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DELAWARE CENTER FOR TRANSPORTATION

YOUR MAIN RESOURCE FOR TRANSPORTATION EDUCATION, RESEARCH & TECHNOLOGY TRANSFER

SUMMER/FALL 2013 VOL. 13, NO. 2

TRANSPORTATION INFRASTRUCTURE FORUM

Wednesday, November 13, 2013-Clayton Hall, University of Delaware

The fourth Transportation Infrastructure Forum which will take place on Wednesday, November 13, 2013 in Clayton Hall on the University of Delaware campus is estimated to attract approximately 400 participants from Federal, State and Local governments, different academic institutions, private companies and contractors as well as public officials and community leaders. Together this group will attempt to identify the most important transportation issues facing the State of Delaware, and the surrounding regions. The Forum will begin at 7:30 am and includes breakfast with visiting exhibitors on hand until 8:30. At 8:30 there will be a brief introduction by Dr. Faghri, the director of the Delaware Center for Transportation as well as a welcome for our morning keynote speakers. The morning keynote speaker invitees include the honorable Jack Markell, the Governor of the State of Delaware, Dr. Patrick Harker, the President of the University of Delaware, the Honorable Shailen Bhatt, the Delaware Secretary of Transportation, Mr. Drew Boyce, the Director of Planning for the Delaware Department of Transportation, and Mr. Ralph Reeb, Director of Research and Statistics at the Delaware Department of Transportation. At 9:00 am Session 1 begins and continues until 10:30 am.

Session 1 topics include:

Planning – the planning process; state, regional and urban transportation planning; land-use, demand forecasting, market estimation and modal selection, travel behavior, transportation demand management, pedestrian and bicycle planning and forecasting, complete streets, transportation and economy, transportation and employment and transportation and human health

Aviation, Rail & Marine – aviation planning, forecasting, finance, socioeconomics, market analysis, airside and landside airport design and operations, air traffic control, intergovernmental relations, regional and commuter airlines, business and general aviation, safety and user needs, rail planning, administration, regulation, safety and operation of rail systems, design, construction and maintenance of track systems and train control, and communication systems, marine planning and management of marine operations, port, inland waterways barge and ship cargo systems, ferryboat operations, intermodal terminals, global freight logistics, intermodal information technologies, marine environmental issues and related regulations, freight transportation, truck, rail, water, pipeline and intermodal freight transportation, transportation of hazardous materials

Traffic & Intelligent Transportation Systems (ITS) – transportation systems operations, traffic flow and highway capacity, law enforcement, parking and parking facilities, road design, operating effects of roadway elements, traffic control devices and systems, railroad-highway grade crossings, transportation communication systems, traffic measurements and evaluations methods, high occupancy vehicles, Intelligent Transportation Systems (ITS), traffic, pedestrian and bike safety issues

Construction, Pavement & Materials – construction, quality control, bituminous materials and mixes, cement and concrete, mineral aggregates, alternative construction mechanisms, surface and subsurface soil and rock, subsurface drainage, earthquakes and landslides, environmental effects on soil, rock and layered systems, pavement management, flexible and rigid pavement design, rehabilitation strategies, environmental forces, pavement data collection and analysis, pavement distress, surface unevenness, skid resistance, vehicle counting, classification and weigh-in-motion

Attendees gather at the 2007 Transportation Forum

Local Issues – developing employee skills, town agreements, pavement repair and management systems, stormwater drainage, asset management, shared equipment use, land-use/transportation plans, parks and recreations, ADA, signage and retroreflectivity, pavement markings, safety issues

Design – photogrammetry, digital mapping, remote sensing and surveying, GIS, GPS, 2D and 3D digital modeling, highway geometrics, traffic barriers, sign support and highway safety appurtenances, right-of-way, environmental design and mitigation, archeological and scenic vistas, utility accommodation, culverts and hydraulic structures, hydrology and hydraulics, ADA, context-sensitive design

From 10:30 am to 10:45 am, there is a break with refreshments and an opportunity to visit with the exhibitors. At 10:45 am session 2 starts and continues until 12:15 pm.

Session 2 topics include:

Bridges & Structures – steel, concrete, timber and composite bridges, bridge safety, economy and service life, structural reliability and integrity, field testing and dynamic responses of bridges, tunnel

continued on page 2

Dare to be first.

University of Delaware

Delaware Center for Transportation

Delaware Center for Transportation

Department of Civil and Environmental Engineering

355 DuPont Hall
Newark, DE 19716

P: 302-831-1446
F: 302-831-0674
www.ce.udel.edu/dct

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Message from the Director

Ardeshir Faghri, Director

The staff at the Delaware Center for Transportation has been hard at work getting ready for the upcoming Transportation Infrastructure Forum which will take place on Wednesday, November 13, 2013, in Clayton Hall at the University of Delaware. The last Forum in 2007 was extremely successful and nearly 300 participants enthusiastically got together in their respective areas of interest and defined nearly 100 different problems that were very useful for all transportation agencies and academic centers. Much has changed since 2007; most notably the state of economy and employment both nationally and internationally are vastly different now than they were six years ago. Almost all public transportation funding needs to be tied to jobs creation and improving the employment and economic pictures. The Federal government has not yet passed a long-term transportation bill and this has created a great deal of uncertainty. State and local governments as well as private contractors find it difficult to do any form of long range planning without a solid, long term financial base. Members of both parties want to see a direct correlation between transportation funding and jobs which in turn will translate into economic improvement. The issues of the ever-increasing price of gas and diesel fuels, becoming less dependent on foreign oil, seeking alternative energy sources, and manufacturing vehicle engines that support alternative fuels plus the needed infrastructure to support alternative energy sources have become much more important now than before. Governments at all levels are supporting the use of alternative energies for different transportation modes through grants and other funding mechanisms. The issue of environmental pollution and sustainability especially as they relate to the transportation sector are the topics of discussions more now than before. Even skeptics of the last few years are increasingly convinced that all civil infrastructure projects, especially the ones related to transportation, need to be built, maintained and operated in a sustainable and environmentally friendly fashion. With the rapid increase in human population, it is more important than ever to build our transportation infrastructure in a manner that does not damage the environment and is sustainable for generations to come. Issues on transportation safety have always been important; governments at all levels have given the matter high priority. The difference now is that the mode choices of the last few years are much different now than before. More and more people prefer to use smaller and more fuel-efficient vehicles and even the percentage of pedestrians and bicyclists both for recreation and commuting purposes have increased. As a result, transportation agencies as well as academia need to take note of this new reality and create new safety procedures and conduct safety processes accordingly. Finally, the correlation between the transportation built environment and human health is a topic that has received much more attention in the last five years than ever before. The increase in obesity in the general population and particularly in children has been described as an epidemic. Increasing pedestrian and bike lanes as well as creating "Safe Routes to Schools" have become extremely important topics. Politicians, academicians and the general public are realizing the direct correlation that exists between the built environment and human health. I am glad to report that the center's upcoming forum will address all of these issues. Not only have we invited national, regional and local experts in each field, but we are also encouraging all the participants to tell us what they think and how we can identify and creatively tackle our most serious transportation infrastructure issues and problems. The forum promises to be an exciting event for all those who care about our transportation system. Registration for attending the forum is free, but you do need to register so that we will have an accurate head count for planning. Online registration will begin in September. Visit the DCT website www.ce.udel.edu/dct for information. I hope to see you all on November 13th.

continued from page 1

design and construction, GRS-IBS, pre-engineered bridge elements and systems

Administration & Government Policy – agency organization, personnel management, finance and economics, data and information systems, strategic management, soft skills, succession planning, workforce development

Maintenance – maintenance management, runway and guidance maintenance, structures and traffic service maintenance, snow and ice control, equipment maintenance, asset management, signs and retroreflectivity, guardrails, culvert and stormwater drainage, roadside maintenance, mowing

Multi-Modal Safety Issues – safety and human performance, road design, system safety, accident countermeasures, right-of-way and vehicular design, operations and maintenance, low cost safety improvements, pedestrian accidents, bike safety, first responders, work-zone safety, accident data, MUTCD, train derailment, airport safety issues

Transit & Public Transportation – rail, bus and new technology transit systems, taxi services, commuter rail, Paratransit, rural transit, car-sharing, bike-sharing, curb-side bus, social media, transit security, transportation and energy

Environment – alternative fuels, fuel economy, ecological systems, noise and air quality, water quality, wetlands, historic preservations, cultural impacts, hazardous wastes, highway vegetation, stormwater treatment and management.

From 12:15 to 1:30 pm, lunch will be served. During lunch two distinguished keynote speakers will talk about their respective areas of research. First, Dr. Ajay Prasad, professor of Mechanical Engineering and Director of the Center for Fuel Cell research, will discuss his work regarding the hydrogen fuel cell powered transit vehicles and hydrogen refueling stations in the State of Delaware. The second invited guest speaker, Dr. Willett Kempton, professor in the College of Earth, Ocean & Environment and Director of the Center for Carbon-Free Power Integration, will talk about his work regarding Grid-Integrated Vehicles (GIV) and Vehicle-to-Grid (V2G) Technologies.

From 1:30 to 2:00 pm, the participants will once again have a chance to visit the exhibits. From 2:00 to 3:00 pm, there is the wrap-up session, in which all the moderators will give a briefing of what topics of importance were identified in their respective sessions. Participants will have an opportunity to hear what other sessions discussed and what important issues and problems they identified.

Finally from 3 to 4 pm, Forum participants will have an opportunity to observe a demonstration of the University of Delaware Zero Emission Hydrogen Fuel Cell Bus. A limited number will have the opportunity to take a ride on the busses.

Christiana Interchange Construction and the Use of Mechanically Stabilized Earth (MSE) Walls

BY ELLEN PLETZ

Motorists who drive along the I-95 corridor between Wilmington and Newark will no doubt notice the construction near the Christiana Mall which has been underway in earnest the last eighteen months. Something they will not notice is a research project going on during the construction phase of this interchange and continuing once the roadways are complete.

