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**Delaware Center
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Environmental Engineering**

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HARD MICROBIOLOGY: USING BACTERIA IN CONCRETE TO PREDICT DAMAGE

Julie Maresca, Ph. D. and her research group in Civil and Environmental Engineering at the University of Delaware are working on finding bio-indicators that can tell inspectors if concrete has been damaged before that damage is visible to the naked eye. Bacteria living in or on concrete require specific environmental conditions: if chemical damage occurs, those conditions change. The Maresca group predicts that in response to chemical changes caused by the alkali-silica reaction (ASR), the kinds of bacteria living there may also then change. If certain kinds of bacteria only appear when ASR has occurred, their presence could be used as a bio-indicator for damage.

ASR is a common problem in the mid-Atlantic region, and is a result of reaction between silica, other cations, and water in the concrete. The reaction forms a hygroscopic gel that expands inside the concrete, causing extensive cracking. To identify bacteria that could potentially be used as bio-indicators for ASR, the Maresca lab, in collaboration with Thomas Schumacher, prepared concrete test cylinders using materials that are highly susceptible to ASR, and a parallel set of cylinders that are resistant to this reaction. These cylinders were placed on the green roof of UD's Colburn Lab in the spring of 2013. Since then, one pair of cylinders has been collected every 4-6 weeks for analysis of the bacterial populations.



Concrete test cylinders on the green roof of Colburn Laboratory, where they are exposed to normal weather conditions.

Because very few bacteria can be cultivated in the laboratory, the bacteria living in and on concrete must be identified



Keira Zhang, a Ph.D student in Civil and Environmental Engineering, collects samples from the top of a test cylinder.

using DNA analysis. Keira Zhang, a PhD student, discovered that a method used to extract DNA from ancient bones also worked on concrete. Using this method, it is now possible to extract DNA from concrete and sequence it to identify all of the bacteria present in the sample. Most of the bacteria present in and on concrete are Actinobacteria, which typically have very tough membranes and are capable of forming dormant cell types. Many of these bacteria are related to bacteria found in alkaline lakes, hypersaline lagoons, or deserts, which are similar to concrete with respect to pH, salt content, and dryness, respectively.

DNA extraction from all of the cylinders removed from the green roof over the past 2 years is ongoing. Analysis of this DNA will show how microbial communities in and on concrete vary as ASR-susceptible and ASR-resistant concrete weathers. After identification of potential bio-indicators, DNA extracted from undamaged and ASR-damaged field samples will be analyzed, to determine whether predictions made using laboratory test samples hold true in the field. If our initial prediction is correct, this research will lead to development of a simple test

for specific bacterial bio-indicators for ASR-susceptible roadways. Early detection of potential ASR damage will enable state and local departments of transportation to remediate roadways before extensive cracking has occurred.

Additional thanks to: Delaware Department of Transportation, for providing concrete materials and mix designs; Devin Harris, at the University of Virginia, for providing field samples; the University of Delaware Research Foundation, for seed funding; and MATS-UTC, for current funding.



Test cylinders. Left: Cylinder made with ASR-susceptible materials from DelDOT. Right: test cylinders made with the same materials, but with fly ash which makes the concrete more resistant to ASR.

Message from the Director



Ardeshir Faghri,
Director

After 17 years at the helm of the Delaware Center for Transportation, I have decided not to sign a new contract and allow a new director with a new vision to lead the center. I

will continue as a full time faculty member in the Department of Civil and Environmental Engineering and as such will contribute to the center for the foreseeable future. I will also continue serving as the coordinator of the Mid-Atlantic Transportation Sustainability University Transportation Center (MATS-UTC), working in conjunction with the other MATS UTC consortium universities. Both the Dean of Engineering Tunde Ogunnaiké and the Chair of the Department of Civil and Environmental Engineering Tripp Shenton, as well as DelDOT Chief Engineer Rob

McCleary, Director of the Division of Planning Drew Boyce, Assistant Director of Planning Ralph Reeb and the Coordinator of Research programs Michael DuRoss are aware of my decision. Efforts are currently underway to find a suitable replacement. Once a new director is appointed, an e-mail message will be sent to all recipients of this newsletter.

It has been an honor to serve as the director of the Delaware Center for Transportation. I look forward to working with you all on future projects. ■

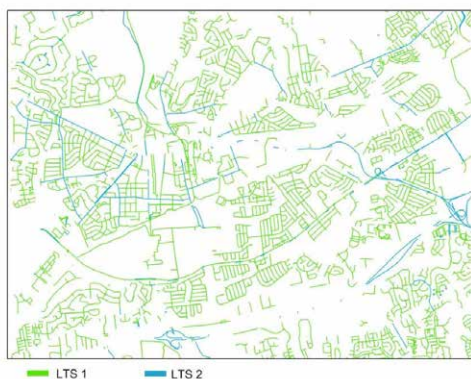
LOW-STRESS BICYCLE NETWORK MODELING

PAUL MOSER

Beginning in the winter of 2014, DeDOT Planning began the implementation of a new method for modeling the state's low-stress bicycle network – the network of connected streets and pathways accessible for bicycling at low "Traffic Stress" conditions. Traffic Stress is defined as the physical and mental stress associated with bicycling near automobile traffic. Confident riders may be comfortable riding on a wide variety of streets, regardless of traffic stress while a less confident rider may only be comfortable riding on low-stress streets or pathways, often times limiting his or her perceived range of mobility by bicycle. The Level of Traffic Stress (LTS) of a street is measured on a scale from 1 to 4. LTS designations are determined by the design of the roadway, or any bicycle facilities present, and how that design influences the way bicyclists interact with automobile traffic.

Low-stress network models provide a platform run network analytics to quantify how new roadway or bikeway projects will affect the size of the low-stress network, how many people have access to it, and how many potential trips can be completed using the low-stress network. This modeling tool is slated to become a part of DeDOT's project prioritization process, favoring projects which provide low stress

