PROGRAM PROGRESS PERFORMANCE REPORT

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Project Title: Center for Advanced Infrastructure and Transportation (CAIT) National UTC Consortium Led by Rutgers, The State University of New Jersey

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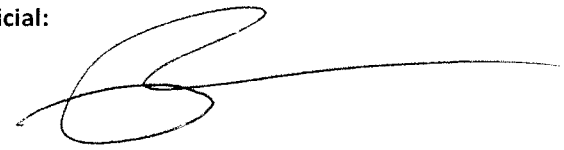


1. ACCOMPLISHMENTS: What was done? What was learned?

What are the major goals of the program?

The major goal of the CAIT National UTC Consortium is to build a program that will: 1) have a sharp focus on maintaining state of good repair of the nation's infrastructure and the interrelated activities of the Secretary of Transportation's strategic goals where the consortium can make significant impacts, and 2) foster intelligent, effective, and meaningful leveraging between institutions and stakeholders to achieve program goals and objectives.

State of Good Repair (SGR) has been identified as the consortium's **primary area of research** and Safety & Economic Competitiveness as secondary areas in which we believe our team's capabilities, resources, past experience, and track record qualify us to make significant impacts toward reaching the goals of the USDOT. To help fulfill these goals and objectives we will:

- **Sharply focus our research portfolio** to make significant and meaningful impacts during the lifetime of the grant. The UTC designation will be a catalyst for generating relevant and sustainable operations that can aid USDOT in fulfilling the objectives of its strategic plan.
- **Develop effective leveraging** with centers of critical mass and establish networks of researchers, laboratories, test-beds, proving grounds, and all other resources necessary to address the objectives of the strategic plan. Through intelligent leveraging, we will minimize potential duplication of effort and promote and encourage meaningful team work and collaboration.
- **Develop and enhance meaningful relationships with local, regional, national, and international stakeholders** to stay abreast of new problems and best practices; work together to address local challenges and needs; and partner in implementing research results and products.

The consortium will cultivate interest in the transportation industry through a comprehensive **education and workforce development program**. The education and workforce goals are to:

- Develop an educational program that will prepare current and future transportation professionals and researchers to be responsive to changes in the transportation field.
- Develop a strong multidisciplinary component that reflects changes in the organizational, intermodal, and global character of transportation, as well as the use of advanced materials and technologies relative to infrastructure.
- Develop educational activities with a focus on K-12 to foster an initial interest in transportation and create opportunities for the students to continue onto other programs, thereby sustaining awareness in transportation careers beyond the initial exposure.

The consortium supports knowledge sharing and is committed to move research results into practice through its **technology transfer initiatives**. The technology transfer goals are to:

- Ensure all research proposals include feasible implementation plans.
- Provide a forum to discuss the state of practice and innovative new technologies that support State of Good Repair, through conferences and symposiums.
- Continuously post reports and research findings in multiple online repositories and clearinghouses, such as the USDOT Research Clusters and CAIT website.

What was accomplished under these goals?

Major Goal Area	Major Activities	Specific Objectives	Significant Results	Key Outcomes
Research	Research Selection	Select projects that make significant and meaningful impacts during the lifetime of the grant	Several new projects have cleared the pre-proposal stage and are now being developed by the PI for full submission and review.	The peer-review panel has reviewed and approved **two new projects during this cycle.**
	Targeted Hits for Modal Parameter Estimation (THMPER™)	This portable bridge evaluation tool that provides faster, cheaper, and less disruptive than conventional methods was created by Dr. Franklin Moon and his research team. THMPER™ could revolutionize how America's 600,000 plus bridges are regularly assessed, rated, and prioritized for repair or replacement. THMPER™'s rapid testing is groundbreaking because it uses three advanced load-capacity estimating methods: modal impact testing, refined analysis and calibration of finite element models, In addition, it is portable, performs the whole operation on site and provides, in just one day, accurate results about how much load a bridge can safely carry. ASCE recognized the value and ingenuity of THMPER™ by awarding it the 2016 Charles Pankow Award for Innovation.		To date, THMPER™ has been used to assess more than 30 bridges in Delaware, Maryland, New Jersey, Pennsylvania, Oregon, and Washington under pilot programs with federal, state, and local transportation agencies.
	Development of accelerated infrastructure testing facility: Bridge Evaluation Accelerated System Testing (BEAST)	Supported by funding from NJDOT, FHWA, and Rutgers, CAIT construct a brand new facility that will create knowledge through UTC research projects and can validate existing research through and facility that will test the effects of heavy loads, extreme temperatures, and active weather on a full-scale concrete bridge deck. To reliably accomplish this, CAIT and its DOT and university partners are constructing the first full-scale accelerated infrastructure testing facility for the evaluation of new and advanced materials and devices: the Bridge Evaluation Using Accelerated System Testing (BEAST) facility. The facility will finally resolve unknown questions about the longevity and performance of preservation treatments and materials exposed to decades of heavy traffic loads and extreme weather patterns. The construction of the facility was completed in May 2015.		BEAST will provide new and valuable information about the longevity and effectiveness of preservation treatments and concrete materials used across the United States. The study will also provide answers about the long-term effects of weight, weather, and temperature variations on bridges in a short period of time.
	Utilization of Pneumatic Flow Tube Mixing	Supported by funding from NJDOT and leveraging our investments in sediment research, this project is going to		The ultimate aim of the project is to determine if

	Technique (PFTM) for Processing and Stabilization of Contaminated Soft Sediments in the NY/NJ Harbor	demonstrate the viability of the Pneumatic Flow Tube Mixing (PFTM) method for the processing and handling of contaminated navigational dredged materials from the NY/NJ harbor complex. The Center for Advanced Infrastructure and Transportation (CAIT) will implement a pilot project at the Koppers Seaboard site, New Jersey. Rutgers Soil and Sediment Management Laboratory in collaboration with international partners will test the raw and amended DM throughout the entire process to initially determine the optimum design of the mix and subsequently monitor the produced amended DM to document the results and quality control parameters. The entire process will be managed by Rutgers CAIT.	Pneumatic Flow Tube Mixing more efficiently achieves structural and environmental properties for amended dredged material while decreasing cost per cubic yard for dredged material amendment and placement than existing methods.

HIGHLIGHTS

Emerging Technologies for Beneficial Reuse of Contaminated Sediments Workshop
In mid-November 2017, Rutgers CAIT hosted a workshop on emerging trends in the management of contaminated sediments. The event was a joint effort with Ramboll Environ, an international environmental, safety, and health sciences consulting firm. People from industry, government agencies, and academia gathered for presentations on the latest advances and to discuss several challenges those working in this field still face.