Dr. Dov Leshchinsky, professor of Civil and Environmental Engineering and renowned geotechnical engineering expert, is using instrumentation embedded in mechanically stabilized earth (MSE) walls to interpret the stress measured in the reinforcement so as to ensure safe design of these walls.

MSE walls are economical retaining walls used for structures such bridge abutments. The main advantages of MSE walls compared to conventional reinforced concrete walls is their ease and quick construction. These walls are safe, economical, and aesthetically pleasing. Those at the Christiana interchange are reinforced with very strong and stiff polyester strips. Dr. Leshchinsky's objectives are to provide DelDOT concrete data on the performance of the MSE wall versus expected performance and to provide design related conclusions following the end of the monitoring phase of the project.

Dr. Leshchinsky, who is also a member of a task force advising the American Association of State Highway and Transportation Officials (AASHTO) on retaining walls, presented some preliminary findings recently and garnered a lot of interest from other state transportation officials as well as federal highway representatives who were attending the meeting.

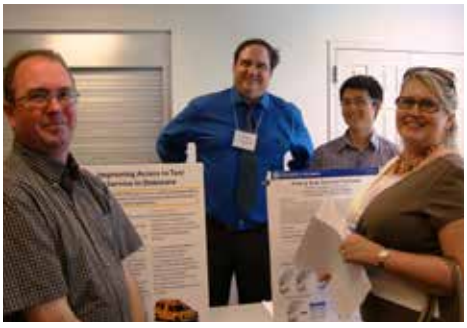
Barry Benton, DelDOT's project manager, said, "The Department is very excited to be a part of this ground breaking research. The results that Dr. Leshchinsky is receiving are the first hard data for this type of wall and are extremely important for design. Once the research is completed, we feel that this innovative project will impact the industry by validating this new technology, allowing other states to follow suit."

This research project, which will help to verify the design of a novel MSE wall, may lead to future enhancements and performance of the walls and demonstrate DelDOT's leadership role in bridge construction techniques.

Solar powered computer collecting real-time data and transmitting it via the Internet. The data includes stresses along many of the reinforcing straps, displacements within the reinforced soil mass, and vertical and horizontal earth pressures. The data is compared with design predictions ascertaining that current design yields safe and economical structures.

DCT Hosts 10th Annual Research Showcase

The Delaware Center for Transportation (DCT) hosted its 10th annual transportation research showcase on Thursday, May 9th at the University of Delaware's Paradee Center in Dover, Delaware. The showcase offered the opportunity for project investigators and graduate students to display posters and share progress on research projects to DelDOT representatives and other interested parties. Showcased were currently funded projects in the areas of environment, pavement & materials, planning, soils, bridges & structures, plus traffic and intelligent transportation systems (ITS). Also included were projects from the University Transportation Center (UTC) program. This year we welcomed visitors from various transportation agencies which included: DelDOT; Delaware Transit Corporation; Federal Highway Administration; local government; as well as representatives from Pennoni Associates; Whitman, Requardt & Associates; Urban Engineers, Inc.; McCormick Taylor, Inc.; Jacobs Engineering; Chilton Engineering; AID, Inc.; and RK&K Engineers. Due to the tremendous popularity at last year's showcase, scoops of ice cream from the University's UDairy Creamery were once again offered to all who cared to indulge.



▲ Jim Hickman (left) from DelDOT and Cathy Smith (right) from Delaware Transit Corporation view posters and speak with Project Manager David Racca, and Graduate Student Denny Zhang.

◄ Project Manager Marcia Scott (right) presents two research posters on Curbside Intercity Bus Industry and Complete Communities with graduate students Eileen Collins (left) and Jessica Graham (middle).

FHWA Clarifies Meaning of "Alteration" Under ADA

BY MATT CARTER

Local governments and state DOTs have wrestled with some of the meanings within the Americans with Disabilities Act (ADA) since it was enacted in June 1990. One element that has been a perennial favorite for argument is the question of what constitutes an "alteration." Why? Because, a lot rides on it. Simplistically speaking, the standards put forth by the U.S. Access Board to implement ADA allow many non-compliant situations to persist unless an alteration to the larger system is made. But what constitutes an alteration within the public right of way? In the early days of ADA, some argued that even milling and paving wasn't an alteration if the surface was put back to the same grade; that notion was debunked some years ago by the Federal Highway Administration (FHWA) and the Department of Justice (DOJ), but plenty of other actions an agency might take with the street, curb, or sidewalks remained a topic of debate that didn't have the clearest of answers.

Recently, DOJ and FHWA released a Joint Technical Assistance document[1] that should put to rest many remaining questions about when curb ramps must be upgraded to current standards or provided (in the case where they previously did not exist). In the document, they reference Kinney v. Yerusalim, 9 F 3d 1067 (3rd Cir. 1993), an early landmark ADA case that established an obligation to provide curb ramps, upon resurfacing of a street, wherever pedestrian walkways intersect the resurfaced street. The argument has continued, however, as to what constitutes an alteration as opposed to maintenance and so the Joint Technical Assistance clarified that the requirement to add curb ramps is triggered if the resurfacing "involves work on a street or roadway spanning from one intersection to another, and includes overlays of additional material to the road surface, with or without milling." They continue with examples (not intended to be an exhaustive list) that include treatments (or their equivalents) such as "addition of a new layer of asphalt, reconstruction, concrete pavement rehabilitation and reconstruction, open-graded surface course, micro-surfacing and thin lift overlays, cap seals, and in-place asphalt recycling."

Conversely, they clarify what constitutes maintenance activities that do not trigger the obligation to provide curb ramps, saying, "Treatments that serve solely to seal and protect the road surface, improve friction, and control splash and spray are considered to be maintenance because they do not significantly affect the public's access to or usability of the road." They again list a number of helpful examples that would normally be considered maintenance: "painting or striping lanes, crack filling and sealing, surface sealing, chip seals, slurry seals, fog seals, scrub sealing, joint crack seals, joint repairs, dowel bar retrofit, spot high-friction treatments, diamond grinding, and pavement patching." Finally, they do note that the combination of several (otherwise) maintenance treatments occurring at or near the same time may, in some cases, qualify as an alteration and would therefore trigger the obligation to provide curb ramps.

Roadway agencies of all sizes should take this clarified guidance into consideration as they prepare for future resurfacing and maintenance activities. Certainly, adequate funds must be budgeted to install or upgrade curb ramps, but additional time may be necessary to design around or move obstacles such as stormwater inlets or gutters, utility manholes, hydrants, or utility poles. Jumping into a resurfacing project and having to stop your contractor while you address one of these issues can result in contractor delay claims, only exacerbating an already frustrating and expensive situation.

[1] http://www.fhwa.dot.gov/civilrights/programs/doj_fhwa_ta.cfm

IPA Hosts Workshops on "State and Local Government Regulatory Barriers to Complete Communities"

BY MARCIA SCOTT, IPA POLICY SCIENTIST

Emerging demographic and economic trends are driving the shift in the housing market, travel behavior, and preferences to live in "complete communities." Described as "attractive, inclusive, efficient, healthy and resilient," complete communities are more compact, provide a greater mix of land uses, offer activity-oriented destinations, foster sociability, and promote greater economic competitiveness.

Edward O'Donnell from the Institute for Public Administration at the University of Delaware speaks to attendees at the workshop.

Two major demographic groups – Baby Boomers and Millennials – are influencing housing, community, and transportation choices. Baby Boomers, who are nearing retirement, are downsizing their homes and seeking to live in complete communities with nearby services, transportation, a sense of place, and active living opportunities. Millennials are opting for complete communities that are more urban, transit friendly, have a mix of uses, and offer affordable housing options. The housing crisis, economic recession, rising fuel costs and energy prices, and quest to lead more healthy lifestyles have also driven consumer demand for complete communities.

Yet, regulatory barriers often hinder high-quality development with complete communities characteristics, both nationwide and in Delaware. At a Complete Communities 2012 Summit, hosted by the Institute for Public Administration (IPA) at the University of Delaware, a panel of private developers offered their perspectives on developing property that responds to market demand for appealing residential, commercial and mixed-use properties while addressing challenges to meet regulatory mandates and ordinances.

As a follow up to the Summit panel session, IPA facilitated a series of workshops in spring 2013 on "State and Local Government Regulatory Barriers to Complete Communities in Delaware." A survey of the Delaware development community set the stage for the workshops. Survey respondents indicated that top regulatory barriers to complete communities in Delaware are the 1) local land development and review process, 2) subdivision/land development ordinance issues, 3) building code inconsistencies, and 4) environmental regulations. Three workshops were held comprised of the Delaware development community/private sector; regulators and code enforcement officials; and state and local government elected officials, planning commission members, and decision makers. Breakout groups in each of the three workshops discussed top regulatory barriers to creating complete communities in Delaware, presented examples of barriers, and considered solutions to these barriers.

IPA's research on complete communities is supported by the Delaware Department of Transportation and in cooperation with the Delaware Office of State Planning Coordination. In addition to these project partners, the National Association of REALTORS® (NAR) and its affiliate, the Delaware Association of REALTORS® have joined together with IPA to host the Complete Communities 2013 Summit on November 4, 2013 at the Dover Downs Hotel and Conference Center. The Summit will feature keynote speaker Jonathan Levine, author of *Zoned Out*, NAR vice president of research and economist Paul Bishop, and panel presentations, including one on addressing regulatory challenges to complete communities. Summit agenda details and registration information may be found on the Planning for Complete Communities in Delaware website at http://completecommunitiesde.org/summit-2013/.

