Newsletter of the Mid-Atlantic Universities Transportation Center

June 30, 2008

MAUTC, a five-university consortium led by The Pennsylvania State University, seeks to attract talented researchers and students to the study of transportation, and to engage them in new approaches to the transportation issues of today and tomorrow. MAUTC's theme is Technology for Integrated Transportation Systems Operation and Performance.

First Annual University/DOT Meeting

The University of Virginia and the Virginia Transportation Research Center hosted MAUTC's first annual university/DOT meeting in May. James Aylor, dean, School of Engineering and Applied Science, University of Virginia, welcomed guests and congratulated MAUTC on its new grant. Gary Allen, Chief of Technology, Research and Innovation, VTRC, encouraged participants to take a long-term view about research, but think about short-term and medium-term deliverables that the states need and people can use. John Mason, executive director of MAUTC, charged the participants with identifying research, education, and technology transfer activities that could be conducted collaboratively (by two or more universities and state DOT agencies) that would address a regional transportation system need.

Each university gave a presentation of its capabilities and expertise. DOT representatives explained how the research function within the DOT is organized within the overall DOT structure, and discussed their most pressing challenges.

MAUTC faculty, in earlier meetings, had identified several regional topics that faculty felt would be of interest to DOTs: critical commerce corridors, vehicle-integrated infrastructure, graduate distance education, and general technology transfer projects. After a lively discussion, four research platforms and a "lead" university for each were agreed upon for further possible development: critical commerce corridors, UVA; vehicle-integrated infrastructure, VT; infrastructure monitoring/preservation, UVA; and greenhouse gas reduction, UMD. In addition, the participants agreed that graduate distance education courses would benefit workforce development in the region and that Penn State will take the lead. WVU will take the lead in identifying technology transfer opportunities for collaborative research projects. The goal is to begin a regional, collaborative project for Fall 2008.

Research

Featured Penn State projects were co-sponsored by the Pennsylvania Department of Transportation.

Crash Testing of Sign Post Structures Leads to Improved Safety

Portable sign post structures serve a key function for safe and effective vehicle navigation on roadways. Posts of this type currently in use by the Pennsylvania Department of Transportation, supporting signs less than 36 inches square at heights of 7 ft off the ground, are assembled using varying techniques and materials and do not meet crash testing standards established in NCHRP 350. This project was performed to review available crash-tested portable sign post structures and, based on this review, design and crash test a new model to meet the NCHRP 350 criteria and establish a standard PennDOT support design protocol. The researchers searched available literature to establish the state of the art for portable sign post structures in the United States for further study, then performed numerical modeling of selected sign post designs to identify optimal designs. A crash testing plan was then developed and crash tests performed for selected sign post designs.

In This Issue:

Sign panel separation and behavior.

Crash testing of two H-base temporary sign support structures was performed at the Crash Safety Research Facility of the Thomas D. Larson Pennsylvania Transportation Institute using full-scale crash testing and performance acceptability according to NCHRP 350 criteria. Results showed that the structures oriented both parallel and perpendicular to the vehicle satisfied the NCHRP Flail-Safe Model requirements with respect to occupant velocities and accelerations/decelerations.

The FHWA crash rating approval procedure for portable work zone devices allows that modifications to already crash-tested structures can be evaluated using best engineering practices. Using the actual crash results from the "H-base" sign post structure and the performed finite element analysis (FEA) of both "H-base" and "X-base" structures, a request for approval of the "X-base" sign post was filed with FHWA upon receipt of approval of the "H-base" sign post. Since the actual dimensions, materials and construction of both sign posts were kept identical, the inertial and kinetic properties of the crash with regard to vehicle deceleration, vehicle trajectory and occupant aggregate

> Continued on page 2 >

risk factors caused by vehicle dynamics remained statistically the same. FHWA subsequently approved the crashworthiness of the "X-base" sign post. "It's uncommon, and therefore noteworthy, that FHWA elected to waive a crash test by virtue of the accuracy of the FEA for that test," said principal investigator Zoltan Rado.

The full report can be found at http://www.mautc.psu.edu/docs/PSU-2006-04.pdf. **Principal Investigator:** Dr. Zoltan Rado, 814-863-5615, zxr100@psu.edu.

Preliminary Assessment of Acid-Producing Rock on Future Construction in Pennsylvania

No one knew that a high place called Skytop in central Pennsylvania would one day provide critical information impacting future highway construction projects throughout the mid-Atlantic states. Researchers at the Thomas D. Larson Pennsylvania Transportation Institute at Penn State found that pyritic rock

unearthed at Skytop is part of a network of deposits that occurred long ago when a meteor crashed into what is now the Chesapeake Bay. Isotopic tests showed that the Skytop pyrite was 35 million years old, and was emplaced as pressurized hot water (about 400 degrees C) shot up from the mantle. The sandstone substrate of rock at Skytop contained fractures called lineaments that formed 250 million years ago when the Appalachian Mountains pushed up. Those lineaments carried the deposits from the cataclysmic impact. This created a unique angle of deposit at such sites, which tends to be more vertical than the familiar sedimentary deposits that occurred over time. Because this was a new and startling discovery, there was no known prior experience with this phenomenon and thus no ready-made protocol for identifying or handling this type of deposit. Efforts to contain environmental damage from the Skytop deposit have so far cost more than $79 million. Can future Skytops be avoided?

