

PROGRAM PROGRESS PERFORMANCE REPORT

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Federal Grant Number: DTRT13-G-UTC28

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

Center Director Name, Dr. Ali Maher, CAIT Director. **E-mail address:** mmaher@rci.rutgers.edu **Phone number:** 848-445-2951

Name of Submitting Official, Title, and Contact Information (e-mail address and phone number), if other than PD: Dr. Patrick Szary, CAIT Associate Director. **E-mail address:** szary@rci.rutgers.edu **Phone number:** 848-445-2999

Recipient Organization (Name and Address): Rutgers, The State University of New Jersey, Center for Advanced Infrastructure and Transportation, 100 Brett Road, Piscataway, NJ 08854-8058

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Signature of Submitting Official:



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 already reviewed and approved two research projects .
	Development of accelerated infrastructure testing facility: Bridge Evaluation Using Accelerated System Testing (BEAST)	Construct a brand new facility that will generate new knowledge 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. Developing reliable performance models for early detection and intervention technologies requires an understanding of the deterioration process—and its root causes— on bridge decks; BEAST will use innovative mechanisms to simulate 25 years of temperature cycles, freeze-thaw, applications of deicing chemicals, bridge materials, coating systems, and repetitive live load actions on a full-scale concrete bridge deck in a fraction of that time. Without distorting their effects, 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 Technique (PFTM) for Processing and Stabilization of Contaminated Soft Sediments in the NY/NJ Harbor	Supported by funding from NJDOT and leveraging our investments in sediment research, this project is going to 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		The ultimate aim of the project is to determine if Pneumatic Flow Tube Mixing more efficiently achieves structural and environmental properties for

		<p>(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.</p>
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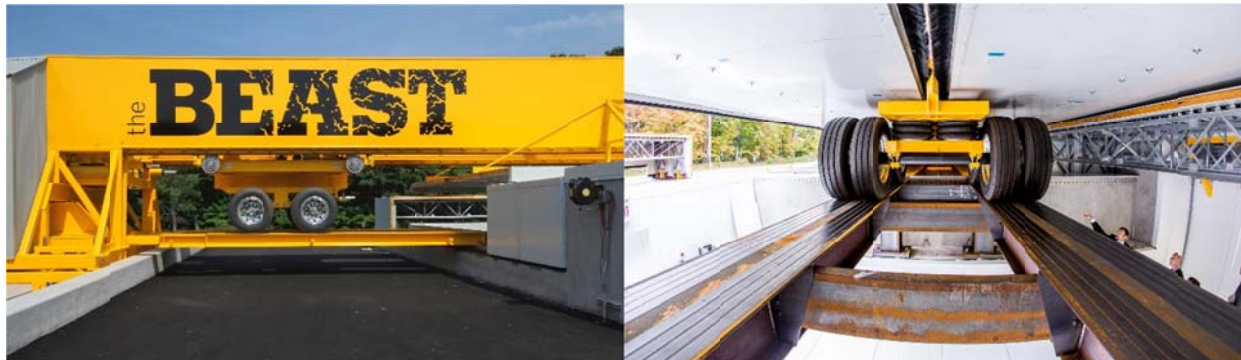
Update: Bridge Evaluation and Accelerated Structural Testing (BEAST) Facility

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 Bridge Evaluation Using Accelerated Structural Testing (BEAST) facility 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. 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.

The construction of the facility has been completed. An aerial view of the completed facility is provided in the following image.



The interior of the BEAST is visible in the following images. In the left image, we present a side view of the BEAST load carriage, and in the right image, we present a view of the loading carriage in the interior of the environmental chamber.



As this is a first-of-its-kind facility, it is critical that the operations and the instrumentation plan for the facility is developed and fully vetted by experts in this field. The operations manual contains the necessary operations and maintenance information, and the instrumentation plan contains the information for the development of procedures necessary for the instrumentation and experimentation of the bridge deck specimen. This includes the development of a procedure for developing bridge deck samples, instrumentation of the specimen with tools for measurement and observation, and the placement of the bridge deck specimen within the facility for testing. Currently, the operations and instrumentation plans are in their final drafts of revision, and discussions are taking place to develop the initial bridge deck specimen.

