Wednesday, 3/15/2017

9:45–11:15 a.m.

Soil and Rock Testing and Modeling 5

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

Numerical Evaluation of the Effect of Unsaturated Soil above the Water Table on Cone Resistance

Pegah Jarast S. and Majid Ghayoomi, University of New Hampshire

Cone Penetration Test is a field investigation technique to characterize soils. However, most of the correlations have been developed for dry or saturated soils. Unsaturated soils are mostly available above the water table where suction stresses can influence the cone resistance. Thus, ignoring the partial saturation could result in inaccurate estimation of mechanical properties from the cone resistance. In this paper, cone penetration is simulated inside soil layers with various ground water levels using Finite Element Method. Mohr-Coulomb constitutive model is modified for unsaturated soils. Material parameters are updated according to the stress state and suction profile in depth using user-material subroutines. Lowering the water table increases the cone resistance above the water table due to the presence of suction stresses that contribute to the effective stresses in the soil. However, this difference diminishes passing the water table where suction goes to zero and effective stress decreases in saturated soil.

Geophysical Waveform's Frequency Attenuation as a Precursor to Rock Shear Failure

Ahmadreza Hedayat and John Hinton, Colorado School of Mines

Ultrasonic wave monitoring methods are among the most promising proven methods in investigating the shear failure of rock discontinuities (fractures or joints). In this study, ultrasonic waves recorded during direct shear experiments on rock joints were employed to investigate the shear failure processes. A series of direct shear experiments was performed on gypsum specimens where shear waves were transmitted through and reflected off the discontinuity as the rock was subjected to shear failure. Distinct peaks in the dominant frequency of transmitted and reflected waveforms were systematically observed prior to the shear failure of the rock and were considered as “precursors” to the shear failure. This study shows that a rock discontinuity behaves as a low pass filter that attenuates the high frequency components of the signal. Such attenuation depends on the stiffness of the rock discontinuity which can be affected by the applied shear stress and the damage at the asperity contact points.

Evaluating the Behavior of a Cohesive Soil Undergoing One Cycle of Freeze-Thaw

Yuchen Huang and Christopher W. Swan, Tufts University

Previous research indicates that significant changes in engineering behavior of cohesive soils may occur if the soil undergoes cycles of freezing and thawing. Understanding this behavior would prove useful to engineering practice as soils subjected to freeze-thaw cycles is a common occurrence during and subsequent to construction or its placement. This research effort focused on the impact of a single freeze-thaw cycle on the deformation characteristics of a resedimented Boston Blue Clay (RBBC). A RBBC specimen was subjected to one freeze-thaw cycle while maintaining vertical stress conditions with a goal to evaluate changes in stress-strain behaviors of the resedimented soil during and after the freeze-thaw cycle. Results indicate that the RBBC heaved 1.6% during freezing but compressed 6.8% upon thaw – all under the same applied vertical stress – this represents a four-fold difference from

movements during freezing, indicating that the behavior of cohesive soils subjected to freezing and subsequent thaw warrants careful evaluation and consideration. Additional research is warranted to better understand other factors, such as the influence of stress history and freezing-thawing temperature, on potential expansion and compression movements.

A New Correlation of Eagle Ford Shale Strength Based on Texas Cone Penetrometer's Results

Minh Le and Tim Abrams, Terracon Consultants

Load carrying capacity of bedrock is needed for the design of foundations for structures in the Dallas-Fort Worth area. The load carrying capacity of bedrock can be estimated by testing rock core samples and by pressuremeter testing. These methods are time consuming and/or rather expensive to implement. An alternative method is to estimate the loading carrying capacity of bedrock in the field using Texas Cone Penetration's (TCP) measurements (number of blows per 12 inch cone travel distance or cone travel distance per 100 blows) and charts developed by Texas Department of Transportation (TxDOT). Moon et al. (2004) have developed empirical equations to mathematically predict the compressive strength of shale in Dallas area. However, the rock quality designation (RQD) and rock percentage recovery, which measure the degree of jointing or fracture in a rock mass, have not been included in the published correlations. This study presents a new approach to incorporate RQD and rock percentage recovery as another contributing factor in new empirical correlations along with the TCP's measurements to better estimate the unconfined compression strength of Eagle Ford shale in particular. This new strength correlation that was developed has a better statistical fitness compared to other previously developed correlations by other researchers.

Applying the techniques of microstructural image processing towards measuring interface angles in Unsaturated Geomaterials

Mohammad Motalleb Nejad, Kalehiwot Nega Manahiloh, and Christopher L. Meehan, University of Delaware

Previously, researchers have examined phase interactions in multi-phase systems such as geomaterials at different degrees of saturation. Some studies have measured the angle made by the solid-liquid and liquid-air interfaces using physical laboratory tests. The lack of technological advancements that enabled microstructural inter-phase examination has largely impeded results from such efforts. In addition, the measurement of contact angle has largely been dominated by user interference. Recent developments in image acquisition and associated advanced image processing platforms have enabled automated quantification of microstructural features. This study proposes two image-based contact angle-measurement approaches: the "liquid-pixel" and "regression" approaches. The study also investigates "center" identification for contact angle measurement. Statistical evaluation of the measurements is performed for both methods and the observed results are discussed. It is concluded that the "non-zero-intercept" approach, one variation within the regression-based techniques, gave the most reliable angle measurement.