Scheetz already has evidence of the broader trend of the findings at Skytop. He and geochemist Ryan Mathur, of Juniata College, have tested samples from nine other deposits, six in nearby Blair and Huntingdon counties, two in York County and one as far away as Montgomery County, in the southeastern part of the state. All have the same isotopic signature. "The fact that we have found ten of these things tells me they could be anywhere in Pennsylvania," Scheetz says. Scheetz and graduate student Chad Ellsworth have mapped some of the major lineaments in the ridge and valley region using landscape features like wind and water gaps and the presence of sandstone to locate additional deposits along these fractures. They have mapped 150 known deposits so far— many, Scheetz suspects, have the potential to result from the same meteoric impact.

Funds are now sought for follow-up research to incorporate aerial reconnaissance and electromagnetic sensing. "Being able to predict where these isolated deposits are likely to pop up," Scheetz says, "could prevent future Skytops around the state and beyond." In fact, implications may exist for significant construction activities in virtually all of Maryland, Pennsylvania, Virginia and West Virginia, and as far afield as Connecticut to the north and South Carolina to the south of the meteor impact's epicenter.

The full report can be found at http://www.mautc.psu.edu/docs/PSU-2005-05.pdf. **Principal Investigator:** Dr. Barry Scheetz, 814-863-5616, se6@psu.edu.

Hardened Air and Freeze/Thaw Resistance in Concrete Roadway Pavements and Structures

Entrained air in cement concrete pavements is vital to protect the pavement from freeze-thaw forces. This study evaluated the validity of current Pennsylvania Department of Transportation (PennDOT) specifications for plastic and hardened air content for pavements and structures; examined the relationship between plastic air measurement instruments (pressure meter), techniques that characterize the air void size and distribution including the Air Void Analyzer (AVA), and

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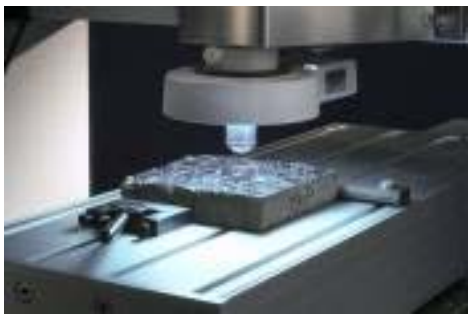
the durability of concrete to resist freeze/thaw cycles, as well as PennDOT specifications differences for pavement and structural concrete. The research recommended specific revisions to the specification for PennDOT 408 on air content in concrete.



Polished contrast enhanced concrete plane section.

To provide supporting experimental evidence for the adoption of the AVA method by PennDOT, the apparatus was evaluated for its internal consistency, the consistency between it and other AVA devices of the same version, consistency between different versions of AVA, comparison between the AVA and the RapidAir 457, comparison with the ASTM C 231 pressure meter, and comparison with the ASTM C 666 performance-based test. The accumulated data were evaluated statistically using standard deviation and coefficient of variation. The analysis together with the authors' experience with the robustness of the instrument concluded that this instrument cannot serve as the basis of a specification to evaluate the air content, spacing factors or surface areas in fresh concrete at the job site. In the intercomparison of AVA instruments of the same generation, the model operated by Penn State showed consistently better results with higher air content value, lower spacing factor value, and higher specific surface value.

In the intercomparison of AVA instruments of different generations, the model operated by Penn State gave consistently higher air content values. However, the AVA 3000 model operated by PennDOT yielded a lower spacing factor and higher specific surface. The results for air void parameters were significantly different, indicating a need for careful and precise calibration of the AVA 2000 and AVA 3000 model before use in the field, with checks for calibration at regular intervals. In the intercomparison study of AVA and RapidAir 457 conducted by Penn State, AVA produced consistently higher spacing factor values and lower specific surface values. The existing specifications and recommendations for spacing factor and specific surface are based on empirical correlation between durability of concrete and air void parameters determined by ASTM C 457. Use of AVA will require calibration to known durable concrete. A large-scale study that correlates the air void parameters as determined by AVA with freeze/thaw durability of concrete is required.

The full report can be found at http://www.mautc.psu.edu/docs/PSU-2005-04.pdf. **Principal Investigators:** Drs. Barry Scheetz and Paul Tikalsky, 814-863-5616, se6@psu.edu

Characterizing Driver Behavior on Signalized Intersection Approaches at the Onset of a Yellow-Phase Trigger

Vehicle crashes in high-speed signalized intersections are typically related to "dilemma zone" problems. A dilemma zone can be a period of time or a place in which drivers must make instantaneous decisions regarding whether to stop at the intersection or proceed through when the traffic signal is in the yellow phase. Wrong decisions can be costly; rear-end crashes sometimes occur in cases where drivers decide to stop when proceeding would have been appropriate, and right-angle crashes with side-street traffic sometimes result when drivers proceed through the intersection even though stopping would have been the better decision. High-speed intersections that allow for appropriate dilemma zone mitigation strategies can save lives, time and money.