On-site Demonstration of Pneumatic Flow Tube Mixing Technique (PFTM) for Processing and Stabilization of Contaminated Soft Sediments in the NY/NJ Harbor

The pneumatic tube mixing system is an accelerated construction technique for the stabilization, transportation, and placement of reclaimed dredge materials, soft soils, and mud. As a result, this process allows for their application as structural and nonstructural fills. The objective of this project is to evaluate this technique for the stabilization and disposal of contaminated dredge materials. On August 29, 2015, a demonstration of this technology was presented on site at Kearney, NJ. In the following images, we can see the Pneumatic Flow Tube Mixing Technique in action.



The ultimate aim of the project is to determine if Pneumatic Flow Tube Mixing can achieve structural and environmental properties for amended dredged material that are comparable or better than

existing amendment methods, increases in production efficiency as compared to existing technology, decreased cost per cubic yard for dredged material amendment and placement. In the following image, we can see work being completed on the site for this project.

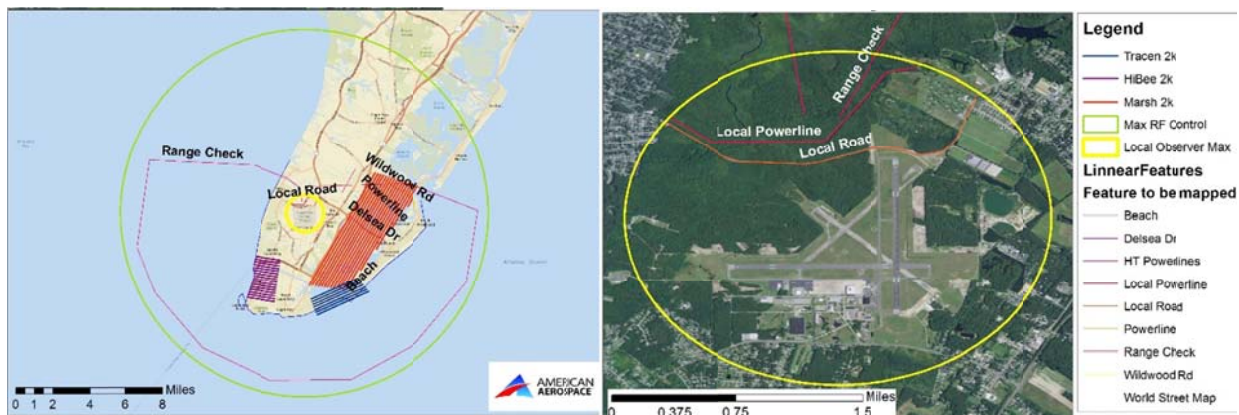


Developments in Applications of Unmanned Aerial Vehicle

In collaboration with CAIT researchers, the School of Engineering at Rutgers University conducted their first flight of an unmanned aerial vehicle. The following figure is an image of the system used, which is a RS-20 fixed wing unmanned aerial vehicle.



The objectives of these flights include the corrosion detection of pipeline and other energy infrastructure components, 3D reconstruction of digital terrain model from UAV-borne imagery for post-disaster damage assessment, and UAV-based traffic incident management experimentation. The left of the following figures is an image of the flight trajectories that took place from June 16th through June 18th, and the right figure is a map that includes attributes that were targets of interest under these flights.



