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Investigation of Soil-Geogrid Interface in Direct Shear test, with Emphasis on the size of Apertures of Geogrid and Different Compaction Degrees of Soil

A. Lakirouhani*, M. Abbasian

Department of Civil Engineering, Faculty of Engineering, University of Zanjan, Zanjan, Iran

ABSTRACT: It has been of great interest among the researchers to investigate the behavior of soil_ geogrid interface. Due to the wide use of geogrids between different layers of soil; these investigations are very important. This paper shows the results of experimental tests on soil_geogrid interface. This study conducts a series of large scale direct shear tests to investigate the interface shear strength of granular soil with various degrees of compaction and various sizes of geogrid apertures. The shear stress versus shear displacement curves and peak shear strength are important for evaluating the results. The interactions between soil and geogrid may include the following mechanisms: 1) shear resistance between soil and the surface of the geogrids; 2) internal shear resistance of the soil in the opening area; and 3) passive resistance of the transverse ribs. The value of α was defined to evaluate the effect of geogrid on the shear strength of the soil which is the ratio of geogrid_soil shear strength to internal shear strength of soil. The results showed that a larger degree of compaction reduces the resistance in soil_geogrid interface and shear strength of soil_geogrid interface will be reduced further by reducing the distances of transverse ribs of geogrid.

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1- Introduction

The interface shear strength of soil against geogrid is of great interest among the researchers in geogrid and geo-synthetic properties. However, the interaction mechanisms under direct shear mode between soil and geogrids are more complex than those between soil and geo-synthetics. The interactions between soil and geogrid may include the following mechanisms: 1) shear resistance between soil and the surface of the geogrids; 2) internal shear resistance of the soil in the opening area; and 3) passive resistance of the transverse ribs [1]. These mechanisms have been quantified by many researchers [2, 3]. On the other hand, the contribution of transverse ribs of geogrid has not been recognized completely. For instance, some researchers have been reported that the contribution of the passive resistance induced by the transverse ribs of geogrids is almost negligible under direct shear mode [4]. Soil has a sliding behavior in front of geogrid, so it is expected that the soil-geogrid interface has significantly lower shear strength than soil strength. The most effective parameters in this reduction are grain size distribution, the size of apertures, degree of compaction and normal stress.

In order to evaluate the effects of these components on shear resistance of soil-geogrid interface, a series of large-scale direct shear tests was conducted as part of this study. The most important consequences are reported in following.

Corresponding author, E-mail: rou001@znu.ac.ir

2- Materials

Two kinds of soils (a kind of sand and a gravel which classified as SP and GP, respectively), a geogrid (the size of apertures=2.5×2.5 cm^2) and a geotextile (a woven geotextile with unit weight= 250 g/m^2) were used in this study. According to have some different size of apertures of geogrid for the purpose of investigating some of longitudinal and transverse ribs were removed as illustrated in Figure 1. The size of the shearing device was 30×30×15 cm^3 .

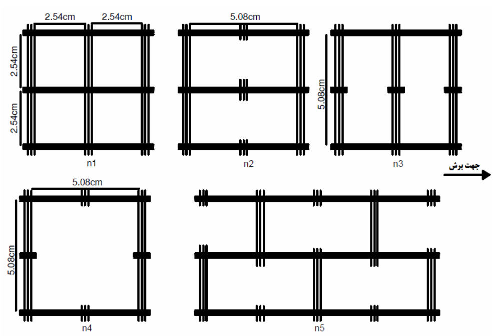

Figure 1. Geogrid specimens

3- Results and Discussion

A series of large-scale direct shear tests were conducted to evaluate the shear strength of sand-geo-synthetic interface using a kind of sand with 40%, 55% and 70% degrees of compaction and a kind of gravel with 70% degree of compaction. These tests were fulfilled on pure sand and pure gravel with various degrees of compaction and on sand and gravel with a layer of geotextile and geogrid embedded on the interface of samples. Figures 2 and 3, illustrates shear stress- horizontal displacement curves for geogrid n1 for sand and gravel samples with different degrees of compaction, respectively. All these curves are based on three normal stresses.