Low-Stress Bicycle Network: Newark

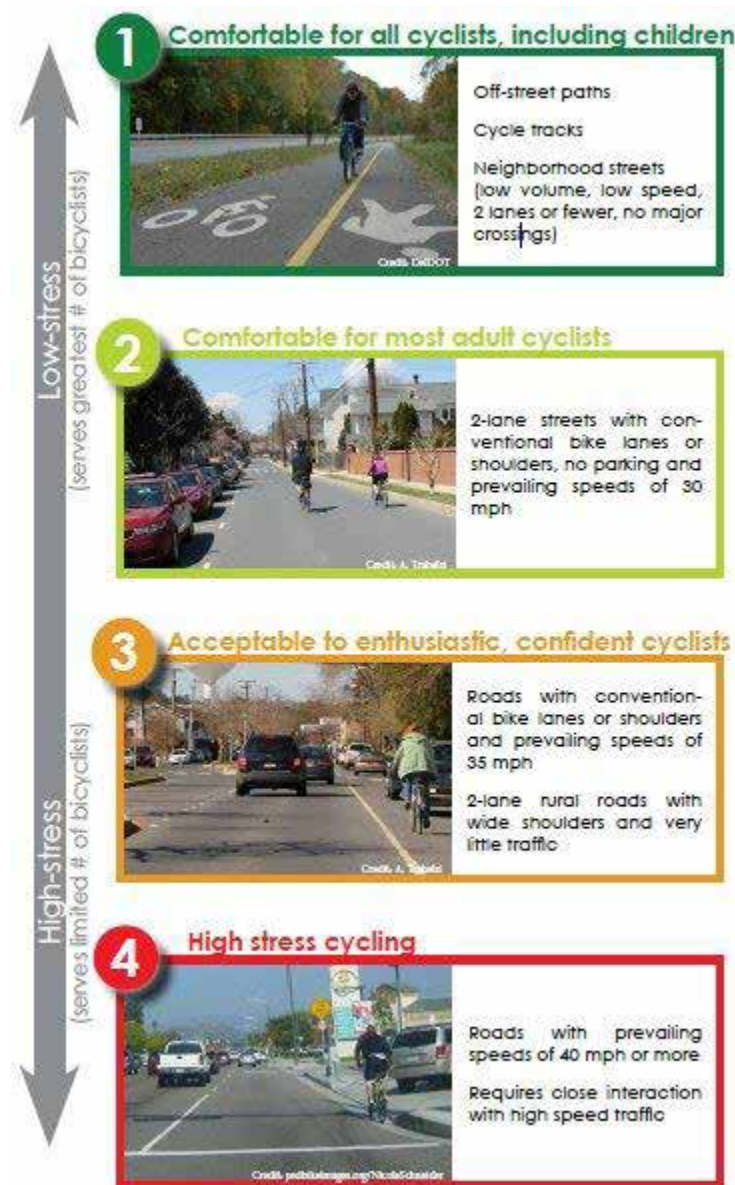


This map shows a preliminary model of the low-stress bicycle network (LTS1 and LTS2 segments) of Newark, DE. Clusters of low-stress streets are disconnected from one another by high-stress segments, creating "low-stress islands". This fragmentation of the bicycle network prevents safe, comfortable travel across the city without significant detour.



The map on the left shows LTS designations for the entire bicycle network of San Jose, CA while the one on the right only shows the low-stress bicycle network (LTS1 and LTS2 segments). Clusters of low-stress streets are disconnected from one another by high-stress segments, creating "low-stress islands". This fragmentation of the bicycle network prevents safe, comfortable travel across the city without significant detour. Preliminary models of Newark have not yet been authorized for public release.

links to expand the network and connect the most potential trip origins to the most potential trip destinations. In other words, infrastructure projects that help make bicycling a safe, comfortable, and practical transportation option for the most people possible.



DELAWARE T²/LTAP CENTER SPONSORS TRAFFIC MONITORING PROGRAMS: GUIDANCE AND PROCEDURES FOR TRANSPORTATION PROFESSIONALS IN THE REGION

Delaware T²/LTAP Center has brought a great opportunity for transportation professionals in the region by sponsoring a two-day course on traffic monitoring on June 3 & 4, 2015 at the University of Delaware's Pardee Center in Dover. This was a chance for state and federal transportation agency employees as well as other transportation professionals in the region to learn the latest revision of the FHWA Traffic Monitoring Guide (TMG). The Instructor-Led Training (ILT) course, *Traffic Monitoring Programs: Guidance and Procedures (FHWA-NHI-151050)*, was specifically designed for transportation professionals involved in traffic monitoring programs. The program covered most topics in the 2013 TMG and informed the audience about traffic monitoring program essentials and practices in other states.



More than 20 people attended the two-day program which included key DELDOT employees who are responsible of data collection and reporting; municipal, and metropolitan planning agency employees; representatives from other state DOTs, and researchers from the University of Delaware.

The main purpose of the course was stated as *"to understand the reasons behind, approaches to, and structure of traffic monitoring programs, using as the primary reference the 2013 FHWA Traffic Monitoring Guide."* The program increased the understanding of the appropriate use of TMG, and described the procedures for obtaining traffic monitoring data for federal and state programs. One of the major benefits of the program was emphasizing the *"value of cooperative and multidisciplinary approaches to traffic monitoring programs."* Most attendees expressed their supportive opinions about how important the communication and cooperation within and between agencies is for an efficient and cost-effective traffic monitoring program.

The program opened with a talk from the director of the Delaware Center for Transportation, Dr. Ardeshtir Faghri, and the FHWA/DE Regional Director Mary Ridgeway. Both highlighted the importance of such courses and trainings that refresh

the knowledge of the professionals in the field and provide updates with new methods and regulations.

The training began with the introduction and overview of the course objectives, and continued with a short presentation from state representative, Luis Rios Fontanez, regarding the state's traffic monitoring program. The first day covered federal regulations and guidelines, and data collection procedures on four major data types: volume, speed, classification and weight. Instructors informed the participants with specific methods recommended by FHWA and also shared the experiences of other states. During the lessons, some hands-on experiences helped participants to digest the necessary formulation and calculations for data processing.

Emerging technologies for the collection of volume, classification, weight, and speed data were one of the hot topics discussed in the program. Instructors shared their valuable experiences and other states' applications while also asking the technologies and methods used by DELDOT and other participant agencies. Length-based classification and currently used vehicle classification technologies in Delaware was also discussed during the course. Both DELDOT and FHWA representatives emphasized the potential in the length-based classification while underlining the importance of developing appropriate models and methods for appropriately classifying and reporting the collected data.

The second day started with covering non-motorized mode, which has been receiving an increased degree of attention in the last decade, and continued with data quality, data reporting and other subjects in the TMG. Luis Fontanez, who is initiating the non-motorized traffic data collection at DELDOT, shared his experience with the audience regarding the data technology, challenges, and observable non-motorized volume trends in Delaware. He also presented the DELDOT's supportive perspective on the importance of non-motorized traffic data collection. All participants including



instructors appreciated DELDOT's non-motorized data collection effort. The second day ended with a comprehensive exam and evaluation that provided credits toward participants' professional degree requirements.

The 2013 version of TMG has some new sections compared to previous versions. One of the new sections, collection and reporting guidelines of speed data, is covered in one lesson since it has been effectively used in many decision making processes such as safety, design, performance evaluation, enforcement studies and applications. Another new section, non-motorized traffic monitoring also received attention by participants. Lastly, quality control and quality assurance methods and practices were widely discussed in the program. At the beginning of the first day, instructors asked participants about their expectations from the course and covered the mentioned topics throughout the lessons within the limits and scope of the program.