At the workshop, presentations by CAIT director Dr. Ali Maher, environmental sciences associate professor and CAIT researcher Dr. Robert Miskewitz, and Juha Forsman from Ramboll Finland focused on technological innovations coming to the fore. Maher reviewed state of practice for management of contaminated sediment in North America. Miskewitz highlighted ongoing research by the CAIT Soil and Sediment Management Lab, including a demonstration project implementing and validating the pneumatic tube mixing method (PTM), investigations into solidification/stabilization binder innovations, ex-situ erosion testing (ESTEM), cohesive sediment resuspension, and in-situ metal sensors.

CAIT brought pneumatic tube mixing (PTM) to the United States for the first time and did a pilot project to quantify and validate it as an effective technique for our region. Photo: ©Drew Noel Photography/Rutgers CAIT.

Overall, the workshop was a meaningful and collaborative event aimed to share knowledge and foster enthusiasm for the future of beneficial reuse. It was an opportunity for attendees to share experiences and design solutions across the agency-industry-academic spectrum that contributes to sediment management solutions. The event will potentially be held annually, further connecting CAIT's cutting-edge research with industry and government agency partners.

19th Annual NJDOT Research Showcase Recap

The New Jersey Local Technical Assistance Program (NJLTAP) hosted the NJDOT 19th Annual Research Showcase on October 25 at the Conference Center at Mercer, in West Windsor, NJ. Approximately 250 professionals from NJDOT, FHWA, NJ Transit, New Jersey Motor Vehicle Commission, local government agencies, private industry, and universities attended. NJLTAP offices are based at CAIT. Keynote speaker Jim Shurbutt, exploratory advanced research program coordinator at FHWA Turner-Fairbank Highway Research Center, addressed the theme of the showcase, "The Exploratory Search for Innovation and Mobility." NJDOT Bureau of Research manager Amanda Gendek and David Aimen, assistant director for planning and technical assistance at Rutgers Voorhees Transportation Center, spoke about NJDOT's Innovation Program. The day also featured presentations from other notable speakers: Roger Lall, acting assistant division administrator at FHWA–NJ Division; Mike Russo, assistant commissioner of capital investment, planning, and grant administration for NJDOT; and Bernardo Kleiner, a transportation safety specialist and senior program officer at the Transportation Research Board. The morning plenary session highlighted recent successes of NJDOT's Unmanned Aircraft Systems (UAS) program, including a NJDOT-sponsored UAS peer exchange, led by speaker Glenn Stott, UAS Coordinator, NJDOT. At the end of the morning activities, NJDOT publicly recognized selected research, innovation, and implementation efforts with presentation of the 2017 Outstanding University Student in Transportation Research Award, notable news event recaps & honors NJDOT Research Implementation Award, Best Poster Award, and NJDOT Innovator Award. Also, throughout the day, high traffic in the research poster exhibit highlighted additional research projects and provided an opportunity for students involved in research to share their work. In the afternoon, attendees could choose from a series of breakout sessions on the topics of environment, infrastructure, safety, and intelligent transportation systems. Through these sessions and discussion with other attendees, NJDOT customers learned about ongoing technology transfer activities and academic research being conducted through the NJDOT Bureau of Research by its university research partners and their associates.

ASCE Honors Two CAIT Civil Engineers

The ASCE Central Jersey Branch honored two Rutgers researchers at its annual awards dinner on October 19, held this year at the Forsgate Country Club in Monroe Township. Dr. Franklin Moon, professor of civil and environmental engineering, was chosen as "Educator of the Year." Moon joined the Rutgers School of Engineering in January 2016, but had been a long-time affiliated research partner with CAIT, notably on the FHWA Long-Term Bridge Performance Program. Moon is a widely respected expert in infrastructure performance and vulnerability. He is especially knowledgeable in the areas of sensing technologies, structural identification, structural health monitoring, numerical modeling, and estimation of service life. In 2016 he won the prestigious ASCE Pankow Award for Innovation for a bridge evaluation device he developed with partners at Drexel University and Intelligent Infrastructure Systems. THMPER™, a portable, stand-alone, highly accurate rapid testing device, combines modal impact testing, refined analysis, and finite element model calibration to determine bridge load-bearing capacity. It is a breakthrough because it does this critical task faster, cheaper, and with less traffic disruption than other methods. Moon is a member of the ASCE Industry Leaders Council, Innovation Committee, an associate editor for the ASCE Journal of Structural Engineering, and a council member of the International Society for Structural Health Monitoring of Intelligent Infrastructure. Dr. Mohammad

Jalayer, a CAIT research associate, received the "Young Civil Engineer of the Year Award." Jalayer has more than nine years of experience in traffic engineering and has been deeply involved in research related to traffic operations and safety, intelligent transportation systems (ITS), and access management. He is an associate member of ASCE T&DI Transportation Safety Committees, a member of ITE and ASCE, and friends of TRB standing committees on safety data, analysis, and evaluation; highway safety performance; roadside safety design; access management; and ITS.

Something in the Air

Last December, New Jersey Senate President Stephen Sweeney (D–Gloucester) invited researchers from Rutgers, NJIT, Stevens Institute of Technology, Rowan University, and Stockton University to a roundtable event at the New Jersey State House for the purpose of updating legislators on current drone research and to discuss opportunities for collaboration. Researchers presented examples ranging from emergency communications links for first responders to marketing real estate. At that event, Christopher J. Molloy, Rutgers senior vice president for research and economic development, told the audience, "Rutgers' UAS researchers are developing technologies for a wide range of critical applications and a number that are particularly valuable for New Jersey … to assist with traffic incident management, for coastal research, and for mosquito-control operations." Sweeney pointed out that the use of drones is accelerating, and five New Jersey universities are leading the charge as far as identifying applications for unmanned aerial devices, responding to needs for customized units, and attracting high quality students whose talents can bolster the state's economy. "In a few years [drone technology] is going to be a couple-billion-dollar industry annually, and the best and brightest are getting degrees at Rutgers to stay and work in these fields." He said lawmakers could consider incentives for universities to continue advancing drone technology.

Railroad research, technology development, and teaching are picking up steam at Rutgers

Dr. Xiang Liu, assistant professor in the School of Engineering's (SOE) Department of Civil and Environmental Engineering and a CAIT-affiliated researcher, is putting his energy into expanding rail research and curriculum at Rutgers. At the same time, he is helping railroads do business more safely and efficiently.

His vision for Rutgers includes developing cutting-edge technological solutions for rail owner-operators, while also providing the well-"trained" talent the industry will need in the near future. According to a 2016 Federal Railroad Administration (FRA) report, the industry is experiencing an "exit wave" as its workforce becomes eligible for retirement.

Liu has garnered well-deserved recognition for his work and more than $1 million in research contracts. He is the principal investigator on several research projects encompassing topics pertinent to both freight and passenger rail: asset management, big-data analytics, advanced train control operations (e.g., positive train control), risk analysis, cybersecurity, and digital railways.

