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Each time we sit down and identify the highlights for the Center’s annual report, one area of activity in our mission always stands out. This time, the Center’s leadership and partnerships deserves to be front and center. During the period covered by this annual report, Michigan Tech’s UTC coordinated and hosted three key partnership meetings - in Houghton! For those of you who have been in the Upper Peninsula of Michigan you’re familiar with its natural beauty, and equally familiar with its remoteness. Hosting a meeting in Houghton is particularly challenging given the limitations on accessibility and, in general, perceptions of smallness. UTC-MiSTI personnel stepped up to each challenge, driven to provide a small town “big” welcome. And if you were one of the folks lucky enough to come to the Upper Midwest Transportation Materials Summit, the Council of University Transportation Center’s 2012 summer meeting, or the Transportation Engineering and

Road Research Alliance (TERRA) summer board meeting and Innovation Series event, we were really happy you met the challenge, set aside your “small town ideas” and made the journey.

This annual report covers activities supported by the Center’s fiscal year five funding (federal FY10) awarded for activity beginning July 1, 2010 through June 30, 2011. These funds were programmed out over two years to include the closeout operations scheduled from July 1, 2011 through June 30, 2012, and an extension through December 31, 2012. The extension allowed for further advancement of the Center’s students towards degree completion and continuation of ongoing efforts to publish and transfer the results of the Center’s five year research portfolio to practitioners. Worth noting, UTC-MiSTI has successfully attained incremental growth in all metric reporting categories demonstrating its ability to leverage the federal investment to meet the needs of the transportation industry. An overview of this growth is available on page 24 of this report.
2010-2011 Center Staff

Center Director
Dr. Lawrence Sutter, PhD
Assistant Director
Elizabeth Hoy
Student Assistants
Miranda Thompson (B.S.)
Sarah Shann (M.S.)
Publications/Communications
Scott Bershing
Trevor Kuehl
Jessica Juntunen
John Velat
Event Support
Angela Irwin
Pam Hannon

Technical Advisory Council

Federal Highway Administration
Suneel Vanikar
Kirk Steudle
Michigan DOT
Roger Olson
Bruce Ramme
We Energies
Robin Graves
Vulcan Materials
Jim Klett
Klett Construction
Emily Lorenz
CTL Group, Inc.
Al Innis
Holcim, Inc.

Baseline Faculty

Dr. Theresa Ahborn, Associate Professor, Structural Engineering
Dr. George Dewey, Associate Professor, Structural Engineering
Dr. Ralph Hodek, Associate Professor, Geotechnical Engineering
Dr. Lawrence Sutter, Professor, Cementitious Materials
Dr. Stanly Vitton, Associate Professor, Geotechnical Engineering
Dr. Zhanping You, Associate Professor, Pavement Materials
Dr. Jacob Hiller, Assistant Professor, Pavement Materials
Dr. Pasi Lautala, Assistant Professor, Rail Transportation
Dr. Devin Harris, Assistant Professor, Structural Engineering

2010-12 Graduate Degrees

The following is a list of graduate degrees granted to students engaged in UTC-MiSTI activities and includes the degree attained and current employer.

Christopher Gilbertson (PhD) Michigan Tech Transportation Institute
Baron Colbert (MS) PhD Program-Michigan Tech
Gerald Anzalone (MS) PhD Program-Michigan Tech
Zeyad Ahmed (PhD) Michigan Tech-Instructor
Melanie Kueber Watkins (PhD)* Michigan Tech Transportation Institute
Pei Tang (PhD)* JCMS Inc.
Karl Kruger (MS) AECOM
Sarah Shann (MS) Wiss, Janney Elstner, Inc., Michigan
Darrell Cass (MS) Minnesota Department of Transportation
Julian Mills-Beale (PhD)* California Baptist University
Baron Colbert (PhD)* Florida State University-Florida A&M
Shu Wei Goh (PhD)* Entrepreneur
Cory Shorkey (MS) Anderson, Ekstein and Westick, Inc.
Rita Lederle (MS) PhD Program-University of Minnesota
Yinghong Qin (PhD) Guangxi University, China
Paul Koning (MS) CH2M Hill
Eric Kreiger (MS) Oakridge National Laboratory, Illinois
Miguel Carbonell (MS) Di Simone, Florida
Jason Fleistra (MS) BCC Engineering, Florida
Yongliang Jin (Phd)*
Gerald Anzalone (PhD)**
Mary Christiansen (PhD)**
Khatereh Vaghefi (PhD)**

*Anticipated degree Fall semester 2012
**Anticipated degree Spring or Summer semester 2013
**People Highlights**

**Two Transportation Faculty Join Michigan Tech**

**Dr. Qingli Dai** is an Assistant Professor in the Civil and Environmental Engineering Department at Michigan Technological University. Her research expertise is in the area of construction materials (asphalt mixtures and concrete) and structural finite element analysis. Her research integrates computational analysis, experimental testing and sensor techniques to investigate asphalt mixture performance, asphalt pavement distresses, concrete microstructure and concrete durability. Her group has been investigating the performance and behavior of asphalt mixtures, viscoelastic responses of asphalt pavements, fracture simulation, self-healing construction materials and internal frost-damage in concrete. Current projects include freeze-thaw damage in concrete, induction healing of asphalt mixtures, self-healing composite materials and concrete structural analysis. Dr. Dai has been a principle investigator on research projects funded by National Science Foundation and Michigan Department of Transportation. She has authored and co-authored more than 45 peer reviewed papers including 29 journal articles. She has presented technical papers in various international and national conferences. She is a member of ASCE EMI granular material committee, ASCE CI bitumen material committee, and ASCE GI pavement committee and geophysics committee. She also serves as an associate editor for ASCE Journal of Materials in Civil Engineering.

