TESTING AND ELASTOPLASTIC MODELING OF UNSATURATED SOIL-STEEL INTERFACE

by Tariq Bin Hamid

ABSTRACT

The objectives of this research were to: (1) design and construct an apparatus for testing unsaturated interfaces and soil; (2) testing of unsaturated soil and interfaces in the new device to study the strength and volumetric behavior of unsaturated soil and interfaces and (3) develop an elastoplastic model to account for the effect of suction and net normal stress on the behavior of an unsaturated interface.

A conventional fully automated direct shear test device was modified for performing the experimental program to achieve the objectives of this study. The newly developed device, called Unsaturated Interface Direct Shear Apparatus (UIDSA), has capability of applying and maintaining suction as well as net normal stress. The UIDSA can be used to conduct constant water content and constant suction tests on unsaturated soil and unsaturated interfaces.

Major device modifications included the construction of an air pressure chamber and testing cells for holding soil and counterfaces, addition of high air entry porous stones, addition of a pore water and pore air control system, and other modifications to accommodate the new apparatus. For saturated soil testing, a High Air Entry Porous Disk (HAEPD) was fixed in the bottom half of the shear box, whereas for interface testing the HAEPD was fixed in the top platen and was placed on the top of the soil during testing.

The performance of the newly developed device was checked and effects of net normal stress, suction, and roughness were investigated. The net normal stresses of 105, 140, and 210 kPa and suctions of 20, 50 and 100 kPa were used and all tests were conducted under constant suction condition. Results presented in this study suggest that the maximum shear stress of interfaces between unsaturated soil and steel is a function of net normal stress and suction. As net normal stress and suction increased, so did the shear strength.

An existing elastoplastic constitutive model was modified to predict the behavior of interfaces between unsaturated soil and steel. Predictions made with the modified elastoplastic model agreed well with the experimental results. The results of this study may be used in the analysis of stability and load-deformation response of unsaturated soil-structure system such as piles, sheet piles, and retaining walls.