Hesham Rakha, Ihab El-Shawarby, and Ahmed Amer of the Virginia Tech Transportation Institute in Blacksburg, Virginia, along with José Reynaldo Setti of the Transportation Engineering Department at the University of São Paulo in São Carlos, Brazil, conducted a study in order to verify the current design standards for yellow-phase signaling. The driver behavior of 60 participants was analyzed at five distances from the stop bar when the onset of the yellow phase occurred. The drivers' perception-reaction time (defined as the interval from the onset of the yellow light to the instant when the brake pedal is pressed) and stopping/running behavior were observed and measured. While the study demonstrates that perception-reaction time that is recommended in traffic signal design procedures is valid and consistent with field observations, it was also concluded that age-related differences in driver behavior are significant and should be considered in the design of yellow times and dilemma zone mitigation strategies at signalized intersections. Furthermore, the study demonstrated that the dilemma zone that is used in current traffic signal control systems needs to be expanded to capture the dilemma zone of the older driver population (should range from 5.5 to 1.5 s).

Additional field studies are being conducted to characterize driver behavior at the onset of a phase transition considering factors such as the impact of a leading vehicle, the proximity of a following vehicle, the surrounding environment, and the impact of the approach speed on driver behavior. In addition, the study is attempting to develop strategies to reduce red light running by developing a better understanding of driver running behavior.

Principal Investigator: Hesham Rakha, 540-231-1505, HRakha@vtti.vt.edu.

Student News

Outstanding Student of the Year

Mason Gemar , MAUTC's 2007 Outstanding Student of the Year, was recognized at the Council of University Transportation Centers' (CUTC) annual banquet for his outstanding accomplishments in academics and research. Mason earned his Master of Science degree in Civil Engineering from Penn State in May 2007. At the Thomas D. Larson Pennsylvania Transportation Institute (LTI), Mason was the lead student on a PennDOT/MAUTC research project to evaluate the operational effects of wide edge lines applied to horizontal curves on two-lane rural highways. In addition, Mason was instrumental in estimating negative binomial regression models of crash occurrence and developing crash severity distributions at interchange locations in Minnesota on an NCHRP project.

In 2003, Mason graduated from Iowa State University with a B. S. in Civil Engineering. While an undergraduate student, he worked as a lab assistant at the Center for Transportation Research and Education (CTRE), where he conducted research for the Iowa Pavement Management Program (IPMP) and aided studies for the Iowa Traffic Safety Data Service (ITSDS). Prior to graduate school, Mason was employed by HNTB, in Overland Park, Kansas. Mason is currently employed by HDR, in Austin, Texas.

PennDOT to Host Student Showcase

PennDOT will host a student showcase in Harrisburg on Wednesday, September 24. Students from Penn State and the University of Pittsburgh will display posters illustrating the research they have conducted under the PennDOT/MAUTC Partnership with Penn State and the Intergovernmental Agreements (IGA) with Penn State and the University of Pittsburgh. Students will explain their research activities to PennDOT employees and university faculty and staff invited to attend the showcase. Following the poster display, deputy secretaries Richard Hogg and James Ritzman will hold a session with the students and attendees to explain how university research fits into PennDOT's mission and core focus areas. Representatives from PennDOT's human resources department will talk about the benefits of working for a state agency.

Faculty News

Dr. Martin Pietrucha was a recipient of the World Traffic Safety Symposium's Traffic Safety Achievement Award. The award was presented on March 28 as part of the New York International Automobile Show at the Javits Center in New York City. Dr. Pietrucha was recognized for his role in the development of the Clearview sign font, which increases the legibility distance of highway signs. Clearview has been adopted for nationwide implementation by the Federal Highway Administration. The World Traffic Safety Symposium and the New York International Automobile Show are programs of the Greater New York Automobile Dealers Association.

Dr. Hesham Rakha was one of five recipients of the Dean's Award for Research Excellence, College of Engineering at Virginia Tech (2007). Dr. Rakha presented several papers at the Uribistics Conference in Tunisia March 9-12 that were accepted for publication and were developed using funding from MAUTC:
1. "Evaluating Alternative Truck Management Strategies along I-81," funded from the MAUTC project "Addressing I-81 Transportation Issues," VPI-R-01.
2. "Integrating Transit Signal Priority and Adaptive Traffic Signal Control," funded from the MAUTC project "Urban Network and State Transportation Issues," VPI-R-14.
3. "VT-MESO Model Framework for Estimating Hot Stabilized Light Duty Vehicle Fuel Consumption and Emission Rates," funded from the MAUTC project "Urban Network and State Transportation Issues," VPI-R-14.

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Strategic Alliances: University of Delaware ❖ Morgan State University ❖ University of Pennsylvania