



MID-AMERICA TRANSPORTATION CENTER

Volume 3 Issue 1

IMPROVING SAFETY AND MINIMIZING RISK ASSOCIATED WITH INCREASING MULTI-MODAL FREIGHT MOVEMENTS

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Student Spotlights



Lucy Munz:

Lucy Munz is a senior in Civil Engineering at the University of Kansas. She has worked as a semester intern at the Kansas Department of Transportation (KDOT) in the Road Design Section for two years. In this position she works under Eric Nichol, P.E. in James Dieztel P.E.'s squad. Mr. Nichols is also the President of the Younger Members group for ASCE in

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Brandon Bortz:

Brandon Bortz is a teaching assistant and graduate student in the Civil Engineering Department at Kansas State University. Brandon graduated from K-State with a Bachelor's degree in Civil Engineering in December of 2008. While maintaining a vigorous research schedule, he will complete his coursework work in December 2009 and with a G.P.A of 3.6. In May 2010,

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THE UNIVERSITY OF IOWA



The Newly Renovated Whittier Building: Home of NTC/MATC

The revitalization of Whittier Hall will reach its completion this spring and will signal an exciting transition as MATC, along with the NTC, move into the renovated building. This relocation will mean that all of the components of the Nebraska Transportation Center will be housed under one roof. With 22,000 square feet allocated for research and office space, faculty and students will be joined in an atmosphere that will allow greater opportunities for research and collaboration. State-of-the-art facilities and greater research space will help MATC and the NTC reach their goal

of becoming national leaders in transportation safety and advanced research.

Whittier Hall, located at 22nd and W streets, is the first building in the United States constructed for the specific purpose of serving as a junior high school. Many of the original structures, dating to the building's completion in 1923, have been maintained during the renovation. In fact, much effort has been expended to maintain and revitalize the building while enhancing energy efficiency by the installation of modern components.

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Photo courtesy of NE Department of Roads

Congratulations to **Dr. Dean Sicking**, Director, Midwest Roadside Safety Facility. Dr. Sicking was presented with the "Challenge Award" at the 2009 Nebraska Highway Safety Summit held last April in Kearney, Nebraska.

Nebraska Governor Dave Heineman SAFETY AWARDS



Congratulations to **Nate Burnett** for receiving the Governor Safety Award for the Intelligent Transportation Engineering student chapter division.



In April of 2009, LOCATE (Lincoln, Omaha, Council-Bluffs Association of Traffic Engineers) was presented with the Governor's Transportation Safety Challenge Special Recognition Award



for reducing the fatality rate for young drivers. **Dr. Aemal Khattak** serves as the director of education on the LOCATE board.



IRF Essay Competition Winner, Jeff Thiele

Congratulations to Civil Engineering graduate student, Jeff Thiele, one of the five winners of the International Road Federation's annual student essay competition. An international panel of judges evaluated essays submitted under five separate categories, and Jeff Thiele's essay won for the "Innovative Financing" group. Thiele responded to his achievement, "I was completely surprised. I'm very thankful to the International Road Federation for this award, and I'm honored that my essay was selected as a winner."



for Jeff to be selected by IRF's review panel for writing the winning essay in the international competition. In this essay, Jeff's dedication and approach is representative of the academic rigor that he has devoted to his engineering studies and graduate research. The students of the University of Nebraska, College of Engineering have continued to demonstrate that they are amongst the best in the world at writing creative, thought-provoking essays on the real issues facing society today."

Mr. Thiele's essay, "Road Pricing to Reduce Congestion, Pollution, and Injury Accidents," suggests that road pricing can be used to reduce congestion, pollution, and accidents, thereby resulting in fewer injuries on our nation's roads. The growth of demand for transportation in our country is consistently outpacing the increase in supply: a trend which is clearly unsustainable. According to Thiele, congestion and injury/fatality accidents cost the national economy over \$250 billion in 2005, and whether or not climate change is a threat, reducing our nation's consumption of (primarily foreign) oil would help our economy and improve our national security. Thiele's essay discusses various types of road tolls and fuel taxes which could help in all of these areas.

A complete list of winners and their essays can be viewed at: <http://www.irfnews.org/news-events/press-release-detail/irf-announces-2009-student-essay-competition-winners/>



Ron Faller, University of Nebraska-Lincoln Civil Engineering professor and Thiele's supervisor, is very proud of his student's accomplishment: "It is a tremendous honor and achievement

Letter from the Director



Dr. Laurence Rilett

Welcome to our latest edition of the MATC newsletter. I am writing this greeting from Chennai, India where I am attending the Indo-US Workshop on Emerging Trends in Intelligent Transportation Systems (ITS). The workshop, which was funded by the Indo-US forum along with partial support from MATC, is bringing together 27 leading ITS experts from academia and the public and private sectors

to discuss their visions of the future of ITS. Held at the Indian Institute of Technology – Madras, the conference had over 150 participants and speakers. As the workshop co-coordinator, I had the pleasure of talking at length with international transportation professionals, and these conversations reminded me that many of the grand challenges we face – safety, congestion, pollution – are universal. Furthermore, these common challenges are so complex that our only hope for successfully addressing them is through partnerships among all stakeholders and across all disciplines. I was also struck by the fact that these types of partnerships are readily formed within MATC, which provides rare opportunities for collaboration not often facilitated by other US transportation organizations nor, indeed, around the world.

In this issue we will highlight a number of MATC partnership successes. Back in 2006 when we were forming our vision of MATC, the associate directors and I adopted two key principles that, in hindsight, have been keys to our success. The first was that MATC would be a true partnership among universities across the region, and the second was that all our MATC activities would be student-focused. While space limitations prevent me from listing all of our initiatives over the past few years that met these ambitious goals, I would like to call attention to one "measure of success" that I am particularly proud of. To date, 31 MATC principal investigators have funded 60 research projects which have provided

full Research Assistantships to 78 students. We've had significant work accomplished at all of our partner schools and in each state in Region VII. I had the privilege of meeting many of these students during January's Transportation Research Board Meeting in Washington, D.C., and was amazed at the breadth of their interests and the diversity of their backgrounds. As these capable, creative students graduate and begin their transportation careers, I am confident they will be fantastic ambassadors for the Mid-America Transportation Center.

I would also like to take this opportunity to introduce you to the new home of MATC headquarters -- the newly renovated Whittier Building-- which is a former Lincoln Junior High School that was built in 1926. UNL has spent \$20 million dollars and the past 2 years renovating the space so that it can be used for multi-disciplinary research at UNL, with transportation research as its primary focus. Of the 25,000 square feet of initial space, 22,000 will house MATC and the Nebraska Transportation Center. The space will include an Intelligent Transportation systems laboratory with over 2000 ft² in addition to a 2100 ft² visualization laboratory. Needless to say, this is a great indication of the UNL administration's commitment to transportation research and education -- as well as being an example of the partnership between UNL and the USDOT that the UTC program was designed to foster. Everyone involved in the fruition of this dream is deeply appreciative of the exceptional facilities that will soon be available at Whittier Hall. After our move in April 2010, we look forward to welcoming you to our new home.

