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Study of geotechnical properties of silty loess soil stabilized with lime and glass fiber

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1-Introduction

Soil is one of the essential building materials, and the primary support of structures has long been a human interest. However, due to weakness in shear strength and lack of resistance to tensile forces, researchers have consistently sought to increase its bearing capacity, strength, and improve its properties and various methods including mechanical modification such as compaction, chemical modification such as treatment with lime or cement (Al Aghbari, 2005; Tang et al., 2007).
One of the most important issues that should be considered in soil projects is the problematic soils. The most important problematic soils are collapsible soils. If these soils are not identified, if structures, roads, or railroads are built on them, water infiltration into the soil can cause significant problems. Loess deposits are common examples from collapsible soils that, based on their considerable distribution in Iran, research has been done on different aspects.
Loess soil combined with fibers and lime has good integrity, and consistency and causes form a composite material. Threads of fibers are distributed throughout the soil volume, and in different directions, it will create a homogeneous soil (Maher and Gray, 1990).
In this study, to improve geotechnical properties of silty loose soil, lime, glass fiber, and combined lime and glass fiber as a stabilizer be used.

2-Methodology

In this study, lime and glass fibers were used to improve the silty loess soil. The silty loess soil was sampled from a Golestan province region and transferred to the Soil Mechanics Laboratory of the Shams University of Gonbad-e-Kavos, to achieve this. Then, to compare soil stabilization and reinforcement, the effect of lime and glass fiber, each individually and simultaneously on geotechnical characteristics of silty loess soil, has been investigated. The percentages of mixing for lime is (0%, 4% and 8% of dry weight of soil) and glass fiber (0%, 0.3%, 0.6%, 0.9%, 1.2%, 1.5% and 2% of dry weight of soil). The mixing rate and different curing periods on the compaction behavior, compressive strength, and shear strength of the samples have been investigated.

3- Results and discussion

For samples mixed with 0% glass fiber, 4% and 8% lime, the optimum moisture content and maximum dry unit weight have increased and decreased, respectively. For soil mixed with 4% lime, the optimum moisture content and maximum dry unit weight were 15% and 1.75 g/cm3. In 8% lime, the optimum moisture content and maximum dry unit weight were 15.5% and 1.72 g/cm3.

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For samples containing 0% lime and different percentages of fibers, the optimum moisture first decreased and increased. However, the maximum dry unit weight has a decreasing trend, and it reached from 1.76 g/cm3 for natural soil to 1.72 g /cm3 for the sample with 2% fibers. For other samples, the soil mixed simultaneously with lime and fibers, the optimum moisture content increased, and the maximum dry unit weight decreased.

When the soil is mixed with lime alone, with increasing lime, the amount of soil strength increased during all curing duration. When soil is mixed simultaneously with lime and fibers, in samples with short curing duration (1 and 7 days), samples with 8% lime have more strength. However, in the 28-day curing duration, samples containing 4% lime have more strength.

By increasing the curing duration from 7 to 28 days, the internal friction angle increases for a soil sample with specified lime and fibers. Where the soil is only reinforced with glass fibers (0% lime), the amount of soil cohesion increases increasing fiber content, so that by increasing the fiber content to 2%, Soil cohesion reached 0.37 kg/cm2. The cohesion of natural soil is 0.03 kg/cm^2.

4-Conclusion

The results of unconfined compressive strength tests showed that adding glass fiber to lime stabilized soil significantly increases the compressive strength of the samples, increases the strain of the rupture, and reduces the cracks' width. In the direct shear test, it was observed that mixing the soil with lime and glass fibers increases the shear strength, increases displacement at failure, increases the soil's friction angle, and increases cohesion. Unconfined compression strength and direct shear tests showed that there is a fiber percentage that, by increasing the fiber percentage from that, the strength decreases. This amount of fiber was obtained in most tests between 0.9 to 1.2% fibers.

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