

Stabilization of Clayey Soil using Human Hair and Coir Fibre

Shamiya U K¹, Swaliha O¹, Thafseena P P¹, Sheena Joseph², Abhaya K²

¹Student, Department of Civil Engineering, KMCT College of Engineering for Women, Kallanthode

²Asst. Professor, Department of Civil Engineering, KMCT College of Engineering for Women, Kerala, India

Abstract – Clayey soil possesses threat for the construction of building due to its low shear strength and high swelling characteristics. Suitable ground improvement techniques need to be adopted on such soil. In this experimental work, clayey soil is treated with both hair and coir fibre in the proportion of 0.5%, 1.0%, 1.5%, 2.0% and then compaction test, Unconfined Compression (UCC) test and California Bearing Ratio (CBR) test were carried out. The optimum percentage of hair and coir was found to be 1.0% from CBR and UCC test.

Key Words: Shear strength, Swelling, Hair, Coir, CBR, UCC

1. INTRODUCTION

Ground improvement refers to a technique that improves the engineering properties of the soil mass treated. Ground improvement has developed as an important tool to support foundations for a wide variety of structures. Unstable soil can create significant problems for pavements and structures. Therefore, soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which is highly active.

Stabilization is the process of blending and mixing materials soil to improve certain properties of the soil. Soil stabilization is used to reduce the permeability and compressibility of the soil and to increase its shear strength and bearing capacity. The main objective of soil stabilization is to increase the strength of soil and to reduce the construction cost by making best use of frequently available material. Recently soil reinforcement with short discrete randomly oriented fibres gives more attention in soil stabilization. A variety of materials including steel, concrete, glass, fibre, wood, rubber, aluminium and thermoplastics can be used as reinforcing materials.

Nowadays human hair is considered as a waste material and it create many environmental issues; however it has many known uses like randomly reinforced fibre in the present state of art and technology. Hair is a non-biodegradable matter which creates environmental problems, so using it as a fibre reinforcing agent can minimize the effects. It is widely available and highly economical.

Coconut coir can be used as a natural fibre for stabilization of soil. Stabilization using natural fibre is also a cost effective and eco-friendly approach to improve properties of soil. Chemical-based or synthetic fibres harm our environment. So the use of natural fibre is an initiative to maintain balance in nature.

2. OBJECTIVE

The main objectives of this project are to study the variation in optimum moisture content (OMC) and maximum dry density (MDD) with the addition human hair and coir fibre and to find out the influence of human hair and coir fibre on UCC strength and CBR value.

3. MATERIALS

The materials used in this project are clayey soil, human hair and coir fibre.

3.1 Clayey Soil

Soil with high clay in nature, high swelling, low bearing capacity (low CBR value) and weak in wet condition was used for this entire experimental work. The maximum dry density of clayey soil used in this study is 1.741 g/cc at optimum moisture content of 20.41%. The specific gravity of the soil sample is 2.66.

3.2 Human Hair

Human hair fibres were used throughout this study to stabilize the soil. They are considered as valueless soil which are dumped to waste landfills. Human hair has been used for reinforcing clay based construction because of its high tensile strength and friction coefficient.

3.3 Coir Fibre

Coir fibre is a natural fibre extracted from the husk of coconut. Coir has a good blend of strength, length and moisture regain. Coir fibre is also a cost effective and eco friendly approach to improve properties of soil.

4. METHODOLOGY

In order to investigate the properties of clayey soil, sieve analysis, specific gravity, atterberg's limits, standard proctor test, unconfined compressive strength test and california bearing ratio test were conducted. The length of the hair and coir fibre used in this study is 20mm. The parameter concerning the addition of fibre was fibre content by weight of soil. Sample was prepared by adding fibre content of 0.5%, 1.0%, 1.5% and 2.0% by weight of soil. Then Compaction test, UCC test and CBR test were conducted to investigate the variation in properties of soil with the addition of fibre.

