

Transportation Research Board
82st Annual Meeting

**Doctoral Student Research in Transportation
Geotechnics**

Sunday, January 12, 2003
1:30 p.m. – 5:00 p.m.
Washington B4
Marriott Wardman Park Hotel

*The workshop is cosponsored by TRB sections: A2K00, Soil Mechanics,
A2L00, Geology and Properties of Earth Materials, and A2J00, Geomaterials*

The National Academies

The Transportation Research Board is a unit of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. Under a Congressional charter granted to the National Academy of Sciences, the National Research Council provides scientific and technical advice to the government, the public, and the scientific and engineering communities.

Transportation Research Board
82nd Annual Meeting

Doctoral Student Research in Transportation Geotechnics

Sunday, January 12, 2003
1:30 p.m. – 5:00 p.m.
Washington B4
Marriott Wardman Park Hotel

Moderators: Pedro Arduino, *University of Washington*
Susan E. Burns, *University of Virginia*

The primary objective of this new workshop series initiated at the 2001 Annual Meeting is to integrate recent and upcoming geotechnical PhD's into the TRB research community, by providing them with an opportunity to showcase their research at the Annual Meeting. The workshop will consist of reports on geotechnical engineering research related to transportation facilities that will be of interest to both practitioners and researchers.

- | | |
|-------------------|---|
| 1:30 pm - 1:45 pm | Introduction
Pedro Arduino, <i>University of Washington</i>
Susan E. Burns, <i>University of Virginia</i> |
| 1:50 pm – 2:05 pm | Geo-Environmental Assessment of Fly Ash stabilized Subbases
Sazzad Bin-Shafique, <i>University of Wisconsin-Madison</i> |
| 2:10pm - 2:25 pm | Mechanics of Compressibility and Strength of Solid Waste in Bioreactor Landfills
Sahadat Hossain, <i>North Carolina State University</i> |
| 2:30 pm - 2:45 pm | Pier Scour and Contraction Scour in Cohesive Soil on the Basis of Flume Tests
Ya Li, <i>Texas A&M University</i> |
| 2:50 pm – 3:05 pm | Characterization and Modeling of Paleoliquefaction Features in Missouri
Houda Jadi, <i>University of Missouri-Rolla</i> |
| 3:05 pm - 3:25 pm | BREAK |
| 3:30 pm - 3:45 pm | Frequency Dependence of Dynamic Soil Properties
Jiewu Meng, <i>Georgia Institute of Technology</i> |
| 3:50 pm - 4:05 pm | Genetic Algorithms Coupled with Neural Networks Present New Possibilities for Backcalculation
Paul Christopher Marshall, <i>The University of Memphis</i> |
| 4:10 pm - 4:25 pm | Advancing Pavement Management through the use of SASW and IR
Vivek Khanna, <i>University of Oklahoma</i> |
| 4:30 pm - 4:45 pm | Incorporation of Environmental Factors into Flexible Pavement Design
Gang Zuo, <i>University of Tennessee</i> |

The workshop is cosponsored by TRB sections: A2K00, Soil Mechanics, A2L00, Geology and Properties of Earth Materials, and A2J00, Geomaterials

The National Academies

The Transportation Research Board is a unit of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. Under a Congressional charter granted to the National Academy of Sciences, the National Research Council provides scientific and technical advice to the government, the public, and the scientific and engineering communities.

Transportation Research Board
82nd Annual Meeting

Doctoral Student Research in Transportation
Geotechnics

Sunday, January 12, 2003

1:30 p.m. – 5:00 p.m.

Washington B4

Marriott Wardman Park Hotel

Moderators: Pedro Arduino, *University of Washington*

Susan E. Burns, *University of Virginia*

Name : Sazzad Bin-Shafique
E-mail: mbinshafique@students.wisc.edu
Address: 1217 Engineering Hall
1415 Engineering Dr
Madison, WI 53706
Tel: (608) 232-0538
Fax: (608) 263-2453

Name : Sahadat Hossain
E-mail: sahadat_hossain@urscorp.com
Address: URS Corporations
200 Orchard Ridge Drive
Suite 101
Gaithersburg, MD 20878
Tel: 301-721-2213
Fax: 301-869-8728

Name : Ya Li
E-mail: em_liya@hotmail.com
Address: College Station, TX 77843
Tel: 979-8629474(h),
979-8459300(o)
Fax: 979-845-6554

Name : Houda Jadi
E-mail: hjadi@umr.edu
Address: 219, Civil Engineering Department-
University of Missouri-Rolla
1870 Miner Circle
Rolla, MO- 65409
Tel: 573-341-6548 / 573-368-4265
Fax: 573-341-4729

Name : Jiewu Meng
E-mail: gt7154d@prism.gatech.edu
Address: 790 Atlantic Dr.,
Atlanta, GA, 30332
Tel: 404-385-0061
Fax: 404-894-2281

Name : Paul Christopher Marshall
E-mail: pcmrshll@memphis.edu
Address: Department of Civil Engineering
The University of Memphis
Memphis, Tennessee 38152
Tel: (Home) (281)837-6588
(Work) (281)931-8674
Fax: (281)931-3246