Research

Following are the projects funded for our FY13 Annual Research Program beginning on September 1, 2012. Information on projects funded for FY14 will appear in the next issue:

REVIEW OF EXISTING PAVEMENT CONDITION RATING SYSTEM

This project will analyze the accepted level of variation among the various measurement methods. This would allow the agency to switch between methods (and vendors) with more confidence that the results are valid.

Principal Investigator:
Nii Attoh-Okine, Department of Civil and Environmental Engineering

Project Manager:
Jennifer Pinkerton, Materials and Research

INTEGRATING ZERO-VALENT IRON AND BIOCHAR AMENDMENTS IN GREEN STORMWATER MANAGEMENT SYSTEMS FOR ENHANCED TREATMENT OF ROADWAY RUNOFF – PHASE II

This project is a continuation which will evaluate two technologies involving the addition of biochar and/or zero-valent iron to existing and new stormwater facilities which will reduce nutrients from DelDOT stormwater discharges.

This phase will be the field demonstration.

Principal Investigators:
Dan Cha and Paul Imhoff, Department of Civil and Environmental Engineering

Project Manager:
Marianne Walch, Maintenance and Operations

PAVEMENT MARKINGS AND SIGNING TO SUPPORT SENATE BILL 120

The various treatment options and signing to assist with safer bike lanes and intersections as mandated by state code will be evaluated through a survey instrument and test sites.

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Mark Luszcz, Traffic Management Center

EVALUATION OF SMART GROWTH DEVELOPMENT PATTERNS AND EFFECTS ON TRANSPORTATION

This project will identify and evaluate the effects of: 1) alternate locations in Delaware for hypothetical residential and mixed-use communities, and 2) alternate street forms and interconnectivity levels for these hypothetical communities in Delaware.

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Mike DuRoss, Division of Planning

VERIFICATION OF DESIGN OF A NOVEL MECHANICALLY STABILIZED EARTH (MSE) WALL AT THE CHRISTIANA INTERCHANGE

During the construction of the Christiana Interchange, instrumentation donated by an Italian company will be utilized in an abutment to measure readings which will help DelDOT with future designs and specifications.

Principal Investigator:
Dov Leshchinsky, Department of Civil and Environmental Engineering

Project Manager:
Barry Benton, Bridge Management

ABANDON, REPAIR OR IMPROVE ROADS IN THE FACE OF CLIMATE CHANGE?

The objective of this research is to provide DelDOT with a defensible strategy for determining road repeatedly damaged by flooding.

Principal Investigator:
Sue McNeil, Civil and Environmental Engineering

Project Manager:
Rob McCleary, Transportation Solutions

DEVELOPMENT OF A COMPREHENSIVE, MULTI-MODAL TRAVEL ACCESSIBILITY INDEXING SYSTEM AT THE TAX PARCEL LEVEL

This research will result in Trip Origin Locations (tax parcels by land use) able to be assigned an "Accessibility" measure indicating multi-modal proximity to potential Trip Destinations.

Principal Investigator:
David Racca, Center for Applied Demography and Survey Research

Project Manager:
Mike DuRoss, Division of Planning

CAPACITY OF REINFORCED CONCRETE MOMENT FRAME CULVERTS

This research project will assess the latest bridge analysis procedures and conduct full-scale laboratory experiments to develop a new evaluation methodology specifically for concrete moment frame culverts.

Principal Investigator:
Thomas Schumacher, Department of Civil and Environmental Engineering

Project Manager:
Ping Jiang, Bridge Management

IMPROVING ACCESS TO TAXI SERVICE – DELAWARE'S "MISSING" TRANSIT MODE

The focus of this project will be on the identification and prioritization of fiscally viable alternatives that can remove barriers and transform taxi service from Delaware's "missing" transit mode to a truly affordable, available, and accessible transportation alternative.

Principal Investigator:
Doug Tuttle, Institute for Public Administration

Project Manager:
Cathy Smith, Delaware Transit Corporation

FY13 GPS TRAVEL TIME AND DELAY DATA COLLECTION AND ANALYSIS

This project entails data collection during peak travel times on roadway segments throughout the state. Each segment will be traveled at least four times for maximum accuracy. Once data collection is completed, data will be transformed into the GIS database and transported to the ARCGIS software.

Principal Investigator:
Arde Faghri, Department of Civil and Environmental Engineering

Project Manager:
Mark Eastburn, Division of Planning

FY13 DELAWARE SIGNAL TIMING ENHANCEMENT PARTNERSHIP (DSTP)

The goals of the DSTEP project are to involve students in traffic engineering services for DelDOT, to develop a continuous research program that addresses DelDOT's needs while minimizing the use of DelDOT's resources, and to maintain a high level of quality so that DelDOT may apply the results to improve intersection operations across the state.

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Gene Donaldson, Transportation Management Center

FY13 LAB BASELINE SERVICE

The objectives of this project are to establish the Delaware Center for Transportation ITS Lab as a state of the art facility with three main focus areas: 1) service to DelDOT; 2) training for DelDOT and support classroom instruction; and 3) research for faculty and students

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Gene Donaldson, Transportation Management Center

FY13 TRAVEL DEMAND MODELING SUPPORT

Support for this project will assist DelDOT with the development, maintenance, application and evaluation of a travel demand forecasting model. The model supports planning studies for Delaware's MPOs and various DelDOT sections on an as-needed basis.

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Mike DuRoss, Division of Planning

CONTINUING ACTIVE RESEARCH PROJECTS SPONSORED BY DELDOT

As each project is completed, a final technical report will be available on the DCT website: http://www.ce.udel.edu/dct.

DESIGN AND CONSTRUCTION OF A GEOSYNTHETIC REINFORCED SOIL (GRS) INTEGRATED BRIDGE SYSTEM (IBS) IN THE STATE OF DELAWARE

This demonstration project will provide the necessary technical expertise to the design, construction, and long-term inspection process that can be used to enhance implementation of this technology in Delaware. Ending 8/31/14

Principal Investigator:
Chris Meehan, Department of Civil and Environmental Engineering

Project Manager:
Percival McNeil, Bridge Design

NON-DESTRUCTIVE TESTING METHODS TO EVALUATE THE INTEGRITY OF CONCRETE BRIDGE DECKS

This research project will evaluate non-destructive testing procedures to help assess the current condition and quantify the extent of deterioration of concrete bridge decks. Ending 8/31/13

Principal Investigators:
Thomas Schumacher and Dennis Mertz, Department of Civil and Environmental Engineering

Project Manager:
Ralph Reeb, Division of Planning

TRAVEL DEMAND MODELING SUPPORT FY12

Support for this project will assist DelDOT with the development, maintenance, application and evaluation of a travel demand forecasting model. The model supports planning studies for Delaware's MPOs and various DelDOT sections on an as-needed basis. Ending 8/31/13

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Mike DuRoss, Division of Planning

2011-2012 GPS TRAVEL TIME AND DELAY DATA COLLECTION AND ANALYSIS

This project entails data collection during peak travel times on roadway segments throughout the state. Each segment will be traveled at least four times for maximum accuracy. Once data collection is completed, data will be transformed into the GIS database and transported to the ARCGIS software. Ending 12/31/13

Principal Investigator:
Arde Faghri, Department of Civil and Environmental Engineering

Project Manager:
Mark Eastburn, Division of Planning

CROSS-FRAME FORCES IN SKEWED STEEL I-GIRDER BRIDGES, YEAR 2

This research will assess the ability of bridges in Delaware to withstand strikes by overheight trucks and also identify critical bridges that need immediate reinforcement to prevent catastrophic failure if hit by a truck. Ending 8/31/13

Principal Investigator:
Jennifer McConnell, Department of Civil and Environmental Engineering

Project Manager:
Jason Hastings, Bridge Design

ITS LAB BASELINE SERVICE FY12

The objectives of this project are to establish the Delaware Center for Transportation ITS Lab as a state of the art facility with three main focus areas: 1) service to DelDOT; 2) training for DelDOT and support classroom instruction; and 3) research for faculty and students. Ending 8/31/13

Principal Investigator:
Rusty Lee, Department of Civil and Environmental Engineering

Project Manager:
Gene Donaldson, Transportation Management Center

BASELINE MONITORING AND TESTING OF THE INDIAN RIVER INLET BRIDGE (IRIB)

This project is phase 2 of the long-term structural health monitoring (SHM) system on the Indian River Inlet Bridge. These funds will be used to conduct various baseline tests, studies, and analyses to characterize the baseline performance of the bridge as a permanent record for the future. DelDOT will be able to understand how the as-built bridge is functioning and through long-term monitoring, will be in a better position to efficiently and effectively manage this significant resource. Ending 6/30/2014

Principal Investigators:
Tripp Shenton and Michael Chajes, Department of Civil and Environmental Engineering and College of Engineering

Project Manager:
Barry Benton, Bridge Management

Monitoring Concrete

KAREN B. ROBERTS

Concrete is the most widely used construction material in the world. However, many concrete roadways and bridges crack due to internal chemical reactions, temperature fluctuations or external chemical and physical stresses.

One internal chemical reaction is the Alkali-Silica Reaction (ASR) that destroys the concrete from within.

ASR occurs when alkalis such as sodium and potassium react with silica minerals within the concrete, creating a gel that absorbs water and expands. Over time, pressure from the expanding gel can crack the concrete, sometimes severely enough to destroy the structure. Little can be done to stop or reverse the reaction once it begins, and there is no effective method for early detection or remediation of ASR-affected concrete.

Julie Maresca and Thomas Schumacher, two researchers at the University of Delaware, are working to design a method to use microbes to identify ASR-damaged concrete before visible cracks appear. Samples have been provided by the Delaware Department of Transportation (DelDOT) from roadways, shoulders and overpasses throughout the state. The researchers will analyze DNA from these samples to identify specific strains of microbes that could be early indicators of ASR damage.

