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SOIL STABILIZATION BY USING HUMAN HAIR FIBERS (PILUS) AND CEMENT

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ABSTRACT

*Soil stabilization is the process of improving the shear parameters of soil and thus increasing the bearing capacity of soil. Soil stabilization is the alteration of soil to enhance its physical properties. Normally clay soil has a low bearing capacity. In order to make it suitable for constructions, the physical properties of it has to be enhanced by the addition of suitable additives that increases its bearing capacity. The main aim of this study is to investigate the suitability of using solid waste materials such as human hair fibers in the process of soil stabilization. It has the potential to replace the already existing fiber materials used in Soil stabilization. Now a days, the excessively generated solid waste and their disposal arises major environmental concerns. The generation of solid waste materials like human hair fiber-**a non-biodegradable matter** can be minimized by using the same as a reinforcing agent in soil stabilization.[2]There are many methods to stabilize the soil by using additives like **jute, lime, waste crumb rubber, rice husk, fly ash, gypsum** etc. But, the usage of human hair fibers (Pilus) in the process of soil stabilization, proves to be beneficial since it is a cost effective material and also easily available. Human hair fibers (Pilus) and Cement mixed with soil samples were tested for its engineering properties by conducting laboratory tests such as **Atterberg limit test, Standard Protractor test, and unconfined compression test.**[12]Human hair strands with a length of 5-50mm and diameter of 45-120µm were used. [5]The test results revealed that the strength of the soil significantly improved with the inclusion of Human hair and Cement ,it further improved when optimum percentage of both Cement and Human hair were added together.*

KEY TERMS – *Soil stabilization, Human hair fiber (Pilus), Reinforcing agent, Cement.*

1. INTRODUCTION

1.1. GENERAL

The most important aspect in the field of civil engineering is to avoid the failure of the constructed structures. Hence, it is important to design the structural elements with great accuracy. However, if the bearing capacity of soil is poor, the whole structure will encounter failure easily. To avoid such failure, the bearing capacity and shear parameters of the soil must be improved. Recently, there are numerous additives that are used in the soil stabilization process to improve the soil bearing capacity of soil. Generally clay soil has a low bearing capacity. Hence, it was chosen as the soil of choice for our investigation. The Clay soil for our study was taken from Lalgudi near Trichy in Tamilnadu..

In this research, we used human hair as an admixture for reinforcing the clay soil and cement was used as an additive to improve the compressive strength of the soil. Human hair collected near main guard gate in Trichy and OPC 43 grade cement were used for this process. After mixing the soil with additives, samples were prepared to conduct

unconfined compression test by using unconfined compression testing machines. The objectives are, [1]to reduce the permeability and compressibility of the soil mass in earth structure, to increase the bearing capacity and shear strength of foundation soils, to minimize the generation of non-biodegradable solid waste by reusing the same as a reinforcing agent.

PROPERTIES OF HUMAN HAIR FIBERS (PILUS)

Human hair fibers (Pilus) were used throughout this project to stabilize the soil used for laying foundation.[12]Human hair strands with length of 5-50mm and diameter of 45-120µm were used. [5]The physical & mechanical properties of hair include elasticity, smoothness and volume due to both the significant adherence of the cuticle scales and malleability. The diameter of hair fiber was determined by electron microscope scanning and analysis.

PROPERTIES OF CEMENT

Ordinary Portland cement (OPC-53 grade) was used in this work. The properties of Cement are determined by using IS Codes.

Table 1: Properties of cement

Properties	**Indian standard used**	**values**
Fineness	IS:4301-1(1996)	3.5
Specific gravity	IS:4301-11(1988)	3.12
Standard consistency	IS: 4301-4 (1988)	39
Initial setting time	IS: 4301-5 (1988)	35
Final setting time	IS: 4301-5 (1988)	600
soundness	IS: 4301-3 (1988)	4

Table 2: Properties of soil

Property	**values**	**IS Code used**
Specific gravity	2.65	IS:2720(Part 3)-1980
Liquid limit	62.32%	IS:2720(Part 5)-1985
Plastic limit	30.15%	IS:2720(Part 5)-1985
Plasticity Index	32.17%	IS:2720(Part 5)-1985
Max dry density	1.56g/cc	IS:2720(Part 8)-1983
Optimum moisture content	21.64%	IS:2720(Part 8)-1983
Percentage of clay	72%	IS:2386(Part 1)-1963
Percentage of silt	26%	IS:2386(Part 1)-1963
Percentage of sand	2%	IS:2386(Part 1)-1963

PREPARATION OF SOIL SAMPLE

The properties of soil sample, [12]human hair fiber and cement were analyzed. Then, soil was thoroughly mixed with human hair fiber in the percentage of 0.5, 1, 1.5, 2, 2.5, by the weight of soil until the mixture became homogeneous.Dr. Ayothiraman Ramanathan and Renju R pillai discovered that the mixing of soil became very difficult by 2.5% that it starts forming lumps. Hence, samples were made only until 2.5% of hair. To avoid the balling effect, soil was mixed with hair in a moist state. Required amount of sample were prepared for each percentage to avoid the sample failure. After mixing the soil with hair, the samples were immediately prepared by compacting for purpose of unconfined compressive testing. Soil was mixed with cement in the percentage of 2, 4, and 6,8,10 by the weight of soil and curing was allowed for a period of 2, 4, 6, 8, 28 days. For preparation of test sample, cylindrical mould of diameter 30mm and height 75mm were used. After the curing process, samples were tested in unconfined compressive testing machine for the specified days.