Education and Workforce Development	New Jersey Governor's School (July 2015)	Generate knowledge and skills to K-12 students to cultivate a world class workforce for the transportation sectors	The consortium is developed and implemented a curriculum for exceptional high school science and math students that will include condition monitoring tools and pavement materials.	Students participated in this weeklong summer program that provided hands-on training and insights on asset management.
	T.A.R.G.E.T. - TARGET The Academy at Rutgers for Girls in Engineering (July 2015)	Generate knowledge and skills to K-12 students to cultivate a world class workforce for the transportation sectors	The consortium is developed and implemented a curriculum that will educate aspiring high school female engineers in a number of STEM disciplines.	This program educated a group of aspiring female engineers from New Jersey high schools about different engineering disciplines and career avenues.
	Host National Summer Transportation Institute with Garret Morgan Academy in Patterson, NJ- (Summer 2015)	Generate knowledge and skills to undergraduate students to cultivate a world class workforce for the transportation sectors	The consortium delivered a curriculum that will educate underprivileged incoming Rutgers engineering freshmen in engineering topics.	This program educated underprivileged high school students in multi-modal transportation engineering topics.
	Hosted the 16 th Annual Work Zone Safety Conference (April 2015)	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 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 "Expect the Unexpected".
Technology Transfer	CAIT Newsletter (June 2015)	Generate knowledge and support research projects and programs that have significant and meaningful impacts	CAIT recorded and delivered newsworthy items to showcase since January 2015.	Disseminated information about transportation research initiatives, applications, and training opportunities to practicing professionals.

	Planning ITS NJ Annual Meeting (October 2015)	Support collaborative efforts and technology transfer	This event, co-hosted by CAIT, facilitates communication and generates research collaborations for Intelligent Transportation Systems research.	The theme for this year's annual meeting is "Transportation Revolution". Sessions will highlight connecting travelers through technology, connecting urban dwellers with multiple modes of transportation and smart parking, and connected vehicle technologies.
	Planning Bridge Evaluation Accelerated Structural Testing Facility Dedication Event (October 14, 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	This event will officiate the completion of the new Bridge Evaluation and Accelerated Structural Testing Facility.	This will generate awareness of the new research opportunities that will be available with the advent of the new state-of-the-art facility.
	Planning Annual Research Showcase for the NJDOT (October 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT is planning this event for 250+ attendees representing NJDOT, academia, public and private industry.	This event brings together those with a strong interest in transportation research and highlights recent projects, as well as fosters interest in new research.
	Hosted Bayonne Bridge Navigational Clearance "Raise the Roadway" Program Presentation (April 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT and the Voorhees Transportation Center hosted a presentation on the rehabilitation and redesign of the Bayonne Bridge.	This event generated awareness of the numerous challenges involved in a critical regional infrastructure improvement project.
	CAIT Traveling Lecture Series: State of Good Repair (May 18, 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT at Princeton hosted a seminar given by Dr. Hoon Sohn of Korea Advance Institute of Science and Technology entitled "Visions for Futuristic Inspection and Monitoring"	This seminar broadened the dissemination of research results, and encourages the discussion and collaboration of important topics among transportation professionals and researchers.

	Hosted the 15 th TRB National Transportation Planning Applications Conference (May 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	This event, co-hosted by CAIT, facilitated communication between transportation professionals nationwide, and generate cross-country research collaborations.	Transportation professionals from across the nation gathered together to discuss successes and challenges, and share their experiences professional experiences that facilitates collaboration and the production of meaningful results on future projects.
	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 first center Safety Sidekick Newsletter and blog, as well as established social media presence.
	Stakeholder outreach for the Northeast Transportation Workforce Center	Support collaborative efforts and bolster transportation workforce development in the northeast region.	As part of the NETWC team, CAIT is working on stakeholder engagement activities for the new regional center.	CAIT coordinated the development and launch of the center website, contributed to a stakeholder compendium, and participated in stakeholder meetings
	9 th University Transportation Centers Spotlight Conference	Generate knowledge and support research projects that have significant and meaningful impacts	This event will bring together transportation professionals to discuss the relevant topic of connected and automated vehicles in society.	Dr. Patrick Szary will be the moderator for the session on infrastructure design and operations.
	ASCE New Jersey Section 41 st Annual Awards Dinner	Generate knowledge and support research projects that have significant and meaningful impacts	This event brings together transportation professionals to celebrate the accomplishments of their peers.	Andy Kaplan was presented with the "Young Civil Engineer of the Year" award.
	Hosted USDOT Site Visit (May 14, 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT hosted a tour of the facilities and presented current research initiatives to USDOT personnel.	CAIT presented an overview and demonstrations of their research initiatives to USDOT.

