Monday 3/13/2017

12:15–1:45 p.m.

Soil and Rock Testing and Modeling 2

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

Numerical Modeling and Analysis of Suffusion Patterns for Granular Soils

Hui Tao and Junliang Tao, University of Akron

Migration of fine particles through constrictions between coarser fabrics by seepage force is the process termed suffusion. A coarser soil structure resulted from fines loss will lead to change in hydraulic and mechanical properties such as increased permeability, decreased strength and stability which can cause significant settlement or failure of the levees, embankments and dams. This paper presents a coupled Computational Fluid Dynamics and Discrete Element Method (CFD-DEM) approach to model the suffusion process. The concept of transition layer is defined and used to explain the suffusion process and patterns. The effects of particle size distribution, seepage velocity, fines content and initial void ratio on the transition layer in suffusion are investigated.

Probing the Mechanical Properties of Shales by Nanoindentation

Degui Xiang, Zhaowei Chen, Simin Wang, and Qian Wang, Drilling Research Institute, China National Petroleum Corp.; Zhenning Yang, Yibing Deng, and Guoping Zhang, University of Massachusetts, Amherst; Dongwei Hou, Shanghai Jiao Tong University and State Key Laboratory of Ocean Engineering;

Nanoindentation testing was performed on 121 fractured core and drill cutting shale samples to investigate the mechanical properties of samples. With a twofold goal to examine the possibility of obtaining mechanical properties from small intact core fragment and to hereafter establish an understanding for upscaling relationship between cuttings and cores. A new hardness-based method for clay matrix is proposed to reasonably process and interpret indentation data. Results reveal that the clay matrix's mechanical properties including Young's modulus, hardness, and fracture toughness can be obtained. Such a hardness-based method for processing indentation data proves to be convenient and feasible. Weak anisotropy is observed for the studied shale samples. The fracture toughness exhibits stronger anisotropy. Comparison of the results from fractured core blocks and shale cuttings shows encouraging agreement in their mechanical properties, hence intact drill cuttings may be advantageously used for nanoindentation testing in cases where intact core samples are unavailable.

Understanding of Florida's Sinkhole Hazard: Hydrogeological Laboratory Study

Adam L. Perez, BooHyun Nam, Ethan Denison, Manoj Chopra, and Amr M. Sallam, University of Central Florida

Sinkholes pose a hazard socially, economically and environmentally. In Florida, sinkhole-related insurance claims between 2006 and 2010 amounted to $1.4 billion. The scope of this study is to develop a sinkhole simulator (soil-groundwater physical testing) that can assess the qualitative behavior of the hydrogeological mechanism of sinkhole formation. The physical model setup incorporates an unconfined and confined aquifer system with constant head controls for each. Water level transducers are used to monitor variations in the water table during the sinkhole process. The study investigates effects of sinkhole affecting parameters such as soil type and compaction level. Scenarios involving adjustments in soil type and compaction are employed to collect data on water table drawdown and

erosion characteristics, as well as the type of sinkhole formation, either cover-collapse or cover-subsidence. A strong relationship between soil compaction, cohesion and the type of sinkhole formed was observed.

Kinematics of Shear Banding in 3D Plane Strain DEM

C. Clay Goodman, Farshid Vahedifard, and John F. Peters, Mississippi State University

Shear banding is generally viewed as a form of instability that occurs when the observed states of a system permit a bifurcation in the solution path to two (or more) solutions. The mechanics of shear bands have been studied extensively both experimentally and analytically, yet mostly in a qualitative manner and in two-dimensions. The evolution of the micro-deformation mechanism leading to the development of shear bands is still not well understood and has important implications in three-dimensional analysis. Presented herein is a promising method of modeling the micromechanics of the shear band phenomenon in plane strain using parallelized discrete element method (DEM). The preliminary results show the DEM's capability of responding correctly to different loading conditions giving an accurate depiction of the behavior of real soil. The preliminary results from the DEM simulations are presented and discussed.

A Semi-empirical Shear Strength Model for Infilled Rock Fractures with Infills in an Unsaturated State

Ali Khosravi and Sayedmasoud Mousavi, Sharif University of Technology; Mahdi Khosravi, Amirkabir University of Technology

Based on the results of recent studies, comprehensive characterization of the behavior of infilled rock fractures under saturated and unsaturated conditions requires knowledge of morphological details of fracture surface, as well as state of stress of infill materials and their initial innate conditions (e.g., void ratio, water content, degree of saturation and dry density). This paper describes a semi-empirical equation to interpret the effects of wall-roughed nature of the fractures and presence of partially saturated fine materials within the fractures on the behavior of infilled rock fractures during shear. The proposed equation incorporates the soil-water retention curve parameters as well as hardening due to changes in either volume or degree of saturation into existing models originally developed for fractures with saturated infills. The literature data is also used to evaluate the reliability of the proposed equation in predicting the shear strength of infilled rock fractures in unsaturated conditions.