

**Tuesday 3/14/2017**

**9:45–11:15 a.m.**

**Geotechnical Aspects of Transportation Systems**

Chairs: Charles Schwartz, University of Maryland; Boo Hyun Nam, University of Central Florida

**Influence of Chemical Stabilization on Flexural Fatigue Performance of Subgrade Soil**

*Moeen Nazari, University of Oklahoma; Rouzbeh Ghabchi, South Dakota State University; Musharraf Zaman, University of Oklahoma; Sesh Commuri, University of Nevada, Reno*

The chemically-stabilized subgrade (CSS) soil layer in a pavement structure can undergo flexural fatigue as a result of a high number of loading cycles and brittleness of the stabilized soil. The type and amount of chemical stabilizing agents are generally selected based on the results of unconfined compressive strength (UCS) and/or resilient modulus (Mr) tests. The UCS and Mr tests help characterize the compressive behavior of the soil and do not specifically assess the flexural behavior of the CSS layer under cyclic loads. This study aims to evaluate the fatigue life of the CSS layer and compare it with other common indicators such as UCS and Mr. For this purpose, a series of UCS, Mr and four-point flexural fatigue (FPFF) tests were conducted on CSS soil samples. The materials tested in this study consisted of six blends of a lean clay stabilized using cement kiln dust (CKD) and hydrated lime. The CKD was mixed with the soil at 5, 10, and 15% by weight of dry soil. The hydrated lime was mixed with soil at 3, 6, and 9% by weight of dry soil. It was found that while increasing the amount of stabilizing agent resulted in higher UCS and Mr values, it had an adverse effect on the fatigue life of CSS. The specimens containing 5% CKD and 3% lime showed the highest fatigue lives compared with other mixes. It was concluded that the strain endured by the material at the peak load (strain at failure) plays an important role in the fatigue life of the CSS. CSS samples with a high strain level at failure possessed a high fatigue life while those with a lower strain at failure failed after a relatively low number of loading cycles.

**Failures of Pipe Culverts from a 1,000-Year Rainfall Event in South Carolina**

*Sarah Gassman, Inthuorn Sasanakul, Charles Pierce, Emad Gheibi, William Ovalle, Mostaqur Rahman, and Ryan Starcher, University of South Carolina*

South Carolina recently experienced a 1000-year rainfall event that caused catastrophic flooding and crippled the transportation infrastructure. Initially, almost 400 roadways were closed due to flooding, a majority of which were closed from roadway washouts. Many of these roadway washouts resulted from failure of the pipe culvert soil system beneath the roadway. The culvert infrastructure is critical to not only preventing flooding during normal and extreme conditions but is integral to proper road and highway maintenance. This paper presents the results from a post-flood reconnaissance study aimed to collect perishable data from sites where pipe culverts failed and roadways were washed out. The study included collection of extensive photographic evidence and documentation of descriptive information related to the failure; collection of soil samples; and field and laboratory geotechnical tests.

**Evaluation of Freeze and Thaw Durability of Road Soils Stabilized with Biofuel Co-Product**

*Bo Yang, Halil Ceylan, Gopalakrishnan Kasthurirangan, and Sunghwan Kim, Iowa State University*

In the past decade, the biofuel industry has seen significant development in the United States and all over the world. Based on a review of recent bioenergy literature, it appears the by-products derived during biofuel production may play a positive role in value-added engineering applications. Recent

studies at Iowa State University (ISU) demonstrated the successful utilization of biofuel co-products (BCPs) in pavement subgrade stabilization. This paper discusses the effect of three types of BCPs containing different lignin content from lignocellulosic biorefineries on a typical Iowa soil called loess in terms of freeze and thaw durability. Emphasis is given to detailed data analysis of laboratory test results in comparing three types of BCPs treated soils with untreated and cement treated soils. Results reveal that the BCPs investigated in this study are promising materials to improve freeze and thaw durability of the Iowa loess classified as CL-ML or A-4 for geotechnical applications.

### **Comparison between the Permeability and Diffusivity Function Derived from Different Methods of Unsaturated Expansive Soils**

*Hussein Al-Dakheeli, and Rifat Bulut, Oklahoma State University; Charles Aubeny and Robert Lytton, Texas A&M University*

Permeability and diffusivity function of expansive subgrade soils are critical parameters in the design of pavements. They govern the moisture flow in and out of the soil and thus the amount of movement the subgrade experiences. Several models have been proposed to estimate the both functions from the soil water characteristic curve (SWCC) and the saturated coefficient of permeability. However, these methods reveal a noticeable difference in the determination of both functions. The permeability coefficient can also be measured from the diffusion coefficient and the slope of the SWCC, or experimentally by the instantaneous profile method. In this paper, a comparison study in the determination of both parameters from the most frequently used SWCC models, diffusivity test, and instantaneous profile method is carried out. It is found that SWCC models reveal significantly less measurements than those derived from the other two methods. However, the results from the diffusivity test manifest good agreement with those derived from the instantaneous profile method.

### **Measurement and Finite Element Modeling of Pavement Response to Superloads**

*Joseph Podolsky, Jeramy C. Ashlock, and R. Christopher Williams, Iowa State University*

The goal of this study is to examine the feasibility of using a bridge structural testing system and finite element modeling (FEM) to assess the impact of heavy hauls in terms of stresses and the corresponding reduction in service life for portland cement concrete (PCC) pavements on grade. FEM simulation results are compared for various numerical treatments of the subgrade using the programs EverFE and COMSOL. With the simplified dense liquid foundation subgrade treatment used in EverFE, the experimentally measured bending strain profile in the slab could not be accurately captured using a single coefficient of subgrade reaction. A more general optimized 3D solid subgrade model was developed in COMSOL using the pseudo-coupled method, by modeling a large solid soil domain surrounding the slab, with the subgrade modulus increasing from the center to the edge of the slab in three separate regions. The optimized 3D solid subgrade model resulted in better agreement with experimental strains.