Fig 1. Soil with hair

3. TEST PROCEDURE FOR PREPAREDSOIL SAMPLE

According to the Indian standard codes, Atterberg consistency limits were determined by using Casagrande's apparatus. After that, consistency limits were also determined for soil with hair and cement. Maximum dry density (MDD) and optimum moisture content (OMC) were determined by using standard proctor compaction test as per Indian standards specification IS2720 (Part10)1991.

[11]Unconfined compression test for soil sample with hair was conducted immediately after the mixing of soil with hair in the percentage of 0.5%, 1%, 1.5%, 2% and 2.5% by weight of soil. The percentage of hair with soil at which the strength of soil increased is considered as the optimum amount of hair. Optimum amount of hair is determined by conducting a series of unconfined compressive strength test. Soil with cement in the percentage of 2%,4%,6%,8% and 10% by weight of soil was added and test were conducted for the specified days such as 2,4,6,8,10…..28 days. The percentage of cement with soil at which the strength of soil increased is considered as the optimum cement content. After the determination of optimum amount of hair and optimum cement content, the percentage of optimum hair and optimum cement content was mixed together with soil and the sample was prepared. Finally the unconfined compressive strength for the soil sample with optimum hair content and optimum cement content was conducted.

RESULT AND DISCUSSION

Unconfined compressive strength of the clay without adding any admixture is given below, Unconfined compressive strength =5.3KN/mm²

Undrained cohesion = 2.6KN/mm²

Strength of the clay was improved, after adding some percentage of cement and hair with soil. Soil mixed with 8% cement gives the maximum strength when compared to other percentage of cement added with soil.

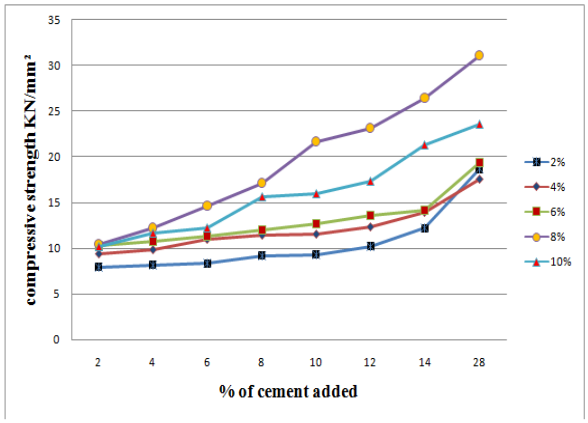

Fig 2. Compressive strength of soil added with cement

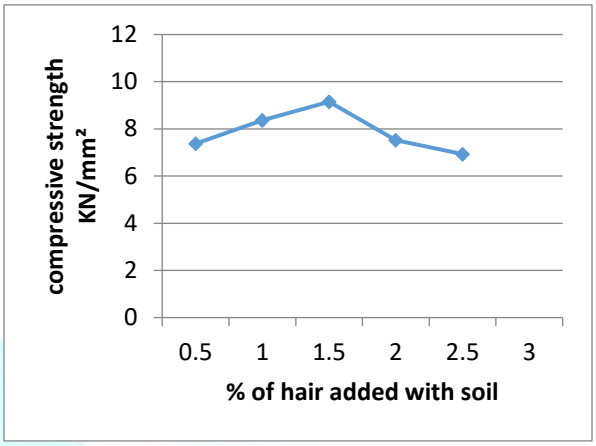

Table 3: Compressive strength of soil mixed with hair

Similarly, the strength of soil is increased by adding 1.5% of human hair by the weight of soil.

Sl. no	Percentage of hair	Compressive strength KN/mm²	Undrained cohesion KN/mm²	Shear strength KN/mm²
1.	0.5%	7.37	4.23	4.23
2.	1.0%	8.36	4.75	4.75
3.	1.5%	9.15	5.63	5.63
4.	2.0%	7.52	4.62	4.62
5.	2.5%	6.93	3.92	3.92

CONCLUSION

From this process, we could understand that liquid limit of clay soil increases when soil is mixed with hair. At the same time, its plastic limit reduces. Cement and Human hair can be effectively used for improving the strength of clay soil. Human hair is easily available in many parlors and it is discarded as a solid waste. Since it is a non-degradable waste and also available for low cost compared to other additives, the usage of it is consider as an environment friendly and economical method. After performing all the required tests on the clay soil with Cement and Human hair, the obtained results are concluded below

- When 1.5% of hair is added with clay soil, the compressive strength improves up to 9.15KN/mm².
- When 8% of cement is added with clay soil, the compressive strength improves up to 31.05KN/mm².

- When 1.5% of Human hair and 8% of Cement is mixed together with clay soil, the compressive strength improves upto 43.49KN/mm².

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