**Dr. Jeffery Lidicker** holds a doctorate in Transportation Engineering from the University of California, Berkeley, a Masters degree in statistics and another Masters in mathematics. Professionally he was manager and statistician at the Transportation Sustainability Research Center at the University of California, Berkeley, and was director of Statistical Consulting Services at the Center for Statistical and Information Science at Temple University in Philadelphia. Before that he worked in the private consulting sector for the pharmaceutical industry. He has 25 peer-reviewed published articles and 30 conference presentations and posters. His expertise spans sustainable asset management, life-cycle assessment, life-cycle cost assessment, economics, discrete choice (behavioral) modeling, generalized linear models, biostatistics, epidemiology, survey design and analysis, and sustainable transportation and planning (emissions, climate change, and energy policy). Publications of particular interest include electric vehicle (EV) economics, pavement maintenance optimization with life-cycle metrics, hydrogen vehicle human factors, car-share, and transportation asset management. His projects have been funded by the National Institute of Health, Philadelphia Department of Health, California Air Resources Board, University of California Transportation Center, California PATH, The Honda Motor Company, and the California Department of Transportation (Caltrans).
**People Highlights**

**2011 UTC Student of the Year**

Khatereh Vaghefi is a PhD student and graduate research assistant at Michigan Technological University. She completed her Master of Science degree in Structural Engineering at Newcastle University, UK in 2009 and her Bachelor’s degree in Civil Engineering in her home country Iran. Her current research is part of the project “Bridge Condition Assessment using Remote Sensors”, sponsored through the USDOT Research and Innovative Technology Administration (RITA). She is working with her advisor, Dr. Tess Ahlborn, and a research team at Michigan Tech to enhance current bridge inspection practice methods. As part of this research, she is evaluating commercial remote sensors for bridge condition assessment and publishing the results of this study in the ASCE Bridge Engineering Journal.

Her research will allow bridge inspectors to detect and quantify subsurface defects that are not visible or detectable during a visual-based bridge inspection. Applying this technology can enhance current bridge inspection practices by speeding the data collection process and reducing lane closures and traffic disruption over and under the bridge, as well as providing more detailed information for maintenance and repair decision making.

**Former UTC Student of the Year: Where are they now?**

2007 UTC-MiSTI Student of the Year

Timothy J. Bates (MS) is a Civil/Structural Engineer with StrongPoint Engineering in Green Bay, Wisconsin. TJ recently became a registered professional engineer in Wisconsin.

2008 UTC-MiSTI Student of the Year

Melanie Kueber Watkins (PhD candidate) is a Research Engineer with the Michigan Tech Transportation Institute at Michigan Technological University in Houghton, Michigan.

2009 UTC-MiSTI Student of the Year

Russ Lutch (MS) is a Structural Engineer with Kiewit Construction Company in Omaha, Nebraska.

2010 UTC Student of the Year

Darrell Cass (MS) is a Graduate Engineer with the Minnesota Department of Transportation in Minneapolis, Minnesota.
Center Provides TRAC Pipeline Scholarships

In 2008, UTC-MiSTI entered into an agreement with the Michigan Department of Transportation to provide first-year civil engineering students, from their TRAC pipeline intern program, a one-time scholarship. These scholarships encourage and enable students to pursue their interest in transportation engineering as a focus and career choice. The Center distributed eleven scholarships between 2008 and 2011, totaling $26,250.00, over four years. Scholarship recipients included:

- 2008 Morgan Hansen*
- 2009 Kodi Padilla
  Richard Poljan
  Bradley St. Germain
  Cody Ponchaud
- 2010 Micha Tate Trierweiler
  Kevin Wilks
  Logan Walz
  Christian Velasano
- 2011 Ellen Nightingale
  Madelina Martin

* Morgan Hansen will graduate with her BS in Civil Engineering in May 2013 and will attend graduate school to study transportation with an emphasis in geotechnical engineering.

Undergraduate Enterprise Program Topics Broadened with UTC Support

The UTC-MiSTI provided leadership and support to broaden the topics of projects explored by students in the Pavement Design, Construction and Materials Enterprise (PDCM). In the fall of 2010, the PDCM was renamed as the Transportation Enterprise (TE). Broadened from only pavement related projects, the TE model allows for non-pavement transportation related topics to be introduced.

