Monday 3/13/2017

2–3:30 p.m.

Thermal & Hydraulic Conduction 1

Chairs: Ingrid Tomac, University of California, San Diego; John McCartney, University of California, San Diego

Comparison of Modified Transient Plane Source and Transient Line Source Techniques for Measuring Thermal Conductivity of Two Sands

Jun Yao and William J Likos, University of Wisconsin–Madison

Experiments were conducted to compare two laboratory techniques for measuring thermal conductivity of unsaturated soils: (a) a modified transient plane source (MTPS) method for non-destructive measurements using a planar, interfacial heat reflectance sensor; and (b) a transient line source (TLS) method utilizing a single-probe heat source. Thermal conductivity and thermal conductivity dry out curves (TCDCs) were measured for two sands, including a poorly graded sand, and a well-graded sand with silt. The MTPS sensor resulted in larger thermal conductivity values than the TLS sensor for pore water saturations greater than 50%. At low pore water saturation, the MTPS sensor potentially underestimates thermal conductivity due to poor sensor-soil contact potentially resulting from the absence of water bridges between the sensor and soil surface.

Modeling of the Coupled Hydro-Mechanical Response of Geological Sequestration Reservoirs Due to CO2 Injection

Marte Gutierrez and Simon Heru Prassetyo, Colorado School of Mines

This paper presents the results of computer modeling to predict the response of GS (Geological Sequestration) reservoirs to CO2 injection. Coupled H-M (Hydro-Mechanical) modeling is conducted using the computer code FLAC (Fast Langrangian Analysis of Continua) developed by Itasca (2011) and applied to the CO2 GS project in the In Salah Gas Field in Algeria. The modeling focused on the H-M response such as the spread of the CO2 plume, time history of pore pressure increase, and ground surface uplift, which are compared with available field monitoring data and previous modeling studies of the In Salah CO2 GS Project. In addition, the potential for mechanical failure and eventual CO2 leakage through the caprock in the In Salah field is analyzed using a critical pressure approach.

Piping Phenomenon of Embankments Constructed by Volcanic Soils and its Evaluation

DAO Minh Hieu and Shima Kawamura, Muroran Institute of Technology; Satoshi Matsumura, Port and Airport Research Institute; Yunzeheng Lan, University of Science and Technology Beijing

This paper aims at clarifying destabilization of volcanic embankments caused by piping phenomenon in which fine particles migrate within void networks. In order to accomplish the purposes, field observation of a full-scale embankment was firstly carried out. Thereafter, a series of upward seepage test was conducted to grasp features of seepage behavior in volcanic soils and to investigate effects of differences in compaction conditions on its behavior. In consideration of test results, it was shown that destabilization of soil structures due to seepage flow is derived depending on an increase of amount of finer soil particles. Additionally, internal stability of compacted volcanic soils under geometric condition was investigated based on Kenny & Lau's, Kezdi's and Li & Fannin's criteria in detail. From the results, a geotechnical evaluation was discussed for the stability of soil structures constructed by volcanic coarse grained soils subjected to seepage flow.

Simulation of Seepage through Fixed Porous Media using Smoothed Particle Hydrodynamics Method

Elnaz Kermani and Tong Qiu, Pennsylvania State University

Seepage of water through soil media, if not controlled, may lead to erosion of earth dams and their foundations and eventually can result in instability and failure. Thus, understanding of flow of water through porous media and accurately modeling of this phenomenon are of great importance in geotechnical engineering. In this study, Smoothed Particle Hydrodynamics (SPH) method is utilized to simulate a 2D pressure-driven vertical flow through fixed porous media. To model fluid motion, the spatially averaged Navier-Stokes equations are implemented into SPH formulations. The spatial heterogeneity and anisotropy of pore space are introduced in the model using local porosity values imported from granular samples created using the discrete element method (DEM). Fluid-solid coupling is considered using classic semi-empirical equations. A SPH model is developed using one-way coupling method, to simulate flow of water through fixed porous media under various hydraulic gradients caused by different mechanisms (e.g., pressure gradient, body force). The effects of porosity values and hydraulic gradients on discharge velocity are studied. The results are compared against published simulation results to validate the developed SPH model.

Comparison of Field and Laboratory Methods for Measuring Hydraulic Conductivity in the Unsaturated Zone in Engineered and Native Soils

Pablo Garza, Zachary Zukowski, and Andrea L. Welker, Villanova University; Derron LaBrake, Wetlands & Ecology Inc.; Richard Nalbandian, MRNenvironmental

Stormwater control measures (SCMs) are used to control runoff volume and peak flow rates. Rain gardens are one type of vegetated SCM which can utilize engineered or native media. Hydraulic conductivity, which can be measured in the field or laboratory, is a major design parameter for infiltration SCMs. The double-ring infiltrometer (ASTM D3385) is the most commonly used technique to determine hydraulic conductivity in the field; however, it can be cumbersome because of its considerable size and large water usage. In this study, various infiltration techniques, such as Modified Philip-Dunne, single-ring, and double-ring infiltrometers, were used to determine the hydraulic conductivity at different sites. In addition, the UMS KSAT Benchtop laboratory method was used to find hydraulic conductivity. Preliminary results indicate that the Modified Philip-Dunne provides results similar to the other tests methods.

Coupled Heat Transfer and Groundwater Flow Models for Ground Freezing Design and Analysis in Construction

Joseph A. Sopko, Moretrench American Corp.

Artificial ground freezing has been used for over 100 years to provide temporary earth support and groundwater control for deep excavation in both unconsolidated soils and rock. Time dependent thermal numeric models have been used to evaluate the required freezing time for ground freezing systems and to evaluate the required refrigeration loads. Groundwater velocity through the freezing system is a mechanism that introduces additional heat energy into the system that can retard or even prevent the formation of a frozen earth barrier. Recent software developments have introduced models that couple the traditional heat transfer model with groundwater flow models. These models allow the

design engineer to evaluate the effects of the groundwater velocity on the freezing system. It permits the design engineer to modify the ground freezing system or to reduce the permeability of the soils with ground improvement techniques thereby reducing the groundwater velocity permitting timely ground freezing operations. This paper discusses the application of these models and compares them to actual field results on key ground freezing projects. The results of these comparisons indicate the commercially available models are reliable thereby establishing a standard method of design for ground freezing projects.