Experimental Investigation of Time-Dependent Effect on Shear Strength Parameters of Sand–Geotextile Interface

Mahmoud Ghazavi[1], Javad Ghaffari[2]

1- Associate Professor, Civil Engineering Department, K. N. Toosi University of Technology, Tehran, Iran

2- PhD Student, Civil Engineering Department, K. N. Toosi University of Technology, Tehran, Iran

Email: j_ghaffari@dena.kntu.ac.ir

Abstract

The time-dependent behavior of soils has been investigated extensively using one-dimensional and triaxial tests. The phenomena associated with time effects in soils are creep, relaxation, strain rate and re-arrangement effects. The engineering properties of soil are often improved significantly with the time elapse. The objective of this paper is to investigate the time-dependent effect on the shear strength parameters of sand–geosynthetic interface using large direct shear test apparatus. For this purpose, the geotextile layer has been adhered gently on a piece of wood with a thickness such that a half of the shear test box has been occupied. The other half of the box has been filled with the sand and the test has been performed. Three normal stresses of 30, 45, and 60 kPa have been applied in all tests. The shear stress has subsequently been applied in different times to the failure stage. In all tests, the shearing velocity has been kept the same. The results of these experiments show that the stiffness and friction angle of the dry sand–geotextile interface increases up to 12.6% and 3.9% at 720 minutes after the sample is poured in the mold.
Keywords: geosynthetic, large direct shear test, aging, friction angle, sand–geotextile interface.

1. INTRODUCTION

For the past three decades, the use of geosynthetics to reinforce soil mass has been grown significantly. Nowadays, they are a well–accepted construction material. The use of reinforcement objects increases resisting forces in the soil mass through the tensile force provided by reinforcement elements, and consequently reducing the horizontal deformations and increasing the overall stability of the soil structure [16]. Therefore, the evaluation of soil-geosynthetic interface parameters, the interface friction angle, δ, and adhesion, ca, is important for the design of reinforced soil structures.

The soil–geosynthetic interaction parameters are influenced by a) interaction mechanism between geomaterials and geosynthetics (pull-out or direct shear), b) physical and mechanical properties of geomaterials (density, grain shape and size, grain size distribution, water content, and plasticity of clayey soils), and c) mechanical properties (tensile peak strength), shape and geometry of geosynthetics.

Although the shear strength of soil/geosynthetic interface has been investigated by conducting other tests, such as tilt table tests [24] and torsional ring shear tests [21, 23], the direct shear test is still the most common testing method. For example, direct shear tests on interfaces between soil and geotextile have been performed by Richards and Scott, Rowe et al., Lafleur et al., Garg and Saran, Orman, Alfaro et al., Mahmood et al., Lee and Manjunath, Bergado et al. and Farsakh et al. [1, 3, 7, 8, 10- 12, 18-20].

It is well established that time dependent property changes after deposition and/or densification occur in clean sand deposits in the field [4, 6, 9, 14, 15, 17, 22]. These changes, which may be significant over periods of days to weeks, including an increase in small strain stiffness and large strain strength, as reflected by increasing penetration resistance. Most published evidence of aging effects in sands comes from in situ tests like cone and standard penetration tests.

Daramola (1980) investigated the effects of aging on both the stiffness and shear strength of Ham River sand. Four consolidated drained tests on the sand were performed. The volumetric strain data that the axial strain at which the soil became dilatant decreased with increasing time. Daramola (1980) concluded that a 50% increase in modulus occurs for each log cycle of time. Despite the increase in modulus and dilatancy, there was no increase in the shear strength of the sand with time [5].

This paper presents the results of a laboratory testing program to study the time-dependent effect on shear strength parameters of sand–geotextile interface using large direct shear test apparatus. Also, in these tests, the influence of thickness of geosynthetic on time-dependent effects has been investigated. The specific properties observed with time are the shear strength parameters and stiffness of sand–geotextile interface.