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Investigation of the Effect of Natural Rice Straw Fibers on the Mechanical Behavior of Clayey Soils Stabilized with Cement

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ABSTRACT: Increased production of lignocellulosic waste and its incineration by farmers have raised bio-environmental concerns. Reusing these fibers to change the mechanical properties of loose soil can reduce these problems. It should be noted that the use of natural fibers has received more attention due to their compatibility with the environment and the realization of sustainable geotechnical goals. The reinforcement effect of rice straw fibers on the mechanical behavior of clayey soils stabilized with cement has been investigated. Studying the effect of different percentages of mixing these fibers on the compressive strength of clayey soils stabilized with different amounts of cement through performing unconfined compressive strength test and evaluation of the effect of the so-called fibers on the results of standard compaction test form the basis of laboratory research in this project. Cement can be used as an additive along with fiber reinforcement to create the required cohesion to increase the compressive strength of the sample. The results of unconfined compressive strength on the uncured samples stabilized with different amounts of cement (4%, 8% and, 12%), and reinforced with different amounts of rice straw fibers (0.25% and, 1%) show that at a constant content of cement, increasing the fiber percentage can increase the compressive strength up to 148% and also, at a constant content of fibers, increasing the cement percentage can increase the compressive strength up to 183%.

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1- Introduction

There are different mechanical and chemical methods for improving loose soils, and the use of each of these methods depends on various factors such as economic conditions, environmental considerations and structural conditions. [1]

Fibers are divided into two categories according to their nature: natural and artificial [2]. A common method to increase soil compressive strength is to use cement as a stabilizer [3]. This increase in strength is associated with brittleness and an increase in the modulus of elasticity [4]. However, the use of cement, along with increasing resistance, has disadvantages such as increasing carbon dioxide production, which is considered a risk to the environment [5]. That is why it is necessary to use environmentally friendly materials to cover this loss.

Many researchers have confirmed the excellent performance of natural fibers for soil improvement [6, 7]. The presence of natural fibers in the soil is like the presence of tree roots in the soil, which causes the stability of the layers near the earth's surface. Engineers use this method to stabilize thin layers of soil and stabilize slopes. However, the use of these fibers in more complex structures requires further investigation [8]. Other benefits of using fibers include reducing the amount of waste produced [9]. Therefore, if the soil in the area needs to be improved, it can be used with natural stabilizers or reinforcers due to its compatibility with nature and goals in accordance with sustainable geotechnics.

By using cement and fibers together, in addition to improving the mechanical properties of the soil and preventing the degradability of fibers, it is possible to reduce cement consumption and prevent further production of carbon dioxide and environmental pollution [10]. In this study, the aim of the study is to investigate the mechanical behavior of fine-grained clay soils reinforced with natural fibers of rice straw fixed with cement and also to investigate the effect of curing time.

2- Materials and Methodology

In this research, in order to improve the clay soil of Chaleh-Bagh area of Gorgan, rice straw fibers and Portland cement type 2 have been used. The grain size distribution curve of the studied soil is shown in Figure 1. This soil is in CL class in the unified classification system and according to ASTM D698-07 standard, the maximum specific dry weight is 1.79 and the optimum moisture content is 18.2%.

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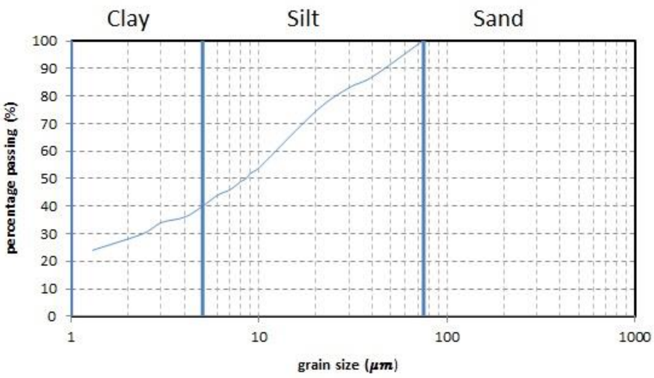