"ASR represents a real challenge for our civil infrastructure and effective ways to detect and potentially mitigate the reaction are needed," said Schumacher, an assistant professor of civil and environmental engineering whose expertise lies in non-destructive testing and structural health monitoring of roadways and bridges.

"Our objective is to study microbes that live on concrete and find out whether the species there are different in the presence of ongoing ASR," added Maresca, also an assistant professor of civil and environmental engineering with a background in microbiology.

She explained that most microbes prefer to live in moist environments at a neutral pH of 7. Concrete, however, is a dry substance with a high pH — around 12 — and a very high salt content. "The fact that any microbe can live in this extremely harsh environment is amazing," she said.

When ASR occurs, the gel that forms changes the chemistry of the concrete and thus the environment in which the microbes live. Species that have adapted to the conditions of normal concrete may not survive as well in ASR-damaged concrete, and other kinds of microbes could move in.

Maresca and her students are recording the similarities and differences between microbial populations in undamaged and ASR-affected concrete. The researchers hope to identify microbes that are exclusive to the damaged samples. If successful, they believe this data could lead to a set of microbes associated with ASR-damaged concrete that could be used as biomarkers to reveal damage before visible cracking occurs.

Maresca's previous background in understanding how microbes work and metagenomic sequencing, which involves extracting DNA from a sample and sequencing it to determine which genes are present or absent, has benefited the project.

"We can start to look at the adaptations these microbes are making in order to live in this environment and then compare them to microbes that live in similarly dry environments like deserts or salt pans," she said.

A significant preliminary observation from microbes isolated from concrete in the lab is that most of the microbes appear to be colored. This may be a protection mechanism, Maresca said, since microbial pigments typically occur in the membrane rather than the cell itself and sometimes protect the cells from environmental stressors. Most of the strains also have minimal nutrient requirements and can survive at a wide range of salt concentrations.

"Our approach may fundamentally change the way we inspect and maintain our deteriorating civil infrastructure network," remarked Schumacher, who along with Maresca, hopes to provide agencies like DelDOT a practical, non-destructive methodology for testing concrete structures in the field.

"It's an inexpensive preventative measure that could enable DelDOT and other transportation personnel to take roadway samples and, by studying what microbes are present, determine if a particular structure is at risk or needs remediation or protection to prevent further damage."

Photo by Doug Baker

UD professors are working to design a method to use microbes to identify ASR-damaged concrete before visible cracks appear.

This work is supported in part through funding from the University of Delaware Research Foundation.

Engineering students collect traffic data using GPS technology

KAREN B. ROBERTS

For the last month eight University of Delaware students have taken a road trip to the Delaware beaches every Friday, Saturday and Sunday — but not to soak up the sun.

The UD students, who log an average of 1,200 miles per weekend, are compiling traffic data using global position system technology to quantify the severity of congestion as part of collaborative research project with the Delaware Department of Transportation (DelDOT).

The students travel in two UD vehicles equipped with GPS devices programmed to capture travel time from one point to another, mean travel speed and delay using longitude and latitude measurements taken while the vehicle is in motion.

They cover all roads leading to and from the Delaware beaches, starting at the Pennsylvania border and ending at the Maryland border during peak weekend travel hours from June 14 to Sept. 2.

While one student drives the others collect data both manually and using the GPS unit. As the vehicles cross each predetermined control point, the students record travel time, delay time and delay sources such as accidents, weather and unexpected occurrences.

The data captured by the GPS devices is downloaded and analyzed in UD's Delaware Center for Transportation, which is housed in UD's Department of Civil and Environmental Engineering.

Each fall, the students present and discuss their findings with DelDOT transportation planners charged with planning future projects, providing a snapshot of current traffic conditions as well as comparison of previous years. To provide the transportation planners with a visual representation of trouble spots, the GPS data is integrated with GIS — Geographic Information Systems — and graphed on roadway maps.

"We are not only pointing out the problems for short term improvements, we are also shaping the 20-30 years ahead, while learning how to participate and manage a real world project," said Abdulkadir Ozden, a doctoral student leading this year's summer project.

New this year, the research team is also capturing data using GPS smartphone applications. At the end of the season, they will compare the high tech GPS data collection with that collected using free GPS capable phone apps to evaluate their accuracy.

UD professor Ardeshir Faghri and a rotating cohort of students, whom he calls the "eyes and ears of area transportation planners," have been working with DelDOT since 1995 when he helped automate the transportation system's data collection mechanism. The project has been ongoing ever since.

"When E-ZPass was implemented, for example, DelDOT used our data aggressively to measure the difference between stop and go and automated toll booth systems on Route 1," said Faghri, professor of civil and environmental engineering and director of the DCT.

The data is also very useful in optimizing the timing of traffic light signals at intersections where "timing adjustments that are only fractions of a second long can dramatically improve congestion and traffic patterns," Faghri said. A similar study of the entire state is completed each fall, and used by both DelDOT and the Wilmington Area Planning Commission (WILMAPCO).

According to Ozden, one of the most challenging parts of the project is the early morning runs.

"Sometimes, we leave very early, between 4:30 and 5 a.m. to catch the morning rush hour traffic in Sussex County," he said. The experience is worth it, he continued, because "I have learned to think about transportation problems from different perspectives — as a transportation planner, driver and researcher, which I believe gives me a better decision making capability."

Dejun Zhang, who is pursuing a master's degree in applied economics and statistics in the College of Agriculture and Natural Resources, said, "I joined the team to learn about real world data collection and to practice classification techniques that will be useful to my future role as a statistician."

Originally from China, Zhang said the down time between the morning drive to southern Delaware and the evening return presents a unique opportunity to better her social skills and "learn about people from different cultures" as the teams walk the boardwalk, shop the Rehoboth outlets or go to the beach.

DelDOT transportation planner Mark Eastburn cited the expansion on Route 1 between Lewes and Five Points as an improvement that resulted directly from data provided by Faghri's research team, calling the project a win-win for both parties.

"We get data that we are unable to capture in other ways and the students learn skills and knowledge that they can apply to a future job," he said. Many students secure future internships as a result; some have even landed jobs with DelDOT, Eastburn said.

Daniel Blevins, principal planner at WILMAPCO, said that Faghri's research data has helped drive the organization's project selection by pinpointing key problem areas on roadway networks since the early 2000s. He cited the student's "consistent data collection" over time and the student's enthusiasm, both for the project and for training future participants, as a plus.

In the future, Faghri and his students may incorporate Bluetooth technology into the project. "Bluetooth technology is emerging as a new tool to capture transportation data on major networks," Blevins said.

Research Pays Off: Methodology for Integrating Adaptation to Climate Change into the Transportation Planning Process

MICHELLE RENEE OSWALD AND SUE MCNEIL

Michelle Renee Oswald is Assistant Professor, Department of Civil & Environmental Engineering, Bucknell University

Sue McNeil is Professor of Civil and Environmental Engineering and Urban Affairs and Public Policy at the University of Delaware. She is also Director of the University Transportation Center.

Strong scientific evidence supports the potential for serious global impacts due to climate change. While mitigation efforts are essential to slowing the threat of climate change, adaptation practices to build resilience to and protection from environmental impacts should be accelerated. This research presents a methodology to integrate adaptation efforts into the long range transportation planning (LRTP) process, and describes a tool, Climate Change Adaptation Tool for Transportation (CCATT) to assist planners. Using a decision theoretic approach that recognizes uncertainty, climate change scenarios are evaluated based on the LRTP timeline. Since climate change impacts vary geographically, the methodology is intended to be repeatable, relevant, and regionally applicable. A case study is developed for the Mid-Atlantic region based on a Metropolitan Planning Organization in northern Delaware. The case study results reveal the effectiveness of the methodology to a real world application and the need for transportation adaptation in response to climate change.

PROBLEM

A growing concern facing the transportation sector in the United States is the potential impact of climate change on land transportation. Adaptation to climate change, in the context of long range transportation planning, is defined as the development, modification, maintenance, and renewal of transportation infrastructure, operations, and policy to moderate the impacts of climate change. This includes infrastructure changes to support mitigation efforts such as the use alternative fuels. Without evaluation and implementation of adaptation along with mitigation, there is the potential for ill-advised investments in transportation infrastructure and development decisions, and premature failure of existing infrastructure with significant economic impacts. Therefore, planning for adaptation in response to potential climate change impacts is needed to support more sustainable processes to protect the natural and engineered environments.

SOLUTION

This research developed a step-by-step methodology for constructing a decision-support tool for incorporating adaptation practices into transportation planning in response to climate change, the Climate Change Adaptation Tool for Transportation (CCATT), to address the needs of Metropolitan Planning Organizations (MPOs) and Departments of Transportation (DOTs) throughout the country. The methodology is repeatable (the same results are obtained with each application), relevant (recognizes ongoing and proposed mitigation activities and produces results that are useful to transportation agencies), and regionally applicable (recognizes differences between geographic locations). The final contribution is a universally applicable methodology for constructing a climate change adaptation tool for land transportation throughout the United States.

METHODOLOGY

The methodology is focused on developing a decision-support tool titled, CCATT. Since climate change impacts vary by region throughout the United States, the methodology is developed with the intentions of being repeatable, relevant, and regionally focused. The methodology presents a general structure for developing CCATT that includes four major components:

1. Evaluation of scenarios, adaptive capacity and impact assessment, recognizing ongoing and potential climate change, and possible mitigation efforts.

2. Inventory of existing transportation facilities to identify infrastructure "at-risk" to climate change impacts.

3. Assessment of proposed projects to reduce the potential risks from climate change.

4. Evaluation of existing mitigation practices promoted by the agency to identify supporting

Figure 1. Methodology for developing CCATT.