Calculating risks of crude oil trains

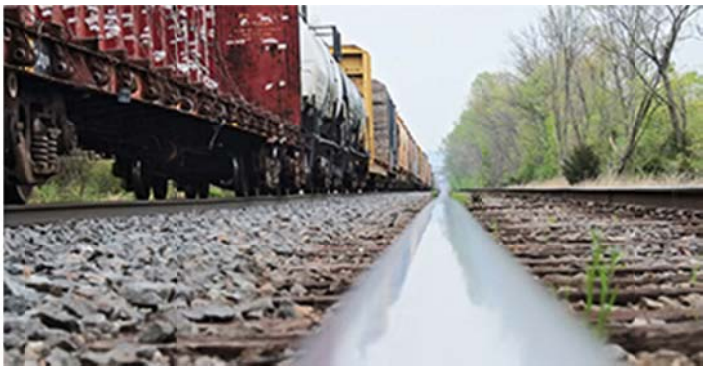
Transporting commodities by rail is about three times more fuel efficient than trucking, and much safer. Still, freight railroads continuously strive to further reduce the number of derailments, especially for trains carrying crude oil or other hazardous materials.

A 2015 derailment near Mt. Carbon, West Virginia, involved 27 crude oil tank cars that released 378,000 gallons of crude oil near the Kanawha River, the source for two counties' drinking water. One home was destroyed and one person was treated for smoke inhalation. Photo: U.S. Coast Guard, Chief Petty Officer Angie Vallier.

A project that CAIT sponsored with UTC funds springboarded Liu's research to develop a systematic, comprehensive methodology for analyzing risk of derailment and the release of hazardous materials that may result. The research he did on the subject earned him the 2017 Outstanding Research Contribution Award from the Transportation Research Board (TRB) Hazardous Materials Transportation Committee, as well as a Young Member Best Paper Award from the TRB Railroad Operational Safety Committee.

In the award-winning paper, Liu presents a practical, data-based probabilistic risk analysis (PRA) model to estimate in-transit risk for crude oil trains. The final product was a computer-aided decision support tool that automatically calculates risk level for variables such as different track types, rolling stock, and operational characteristics. Calculating risk is just one part of railroad safety that Liu is pursuing. Understanding underlying causes of accidents is equally important. Liu found through his earlier research that broken rails have been the leading cause of freight train derailments over the last 10 years.

FRA and railroad operators have a keen interest in anything that will help avoid incidents that have large economic and human impacts. In another FRA project, Liu will develop a framework to help manage the risk associated with broken rails. "The industry can implement proactive, risk-based asset management," Liu explains. "This will be an improvement over a reactive maintenance strategy used in the past."



In another FRA project, Liu will develop a framework to help manage the risk associated with broken rails. Photo ©A. Thomas

Pump the brakes

Another project Liu is working on aims to determine cost/benefit implications for using positive train control (PTC), even when trains are operating at or below restricted speeds. PTC is a sophisticated, intelligent technology designed to automatically stop a train before it derails or crashes. Currently, regulations don't require PTC to be activated while a train is traveling under restricted speeds.

"The impact of PTC on the rail industry is similar to that of connected vehicles on highway. We are stepping into the stage of communications-based digital railways, leading to a new array of questions related to PTC, cybersecurity, and optimal train operations based on this technology."

Delving into historical data on train accidents, the research team will identify those that may have been prevented if restricted-speed PTC was being used, analyze the accidents and resulting property damage, casualties, or other consequences to quantify future accident risk.

The light at the end of the tunnel

AAR estimates that freight loads will nearly double between now and 2035, which backs up Liu's confidence that the industry is both viable and sustainable. "Warren Buffett bought the Burlington Northern Santa Fe railroad a few years ago. He doesn't buy dying companies. And he's conservative," Liu says, and he wants Rutgers to be a driving force for rail in the Northeast Corridor. There's a saying: "I can see the light at the end of the tunnel, but it's an oncoming train." Liu turns that colloquialism on its head. In his mind, that light is the bright future for U.S. railroads, heading straight for us and picking up speed.

Education and Workforce Development	Presented two sessions at the New Jersey State League of Municipalities Conference (November 2017)	Generate knowledge and skills for the municipal and county transportation community	This program promoted a safety culture within the workplace for public agencies.	More than 50 attendees learned about project inspection and ADA compliance for public works projects.
Technology Transfer	CAIT E Newsletter (Next issue to be published May 2018)	Generate knowledge and support research projects and programs that have significant and meaningful impacts.	CAIT recorded and delivered newsworthy items to showcase since January 2016.	Disseminated information about transportation research initiatives, applications, and training opportunities to practicing professionals.
	19th Annual Work Zone Safety Conference (March 2018)	Generate knowledge and support research projects that have significant and meaningful impacts	This conference promotes work zone safety awareness on our local and state roadways to a multi-disciplinary audience of construction, maintenance and operations, and public safety personnel.	A multi-disciplinary audience of transportation professionals were exposed to a variety of work zone safety concerns, and provided with an awareness of the necessity of an effective and safe work zone under this year's theme of "Work Zone Safety: Everybody's Responsibility."
	Hosted ITS NJ Annual Meeting (October 2018)	Support collaborative efforts and technology transfer	This event, co-hosted by CAIT, facilitates communication and generates research collaborations for Intelligent Transportation Systems research.	Disseminated the most current information on ITS practices and plans for the future.
	Tech transfer activities for the National Center for Rural Road Safety	Support collaborative efforts and technology transfer with an impact on rural and local road safety.	As part of the NCRRS consortium, CAIT is leading several Tech Transfer efforts promoting rural and local road safety.	CAIT produced the second and third center Safety Sidekick Newsletter and blog, as well as developed and maintained social media presence.

	Tech transfer for the Northeast Regional Transportation Center	Generate knowledge and support resource sharing transfer for workforce development issues in the NE.	As part of the NETWC team, CAIT is leading the communication efforts for the project and developing and promoting tech transfer events.	CAIT maintains the NETWC website and social media presence.
	Tech transfer talk for the NJ Department of Transportation	Generate knowledge and skills for the state level transportation community	Provided a presentation on non-destructive testing of infrastructure, particularly bridges	40+ attendees from the NJDOT learned about automated condition assessment.
	Rutgers NJ Asphalt Paving Conference (March 2018)	Further the professional and technical expertise of the asphalt paving industry.	As a co-sponsor of the Rutgers Asphalt Paving Conference, CAIT co-chaired and administered the conference planning committee.	Disseminated the most current information on asphalt practices, technologies, specifications, and projects.

What opportunities for training and professional development has the program provided?

This information has been integrated into the table above for the "what was accomplished under these goals?" section. Please see table above.

How have the results been disseminated?

