Tuesday 3/14/2017

1:15–2:45 p.m.

Soil and Rock Testing and Modeling 4

Chairs: Maurice Morvant, Trautwein GeoTAC; Neil Schwanz, U.S. Army Corps of Engineers

Evaluation of Uncertainty for Soil Water Characteristic Curve Measurements and Implications for Predicting the Hydro-mechanical Behavior of Unsaturated Soils

Lauren Fissel and Ronald Breitmeyer, University of Nevada, Reno

Reproducibility of inter-specimen soil water characteristic curve (SWCC) measurements was quantified for four soil samples collected from the Sagehen Experimental Watershed near Truckee, California. The hanging column method, the UMS HYPROP apparatus, and the dew point potentiometer method provided measurement of the SWCC. The van Genuchten SWCC function was parameterized using regression on data from 10 HYPROP trials per soil and individual measurements from the hanging column. Variability in water content (θ) was $\pm$ 0.03 to $\pm$ 0.13 at any given suction (ψ), indicating random variability in SWCC prediction despite identical specimen preparation. Variability in replicate parameter estimates for a single soil may be greater than 14% of median estimates. This variability could affect strength testing reliant upon replicate specimen preparation. Additionally, this result may impact testing programs that commonly rely upon a single SWCC measurement and subsequent parameterization.

Analysis of the Fabric Changes in a Clay-Rock Mixture under Shear

Luis Vallejo, University of Pittsburgh

Mudflow deposits have a distinct fabric consisting of a mixture of clay and large dispersed rock- like particles. The evaluation of the mechanical properties of these mixtures is challenging. Very little is known about the changes in fabric experienced by these mixtures when subjected to shear, and how these changes influence the failure of the mixtures. In this, study the fabric changes will be studied using simulated clay-rock mixtures. Clay samples containing wooden rods were subjected to direct shear in a Plane Stress Direct Shear Apparatus (PSDSA). The tests indicated that the clay developed regions of intensified compression at the interface between the clay and the rods. Failure took place in these regions. If more than one rod was present in the samples, the regions of failure interacted producing a continuous failure surface. Also, clay regions near the rods developed voids that influenced the permeability of the simulated clay-rock mixtures.

Investigating the Role of Soil Fabric in Unsaturated Soils

Mohammad Motalleb Nejad and Kalehiwot Nega Manahiloh, University of Delaware

The principle of effective stress states that the strength and volume change behaviors of soil are governed by intergranular forces expressed in terms of a continuum quantity called effective stress. Past research on effective stress formulations has identified a tensorial quantity that characterizes the liquid phase of unsaturated granular geomaterials. This quantity was named fabric tensor of the liquid phase and was shown to be anisotropic and to have an intrinsic association with the evolution of the effective stress tensor. It was also shown that its variation is random and can be depicted with microstructural image analysis. In this study, two past micromechanical effective stress formulations are discussed in comparison with Bishop's effective stress. The extended Mohr-Coulomb and effective stress approaches

are used in interpreting shear strength parameters and effective stress parameter for partially saturated granular soils. Correlations are identified for some material variables. The nonlinearity observed in the angle of friction associated with the matric suction was discussed in relation to the fabric tensor of the liquid phase.

Effects of Common Boundary Types in Direct Shear Tests

Anjana Kittu and Michelle L. Bernhardt, University of Arkansas

The direct shear test is one of the oldest and simplest tests used for determining the shear strength of granular soil. The common boundary plate inserts used in the physical tests are either porous stones or grid plates, which ensure drainage, as well as the transmission of shear stress across the soil sample. Often in Discrete Element Method (DEM) simulations, however, a fixed-particle boundary or sawtooth boundary are used. At present, there is limited information available regarding the effects of these boundary types on the observed response. The current study focuses on the laboratory response of the granular material, under four different boundary conditions (fixed-particle, saw tooth, and two sizes of grid inserts). Direct shear tests were conducted on samples of metal ball bearings for each of the boundary types. The influence of these boundaries in relation to the peak shear stresses and friction angles are compared and evaluated. The data collected in this study will serve as experimental validation for DEM simulations of similar direct shear tests.

Impact of Wet-Dry Cycle on Shear Strength of High Plastic Clay Based on Direct Shear Testing

Md. Ashrafuzzaman Khan, Md. Sahadat Hossain, and Sonia Samir, University of Texas at Arlington; Md. Sadik Khan, Jackson State University; Al Aramoon, Texas Department of Transportation

Cyclic wetting and drying of compacted highly plasticity clays and shales cause volume change through shrinkage and swelling. This eventually may decrease the shear strength to the fully softened state. The objective of the current study is to determine the change in strength as well as physical properties of high plasticity clay due to repetitive swelling and shrinking over time. During this research, the effects of cyclic wetting and drying on the shear strength of the clayey soil were investigated. Soil samples were collected from a slope located on I 35 near Mockingbird, Dallas to prepare test specimens which were subjected to 1, 3 and 5 wet-dry cycle before the direct shear testing. It is observed that the angle of internal friction decreased by 6o and cohesion decreased by 55% of initial compacted stage after the fifth wet-dry cycle.