The course was taught by two knowledgeable transportation experts, Steven Jessberger and Daniel Jenkins of FHWA. Steven Jessberger has been a Transportation Engineer for over 15 years and is currently working for the FHWA as Traffic Monitoring Program Manager. His responsibilities include the new Travel Monitoring Analysis System (TMAS) software, which is used to produce Traffic Volume Trends (TVT) report. Prior to his position with the FHWA, he worked at the Ohio DOT and

served on the TRB Traffic Expert Task Group. Daniel Jenkins is a Senior Transportation Specialist with the FHWA. He is the Compliance Manager for traffic monitoring policy and guidance and also responsible for production of Traffic Volume Trend Reports. Prior to his position at FHWA, he worked at the FHWA Virginia Division Office for nine years.



MUNICIPALITIES CONTINUE TO LEVERAGE VALUE OF INTERNS

Again this summer, Delaware municipalities, state agencies, and private sector employers are leveraging the value of engineering interns. With assistance from the Delaware T2/LTAP Center's engineering circuit rider program, two groups of interns were placed in the cities of Newark and New Castle, in addition to those placed with Cecil County Roads Division in Maryland. The Center solicited and evaluated prospective interns for a number of positions and assisted employers with training, and technical oversight, as well as lending data collection equipment.

In Newark, a total of five interns were placed, three of whom have worked part or all of the summer completing the traffic sign inventory and analysis that began in the summer

of 2014 with two other (since graduated) engineering interns. Together, these students will have documented Newark's sign inventory to assess compliance with the Delaware Manual on Uniform Traffic Control Devices (MUTCD), including retroreflectivity, size, mounting height, edge offset, and crash worthiness. Newark has been pleased with early analyses that show their operations and maintenance folks have made great progress towards full compliance.

The City of New Castle began its engineering intern program in the fall of 2014, continuing through the winter and pausing only when their first intern graduated from the University of Delaware then had to find a replacement for the summer. Work was quickly back on

track and the City now has a much better handle on its curb ramp compliance with the Americans with Disabilities Act, traffic sign compliance with the MUTCD, and the state of pavement distress in their streets. New Castle is already acting on this new information with plans to upgrade or replace a number of sidewalk curb ramps.

These are just two recent examples of how valuable engineering interns can be for a municipality, state agency, or private sector employer when a meaningful (often orphaned) project is identified for the intern, adequate training and support is provided, and they are required to take ownership for the analyses and deliverables. ■

MID-ATLANTIC TRANSPORTATION SUSTAINABILITY CENTER ANNUAL MEETING



Over seventy research faculty, graduate students, undergraduate students and Advisory Panel members attended the Mid-Atlantic Transportation Sustainability Center's (MATS UTC) first annual meeting in Wilmington, Delaware. The two-day meeting held on August 6th and 7th included an Advisory Panel meeting, a poster session, demonstrations of two innovative vehicles, panel speakers plus blocks of time devoted to networking and charting future collaborations on research projects.

The meeting was scheduled to bring together the six institutions which form the consortium: University of Virginia (lead institution), Morgan State University, University of Delaware, Virginia Tech, Marshall University, and Old Dominion University. The center's mission is to accelerate adoption of sustainable practices in the provision of transportation services. Agencies and firms in the region recognize that the standard environmental practice in transportation has focused on "compliance" with regulations, as opposed to a focus on sustainability.



EXPLORING CONNECTED VEHICLE TECHNOLOGIES WITH THE UD FUEL CELL HYBRID BUS

**YONGQIANG WANG, PROF SURESH ADVANI AND
PROF. AJAY PRASAD**
CENTER FOR FUEL CELL RESEARCH
DEPARTMENT OF MECHANICAL ENGINEERING
UNIVERSITY OF DELAWARE

Connected vehicle technologies have advanced and matured in the past decade to the point that they can now be harnessed to improve the overall efficiency of traffic systems, thereby reducing traffic congestion, travel time, fuel consumption, and harmful emissions. These technologies enable realtime vehicle-to-vehicle and vehicle-to-infrastructure communication that can be leveraged in several useful ways. In particular, realtime congestion and velocity data can be intelligently utilized by hybrid vehicles to predict system loading, and optimize the onboard power management strategy to achieve the highest fuel

economy and system longevity. The presence of multiple power sources in hybrid vehicles presents the unique opportunity to draw power from each source in a manner that maximizes fuel economy while reducing stress on the drivetrain components.

The University of Delaware has been operating its fuel cell/battery hybrid buses since 2007. Both buses employ onboard sensors to collect and upload data to our server in realtime. These data are then used to assess velocity patterns along the bus route which enables the onboard control system to operate in an intelligent manner to maximize fuel economy and system durability. A Matlab/Simulink model called LFM (Light, Fast and Modifiable) was developed by our group in 2009 to simulate the fuel cell bus system under any desired driving schedule. LFM has been rigorously validated and has served as a platform for many research projects on the power

management strategy of hybrid vehicles within our group. LFM has been extended here to incorporate control system optimization using traffic data as an input to improve fuel economy while reducing wear and tear on the fuel cell and the battery. This approach can be readily adapted for connected vehicle technologies and incorporated into an intelligent transportation system to provide data communication and optimized power management strategies for any class of hybrid vehicle.

The outcome from this project will be a more efficient transportation system that responds to traffic situations in an intelligent and efficient manner. Results from this effort will provide key insights as we progress toward a future with fully connected vehicle systems.

DCT, IPA, MU Research Team Collaborate on Mid-Atlantic Transportation Sustainability Center Project

BY BILL STAVRU

Researchers from UD's Delaware Center for Transportation (DCT) and the Institute for Public Administration (IPA), along with collaborators from Marshall University's Rahall Transportation Institute in West Virginia, have been conducting research on the use of smart growth scorecards/assessment tools to advance sustainable land-use practices. Funded by the Mid-Atlantic Transportation Sustainability (MATS) Center, the research team is studying how the concept of smart growth and scorecards/assessment tools have co-evolved and are currently being used to assess state, regional, and local sustainability goals.

The core principles of smart growth support land-use management practices that foster mixed-use development, a range of transportation options, pedestrian-scale development, and efficient, compact land use. Because smart growth has significant environmental, economic, and social benefits for communities that choose to curtail sprawl and implement more sustainable land-use practices, its principles are widely accepted and have been advanced in the past several decades by advocacy groups and professionals across all sectors.

To provide communities a means to measure the extent to which plans and policies have achieved local sustainability goals, smart growth scorecards and other assessment tools have been developed by federal, state, and local governments; metropolitan planning organizations (MPOs), regional councils of government;

and advocacy groups like Smart Growth America. However, many static, paper-based or early geographic information systems (GIS)-based analytical tools that were created and lauded as "best practices" by the U.S. Environmental Protection Agency (EPA) in the late 1990s and early 2000s are now out of date and no longer used.