To jump start this initiative, the UTC-MiSTI provided matching funds to the TE program to attract industry support for four new projects. Twenty seven undergraduate students were enrolled in the TE program during the 2010-11 academic year. These projects and sponsors in the first year of the TE program included:

- **CXT/CN Sustainability Assessment**, sponsored by CXT, CN and Michigan Tech’s Rail Transportation program
- **City of Houghton Complete Streets**, sponsored by General Motors
- **Warm Mix Asphalt Application Synthesis for the Upper Midwest**, sponsored by the Minnesota Department of Transportation
- **Carbonate Aggregate Characterization**, sponsored by Vulcan Materials

More information on the Transportation Enterprise program is available at [http://transportation.enterprise.mtu.edu/](http://transportation.enterprise.mtu.edu/)
Research

Year 5 Research: Center Awards Two Research Projects, Conducts Two Internal Investigations and Supports Two PhD Candidate Thesis Projects

PROJECT 1: Selecting the Combination of Innovative Sustainable Materials for Asphalt Mixtures

There are a number of innovations in asphalt pavement design and construction that can positively affect the sustainability of those pavements. These innovations include the use of recycled aggregates, reclaimed asphalt pavement (RAP), waste shingles, warm mix asphalt (WMA) and bio-asphalt generated from biomass. The purpose of this project is to integrate the various recycled material innovations used in designing more sustainable asphalt pavements. Engineers normally select one of these materials for asphalt pavement design and construction. A challenge to implementing these new technologies is the lack of a systematic approach to evaluating combinations of these materials.

Research Objective

The objective of this research is to provide a systematic approach to selecting the right combination of these components in designing an asphalt mixture. The individual materials to be considered include WMA and RAP. The research project will utilize data from existing research projects to develop a systematic approach to selecting the optimum combination of materials with performance and life cycle cost in mind. The deliverable will be a guideline for a life cycle assessment (LCA)-based selection approach for multiple streams of materials.

Methodology

This research will evaluate the rutting performance and moisture susceptibility of WMA and RAP mixtures using AASHTO T 283 Resistance of Compacted Bituminous Mixture to Moisture-Induced Damage, and AASHTO TP 63 Determining Rutting Susceptibility of Asphalt Paving Mixtures Using the Asphalt Pavement Analyzer. The research team will then conduct a hybrid life cycle assessment by reviewing the entire industrial process associated with producing RAP and WMA using analysis tools such as SimaPro and EIO-LCA.

Anticipated Research Findings

This research will produce characterization and performance data, for WMA and RAP mixtures, that will be used in parallel with life cycle assessment data to provide a systematic approach for identifying the best combination of sustainable materials. The deliverable will be guidelines for LCA-based materials selection for asphalt mixtures using multiple material streams.

Anticipated Implementation

Laboratory-based testing results will be used to complete the hybrid LCA and will lead toward a larger-scale research project involving state and regional transportation authorities. WMA and RAP maintenance schedules will be determined from the rutting and moisture susceptibility results. Various combinations of recycled materials such as RAP and WMA materials in asphalt pavements will be determined from the hybrid LCA developed for this project. Pavement designs, which are optimal in cost, performance, and environmental impact, will be identified.
Research

PROJECT 2: Leaching of Toxic Heavy Metals from Additives in Concrete

Disposal of coal combustion fly ash represents a significant environmental problem due to the potential enrichment of heavy metals within the ash. In order to alleviate this problem, beneficial reuse of coal combustion byproducts is increasingly being promoted. Coal combustion byproducts are reused mainly in cementitious products in construction applications such as highway road bases, grout mixes, stabilizing clay-based building materials, infiltration barrier and underground void filling. However, one concern regarding the beneficial reuse of fly ash is the potential leaching of the heavy metals that can contaminate the underlying soil, surface and groundwater, resulting in serious ecological and human health impact.

The Environmental Protection Agency (EPA) issued guidelines for testing ash samples utilizing the toxicity characteristic leachate procedure (TCLP), also referred to as EPA Testing Method 1311 and described in EPA publication SW846. The test is used to determine whether an ash exhibits the characteristic of a hazardous waste. A list of contaminants and their associated threshold concentrations in an extract of solid waste are listed in 40 C.F.R. §261.24. If a contaminant equals or exceeds its threshold concentration when tested using the TCLP analysis as specified at 40 C.F.R. §260.1, the material is classified as being toxic and cannot be deposited into a non-hazardous waste landfill or ash monofil without first being treated. In addition, there exist various states such as California, Michigan and Vermont, which require additional leaching tests on solid waste in order to classify the waste. These states direct the heavy metal leaching wastes to hazardous waste landfills.

Some researchers feel the TCLP may not be the best leaching procedure to assess coal combustion byproducts as this procedure is designed to determine the hazardousness of materials disposed of in a municipal landfill, where acid is generated by the waste. For coal combustion byproducts used in road construction, cement and concrete additives, TCLP may not represent the actual conditions.

Research Objective

The objective of this study is to generate information regarding the appropriateness of the use of TCLP versus distilled water for leaching tests of concrete materials in which fly ash has been used.

Methodology

Two classes of fly ash, F and C will be added to concrete material. Two types of leaching procedures – TCLP and distilled water – will be used to leach the concrete. A suite of metals will be analyzed in the leachate, namely As, Cd, Hg, Pb, Cr, V, Cu, Mo, Se and Zn. The leachates generated will be tested for metals using an Atomic Absorption Spectrophotometer (AAS) or an Inductively-Coupled Plasma Mass Spectrometer (ICP-MS).

