Evaluation of the Effect of Moisture on Interface Shear Strength Parameters of Lime Stabilized Clayey Soil-Geogrid with Sifferent Aperture Size

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Extended Abstract

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Introduction

Many studies have shown that the lime stabilization method can increase the strength and hardness of cohesive soils. Increasing these parameters is dependent on several factors such as curing time, lime content, clay minerals, soil particle size and moisture content.

When lime is added to moisture clay soils, a number of reactions occur to improve soil properties: 1- short-term and 2- long-term reactions. The short-term reactions include cation exchange, flocculate and carbonation; whereas, the long-term reactions include pozzolanic reactions. Since adding lime changes clay particles structure, it can change shear strength parameters.

Using geogrids as reinforcement in soil mass creates a composite system in which the soil tolerates compressive stresses. The elements of the reinforcement are also responsible for tensile stresses and interaction the reinforcement elements and soil increases the strength and ductility. The mechanism of stress transfer is based on interaction between soil and reinforcement. Accordingly, one of the most important issues in the analysis and design of reinforced soil structures is determination of frictional resistance parameters in soil-geogrid interface (adhesion and friction angle) which is discussed in this paper.

Stability and performances of reinforced earth structures significantly depend on the shear behavior of interface soil-geogrid in different weather conditions. Factors such as rainfall, seepage of groundwater and seasonal changes influence on soil moisture content. Changes in moisture content or soil dry density change interface soil-geogrid resistance. Increasing moisture content reduces the shear strength of reinforced soil and sometimes leads to large deformation or failure of system.

In this study, clayey soil with low plasticity (CL), hydrated lime for soil stabilization and two types of geogrid with different aperture size for reinforcing were used. In order to improve the brittle behavior of lime stabilized soils and to increase ductility of the samples, in the present study, lime stabilization and geogrid reinforcement was investigated, simultaneously. The interface shear strength parameters of treated soil with different lime content-geogrid and reinforcement coefficient were determined by direct shear tests. In addition, to study the effect of moisture content on interface shear strength soil-geogrid, all samples were subjected to shear in optimum and higher moisture content because the long-term performance of reinforced cohesive soils exposed to seasonal variations is evaluated.

Material and methods

The selected soil for the study is clayey soil from south region of Tehran, Iran. According to Unified Soil Classification System (USCS), the soil was classified as CL (clay of low plasticity).

In this study, three series of specimens were prepared and tested as follows:

- Stabilized samples with 0, 2, 4 and 6% lime for 7 days curing time
- Reinforced samples by geogrid (with and without transverse ribs of geogrid)
- Reinforced stabilized samples with different lime contents (0, 2, 4, 6 and 8%) by geogrid (with and without transverse ribs of geogrid) for 7 days curing times

To investigate the effects of bearing resistance provided by the transverse members of the geogrid and their contribution to the overall strength for reinforced soil sample, numerous tests were conducted with the geogrid without transverse members (all the samples had the same number of longitudinal members of the geogrid).

Direct shear tests were carried out on specimens based on ASTM D5321 at constant horizontal displacement rate of 1 mm/min.

Results and discussion

The results reveal that the shear strength of the stabilized soil increased and there are maximum values in an optimum lime content which is about 4%. Increasing lime content to an optimum lime content of clay caused the maximum changes in clay minerals because of cementitious and pozzolanic reactions and increases the strength of the clayey soil. Reduction of strength by adding lime to the soil more than the optimum content may be caused by the following reasons:

1. Stopping pozzolanic reactions because of finishing reactance during reaction
2. Making difficult the release of limewater (Ca OH $_2$) in the cementitious context of soil.

Until SiO_2 and AL_2O_3 are not finished, pozzolanic reactions continue and produce cementitious product, thus the shear strength increases and improves the long-term performance of the stabilized soils.

Reinforced soil samples have higher shear strength relative to samples without reinforcement subjected to the same normal stress. This increase in shear strength is mainly attributed to the interlocking of soil particles that penetrate through geogrid apertures. In addition, geogrids restrain particles´ movement and thus increase the mobilized frictional resistance at particle contact points.

Increasing in lime content to 4% (optimum lime content in this study) has significant effect on the development of adhesion and then decreases gradually with increasing of lime content from 4 to 6%, while friction angles remain constant approximately.

Adhesion and friction angles decrease with increasing moisture content.

The results show that the reinforced stabilized specimen with 4% lime has the maximum value of reinforcement efficiency. The increase in moisture content can significantly reduce the reinforcement efficiency.

It is clearly observed that the reinforcement coefficient of reinforced stabilized sample by geogrid that has smaller aperture opening size (4×4 mm) is higher than reinforced stabilized sample by another geogrid (10×10 mm) in optimum and higher than optimum moisture content.

Conclusion

One hundred and twenty samples in 3 specimen categories including lime treated, reinforced and reinforced treated samples were prepared for the current study for 7 days curing time in optimum content and higher than optimum content. The main results can be concluded as:

The test results indicate that the shear strength of stabilized clayey samples increases after 7 days curing time due to pozzolanic reactions.

The results show that reinforced samples have higher shear strength relative to unreinforced samples.

Adhesion and friction angles and reinforcement efficiency decrease with increasing moisture conten**t.**

The reinforcement coefficient of reinforced stabilized sample by geogrid 1 that has smaller aperture opening size is higher than by geogrid 2. In general, interaction between particles and geogrid with smaller mesh size is stronger because of matching the size of soil particles and meshes.

Keywords: Moisture content, Interface shear strength parameters, Clay soil, Lime, Aperture size of geogrid, Direct shear test

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