This information has been integrated into the table above for the "what was accomplished under these goals?" section. Please see table above.

What do you plan to do during the next reporting period to accomplish the goals?

- **RESEARCH ACTIVITIES:**
  - **Ongoing Review of Research projects by the Research Advisory Board:** As previously described.
  - **Modify Agreements to Approve expenditure of Research Funds:** No research activities can start until the projects have been reviewed and approved as outlined in the prime proposal submitted to OST-R. CAIT has and will continue to issue modifications to the master agreements with each partner as research projects are approved.
  - **Ongoing Research:** Each of the consortium members will continue to perform SGR oriented research.
- **EDUCATION AND WORKFORCE DEVELOPMENT ACTIVITIES:**
  - Continue planning for the upcoming summer T.A.R.G.E.T. and other K-12 programs to support STEM and workforce development goals for the consortium.
  - Work with partner schools to develop new training seminars based on research.
  - A new Masters student, Ms. Renee Lamprinakos, was hired as a research assistant at the University of Delaware to work on the project entitled "Experimental Evaluation of the engineering behavior of soil-biochar mixture as a roadway construction material." Ms. Lamprinakos started her studies in September 2017 (Fall 2017). She is now in her second semester at UD studying Geotechnical Engineering under the supervision of Dr. Manahiloh.
  - Team members from USU interacted with professionals in a variety of fields who attended the Sustainable Electrified Transportation (SELECT) showcase event which was hosted in

Logan, UT. In this day and a half meeting, the accomplishments and products of the UTC were prominently displayed.

- **TECHNOLOGY TRANSFER ACTIVITIES:**
  - Continue to promote consortium research and applications through vehicles like UTC Spotlight and quarterly newsletter.

2. <u>PRODUCTS</u>: What has the program produced?

Research projects awarded:

The Research Advisory Board has reviewed two new research projects during this cycle.

Publications, conference papers, and presentations

Journal publications.

- ASCE Civil Engineering Magazine news article, "Adding Biochar to Soils beside Highways Could Reduce Runoff, Report Says" by Jay Landers, Contributing Editor; ASCE, ASCE World Headquarters, 1801 Alexander Bell Drive, Reston, VA, Serial Information: Issue 1, Pg. 31-32, 2018.
- Luong, T. D., Tahlyan, D., Pinjari, A. R., 2018. Comprehensive Exploratory Analysis of Truck Route Choice Diversity in Florida. Paper presented at 97th Annual Meeting of Transportation Research Board, Washington D.C. Accepted for publication in Transportation Research Record: Journal of the Transportation Research Board.
- Tahlyan, D., Pinjari, A. R., 2018. Performance Evaluation of Choice Set Generation Algorithms for Modeling Truck Route Choice: Insights from Large Streams of Truck-GPS Data. Paper presented at 97th Annual Meeting of Transportation Research Board, Washington D.C. Under review for publication consideration in Transportation Research Part C.
- Dorafshan, S. Thomas, R., Maguire, M. "Edge detector comparison for UAS collected concrete crack images" Journal of Advanced Concrete Technology. Submitted in March 2018.
- Dorafshan, S., Maguire, M. "Bridge Inspection and Unmanned Aerial Vehicles: A State-of-the-Art Review" Journal of Civil Structural Health Monitoring. Springer. Submitted October 2017. Second Review.
- Dorafshan, S., Thomas, R., Maguire, M. "UAS Fatigue Crack Detection" ASCE Journal of Bridge Engineering. Submitted October 2017. Revise for editor only.
- Quezada, I., Thomas, R. J., Maguire, M. "Internal curing to mitigate cracking in rapid set repair media" Special Issue on Internal Curing. Advances in Civil Engineering Materials. American Society of Testing and Materials. Submitted December 2017, Second Review.
- 5. Thomas, R., Maguire, M., Sorensen, A. Quezada, I. (2018) "Calcium Sulfo-Aluminate Cement" Concrete International.

Books or other non-periodical, one-time publications.

"Nothing to Report"

Other publications, conference papers and presentations.

- Abera, K., Manahiloh, K.N., and Motalleb Nejad, M. (2018). "Global Segmentation Algorithm for Partially Saturated Granular Geomaterials." IFCEE 2018, March 5 – 10, Orlando, FL.
- Abera, K., Manahiloh, K.N., and Motalleb Nejad, M. (2018). "Global Segmentation Algorithm for Partially Saturated Granular Geomaterials." IFCEE 2018, March 5 – 10, Orlando, FL.
- Talebi, M., Meehan, C. L., and Poggiogalle, T. M. (2018). "Strain in a GRS Bridge Abutment: Strain Gauge Attachment Techniques, Performance and Survivability During Construction

and Operation." Proc., IFCEE 2018: International Foundations Congress and Equipment Expo, Orlando, FL, March 5-10, 2018, ASCE, Reston, VA.