Name : Vivek Khanna
E-mail: vkhanna@ou.edu
Address: School of Civil Engineering and
Environmental Science
University of Oklahoma
202 W. Boyd Street, Room 334
Norman, Oklahoma 73019-1024
Tel: (405) 325-9244
Fax: (405) 325-4217

Name : Gang Zuo
e-mail: gzuo@engr.utk.edu
Address: Department of Civil and Environmental
Engineering
University of Tennessee
223 Perkins Hall
Knoxville, TN 37996
Tel: (865)974-4835
Fax: (865)974-2608

Doctoral Student Research in Transportation Geotechnics

Title: Geo-Environmental Assessment of Fly Ash stabilized Subbases

Author: Md Sazzad Bin-Shafique, *University of Wisconsin-Madison*

Abstract:

A combined experimental and computer modeling approach is adopted to evaluate the potential for groundwater contamination for using fly ash for the stabilization of soft subgrades in highway construction. The leaching potential for soil-fly ash mixture estimated from water leach tests is non-linear with the fly ash content because of variation of pH of the leachate. Column leaching tests conducted in laboratory showed that the hydraulic conductivity, pH of the effluent, and initial effluent concentration of soil-fly ash mixtures increase with increasing fly ash content. The release pattern for metals from the soil-fly ash mixtures appears to be adsorption-controlled and the retardation factor is essentially similar to that of the subgrade soil. Lysimeters installed at two field sites showed that the liquid flux through the stabilized layer is approximately 4-6% of average annual precipitation. A numerical model that simulates field scenarios was operated using transport parameters obtained from column leaching tests showed that the maximum concentration decreases abruptly 5 times in the first meter, and then decreases more gradually at deeper depths. The maximum concentration at a given depth is independent of the retardation factor, and decreases with higher dispersion and lower thickness of the stabilized layer.

Doctoral Student Research in Transportation Geotechnics

Title: **Mechanics of Compressibility and Strength of Solid Waste in Bioreactor Landfills**

Author: Sahadat Hossain, *North Carolina State University*

Abstract:

A major aspect of bioreactor landfill operation is the recirculation of collected leachate back through the refuse mass. The overall objective of the research was to develop an understanding of change in refuse compressibility and strength during accelerated waste decomposition in bioreactor landfills. An experimental program was performed to provide data on parameters describing MSW compressibility and strength properties as a function of the state of decomposition, gas generation, and physical characteristics of waste particles. Refuse samples were generated in laboratory-scale reactors. The reactors were destructively sampled to obtain refuse at various states of decomposition, based on the reactor's methane production rate curve. In addition, the state of decomposition was quantified by measurement of concentrations of cellulose (C), hemicellulose (H), and lignin (L). Reactors were sampled to obtain refuse different phases of decomposition.

Test results indicated shredding of MSW affects mainly initial compression and shear strength. The coefficient of primary compression (C_c) for all samples showed an increasing trend with decreasing $(C+H)/L$. The creep index (C_α) is independent and the biological index (C_β) is dependent of the state of waste decomposition. Measured shearing angle decreases with decomposition. A simple compressibility model and a shear model were developed.

Doctoral Student Research in Transportation Geotechnics

Title: Pier Scour and Contraction Scour in Cohesive Soil on the Basis of Flume Tests

Author: Ya Li, *Texas A&M University*

Abstract:

In the present study, a systematic investigation was carried out by conducting flume tests on complex pier scour and contraction scour in porcelain clay.

For complex pier scour, the individual and combined effect caused by shallow water, pier spacing, pier shape and flow attack angle are examined, and corrector factors with respect to the simple pier scour are proposed. In addition, a thorough shear stress approach was developed, where the influence of soil properties on pier scour is fully represented by the involvement of critical shear stress of the eroded soil.

For contraction scour, a methodology is developed to predict the contraction scour depth distribution along the channel centerline. The critical shear stress is involved in the prediction process as well as correction factors for the contraction length effect and transition angle effect with respect to a long contraction scour case.

Finally, the integration method is developed to calculate the total bridge pier scour, in which bridge contraction scour, abutment scour and pier scour are integrated together based on the concept of critical shear stress of soil and the relationship between bridge abutment scour and contraction scour observed in flume tests.

Doctoral Student Research in Transportation Geotechnics

Title: Characterization and Modeling of Paleoliquefaction Features in Missouri

Author: Houda Jadi, *University of Missouri-Rolla*

Abstract:

This research supports studies of earthquake hazards assessment in Missouri, and Missouri-New Madrid Seismic Zone (NMSZ). It entertains objectives related to improving earthquake hazard assessment techniques through the investigation of recently discovered paleo-liquefaction features (i.e. Clastic sand dikes intruding a fine-grained host stratum) along the Meramec River near St. Louis, Missouri and in the southeastern part of the state situated within the NMSZ. Geotechnical Characterization, in conjunction with analytical dynamic modeling of the paleo-liquefied soils is used to predict the characteristics of the pre-historic earthquake event(s) that caused such features. A ground motion time history with associated earthquake magnitude, peak ground acceleration (PGA) and distance from source region , which will cause the observed liquefaction failure condition will be back-calculated. Results of this study are anticipated to provide tools for engineering seismic design and evaluation of soil amplification and liquefaction potential. These results will also provide a tool to prioritize the need for infrastructure remedial actions in the study areas, particularly that no strong ground motion data has been recorded in history. Though infrequent, a seismic event in the northeastern part of the NMSZ and St. Louis area can be devastating.