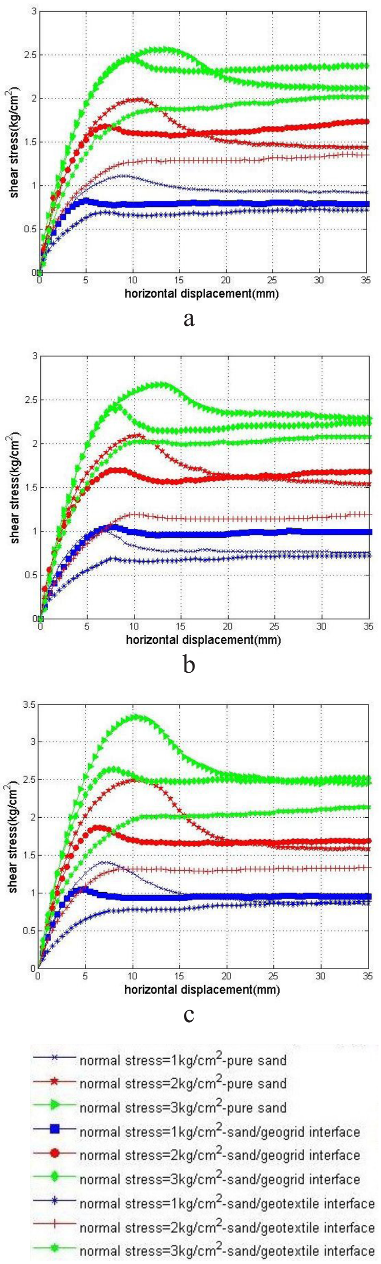

Figure 2. Shear stress- horizontal displacements behavior of sand samples with a) 40%, b) 55% and c) 70% degrees of compaction

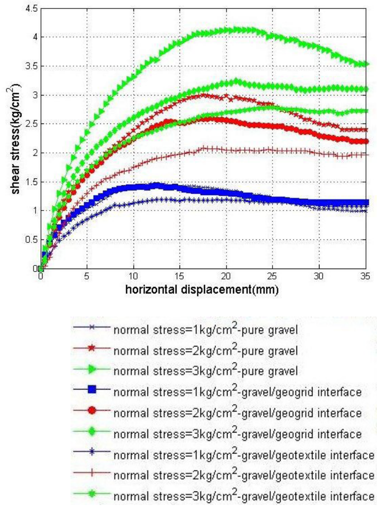

Figure 3. Shear stress-horizontal displacements behavior of gravel samples with 70% compaction degree

Test results clearly showed that the behavior of sand-geogrid shear strength interface is completely different from behavior of pure sand and sand-geotextile shear strength interface. Sand-geogrid interface shows peak shear strength then experiences a "yield" shear stress and at least with a mild slope it shows a hardening behavior. After yielding and in the hardening part sand-geogrid shear strength interface with 40% and 70% relative densities is higher than the pure sand. In 55% relative density, the residual resistance of pure sand and sand-geogrid interface are equal. It indicates that the passive resistance developed by transverse ribs of the geogrid is more effective in larger shear displacements.

4- Interface shear strength coefficient (α):

This parameter defined as:

$$\alpha = \frac{\tau_{soil-geosyncetic}}{\tau_{soil}} \quad (1)$$

$\tau_{soil\text{-}geosyncetic}$ and τ_{soil} refers to maximum shear strength of sand geo-synthetic interface and maximum internal shear strength of soil, respectively. It can be concluded that increasing in degrees of compaction of samples causes a reduction in the shear strength of sand-geogrid interfand the greater aperture sizes, especially in shear direction, result a larger values of α. On the other hand, a reduction in distances between transverse ribs causes a great reduction in the shear strength of sand-geogrid interface. The values obtained in this study are generally consistent with those reported in previous investigations [1, 4].

5- Conclusions

The shear strength of soil-geo-synthetic interface is lower than the shear strength of pure soil. There are three components for shear resistance of soil-geogrid interface under direct shear mode. According to the test results, the second component-internal shear resistance of the soil in the opening areas of geogrid has the most contribution.

For a geogrid with a larger size of apertures in shear direction the value of α increases. When the sizes of apertures are smaller, there is a separate space between the upper and lower shear box and a bit of sliding in the shear interface, so the value of α decreases. On the other hand, the largest shear strength belongs to the pure sand and then the shear strength of sand-geogrid interface. When the degree of compaction increases, the shear zone plays a more important role. There was a reduction in the shear strength of soil- geogrid interface when the degree of compaction was larger. So it should be considered that embedding a layer of geogrid, for every reason, causes a reduction in shear strength. A 25% strength reduction was obvious when the degree of compaction was 70%.

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