I am always deeply appreciative of the hard work done by our faculty, students and staff across all the consortium partners--as I am confident you will see their dedication and hard work in the articles highlighted in this newsletter. We are optimistically preparing for the next transportation authorization bill that in the coming months will determine whether the competitive USDOT University Transportation Center program will continue and, if so, in what form. As always, I welcome your feedback and suggestions. Thank you for your interest and continued support.

Sincerely,
Larry

The Newly Renovated Whittier Building: Home of NTC/MATC

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The building has been reconditioned to its original external appearance with the only exception being the installation of energy efficient windows. Whittier's most pleasing interior details have been preserved, such as the decorative columns, brick hallways, enormous windows, and a large, sky-lit atrium, which floods the building with natural light.

Construction on Whittier has followed the "green building" guidelines as defined by the Federal Leadership in Energy and Environment Designation program. Transoms, as well as full length windows in the hallways, are used to allow offices without windows access to light from the central atrium. One of the advanced technologies to be utilized in Whittier Hall is a geothermal system to control heating and cooling. This building will be the first on UNL campus to use such technology. Advanced technology is also hidden within the walls and floors; in the intelligent transportation systems (ITS) lab the floor tiles can be easily removed to provide access to electrical wiring. Consequently, equipment can be easily relocated or installed through such ready access to the electrical system.

MATC and NTC are looking forward to the opportunities that the move to Whittier Hall will bring. We would especially like to thank

the University of Nebraska for their generous sponsorship of this renovation. We are truly appreciative of the university's on-going support and are grateful for the expanded facilities at Whittier Hall.



Photo by Troy Richardson/University Communications

MATC Affiliated University Academic Offerings



MID-AMERICA
TRANSPORTATION CENTER

MATC Transportation Engineering Seminar

The **MATC Transportation Engineering Seminar**, was taught this past fall by Dr. Rilett with the stated purpose of introducing graduate level transportation engineering students to everyday issues in the profession that standard coursework may not address. To this end, a professional from a specific division of transportation engineering was scheduled to lecture each week. The lecture series benefited faculty and students in the transportation field generally, as these events were open for all to attend.

Lecturers represented different sectors of the discipline including private, public, and academic spheres:

Joe Werning, Division Administrator, FHWA, NE
Justice Appiah, NTC Post-Doctoral Engineer, UNL
Mike Malone, Vice President-Heartland Region, ITERIS, IA
Virginia Baldwin, Professor of Library Science, UNL
Cindy Newsham, Response and Recovery Division Manager, NEMA
John R. LaRondeau, Inland Navigation Program Manager, Army Corps of Engineers
Erin E. Sokolik, Traffic Signal Engineer, City of Lincoln
Qizhou Shi, Professor, Tongji University, China
Anuj Sharma, Assistant Professor, UNL

Class time was also scheduled to facilitate the students' attendance of a Valmont Industries Incorporated's testing facility tour in October, as well as the Omaha-Council Bluffs Traffic Forum and the Nebraska

Highway Commission Meeting in November. When asked about his experience in this course, graduate assistant Nathaniel Burnett replied: "as the field of transportation continues to grow, possessing a thorough knowledge of concerns and problems throughout transportation is imperative. MATC's Transportation Seminar offered students the unique opportunity of learning about the various sectors of transportation."



University of Iowa Freight Transportation Planning Course

Drs. John W. Fuller and Barton Cramer of the University of Iowa have organized a one-semester course in Freight Transportation Planning and offered it on a trial basis at the UI campus. Consideration is being given to making the course available through distance learning mechanisms at universities affiliated with the Mid America Transportation Center. The course focused on the growing need to expand and restructure the U.S. freight transportation system due to the globalization of production practices and steep increases in commodity prices. The recent economic downturn aside, urgent issues such as urban traffic congestion and air quality degradation, as well as rapidly rising fuel costs, are constraining the freight transportation sector. Though individual European countries and the E.U. have begun addressing these issues, U.S. freight transportation planning has been dealing with this growth in a piecemeal and ad hoc way, complicated by the fact that freight planning tools are lagging and there are serious data availability and finance issues to overcome. Moreover, freight and passenger transport interactions and trade-offs are not integrated within most urban or state transportation plans.

The course examined the state of the art in freight transportation planning in the US with emphasis on surface modes, primarily railway, maritime (especially ports), and trucking. Policy, planning, and practices of European models were examined in conjunction with recent U.S. planning examples.

The Freight Transportation Planning course has been structured so that, initially, students are provided with a background of the U.S. surface freight system through an explanation of the modal characteristics and modal markets, including competitive boundaries and areas of cooperation. Then, the course content shifts to current public sector planning, laws, and regulations, financing information, freight planning methodologies and sample plans. These six primary sections of the course are further subdivided into more detailed content. For instance, the freight planning methodologies section examines public planning processes, modal trade-offs, and freight demand models.



Goals for students in this course are to gain familiarity with evolving U.S. surface-freight planning practice, including its strengths and weaknesses; to expand knowledge of the institutional, financial, and regulatory conditions that enable or constrain planning options; to better understand the industrial structure and economics of the surface modes; and to attain the practical skills needed to engage in effective freight transportation planning.

University of Kansas Scholars Program



The University of Kansas is, once again, offering the Jayhawk Transportation Scholars Program which provides undergraduate students with an all expense paid trip to the Annual Meeting of the Transportation Research Board (TRB). Held in Washington D.C., the TRB is the world's largest transportation research symposium. It features colleges from across the nation; over 3,000 presentations on transportation related topics; and agencies from the federal, state, local and private sectors. TRB is one of six major divisions of the National Research Council—a private nonprofit institution that is the principal operating agency of the National Academies in providing services to the government, the public, and the scientific and engineering communities. Attendance at this conference benefits undergraduate students by providing the opportunity for them to meet professionals and learn about current research in the transportation engineering field. Requirements for this program include that the candidate must study Civil Engineering and be a currently enrolled KU undergraduate student in good academic standing (December 2009 graduates are ineligible).



