Center for Transportation Infrastructure and Safety

NUTC NEWS

at Missouri University of Science and Technology

National University Transportation Center

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A Message from the Director — John J. Myers

Season's Greetings from CTIS! As usual, with the semester coming to a close and the Holiday season fast approaching, CTIS is bustling with educational, research and technology transfer activities.

On page 2, read about new and faster ways to evaluate aggregates during construction. These two systems,developed by Dr. David Richardson, will aid in predicting the durability of concrete and in predicting the amount of harmful deleterious materials present in aggregate.

In this issue, we are pleased to feature updates on both the MTI/MoDOT Structural Research Collaborative and MTI/MoDOT Geotechnical Transportation Research Program on pages 3 and 4. Read about our progress on these large, collaborative endeavors of the University of Missouri System and MoDOT.

IN THIS ISSUE...

Read a summary of the 5th International Conference on Recent Advances in Geotechnical Engineering and Soil Dynamics, prepared by the conference organizer Dr. Shamsher Prakash, on page 5. This successful conference was held in San Diego, CA in May.

Our education focus includes a profile of graduate research assistant Tao Wei on page 6. Congratulations to the recently named "Dr. Wei"!

From all of us at CTIS, we wish you Happy Holidays and happy reading!

Warm Regards,
John

Upcoming Events

53rd Annual Asphalt Conference

December 7-8, 2010
Rolla, Missouri

More info at http://asphalt.mst.edu/

Spring 2011 ACI Convention

April 3-7, 2011
Tampa, Florida

More info at http://www.concrete.org/events/ev_conventions.htm

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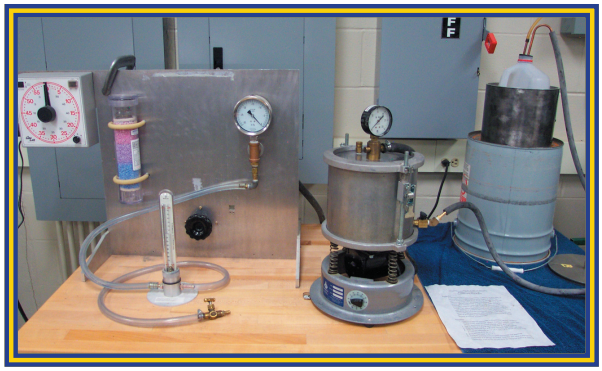
Changing Aggregate Evaluation

Point Load Device

Dr. David Richardson, associate professor of civil, architectural and environmental engineering, has been studying rocks as a construction material for most of his 25 years in academia, and for several years before that. In recent years, aggregates in concrete, asphalt and highway base layers have been a focus for Richardson and he has completed nine funded projects for National Science Foundation (NSF) and Missouri Department of Transportation (MoDOT) in these areas. Most recently, he developed two separate aggregate evaluation systems for prediction of the durability of concrete and for prediction of the amount of harmful deleterious materials present in aggregate. Both systems are based on a concept he developed during his Ph.D. research.

Aggregate makes up the largest proportion of concrete and asphalt mixtures. Thus, the properties of the aggregate, such as durability, have a strong effect on the properties of the concrete or asphalt of which the aggregate is a part. With support from MoDOT and the Center for Transportation Infrastructure and Safety (CTIS), Richardson's first project focused on freeze-thaw durability of concrete. Some aggregates used for concrete pavements do not stand up well to winter conditions. The most definitive predictive test for aggregate durability is the freeze-thaw test, which takes up to 90 days to complete and involves extremely expensive equipment that few entities can afford. These two issues create a roadblock in MoDOT's quest for field-friendly test methods that can be used in its movement toward performance-based specifications. In contrast, Richardson's prediction system involves low-cost, fast-turnaround time tests that estimate the results of the more involved freeze-thaw method with up to 95% accuracy. The system is based on test methods that mimic the various destructive mechanisms in aggregate during freeze-thaw attack. The method is presently being validated by MoDOT for adoption.