Few studies have examined whether policy implementation tools provided a method for determining how well communities were meeting sustainability goals, or gauged how new focuses of smart growth align with the contemporary use of smart growth assessment tools. Consequently, the research team is investigating the development, evolution, and use of smart growth scorecards/assessment tools. As part of the study, the research team developed an electronic survey on the current use of smart growth scorecards/assessment tools. The survey was distributed broadly to approximately 250 state, regional, and local land-use and transportation planning practitioners and smart growth advocates in the Mid-Atlantic region.

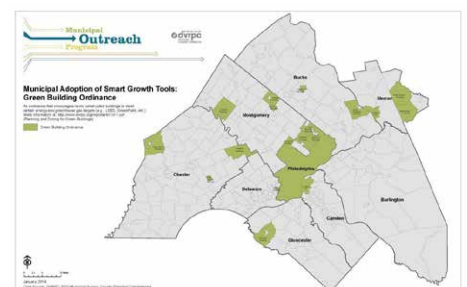
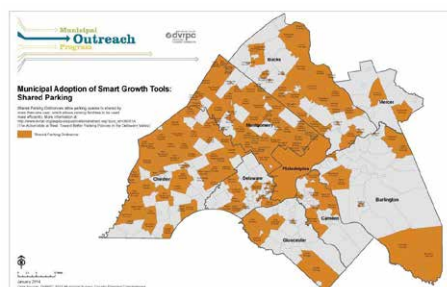
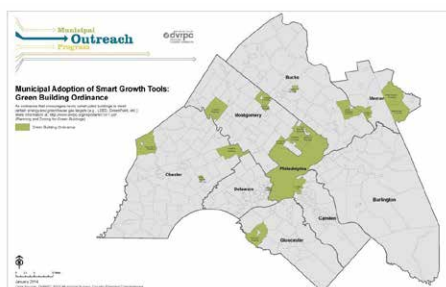
In addition, to explore the extent to which digital tools are produced, socialized, and used, the research team conducted informational phone interviews with two separate regional planning organizations that have an extensive, sophisticated digital presence. Staff members were interviewed at the New England Sustainable Knowledge Corridor, which represents three regional planning agencies across central Connecticut and western Massachusetts. The second interview was with staff members at the Delaware Valley Regional Planning Commission, a metropolitan planning organization

that serves Philadelphia and its bordering counties in southeastern Pennsylvania and southern New Jersey.

Last, the research team examined the EPA's use of GIS-based analytic tools. EPA has been involved in the creation of tools and models used to measure land use change and transportation efficiency. The research team studied the EPA's shift from its use of the Smart Growth INDEX® (SGI), a GIS sketch tool, to its current use of the Smart Location Database (SLD) to address the growing demand for data products and tools that consistently compare the location efficiency of various places.

Preliminary findings show that smart growth and scorecards/assessment tools have co-evolved in recent years and have tremendous potential to not only perform expected analyses, such as quantifying performance on key indicators of sustainability, but also to better educate and engage the public—a smart growth principle that previously has been difficult to operationalize—through scenario planning and the development of interactive, visualization tools. Further, digital assessment tools are offering a much needed, dynamic platform with which to satisfy mandates for increased transparency, accountability, and public engagement.

Members of the University of Delaware research team are Marcia Scott, policy scientist with the Institute for Public Administration (IPA); Mingxin Li, postdoctoral research fellow at the Delaware Center for Transportation; Philip Barnes, postdoctoral fellow with IPA; and Bill Stavru, graduate research fellow with IPA.



Web-Based Interactive Smart Growth Maps, Delaware Valley Regional Planning Commission

Delaware Valley Regional Planning Commission. n.d. Smart growth tools maps. <http://www.dvrpc.org/smartgrowth/maps>

RESEARCH

Projects selected from the FY16 1739 Research Program solicitation will be reported in the next newsletter issue.

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

1687-A LIGHTING-URBAN DESIGN

The purpose of this literature search is to provide transportation planners and engineers with the most effective types of lighting (fixtures, placement, light color and types) to improve pedestrian visibility at night, not simply driver visibility. Ending 2/19/16

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

Project Manager: Ralph Reeb, Division of Planning

1687-B PAVEMENT-STORMWATER

This literature search will weight the potential water quality benefits of installing porous pavement shoulders against the construction, maintenance and operations costs to maintain them. Ending 2/18/16

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

Project Manager: LaTonya Gilliam, DelDOT Stormwater Quality Program

1687-C SURVEYING-STATISTICS

Utilizing publicly and privately held sources along with a qualitative survey of state transportation agencies, this project will collect current best practices in travel monitoring techniques. Ending 12/8/15

Principal Investigator: Tibor Toth, Center for Applied Demography and Research

Project Manager: Michael DuRoss, Division of Planning

1687-D STORMWATER-NUTRIENT REMOVAL

Leveraging results obtained from preliminary laboratory research, this project will continue evaluation of two promising technologies involving the addition of biochar and/or zero-valent iron to existing and new stormwater bioinfiltration facilities. Ending 12/14/15

Principal Investigators: Paul Imhoff, Daniel Cha, Pei Chiu and Julia Maresca, Department of Civil and Environmental Engineering at Univ of Delaware; Mingxin Guo, Department of Agriculture and Natural Resources, Delaware State University

Project Manager: LaTonya Gilliam, DelDOT Stormwater Quality Program

1687-E BRIDGE-ENGINEERING SPECIFICATIONS

This project will investigate the factors that influence the impact factor which will help to eliminate some of the uncertainty in the factor and allow DelDOT to use a more accurate factor in their load rate of the culverts. End date: 12/15/15

Principal Investigator: Harry Shenton and Kalehiwot Manahiloh, Department of Civil and Environmental Engineering

Project Manager: Ping Jiang, Bridge Design

1687-G PAVEMENT-INSPECTION

This research will address the question of what is an acceptable variation in values between pavement evaluation surveys that use visual and auto-visual surveys. Ending 2/2/16

Principal Investigator: Sue McNeil, Department of Civil and Environmental Engineering

Project Manager: Sarah McDougall, Procurement Management Engineer

1687-H TRAFFIC- SAFETY

The end result of this research project will be to provide transportation planners and engineers with guidance for the deployment of radar speed signs which could be employed in a systematic manner to restore and maintain a balance between mobility and neighborhood quality of life. Ending 2/24/16

Principal Investigator: Mingxin Li, Department of Civil and Environmental Engineering

Project Manager: Michael Somers, Division of Planning

1687-J MULTI-MODAL TRAVEL MODELING

Using estimates of accessibility developed in previous research and using data available from the Delaware Trip Monitoring System Survey, this project will develop and refine a repeatable process to estimate a more detailed set of trip generation rates at the tax parcel level that incorporate a multimodal accessibility index. Trip generation rates will be provided by trip purpose as well as travel mode. Ending 12/8/15

