© 2016 IJSRSET | Volume 2 | Issue 4 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

An Innovative Method of Improving Subgrade Strength of Soft Soil Using Human Hair Fibers as Reinforcement

Prakash Patil*[1], Harini H. N.[2]

*[1] M.Tech. (Transportaion), Reva I.T.M. Bengaluru-64, Karnataka, India
[2] Asst. Prof. Department of Civil Engineering, MIT Mysuru, Karnataka, India

ABSTRACT

Human hair fiber (HHF) is a natural non-biodegradable waste material which creates nuisance to the environment if not disposed of in a proper manner. In this project HHF is used as a reinforcement to increase the subgrade strength for the soft clayey soil. HHF is used in varying percentages and Unconfined Compressive Strength test, CBR test were conducted. The results are compared with unreinforced soil. Fibers with average length of 20mm are used. The test result shows that strength significantly increases with addition of HHF and also prevents the sample from cracking.

Keywords: Human Hair Fiber (HHF), waste material, Clayey Soil, UCC Test, CBR Test.

I. INTRODUCTION

The performance of pavement depends upon the quality of soil-subgrade. A stable soil-subgrade and properly draining pavement helped to produce a long-lasting pavement. Subgrade soil provides support to the remainder of the pavement system. The quality of the subgrade would be greatly influence the pavement design and the service life of the pavement[1]. Road running in clayey soil areas are known for bad condition and unpredictable behaviour for which the nature of the soil contributes to some extent. The failures of pavement, in form of heave, depression, cracking and unevenness are caused by the seasonal moisture variation in the subgrade soil[6]. For many years, researchers have studied the clayey soil-subgrades in an effort to determine the most appropriate methods of design and construction practices where these soils cannot be avoided. Furthermore, there has been significant amount of research on soil-subgrade improvement techniques to construct a uniform and stable pavement on clayey soils or highly plasticity soil as classified A-7-6 by Highway Research Board (HRB) Classification System. One approach is to use chemical to stabilize the clay sub grade. Instead of using chemical product, natural fibers may offer more economical alternatives for a wide range application of soil stabilization. Subgrade stabilization of clayey soil besides to improve the engineering properties, make the upper part of road structure become stable and decrease pavement thickness.

Now days, many of the wastes produced will remain in the environment for hundreds thousands of years. The creation of non-decaying waste materials combined with a growing consumer population has resulted in a waste disposal crisis. One solution to this crisis lies in recycling and reused waste into useful products. In general the engineering properties of soil subgrade were high plasticity material were improved by using waste material as stabilizer. Soil reinforcement with randomly distributed fiber is another approach which may increase the internal cohesion of soil, improved the shear strength parameter, compressive strength and bearing capacity[8].

In this study an attempt is made to use the human hair fiber as reinforcement to soil to increase the subgrade strength. Human hair fiber is a non-degradable material which creates health and environmental hazards if not disposed of properly. HHF is available widely at a very low cost and is used as a reinforcement material is soft clayey soils to improve the shear strength and bearing capacity of the soil.

I. METHODS AND MATERIAL

A. Materials

Soil: The soil used in the present study is clayey in nature which is collected in Hubli-Dharwad region of Karnataka state. Laboratory tests for index and engineering properties were conducted according to IS methods of testing. The properties of soil is given in table-I.

Table I

Properties of clayey soil

Properties	**Values**
Silt & Clay content	59%
Specific gravity	2.48
Liquid Limit	46.50%
Plastic Limit	24.70%
Plasticity Index	21.80%
Maximum Dry Density	1.8 g/cc
Optimum moisture content	18%
CBR at OMC	3.20%
Classification	A-7-6

Human Hair Fiber: These fibers are considered as value less solid wastes which creates environmental problems because of being non-biodegradable in nature. The HHF are collected from locally available sources. The length of these fibers varies from 20 to 25 mm generally. These fibers are available all over the world with very less cost. The properties of human hair fibers are given in table-II which is obtained from a research paper[6].

Figure 1: Human Hair Fibers

Table II

Properties of human hair fibers

Property	**Remark**
Cross-section	Circular
Diameter	50µm
Length	20-25 mm
Linear density (gm/cc)	1.25–1.40
Elongation	1.5 times its dry weight
Tensile strength	About 400 Mpa
Flexural strength (Mpa)	25–30
Chemical reaction	Depends on Hair surface porosity. About 80 % of human hair is formed by a protein known as keratin
Absorption	Depends on physical process of surface tension
Friction	Depends on the cuticle geometry and on the physical–chemical status of the hair

B. Methods

Preparation of samples:

All the samples were prepared at the OMC and MDD with different percentages of fiber content i.e. 0%, 0.05%, 0.1%, 0.2%, 0.3%, 0.4%, and 0.5%. Fibers were mixed to the air dried soil. Addition of fibers was done very carefully and percentage is calculated by weight.

