STABILISATION OF BLACK COTTON SOIL WITH HUMAN HAIR FIBER

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Abstract: ***soil reinforcement technique has been used in present times to improve the shear strength of weak soils. The main objective of this study is to investigate the suuitability of solid waste materials such as human hair fibers in the process of soil stabilisation as a reinforcement which can replace conventional commercial fiber materials. Human hair fiber is a natural non-boidegradable waste material which create health and environmental problems. Physical properties of soil like Atterberg limits, compaction characteristics & strength characteristics of virgin soil samples were determined. The soil sample were treated with different percentages of human hair fiber (0.5%,0.7%,0.9%,1.2% and 1.5%). The strength of soil sample increased up to 1.2% and then it decreased.***

Keywords: ***Atterberg's limits, Human Hair Fiber (HHF), CBR, Unconfined Compression Test, Specific Gravity, Sieve Analysis***

1.INTRODUCTION

Expansive soils always pose challenge to foundation engineering. In India, these soils occupy around 20% of the total area. When geotechnical engineers are faced with swelling type of soils, it is great challenge to foundation engineers. The design of foundations and pavements founded on swelling soils always involve a certain degree of risk and damage. The characteristics that are of concern to the design engineers are permeability, compressibility and durability. The test results such as Atterberg's limits, Compaction, California Bearing Ratio and Strength characteristics obtained in expansive soils admixed with human hair fiber at varying percentages of 0.5%, 0.7%, 0.9%, 1.2% and 1.5% of the expansive soil. The purpose of this study is to investigate the influence of human hair fiber on the geotechnical properties of an expansive soil. This paper focus on experimental test plan was to investigate the effect of HHF on strength improvement of expansive soil. K. Shankar Narayanan and S. Mary Rebakh Sharmila (2017) conducted research on "stabilisation of clay with human hair fiber". They studied to improve the shear strength parameters and found that uncompressive strength of soil was increased at 1.2% of HHF. The CBR value increased at 1.2% of HHF. Renju R Pillai et.al (2012) studied on "Innovtive technique of improving the soil using human hair fibers". They found that the engineering properties of soil increased by adding HHF. The liquid limit increased, plastic limit decreased and moisture content increased and maximum dry density decreased due to the addition of HHF. The Unconfined compressive strength value increased upto 2 times that of unreinforced soil. Wajid Ali Butt et.al (2014) studied on "Soil Sub-grade improvement using Human hair fiber" and concluded that the CBR value increased by adding HHF and attains maximum value at 2% of fiber. Fibers of different length and equivalent diameter were used with aspect ratio of 295 to 500. Prakash Patil et.al (2016) studied on "Innovative method of improving subgrade strength of soft soil using Human Hair fibers as reinforcement" and concluded that by adding HHF the subgrade strength of clay soil was improved. They use fibers having average length of 20mm. The CBR value has increased at 0.1% of HHF. The compressive strength also attains maximum value at 0.1% of HHF. Rohin Kaushik (2014) studied on Innovative technique of improving the CBR Value of soil using hair fiber and flyash by using different proportions of human hair fibers at 0.5, 1.0 and 1.5 by percentage and observed

that there was increase in the bearing ratio of the soil, CBR value got increased at 1.5% of HHF. Tom Elias et.al (2016) studied on comparision of soil stabilisation with Human hair fiber and lime. They found that strength was increased with optimum percentage of HHF and lime added together. The strength value increased with 9% of lime and 1.5% of hair fiber mixed together. Sanjay Choudary et.al (2012**)** studied that the effect of Human hair fiber is mixed with polypropylene at different percentages as rolled mills. They have better flexural and impact strength. They observed that the tensile properties were increased with percentage of Human hair fiber along with different resins. Anjanadevi K..A. et.al (2019**)** studied on "stabilisation of clay using jute and Human hair fiber". They observed that the maximum dry density value has maximum value at 0.5% of jute and 1% of HHF and has OMC decreases. The UCC value was increased. The CBR value was increased with a mixture of 1.5% of hair and jute. Sonu Singh et.al (2018) studied that subgrade properties of soil increased with addition of HHF. They conduct experiments of soil with fiber by using CBR and triaxial test. The CBR value has increased with inclusion of 1% HHF. J.N. Akhtar and Sh. Ahmad (2009) studied the effect of mixing of hair fiber on mechanical properties of flyash. They done experiments to determine effect of randomly oriented hair fiber on mechanical properties of flyash based hollow block. The compressive strength increases at 2% of fiber content.