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:**
 - Plan for the upcoming summer National Summer Transportation Institute with Garret Morgan Academy, T.A.R.G.E.T., New Jersey Governor’s School programs, and other K-12 programs to support STEM and workforce development goals for the consortium.
 - Plan to deliver a work zone safety awareness conference for 300 law enforcement and public works personnel to reduce traffic incidents in road construction sites.
 - Work with partner schools to develop new training seminars based on research.

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

2. PRODUCTS: What has the program produced?

Management

Subcontract agreements have been issued to the consortium members.

Research projects awarded:

The Research Advisory Board has reviewed and approved two new research projects:

- “Optimization of Pavement Surface Characteristics” (Virginia Tech)
- “Long-Term Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)” (University of Delaware)

Publications, conference papers, and presentations

- Greer, Alex. “Household Residential Decision-Making: Findings and Future Research.” Presented at Oklahoma State University as part of seminar series Let’s Talk Disasters. September 24, 2015. Stillwater, Oklahoma.
- Greer, Alex. “Issues in Disaster Recovery II: Household and Community Recovery.” Panelist at 40th Annual Natural Hazards Center Disasters Hazards Researchers Meeting, July 19-22, 2015. Broomfield, CO (panel presentation).

- Overby, Lynnette, "Transportation and Dance," CUTC Summer Meeting, New Brunswick, June 2015.
- Faghri, Arde, Mingxin Li and Kadir Ozden, "Pavement management and SAR-based monitoring for deteriorating roadway infrastructure," UTC Brown Bag Seminar, September 23, 2015.

Journal publications.

- Pettigrew, C.P., Barr, P.J., Maguire, M. and Halling, M.W. "Behavior of 48-Year Old, Double-Tee Bridge Girders, made with Lightweight Concrete." Submitted to the ASCE Journal of Bridge Engineering. July 2014.

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

"Nothing to Report"

Other publications, conference papers and presentations.

- Clarke-Sather, Abigail and Arsha Tabrizi, "A Life Cycle Assessment Approach to Bridge Management Decision Making," Delaware Center for Transportation, Research Showcase, Dover Delaware, May 2015.
- Greer, Alex, Sue McNeil Joseph Trainor, Israt Jahan, and Kelsey Mininger. "Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy." Delaware Center for Transportation, Research Showcase, Dover Delaware, May 2015.
- Faghri, Arde, Mingxin Li and Kadir Ozden, "Satellite Assessment and Monitoring for Pavement Management," Delaware Center for Transportation, Research Showcase, Dover Delaware, May 2015.
- Chiquoine, R., Cronin, J., Martey, E., and Fisher, B., "Analysis of NCDOT Pavement Rating and Implementation of New Pavement Rating Method," Poster presentation as part of the Asset Management Challenge at the 9th International Conference on Managing Pavement Assets. Alexandria, VA. May, 2015.

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.

Inventions, patent applications, and/or licenses

"Nothing to Report"

Other products: outreach activities, courses and workshops

"Nothing to Report"

3. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS:

What individuals have worked on the program?

Program Director: Dr. Ali Maher

Project Directors: Dr. Sue McNeil (University of Delaware), Dr. Paul J. Barr (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 (North Jersey Transportation Planning Authority, Delaware Valley Regional Planning Commission, and South Jersey Transportation Planning Organization)	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
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

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:

Project: "Transportation Options for Individuals with Autism Spectrum Disorders"	<ul style="list-style-type: none"> • CAIT • Rutgers' Edward J. Bloustein School of Public Planning and Policy 	The objective of the project is to help adults with autism and other developmental disabilities and their caregivers to perform these assessments by reducing the potential
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		for injury and allowing them to fully demonstrate their true abilities.
Northeast Regional Surface Transportation Workforce Center	<ul style="list-style-type: none"> • University of Vermont • CAIT • John J. Heldrich Center for Workforce Development 	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 UTC**

Multiple DOT and University Partners

Accelerated Infrastructure Testing Facility: Bridge Evaluation Using Accelerated System Testing (BEAST)

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. Partners include NJDOT, VDOT, Advanced Research Associates, Drexel University, the University of Delaware, and Utah State University. Currently, the operations and instrumentation manuals are in the process of being finalized, and discussions are being held to plan the development and construction of the first bridge deck sample for use in the BEAST facility.