5. RESULTS

5.1 Proctor Compaction Test

Standard proctor test was conducted to determine the variation in optimum moisture content and dry density of clayey soil with the addition of hair and coir fibre. The test result is shown in chart 1. The dry density of clayey soil decreased with increase in addition of hair and it increased with increase in addition of coir fibre.

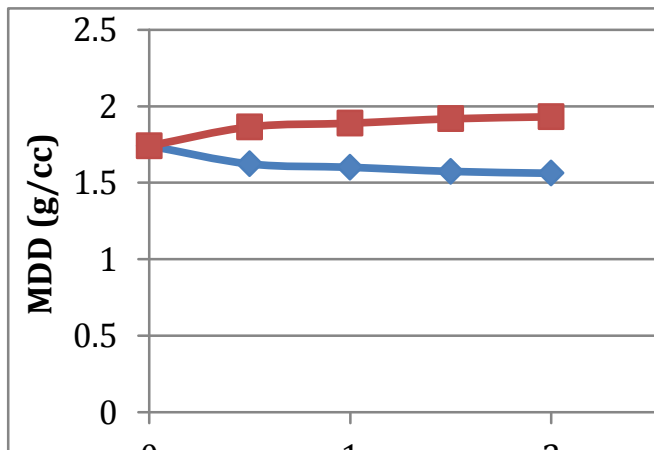


Chart-1: Variation in MDD with the addition of human hair and coir fibre.

5.1 Unconfined Compression Test

5.1.1 Variation in UCC with the varying percentage of hair and coir

Unconfined compressive strength test was conducted on clayey soil treated with varying percentage of human hair and coconut coir as per IS 2720 (Part 8). The variation in UCC with the varying percentage of human hair and coir fibre is shown in chart 2. The maximum UCC obtained at optimum fibre content (1%) in the case of soil treated with coir fibre is more than that of the soil treated with human hair.

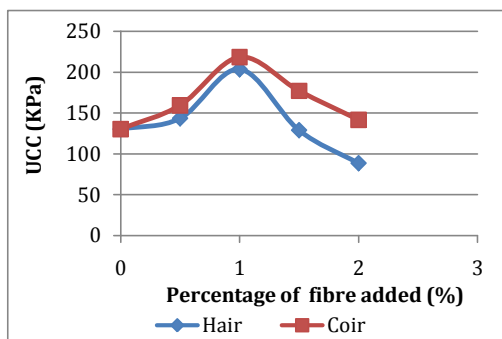


Chart-2: Variation in UCC with the addition of human hair and coir fibre.

5.1.2. Variation in UCC with the combination of hair and coir

Chart 3 shows the test result of variation in UCC with the combination of hair and coir. The UCC value increases with addition of hair and coir, and the optimum proportion of both was found out to be 1.0%. The UCC results are the criteria for determining the strength parameter for cohesive soils. From the results it is clear that addition of 0.5% hair and 0.5% coir to the cohesive soil give maximum UCC value.

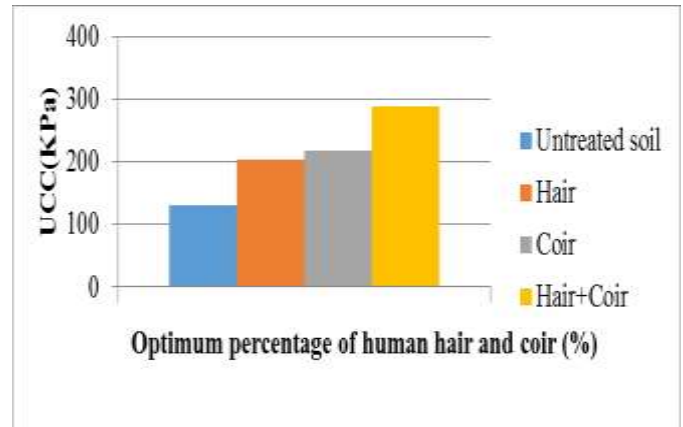


Chart-3: Variation in UCC with the combination of Human hair and Coir fibre

5.2 California Bearing Ratio Test

5.2.1 Variation in CBR value with the varying percentage of hair and coir

California bearing ratio test was conducted on clayey soil treated with varying percentage of human hair and coconut coir as per IS 2720 (Part 8). The variation in CBR value with the varying percentage of human hair and coir fibre is shown in chart 4.