Laboratory Tests:

All the basic tests were carried out for the plain soil such as, Sieve analysis (Dry and Wet), Modified Proctor Test, Specific Gravity Test, Atterberg Limits, Unconfined Compressive Strength and CBR Test. Modified Proctor compaction test was carried out as per IS: 2720 (Part VII) for the determination of the maximum dry density and UCC tests were carried out at MDD and OMC at different percentages of the fiber content. The optimum content of HHF was found out and CBR tests were conducted to the optimum content of HHF quickly so that the moisture may not lost. The plunger in the CBR test penetrates the specimen in the mould at a rate of 1.25 mm per minute.

II. RESULTS AND DISCUSSION

The unconfined compression test is the most popular method of soil shear strength testing because it is the fastest and cheapest methods of measuring shear strength. This method is useful for saturated, cohesive soils recovered from thin-walled sampling tubes. The length of the specimen is 76 mm and diameter is 38 mm.

With 0% of HHF the UCC value was 0.349 kg/cm^2 which then increased to 0.591 kg/cm^2 after adding 0.1% of HHF. Therefore it is quite evident of mixing HHF in the marginal soil for construction of road pavements. As seen from the results about 0.1% HHF is the optimum quantity to enhance the Unconfined Compressive Strength figure 3.

The increase in UCC values due to addition of HHF to clayey soil may be attributed due to improved interfacial adhesion between the soil particles and the fiber, which allows a more efficient transfer of stress along the fiber matrix interface. However, the decrease in UCC values beyond optimum fiber content may be due to the increase in fiber–fiber interaction figure 3. The fiber may not be perfectly aligned with soil matrix leading to poor dispersion of fiber in the soil matrix thus resulted in a lower efficiency of load transfer with increase in fiber content. Hence up to some optimum content of natural fibers as a potential reinforcement ingredient offers many advantages such as good strength properties, low cost, high toughness, and biodegradability. However, the overall performance of any fiber depends to a large extent upon the fiber–matrix interface which in turn is governed by the surface topography of the fiber and by the chemical composition of fiber surface and resin properties.

For the optimum content of HHF which is obtained from UCC test, CBR tests were carried out for optimum HHF for both soaked and un-soaked conditions. And the CBR values are compared to the CBR values with 0% HHF. With 0% HHF CBR value obtained for soaked condition is 2.89% which is then increased to 4.82% after addition of 0.1% HHF as shown in figure 4.