The second aggregate project, also supported by MoDOT and CTIS, concerned prediction of the amount of deleterious materials in aggregate used for three end-products: concrete, asphalt and highway base materials. Presently, MoDOT uses a visually-based method of determination of the types and amounts of deleterious materials in aggregate, such as soft rock, shale and chert. The problem is the subjective nature of the test methodology. Different inspectors report significantly different results for the same sample, leading to disputes in acceptance/rejection of materials. Again, using a combination of test methods that are easily performed, yet objective in nature, Richardson was successfully able to develop a predictive system that mimics various destructive mechanisms in different types of objectionable materials. This method is also presently being validated by MoDOT.



Vacuum Saturated Specific Gravity Work Station

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MTI/MoDOT Structural Collaborative Research Update

In 2008, to address MoDOT's and the nation's needs in developing better, faster and cheaper solutions for transportation structures with superior long-term performance, innovative construction technologies and effective maintenance and preservation strategies, Missouri Department of Transportation (MoDOT), with administrative oversight from Missouri Transportation Institute (MTI), collaborated with University of Missouri (UM) Structures faculty to cooperatively conduct research on transportation structures.

In order to comprehensively and effectively complete work within these areas, research was divided into tasks and sub-tasks to be conducted by those researchers with the appropriate expertise.

2A: Evaluation of Bridge Components for Consistent Safety Margins

The objective of this project is to calibrate load and resistance factors in LRFD to achieve a more uniform level of safety (reliability) in bridge design. The calibration of the load and resistance factors, specifically considering Missouri environment, will lead to a reduction in the up-front cost of bridges. Extensive data for the past twenty to thirty years was collected, including daily traffic, bridge maintenance records and relevant cost to maintain bridge performance. The collected data was then organized into an efficient and extensible database to be used for future study. Service Limit State was also determined based on the performance of bridges in the past years.

Reliability of bridge components designed with LRFD will be analytically evaluated. The focus of the reliability analysis will be on Service Limit State. Load models and Service Limit States from Task 1 were used in reliability analysis. Load factors were calibrated with two main objectives: 1) the bridge components should have consistent safety margin and 2) the bridge components designed with LRFD should be compatible with components designed with LFD which have performed well for the past years.

2B: Enhanced Concrete-Steel Bond Strength and Corrosion Resistance

The objective of this project is to optimize technology for the construction of RC structures for bridges while reducing construction costs and improving structure performance.

Main tasks include: 1) characterize and quantify the bond strength between coated rebar and concrete; 2) characterize the corrosion resistant properties of coated rebar in alkaline environments, including reinforced concrete; 3) develop new design equations for RC members and 4) develop design specifications for RC members using coated rebar and provide design training for MoDOT engineers as well as compare costs with conventional RC members.

To learn more about the scope of work and objectives for individual projects and the researchers involved, visit http://utc.mst.edu/research/2007.html. Or, look for more information in future issues of the NUTC News.

MTI/MoDOT Geotechnical Transportation Research Update

In 2008, in order to achieve significant and recurring cost savings for MoDOT (Missouri Department of Transportation) a collaborative project was undertaken by expert researchers within the University of Missouri (UM) system. The execution and completion of this program will address many of MoDOT's most pressing research needs while making notable improvements to the state of the art and practice of geotechnical engineering at a national and international level.

In order to comprehensively and effectively complete work within these areas, research was divided into tasks and sub-tasks to be conducted by those researchers with the appropriate expertise.

Task 2: Foundation Selection for Lowest Cost Transportation Products

The objective of Task 2 is to develop methods and procedures to improve foundation selection so that the most appropriate foundation type is selected and to decide when design and/or construction phase field load tests will produce lower cost structures.

The focus of these efforts has been to develop the knowledge, procedures and techniques to perform site characterizations that will produce the lowest cost transportation products possible on a system-wide basis. Specific objectives include:

- Quantify "hidden" conservatism or "bias" in measurements of design parameters relevant to foundations and earth slopes based on current practices and potential improvements to those practices
- Develop methods to establish site-specific variability in design parameters for use in LRFD design specifications based on laboratory and field measurements

This specific portion of the work involves a program of full-scale load testing of foundation elements to evaluate and quantify variability and bias in relevant design methods for deep foundations.

To learn more about the scope of work and objectives for individual projects and the researchers involved, visit http://utc.mst.edu/research/2008.html. Or, look for more information in future issues of the NUTC News.