Anticipated Research Findings

The study will generate preliminary data regarding the appropriateness of using TCLP to test the leaching of heavy metals from concrete materials in which coal combustion byproducts such as fly ash are being used.
Research

INVESTIGATION 1: AASHTO T 318 Water Content of Freshly Made Concrete Using Microwave Oven Drying

T 318 calls for a microwave of at least a 900-watt power setting. With 1200-watt microwaves being readily available in the marketplace, this project has been conducted to determine if there are any advantages to using a higher powered microwave. The project will also evaluate a procedure to correct for coarse aggregate water absorption and will develop a data set to establish a precision and bias statement for the test method.

For this project, a matrix of five mixture designs were replicated twenty five times each and microwave testing was conducted on each batch. The project used two 900-watt microwaves and two 1200-watt microwaves. Each microwave was operated by one of four technicians that operated the same microwave for the duration of the testing.

Two of the mix designs were made with water to cement ratio (w/c) of 0.42 with the only difference between them being the type of aggregate used in the mixture, one being a limestone and the other an igneous aggregate. The next mixture design used the same igneous aggregate and the w/c was increased to 0.48. For the fourth mixture design, the volume of igneous aggregate was decreased ten percent and the volume of cement paste was increased ten percent with the w/c remaining constant at 0.48. There was also a 0.48 w/c mixture prepared using limestone aggregate. However, the aggregate and paste volumes were not held to the same values as the other mixtures.

A statistical analysis of the data has shown that with a limestone aggregate both the 900 and 1200-watt microwaves perform equally well, with the 1200-watt microwave running the test about four minutes faster than the 900-watt microwave. This was consistent with both the 0.42 and 0.48 w/c mixtures. With the igneous aggregate the 900-watt microwaves were a little more consistent than the 1200-watt microwaves. This was likely due to the 1200-watt microwaves heating the aggregate too fast. Every test had aggregate that would crack and explode due to trapped water converting to steam and expanding faster than the pore structure of the aggregate could accommodate. Regarding the absorption correction, the data showed that an accurate estimate of water content required use of the coarse aggregate absorption correction. Finally, the precision data developed confirms the existing precision statement is in error by a significant factor, i.e., the existing precision statement for AASHTO T 318 is 2.7 lbs/cubic yard while the data from this test shows the precision to be approximately 8.3 lbs/cubic yard.

More information on the Non Conductive/Volatile Phase Material Characterization Facility, Benedict Laboratory or Michigan Tech’s other construction materials research facilities is available in this capabilities document http://www.mtti.mtu.edu/pdf/MTTI_Facilities_Brochure_small.pdf

The results of this study are currently being evaluated by AASHTO for revision of the test method.
In Investigation 2: Evaluation of ASR Expansion Mitigation Potential of Fly Ash from Various US Sources with a Kinetic Based Expansion Model

Coal fly ash is a byproduct of the combustion of pulverized coal by power plants. It is recovered in the gas handling system as a finely divided, glassy phase and is primarily composed of oxides of silicon, aluminum, iron and calcium. Fly ash, having properties meeting established criteria, may be used as a supplementary cementitious material (SCM) in portland cement concrete, enhancing the performance of the concrete while beneficially using a waste product. Properties of fly ash vary with the type of coal burned, combustion technology employed and operating practices at the power plant. The properties of fly ash responsible for enhancement of concrete performance also work to mitigate a materials related distress known as alkali-silica reactivity (ASR).

ASR occurs with aggregate containing poorly to non-crystalline (amorphous) silica minerals. These minerals tend to chemically react in the alkaline pore solutions typical of portland cement concrete and, depending upon system chemistry, can react to form silica gel that expands when exposed to water. Forces caused by the expanding gel causes fracturing of the concrete and in very severe cases the integrity of the affected structure can be impaired.

Testing methods used to evaluate SCM mitigation of ASR are based upon methods used to evaluate the performance of potentially reactive aggregate. Evaluation criteria for these tests are based on measured uniaxial expansion after a period of time under prescribed conditions. The test results are not necessarily predictive of field performance. A kinetic based interpretation of these expansion measurements has been proposed and may yield results better reflecting performance of aggregate in the field.

The research objective is two-fold: 1) Using the established testing methodology, evaluate the ASR expansion mitigation potential of fly ashes sourced by a number of geographically dispersed US producers, 2) Evaluate the same expansion data utilizing a kinetic based interpretation, developing potentially more meaningful criteria for ASR expansion mitigation potential.

Fly ashes from approximately 20 US producers will be evaluated utilizing ASTM C1567 with known reactive silica aggregate. Portland cement replacement levels will be varied with each fly ash so as to determine the relative mitigation potential of each ash. The data collected will be analyzed per the published ASTM C1567 methodology and also using the kinetic-based approach. Emphasis will be placed upon developing meaningful criteria for assessment of aggregate ASR potential as well as the ASR mitigation potential of a given fly ash.

