases from 8.72% to 13.55% of soil mixed with 1% coir fibre. UCS of the soil increases from 2.75 kg/cm² to 6.33 kg/cm² upon addition of 1% randomly distributed coconut fibre. Adding of coconut coir fibre results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of natural fibre changes the brittle behaviour of the soil to ductile behavior.

III. MATERIALS AND METHODOLOGY

3.1 Clayey Soil

Clay is a fine-grained natural rock or soil material that combines one or more clay minerals with traces of metal oxides and organic matter. Clays are plastic due to their water content and become hard, brittle and non–plastic upon drying or firing.[1] Geologic clay deposits are mostly composed of phyllosilicate minerals containing variable amounts of water trapped in the mineral structure. Depending on the content of the soil, clay can appear in various colours, from white to dull grey or brown to a deep orange-red.

3.2. Coir Fibre

Coir or coconut fibre belongs to the group of hard structural fibres. It is an important commercial product obtained from the husk of coconut. Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre is coir, Cocos Nucifera and Arecaceae (Palm), respectively.

3.3. Experiment Performed

3.3.1. Determination Of Grain Size Distribution

- Sieve analysis.
- Sedimentation analysis.

Sieving was done to determine the coarser content of the soil which determines gravel and sand proportion in the soil sample. This was done by using various sieves ranging from 4.75mm sieve size to 0.75mm as per IS: 2720 (Part IV)-1985.

3.3.2. Determination Of Consistency Limits

To determine the Liquid limit, Plastic limit of soil tests was conducted with reference to IS: 2720 (Part V)-1985.Liquid limit is the minimum water content at which soil has a tendency to flow and all soil possess a negligible shear strength at the liquid limit, it is performed with the help of Casagrande's apparatus in the lab. Plastic limit refers to that water content at which soil sample would just begin to crumble when rolled into a thread of approximately of 3 mm in diameter. Plasticity index is the range of moisture content over which a soil exhibits plasticity. It is equal to the difference of liquid limit and plastic limit.

3.3.3. Specific Gravity Determination

Specific Gravity was determined by soil fraction passing through 4.75 mm IS sieve with the help of Pycnometer as per instruction of IS: 2720 (Part Ill) 1980.It is defined as the ratio of weight of a given volume of solids to the weight of the equivalent volume of water at 4°C.

3.3.4. Standard Proctor Test

To analyses the geotechnical properties of soil like unconfined compressive strength, CBR value of soil, we need to find out the water content at which with the help of compactive effort we can find the maximum value of dry density, referring this water content to be as optimum moisture content (OMC) and dry density as maximum dry density (MDD) and in order to determine these values standard proctor tests were conducted in the lab with a help Cylindrical mould of 1000 cc capacity with 100 mm of diameter and 127.3 mm height fitted with detachable base and collar with 50 mm height was used. The soil was compacted in 3 layers each receiving 25 number of blows from a rammer of weight 2.6 kg falling from a height of 310 mm. Fig. 4.3 shows the sample of mould in which compaction is done.

3.3.5. Unconfined Compression Test

In order to determine the shear strength of soil, it is one of the fastest and easy to perform test which widely used for cohesive soil. To study the effects of coir fibre in strength behaviour of soil unconfined compression test were performed in accordance with IS: 2720 (Part X) - 1991.The cylindrical test specimens were prepared from a mould of size 50 mm (diameter) X100 mm (height). For strength determination samples were put in compression testing machine and a load was applied on it with a strain rate of 1.25 mm per minute until either the sample fails by cracking or strain in the sample is more than 20% of the length of the sample. The unconfined compressive strength of specimens was determined from stress versus strain curves. Fig. 4.5 represent the UCS testing machine.

IV. RESULTS OF ABOVE MENTIONED TEST:

4.1: Properties Of Coir Fibre.

Table 1: Physical Properties Of Coir Fibre**.**

Length in inches	6-8
Density(g/cc)	1.40
Tenacity(g/Tex)	10.0
Breaking Elongation%	30%
Diameter in mm	0.1to 0.5
Rigidity of modulus	1.8924dyne/cm^2

Table 2: Chemical Properties Of Coir Fibre.