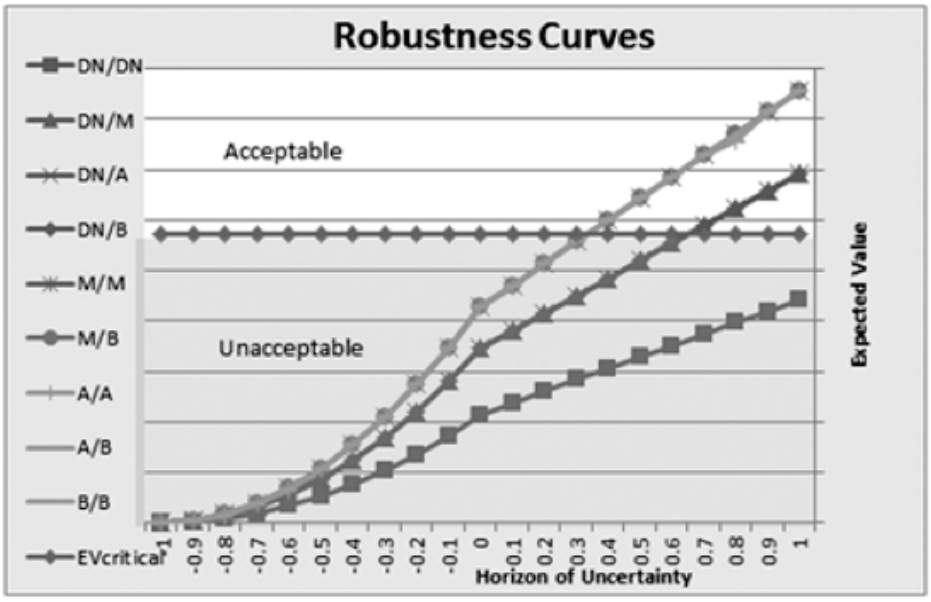


Figure 2. Sample results for scenario analysis.

adaptation efforts. For example, if the agency is supporting new infrastructure (an adaptation effort) they should be simultaneously supporting the use of alternative fuel vehicles (a mitigation effort).

For each component, specific steps are described in detail with the purpose of allowing agencies to create their own jurisdiction-specific tool. Figure 1 displays the steps included for each of the four components.

One of the end results is a series of robustness curves—one for each pair of actions—each curve varying with the horizon of uncertainty, as shown in Figure 2 (where DN is do nothing, M is mitigate, A is adaptation, and B is both) over the planning horizon of short and long-term time frames. In the case of climate change scenarios, both underestimation and overestimation is evaluated.

APPLICATION

Using the methodology described above, the transportation adaptation tool, CCATT, was developed with the intention of applying it to a case study at the local scale consistent with the LRTP. CCATT is developed for the Mid-Atlantic coastal region to demonstrate the use of the tool by the Wilmington Area Planning Council (WILMAPCO), a Delaware MPO. Developing the tool for the Mid-Atlantic region focuses on the climate change impacts on land transportation specific to that region. These are (a) increases in very hot days and heat waves, (b) rising sea levels, and (c) increases in intense precipitation events. The development of CCATT: Mid-Atlantic serves as an example of how to apply the general CCATT methodology to other regions and agencies with varying climate change impacts, other than those specified for the Mid-Atlantic region. The tool is created in Microsoft Excel™ in order to provide a user-friendly environment for data entry and rapid prototyping. Within the Excel™-based tool, each worksheet represents another step in the process of evaluating transportation adaptation. Therefore, the twelve steps discussed previously are expanded into 18 Excel™ worksheets in order to allow for multiple worksheets for step 1-Scenario Analysis which has a number of user inputs and outputs as well as for a background and an introduction page which provide instructions on how to use the tool. The results reflect the information provided by WILMAPCO and are used not only to further the adaptation efforts of that agency, but also serve as an example for future applications of the tool to agencies throughout the region.

TECHNICAL BENEFITS

The 12-step methodological process defined in this research can be applied in order to develop transportation adaptation tools similar to CCATT: Mid-Atlantic. Each of the steps can be applied universally to a variety of geographic locations, transportation agencies, as well as a variety of infrastructure types, not only land transportation. Therefore, it is recommended that agencies and/or research institutes follow the 12 steps to create adaptation tools for a diversity of applications. By using the tool on an annual basis, the agency can identify vulnerable infrastructure as well as opportunities for adaptation practices that can be incorporated into the long range transportation planning process, which includes evaluation and decision making.

BENEFITS OF PARTNERING

The development of CCATT specifically for the Mid-Atlantic addresses the regional differences with regards to climate change impacts. The case study, applying CCATT: Mid-Atlantic to WILMAPCO, reflects the ability to apply the tool to a real world network. The results are useful at the local level; however, they also serve as an example for how the information from CCATT can lead to improved decision making across agencies. Ideally, a tool such as CCATT: Mid-Atlantic would be developed for each region throughout the United States and would be expanded beyond land transportation to include maritime and aviation as well. As the tools are developed for specific locations and infrastructure types, they should be shared throughout the transportation planning community so that all agencies can benefit from the tools developed to prevent agencies from "recreating the wheel." Lastly, as innovation and technology improves, the methodology and application of CCATT should be enhanced to further support transportation planning both in practice and in academia for years to come.

Delaware Center for Transportation invites you to attend

Identifying Important Issues Related to the Transportation Infrastructure in Delaware and Surrounding Region

2013
Delaware Transportation Infrastructure Forum

Wednesday, November 13, 2013
8:00 am—4:00 pm
Clayton Hall
University of Delaware
Newark, DE

Admission is free but seating will be limited.

Continental Breakfast & Lunch Provided

Registration for this event will begin in September

Sponsored by the Delaware Center for Transportation

&

Delaware Department of Transportation

WHO SHOULD ATTEND

State DOTs • Federal Highway Administration • Federal Transit Association • Local Towns • Government Officials • Private Firms • Economic Institutions • Academia • Civic Groups • Individuals

BREAKOUT SESSIONS

Planning • Bridges & Structures • Traffic & ITS • Administration, Government & Policy • Maintenance • Aviation, Rail & Marine • Design • Construction, Pavement & Materials • Transit & Public Transportation • Environment • Local Issues • Multi-Modal Safety Issues

INVITED KEYNOTE SPEAKERS

Jack Markell, Governor, State of Delaware
Patrick Harker, President, University of Delaware
Shailen Bhatt, Transportation Secretary, Delaware Department of Transportation
Drew Boyce, Planning Department, DelDOT
Ralph Reeb, Planning Department, DelDOT
Lunch Guest Speakers
Professor Ajay Prasad, University of Delaware—Fuel Cell Bus Presentation
Professor Willet Kempton, University of Delaware—Vehicle-to-Grid (VG2) Technology

For complete forum agenda and registration information visit our website
www.ce.udel.edu/dct or contact Sandi Wolfe
302-831-4094

WHY YOU SHOULD ATTEND

Approximately 400 participants concerned about mobility and logistics will attend the 2013 Transportation Infrastructure Forum on Wednesday, November 13th in Clayton Hall on the campus of the University of Delaware to identify the most important and crucial issues facing the transportation system in our region. Transportation in the 21st century affects all aspects of life including the efficiency of travel, economy and employment, safety, environment, energy, sustainability and health. The forum will cover all aspects of the modern transportation system. Participation will guarantee that your voice will be heard and documented so that our decision makers can take action.

The forum will cover a broad array of multi-modal transportation issues. In addition to topical breakout sessions, we anticipate 15 vendors to display their products and services.

ANTICPATED PARTICIPANTS

- Elected and appointed officials
- Federal, state, and local transportation agencies
- Universities
- Consultants and transportation service providers
- Civic groups
- Citizens

ARRANGEMENTS

- Admission will be free, but attendance will be controlled by seating limitations
- Electronic registration will begin September 2013 at www.ce.udel.edu/dct
- We will serve a continental breakfast, lunch, and breaks
- Driving directions to Clayton Hall will be on our web page. Parking will be free for the forum.
- Clayton Hall is accessible to the physically challenged and complies with ADA requirements.

We are looking forward to seeing you at our forum. If you have any comments or questions, please contact us at 302-831-4094 or at Sandiw@udel.edu.

INVITEES TO THE 2013 TRANSPORTATION INFRASTRUCTURE FORUM INCLUDE, BUT ARE NOT LIMITED TO:

Federal Agencies:

- Federal Highway Administration
  - Del-Mar Division
  - New Jersey Division
  - Pennsylvania Division
  - Eastern Resource Center
  - National Highway Institute
  - National LTAP-T² Office
- Federal Transit Administration
- Research and Innovative Technology Administration
- Federal Railroad Administration
- National Highway Traffic Safety Administration
- Federal Motor Carrier Safety Administration
- Maritime Administration
- Federal Aviation Administration
- Department of Homeland Security

State Agencies:

- Delaware Department of Transportation
- Pennsylvania Department of Transportation
- New Jersey Department of Transportation
- Maryland State Highway Administration
- Delaware Department of Natural Resources and Environmental Control
- Delaware Safety Council
- Delaware State Police
- Delaware Department of Safety and Homeland Security
- Delaware Office of State Planning
- Delaware Economic Development Office
- Delaware Contractors Association

Private Engineering Firms and Transportation Agencies

Local Agencies:

- New Castle County
- Kent County
- Sussex County
- Cecil County, MD
- Delaware League of Local Governments
- Cecil County Planning Department
- WILMAPCO
- Dover/Kent MPO

Other Agencies:

- Delaware River & Bay Authority
- Delaware Valley Regional Planning Commission
- Delaware River Port Authority
- I-95 Corridor Coalition

Educational Institutions:

- University of Delaware
- Delaware State University
- Delaware Technical and Community College
- Delaware Department of Education
- University of Pennsylvania
- University of Maryland

Professional Organizations:

- American Public Works Association (APWA)
- American Transportation and Road Builders Assoc. (ATRB)
- American Society of civil Engineers (ASCE)
- American Society of Highway Engineers (ASHE)
- Transportation Research Board (TRB)
- Delaware Professional Engineers (DAPE)
- Institute of Transportation Engineers (ITE
- American Planning Association (APA)

Registration for this FREE event will begin in September at www.ce.udel.edu/dct

The mission of the Delaware Center for Transportation is to improve the movement of people, goods, and ideas, and be viewed as a valuable resource for transportation-related issues and challenges within the state, the mid-Atlantic region and beyond.