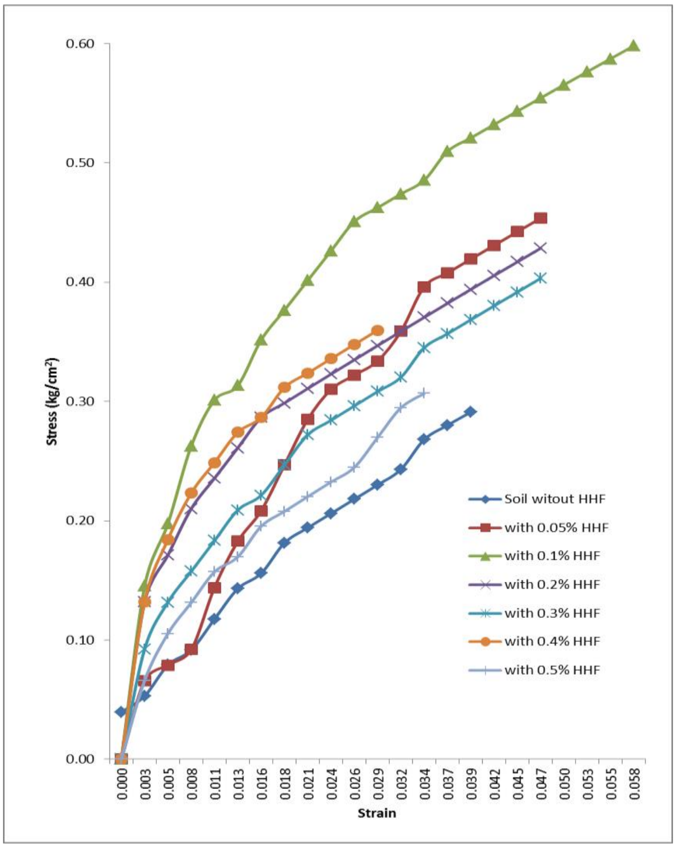

Figure 2: UCC curve for varying percentages of HHF

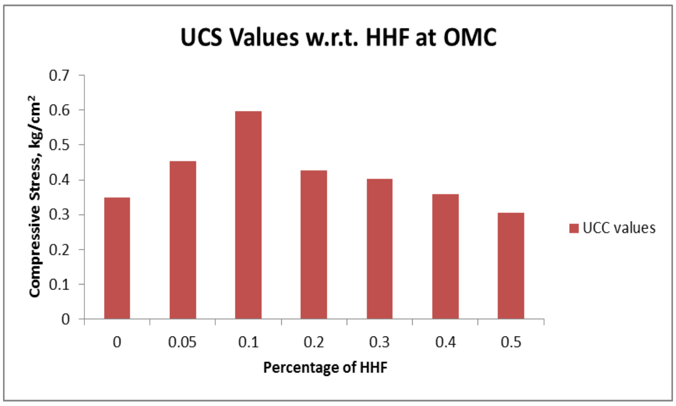

Figure 3: Variation of strength with varying percentage of HHF

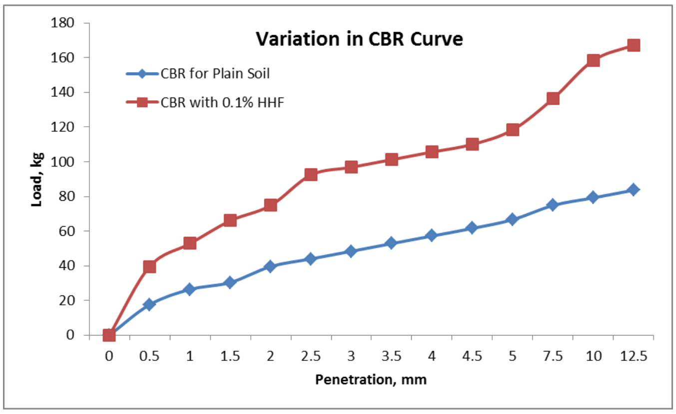

Figure 4: CBR Values with and without reinforcement of HHF

III. CONCLUSION

- From UCS test at OMC, for un-reinforced soil the compressive strength found was 0.35 kg/cm^2 which is then increased to 0.59 kg/cm^2 showing an increase in strength of 71.3% with addition of 0.1% of HHF.
- From the test results 0.1% is considered to be optimum percentage of reinforcing material.
- The CBR value at OMC for un-reinforced soil was 2.89% which is increased to 4.82% by the addition of 0.1% of HHF leading to 66.78% increase in strength in soaked condition.
- The experimental result shows that with usage of very little percentage of HHF as reinforcement to clayey soil leads to considerable increase in strength.
- By increasing the HHF content, the OMC increases marginally due to moisture absorption of hair fibres.
- The human hair fibers can also be used as reinforcement material for the stability of slopes.

IV. REFERENCES

[1] Dr. Sinan Abdulkhaleq Yaseen - University of Salahaddin, *"An Experimental Investigation into the Mechanical Properties of New Natural Fibre Reinforced Mortar"*, 2013.

[2] Darsh Belani, Dr. F.S. Umrigar & Prof. Jayeshkumar Pitroda B.V.M Engineering College, Gujarat, *"Use of Human Hair as Natural Fibre for Fly Ash Bricks"*, 2013.

[3] Renju.R.Pillai & Ayothiraman Ramanathan - IIT Delhi, *"An Innovative Technique of Improving the Soil Using Human Hair Fibre"* 2012.

[4] Ganiron Jr. and Tomas U. - Australian Institute of Geoscientists, Qassim University, *"Effects of Human Hair Additives in Compressive Strength of Asphalt Cement Mixture"*, 2014.

[5] Rohin Kaushik Asst. Prof. Chandigarh University, India, *"An Innovative Technique of Improving the C.B.R Value of Soil Using Hair fibre"* in June 2014.

[6] Wajid Ali Butt et al, *"Strength Behavior of Clayey Soil Reinforced with Human Hair as a Natural Fibre"* in Nov 2015.

[7] Karan Gupta et al, *"Soil Sub- grade Improvement Using Human Hair Fiber"* in Dec 2014.

[8] J.N. Akhtara and Sh. Ahmad A. M. U., *"The effect of randomly oriented hair fiber on mechanical properties of fly-ash based hollow block for low height masonry structures"* in 2009.

[9] V.Raja Mahendar et al, *"An Experimental Study on Mechanical Properties of Human Hair Fibre Reinforced Concrete (M-40 Grade)"*, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

[10] Dr. Hussein H. Karim et al, *"Soft Clay Soil Improvement Using Stone Columns and Dynamic Compaction Techniques"*, Eng. & Tech. Journal,Vol.27, No.14,2009.