Additional ongoing collaborations include:

Northeast Regional Surface Transportation Workforce Center	<ul style="list-style-type: none"> • University of Vermont • CAIT • John J. Heldrich Center for Workforce Development 	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	<ul style="list-style-type: none"> • 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).**

- 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”

- Festo is an industrial and automation company based in Germany, and as part of their services, they offer hands-on training simulators. On July 13, 2015, and September 24, 2015, CAIT staff members met with Festo to discuss the potential to expand our training and STEM activities, and the potential adoption of their techniques for infrastructure training and education.

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
“Optimization of Pavement Surface Characteristics” (Virginia Tech)	This research will compile all the data collected as part of the VDOT Quiet Pavement Implementation Program, create a comprehensive database, analyze the relationship between the various pavement surface properties and vehicle response parameters, study their evolution over time and provide recommendations regarding the potential benefits of the best performing pavement surfaces.	State DOTs are very interested in the use of pavement surface properties to measure the level of service provided to the user and defining road performance. This research will be a step forward in the understanding of pavement surface properties of various pavement types and their impact on road performance.
“Long-Term Monitoring of a Geosynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)” (University of Delaware)	The objective of this research is to perform structural health monitoring using GRS-IBS for at least one year, analyze data from these sensors to improve our understanding of GRS-IBS behavior, and to couple conventional geotechnical and structural engineering design tools with sensor data to improve the design process for GRS-IBS structures.	The results of this study will be shared with the broader engineering community, and will be used to provide guidance and recommendations for updating the FHWA’s “Interim Implementation Guide...” document, which is the design manual that is currently utilized by State DOTs and practicing engineers for the design of GRS-IBS structures.

ONGOING RESEARCH PROJECTS DURING CURRENT REPORTING PERIOD

Outputs	Expected Outcomes	Impacts
<p>“Load Testing and Analysis of 48 Year Old Out-of-Service Double Tee Girder Bridge” (Utah State University)</p>	<p>Recommendations will be developed to aid stakeholders in understanding the effects of deteriorated double tee bridges in their inventory.</p>	<p>The results from this project will provide bridge owners with recommendations on load distribution in double tee bridges, and will allow engineers to make better assumptions about the in service bridge behavior needed for bridge ratings and posting.</p>
<p>“Carbon Fiber Shear Reinforcement for Prestressed Bridge Girders” (Virginia Tech)</p>	<p>The goal of this research is to develop an easily designed and fabricated carbon fiber shear reinforcement system for use in bridge girders used in adverse environments.</p>	<p>This research is focused on developing construction and design methods for new, innovative materials. Carbon fiber reinforcement is one such material that will provide longer life of transportation structures especially where built in adverse environments and exposed to de-icing chemicals and/or salt.</p>
<p>“Bridge Health Monitoring using a Machine-Learning Strategy” (Columbia University)</p>	<p>The purpose of this research is to develop a bridge health monitoring method that utilizes statistical pattern recognition algorithms to determine if data was acquired from a damaged bridge or healthy bridge.</p>	<p>This method would provide DOTs and bridge inspectors with the opportunity to better characterize the current state of the bridge by using observational data in both the short and long term. This would provide them with the opportunities for a significantly more thorough analysis of the condition of the bridge as time progresses.</p>
<p>“Satellite Assessment and Monitoring for Pavement Management” (University of Delaware)</p>	<p>The goal of this study is to investigate the capability of remote sensing satellite data for use in advanced infrastructure monitoring.</p>	<p>The result of the proposed research will increase the efficiency and ease at which pavement condition is determined and minimize the obstruction of traffic that would result from current methods of assessment.</p>
<p>“Bridge Retrofit or Replacement Decisions: Tools to Assess Sustainability and Aid Decision Making” (University of Delaware)</p>	<p>The purpose of this research is to develop an inventory database and an early-state decision-making tool for considering sustainability of bridge repair or replace decisions.</p>	<p>The products of this project will provide decision-makers with the information and tools necessary to better strategize on the rehabilitation or replacement of bridges.</p>
<p>“Using Information at Different</p>	<p>The purpose of this research is to</p>	<p>Asset management at local and</p>