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

Project Manager: Michael DuRoss, Division of Planning

1687-K TRAFFIC- SAFETY

The goal of this research project is to develop Delaware-specific values for determining work zone lane capacities along multilane signalized corridors. This has safety implications for both users and construction personnel in work zones. Ending 12/8/15

Principal Investigator: Mingxin Li, Department of Civil and Environmental Engineering

Project Manager: Adam Weiser, Division of Transportation Solutions

DELAWARE TRANSPORTATION LIGHTING INVENTORY AND ASSESSMENT

Lighting infrastructure needs will be inventoried and assessed in selected areas in Delaware that feature multiple modes of transportation and motorized and non-motorized transportation routes. The inventory will consist of mapping formal and informal lighting stock within a given geographical area to determine target areas for enhancement. The research will result in a compilation of lighting policies for areas within Delaware. Ending 8/31/15

Principal Investigators: Martin Wollaston and Ted Patterson, Institute for Public Administration

Project Manager: Ralph Reeb, Division of Planning

DEVELOPMENT OF CAPACITY ADJUSTMENTS FOR ADAPTIVE CONTROL SYSTEMS

This research will compare data on current practices around the country and compare this to conditions along Delaware roads to see if the computed capacities compare to observed behavior. Comparing predicted behavior with data from the Traffic Management Center, this research will further develop the “true” capacity for a segment. Ending 8/31/16

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

Project Manager: Gene Donaldson, Transportation Management Center

PASSENGER AND FREIGHT RAIL SERVICE SUPPORT

The Delaware Center for Transportation will provide expert technical review, research and support with regard to passenger and freight operations in the areas of cost allocation, evaluation of railroad infrastructure, and engineering analysis. Ending 11/30/15

Principal Investigator: Allan Zarembski, Department of Civil and Environmental Engineering

Project Manager: Albert Loyola, Delaware Transit Corporation

TRAFFIC MONITORING PROGRAM USER'S MANUAL

This project will develop a traffic monitoring program user's manual containing the most important information and step-by-step procedures for DelDOT

personnel to maintain an accurate and up-to-date data on volume, classification and weight for all roads in the state as well as maintaining a high quality HPMS program. Ending 12/31/15

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

Project Manager: Kevin Gustafson, Division of Planning

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS – PILE DOWNDRAG DESIGN PROVISIONS

This project focuses on assessment of the new AASHTO LRFD bridge design specifications for pile downdrag, and the associated implications for the design of future deep foundation projects in the State of Delaware. Ending 8/31/16

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

Project Manager: Jason Hastings, Bridge Design

SUMMER 2015 TRAVEL TIME, DELAY, AND SPEED 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 12/31/15

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

Project Manager: Mark Eastburn, Division of Planning

FY15 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. Ending 12/31/15

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

Project Manager: Mike DuRoss, Division of Planning

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

The objective of this research project is to construct and monitor the performance of this innovative bridge technology and hopefully be a model for future GRS-IBS structures in the state of Delaware. Ending 8/31/16

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

Project Manager: Jason Hastings, Bridge Design

A COMPREHENSIVE REVIEW AND UPDATE OF THE TRAFFIC MONITORING PROGRAM AT DELDOT

To assist in the compliance with Federal regulations, this research project will evaluate the accuracy of traffic data being presented in the Traffic Summary with regards to traffic volumes. Ending 12/31/15

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

Project Manager: Kevin Gustafson, Division of Planning

DCT hosts 12th Annual Research Showcase

On Tuesday, May 5, 2015, the Delaware Center for Transportation hosted the 12th Annual Transportation Research Showcase at University of Delaware's Paradee Center in Dover. The showcase featured poster displays for each of current research projects which were presented by the principal investigators and graduate students. The posters were divided into six categories: Environmental, Planning, Pavement and Materials, Soils, Structures and Bridges, Traffic & ITS, and Transit. University Transportation (UTC) projects funded by the USDOT were also on display. Visitors who attended the showcase had the opportunity to view the posters and discuss the project with the researchers and graduate students. Each year the event draws guests from various agencies including DelDOT, Federal Highway Administration, the University of Delaware, local government, and private industry.



UD graduate student, Wenling Tian (left) and Patrick Kennedy, FHWA (right) discuss the project titled *Integrating Zero-Valent Iron and Biochar Amendments in Green Stormwater Management Systems for Enhanced Treatment of Roadway Runoff*



Mark Eastburn (left) of DelDOT visited the showcase. Kadir Ozden, displays the UTC project titled *Satellite Assessment and Monitoring for Pavement Management*



Poster displays from UD's Institute for Public Administration were presented by graduate students, Kristen Jones (left), Matthew Watkins (right), and Policy Scientist, Marcia Scott (center).

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.

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OR contact the U.S. Department of Education - Office for Civil Rights
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A yellow circular logo with a white border containing the text "UTC NEWS INSERT" in black, slanted capital letters.

UTC NEWS
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A night-time photograph of a city skyline with a bridge, likely the San Francisco Bay Bridge, illuminated against a dark sky.

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Director's Message

In this newsletter we focus on our students. With support from CAIT at UD, our students participated in the WTS Convention in Chicago, the International Conference on Managing Pavement Assets and the Pavement Management Challenge, and the ENO Fellowship program; they organized the 11th Annual Interuniversity Symposium on Infrastructure Management; and they won prizes and fellowships. Each of these activities and accomplishments are described in more detail in the following pages.

This is also a time for change. Offei Adarkwa completed his PhD in Civil Engineering. Alex Greer and Ryan Burke completed their PhDs in Disaster Science and Management, and Israt Jahan completed an MS in Disaster Science and Management. All four students have been actively involved in projects funded by CAIT at UD. Faculty colleague, Thomas Schumacher, is leaving us to join the faculty at Portland State University. We wish them all well in their new endeavors. They have been an important part of CAIT at UD.

As summer draws to a close we are wrapping up Tier 1 projects and launching a new round of National UTC projects. Our next newsletters will include more details about these exciting projects. We have included a few highlights in this newsletter.

Sue McNeil

Professor, Department of Civil & Environmental Engineering

WTS Annual Conference – 2015

The 2015 WTS (Womens Transportation Seminar) conference was held in Chicago, Illinois from May 20-22. The conference includes speakers, professional development workshops and networking opportunities. As the conference coincided with final exams, Civil Engineering juniors Sarah Doggett and Natalia Belkova had to rearrange their exam schedule to participate.

In her application, Sarah stated "I went to the conference last year and had a wonderful time. I learned a great deal and was able to network with high-ranking professionals. If I could attend this year, I would learn even more, and I would be able to renew my acquaintances and make new contacts. Additionally, as I will be writing a thesis on transit-friendliness next year, several of the panels are very interesting to me. I am looking forward to hearing the presentation on Women in Rail and the panel on bike sharing."