Delaware Center for Transportation Staff

Ardeshir Faghri,
Director
faghri@udel.edu

Ellen Pletz,
Business Administrator I
ebourett@udel.edu

Sue McNeil,
Director UTC
smcneil@udel.edu

Mingxin Li
Postdoctoral Research Fellow
mlx@udel.edu

Jerome Lewis,
Associate Director
jlewis@udel.edu

Matheu Carter,
T² Engineer
matheu@udel.edu

Earl Rusty Lee,
T² Program Coordinator
elee@udel.edu

Sandra Wolfe,
Event Coordinator
sandiw@udel.edu

UTC NEWS INSERT

RESILIENCY OF TRANSPORTATION CORRIDORS

PUBLISHED BY THE UD UNIVERSITY TRANSPORTATION CENTER

SUMMER/FALL 2013

Dare to be first.

UNIVERSITY OF DELAWARE

University Transportation Center

Department of Civil & Environmental Engineering

355 DuPont Hall
Newark, DE 19716

P: 302-831-1446
F: 302-831-0674
www.ce.udel.edu/dct

Director and Managing Editor
Sue McNeil

Design
University of Delaware College of Engineering communications team

Director's Message

As summer draws to a close we are able to report on the activities of our faculty and students. In particular, six undergraduates have participated in UTC funded internships and research projects. We asked the students to describe what they did and what they learned. I hope you will enjoy reading about their experiences as much as I did. I also had the opportunity to interact with them and know that we have a group of motivated and bright students who have made some interesting and valuable contributions.

In this newsletter we also have three graduate students report on their interactions with the International Road Federation (IRF). The IRF Fellows and Global Scholars are rich opportunities to learn more about professional practice and international experiences. In addition to these programs we were fortunate to have Mike Dreznes, Executive Vice President of IRF present "Forgiving Highways" as UD-UTC distinguished lecture and ITE Student Chapter presentation. Mr. Dreznes not only entertained but challenged the students to think about road safety issues and the ethical issues if problems are not addressed. We look forward to more interactions with IRF.

This summer, as part of our collaboration with the Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers, we launched three new collaborative projects. The projects involve UD faculty and students as well as researchers from Rutgers, Utah State, Princeton, Columbia and University of Texas El Paso. Brief descriptions are included in the edition of the Newsletter.

Also drawing to a close is our UD-UTC grant. Our theme "Resilience of Transportation Corridors" has served us well as we have critically looked at the transportation challenges in the BOSWASH corridor as well as other similar corridors. As we transition to the focus on State-of-Good-Repair as part of the CAIT collaborative, we still have research issues to address but we also are armed with many practical experiences and applications. In our next newsletter we will provide a synthesis of our research.

Sue McNeil
Professor, Department of
Civil & Environmental Engineering

DelDOT Summer Interns Estimate Costs for Future Flooding Repairs

CAIT at UD has committed to supporting summer interns at DelDOT. These interns will gain valuable experience and become part of the workforce of the future and DelDOT has the opportunity to explore projects that contribute to State of Good Repair that are not part of the usual programs. This summer Brandon Goldfine and Dan Calabro spent the summer at DelDOT under the supervision of Mike Kirkpatrick, in the Planning Department. In the fall, Brandon and Dan will be seniors in the Department of Civil and Environmental Engineering. We are grateful to DelDOT and Mike Kirkpatrick for providing this opportunity.

BRANDON GOLDFINE AND DAN CALABRO

Brandon Goldfine and Dan Calabro worked as DelDOT interns analyzing the flooding of state-owned roadways and bridges in Delaware. The goal of their work was to come up with an estimated cost to raise the roadways to accommodate any flooding caused from sea level rise by the year 2100. They focused on the worst case scenario of flooding by the year 2100 which they determined to be 5 feet (about 1.5 meters). They found that the total cost to accommodate fixing state-owned roadways and bridges in the worst case scenario was estimated to be $1.45 billion. Throughout the process, the resources used to determine this cost included ArcGIS, Microstation, Google Earth, and Python. Guided by Erik Archibald, a graduate student in the Department of Civil and Environmental Engineering, Brandon and Dan feel that the experience was very helpful in teaching them how to better use these programs. In the process they also learned what it is like to work on a controversial topic. They said that overall, most people supported their work, but as always there were some people who did not. Most people think that improving the roadways for the future is a very important topic right now, especially with the recent destruction of Hurricane Sandy and the heavy rainfall and flooding that we have been having this summer. However, there are always people who do not agree. Since the research focuses on the year 2100, some people think that this is too far away to worry about now, considering it is not in their lifetime. More people think that the work is unnecessary because it is associated with the controversial topic of climate change. Most people however see that flooding in Delaware is evident and an important topic to start thinking about. Brandon and Dan learned that they must take their work seriously even if some people do not think it is important yet. They feel that overall it was a great experience and they plan to present their work to a DelDOT engineer on their last day.

KIMBERLY AMBROSE

Undergraduate Research

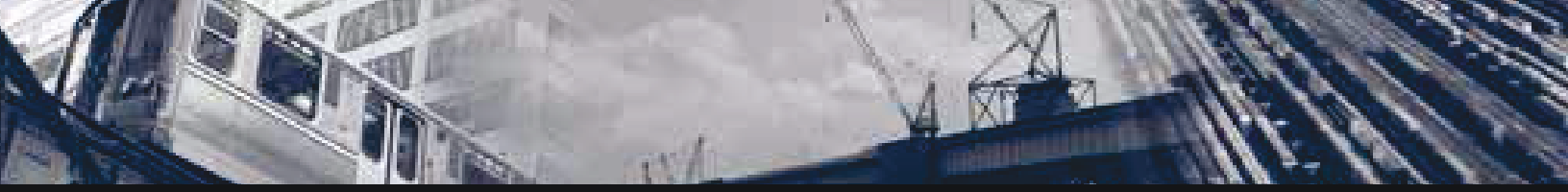
Four undergraduate Civil and Environmental Engineering student's research projects related to the resilience of transportation corridors. The students - Kimberly Ambrose, a junior; Matthew Sparacio, a senior; Jessica Vargas Okajima, a senior and visiting student from Brazil; and Matthew Hartnett, a senior – worked on a variety of projects. Here are their stories.

RESEARCHING THE EFFECTS OF EARTHQUAKES ON TRANSPORTATION

Kimberly Ambrose

Kimberly Ambrose has been working over the summer on a research project, guided by Sekine Rahimian and Sue McNeil, focusing on how the transportation in a section of Los Angeles, California called Northridge is affected by earthquakes. Kimberly researched performance measures used on transportation corridors in previous studies and formulated this information into a literature review. With this literature review, Kimberly and Sekine plan to pick one or two performance measures that they can use for their own project focusing on the Northridge area. The performance measures that they pick must be able to help analyze the roadways in regards to how the earthquake affected the transportation before and after the incident. Kimberly used 47 specific earthquake scenarios to aid her in collecting pertinent data for her research by running these scenarios through a computer program called HAZUS MH. Through this program, she found information such as casualties, building damage, bridge damage, and fires that each earthquake would cause in the Northridge location. This information is important to the research because of their effect on the transportation in the area. For example, under the casualties category, Kimberly recorded the injuries that require ambulances and medical crews to be on the road for each specific earthquake scenario. The number of rescue crews to recover victims from damaged buildings and the amount of fire trucks on the road can all be found using the information that Kimberly collected with this program. She also implemented a formula to calculate the traffic flow with the recorded levels of severity of bridge damage due to each earthquake scenario. Kimberly plans to use the recorded data from HAZUS MH to run more computer simulations using CUBE, which will help her record data relevant to the performance measures that she and Sekine will choose to use in their study. Kimberly also used ArcGIS to match certain elements of the Northridge area that will also assist her in collecting this data from CUBE simulations.

Throughout the summer, Kimberly has learned many valuable skills. Not only has she learned how to operate HAZUS MH, ArcGIS, Google Earth, and CUBE, but she has also learned a multitude of ways in which to research a particular topic. She has also gained a greater appreciation for the research process by experiencing just how many aspects are involved and by overcoming setbacks along the way. Over the summer, Kimberly has also learned about some of the projects that other undergraduate and graduate students have been working on, giving her a better



idea of the large range of topics that civil engineering covers. Kimberly feels that this was an overall great experience for her and she plans to continue this research and pursue her studies in civil engineering at the University of Delaware.

RESILIENCE IN CIVIL ENGINEERING

Jessica Vargas Okajima

Jessica Vargas Okajima has been researching the topic of Resilience Engineering this summer. Resilience Engineering is a relatively new topic and is growing in interest due to the increasing number of natural and manmade hazards. Resilience is the means by which a system can quickly respond, recover, and learn from a disturbance or a disaster. Jessica developed a background idea about the term resilience by studying many scientific papers about definitions, applications, and case studies in various areas, such as transports, ecology, industry, electricity, chemistry, meteorology, supply chain, and community. She has assisted her advisor, Dr. Nii Attoh-Okine, in writing his book about Resilience Engineering. She worked on some of the figures for the book and prepared an annotated bibliography of various articles to include. Jessica was introduced to LaTeX by her advisor and found that this system was very helpful in writing scientific articles and papers. Throughout the process, Jessica has learned many new skills and, by interacting with other graduate students, has also learned what some ideas of other research areas in civil infrastructures might be. She has also learned that resilience applications at the design level are missing in current building codes. Her main interest is in structures and she focuses her research on applications of resilience in this field. She plans to continue her research in this area and to write her undergraduate research project on resilience in structural engineering.