A data store containing all expansion data generated by this research will be produced. An evaluation of the kinetic interpretation of the expansion data will also be produced while concurrently evaluating criteria for assessing the ASR expansion mitigation potential of the tested SCMs. No single large-scale, data store of fly ash ASR mitigation performance currently exists. This data will benefit both producers and consumers of fly ash, potentially enhancing the use of fly ash in concrete construction. Establishing criteria that better reflect the actual performance of aggregate with ASR mitigation will aid decision making with regards to aggregate use, selection of fly ash and replacement rates, for aggregate/SCM combinations.
Mary Christiansen is a PhD candidate and graduate research assistant with working in the UTC-MiSTI with adviser Dr. Larry Sutter. Her research is focused on an alternative binder to portland cement called geopolymer. Geopolymers behave similar to portland cement in terms of mechanical performance and durability, while offering a much lower carbon footprint (approx. 80% less). Mary is specifically interested in geopolymers based on the alkali activation of waste glass; the use of waste glass further lowers the associated emissions and cost of the binder as well as providing a potential market for waste glass. Physical testing, in the form of compression strength testing, as well as microstructural analysis makes up the bulk of the research. Utilizing capabilities of Michigan Tech’s Non Conductive/Volatile Phase Material Characterization Facility including the scanning electron microscope (SEM) and chemical analysis allow for a detailed study of the microstructure of these novel new binders.

PhD candidate Khatereh Vaghefi, and her advisor Dr. Tess Ahlborn, are working to solve the challenges of prestressed concrete box-beam bridge inspection by evaluating infrared thermography. Detecting subsurface defects and delaminations, specifically for prestressed concrete box girder bridges, has always been a challenge for bridge inspectors. This study will focus on enhancing the use of infrared thermography technique for assessing the concrete bridge deterioration. As part of this project, active infrared thermography testing is being conducted on a 23-foot segment of a deteriorated prestressed concrete box beam bridge girder that was taken out of service in Oakland County, MI. This bridge had severe deterioration in beams and pier caps and was rated as a poor condition bridge before demolition. The section of the bridge that was saved for research study has a depth of 3.5 ft and a width of 3 ft. The weight of the specimen is around 20 kips. This unique specimen was transferred nearly 600 miles to Michigan Tech’s cement and concrete research facility in Houghton, MI. The photos below show a test subject box-beam being moved into Benedict Laboratory.
**Research**

**Center Supports Standards Development**

As new cementitious materials enter the market for implementation into our transportation infrastructure, it is imperative that we understand the behavior of these materials and how this behavior will influence long-term performance. In the case of ultra-high performance concrete, little is understood regarding compressive creep behavior and no ASTM standards exist for testing the creep of this new material, particularly under conditions that are representative of field conditions.

The UTC provided funding to build compressive creep loading frames (top right photo) that would encompass extreme high load levels, and allow for field conditions to be simulated. The lower photo shows the loaded frames in the curing chamber, affording the test to simulate standard precast concrete manufacturing techniques (loading concrete with prestress forces then curing with the member under load). These frames are 3-4 times stiffer than typical compressive creep frames used for concrete to accommodate the high capacity level of UHPC and other advanced materials. Research has already provided valuable insight into the short-term behavior, and continued studies are investigating the long-term material performance. Results will be used to develop and propose new ASTM test standards for materials such as UHPC that can be cured while under an applied load.

UTC-MiSTI has also been participating with ASTM to develop a test method for determining the water content of fresh concrete. The test method being considered is similar to the AASHTO T 318 method except for i) providing a correction for coarse aggregate absorbed water, ii) a higher wattage microwave oven, and iii) a revised precision and bias statement. Currently, the results of UTC-MiSTI research on the new test method has been used to develop a draft method for ASTM but also the results are being considered by AASHTO for revisions to AASHTO T 318. A final decision on both is expected in 2013. More information on this project is available on page 9 of this report.
Research Products

The following is a list of reports and other products resulting from research supported by the UTC-MISTI.


Research Products  

Lederle, R.E. and Hiller, J.E., “Reversible Shrinkage of Concrete Made with RCA and Other Aggregate Types,” accepted to ACI Materials Journal, (October 2012)

Lederle, R.E. and Hiller, J.E., “Development of New Warping and Differential Drying Shrinkage Models for Jointed Plain Concrete Pavements Derived with a Nonlinear Shrinkage Distribution,” accepted to the Transportation Research Record, (January 2012)


Lederle, R.E. and Hiller, J.E., “Quantifying Components of Permanent and Cyclic Warping in Concrete Pavements,” 10th International Conference on Concrete Pavements, Québec City, Québec, Canada, pp 365-380, (July 2010)


Lautala, P.T., “Responding to Emerging Demand - New Generation of Cold Climate Rail Lines in the World,” International Heavy Haul Association (IHHA) Conference, Calgary, Canada, (June 2011)


Sutter, L.L., and K.W. Peterson, “Reduction of Minimum Required Weight of Cementitious Materials in Concrete Mixes,” Final Report 0092-08-08, Wisconsin Department of Transportation, Madison, Wisconsin, (July 2011)


Completed Research

Title: Reduction of Minimum Required Weight of Cementitious Materials in WisDOT Concrete
Sponsor: Wisconsin Department of Transportation
Start Date: 9/1/07  End Date: 5/31/11
PI: Dr. Lawrence Sutter  Value: $166,833.66

Title: Impact of Hydrated Cement Paste Quality and Entrained Air-void System on the Durability of Concrete
Sponsor: Michigan Department of Transportation
Start Date: 7/31/07  End Date: 2/28/11
PI: Dr. Lawrence Sutter  Value: $304,826.21