- Christine Chapman, Seyyedaliakbar Nakhli, Joseph Brown, Julia A. Maresca, Paul T. Imhoff. Biochar Amendment to Roadway Soils for Stormwater Treatment – Role of Soil Aggregation. DENIN Graduate Research Symposium, March 15, 2018. (Poster Presentation)
- Imhoff, P.T. ,Brown, J.D., Panta, S., Nakhli, S., Chapman, C., Yan, Y., Saquing, J., Chiu, P., Maresca, J., Hegberg, C., and L. Trout (2018) Reducing Roadway Runoff Volume & Nutrient Load with Biochar, 2018 Transportation Research Board Annual Meeting, January, Washington, DC (INVITED)
- Lamprinakos, R., Manahiloh, K.N. (2018) "Effect of biochar on geotechnical properties of soils." ASCE Delaware valley Geotechnical Institute, March 15, Villanova, PA. (Poster)
- Lamprinakos, R., Manahiloh, K.N. (2018) "Examining the behavior of compacted soil-biochar specimens." ASCE Delaware valley Geotechnical Institute, March 15, Villanova, PA. (Poster).
- Meehan, C. L. (2018). "Rapid Bridge Replacement: Construction and Performance Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System." ASME & ASCE DE Sections – Joint Meeting, University of Delaware, Newark, DE, 4/4/18.
- Meehan, C. L. and Poggiogalle, T. M. (2017). "Long-Term Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)" Report of the Department of Civil & Environmental Engineering, University of Delaware, Newark, DE, November 2017, 139 pp.
- Meehan, C. L., Poggiogalle, T. M., and Talebi, M. (2018). "Construction and Performance Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System." Delaware Department of Transportation, Dover, DE, 3/13/18.
- Poggiogalle, T. M., Meehan, C. L., and Talebi, M. (2018). "Changes in Temperature Distribution in a Geosynthetic Reinforced Soil Bridge Abutment." Delaware Valley Geo-Institute Meeting, Villanova University, Villanova, PA, 3/15/18, (poster presentation).
- Poggiogalle, T. M., Meehan, C. L., and Talebi, M. (2018). "Live Load Testing of a Geosynthetic Reinforced Soil Bridge Abutment." Delaware Valley Geo-Institute Meeting, Villanova University, Villanova, PA, 3/15/18, (poster presentation).
- Poggiogalle, T. M., Talebi, M., and Meehan, C. L. (2018). "Changes in Temperature Distribution in a Geosynthetic Reinforced Soil Abutment and Their Effect on Measured Strain." Proc., IFCEE 2018: International Foundations Congress and Equipment Expo, Orlando, FL, March 5-10, 2018, ASCE, Reston, VA.
- Tahlyan, D., Pinjari, A. R., 2017. Performance Evaluation of Choice Set Generation Algorithms for Modeling Truck Route Choice: Insights from Large Streams of Truck-GPS Data. Paper presented at 4th Conference of Transportation Research Group, Mumbai, India.
- Tahlyan, D., Pinjari, A. R., 2017. Performance Evaluation of Choice Set Generation Algorithms for Modeling Truck Route Choice: Insights from Large Streams of Truck-GPS Data. Paper presented at 5th Annual UTC Conference for the Southeastern Region, Gainesville, FL.
- Zolghadri, N., M.W. Halling (2018). Using Statistical Indicators for Condition Assessment of Bridge Structures. TRB Testing and NDE of Transportation Structures Committee (AFF40), Washington D. C., Jan 2018. (Oral Presentation).
- J. Ward, M. Magee, C. Roberts-Wollmann and T. Cousins, "Carbon Fiber Reinforced Polymer Grids for Shear and End Zone Reinforcement in Bridge Beams", final project report VTRC 18-R17, Virginia Transportation Research Center, Charlottesville, VA, January 2018, 73 pages.
- Xue, W., Flintsch, G., Diefenderfer, B., and Bowers, B., "Evaluation of Cold Central-Plant Recycling (CCPR) Technique Using Full-Scale Accelerated Pavement Testing," final project

report Center for Sustainable Transportation Infrastructure, Blacksburg, VA, December 2017, 16 pages.

- C. Zimmerman, "Effect of Loading Conditions on the Magnitude and Variation of Pavement Responses in Accelerated Loading Testing," International Conference on Highway Pavements and Airfield Technology 2017, August 27–30, 2017, Philadelphia, Pennsylvania.

Website(s) or other Internet site(s)

CAIT has established two internet sites:

- http://cait.rutgers.edu/cait/research to disseminate research results
- http://cait.rutgers.edu/cait/program-sites to inform about consortium program activities

Technologies or techniques

- CAIT and multiple DOT and university partners are creating the nation's first full-scale accelerated bridge deck testing facility in Piscataway, New Jersey. This facility, called the Bridge Evaluation Using Accelerated System Testing (BEAST), will test the effects of many years of heavy loads and extreme temperature and weather patterns on a full-scale concrete bridge deck over a short period of time. To leave the experiments undisturbed, observations will be recorded using a 24-hour closed circuit video recording system. The results of the study will give bridge engineers valuable new information about the longevity of preservation treatments and concrete materials that can be incorporated into future bridge repair and construction projects. Recently, the testing facility has been completed, and CAIT and its partners are working toward developing the first bridge deck sample for testing in the BEAST facility.
- For the Speaker Recognition Based Damage Detection project, Columbia University has followed two main directions of research. First, the study of the use of Cepstral Coefficients for assessing the presence of structural damage has looked at structural models that could represent bridge structures. In particular, special consideration has been given to the effect of the temperature on the Cepstral Coefficients and how they perform in the presence of temperature variations and damage. To assess these effects, a technique called Co-Integration has been tested on measurements obtained from the Z-24 bridge in Switzerland. In addition, a different methodology has been developed that focuses on the use of Artificial Neural Network to create a model that can be used for damage detection using only the output measurements.
- The UTEP team working on research project "Evaluating Corrosivity of Geomaterials in MSE walls: Determination of Resistivity from Pore Water Chemistry" has developed a spreadsheet model to predict the electrical conductivity of a soil-water leachate as a function of the concentrations of chloride, sulfate, and alkalinity. The electrical conductivity of the leachate is an indicator for the rate of corrosion in metal reinforcements in mechanically stabilized earthen (MSE) walls. A journal manuscript will be submitted for review this summer.

Inventions, patent applications, and/or licenses

"Nothing to Report"

Other products: outreach activities, courses and workshops

- CAIT co-hosted the ITSNJ Annual Meeting (October 2018). The purpose of this event was to disseminate the most current information on IRS practices and plans for the future.
- CAIT organized the 19th Annual Work Zone Safety Conference (March 2018) to promote work zone safety awareness on our local and state roadways to a multi-disciplinary audience of construction, maintenance and operations, and public safety personnel. This year's theme was "Work Zone Safety: Everybody's Responsibility."

- CAIT and other transportation experts, advocates, and industry people were invited to the New Jersey Assembly Transportation and Independent Authorities Committee meeting of the 2018–2019 legislative session. This was done under the leadership of its new chair, Assemblyman Daniel R. Benson and vice chair Patricia Egan Jones to share their expertise and knowledge on pressing issues. Dr. Franklin Moon, School of Engineering professor of civil and environmental engineering and a CAIT researcher, covered several salient points in his testimony, among them the particular strain on New Jersey infrastructure. Another issue Moon addressed was the need for our infrastructure to be made to last as well as more resilient as we face more extreme weather, but also accounting for "routine" flooding we are experiencing more and more frequently. CAIT director Ali Maher also spoke before the committee. He focused his testimony on the crisis facing NJ Transit. "NJ Transit is facing a multitude of challenges in operating safely and reliably and doing what is necessary to keep the system in [good working order.] Both professors encouraged lawmakers to view higher education institutions as a key partner and a resource for training the current workforce on emerging tools and practices and for creating "next gen" technologies that improve durability, performance, and economics whether it's preserving the assets we have or those we build going forward.

3. <u>PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS</u>:

What individuals have worked on the program?

Program Director: Dr. Ali Maher

Project Directors: Dr. Sue McNeil (University of Delaware), Dr. Marvin Halling (Utah State University), Dr. Raimondo Betti (Columbia University), Dr. Lazar N. Spasovic (NJIT), Dr. Branko Glisic (Princeton University), Dr. Abdul R. Pinjari (University of South Florida), Dr. Soheil Nazarian (University of Texas at El Paso, Dr. Carin Roberts-Wollmann and Dr. Gerardo Flintsch (Virginia Polytechnic Institute).