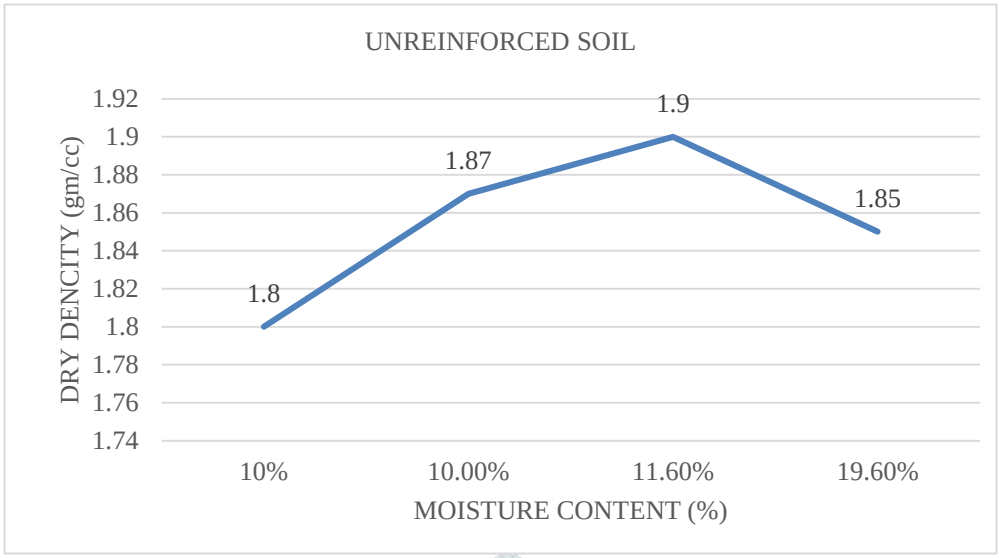
Lignin	45.84%
Cellulose	43.44%
Hemi-Cellulose	0.25%
Pectin & related cpd	3.0%
Water Soluble	5.25%
Ash	2.22%

Table 3: Properties Of Clay Soil

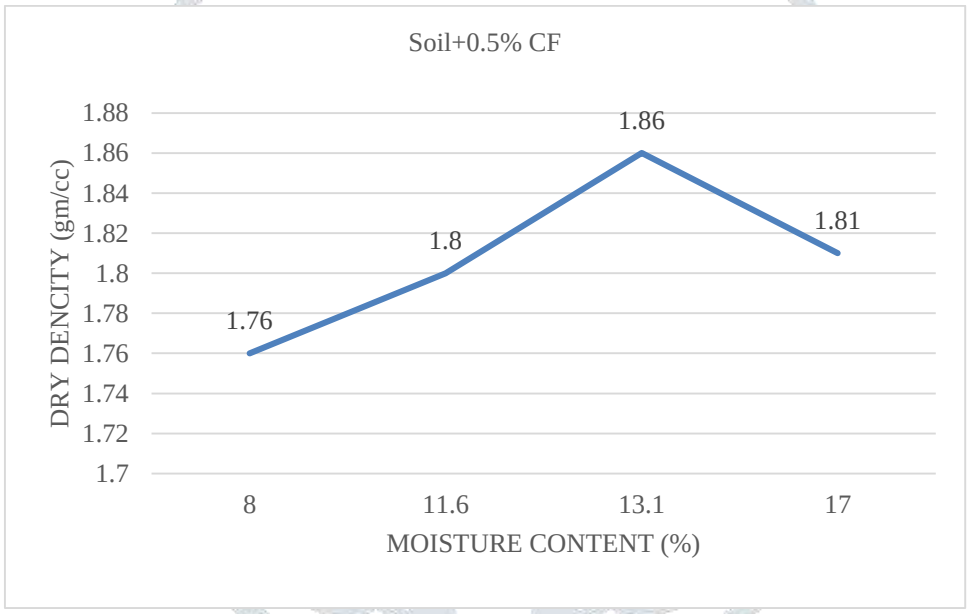
Sl.No	**Properties Of Clay Soil**	**Test Value**
1.	Specific Gravity	2.32
2.	Liquid Limit (%)	41
3.	Plastic Limit (%)	22.66
4.	Optimum Moisture Content (%)	11.6
5.	Maximum Dry Density (g/cc)	1.90
6.	Unconfined Compression Strength Test(kn/mm^2)	180.7