Title: An Integrative Framework to Study Carbon Emissions of Road Construction Projects
Sponsor: Michigan Department of Transportation
Start Date: 5/1/09  End Date: 6/30/11
PI: Dr. Amlan Mukherjee  Value: $199,999.49

Title: Specifications and Protocols for Acceptance Tests of Fly Ash Used in Highway Concrete
Sponsor: National Cooperative Highway Research Program
Start Date: 7/16/07  End Date: 9/25/12
PI: Dr. Lawrence Sutter  Value: $749,125.00
Final Report: In Review
Technology Transfer

UTC-MiSTI coordinated and hosted three state and national meetings in Houghton during this funding cycle. The events delivered recent and on-going research results and information on commercialization and the transfer of technology. Combined, the three events reached 248 participants from state and federal government, industry, and academic organizations.

Summit Brings Research Updates to the State

The UTC-MiSTI coordinated and facilitated a one-day meeting in Houghton for state DOT and industry professionals. The Upper Midwest Transportation Materials Summit was held in Houghton in November 2010. Ninety-six people attended a full-day of research updates focusing on materials and structural applications of materials. Michael Darter, principal engineer at Applied Research Associates and professor emeritus at the University of Illinois (Urbana-Champaign), delivered the keynote address on the status of MEPDG implementation. Sixteen research updates were provided by researchers from across the country.

In a TV 6 news interview, MDOT’s Chief Operations Officer, Gregory Johnson commented on the importance of Michigan adopting the MEPDG, “We may have been overdesigning. Some states have found that their pavement thickness is too high for the given conditions, so we may see a change in pavement design and, therefore, a savings to citizens.” “If we can design pavement that’s two inches thinner and get the same performance as the thicker pavement, we’ve saved a lot of material, money, construction costs and made a positive impact with sustainability,” says Larry Sutter, Director of the UTC-MiSTI.

More information on this event is available in Vol. 5 No. 1 of the Transportation News, bi-annual newsletter produced by the UTC-MiSTI and available electronically on the Center’s website www.misti.mtu.edu on the publications page.
Technology Transfer

National Council Meets in Houghton

In June 2012, 101 representatives from academia and state and federal DOT agencies met in Houghton on Michigan Tech’s campus for the annual Council of University Transportation Center’s (CUTC) summer meeting. Most universities who have UTC programs are members of CUTC but the membership also includes a number of institutions without UTCs. The two-and-a-half day event began with updates from the USDOT’s Research and Innovative Technology Administration (RITA) program staff that administer the UTC program at the USDOT. A special presentation was delivered live from Brussels by Dr. Caroline Almeras, Secretary General of the European Transport Research Institutes and Universities (ECTRI). Dr. Almeras’s presentation highlighted efforts within ECTRI to promote transportation research and development across the Europe.

During the CUTC portion of the meeting, an update was provided on the recent Workforce Development Summit held in Washington DC and the membership engaged in CUTC strategic planning activities. Special presentations were made by MDOT Director, Kirk Steudle, MDOT’s TRAC Program Manager, Julie VanPortfleit, and Michigan Tech’s Dean of the College of Arts and Sciences, Dr. Bruce Seely. Seely, past chairman of the TRB History committee, provided a historical perspective on the future of transportation funding. Steudle, current AASHTO President, provided his observations of how DOT’s and others in the transportation community are persevering in tough economic times. In another special presentation, Steudle joined VanPortfleit to provide an overview of MDOT’s TRAC program activities, including the NSTI and TRAC Pipeline Internship Scholarship programs, both in implemented in Michigan in partnership with the UTC-MiSTI.

The final session featured local and state programs to support entrepreneurialism and technology transfer. Presentations included overviews of University programs and the Michigan Economic Development Corporations SmartZone initiative, designed to accelerate commercialization of university research products. Transportation related case studies from the University and local community were featured.
Regional Partnership Convenes in Houghton

In August 2012, the Transportation Engineering and Road Research Alliance (TERRA) met in Houghton on Michigan Tech’s campus for its summer board meeting and strategic planning discussions. TERRA is a dynamic partnership of government, industry and academic partners brought together to advance innovations in road engineering, especially those related to cold climates. Michigan Tech, represented by UTC-MiSTI Director Larry Sutter, serves as one of three academic partners in the alliance.

During the two day meeting, Michigan Tech’s remote sensing technologies were the focus of a half-day TERRA Innovation Series event. Research spotlights included two USDOT funded projects using remote sensing technologies, infrared imagery and the use of an unmanned aerial helicopter. A local entrepreneur and SmartZone company, Talon Research, reviewed their product, BridgeGuard. BridgeGuard is an infrared thermal-imaging tool developed by Talon Research and being used in field applications in Michigan and Florida to collect data that may alert an agency to problem areas in a structure warranting further inspection.

A full brief on the TERRA Innovation Series event, held in Houghton, is available in the October 2012 TERRA e-news at http://www.terraroadalliance.org/publications/enews/2012/04/.