After the conference, Sarah wrote "I got a lot out of the conference. Not only were there fantastic networking opportunities, I also was able to connect with several

other students who are doing research relevant to my senior thesis. I was able to obtain their contact information and they should be a valuable resource as I write my thesis. Additionally, during many of the panels, I learned about companies that are doing work in the areas that I want to pursue. It was all very helpful."

Natalia wrote "The conference was a wonderful opportunity to network with transportation professionals from all modes, including both public and private sectors. Conference was very well organized including welcome reception, banquet dinner, and information and speaker sessions. I attended multiple information, exhibit, and poster sessions; also, I participated in the silent auction. My favorite speaker was Erin Brockovich with a story of her success. And the most interesting information session was about bike sharing and sharing the road. This session was about how to remodel and incorporate bikes and pedestrians into existing transportation system in Chicago. Moreover, since the weather was good, I had a chance to test bike-sharing facilities. I really enjoyed exploring downtown Chicago on a bike. Bike stations were easy to use, and many stations are located in the center of the city, and this is beneficial for commuters who work in downtown and tourists."



Sarah Doggett and Natalia Belkova display their name badges at a WTS networking event

Natalia added this "I truly enjoyed the WTS conference, and, if UD offers the opportunity to go to WTS in Texas next year, I will definitely apply."

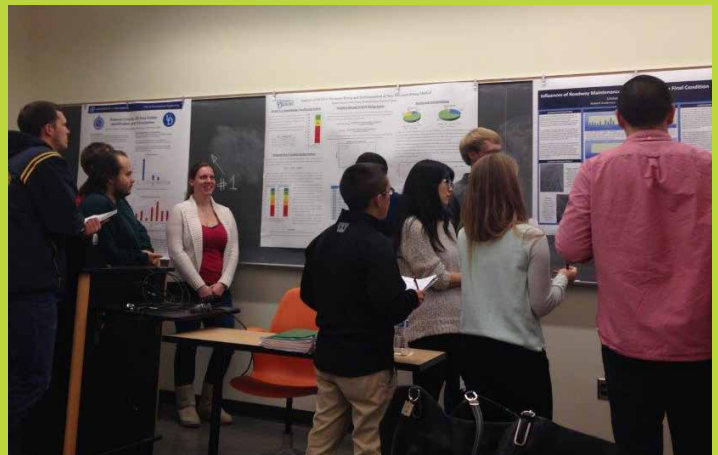
Support was provided by the Women in Engineering (WIE) program, Delaware Center for Transportation (DCT), and the CAIT at UD.

Pavement Management Challenge

Every three years the International Conference on Managing Pavement Assets (ICMPA) is held. The conference organizers issue a challenge to students and young professionals - the pavement management challenge. The pavement management challenge presents a real problem and invites teams to address the problem. ICMPA was held in May 2015 in Arlington Virginia and the organizers issued the following challenge:

Controlling the quality of infrastructure condition and monitoring data is a real challenge faced by transportation agencies. This is further complicated by the evolution of data collection and reporting methods over time, and by the periodic replacement of equipment over time.

A sample pavement management data set is provided, extracted from a real state agency's data. The challenge is to assess and improve the quality and continuity of pavement management data by applying new or existing techniques to this data set. Innovation is encouraged, but example ways to meet the challenge include:



Students in Civil Infrastructure Systems Present their Posters for the Pavement Management Challenge.

- Measure the quality of this data set
- Identify and impute missing data values
- Identify likely errors and outliers

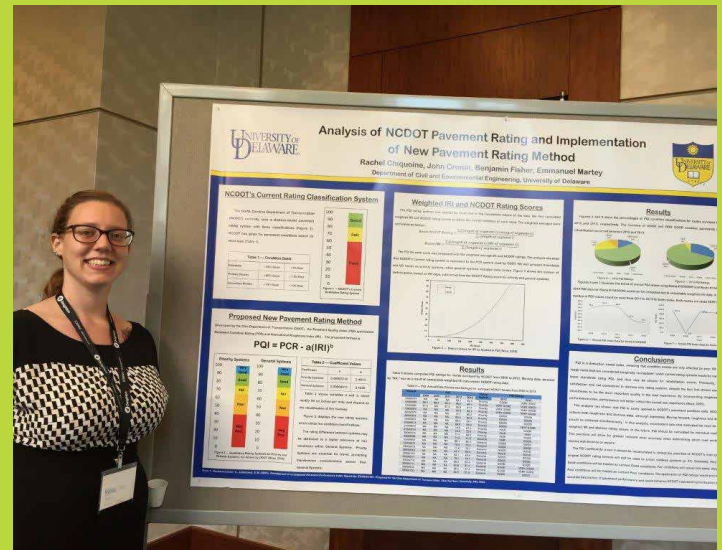
- Demonstrate a quality control or data acceptance methodology
 - Assess consistency between pavement work history and historical performance
 - Develop ways to visualize this data set
- See more at: <http://www.cpe.vt.edu/icmpa9/students.html#sthash.06N5rZsJ.dpuf>

UD Students in CIEG 655 Civil Infrastructure Systems in the Fall 2014 semester were presented with the challenge as a homework assignment. Four teams presented posters addressing the challenge and the student team presenting the best solution (based on instructor and peer evaluation) was offered the opportunity to present their poster at the 9th International Conference on Managing Pavement Assets.

The poster developed by Rachel Chiquoine, John Cronin, Ben Fisher and Emmanuel Martey was selected for presentation. Rachel Chiquoine represented the team at the conference.

The conference also provided an opportunity for participants to network with engineers, planners, and other professionals involved in pavement management. The focus of the program is on updating pavement management practices to include 21st century techniques. The UD team's poster, "Analysis of NCDOT Pavement Rating and Implementation of New Pavement Rating Method," followed this theme by redesigning the pavement management system currently utilized by NCDOT. The method applies a new pavement rating system, by Reza, Boriboonsomsin, and Bazlamit (2005), that

considers user experience in addition to pavement distresses. User experience, not previously considered in condition ratings, is the number one concern of drivers. By applying this new methodology, project prioritization and implementation would raise user satisfaction on roads.



Rachel Chiquoine with her Pavement Management Challenge at the ICMPA.

Brown Bag Seminars and Webinars

This fall the "Brown Bag" seminars will resume. "Brown Bag" is in quotes because the seminars will be held on Wednesdays from 3:30

to 4:30pm. That would mean a VERY late lunch. However, we will provide drinks and snacks so, look for the announcements. The following three have already been scheduled:

September 23, 2015: Arde Faghri, Ming Li and Kadir Ozden "Satellite Assessment and Monitoring for Pavement Management"

October 14, 2015: Abigail Clarke Sather and Arsha Tabrizi. "Bridge Retrofit or Replacement Decisions: Tools to assess Sustainability and Aid Decision-making"

November 11, 2015: Sue McNeil "Using information at different spatial scales to estimate demand to support asset management decision making."