2.MATERIAL INVESTIGATION

2.1 Expansive soil:

Soil sample was collected from paidikalva village, near krishnapuram kadapa, A.p, India. From 3 meter depth below the natural ground level, the samples were collected. The soil classified as 'CH' as per I.S.Classification (I.S: 1498-1978)

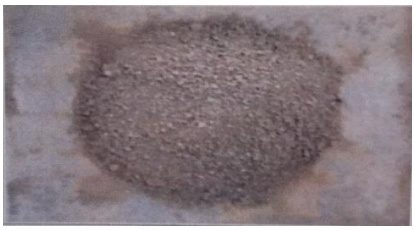

Fig1: Expansive soil

Table1:Basic properties of the soil

S.NO	Properties of soil	Values
1	Grain size distribution:	
	(a) Sand	17 %
	(b) Silt	19 %
	(c) Clay	64 %
2	Atterbergs limits:	
	(a)Liquid limit	83 %
	(b)Plastic limit	39 %
	(c)Plasticity index	46 %
3	IS Classification	CH
4	Free Swell Index	140 %
5	Specific Gravity	2.58
6	Compaction Characteristics	
	(a)Maximum Dry unit weight	1.62 g/cc
	(b)Optimum Moisture Content	20.83 %
7	California Bearing Ratio Value	2.48 %
8	Unconfined Compressive Strength at Proctor Density	1.36 kg/cm^2

2.2 Human hair fiber:

From local sources, the human hair was collected. It can be used as a reinforcing agent to minimize environmental problems. To obtain the average diameter of human hair fiber, Scanning Electronic Microscope (SEM) analysis was conducted. By adding fibre content of 0.5%, 0.7%, 0.9%, 1.2% and 1.5% by weight of soil, samples were prepared. Fig. 1.2 show fibers used in this study. Fig. 1.3 shows the SEM images of human hair fibers.

Fig 2: Human hair fiber

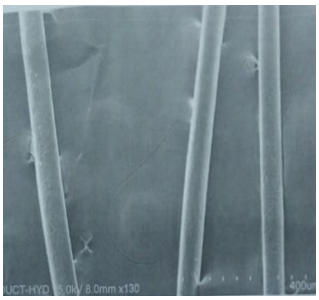

Fig 3: SEM Image of hair

Table 2: Properties of Human Hair Fiber

PROPERTY	SPECIFICATIONS
Length	4mm-40 mm
Diameter	4oμm-111 μm
Protein present	Keratin
Cross section	Circular
Outer Covering	Cuticle
Tensile strength	Equal to copper wire of similar Diameter
Elongation	1.5 times by its dry weight

2.3 Sample preparation:

Here the commercial grade human hair fiber (HHF) used as a stabilizer. HHF added at 0.5%, 0.7%, 0.9%, 1.2% and 1.5% by weight of soil. The quantity of fiber computed corresponding to the above percentage directly mixed to soil before water adding to it.in order to obtain even distribution of fiber.

The various laboratory tests were conducted on virgin soil samples as per IS standard (IS:2720) to determine its Index and Engineering properties. The soil sample is mixed with various percentages of human hair fiber. Compaction characteristics i.e., Maximum Dry Density and Optimum Moisture Content were determined by Standard Proctor test results. Addition of fibers was done carefully and percentage is calculated by weight.

2.4 Laboratory Tests and Program:

As Per Codal procedure using Casagrande's apparatus the Atterberg's Consistency Llimits (liquid limit and plastic limit) were determined. With human hair fibers of different proportions, the tests were carried out on the soil. To determine the Maximum Dry Density (MDD) and the Optimum Moisture Content (OMC) of both unreinforced and reinforced soils. Proctor's standard compaction test was carried out and with various moisture content the fibers were thoroughly mixed with soil. To determine the compaction properties of the unreinforced soils and proctor compaction properties of the black cotton soil mixed with human hair fiber of different percentages. For BC soil and human hair fibers of various proportions compacted to their Maximum Dry Density (MDD) and Optimum Moisture Content (OMC), Unconfined compressive strength tests were conducted and by compacting the sample in mould using hammer in three equal layers with 25 blows per layer, cylindrical specimens were prepared. At an average MDD and OMC of 1.62g/cc and 20.83%, all specimens were prepared. The mix proportions of OMC and MDD do not vary to great extent. The unreinforced and fiber reinforced specimens were thus avoided due to effects caused by differences in dry density and water content.

3.RESULTS AND DISCUSSIONS

3.1Effects on Consistency Limits:

There is reduction in liquid and plastic limit of soil with addition of fiber upto 0.9%. Beyond that it has been observed that there is increase in LL and PL. The influence of fiber on plasticity index is considerable upto 0.9% human hair fiber admixed soil.