Fig. 1. Grain size distribution curve of the studied soil

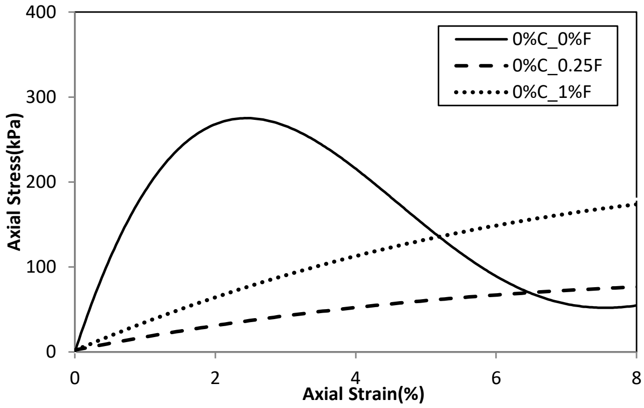

Fig. 2. Stress-strain curves of the reference sample and the fiber-reinforced samples

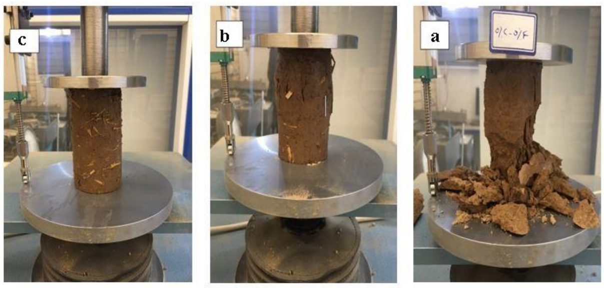

Fig. 3. Failure of reinforced samples (a) Reference samples. (B) Sample containing 0.25% of fibers. (C) Sample containing 1% of fibers

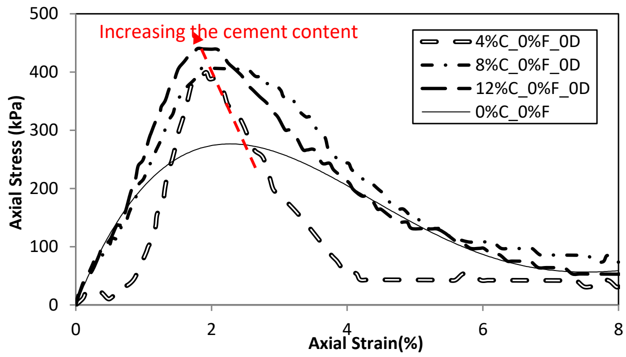

Fig. 4. Stress-strain curves of the reference sample and uncured samples stabilized with different weight values of cement

To determine the maximum specific dry weight and optimum moisture content of the samples, a standard compaction test was performed. After determining the necessary parameters, the samples were made in a special sampler for unconfined compressive strength test and then the compressive strength and failure strain values were measured.

3- Results and Discussion

30 unconfined compressive strength tests have been performed to evaluate the compressive strength under different conditions. Variable parameters of the experiment include fiber weight percentage (0%, 0.25% and 1% in terms of maximum dry specific weight), cement weight percentage (0%, 4%, 8% and 12% in terms of maximum dry specific weight) and curing time (0, 7 and 28 days). The results are given below:

4- Conclusion

The present study was conducted to improve clay soils. In this research, rice straw fibers and cement have been used to improve the clay and evaluate the compressive strength. The results of this research are as follows:

1. The results of the standard compaction test show that by increasing the amount of fibers in the same cement content, the compaction diagram has moved to the right and down, which indicates the reduction of maximum dry specific weight and increase of optimum moisture content.

2. The results of the unconfined compressive strength test of fiber-reinforced specimens indicate that the fibrous specimens have a flexible behavior and the compressive strength is slightly improved by increasing the amount of fibers from 0.25% to 1%.

3. The results of the unconfined compressive strength test of cement-stabilized specimens show that there is a turning point in the stress-strain diagram of these specimens, which indicates brittle behavior.

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