Doctoral Student Research in Transportation Geotechnics

Title: Frequency Dependence of Dynamic Soil Properties

Author: Jiewu Meng, *Georgia Institute of Technology*

Abstract:

Natural and man-made vibrations typically occur within the frequency range of about 1 mHz to 100 Hz. Measurements using conventional laboratory test methods including the resonant column and torsional shear tests are performed at a limited number of discrete frequencies, which hinders the ability to characterize the frequency dependence of modulus and damping within this frequency range.

A non-resonance method has been developed based on linear viscoelastic theory to determine the modulus and damping of soils as a continuous function of frequency from 10 mHz to 30 Hz and at strain amplitudes from 10^{-5} to 10^{-2} . The new method utilizes the same test device commonly used for resonant column and torsional shear tests. The non-resonance method has been validated using metal and polymer calibration specimens and with tests on coarse-grained and fine-grained soils. In addition, the back-EMF phenomenon that affects damping measurements has been analyzed theoretically and a real-time solution has been developed and implemented.

The results indicate that both of modulus and damping of fine-grained soils are functions of frequency; coarse-grained soils exhibit less frequency dependence. Furthermore, the frequency dependence of modulus and damping is consistent with the Kramers-Kronig relationship. The test results contribute to our understanding of dynamic soil properties and permit more accurate predictions of soil response to dynamic loads.

Doctoral Student Research in Transportation Geotechnics

Title: Genetic Algorithms Coupled with Neural Networks Present New Possibilities for Back calculation

Author: Paul Christopher Marshall, *The University of Memphis*

Abstract:

Back calculation is just the search for a mathematical model of the pavement system that produces the same response to load as the real pavement system. Traditionally, the mathematical model is based on layered elasticity. Researchers have long known that pavements aren't accurately modeled as simple layered elastic systems, but more complex models are computationally inefficient and contain more material parameters than can be back calculated from a single deflection basin. Genetic algorithms can be combined with artificial neural networks to search for complex pavement models that simultaneously reproduce the response of the real pavement system to an entire suite of FWD tests. Genetic algorithms are computationally simple yet powerful search algorithms based on the mechanics of natural selection ("survival of the fittest"). A "population" of pavement models is made to evolve over many generations into increasingly "fit" models that ever better capture the response of the pavement system. To speed the search, the finite element model is replaced by an artificial neural network that produces the same output in a fraction of the time. Together, the inherent calculation efficiency of neural networks and genetic algorithms lets us search much more complex solution spaces using much more information than ever before.

Doctoral Student Research in Transportation Geotechnics

Title: Advancing Pavement Management through the use of SASW and IR

Author: Vivek Khanna, *University of Oklahoma*

Abstract:

A pavement management system (PMS) provides a systematic procedure for selection of the most appropriate maintenance & rehabilitation (M&R) strategy for a pavement network. M&R decisions in a PMS are based on an assessment of current and future pavement condition. This assessment is traditionally performed by visual distress surveys that determine a pavement condition index (PCI). This index cannot be used with any of the existing pavement analysis techniques to estimate structural capacity or remaining life of a pavement section. Therefore M&R recommendations from a PCI based PMS will not be the most suited for the observed distress. This research advances pavement management by integrating mechanistic pavement condition evaluation into the process. Non-destructive procedures like the spectral analysis of surface waves (SASW) method and the impulse response (IR) method were used for assessing pavement condition. The SASW and IR methods evaluate parameters like pavement layer thickness, their low-strain moduli and the quality of subgrade support. The measurement of layer moduli and their decay with time allows prediction of pavement capacity and its remaining serviceable life. This enables the selection of the most appropriate M&R strategy for the section and leads to improved pavement management.

Doctoral Student Research in Transportation Geotechnics

Title: Incorporation of Environmental Factors into Flexible Pavement Design

Author: Gang Zuo, *University of Tennessee*

Abstract:

The performance of flexible pavements is affected by environmental factors such as temperature change in the asphalt layers and the water content variation in the base and subgrade layers. The resilient modulus of the unbound materials decreases with water content, and varies with stress state. Temperature changes affect the stiffness of the hot mix asphalt (HMA) layer and thus the stress transferred to the unbound materials, which in turn affects the resilient modulus of the unbound materials. Therefore, the estimation of design pavement life should account for the daily variation of temperature and the seasonal variation of water content in the pavement system. As a research project for the Tennessee Department of Transportation (TDOT), four pavement sites were instrumented for over five years. Environmental data collected at the instrumented sites were used in a 3D finite element parametric study to quantify the changes in predicted pavement life as a result of temperature averaging interval and water content variation. The results of the parametric study suggest that the predicted pavement life is significantly affected by the chosen interval for temperature averaging.