KSU Transportation Engineering Graduate Certificate



Kansas State University is offering transportation professionals the opportunity to expand their knowledge and skills by earning a Transportation Engineering Graduate Certificate. The graduate certificate is a 12-credit-hour online program that allows candidates to engage in graduate study that is less extensive than a traditional master's program. Since coursework is fully online all candidates pay the same rate, regardless of location. Any hours earned through this program can be applied towards a master's degree. Applicants must hold a bachelor's degree in Civil Engineering from an ABET accredited institution with an undergraduate GPA of 3.0 or higher for the last 60 hours of courses taken. This program is an initiative of the KSU and Mid-America Transportation Centers. KSUTC and MATC are funded by US DOT RITA and greatly appreciate this support. Additional information can be found at the following link, <http://www.dce.k-state.edu/engineering/certificates/transportation/>



Missouri S&T Intern Program

For the past few years, the Missouri Department of Transportation (MoDOT) and Mid-America Transportation Center (a Missouri S&T Partner) have been working in conjunction to develop a recruiting plan that will encourage undergraduate students to seek employment with MoDOT after graduation. With this aim in mind, MoDOT and MATC are offering a competitive financial package for students at the Missouri University of Science and Technology (Missouri S&T) which will include a summer internship and hourly pay from MoDOT. As an additional incentive, each student will receive a \$1,000 scholarship from MATC over the funding period. In order to locate interested candidates, MoDOT and MATC have developed a recruiting plan:

- MATC will distribute the summer internship opportunity among all undergraduate students at MS&T, particularly those from the Department of Civil, Architectural, and Environmental Engineering.
- MATC will encourage perspective students to visit with MoDOT during the annual Career Fair on campus and apply for summer internships.
- MoDOT will review all applications received from perspective students and select summer internships based on various needs from MoDOT districts.

Following the summer internship, students will be expected to compose a one-page report that will include a brief description of the projects they were involved in during the internship, an explanation of their role in each project, and an evaluation of the internship program. Once finalized, this report will be submitted to the MATC Associate Director at Missouri S&T. MATC will award up to 15 scholarships to selected students upon their completion of the internship and submission of the final report.

For more information contact Genda Chen at gchen@mst.edu or call (573) 341-4462



MATC UNL Undergraduate Summer Intern Program

The Mid-America Transportation Center Undergraduate Summer Intern Program provides undergraduate students the opportunity to learn more about transportation engineering careers by working for a transportation engineering consulting firm or public transportation agency. The internship includes an intern-sponsor orientation luncheon, an expense-paid field trip to transportation-related facilities within the Midwest region and a recognition luncheon on the last day of the internship. Room, board and travel expenses to sponsors' work sites are not provided by this program unless specifically stated.

Interns work for a sponsor, located in the Midwest region, for the summer months and participate in program events during the internship period. Positions are available in (but not limited to) the following sectors: roadway design, traffic engineering, intelligent transportation systems, railway design, planning, and transportation research. Interns will be matched with sponsors based upon their qualifications, interests, character, workplace location, and position availability. Interns will work a minimum of 40-hours per week for their assigned sponsor.

The program is open to any currently enrolled civil engineering junior (53 credit hours completed by May 2010) or senior at UNL, UNO, University of Iowa, Kansas State University, University of Kansas, and Missouri University of Science and Technology. Applicants must be considering a career in transportation engineering and have completed Highway Engineering, CIVE 361, at UNL or UNO, or the entry-level transportation course at MATC member institutions. Students that will graduate before December 2010 are ineligible. Only US citizens are eligible to apply. For more information please visit <http://matc.unl.edu/internship.php> or contact Valerie Lefler at vllefer2@unl.edu.



2009 MATC Interns



2008 MATC Interns

University Student Spotlights

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Lucy Munz: KU MATC Student Spotlight

the Kansas Section and encouraged Lucy to become involved. Through this mentorship, Lucy is currently involved in this ASCE group and is meeting people in her field. Among the many opportunities that this internship has provided, Lucy has learned about pipe sizing, making estimates for projects, designing pavement, running earthwork quantities, cutting profiles and cross-sections. Moreover, Lucy feels that her supervisor always tries to give her meaningful work that will expand her knowledge base. Of her internship she writes, "I am very grateful to KDOT for all the experience and knowledge that this job position has allowed. I have more practical experience than most seniors my age and this that makes me very marketable candidate. KDOT is a great working environment and I look forward to becoming a full-time employee."

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Brandon Bortz: KSU MATC Student Spotlight

Brandon plans to graduate with his Master's degree and wants to continue his education by pursuing a Ph.D. Meanwhile, he is finishing his research on the durability of concrete containing fly ash and has completed the majority of this project in less than a year.

Brandon's project has two main activities. The first is laboratory testing in which he conducts salt scaling according to the ASTM C 672. For this part of his research, seventy-eight specimens that weigh approximately thirty pounds must be moved twice a day. The second part of his project is the construction of a durability site and specimens at CISL. With only a small budget for his project, he is ever-inventive in the processes he develops to complete his research.

The MATC newsletter Issue 3.2 will feature student spotlights from UI and MS&T.

Best field trip ever

Lincoln Northeast High School Students visit NTC & MATC



Janet Emery & Adell Stiles Teachers from Lincoln Northeast

"Best field trip ever" was the reaction of Lincoln Northeast High School students after spending the day at NTC and MATC. Students easily picked the crash track test site and the speed guns as their favorite parts of the tour. It was a great way to excite the students and set the tone for the rest of the day.

It was "real cool" for the students to stand outside Nebraska Hall with the speed guns. They were amazed at all the details involved in creating red-light stop times. Students were surprised that drivers slowed down when they pointed the speed gun toward the car.

Engineers at the track were excellent in their manner of presentation by reinforcing that math and science are used daily in their field. Trial and error processes, as explained by the engineers, gave the students a realistic picture regarding the invention of the NASCAR safety bumper.

Donnie Butler's explanation at the ITS Detection lab intrigued the students. Because LNE students are familiar with the 35/Adams Street intersection, the data collected by the three real-time cameras was meaningful. Students were impressed by the process used to create solutions to the two problems being studied at that intersection. Moreover, Dr. Anuj Sharma's first-rate presentation helped the student's realize the broad job opportunities available with a civil engineering degree.

"It was great to have a quiz" was the comment from many students as the day ended with a friendly competition among four groups of students. They all wanted to win a T-shirt and water bottle. At the end of the day, students and teachers alike felt it was an extremely successful field trip.



Bhaven Naik Graduate Student

"My presentation illustrated how transportation engineers conduct spot speed studies using Lidar guns. The students had the opportunity to conduct a simple spot speed study using the Lidar guns. After this demonstration, I explained that the speeds they collected could be used for defining the posted speed limits on the highways, timing traffic signals or as input for micro-simulation models. They were also introduced to other traffic data collection devices such as loop detectors, video recording, and the simple stop watch. The use of the video and loop detection devices interested the students the most.

This is partially because they encounter these mechanisms every day, but mainly due to the students' unawareness of the equipments' purpose."



Walter Moy Graduate Research Assistant

"At the MATC tour, I presented on Geographical Information System (GIS) software. This program enables the user to assign information to a line or shape which is then displayed according to these specifications. Everyday uses for this software include map production and programs, such as Google Earth. During my presentation I explained the basics of the program, and allowed time for the students to explore it themselves. The students made different kinds of maps and, overall, I think that they enjoyed their time learning about GIS software."