Table 4: Effect Of Coconut Fibre In Standard Proctor Compression Test

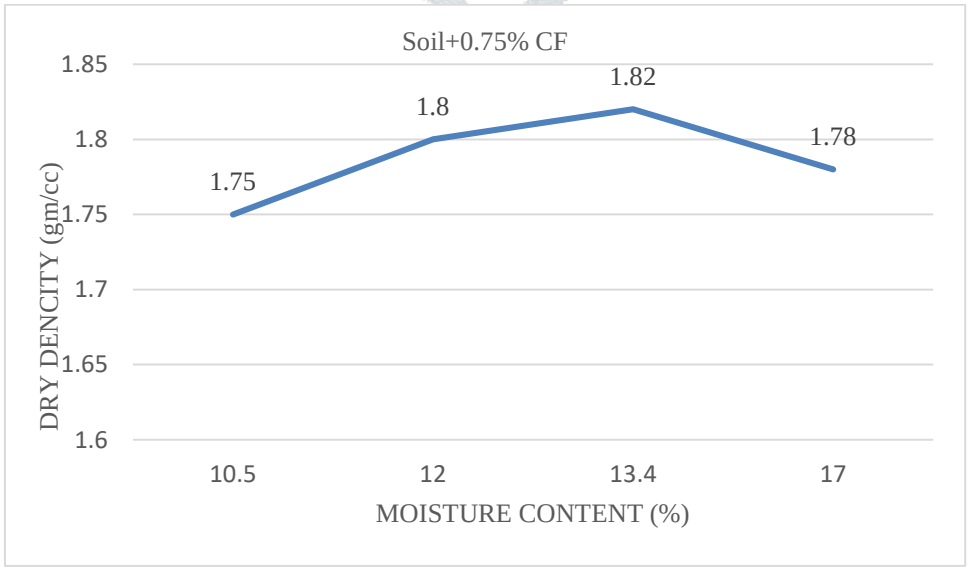
	OMC	**MDD**
Unreinforced Soil	11.6	1.90
Soil+0.5% CF	13.1	1.86
Soil+0.75% CF	13.4	1.82
Soil+1% CF	13.9	1.80



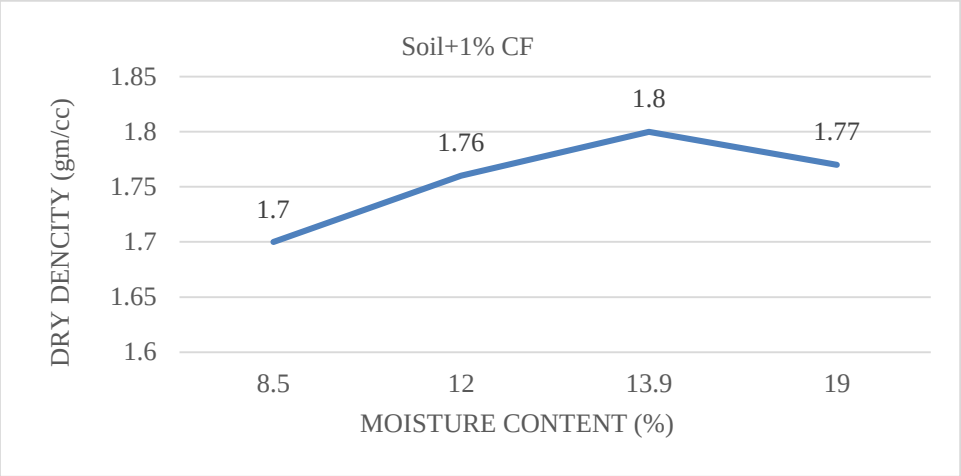
Graph 1:- OMC and MDD For Unreinforced Soil.



Graph 2:-OMC and MDD For Soil +0.5%CF.



Graph 3:-OMC and MDD for Soil+0.75%CF.