Photos provided courtesy of the Transportation Engineering and Road Research Alliance (TERRA)
Technology Transfer

Webinars and Trainings Provide Current State and Practice for Transportation Professionals

UTC-MiSTI joined an effort being led by the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University and the Iowa DOT to support the TTCC pooled fund, TPF 5 (159). TPF 5 (159) provides technology transfer and trainings through the National Concrete Consortium (NCC). UTC-MiSTI committed $77,000 of year five funding to support training events in twenty-one states reaching 2125 transportation professionals. Training topics included:

- Concrete Pavement Preservation Training
- Design and Construction of Concrete Overlays
- Roller Compacted Concrete
- Concrete Pavement Surface Characteristics
- Pervious Concrete Design and Construction
- Concrete Paving Mixture (COMPASS Software Explanation)
- Quality in Concrete Paving Process (Quality Assurance Training)
- Early Age Cracking
- Cement-based Integrated Pavement Solutions

Webinar Demonstrates Multimodal Freight Management Systems Developed in Brazil

Michigan Tech’s UTC-MiSTI and the Rail Transportation Program co-sponsored an international information exchange webinar featuring four freight management systems developed by the Brazilian group LabTrans. LabTrans is a research/development group at the Federal University of Santa Catarina. The webinar provided information on the FRETES and PrevFretes tools developed to assist Brazilian national agencies and private companies track and protect freight systems. The webinar also provided information on SISLOG, a logistics simulator tool and SIAM, a market analysis logistics system decision making support tool. Fifty-nine participants included representatives from academia, state and federal DOT, private industry and international organizations.
Technology Transfer

**Undergraduate Student Projects Leads to a National WMA Webinar**

More than 190 transportation professionals participated in a national webcast focusing on work performed by a team of undergraduate students in the Transportation Enterprise at Michigan Tech. The student project gathered industry perspective on the adoption of warm mix asphalt (WMA) technologies by road agencies in northern climates. Webinar participants included representatives from fourteen state departments of transportation, more than thirty local and municipal road agencies, a dozen federal transportation professionals and many industry personnel.

WMA is a suite of technologies that offer potential environmental benefits, performance enhancement and cost savings in road construction. WMA technologies are part of the Federal Highway Administration's "Ever Day Counts" initiative which is designed to identify and deploy innovation aimed at shortening project delivery, enhancing the safety of roadways and protecting the environment.

Undergraduate student Luke Arnold*, who served as the team leader spring semester, provided a twenty minute overview of WMA technologies and their potential benefits. Student team members included CEE undergraduates Ben Kohler, Paul Kopanna, Tim Nygard, Wes Hineline and Luke Arnold. The team was advised by Dr. George Dewey and Dr. Zhanping You. The student team was also supported by an advisory team of professionals drawn from the industry membership of Transportation Engineering Road Research Alliance (TERRA). TERRA brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction. Its mission is to develop, sustain, and communicate a comprehensive program of research on pavement, materials, and related transportation engineering challenges, including issues related to cold climates. This project was sponsored by the Minnesota Department of Transportation and the UTC-MiSTI.

*Luke Arnold, the WMA project team leader, graduated with his BS in Civil Engineering and now works for the Michigan Department of Transportation.
Outreach and Leadership

UTC-MiSTI continued an aggressive schedule of participation at regional and national meetings, conducting technology transfer activities, Center outreach, and building relationships towards future partnerships.

2010-2011
Sustainable Construction Materials Conference, Ancona, Italy (July)
National Local Technical Assistance Program Association summer meeting, Oklahoma City, Oklahoma (July)
AASHTO RAC meeting (July)
Mackinaw Bridge Dedication as a Historical Civil Engineering Landmark, St. Ignace, Michigan (August)
Midcontinent Conference, Madison, Wisconsin (August)
Transportation Engineering and Road Research Alliance (TERRA) summer board meeting and MnROAD open house, Minneapolis, Minnesota (August)
National Concrete Consortium meeting, Sacramento, California (September)
FHWA International Conference on Concrete Pavement Sustainability, Sacramento, California (September)
FHWA Fly Ash meeting, Washington, DC (September)
ARTBA/CUTC Executive meeting (October)
American Concrete Institute, Pittsburgh, Pennsylvania (October)
Anna Maria Conference on Concrete Durability (November)
ASTM (December)
MDOT/APAM meeting, Lansing, Michigan (December)
Louisiana Transportation Conference (January)
Transportation Research Board (January)
TERRA winter board meeting and Minnesota Pavement Conference, Minneapolis, Minnesota (February)
Meeting with MnDOT, Office of Materials, Maplewood, Minnesota (February)

Professional Development Seminar - NYDOT, Albany, New York (March)
Country Road Association of Michigan meeting, Lansing, Michigan (March)
Asphalt Paving Association of Michigan winter meeting, Mt. Pleasant, Michigan (March)
American Concrete Institute, Tampa, Florida (April)
International Cement Microscopy Association annual meeting, San Francisco, California (April)
Construction Career Days, Mason, Michigan (April)
National Concrete Consortium spring meeting (April)
Nordic Concrete Research Symposium, Hämeenlinna, Finland (May)
Council of University Transportation Centers summer meeting, Portland, Oregon (June)
ASTM, Los Angeles, California (June)