Justice Appiah & Chung-Jen Hsu "CJ" Research Assistants

"We spoke about the traffic micro-simulation model, VISSIM and how it is used at UNL and institutions across the nation to analyze many complex transportation problems. One of the projects we discussed was the development of a "state-of-the-art traffic micro-simulation model of the I-80 freeway between Lincoln and Omaha." When completed, this model can be used to predict the likely impact of changes in traffic patterns resulting from modifications in traffic flow (such as on game days) or from alterations to the physical environment (such as lane closures). The ability to predict or anticipate these potential impacts means engineers, planners, and policy makers can proactively develop, test, and implement possible remedies. The students were particularly impressed with the potential cost savings and the safety implications of these projects—some even expressed interest in pursuing a career in transportation."



Donnie Butler Graduate Research Assistant

"Of the many aspects of transportation engineering, my presentation at the MATC tour focused on traffic detection systems. The students listened attentively as I presented the origins and types of vehicle detection devices. We discussed some example applications of video detection systems, as well as the associated benefits and disadvantages. For instance, I showed the students the City of Lincoln website and explained that they can use traffic cameras, accessible at this site, to check traffic congestion and determine the best driving route. The students particularly enjoyed the futuristic application opportunities of video detection, such as vehicles that can detect other vehicles and respond by slowing down or stopping to prevent an accident."



MATC Seminar Tours the Valmont Manufacturing Plant

by Benjamin Grone,
UNL master's student

On October 30th, the MATC Seminar joined with UNL's Institute of Transportation Engineers (ITE) student chapter and the Lincoln-Omaha-Council Bluffs Association of Transportation Engineers (LOCate) in a tour of the manufacturing facility for Valmont Industries, Inc. Located near Valley, Nebraska, Valmont Industries manufactures engineered support structures, utility poles and structures, tubing, and irrigation structures.

In addition to such manufactures, Valmont Industries also provide various metal coating services. During the tour, participants were able to observe some

of the production processes that take place at the Valley location. We were able to observe small and middle-sized pole production, as well as fluting, and galvanizing processes. I was impressed by the degree of automation involved in lighting/traffic signal pole production from raw steel coil. One of the exciting stages of the process was laser beam welding technology which is a rapid and precise method of welding the pole cylinder.

Of the various processes observed, the most interesting was the hot-dip galvanizing line. Galvanization is a process by which steel (or other metals) may be coated in a layer of zinc which reacts with oxygen and carbon dioxide in the air to form a compound that protects the underlying steel from corrosion. In the production facility, large steel products were moved by cranes and systematically submerged in a series of (approximately) 30,000 gallon tanks full of various chemical baths to cleanse their surfaces. Finally, they were submerged in molten zinc (800°F) which chemically bonded to the surface to create the corrosion resistant

coating. When the steel encountered the hot zinc, air pockets were heated rapidly—creating violent explosions of molten zinc from the bath. In response to such dangers, the safety precautions in place to protect technicians and visitors were quite extensive.

After the tour was completed, a short discussion was given by a structural engineer about Valmont's onsite testing facility. He discussed the structural concerns with the poles and support structures manufactured by Valmont. He introduced the problem of fatigue in pole products through a multi-media presentation. Interestingly, poles can be designed to withstand high velocity winds, but at specific lower velocities fatigue failure can occur relatively early. Our presenter explained the concept of mast arm galloping and natural structural resonance; namely, resonance introduces a situation where a low velocity wind could cause amplification of vibration to the point of fatigue failure in a matter of hours.

After an explanation of the testing being conducted on pole resonance, the

Valmont representative introduced an innovative patented design that increases the fatigue life of square poles by altering the base section.

The tour and presentation at Valmont was an enjoyable and impressive experience for all who attended. We extend our gratitude to the organizers, tour guides, and employees who let us share their workspace, as well as to the engineer who acquainted us with the complications in the light pole design.

ITERIS Donates Video Detection Equipment

MATC would like to extend their gratitude to Iteris, Inc. for their donation of vehicle video detection equipment to the Intelligent Transportation Systems Lab. On September 28, 2009 Mike Malone and Mark Fayta of Iteris, Inc. and Scott Carlson of Brown Traffic Inc. installed the equipment in the Nebraska Transportation Center ITS Lab.

The video detection components donated included a Vantage TS1 VRack, a Vantage Edge 2 dual camera input video detection processor, a four channel extension module for the Edge 2 processor and a Vantage Edge Connect video communication module. Additionally, a vantage video detection camera was installed, as well as the various cables and DVD players required to complete the lab test station. The donated equipment will be used for both research and teaching purposes: the video recorded at the test site can be processed to provide valuable information on both microscopic and macroscopic traffic characteristics.

The new equipment donated by Iteris will enhance MATC's research capabilities. Specifically, Vantage Edge2 processors can be used for data collection applications when loaded with the suitable firmware and with the appropriate camera setup. "Express," the Vantage data collection firmware, provides accurate count, speed, occupancy, gap, and user defined classifications, among other information. The firmware on the Vantage Edge2 processor module draws detection zones on the camera's video image and allows a maximum of twenty-four defined



detection zones per camera view. To define a detection zone, four corners of an area must be designated on the video screen. The processor module then analyzes the camera image to determine when a vehicle is present in

a zone. Vehicle detection information is passed to the traffic control equipment for real-time traffic management and control. Video can also be transmitted via fiber optics, twisted pair, microwave, or radio-communication methods to be visually displayed and monitored at a traffic management center.

The new equipment will allow greater connectivity between researchers by creating an integrated system. The Edge Connect Module is designed to stream four channels of video and allow Edge2 processor setup and control over an Ethernet network connection. The Edge Connect's Ethernet port enables MPEG-4 or H.264 streaming video to be viewed on a personal computer using a widely available internet browser. The module also provides central hub functionality for local Edge2 processors by allowing a monitor connected to the module to access and setup any of four Edge2 processors from a central point.

MATC is excited about the research opportunities that such equipment will afford both teachers and students alike. We extend our sincerest thanks to Iteris, Inc. for their generosity in donating this technology.



Above: Mark Fayta, Iteris, demonstrates how to set up sensors in traffic lanes in NTC's ITS lab. Right: Individuals listed from left to right: 1) Mike Malone, Vice President, Iteris Inc., 2) Roger Koehler, Product Marketing Manager, Iteris Inc., 3) Dr. Andrzej Nowak, Professor, Civil Engineering, University of Nebraska-Lincoln, 4) Dr. Laurence Rilett, Keith W. Klaasmeyer Chair in Engineering and Technology, Director, Nebraska Transportation Center.



KSTATE KSU Superpave Field Certification

Kansas State University will offer four sessions for Superpave Field Laboratory Technician (SF) Certification Training with cooperation from the Kansas Department of Transportation (KDOT) and under the sponsorship of the Mid-America Transportation Center. This course is intended to certify engineers, technicians, and other personnel who will be involved in the construction of Superpave hot-mix asphalt (HMA) pavements using Quality Control and Quality Assurance (QC/QA) specifications in the State of Kansas. Superpave represents an improved system for specifying asphalt binders and mineral aggregates, developing asphalt mixture design, and analyzing and

establishing pavement performance prediction. This system is expected to extend the life of asphalt pavements—thereby, reducing construction-related congestion and enhancing public safety.