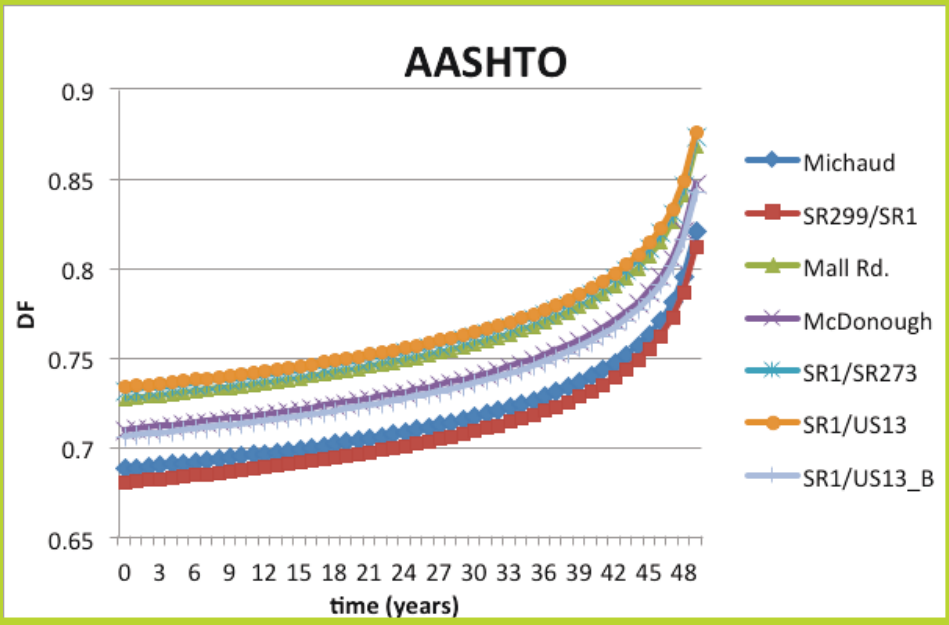
ANALYZING THE EFFECT OF AGING ON A BRIDGE DECK'S ABILITY TO TRANSFER LOAD AND ITS CAPABILITY FOR SYSTEM LEVEL INTERACTION

Matthew Sparacio

Over the summer, Matthew Sparacio has been working with Professor Jennifer McConnell by supporting her research on the system level analysis of highway bridges. Generally, the elements of a bridge are designed individually and do not account for the ability of load to be transferred from element to element, which ignores the potential for additional capacity. In an attempt to better understand the system level interactions in typical highway bridges, Matthew set out to study how the live load distribution factor (DF) of a bridge deck might change due to the aging process. A distribution factor is one of the main parameters that determine a bridge's ability to transfer load, and therefore be analyzed as a system and not a collection of individual elements. If the value of a bridge deck's distribution factor becomes too large, that is an indicator that the bridge does not effectively transfer load between its girders, and therefore behaves less as a system.

After reading through publications such as "Distribution of Wheel Loads on Highway Bridges", "An Approach to Evaluating the Influences of Aging on the System Capacity of Steel I-Girder Bridges", and the current AASHTO design codes, Matthew discerned that developing an equation that could demonstrate how the distribution factor changes with time would be an appropriate way to model all of the factors that contribute to the aging process such as weathering and exposure to de-icing agents. Over the summer, Matthew has created various graphs that plot the live load distribution factor against time, inspection rating, and environmental influence. By observing the state of its distribution factor at any point in its life cycle, these plots can assess the usefulness of analyzing a particular bridge as a system; therefore, supporting Professor McConnell's studies. This data could be used as a tool when inspecting bridges and making decisions about its condition and necessary repairs. Analyzing the bridge as a system usually reveals reserve and unnecessary capacity, which can be used to delay potentially necessary repairs.

Throughout the summer, Matthew has learned a lot about the science behind bridge design and inspection, but most importantly has gained an appreciation for the research process itself. He found a very rewarding aspect about developing his own original equations that not only he can use to his benefit, but that others can use as well. He found a sense of importance in trying to develop solutions to problems that have never been solved. The research process showed him that much can be learned from the work of others and that research is a global initiative. Matthew feels very privileged to be given this opportunity to make a contribution of his own to a system based on improving our understanding of the engineering world and increasing the efficiency of our designs and practices. He is continuing his research by preparing a report that will coherently present his findings over the summer so that others can utilize his hard work in the future. Matthew is also planning on continuing his research on this topic. He feels that it is important to invest our



time in improving the way we initially design and periodically analyze our nation's bridges and that this has the ability to positively affect the world of Civil Engineering and the multitude of people that interact with these structures every day.

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Matt Hartnett and Kim Ambrose work in the ITS Lab

COMMUNITY RESILIENCE TO ENERGY DEMANDS IN A POST PEAK OIL WORLD

Matthew Harnett

This summer, Matthew Harnett has begun a yearlong research project studying community resilience to the anticipated economic consequences incurred by the world's ever growing energy demands in a post peak oil world. Peak oil refers to a point in time at which worldwide production of oil has reached a maximum. Most experts estimate that peak oil will occur anywhere between 2010 and 2020. All indications imply that economic strain will afflict the entire globe and only worsen as we move further and further beyond peak production unless we take measures to create more resilient communities.

In the context of Matthew's research, he will equate resilience to economic localization, or according to Talberth et al.: "the process by which a region, county, city, or even neighborhood frees itself from an overdependence on the global economy and invests in its own resources to produce a significant portion of the goods, services, food, and energy it consumes from its local endowment of financial, natural and human capital." Economic localization dictates a condition that relies very little on energy intensive transportation facilitated exchanges of material resources and human capital, thus instilling a community with increased resilience to volatile swings in the price of oil. For his research, attributes of economic localization that Matthew will quantify in order to measure a community's resilience include economic diversity, local employment, and production/consumption relationships. The aim of his research will be to determine if there are common characteristics in the built environment and land use zoning in a wide collection of communities across the American northeast that are indicative of economic localization.

Matthew has made progress in his research so far by completing a preliminary literature review focusing on the relationships between community development and design and local economic health. Specifically, he has been conducting research on peak oil to effectively articulate the motivation for this research project. He has done this by studying a small sample of theoretically and empirically derived initiatives seeking to drive the creation of more resilient communities such as "Sustainable Urbanism" and the "Transition Town" movements, and calculating simple metrics describing economic localization for a set of communities he will be taking as case studies in his final report. From the start of this project, he has learned that this will be a cross disciplinary study that will involve at least a basic knowledge across a spectrum of disciplines: economics, sociology, urban policy, and a background in civil engineering among other fields. He plans to continue with this research over the course of the year.

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-Kimberly Ambrose, Jessica Vargas-Okinawa, Matthew Sparacio and Matthew Hartnett

International Road Federation

In 2010, Delaware Center for Transportation and University of Delaware University Transportation Center joined the International Road Federation (IRF). As members, our students have access to a variety of scholarships and educational opportunities. The following is a personal account of three of our students.

Offei Adarkwa

I am Offei Adarkwa, currently pursuing a PhD in transportation engineering. My supervisor is Professor Nii Attoh-Okine. He and Professor Sue McNeil encouraged me to apply for the IRF program. I am now an IRF scholar for 2013-2014. My work is mainly on data analysis using tensor factorizations. For my masters, I used tensor factorizations in the identification of pavement cracks. I intend to build on the knowledge gained from my masters and help provide practical transportation design and management solutions.

I look forward to attending the IRF meeting in Washington, DC where I hope to gain helpful insights and knowledge by interacting with other scholars and experienced transportation professionals.

Leslie Mills

My name is Leslie Nii Odartey Mills, and I am a 2012 IRF Scholar. My association with IRF began in January 2012 when I was invited to participate in a 2 week Road Scholar Program with twenty-six other international students who were attending schools across the United States. I would like to express my gratitude to Professor Sue McNeil for facilitating my participation in the Program. It was an amazing 2 weeks as I had the opportunity not only to enhance my professional career but to learn life principles that have had a tremendous influence on my life since last year. During the 2 weeks that IRF hosted the group in Washington D.C., I had the chance to learn more about the importance of the civil engineering discipline and its role in changing lives and economies around the world. IRF's slogan is: "Better Roads; Better World" and concerns itself with all aspects of a highway that improves the lives of users and the activities they engage in. By the end of the 2-week program, all the participants had become firm believers in this slogan and our resolve to change our societies as civil engineers was solidified. In addition to workshops and presentations about IRF and its affiliates, we also had the opportunity to visit agencies in Washington, DC that play different roles in formulating and implementing transportation policies across the nation and around the world. These included the World Bank, the Federal Highway Administration (FHWA) and the American Association of State and Highway Transportation Officials (AASHTO). Professionals from these organizations were helpful in sharing more about their groups and answering our questions. It was also a great networking platform.

My association with IRF since last January has been on an upward trajectory. From participating in free webinars on best practices for roadways through to basic tenets such as developing my LinkedIn profile so as to create an online presence professionally, IRF has provided me with terrific resources. I cannot emphasize enough the connections I have made with various policy makers and engineers from across the globe and how the IRF Scholars Alumni Association has served as a strong support system outside that which the University of Delaware provides. Mr. Patrick Sankey and Mr. Michael Dreznes, President and Executive Vice-President of IRF respectively, are great mentors and good friends as well. The ultimate step with IRF came this summer when I was hired to work with the IRF team as Manager for Africa. My primary role will be to enhance IRF activities in Africa through our central theme: "Better Roads, Better World." In this capacity, I will create the needed platform for IRF to meet up with professionals as well as relevant agencies and brainstorm ways to make transportation infrastructure on the African continent safer and more efficient. It will also be my responsibility to educate more African civil engineers about professional development opportunities that IRF offers so as to encourage them to seek best practices through these opportunities. I am looking forward to my new role with IRF and a relationship which started in January of 2012 looks set to continue very well into the future.