<p>Spatial Scales to Estimate Demand to Support Asset Management Decision Making” (University of Delaware)</p>	<p>develop a framework for integrating and synthesizing data for demand forecasting with respect to asset management.</p>	<p>state DOTs will be able to make informed decisions as to how to forecast asset demand and allot assets accordingly during hazardous situations, such as storms and the resulting damage to infrastructure, properties and businesses.</p>
<p>“Arrangement of Sensors and Probability of Detection for Sensing Sheets Based on Large-area Electronics for Reliable Structural Health Monitoring” (Princeton University)</p>	<p>Products from this research include the development of a method for determination of sensor arrangement and evaluation of probability damage detection, and practical guidelines with associated “probability of detection” diagrams for the most frequent types of damage.</p>	<p>The method produced by this research will allow bridge inspectors to better determine the current state of bridges by providing them with a more reliable method of damage identification.</p>
<p>“Unmanned Aerial Vehicle (UAV) based Traffic Monitoring and Management” (Rutgers University)</p>	<p>A prototype Air traffic monitoring systems will be developed with all hardware and software components fully validated with a full user manual.</p>	<p>This device will allow for monitoring and optimization of traffic flows in the events of traffic incidents or congestion. The technology could be further employed in multiple applications such as infrastructure monitoring and emergency/disaster response.</p>
<p>“Developing a Low Shrinkage, High Creep Concrete for Infrastructure Repair” (Utah State University)</p>	<p>The objective of this study is to develop concrete mixture that optimizes time dependent strains.</p>	<p>Concrete repairs represent a large tax payer burden, and the improvement of the lifetime performance of concrete repairs could save state DOTs a significant amount of maintenance funding.</p>
<p>“Development of Protocols and Instrumentation Plan for Accelerated Structural Testing Facility” (Rutgers University)</p>	<p>The protocols and instrumentation plan for the Bridge Evaluation and Accelerated Structural Testing facility will be developed.</p>	<p>The development of the protocols and instrumentation plan for the new facility will provide researchers with the ability to conduct experiments and aid in their acquisition of realistic and reliable data.</p>
<p>“Live-load Testing and Finite-Element Modeling of a Fracture Critical Bridge” (Utah State University)</p>	<p>It is expected that the live-load testing and developed finite element model of the fracture critical bridge will provide modeling specifications for future field use in addition to a program of load testing bridges.</p>	<p>The procedure can be more broadly applied to other bridges and can lead to the proper load posting of bridges that can reduce the cost of rerouting vehicles. This would assist DOTs in maintenance decision.</p>