Instruction will be provided by a selected group of instructors from KDOT, KSU, and professionals in the industry. Approximately 80 engineers, technicians and constructors from public and private sectors are expected to attend. Successful completion of the course and certification (subjected to a passing score on a test given at the end of the course) will be required for all KDOT and

contractor personnel performing tests on these projects. The following sessions will be included in the course: overview of Superpave volumetric mixture design; asphalt mixture volumetrics; hands-on training in the required tests for Superpave HMA construction; and Superpave mixture data analysis and interpretation as required in the QC/QA special provisions. Class sessions will be held on Kansas State University campus during the 2010 spring semester.

For more information contact Robert Stokes at drbobb@ksu.edu or call (785) 532-1595



Mara Campbell



Rodney Montney



Moe Jamshidi



Sandra Larson



MATC Funded Research Projects Fiscal Year 2010

University of Nebraska Projects



Effect of Freeway Level of Service and Driver Education on Truck Driver's Stress - Phase 1

PI: Dr. Anuj Sharma, Assistant Professor, Civil Engineering, University of Nebraska-Lincoln

Co-PI's: Dr. Senem Velipasalar, Assistant Professor, University of Nebraska-Lincoln; Mr. David Engel, Project Coordinator, Community College Hastings; Dr. Sanjay Singh, Associate Professor, University of Nebraska Medical Center



Student participating in truck driving simulation.

DESCRIPTION: This project conjectures that truck driver's stress on freeways is a function of variables such as level of service, time of day, weather conditions, and level of driver training. The Highway Capacity Manual uses density to measure the level of service on basic, weaving, and merging sections of freeways. The efficiency of flow can be estimated by calculating the speed of traffic and travel time from density. Yet, there is a need for a methodology to estimate safety as a function of density. By utilizing truck driver's stress as a model, this study will be able to supply this knowledge. The predicted stress level can be used as a surrogate measure for safety.

A sample set of 50 subjects will be observed under simulated and real-world driving environments for the data collection. The study subjects will include trainees from a six-week truck driving certification course offered by Central Community College's Truck Driving

Program (which hosts more than 100 participants per year). The driver's stress will be measured using technology (such as electrocardiograms), and physiological markers (such as respiration temperature, posture and blood pressure). The technology used for these measurements will not interfere with the subject's capacity to perform their role as driver. As this study will focus on driver's stress in local areas, a second phase for this proposal will be submitted next year to evaluate truck driver stress in urban street settings. Partial support for this proposal comes from Layman Award endowed on Dr. Anuj Sharma and Dr. Senem Velipasalar, by the University of Nebraska Lincoln to produce prominent scholarly work.

BENEFITS: The model of truck driver stress levels for this project can be applied as a measure of safety for improving the traffic facility design

Heavy Vehicle Adjustment Factors for High Percentages of Trucks

PI: Dr. Elizabeth Jones, Associate Professor, University of Nebraska-Lincoln

DESCRIPTION: The most common reference for analyzing the operational characteristics of multi-lane highways and freeways is the Highway Capacity Manual (HCM). The general procedure used by the 2000 HCM to account for heavy vehicles is to use a heavy vehicle adjustment factor that converts heavy vehicles to passenger-car equivalents. In this manual, this heavy vehicle adjustment factor, fHV, is independent of the percentage of heavy vehicles for extended highway and



Trucks on a training range.

freeway segments. It varies by percent of heavy vehicles for specific grades, but the tables in the 2000 HCM only provide analysis guidance for heavy vehicle percentages of 25% or less. Nebraska's highways carry a significant portion of heavy vehicle (trucks, buses and RVs) traffic. The NDOR 2004 Statewide Traffic Flow Map indicates that on I-80 alone, the percentage of AADT represented by heavy commercial vehicles is more than 25% from Lincoln to the Wyoming border. Just west of the I-80/I-76 junction on I-80, this percentage reaches a maximum of 60.9%. The objective of this research is to quantify the impact of heavy vehicles on multilane highway and/or freeways for heavy vehicle percentages of greater than 25%.

BENEFITS: The expected benefit is more accurate reporting of levels of service and performance measures for multilane highways and freeways that have percentages of heavy vehicles in excess of 25%.

Impact of Truck Loading on Design and Analysis of Asphaltic Pavement Structures - Phase II

PI: Dr. Yong-Rak Kim, Assistant Professor, University of Nebraska-Lincoln

DESCRIPTION: Trucking is the dominant mode of transportation for U.S. freight, and is expected to grow significantly in the future. Better preservation of existing roadways against heavy-load trucks is therefore crucial, and success in this aim necessitates a more accurate and realistic analysis of pavement structures. To this end, a research project led by the PI was initiated in FY 2009 to investigate pavement performance predictions, and particularly focused on the impact of heavy truck loading on pavement damage. Both the newly-released "Mechanistic-Empirical Pavement Design Guide" approach, or MEPDG, and the "purely mechanistic approach based on the Finite Element Method", or FEM were used as guides for this study. Preliminary outcomes and significant findings during the FY 2009 necessitate this effort being continued, and this "Phase II" research with extended work scope is herein proposed. Phase II will specifically focus on the effects of truck-loading configurations and constitutive materials behavior on actual pavement structural responses.

BENEFITS: The proposed effort will provide a better understanding of the effects of heavy-load trucks on the overall structural performance and life of pavements in Region 7. In addition, more appropriate use and future advancements of the current MEPDG for pavement analysis and design can be achieved based on proper incorporation with mechanistic approaches.

Reducing Impact of Heavy Truck Traffic on Service Life of Bridge Structures

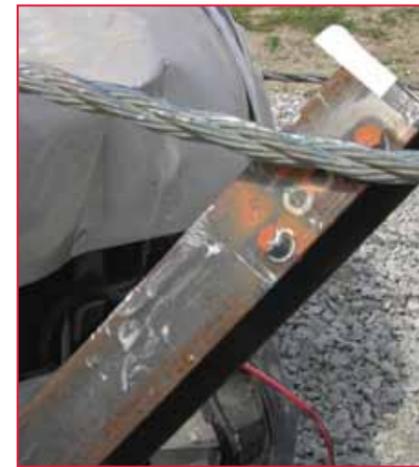
PI: Dr. Atorode Azizinamini, Endowed University Professor, University of Nebraska-Lincoln

DESCRIPTION: Heavy truck traffic pounds on expansion joints annually and pushes debris into the joints causing extensive

damages. This study envisions an innovative system that will completely eliminate expansion joints.

BENEFITS: The proposed system will eliminate the safety risk associated with road closure, and result in significant saving over long period of time.

Simulation and Evaluation of a Cable-to-Post Attachment for High-Tension, Cable Barriers Placed in Medians along Freight Transportation Systems



Car impact on cable post.