UD Student Selected as 2015 Eno Fellow

ANDREW WELLS

Andrew Wells (far left), a Masters student in Civil & Environmental Engineering at the University of Delaware, was selected to attend the 2015 Eno Future Leaders Development Conference in Washington, D.C. last month hosted the Eno Center for Transportation. As an Eno Fellow, Andrew met with leaders from across all modes of transportation (including Secretary Foxx, center back row) to discuss the challenges facing the nation's infrastructure and transportation policy in specific. Additionally, he got a behind-the-scenes look at the operations of both DC Union Station and Reagan National Airport. For the past two and a half years, Andrew has been advocating for transportation investment on both the state and the national level. Here, he shares his experience in his own words.

Last month, I had the honor of attending the 2015 Future Leaders Development Conference, organized by the Eno Center for Transportation. Along with 19 other transportation/civil engineering graduate students from across the country, I had the opportunity to interact with industry, government, and policy leaders on a wide array of topics from performance measures to funding to environmental impacts.

The format of the conference was such that each day we would travel to various locations and offices around the Capitol to meet with panels of transportation experts, often times in their own conference rooms. One day we discussed highway policy with agency heads at the USDOT. While there, Secretary Foxx spoke for half an hour and answered questions. Another day we discussed the funding problems facing the Highway Trust Fund in the Dirksen Senate Office Building with congressional staff members. Additionally, we were taken on tours of Reagan National Airport as well as Union Station after discussing air and rail policy.

As someone who is involved in infrastructure policy discussions as an advocate, this conference was a great chance to dig in and engage transportation from a wide range of positions. One of my personal highlights was the high caliber of the other fellows. As a group, we came from a wide range of political backgrounds, regions of the country, research interests, and career goals. Consequently, I was forced to think and learn in ways that I would not have otherwise.

One of the other aspects that I enjoyed was the genuine interest that the panel members took in me and the other fellows. Not only were they happy to speak at the conference, but they were willing to be resources in the future as well.

Overall, this was a great experience. I would recommend that any graduate student interested in transportation policy apply. Not only did it expose me to new ideas, but to people who are moving transportation issues forward. As my career progresses, I know that I will be able to look back on this conference and see its fruits—in fact I already am.



2015 Eno Fellows with U.S. Secretary of Transportation Anthony Foxx

AISIM11

The Annual Interuniversity Symposium on Infrastructure Management (AISIM) is now in its 11th year. This graduate student focused, graduate student organized event is intended to provide a welcoming environment for graduate students working in infrastructure management to present their research, to help students build a network of peers, and to provide graduate students with some experience in organizing a conference. AISIM 2015 was held at the end of the ICMPA (May 22nd) in Alexandria Virginia to leverage the participation of students and faculty. UD students were responsible for the symposium including the program and related events. See <https://sites.google.com/site/aisim11tech/home>

The AISIM11 Organizing Committee members are graduate students from the University of

Delaware pursuing Master's and PhD degrees in Structures, Railroads, Transportation Engineering and Civil Infrastructure systems.

The program had two components. On the Thursday afternoon, ASCE Government Relations and Infrastructure Initiatives staff presented a workshop on Transportation Policy. The workshop gave the participants the opportunity to discuss key issues and provided practical advice for talking with legislative staff members. The policy workshop was followed by a social evening providing an opportunity for students and faculty from participating universities to meet.

The Friday program included eighteen presentations by students from thirteen different universities. Janet Kavinoky, Executive Director, Transportation & Infrastructure and Vice President, Americans for Transportation Mobility Coalition for the US Chamber of Commerce presented the keynote address.

The day concluded with a symposium dinner at which awards were presented. A panel of faculty from three different universities selected the five best presentations. These presenters are invited to participate in a poster session at the January 2016 TRB Annual Meeting sponsored by the Pavement Management and Asset Management Committees. Two UD student presenters were selected for the poster session:

Rachel Chiquoine - Comparison and Analysis of Manual and Automated Pavement Condition Data Collection Methods (Advisor: Sue McNeil)

Silvia Galvan-Nunez - Markov Chain Monte Carlo in Rail Track Defect Analysis (Advisor: Nii Attoh-Okine)

Congratulations to Rachel and Silvia!



AISIM Organizing Committee

From L-R: John Cronin, Matija Radovic, Omar Ghonima, Silvia Galvan Nunez, Hadi Al-Khateeb, Offei Adarkwa, Andrew Wells, Rachel Chiquoine & Emmanuel Martey



Best Presentations at AISIM 11 - Rachel Chiquoine and Silvia Galvana Nunez with Margaret Akofo-Sowah (Georgia Tech), Zaid Alyami (University of Waterloo), and Ross McCarthy (Virginia Tech)

Winner of the School of Public Policy and Administration Marvin B. Sussman Dissertation Prize

Recent Disaster Science and Management PhD graduate Alex Greer was awarded the Sussman prize for his dissertation, "Household Residential Decision-Making in the Wake of Disaster: Cases from Hurricane Sandy." He was also a speaker at the School of Public Policy and Administration's May 30th Convocation. The Marvin B. Sussman Dissertation Prize is awarded annually to the Ph.D. student in the School of Public Policy & Administration whose dissertation is judged to be the most outstanding in its theoretical formulations or empiricism. Two CAIT at UD projects supported this work. The projects are "Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy," and "Using Information at Different Spatial Scales to Estimate Demand to Support Asset Management Decision Making." Alex spearheaded the data collection and analysis effort to develop a picture of the influences on residential housing decisions in Sea Bright, NJ and Oakwood Beach, NY.



Alex Greer at the PhD Hooding with Fellow Graduate Ryan Burke

2015-2016 CAIT at UD Graduate Student Fellowship

Congratulations to Emmanuel Martey! Emmanuel has been awarded the 2015-2016 CAIT at UD graduate student fellowship. The fellowship includes tuition, a stipend plus modest travel and computing resources.

Emmanuel is a second year MS student in the Civil Infrastructure Systems program. Born and raised in New York, Emmanuel's family moved to Ghana where he completed his undergraduate studies in Civil Engineering at the Kwame Nkrumah University of Science & Technology (KNUST) in Kumasi. Emmanuel says "Living in these two distinct places has given me a broader understanding of the various issues affecting



CAIT at UD Fellowship Recipient Emmanuel Martey

infrastructure development and management in both advanced and developing countries and the possible solutions to such predicaments in each setting."

Emmanuel's research focuses on Railroad Tank Car Safety. This has become an issue of great national concern in light of recent high profile rail accidents involving hazardous materials release coupled with the surge in crude oil production and its transportation by rail tank cars in North America. He is utilizing Hybrid Bayesian Network models in the evaluation of the conditional probability of release (CPR) of hazardous chemicals such as crude oil and ethanol given varying railroad tank car safety designs, operating conditions and environmental conditions. This research directly addresses CAIT's focus on state of good repair and safety.

