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Enhancing strength parameters of Firoozkooh sandy soil improved with Persian herbal gum

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ABSTRACT: Various improvement methods have been proposed to improve the mechanical and physical characteristics of soil for construction and other similar matters. One of the improvement methods is using environmentally-friendly elements such as Persian herbal gum as a renewable hydrocolloid biopolymer. Regarding this, in the present laboratory study, the effect of adding this gum to the Firoozkooh sand (No 161) was investigated. Persian gum-water mixture was added in different percentages relative to the weight of dry soil, and the created samples were subjected to unconfined compressive strength test to identify the optimal conditions of the composition. In spite of the variability of the weight percentages of water and gum added to the soil, the effect of the weight of the soil, curing temperature (room or oven temperature), and curing time (7 to 56 days) were investigated. To interpret the effect of Persian gum addition, several scanning electron microscope tests were performed on selected dry samples. The results clearly revealed an increase in the unconfined compressive strength of the samples improved with Persian gum up to 4 MPa due to the presence of many carboxyl and hydroxyl groups in the gum. Samples cured at room temperature with relative humidity of 15% displayed lower unconfined compressive strength than similar samples cured at oven temperature due to the hydrophilic properties of herbal gum and increased flexibility of the created bonds.

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1- Introduction

For a long time, traditional materials such as Portland cement and lime have been widely used to improve various types of soil [1,2]. Due to various environmental concerns, such as the increase in cement pollution and greenhouse gases [3,4], nowadays, engineers are faced with limitations in using these materials. For this purpose, proper environmental-friendly materials for soil improvement like biopolymers have been evaluated in recent literature. Regarding this, Plant-based, animal-based, and microorganism-based of biopolymers are three famous categories, which are used in soil improvement [5-7]. In light of plant-based biopolymers, Guar, agar, and alginate are three main materials in this category that are widely used to improve the geotechnical properties of soils such as reducing permeability and increasing shear strength parameters [8]. Persian gum, which is also called Zedo or Farsi gum is one of the unknown biopolymers that is used in the medicine and food industry. It has recently shown good performance in stabilizing and improving sandy and clay soil [9-12].

In this research, the effect of adding Persian gum on increasing the compressive strength of Firoozkooh soil (No. 161) has been investigated. Optimizing the weight percentage of Persian gum, humidity, and initial density of the soil is done by unconfined compressive strength test, and the effect of curing time and place on the unconfined compressive strength is checked on the treated samples. Also, to check the microscopic structure, scanning electron microscope test was performed on the dry improved samples.

2- Methodology

A standard mold with a diameter of 10 cm (ratio of height to diameter: 2) was used to make unconfined compressive samples. After the initial tests on the Firoozkooh soil, the dry density of the soil was determined in different initial states (DR=30%,50%,70%). Then, according to the volume of the mold, the soil is completely dried in the oven (110 ^{0}c) to minimize the initial moisture content of the soil. To prepare each sample, we first dissolve the amount of gum in a certain amount of water at a temperature of 25 degrees and mix it with soil using a hand mixer at room temperature for 3 minutes. Covered the inside of the mold with thin greased paper, it has been tried to prevent the sample from sticking to the mold. After that, using the reduced density method, the materials are added to the mold in 4 steps and transferred to its curing place immediately.

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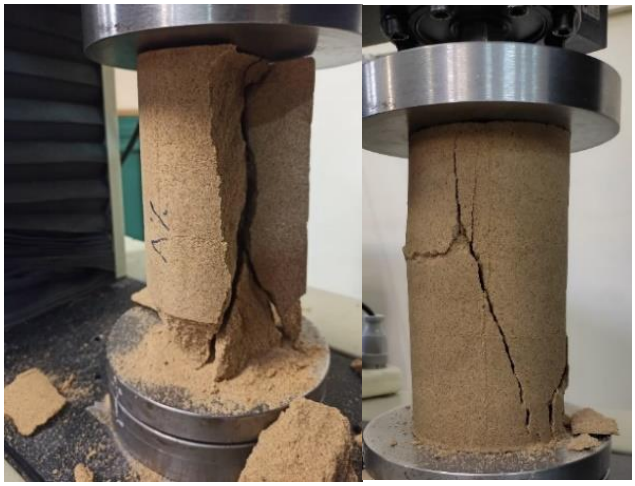

a) b)

Fig. 1. Appearance after unconfined compressive strength a) Room cured sample b) Oven cured sample

3- results and discussion

Some of the results obtained according to this research based on the carrying out unconfined compressive strength tests on treated samples are as follows:

1-Gum-water solution to the Firoozkooh sand creates gel bonds between the solid grains of the soil and with the loss of sample moisture, the created gel becomes stronger and increases the unconfined compressive strength of the samples.

2- Increasing the amount of gum or moisture by passing a certain percentage increases the lubrication property and reduces the strength, and the sample containing 2% gum and 16% moisture with 3.8 MPa compressive strength was identified as the optimal state of the composition.

3- With increasing the initial soil density, the unconfined compressive strength increases until reaching the final dry density of 15.15 and then follows the decreasing trend.

4- The gum-water solution combined with soil depends on temperature completely and at increased temperature (Oven) creates a strong and brittle structure compared to a flexible structure at room temperature. (Fig. 1)

5- The final compressive strength of improved samples at room temperature is 50% lower than the similar samples treated in an oven, but it still has considerable compressive strength compared to its untreated soil.

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