PI: Mr. Robert Bielenberg, Research Associate Engineer, University of Nebraska-Lincoln

Co-PI's: Dr. John Reid, Professor, Mechanical Engineering Department; Dr. Ronald Faller, Research Assistant Professor; Dr. Dean Sicking, Professor, Midwest Roadside Safety Facility

DESCRIPTION: The research described herein will aid in the development and implementation of a new cable-to-post attachment for the four-cable, high-tension cable median barrier being developed at MwRSF. Completion of the attachment design will allow MwRSF to execute the full-scale crash tests necessary for the system to be safely implemented on the nation's highways. In addition, this research will help evaluate the performance of the terminal design required for the ends of the barrier. It is anticipated that this non-proprietary cable barrier design will be implemented by a large number of State Departments of Transportation. This undertaking represents a significant step forward in the design of cable median barriers.



Simulation of a cable barrier collision.

BENEFITS: In terms of safety and constructability, this research can provide a vast improvement in the performance cable median barriers. The completed cable median barrier design would have the ability to be placed at any location within a 4H:1V V-ditch median. This makes it easy to implement and gives designers more flexibility, thus ensuring that economical median barriers can be installed in areas where they are needed. This project has the potential to improve the safety of our nation's freight and public transportation systems by reducing the number of cross-median accidents as well as the number of severe injuries and fatalities. Finally, this research study will also allow for upcoming engineers (graduate research assistants) to gain knowledge and experience in the field of transportation safety and learn to develop and apply innovative solutions to those problems found within our U.S. transportation system.

Investigating RFID for Linear Asset Management

PI: Dr. Erick Jones, Associate Professor, University of Nebraska-Lincoln

DESCRIPTION: Linear assets, traffic lights, and highway billboards can be hard to physically access, and information files that were captured previously may be inaccurate. Local Departments of Transportation and Departments of Roads are investigating technologies that will assist in solving this asset inventory problem. The focus of this project is to evaluate the feasibility of utilizing Radio Frequency Identification (RFID) as a means of gathering, verifying, and storing information.

BENEFITS: This project will extend the relationship between the Nebraska Department of Roads, the university, and the Departments of Transportation in other states. This project will support students who may become employees, as well as provide positive marketing for NDOR along with other transportation initiatives that support future funding.

2010 MATC Research Projects



Kansas State University Projects

Characteristics and Contributory Causes Related to Large Truck Crashes-Phase II

PI: Dr. Sunanda Dissanayake, Associate Professor, Kansas State University

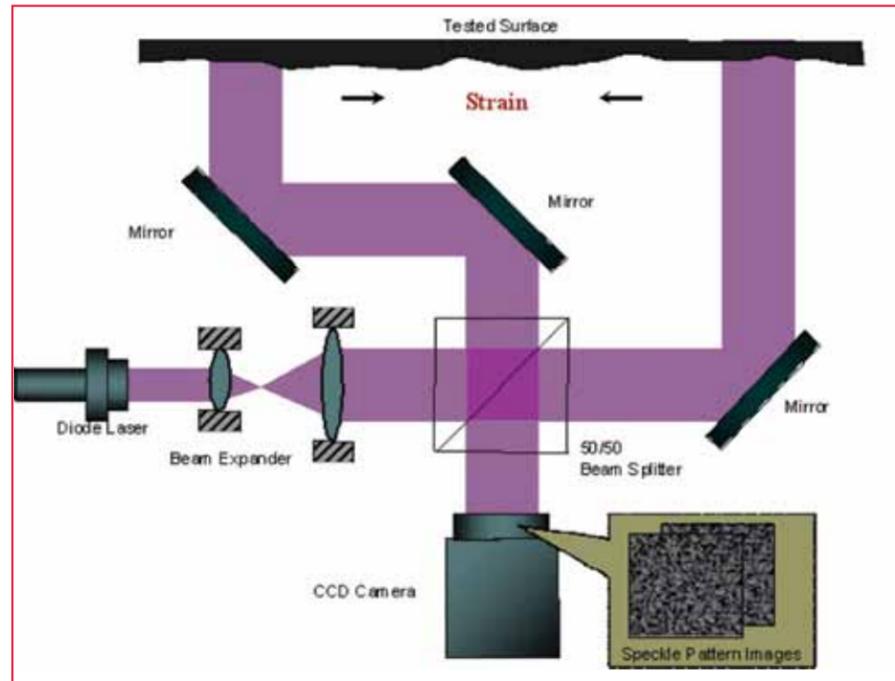
DESCRIPTION: In order to improve the safety of the overall surface transportation system, each of the critical areas needs to be addressed separately with more focused attention. Statistics clearly show that large truck crashes contribute significantly to an increased percentage of high severity crashes. It is therefore important for the highway safety community to identify the characteristics and contributory causes related to large truck crashes. During the first phase of this study, fatal crash data from Fatality Analysis Reporting System database are studied to achieve that objective. In this second phase, this study will analyze truck crashes of all severity levels with the intention of identifying the factors contributing to increased severities of truck crashes, which could not be achieved by analyzing fatal crashes alone.

BENEFITS: Upon completion of the project, the characteristics and contributory causes related to increased severities of large truck related crashes will be identified, which will in turn be used to recommend countermeasure ideas to reduce severities and focus areas needing particular attention for improving the safety situation of truck related crashes.

Determining the Stresses in Steel Railroad-Track Rails Due To Freight Movements using Non-Contact Laser-Speckle

PI: Dr. Robert Peterman, Professor, Kansas State University

DESCRIPTION: The ability to accurately determine the existing stresses in railroad track rails is extremely valuable when assessing the condition of an existing



A depiction of the method for analyzing stress in the railway.

railway line. This is especially important for routes that pass through Kansas and Nebraska transporting heavily loaded coal-carrying cars from Wyoming's Powder River Basin. This project focuses on the extension of a non-contact strain measurement technique for use on steel rails as a means of determining the stresses in the rails under heavy freight movements.

BENEFITS: The specific outcome will be the extension and optimization of the laser-speckle strain measurement technique for use on steel rails, and the establishment of the procedures necessary to determine the corresponding stresses in the rails. Upon the successful completion of this project, the laser-speckle device will be demonstrated and will provide key information that can be used to make decisions about track maintenance and the impact of heavy freight movements along the rails.



Crash Analysis in MoDOT I-64 Closure Project

PI: Dr. Hojong Baik, Assistant Professor, Missouri University of Science & Technology

Co-PI: Dr. Ghulam Bham, Assistant Professor, Missouri University of Science & Technology

DESCRIPTION: For the I-64 reconstruction project, MoDOT has been reconstructing approximately 10 miles of the highway since January 2008. Reconstruction is being carried out in multiple stages at different sections of the highway, but during each stage, all roadways within the specified section are completely closed. Roadway closures prompted traffic safety engineers to question: "Could closing the roadways possibly contribute to accidents?" Furthermore, if noticeable changes exist in the number and types of accidents, are these changes a result of closing the roadways? This study aims to answer these questions by examining crash data before and after the roadway closings, and providing scientific explanations for any relevant findings.