Consortium Universities Involved:

Rutgers, The State University of New Jersey (Lead)
University of Delaware, Newark, DE
Utah State University, Logan, UT
Columbia University, New York, NY
New Jersey Institute of Technology, Newark, NJ
Princeton University, Princeton, NJ
University of Texas, El Paso, TX
University of South Florida, Tampa, FL
Virginia Polytechnic Institute, Blacksburg, VA

What other organizations have been involved as partners?

The consortium has collaborated with a number of external agencies across the United States:

New Jersey Department of Transportation	Trenton, NJ	Financial support and collaborative research on multiple projects, including ITS research and a time-accelerated infrastructure testing facility that will simulate extreme loads and environmental conditions in on a real bridge deck
Virginia Department of Transportation Virginia Center for Transportation Innovation and Research (VCTIR)	Richmond, VA	Collaborative research on multiple projects, including a time-accelerated infrastructure testing facility that will simulate extreme loads and environmental conditions in on a real bridge deck

Applied Research Associates, Inc.	Panama City, FL	Collaborative research on multiple projects, including a time-accelerated infrastructure testing facility that will simulate extreme loads and environmental conditions in on a real bridge deck
Drexel University	Philadelphia, PA	Collaborative research on multiple projects, including a time-accelerated infrastructure testing facility that will simulate extreme loads and environmental conditions in on a real bridge deck
ITS New Jersey (a state chapter of ITS America)	Trenton, NJ	Collaborative research and personnel exchanges for workshops, meetings, and conferences on ITS research
Parsons Brinckerhoff	New York, NY	Collaborative research and support on a number of research and technology transfer activities, including workshops, meetings, and conferences on ITS research
New Jersey Asphalt Paving Association	Trenton, NJ	Personnel resources, knowledge exchange, and technology transfer collaboration for annual paving conference
New Jersey metropolitan planning organizations (NJTPA, Delaware Valley Regional Planning Commission, and SJTPO)	Newark, NJ; Philadelphia, PA; Vineland, NJ	Collaborative research and knowledge exchange for freight advisory committee and other improvement task forces and projects
New York State Department of Transportation	Albany, NY	Personnel resources, knowledge exchange
Maryland State Highway Agency	Baltimore, MD	Personnel resources, knowledge exchange
Utah Department of Transportation	Salt Lake City, UT	Personnel resources, knowledge exchange, financial support
Idaho Department of Transportation	Boise, ID	Personnel resources, knowledge exchange, financial support
American Aerospace Technologies, Inc.	Bridgeport, PA	Personnel resources, knowledge exchange
University of Vermont	Burlington, VT	Collaborative research and partnership in the Northeast Regional Surface Transportation Workforce Center
Montana State University	Bozeman, MT	Collaborative research and partnership in the development of the National Center for Excellence in Roadway Safety
Clean Earth Dredging Technologies Inc.	Jersey City, NJ	Collaborative research, personnel exchange
JAFEC USA Inc.	San Jose, CA	Collaborative research, personnel exchange
ArtsBridge	Newark, DE	Collaborative research, personnel exchange
Cape May County	Cape May, NJ	Collaborative research on technology transfer events.
Delaware River Bay Authority	New Castle, DE	Collaborative research on technology transfer events.
MAGTUG	MidAtlantic	Served as a partner in delivering one-day meeting, helped with contacts, logistical support
Delaware T^2/LTAP	Newark, DE	Served as partner in delivering one-day meeting, helped with contacts and logistical support
Florida Department of Transportation	Tallahassee, FL	Financial support, knowledge exchange
Florida DOT District 7 office	Tampa, Florida	Financial support, knowledge exchange
Delaware Department of Transportation	Dover, DE	Collaborative research and financial support
National Cooperative Highway Research Program (NCHRP)	Washington, D.C.	Financial Support

McMahon & Mann Consulting Engineers, PC	Buffalo, NY	Collaborative research
University of Texas at Austin	Austin, TX	Collaborative research
American Transportation Research Institute (ATRI)	USA	Provided large streams of valuable GPS data on truck-movements in Tampa region.
Clemson University	Clemson, SC	Collaborative research
McMahon & Mann Consulting Engineers, PC	Buffalo, NY	Collaborative research

Have other collaborators or contacts been involved?

- **collaborations with others within the lead or partner universities; especially interdepartmental or interdisciplinary collaborations**

Partner Meeting/Communication: The UTC partners communicated regularly throughout this reporting period.

Research Collaborations: The research selection process will yield many collaborative proposals to perform joint research with partners.

Ongoing collaborations for this reporting period include:

Accelerated Infrastructure Testing Facility: Bridge Evaluation Using Accelerated System Testing (BEAST)	• Utah State University • University of Delaware • NJDOT • VDOT • Applied Research Associates • Drexel University	The consortium created a working group to exchange ideas and knowledge about the construction of a massive, time-compressed facility that will study the effects of extreme weather and temperatures on real concrete bridge decks.

- **collaborations or contacts with others outside the UTC**

Multiple DOT and University Partners

Additional ongoing collaborations include:

Northeast Regional Surface Transportation Workforce Center	• University of Vermont • CAIT	The objective of the new center is to forge relationships between private and public transportation agencies and an extensive network of education, labor, and workforce enrichment organizations to develop programs, resources, and opportunities aiming to prepare future transportation workers and provide current transportation workers with chances for career development.
National Center for Excellence in Roadway Safety	• Western Transportation Institute at Montana State University • CAIT	The center will offer training, technical support, and easily accessible information to transportation practitioners around the country, and provide national leadership in finding solutions to critical safety issues, especially on rural roads.

- **collaborations or contacts with others outside the United States or with an international organization (country(ies) of collaborations or contacts).**

University of Delaware presentations based on finding from the project "The Connection Between State of Good Repair and Resilience: Measures for Pavements and Bridges" have led to an emerging collaboration with the American Society of Civil Engineers Infrastructure Resilience Division (IRD) and the Japanese Society of Civil Engineers (JSCE) and the project team. The focus is on how to operationalize the concept of resilience for practitioners. The IRD is particularly interested in integrating resilience into design and the JSCE has a long history of developing design standards that integrate resilience to earthquakes.

Previously reported collaboration currently ongoing:
The Tokyo Institute of Technology is a research collaborator on the project titled "Utilization of Pneumatic Flow Tube Mixing Technique (PFTM) for Processing and Stabilization of Contaminated Soft Sediments in the NY/NJ Harbor"

4. IMPACT: What is the impact of the program? How has it contributed to transportation education, research and technology transfer?

The consortium's research activities and conclusions will be made available through workforce development and technology transfer efforts and reach over 12,000 transportation professionals nationwide, including consortium members, external university partners, government officials, and private industry partners.

What is the impact on the development of the principal discipline(s) of the program?