Emmanuel's advisor, Professor Attoh-Okine sees the fellowship as an excellent opportunity for Emmanuel to use his statistical analysis skills and knowledge of transportation infrastructure to address an important national problem.

Highlights from Selected Recent and Ongoing CAIT at UD Tier 1 UTC Projects

CAIT at UD researchers are working on wrapping up the collaborative projects and the projects funded in the second year of the Tier 1 UTC program.

Final Reports

Enhancing Removal in Stormwater Treatment Facilities for Transportation - <http://cait.rutgers.edu/cait/research/collaborative-proposal-enhancing-nitrogen-removal-stormwater-treatment-facilities-tran>

Asphalt : Rheology and Strengthening through Polymer Binders - <http://cait.rutgers.edu/cait/research/asphalt-rheology-and-strengthening-through-polymer-binders>

Publications

Shariati, A., Schumacher, T., and Ramanna, N. (2015). Eulerian-Based Virtual Visual Sensors to Detect Natural Frequencies of Structures. *Journal of Civil Structural Health Monitoring*. Available online first as of June 23. DOI: 10.1007/s13349-015-0128-5.

Conference Papers

Tian, J., Yi, S., Imhoff, P., Chiu, P., Guo, M., Maresca, J., Beneski, V., and Cooksey, S. (2014) Biochar-Amended Media for Enhanced Nutrient Removal in Stormwater Facilities. 2014 World Environmental and Water Resources Congress, pp. 197-208. doi: 10.1061/9780784413548.022.

Shariati, A. and Schumacher, T. (2015). Oversampling in Virtual Visual Sensors as a Means to Recover Higher Modes of Vibration. *AIP Conference Proceedings* (Proceedings of QNDE, Boise, ID, July 20-25, 2014), Vol. 1650, pp. 1717-1724. DOI: 10.1063/1.4914793.

Conference Presentations

5/15- Delaware Center for Transportation Research Showcase, Dover, DE. Poster presentation. "Pilot Demonstration of Enhanced Nitrate Removal

through Incorporation of ZVI and Biochar into a Stormwater Bioretention Cell."

4/15- Shariati, A. and Schumacher, T. (2015). Structural Health Monitoring Using Digital Videos: an Approach Based on Virtual Visual Sensors. SEI-ASCE Structures Congress. Portland, OR. April 23-25.

2/15- Shariati, A. and Schumacher, T. (2015). Video-Based SHM: Research Update. Technical communication during the AFF40(1) committee meeting at the Transportation Research Board (TRB) 94th Annual Meeting, Washington, D.C. January 11-15.

Invited Seminars

4/15- Department of Civil and Environmental Engineering, Penn State University, University Park, PA. "Microbial Nitrate Reduction Promoted by Zero-Valent Iron and Biochar"

3/15- Schumacher, T. (2015). Novel Distributed Sensing Methodologies for NDT and SHM of Bridges. Construction Material Seminar. University of Illinois at Urbana-Champaign, Champaign, IL. March 4. (invited).

2/15- Department of Civil and Environmental Engineering, University of Virginia, Charlottesville, VA. "Microbial Nitrate Reduction Promoted by Zero-Valent Iron and Biochar"

Other Products

Alex Greer. "Household Residential Decision e Sandy." PhD Dissertation, Disaster Science and Management, University of Delaware, May, 2015.

Israt Jahan, "Assessment of Long Term Housing Recovery after Hurricane Sandy," Master of Science, Disaster Science and Management, May 2015.

Investigators Professors Paul Imhoff and Pei Chu have completed the project "Enhancing Removal in Stormwater Treatment Facilities for Transportation." Their project is already having significant impact.

This study produces the knowledge that is necessary to guide future design and implementation of field-scale

stormwater treatment systems. The proposed biochar/zero-valent iron (ZVI) technology represents a promising and sustainable approach to stormwater management. It could reduce the footprint required for stormwater treatment and potentially provide significant savings for state DOTs.

This study also impacts disciplines including environmental engineering and geo-microbiology. It produces empirical evidence to support the underlying hypothesis; i.e., black carbon such as biochar can serve as an electron donor and acceptor to support/enhance microbial transformation reactions. This new finding has important implications for not only stormwater treatment but (bio)remediation of a broad range of contaminants in groundwater and sediment.

This study provided research opportunities for seven (graduate and undergraduate) students in Civil and Environmental Engineering at UD and three summer students from Delaware Technical Community College and the Charter School of Wilmington, all of whom were planning to pursue a degree in engineering. The research experience from this project improved these students' understanding of the stormwater issue and their ability to better address environmental problems in the transportation sector.

The biochar technology has been moving steadily from the laboratory to the field. Based on the theory investigated in this CAIT study, we recently conducted two field tests in a pilot-scale bioretention system located in Newark, DE. We are also assessing the combined effectiveness of ZVI and biochar in a reconstructed, full-scale bioretention cell in Charlottesville, VA. In addition, we recently initiated a field test of biochar amendments to roadway soils in a project supported by the Chesapeake Bay Stewardship Fund and the USEPA. In these projects we are partnering with the Delaware Department of Transportation, the City of Charlottesville, VA, and the University of Virginia. We expect these and subsequent laboratory and field results to further validate the technology and accelerate its field deployment.

Based on the success of the laboratory and field trials to date, the Delaware Department of Transportation has asked the research team to develop design guidelines for including biochar in their existing sand filters that treat urban stormwater runoff.

This is important as high levels of nutrient loading to surface waters is a leading cause of water quality impairment not only in Delaware but in many other parts of the U.S. and the world. With increasing

population, food production and waste discharge, nutrient pollution will likely get worse in the foreseeable future. The proposed technology, which involves beneficial use of waste materials (biochar and ZVI) to

remove both nitrogen and phosphorus, may represent a viable and affordable method to intercept nutrients and protect our precious water resources.

Transportation and Dance at the Council of University Transportation Centers Summer Meeting

Professor Lynnette Overby led a post-lunch dance workshop at the Council of University Transportation Centers (CUTC) summer meeting hosted by CAIT in New Brunswick in June. The CUTC summer meeting brings together faculty and staff from University Transportation Centers all over the country as well state and federal transportation administration to share, learn and network. The meeting includes sessions on administration, technology transfer and other initiatives.

Over the past five years, supported by UTC funding, Professor Overby has worked with interdisciplinary teams of students to introduce transportation concepts to elementary and middle school students through dance. Professor Overby shared the concepts with the participants in workshop and then had them participate in the most active session of the meeting!



Professor Lynnette Overby explains the concepts to participants.



Participants in the CUTC Summer Meeting "Dance" Transportation

Contact Us

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