<p>“Initial Evaluation of the Albedo and Solar-Radiation Flux of Asphalt Pavements” (Rutgers University)</p>	<p>The goal of this research is to improve the procedures utilized to analyze albedo and solar radiation flux of asphalt pavements.</p>	<p>This project would result in the creation of a guidebook explaining the viability of the improved test procedure, and will provide pavement engineers with the opportunity to reliably obtain pavement data.</p>
<p>“Dynamic Effects and Friction Values of Bridge Moves for ABC Bridges” (Utah State University)</p>	<p>This results of this project will be incorporated into the AASHTO ABC Guide Specification through the NCHRP process.</p>	<p>This research will supply bridge designers with the specifications necessary for the development of bridges being constructed using Accelerated Bridge Construction techniques.</p>
<p>“Development of Concrete Mix Proportions for Minimizing/Eliminating Shrinkage Cracks in Slabs and High Performance Grouts” (Rutgers University)</p>	<p>The aim of this project is to develop two formulations. One that would be suitable for casting slabs with minimal amounts of creep and shrinkage, which would eliminate cracking. The other is a high performance composition that sets quickly, is dimensionally stable, and has high strength, stiffness, and toughness.</p>	<p>Accelerated Bridge Construction is a high priority area for the US DOT, and therefore, this research has enormous potential for immediate real world implementation and would aid in the further adoption of ABC techniques.</p>
<p>“Methodological Framework for Optimal Truck Highway Parking Location and Capacity Expansion” (Rutgers University)</p>	<p>The product of this project will provide customers with the engineering guidelines and economic insights for addressing the regional parking capacity shortfall and safety concerns.</p>	<p>It is a vital component that should be integrated into sustainable planning and system design of an integrated intermodal freight system. This will provide decision makers with the tools necessary to better develop future policies.</p>
<p>“Development of a Risk Assessment Tool for Rail Transport of Flammable Energy Resources” (Rutgers University)</p>	<p>This research will develop a risk assessment model to evaluate the safety of rail transport of flammable energy resources (petroleum crude oil, natural gases) which accounts for infrastructure conditions, rolling stock characteristics, and population densities as well as tank car safety design features.</p>	<p>The products of this research will provide railroad operators with the ability to evaluate the safety and effectiveness of different risk mitigation strategies for rail transport of hazardous materials. The model may be used to explore shipper decisions to switch origin points, or to ship different, less hazardous forms of the chemical.</p>
<p>“Piezoelectric Energy Harvesting in Airport Pavement” (Rutgers University)</p>	<p>This project is conducting research into using piezoelectric technology embedded in pavement to harvest electricity, and will result in the development of smart pavements</p>	<p>Initially, the results from this project will be implemented as a prototype in partnership with the FAA, and could lead to the development of smart pavements with multiple</p>

	with multifunction to eventually generate renewable energy.	functions for future applications or environments.
“Port Authority of New York and New Jersey Resiliency Initiative” (Rutgers University)	The aim of this research is to develop an emergency preparedness, response, and recovery strategy to be informed by international best practices & standards for risk management, and develop emergency operations subject matter information enabling a common operating picture of the goods movement system.	The products of this project will be the development of an Emergency Preparedness, Response and Recovery Strategy and Subject Matter Information for Port Authority emergency operations.
“A Study on 3D Printing and its Effects on the Future of Transportation” (Rutgers University)	The goal of this project is to provide an initial forecast into the potential effects that 3D printing technology will have on transportation in the future.	This project would provide decision makers with guidance into the potential future of transportation, and could provide them with the necessary foresight to act in the current technological climate.

What is the impact on other disciplines?

- “Unmanned Aerial Vehicle (UAV) based Traffic Monitoring and Management” (Rutgers University): The development of unmanned aerial vehicles requires collaboration among multiple engineering disciplines such as mechanical engineering and electrical engineering. The application of UAVs to transportation and infrastructure engineering further encourages the collaboration between multiple engineering disciplines. Additionally, it progresses the development of the technology and knowledge-base of each of the involved engineering disciplines.
- “Arrangement of Sensors and Probability Detection for Sensing Sheets Based on Large-area Electronics for Reliable Structural Health Monitoring” (Princeton University): The development and application of sensors and sensing sheets couples concepts from electrical engineering to applications of structural engineering. Additionally, applications can be further extended to fields such as mechanical engineering where monitoring of structures and machines may be necessary.
- “Bridge Health Monitoring using a Machine-Learning Strategy” (Columbia University): The application of machine learning to bridge health monitoring extends the applicability of computer science concepts to physical applications. In this instance, the concepts are applied to structural engineering, but the potential exists that these concepts could be extended to applications in mechanical engineering as many systems and machines require monitoring to ensure proper functionality.
- “Piezoelectric Energy Harvesting in Airport Pavement” (Rutgers University): This project involves the application of piezoelectric devices to generate energy from airport pavement. This requires the expertise from various fields, such as civil engineering, electrical engineering, and materials science and engineering, and extends the applicability of these fields to new frontiers that have otherwise gone undeveloped.

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.

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, CAIT provides labor and online registration capabilities to record planned attendances to various conferences and workshops for other organizations, like ITS New Jersey.

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.

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.

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”