PROJECTS SELECTED DURING CURRENT REPORTING PERIOD

Outputs	Expected Outcomes	Impacts
"Bond Performance of 1.125 Inch Diameter Prestressing Strands" (Utah State University)	This project could result in a training program for engineers regarding the best practices of how to implement UAS into their interchange inspections. It could provide additional information regarding flight planning, image distances, sensor types, altitude, and safe distances necessary for a safe and productive inspection.	This research could lead to additional projects in identifying and developing best practices for other types of infrastructure assets. This could include utilizing UAS for traffic monitoring, highway inspections, bridge inspections, railway inspections, and other transportation assets.
"Residual Capacity of Impacted Bridge Piers" (Utah State University)	The objective of this research project is to develop an easy to use, relatively inexpensive laboratory test and equipment to determine potential concrete mixture incompatibilities among the sulfate system, mineral and chemical admixtures.	It is the desire of the research team that the resulting test method to be practical enough so that it can be performed, ideally by the concrete producers, but also by a district laboratory during the mix design process.

ONGOING RESEARCH PROJECTS DURING CURRENT REPORTING PERIOD

Outputs	Expected Outcomes	Impacts
"Utilizing Unmanned Aircraft Systems for Infrastructure Management" (Rutgers University)	This project could result in a training program for engineers regarding the best practices of how to implement UAS into their interchange inspections. It could provide additional information regarding flight planning, image distances, sensor types, altitude, and safe distances necessary for a safe and productive inspection.	This research could lead to additional projects in identifying and developing best practices for other types of infrastructure assets. This could include utilizing UAS for traffic monitoring, highway inspections, bridge inspections, railway inspections, and other transportation assets.
"New Methodology for Evaluating Incompatibility of Concrete Mixes in	The objective of this research project is to develop an easy to use, relatively inexpensive laboratory test and equipment to determine	It is the desire of the research team that the resulting test method to be practical enough so that it can be performed, ideally by the concrete

Laboratory: A Feasibility Study" (University of Texas at El Paso)	potential concrete mixture incompatibilities among the sulfate system, mineral and chemical admixtures.	producers, but also by a district laboratory during the mix design process.
"Evaluating Corrosivity of Geomaterials in MSE Walls: Determination of Resistivity from Power Water Chemistry" (University of Texas at El Paso)	The goal of this research is to develop a fundamentals-based model for calculating the electrical conductivity of pore water and moist soil. These models would allow evaluators to confidently judge the corrosivity of a geomaterial based on pore water chemistry.	This research will also allow the development of rigorous acceptance criteria for MSE backfill materials, and these acceptance criteria will be implemented in state and national protocols.
"Development of a Robust Framework for Assessing Bridge Performance using a Multiple Model Approach" (University of Texas at El Paso)	The primary product from this research is a robust, flexible framework to integrating disparate quantitative data sources on bridge performance using non physics-based models to provide reliable assessment and performance forecasting. This framework would be flexible in that it can readily integrate new data sources and multiple model forms if needed.	The proposed framework will be valuable not only for management decision-making for bridge owners at the state DOT level, but will also be valuable for research efforts into predictions of bridge performance. Adoption of the approach by state DOTs is dependent on showing value, and integrating smoothly with their existing management workflow.
"Experimental Evaluation of the Engineering Behavior of Soil-biochar Mixture as a Roadway Construction Material" (University of Delaware)	The objective of this work is to advance a fundamental and mechanistic understanding of biochar's influence on soil strength-, deformation-, and flow-behaviors.	The long-term outcomes will impact some important policies and products that have practical significance to local and federal agencies that constantly deal with road-construction materials. The PI identifies Delaware Department of Transportation as the primary external client.
"Sustainable Geotextiles for Transportation Applications from Recycled Textiles" (University of Delaware)	The goal of this project is to explore the use of waste stream textiles as potential replacements for engineered geosynthetics in various transportation applications.	Collaborations with Goodwill of Delaware and Delaware County's Recycled Goods Manufacturing Initiative and SMART (Secondary Materials and Recycled Textiles) Industry Association will be established in order to disseminate research results and to interest recycled textile manufactures in exploring producing of a new product, geotextiles from waste stream textiles.
"Reducing Stormwater Runoff Volumes with Biochar Addition to Highway Soils" (University of Delaware)	The goal of this proposed research is to test the hypothesis that biochar addition to highway soils increases water infiltration, thus reducing stormwater runoff volume for treatment. Further, we hypothesize that biochar increases water infiltration through a multistep process: microbial populations are altered and increase, these population generate more extrapolymeric substances (EPS) that "glue" soil particles into aggregates, and soil aggregates increase	The research proposed here will advance a new and environmentally sustainable stormwater technology that can potentially help the USDOT meet the challenges of nutrient reduction in stormwater volume with at reduced costs. Results of this research will have important implications for the design, maintenance, and long-term performance of stormwater treatment systems containing biochar.

	preferential water flow and thus water infiltration.	
"Collaborative Proposal: The Connection Between State of Good Repair and Resilience: Measures for Pavements and Bridges" (Delaware, Virginia Tech, and Rutgers)	The goal of this research is to demonstrate the relationships among the concepts of resilience, other performance measures particularly related to state of good repair, and decisions related to improvement of pavements and bridges.	This research is most likely to inform policy and decision making. We will work with our clients at DelDOT and NJDOT to explore these ideas and present them in a form of value to DOTs.
"National University Transportation Consortium: A Speaker Recognition Based Damage Detection" (Columbia University)	In this proposal, we intend to cast the SHM problem within a statistical pattern recognition framework. It is an approach only based on data recorded during regular service operation and relies on the use of dense sensor arrays. With properly defined "damage sensitive features" (dsf), it would be possible to correlate these features from a dense array of data sets and establish their correlations. By looking at the variation in time of such correlations, it would be possible to learn about the regular operation of the bridge and determine events when damage has occurred.	The advances in computer and sensor technologies are pushing many areas (including structural health monitoring of civil structures) towards a greater use of measurement data, machine learning and statistical tools. This project will build on the results of a previous project and will continue the effort to extend to the diagnosis of the health of bridges and buildings methodologies that are currently used in other sectors of our society (e.g. bank security). If successful, it will represent a breakthrough in the way bridge inspections will be conducted in the future.