The I-270/I-255 corridor in St. Louis County, MO.

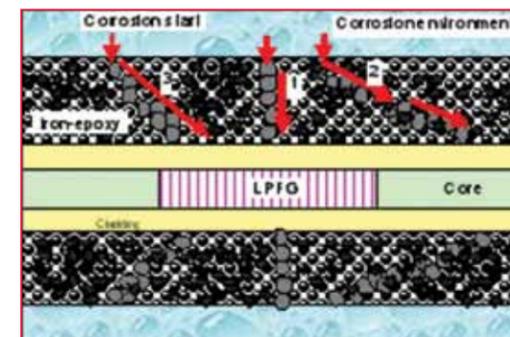
BENEFITS: A better understanding of the safety impacts of the lane-closure reconstruction will assist transportation agencies in enhancing safety performance and planning for highway reconstructions with total lane closure.

I270/I-255 Variable Speed Limit Study

PI: Dr. Ghulam Bham, Assistant Professor, Missouri University of Science & Technology

DESCRIPTION: This research project will determine the effectiveness of the Variable Speed Limit (VSL) system on I-270/I-255 corridor in St. Louis County, Missouri.

BENEFITS: The potential benefit of the study is to find measurable indications of success with the system. The purported benefits of the VSL system include improvement in the traffic flow, speed harmonization and vehicle safety. The desired outcome from the study is a report on findings with recommendations for improvements.



Sketch of an iron-epoxy coated LPFG corrosion sensor.

Initial Study and Verification of a Distributed Fiber Optic Corrosion Monitoring System for Transportation Structures

PI: Dr. Hai Xiao, Associate Professor, Missouri University of Science & Technology

Co-PI: Dr. Genda Chen, Professor, Missouri University of Science & Technology

DESCRIPTION: Corrosion has long been recognized as one of the major contributors to catastrophic failure of transportation structures. Cost-effective technologies for large-scale transportation structures are basically unavailable. A recent study by Koch et al (2002) indicated that the annual direct cost for the corrosion-related maintenance of U.S. highway bridges was estimated to be \$8.3 billion [1]. This proposal aims to develop an innovative distributed fiber optic corrosion monitoring system for long-term deterioration assessment of bridges. Core to the monitoring system is a novel corrosion sensor that can be constructed by coating a thin layer of iron-epoxy around the surface of an optical fiber that is inscribed with a long period fiber grating (LPFG). Due to its coupling effect with strain and the need for monitoring of the corrosion environment (e.g., pH and temperature) in practical applications, a polymer-coated LPFG sensor and an uncoated LPFG sensor will be integrated with the corrosion sensor to form a multiplexed, self-referencing monitoring system.

BENEFITS: The potential benefits of reinforcing the ballast is that it will enable the stone to last longer, which will reduce the demand on quarries for new stone along with reducing the time and money required for maintenance. It also may enhance safety by stiffening the foundation of the track, thus reducing the movement of the track under loading and potentially resulting in a more stable track.

The proposed study will focus on the design, characterization, integration and demonstration of the triple-sensor monitoring system. Two reinforced concrete (RC) blocks will be used to test and demonstrate the feasibility of the above monitoring system towards practical applications.

BENEFITS: The proposed research will lead to the development of a comprehensive, distributed corrosion monitoring system that provides important information on corrosion, corrosion environment and its implication on structural health and safety. Such information is critical for the assessment of corrosion-induced structural deterioration. In turn, timely preventive actions can be taken against a catastrophic failure in order to ensure the safe and smooth operation of our nation's transportation structures.



Enhanced Sustainability of Railroad Ballast

PI: Dr. Robert Parsons, Associate Professor, University of Kansas

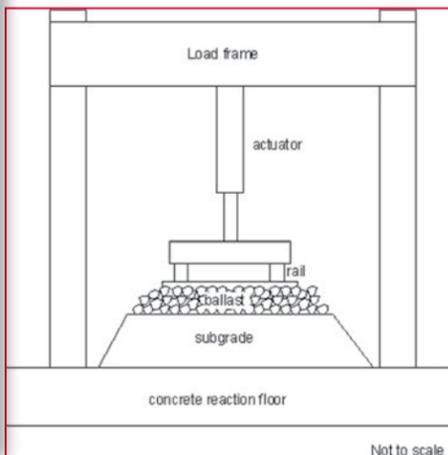
Co-PI: Dr. Jie Han, Associate Professor, University of Kansas

DESCRIPTION: Railroads require continuous supplies of crushed stone for use as ballast to maintain tracks. Under the repeated loading of rail traffic, this stone is degraded through crushing and this damage is compounded by the upward migration of fines from soft subgrades below. For this project a full scale section of track will be constructed with ballast that is reinforced with geosynthetics. This study will evaluate the improvement in the durability of the ballast and reductions in track deformation that occur with said reinforcement.

BENEFITS: The potential benefits of reinforcing the ballast is that it will enable the stone to last longer, which will reduce the demand on quarries for new stone along with reducing the time and money required for maintenance. It also may enhance safety by stiffening the foundation of the track, thus reducing the movement of the track under loading and potentially resulting in a more stable track.

2010 MATC Research Projects

RESEARCH



Rendering of load frame and railway configuration.

BENEFITS: This research will improve on the ability to determine the extent of freight traffic on the highway and from specific businesses, such as rail-truck intermodal facilities.

Modeling Truck Speed in the Upstream of Two-lane Highway Work Zones: Implications on Reducing Truck-Related Crashes in Work Zones

PI: Dr. Yong Bai, Associate Professor, University of Kansas

Co-PI's: Dr. Steven Schrock, Assistant Professor, University of Kansas; Dr. Thomas Mulinazzi, Professor, University of Kansas

DESCRIPTION: Truck-related crashes constitute a major safety concern for government agencies, the transportation industry, and the traveling public. Due to rising needs in highway maintenance and construction, the number of work zones is increasing throughout the United States, and, simultaneously, freight movement using trucks is augmented nationwide. Developing effective safety countermeasures to reduce the truck-related crashes is a major challenge that the government agencies and transportation industry face. The main objective of the proposed research project is to model the truck speeds in the upstream of two-lane highway work zones.

BENEFITS: Understanding actual truck speed and speed deviation will help traffic engineers to better design work zone traffic control, thus avoiding truck-related crashes and improving safety for construction workers and drivers.



Smart sensor for determining truck speed.