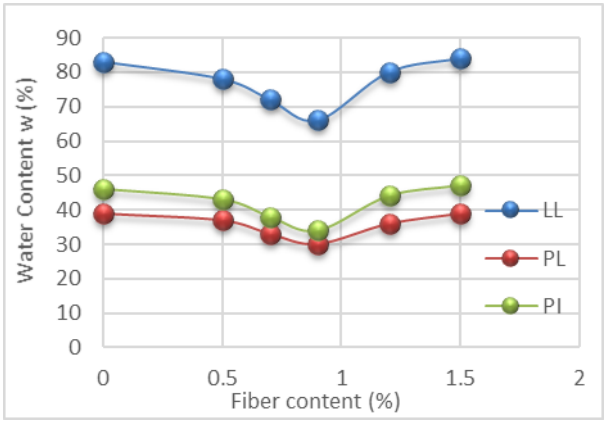

Fig 4: Variation of Consistency Limits

3.2 Effects on Compaction Characteristics

From Fig. 5, 6 & 7 the decrease in dry density with increase in fibre percent as usual the water content may be increases with respect to percentage of fiber admixed soil upto 1.2% of HHF admixed soil. With addition of 1.2% of HHF the optimum water content increased to 27.02% , beyond that it decreases and the dry density decreased to 1.52%, beyond that it increases. Hence it is concluded that at 1.2% of HHF,

Optimum water content increases i.e., 27.02% and dry density decreases i.e., 1.52%.

3.3 Effects on California Bearing Ratio & Unconfined Compression Strength

It was observed that from the Fig. 8 CBR value of soil samples admixed with HHF increase with increase in percentages of HHF upto 1.2% HHF admixed soil and it was found that the excess of HHF more than 1.2% causes decrease in CBR value.

From the Fig. 9 & 10 unconfined compressive strength was observed in terms of additive percentage better shear strength observed at 1.2%. Index properties and compaction characteristics reveals 1.2% HHF admixed soil is better strength achieving percentage.