Sekine Rahimian

My name is Sekine Rahimian, and I am a 2013 International Road Federation (IRF) Scholar and a PhD student. Following is the list of questions I had in my mind when I was applying for the IRF program in 2012. The answers are based on my personal experience and the IRF website: irfnet.org. I hope this encourages International and American students to apply for this program because it was a marvelous experience.

What is IRF?

The International Road Federation (IRF), founded in 1948, is a not-for-profit, non-political, organization with the mission to encourage and promote development and maintenance of better, safer and more sustainable roads and road networks.

What is the IRF fellowship program?

This program is for the international student in their home country, basically your friends. The Program provides a one-time grant toward the costs of university graduate study in fields related

to the development of better and safer roads, and road networks worldwide.

As Executive Fellows, these students are invited to participate in the Road Scholar Program, alongside IRF's current class of Traditional Fellows, which is designed to provide the Fellows with a better understanding of the process of doing business in the transportation industry in the United States, the importance of leadership, and the benefits and merits of the International Road Federation. The Road Scholar Program will allow IRF members to make contact with some future international leaders before they return to their home countries.

So, what does this mean?

If you are an international graduate student at University of Delaware you can apply for the IRF road scholar program but you need to be recommended by University of Delaware. Just one out of twenty five places is reserved for a very lucky American graduate student to take part in annual road scholar program. The annual 10-day IRF road scholar program takes place in DC in January at the same time as the Transportation Research Board Annual Meeting.

The program is informative, educational and fun. During the 10 day period you will bond with a group of graduate students from all over the world. The program is designed to give you information about and show you all the opportunities you may have for future jobs, you will visit important agencies active in the area of transportation and pavements including the American Association of State Highway and Transportation Officials, Federal Highway Administration and the World Bank. Moreover, the close relationships between IRF and some important private companies give you an opportunity to talk and be in contact with the CEOs of large companies in transportation. You will see these important people at luncheons and they will have presentations for you. The IRF staff provides a very friendly environment that you are comfortable in and you will enjoy the program for all 10 days. If all of these do not convince you to go for this great experience, a $1000 check will be given to you as the participant of the program.

Opportunities for Students

Look for announcements of the following opportunities:

- The 2014 IRF Road Scholar Program (RSP) will be held in Washington DC in January 9-18, 2014.
- The IRF Student Essay Competition is an annual contest held to recognize promising road research and open to transportation students that attend IRF member universities.

IRF

2013 Road Scholars: Sekine Rahimian (front row, far right)

CAIT Collaborative Projects

This summer UD researchers began three collaborative projects with other members of the CAIT consortium.

MULTI-SENSOR SHEETS BASED ON LARGE-AREA ELECTRONICS FOR ADVANCED STRUCTURAL HEALTH MONITORING OF CIVIL INFRASTRUCTURE

Principal Investigators: Branko Glisic (Civil and Environmental Engineering, Princeton University)

Thomas Schumacher (Civil and Environmental Engineering, University of Delaware)

Raimondo Betti (Civil Engineering, Columbia University)

Abstract

Many bridges in the country have reached their intended service life limit. Some of them do not pass current load-ratings or show deterioration such as corrosion and cracking. Monies for replacement and repair of bridges, however, are scarce. In order to keep these critical infrastructure components in operation, inspection, maintenance, and monitoring play a vital role. Existing monitoring approaches use sensors such as strain gauges or accelerometers that capture a physical measurement at a point. One pressing problem is fatigue cracking in fracture critical bridge members, which can have disastrous consequences to the infrastructure and public safety. Because detection of fatigue cracks can be difficult, it is essential that a sensing technology is utilized that is able to measure strains at a large number of points with high accuracy. One challenge by deploying a traditional array of strain gauges or strain rosettes is the complexity in the wiring. Also, for reinforced or prestressed concrete structures, damage that may lead to catastrophic failure is typically associated with internal processes such as wire fracture that may not necessarily be detectable on the surface. Acoustic Emission (AE) monitoring techniques represent a possible solution to this problem. Often, however, it is not feasible to install a network of AE sensors due to the prohibitive costs associated with such a system. Current available technologies give bridge managers access to sparsely spaced sensors. These, unfortunately, do not allow reliable early detection of anomalies such as strain concentrations or cracks at locations of even modest distances away from the sensor. To infer localized anomalies, such forms of indirect sensing rely on complex algorithms whose reliability is challenged by practical noise sources (i.e., temperature, precipitation, and normal loading variability). Thus, a need exists for a cost-effective sensing approach that is able to incorporate a variety of sensors applied in form of very dense arrays to maximize the chances for capturing damage externally as well as internally at an early stage. The measurements should support the bridge owners for informed decision making. This research addresses the need for direct sensing, where anomalies are sensed at close proximity via a dense array of sensors

EVALUATION OF BIOTECHNOLOGIES FOR FLEXIBLE PAVEMENT APPLICATIONS

Principal Investigators: Thomas Bennert (CAIT, Rutgers)

Vivek Tandon (Civil Engineering, University of Texas El Paso)

Nii Attoh-Okine (Civil and Environmental Engineering, University of Delaware

Abstract

The use of biotechnology has many benefits in construction applications, in this case, the construction and performance of flexible pavements. From a materials standpoint, the potential use of biomaterials can reduce the dependency on petroleum products required for asphalt materials, as well as helping to reduce greenhouse emissions during production and construction. If adaptable, biomaterials may also be able to help increase the general life of the pavement while reducing the total cost of construction. Biotechnologies may also be able to help in the stabilization of subgrade soils prior to constructing roadways over the top of them. Researchers have found that the use of microbial activity allows for a level of stabilization in liquefiable soils. Including the use of biomaterials to help stabilize these problematic soils is a cost effective and environmentally sensitive solution. Although biomaterials have shown to help improve pavement and soil performance, there is also evidence to show that some pavement biodeterioration does occur and may affect the general roughness of the pavement. To conclude the research study an assessment of paved road deterioration due to biodeterioration and how it influences roughness progression will also be conducted.

BIG DATA: OPPORTUNITIES AND CHALLENGES IN ASSET MANAGEMENT

Principal Investigators: Jie Gong (Civil and Environmental Engineering, Rutgers University)

Sue McNeil (Civil and Environmental Engineering, University of Delaware)

Kevin Heaslip (Civil and Environmental Engineering, Utah State University)

Abstract

Asset management is largely a data driven process as one of the key elements of asset management is using data to support decisions. However, the databases representing inventory and historical records of road, bridge, and roadside assets collected using video logging, automated pavement distress survey, regular inspections, structural health monitoring, and other methods can rapidly explode. Such data is a key to maintaining physical assets in a state of good repair and addressing safety issues. Simple tasks such as capture, curation, storage, search, sharing, and analysis are challenging as our ability to collect data expands. Ideally "better" data will be understandable, transparent, interoperable, automated, and visual. Some of the experiences with "big data" in other fields may help to manage, more proactively, our data assets to support the management of our physical assets. "Big Data" refers to datasets that are so large and complex they are not easily manipulated using the commonly available database tools. These challenges are characterized by the three "V's" - velocity, volume and variety. This project will identify areas where big data may be an issue for asset management in Departments of Transportation (DOTs) and develop strategies for dealing with big data.

State of Good Repair Summit

DelDOT personnel and University Professors Thomas Schumacher, Jennifer McConnell and Sue McNeil participated in the 2013 State of Good Repair Summit in New Brunswick hosted by CAIT. Professor McNeil spoke on "Demonstrating the Benefits of Asset Management Implementation."

The one-day summit engaged academicians, practitioners and policy and decision makers in exploring nationally applicable asset management and condition monitoring best practices to keep our infrastructure in a state of good repair. For more information see "transportation today", Rutgers Center for Advanced Infrastructure and Transportation, Newsletter Issue 12, May 2013 http://cait.rutgers.edu/system/files/u5/Rutgers-CAIT_NL_12_May2013.pdf<maher.jpg>

Rutgers

Ali Maher, Director of CAIT, opens the State of Good Repair Summit

AISIM9

The 9th Annual Interuniversity Symposium on Infrastructure Management (AISIM) was held at University of California, Berkeley in June. Hongbo Dai, a PhD student in structures presented a paper "Development of Carbon Nanotube-Based Sensing Approach for Structural Health Monitoring of Civil Infrastructure," and Lassaad Mhamdi, also a PhD student in structures presented a paper titled "Quantitative Acoustic Emission Techniques for Real-Time Monitoring of Fracture Processes in Civil Infrastructure." Hongbo's paper was selected as one of the five best presentations from the Symposium. As such he is invited to present a poster at the Transportation Research Board Annual Meeting in Washington DC in January 2014.

Professors Schumacher and McNeil also participated in AISIM9. AISIM9 is a student-run symposium to advance the infrastructure management body of knowledge and applications by providing a forum for information exchange and for professional conversations about ongoing research. Engineers, scientists, and administrators around the world continually analyze state-of-the-art and best practices in this field, seeking innovative solutions in managing assets. The exchange of information and knowledge in infrastructure management is critical to this search for more effective and efficient methods of retaining initial investment.

AISIM 10 will be held at Virginia Tech during the summer of 2014.

Women in Transportation (WTS) Annual Meeting

Sara Patterson, A PhD Student, Ariella Schiff, a graduating Senior and Andrea Carberry, a rising sophomore, all from the Department of Civil and Environmental Engineering attended the WTS Annual Meeting in Philadelphia in May. As Ariella said "The conference was great. I really got a lot out of it by listening to the guest speakers and also meeting a lot of women in the railroad industry. Thanks so much for electing me to go! I know I benefited a lot from attending." Ariella has joined Amtrak in Philadelphia and we look forward to hearing about her experiences.

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