5th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics and Symposium in Honor of Professor I. M. Idriss

For the fifth time since 1981 Dr. Shamsher Prakash of Missouri S&T has organized this international conference. One of the aims of the conference this year, held May 24-29, 2010 in San Diego, CA, was to honor Professor I.M. Idriss, who made long and tremendous contributions to the development and practice of geotechnical earthquake engineering. Hundreds of engineers, particularly young geotechnical engineers, availed themselves of the opportunity to present their work and interact with the international audience. The Keynote Lecture was delivered by Professor Liam Finn. Other state of the art and practice lectures were delivered by George Gazetas, Pedro S. Seco e Pinto, Ricardo Dobry, Susumu Iai, Ahmed Elgamal, Takaji Kokusho, Michael Pender, J. David Rogers, Atilla Ansal, Bruce Kutter and J.P. Singh.

A highlight of this event was the presentation of three GEER (Geo-engineering Extreme Events Reconnaissance) sessions – the first on Haiti and Chile Earthquakes in 2010, the second on Recent GEER Post-Event Reconnaissance and Emerging Reconnaissance Techniques and Practices and the third discussing recent earthquakes in China, Japan, Pakistan, Italy, Honduras and the 2009 tsunami in American Samoa.

Kenji Ishihara, Vlad Perlea, Raymond Seed, Ion Vlad, Mary Perlea, Dave Gillette and Tara Schenk McFarland enjoying the reception

Conference participants enjoying the Soil Dynamics Short Course

A pre-conference short course on "Soil Dynamics in Engineering Practice" was attended by 80 engineers from 16 countries. Also during the conference, the Shamsher Prakash Awards of 2008-2009 for young professionals were presented to Tara Hutchinson from USA and Jean-Francois Semblat from France for their research achievements, while Allen William Cadden from USA and Zygmunt Lubkowski from UK were honored for their excellent practices.

A post-conference tour to the Englekirk Center at the University of California San Diego (UCSD) was enjoyed by 90 of the conference participants. The tour was a collaboration between UCSD, University of California Santa Barbara, University of Texas and University of California Los Angeles. Participants observed demonstrations of some of the most impressive and significant large-scale earthquake engineering research equipment in the U.S.

Conference proceedings are available for purchase by visiting the website http://5geoeqconf2010.mst.edu.

Article written by Shamsher Prakash

NUTC Student Solutions: Tao Wei

Tao Wei was awarded a one-year graduate assistantship from the Center for Transportation Infrastructure and Safety to pursue doctoral studies in a transportation-related field. The award was made based on an exemplary academic career and the merit of his proposed research.

Under the supervision of Dr. Hai Xiao in the Department of Electrical and Computer Engineering, Wei's research at Missouri University of Science and Technology has focused mainly on the development of fiber optic-based sensors.

Optical fibers are used as hydrophones for seismic and sonar applications. Hydrophone systems with more than one hundred sensors per fiber cable have been developed and are in use by the oil industry, power plants and in naval defense in some countries. The technology Wei has developed uses light to measure physical parameters, such as refractive index, pressure and temperature, in order to optimize power plant operations at system and subsystem levels. The basic sensing elements and devices used in a typical power plant today have remained virtually unchanged since 1970.

The main goal of Wei's research was to develop robust measurement techniques for in situ monitoring of the operating conditions of a power plant in harsh, high-temperature and high-pressure environments. These advancements will improve efficiency and plant reliability as well as reduce pollutant emissions and water use.

A fascination with his research topic as well as a dedicated and supportive faculty group led Wei to pursue doctoral studies at Missouri S&T. Now that his research at Missouri S&T is complete, Wei hopes to become a professor at an academic institution of higher learning.

Wei was awarded a Master's of Science in January of 2008 and his Ph.D. in November 2010, both in Electrical and Computer Engineering at Missouri S&T. He has authored and co-authored more than 10 journal papers as a graduate student at Missouri S&T, one of which was featured in an article in Photonics Spectra in May 2008. Visit http://web.mst.edu/~xiaoha for more information.

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Over 1,500 tests were performed during the course of 2 years to provide data for both of the systems. The adoption of the concrete durability prediction system will assist MoDOT in achieving its goal of moving toward more performance-types of specifications. The use of the deleterious materials prediction system removes the subjectivity of the acceptance/rejection factor of the method MoDOT currently employs, leading to more precise results.

This article first appeared in The Bridge 2010

Happy Holidays from CTIS!