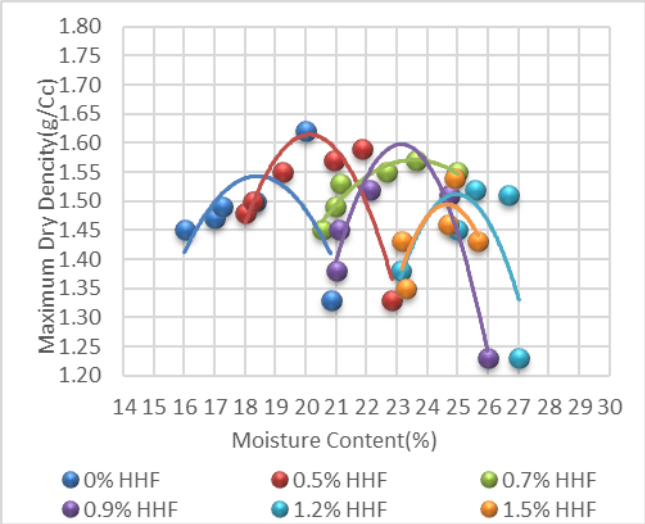

Fig 5: Moisture content Vs Dry density for HHF Admixed soil

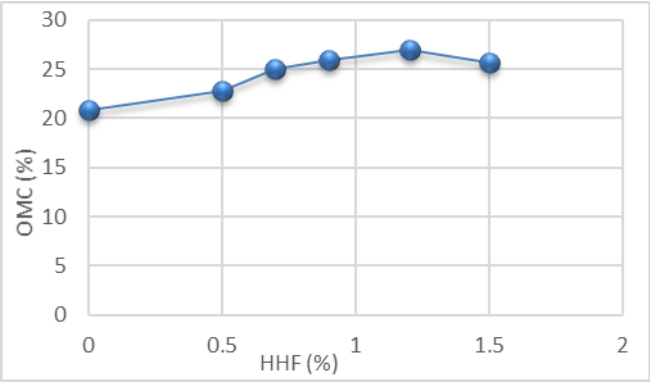

Fig 6: HHF% Vs Corresponds optimum moisture content

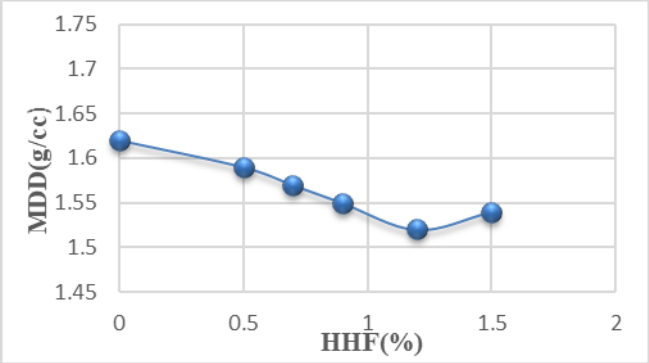

Fig 7: HHF% Vs Corresponding Dry densities

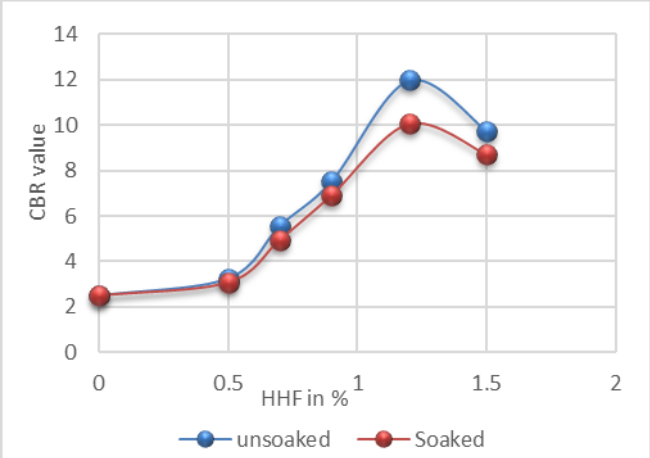

Fig 8: CBR values for un-soaked and soaked conditions for HHF admixed soil

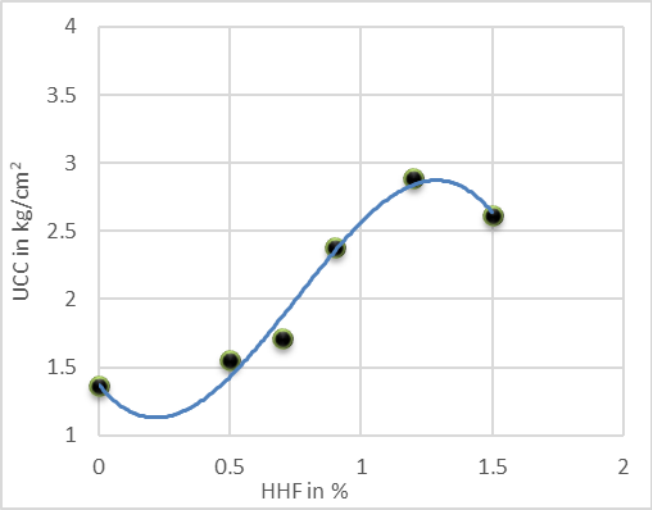

Fig 9: HHF Vs UCC strength

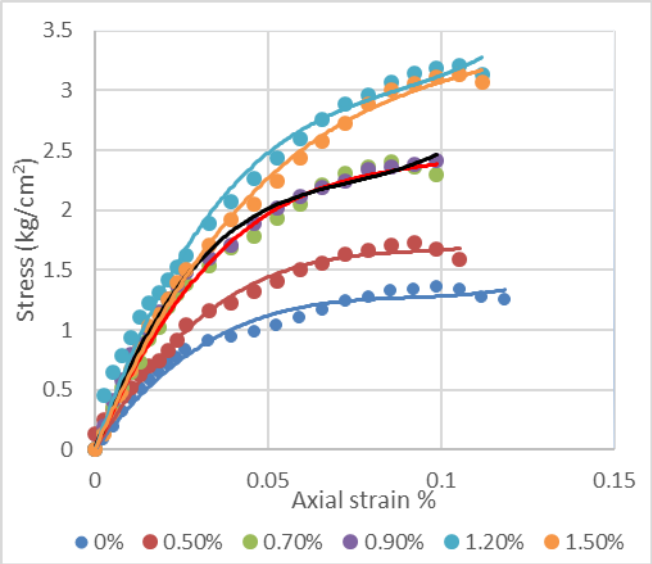

Fig. 10: Stress Vs Strain

5. CONCLUSIONS

1. The liquid limit value first decreases and then increases at 1.2% of HHF.
2. The unsoaked CBR has maximum value at 1.2% of HHF.
3. The UCC strength of unreinforced andr einforced soils are substantially different with addition of 1.2% of fibers by weight. The UCC value increased upto 2.3 times of unreinforced soil.

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