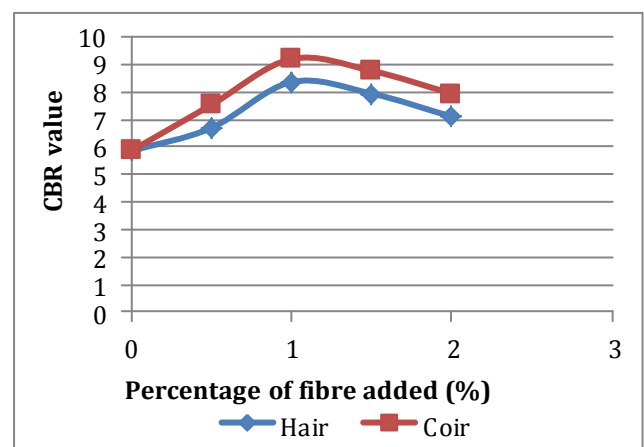


Chart-4: Variation in CBR value with the addition of human hair and coir fibre.

5.2.2 Variation in CBR value with the combination of hair and coir

Chart 5 shows the test results of CBR test for the combination of hair and coir blended with clay soil. For cohesive soils, the pavement thickness should be based on CBR value of the soil.

The CBR value increases with the addition of both hair and coir content and the optimum percentage was found out to be 1.0%. From the results it is clear that addition of 0.5% hair and 0.5% coir to the cohesive soil give maximum CBR value.

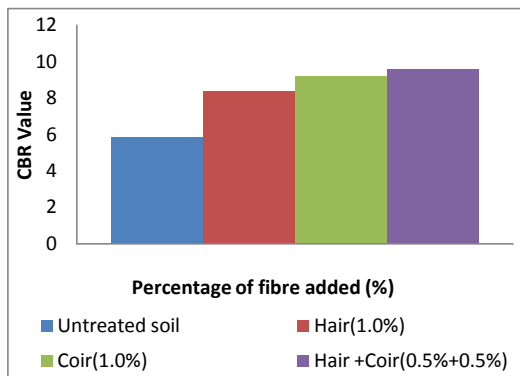


Chart-5: Variation in CBR value with the combination of hair and coir fibre

6. CONCLUSIONS

- MDD decreases with the addition of human hair.
- CBR value and UCC strength increases with the addition of human hair up to 1.0% and further addition of human hair decreases these values. Hence optimum percentage of human hair is selected as 1.0%.
- CBR value increased by 42.86% at optimum percentage of human hair.
- UCC strength increased by 56.305% at optimum percentage of human hair.
- MDD, CBR value and UCC strength increases with the addition of coir fibre up to 1.0% and further addition of coir fibre decreases these values. Hence optimum percentage of coir fibre is selected as 1.0%.
- MDD of soil is increased by 8.501% at optimum percentage of coir fibre.
- CBR value increased by 57.152% at optimum percentage of coir fibre.
- UCC strength increased by 67.685% at optimum percentage of coir fibre.
- Combination of 0.5% human hair and 0.5% coir fibre increases the MDD by 8.731%.
- Combination of 0.5% human hair and 0.5% coir fibre increases the CBR value by 64.245%.

- Combination of 0.5% human hair and 0.5% coir fibre increases the UCC by 121.06%.
- It can be concluded that, hair and coir fibre are the most promising materials in soil stabilization

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