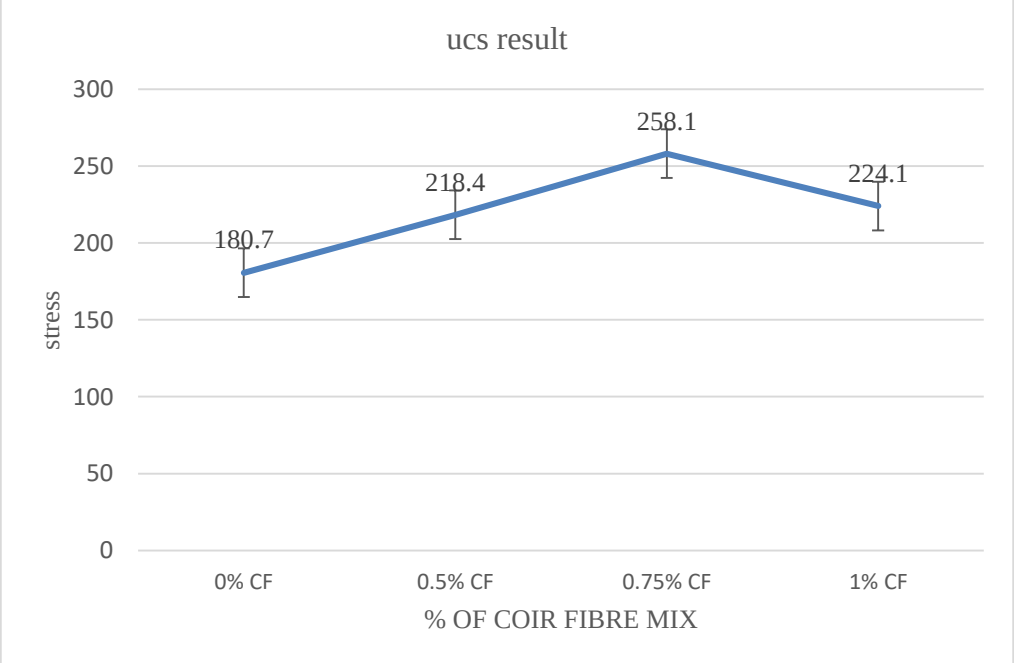


Graph 4:- OMC and MDD For Soil+1%CF.

Compaction tests were carried out on different proportions of coir fibre and soil to study their moisture-density relationship. Graph 1, 2, 3 &4 shows the variation in maximum dry density (MDD) and corresponding optimum moisture content (OMC) for different percentages of coir fibre. It can be observed from the table 3, that the dry density is constantly decreasing by the addition of coir fibre. This is because of the addition of coir fibre having low density in place of soil having comparatively high density. It can also be seen from table 3, That OMC of the soil mix does increase with an increase in the fibre content, the increase in optimum moisture content at high coir fibre content may be due to the greater water absorption capacity of fibres.

Table 5: Effect Of Coconut Fibre On Unconfined Compressive Strength

	Axial Stress(kn/mm^2)
Unreinforced Soil	180.7
Soil+0.5% CF	218.4
Soil+0.75% CF	258.1
Soil+1% CF	224.1



Graph 5:- Unconfined Compression Strength Result.

The unconfined compressive strength tests were conducted on the optimum mixes obtained from standard compaction. The stress-strain behaviours of different composites are shown in Graph 6. Unconfined compressive strength of clay used in this study was 180.7 KN/mm^2. For all the optimum mixes, the value of unconfined compressive strength is greater than that of pure clay. The value of unconfined compressive strength for the mix of 0.75% coir fibre comes out to be maximum. The addition of coir fibre increases the strength capacity of the soil which can be seen from the Graph 5.

V. CONCLUSION

The present study has been shown quite encouraging results and following important conclusion can be drawn from the study

1. Coir fibre is a useful biodegradable waste that improves strength and stiffness of all of types of soil coir used in different proportion and different lengths affect the soil properties. Further work can be done on degradation of coir waste.
2. Coir fibre is a waste material which could be utilized in a stabilization of clayey soil.
3. The strength of soil-coir mix increases with increasing the percentage of coir fibre
4. UCS valve of soil-coir fibre mix increases with increasing percentage of soil
5. Maximum improvement in UCS valve are observed when 0.75% of coir fibre is mixed with the soil.
   It is concluded that proportion of 0.75% coir fibre in a soil is optimum percentage of materials. Hence this proportion may be economically used in stabilization of clayey soil

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