2011-2012
AASHTO RAC (July)
Portland Cement Association, Chicago, Illinois (August)
National Concrete Consortium, Rapid City, South Dakota (September)
American Concrete Institute (October)
Anna Maria Conference on Concrete Durability (November)
ASTM, Tampa, Florida (December)
Meeting with MDOT/APAM, Lansing, Michigan (December)
Transportation Research Board, Washington, DC (January)
TERRA winter board meeting, Minneapolis, Minnesota (February)
Wisconsin Concrete Paving Association meeting (February)
Outreach and Leadership  

Key Leadership Highlights

Dr. Lawrence Sutter - ASTM C01 and C09 executive, chairman C01.99/C09.99 joint committee on research, chairman C09.24 SCM, ACI secretary of 232 Fly Ash, and Board member - Education Activity Committee


Dr. Stanley Vitton - Director, Transportation Materials Research Center (Center of Excellence funded by the Michigan Department of Transportation)

Dr. Jacob Hiller - Board of Directors (2008 to present) International Society for Concrete Pavements (ISCP) and Chair (2010 to present) ISCP Technology Transfer Committee

Dr. Tess Ahlborn - Appointed co-chair of the North American UHPC Working Group to develop guidelines for Ultra-High Performance Concrete. Her efforts have resulted in the formal establishment of ACI 239 and an invitation by the Department of Homeland Security to address industry on UHPC adoption

Dr. Pasi Lautala - Chair American Railway Engineering and Maintenance of Way Association (AREMA) Committee 24 “University Course Curriculum”

Dr. Zhanping You - Associate Editor, ASCE Journal of Materials in Civil Engineering (2008 to present), Guest Editor, Special Issue of “Journal of Materials in Civil Engineering,” and Editorial Board (2008 to present) International Journal of Pavement Research and Technology

Dr. Devin K. Harris - Recipient of the 2011 ACI Young Member Award for Professional Achievement

Michigan Concrete paving Association and Michigan Concrete Association meetings, Grand Rapids, Michigan (February)
Minnesota Concrete Paving Association meeting, Mankato, Minnesota (March)
American Concrete Institute, Dallas, Texas (March)
National Concrete Consortium meeting, Oklahoma City, Oklahoma (March)
International Cement Microscopy Association annual meeting, Halle, Germany (March)
Workforce Development Spotlight Conference, Washington, DC (April)
Michigan Department of Transportation Research Summit, Lansing, Michigan (May)
Toronto Concrete Workshop, Toronto, Canada (May)
ASTM, San Diego, California (June)

2012-2013
AASHTO Subcommittee on Materials, Biloxi, Mississippi (August)
National Pavement Preservation Conference, Nashville, Tennessee (August)
FHWA Fly Ash meeting, Washington, DC (September)
International Conference on Long Term Pavements, Portland, Oregon (September)
FHWA Intelligent Transportation Systems Workshop, Chicago, Illinois (September)
Michigan LTAP Winter Maintenance Conference, Lansing, Michigan (October)
2012 Concrete Seminar, Grand Rapids, Michigan (October)
American Concrete Institute, Toronto, Canada (October)
TERRA fall board meeting, Minneapolis, Minnesota (November)
Anna Maria Conference on Concrete Durability (November)
ASTM (December)
The 2010-2011 Center budget included $462,900 in federal funding and an equal amount of funds from matching sources. To facilitate the Center’s Technology Transfer activities, a significant portion of the FY 5 budget was allocated to salaries to carry out the planning, promotion, delivery and execution of these activities. FY 5 funds were also scheduled to cover staff effort for the closeout of the UTC-MiSTI by December 31, 2012.

UTC-MiSTI posted significant growth in most metric categories and successfully demonstrated their contribution to addressing the research, education, workforce development and technology transfer needs of our nation. The Center’s five year metric track record is shown on page 24 of this report.
# Fiscal Year Five Baseline Performance

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* Includes students graduating in fall 2012, or spring or summer semesters of 2013. See list on page 3.
Dr. Tess Ahlborn, PhD, P.E. is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. She also directs the Center for Structural Durability. Her areas of research include pre-stressed concrete, ultra high performance concrete and bridge engineering.

Dr. George Dewey, PhD, is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He serves as the advisor of the Pavement Design, Construction and Materials student Enterprise. His areas of research include pavement design and structural engineering.

Dr. Devin Harris, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include innovative materials for civil infrastructure and behavior and design of bridges.

Dr. Jacob Hiller, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include pavement mechanics and the interaction between materials, analysis and performance.

Dr. Ralph Hodek, PhD, P.E., is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He is the chair-elect of the ABET Applied Science Accreditation Council. His areas of research include the use of cement kiln dust as a base stabilizer and geotechnical engineering.

Dr. Pasi Lautala, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He serves as the Director of the Michigan Tech’s Rail Transportation Program. His areas or research include multimodal freight, railway engineering and workforce development and rail education.

Dr. Amlan Mukherjee, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include developing platforms and tools that support informed decision making for construction processes.

Dr. Lawrence Sutter, PhD, is a Professor in the Michigan Tech Transportation Institute. His areas of research include the effects of deicing chemicals on pavement materials, use of fly ash and other recovered industrial materials in pavements and materials characterization.

Dr. Stanley Vitton, PhD, P.E., is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include geotechnical engineering, geomechanics, slope stability and dust management.

Dr. Zhanping You, PhD, P.E. is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include bituminous materials, asphalt binders, use of recycled asphalt pavements and sustainability related to asphalt materials.