PROJECTS COMPLETED DURING CURRENT REPORTING PERIOD

- "Long-Term Evaluation of Prestress Losses in Concrete Bridges using Long-Gauge Fiber Optic Sensors" (Princeton University)
- "Refined Load Rating through Rapid Modal Testing" (Rutgers University)
- "Evaluating Electrical Resistivity as a Performance based Test for Utah Bridge Deck Concrete" (Utah State University)
- "Prediction of Hydroplaning Risk of Trucks on Roadways" (Rutgers University)
- "Developing a Low Shrinkage, High Creep Concrete for Infrastructure Repair" (Utah State University)
- "Unmanned Aerial Vehicle Augmented Bridge Inspection Feasibility Study" (Utah State University)

Projects Previously Reported Completed:

- "Optimization of Pavement Surface Characteristics" (Virginia Tech)
- "Satellite Assessment and Monitoring for Pavement Management" (University of Delaware)
- "Methodological Framework for Optimal Truck Highway Parking Location and Capacity Expansion" (Rutgers University)
- "Development of a Risk Assessment Tool for Rail Transport of Flammable Energy Resources" (Rutgers University)
- "Bridge Health Monitoring using a Machine-Learning Strategy" (Columbia University)
- "Arrangement of sensors and Probability of Detection for Sensing Sheets Based on Large -area Electronics for Reliable Structural Health Monitoring" (Princeton University)
- "Bridge Retrofit or Replacement Decisions: Tools to Assess Sustainability and Aid Decision-making" (University of Delaware)
- "Using Information at Different Spatial Scales to Estimate Demand to Support Asset Management Decision Making" (University of Delaware)
- "Load Testing and Analysis of 48 year old out-of-service Double Tee Girder Bridge" (Utah State University)
- "Carbon Fiber Shear Reinforcement for Prestressed Bridge Girders" (Virginia Tech)

- "Development of Concrete Mix Proportions for Minimizing/Eliminating Shrinkage Cracks in Slabs and High Performance Grouts" (Rutgers University)
- "Port Authority of New York and New Jersey Resiliency Initiative" (Rutgers University)
- "A Study on 3D Printing and its Effects on the Future of Transportation" Rutgers University)
- "Live-Load Testing and Finite-Element Modeling of a Fracture Critical Bridge" (Utah State University)
- "Unmanned Aerial Vehicle (UAV) based Traffic Monitoring and Management" (Rutgers University)
- "Initial Evaluation of the Albedo and Solar-Radiation Flux of Asphalt Pavements" (Rutgers University)
- "Long-Term Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)" (University of Delaware)
- "Development of Protocols and Instrumentation Plan for Accelerated Structural Testing Facility" (Rutgers University)
- "Dynamic Effects and Friction Values of Bridge Moves for ABC Bridges" (Utah State University)
- "Piezoelectric Energy Harvesting in Airport Pavement" (Rutgers University)
- "Modeling the Impacts of Changes in Freight Demand, Infrastructure Improvements and Policy Measures on a Metropolitan Region" (NJIT)
- "Multi-Scale Condition and Structural Analysis of Steel Bridge Infrastructure" (University of Delaware)
- "Lean Construction Applications for Bridge Inspection" (University of Delaware)
- "Development & Implementation of NJ TRANSIT's Access Link Program" (Rutgers University)
- "The Hudson River Rail Tunnel Like Study" (Rutgers University)
- "Improving the Durability of the Inverted T-Beam Bridge System" (Virginia Tech)
- "Characterization and Modeling of Recycled Pavement Sections" (Virginia Tech)
- "Infrastructure Issues Related to In-Motion Electric Wireless Power Transfer" (Utah State University)
- "Truck Route Choice Modeling Using Large Streams of GPS Data" (University of South Florida)
- "Installation of Embedded Accelerometers in Precast Girders for the Nibley Utah Bridge" (Utah State University)
- "Installation of Thermocouples, and Analysis of Temperature Data from the 21st South Bridge" (Utah State University)
- "Investigating the effects of corrosion protection coatings on the ductility of welded wire reinforcement" (Utah State University)
- "The Impact of Tolls on Access and Travel Patterns of Different Socioeconomic Groups: A Study for the Greater New York Metropolitan Area" (Rutgers University)
- "Ultra-Compact and Rugged Electrochemical Sensor for Monitoring Toxic Metals in Natural Water Sources" (Rutgers University)

What is the impact on other disciplines?

Previously Report Impacts on other disciplines:

"Sustainable Geotextiles for Transportation Applications from Recycled Textiles" (University of Delaware)	Geosynthetic fabrics and fibers are used in a wide variety of transportation applications including: silt fencing; soil stabilization of base and subbase layers; construction of reinforced earth retaining structures, stabilizing poor quality soils, and fiber-cement applications. Traditional geosynthetic fabrics and fibers are engineered with specific performance applications in mind but with a relatively high material cost. Apparel and home textiles are routinely landfilled, representing a large waste stream that is increasing drastically in volume. This waste stream is a potential feedstock that could improve the sustainability and reduce the cost of geotextiles/geosynthetics for a wide variety of transportation applications.

What is the impact on the development of transportation workforce development?

It is anticipated that research projects will lead to the adoption of new practices, policies, or methods that will be disseminated to the transportation workforce through training. These training events will enhance the transportation industry through the creation of new career paths and an industrywide understanding of best practices and the USDOT state-of-good-repair mission. The partners have

employed Post-doctoral researchers, PhD, MS, and undergraduate students on almost all of the research projects. These students will graduate and many will become leaders in the transportation industry of the future. Also, the opportunity for the undergraduates to participate in these innovative projects encourages them to progress and pursue advanced degrees themselves.

What is the impact on physical, institutional, and information resources at the university or other partner institutions?

It is anticipated that CAIT and its partners will share personnel and technological resources to streamline research, workforce development, and technology transfer efforts. For example, the UTC funding has resulted in a direct impact on the quality of both the graduate and undergraduate programs in Civil Engineering at Utah State University. The impact has been felt probably most markedly in the discipline of Structural Engineering and Bridge Engineering. There has been a steady flow of both PhD and Masters students that have participated in UTC projects due to the existence and activity of the Center. In addition, state and private funding sources have increased due to the opportunities to match funding which results in a beneficial relationship and leveraging of funds for all parties involved.

What is the impact on technology transfer?

It is anticipated that research projects will lead to the adoption of new or more efficient practices or inform policy. For example, the research team at the University of South Florida developed improved methods for analysis and forecasting of truck route choice expected to lead to improvements in travel conditions for freight movement.

What is the impact on society beyond science and technology?

Workshops and conferences on advanced technologies, materials, and best practices will lead to the maintenance and construction of intelligent, resilient infrastructure systems that enhance commercial vitality and improve the safety, security, and quality of life for Americans who depend on them. For example, the project on electric wireless power transfer will have an impact on all the traveling public and the way the future of transportation looks. In addition, the reduction of emissions and the positive effects on the urban environment will affect the overall population in many ways.

5. CHANGES/PROBLEMS

Changes in approach and reasons for change

"Nothing to Report"

Actual or anticipated problems or delays and actions or plans to resolve them

"Nothing to Report"

Changes that have a significant impact on expenditures

"Nothing to Report"

Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

"Nothing to Report"

Change of primary performance site location from that originally proposed

"Nothing to Report"

6. SPECIAL REPORTING REQUIREMENTS

"Nothing to Report"