Improving the Long-Range Tracking Algorithm for use in Tracking Long-Haul Trucks using Cellular Data

PI: Dr. Steven Schrock, Assistant Professor, University of Kansas

DESCRIPTION: Previous research has shown that it is technically possible to estimate the extent that heavy trucks will travel from a specific facility, such as a rail-truck intermodal facility, based solely on the remote tracking of these vehicles using cellular telephone position data. The use of cellular tracking data to determine travel times along highway corridors is well developed, but, in other areas, the entire process is contingent on cellular coverage. In order to properly track freight departing from a facility a different approach is needed. An effective tracking process must be able to track a vehicle for hours or days depending on the truck's ultimate destination, as well as the ability to differentiate between freight-hauling trucks and other non-freight vehicles (e.g., cars). The latter is necessary in order to spend effort only tracking vehicles of interest. In previous research, this aspect of the tracking process was developed ad-hoc, and may not have been an optimal technical solution. This research effort is focused on improving both the ability to differentiate between freight and non-freight traffic as well as improving the capacity to determine when the tracked trucks have reached their destination.



University of Iowa Projects

Automated Erosion System to Protect Highway Bridge Crossings at Abutments

PI: Dr. Thanos Papanicolaou, Professor, University of Iowa

DESCRIPTION: Conventional monitoring methods of erosion of bank soils and removal of abutment fill material have difficulty capturing the exact time of the event. This type of monitoring provides only net measurements that have occurred since the previous sampling. Moreover, these methods are laborious and expensive, which often leads to under-sampling. This pilot study will develop a protocol for monitoring erosion near bridge abutments using innovative technology, Photo-Electric Erosion Pins (PEEPs), and a test study near the U.S. Highway 965 bridge crossing over the Iowa River in Johnson County. PEEP's provide automated and continuous monitoring of localized erosion especially in areas in which channel surveying and/or installation of erosion pins are difficult. The primary goal of this pilot study is the development of a protocol for monitoring erosion near bridge abutments using innovative technology.

BENEFITS: This project will provide continuous rates of bank erosion at a highly traveled, but threatened, Iowa bridge crossing. The results will identify key hydrological and climatic conditions leading to failure near bridge abutments. The primary products for this project include a thorough and well illustrated operational manual for local engineers describing an innovative monitoring procedure for continuous, automated evaluations of bank erosion via a new instrument (Photo-Electric Erosion Pins).



Erosion of a bridge abutment.

Improving Freight Fire Safety: Experimental Testing and Computer Modeling to Further Development of Mist-controlling Additives for Fire Mitigation

PI: Dr. Albert Ratner, Assistant Professor, University of Iowa

DESCRIPTION: This project will continue to develop the science and technology required to implement fuel additives that improve fire safety for trucks and trains. The polymer-based fuel additives reduce fuel misting in accidents, and thereby reduce the chance of fire. Current project work includes both experimental testing and computer simulation.



High-speed image of a diesel drop impact.

BENEFITS: Being able to characterize and classify additive behavior will enable faster and less expensive development of better polymers, thereby bringing a fire reducing polymer into service quicker.

while achieving the longer performance life due to the significantly reduced oxidation of asphalt. During the phase 1 study, six commercially available WMA products were evaluated in the laboratory: Advera WMA, Asphalt-min®, CECABASE RT®, Evotherm J1, Rediset WMX and Sasobit®. Based on the laboratory test results obtained from the phase 1 study, it was found that these WMA mixtures were susceptible to moisture damage. Therefore, it is critical to consider anti-stripping agents for WMA mixtures with the end goal of using it in highways with heavy traffic and high tire pressures. Using the control WMA mixture and the control HMA mixture, characteristics of friction and unraveling will be evaluated and compared to determine which mixture can accommodate high-pressure tires on high-traffic highways.

BENEFITS: The main product anticipated from this research is the safe and reliable WMA mixtures with a WMA additive and an anti-stripping agent. Upon completion of the proposed phase 2 study, the most appropriate WMA additive and anti-stripping agent will be identified to produce WMA mixtures with a resistance to moisture damage, skidding, and raveling. This information would be very useful for all pavement engineers who are interested in utilizing the WMA pavement under a heavy traffic with a high tire pressure.

Performance Measures of Warm Asphalt Mixtures for Safe and Reliable Freight Transportation (Phase 2: Evaluation of Friction and Raveling Characteristics of Warm Mix Asphalt Mixtures with Anti-stripping Agents)

PI: Dr. Hosin, Associate Professor, University of Iowa

Co-PI: Dr. Yongjoo Kim, Research Associate, University of Iowa

DESCRIPTION: It is anticipated that more highway pavements will be constructed using warm mix asphalt (WMA) mixtures in order to reduce carbon dioxide emission



The six commercial products used in the WMA analysis.

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IMPROVING SAFETY AND MINIMIZING RISK ASSOCIATED WITH INCREASING MULTI-MODAL FREIGHT MOVEMENTS

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Maurice D. Cavitt: MATC Student Spotlight

Maurice D. Cavitt is a Ph.D. student at the University of Nebraska-Lincoln in the Department of Industrial and Management System Engineering (IMSE). He holds a B.S.E.E. degree from Prairie View A&M University, a Historically Black College and University (HBCU) located near Houston, Texas. Cavitt has been selected as the 2010 MATC Doctoral Student of the Year,

an award which includes a \$1,000 scholarship and \$750 in travel funds to attend the 2010 Transportation Research Board meeting in Washington DC.

"It is an honor and a great privilege to be recognized as the Mid-American Transportation Center (MATC) Doctoral student of the year. It is an awesome feeling to be acknowledged for my research efforts and it was exciting to be able to attend the 89th Annual Transportation Research Board (TRB) Conference. Being invited to the same conference as other great researchers and intellectual minds allowed me to network and see great research," states Cavitt. He is thankful to his professors and family for inspiring him to achieve

this award: "I would like to thank my professor and mentor Dr. Erick C. Jones for allowing me to work with his innovative research and projects to gain valuable research experience that will equip me with the necessary tools to be a great professor and researcher as himself. I would like to thank my family and friends for believing in me the most when I doubted myself at times for this I am greatly thankful."



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Dr. Erick C. Jones, one of Cavitt's professors, speaks on behalf of the RFID Supply Chain Logistics Lab in sending his compliments and congratulations on "starting off on a great note."

Likewise, Dr. Judy Perkins, from Prairie View A & M University, extends her congratulations "on behalf of the entire PVAMU crew" and encourages him to "keep up the good work."



Upcoming 2010 MATC Events:

March 29-31:

ITS Heartland Annual Meeting

**To register visit:*

www.itsheartland.org

April 13-14:

KSU 92nd Annual Kansas Transportation Engineering Conference

**For details visit:*

www.dce.k-state.edu/conf/transportation/

April 29-30:

Union Pacific Bailey Yard Tour

**To apply visit:*

matc.unl.edu/union_pacific_app.php

May 17-August 13:

MATC Summer Intern Program

**For details visit:*

matc.unl.edu/internship.php

June 15-17 & July 7-8:

UNL Professional Development Science and Math Summer Institute

**For details visit:*

matc.unl.edu/summer_institute

July 8-15:

Engineering Education Excellence Institute

Lincoln, NE - July 8

Omaha, NE - July 9

Lexington, NE - July 13

Hastings, NE - July 15

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