

PROGRAM PROGRESS PERFORMANCE REPORT

Awarding Federal Agency: US Department of Transportation, Office of the Assistant Secretary for Research and Technology of the Department of Transportation (OST-R)

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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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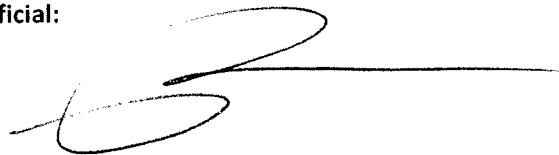
Project/Grant Period: September 30, 2013 through September 30, 2017

Reporting Period End Date: March 31, 2016

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Signature of Submitting Official:

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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 seven research projects .
	Development of accelerated infrastructure testing facility: Bridge Evaluation 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. 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 (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.		The ultimate aim of the project is to determine if 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.

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 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 was completed in May of 2015. An aerial view of the completed facility is provided in the following image.



On October 14, 2015, a dedication event was held to officially open the BEAST facility for business, and to generate awareness of the new state-of-the-art facility. Images from this event are shown below.



Numerous professionals from various transportation agencies, including the US Department of Transportation and Federal Highway Administration, came to get a tour of the BEAST and to see the BEAST in action.

As this is a first-of-its-kind facility, it is critical that the new facility be fully tested and optimized for performance. Presently, the team is developing plans for the initial experiment. The team is also fine-tuning the equipment to provide the needed environmental and physical loading conditions. The team is evaluating load response from the carriage onto a fabricated structural-steel girder-pair, as well as establishing maximum attainable temperature deltas inside the environmental chamber. This has resulted in a number of facility optimizations being implemented.

Developments in the Applications of Unmanned Aerial Vehicle

CAIT has been leading the organization and development of UAV research activities at Rutgers University. CAIT has been collaborating with faculty from Civil Engineering, Mechanical & Aerospace Engineering, Industrial Engineering, and Environmental Science to facilitate the UAV registration process and the coordination of flights for researchers that apply UAV technology to their subject of study. In addition to the internal partners, CAIT has been collaborating with NJIT, MAAP, Cape May County, and Atlantic Cape Community College in the coordination of flights and sharing of knowledge to ensure that flights are operating according to FAA policies.

Currently, we are planning the flights in cooperation with faculty from the Department of Civil Engineering and Atlantic Cape Community College, and a demonstration of UAV technology and applications for NJDOT, and a larger-scale demonstration of advanced technological techniques in emergency preparedness and response for the personnel of the United Nations.

Education and Workforce Development	Planning for New Jersey Governor's School (July 2016)	Generate knowledge and skills to K-12 students to cultivate a world class workforce for the transportation sectors	The consortium is developing and implementing a curriculum for exceptional high school science and math students that will include condition monitoring tools and pavement materials.	Students will participate in this weeklong summer program that provided hands-on training and insights on asset management.
	Planning for T.A.R.G.E.T. - TARGET The Academy at Rutgers for Girls in Engineering (July 2016)	Generate knowledge and skills to K-12 students to cultivate a world class workforce for the transportation sectors	The consortium is developing and implementing a curriculum that will educate aspiring high school female engineers in a number of STEM disciplines.	This program will educate a group of aspiring female engineers from New Jersey high schools about different engineering disciplines and career avenues.
	Presented at the New Jersey State League of Municipalities Conference	Generate knowledge and skills for the municipal and county transportation community	This program promoted proper transportation safety for local communities	More than 50 attendees learned about proper transportation safety techniques for their communities, including signage, traffic calming, ped/bike issues.
	Planning for the 17 th Annual Work Zone Safety Conference (April 2016)	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	A multi-disciplinary audience of transportation professionals were exposed to a variety of work zone safety concerns, and provided with an

			operations, and public safety personnel.	awareness of the necessity of an effective and safe work zone under this year's theme of "Expect the Unexpected".
	Conducted Professional Development for the NJ State Association of County Engineers	Generate knowledge and support research implementation for practices that have significant and meaningful impacts	Promotes proper state of the practice at the local level	Presented asphalt and ADA issues to two occasions to 30+ county engineers each, through technical education sessions
Technology Transfer	CAIT Newsletter (March 2016)	Generate knowledge and support research projects and programs that have significant and meaningful impacts	CAIT recorded and delivered newsworthy items to showcase since June 2015.	Disseminated information about transportation research initiatives, applications, and training opportunities to practicing professionals.
	Hosted 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.	Disseminated the most current information on ITS practices and plans for the future.
	Hosted 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 made official the completion of the new Bridge Evaluation and Accelerated Structural Testing Facility.	Generated awareness of the new research opportunities that will be available with the advent of the new state-of-the-art facility.
	Participated in New Jersey State Transportation Innovation Council (STIC)	Generate knowledge and support research implementation of proven practices	Promotes FHWA chosen initiatives to promote to the local level	Generates awareness of successful practices across the country to the local level
	Hosted Annual Research Showcase for the NJDOT (October 2015)	Generate knowledge and support research projects that have significant and	CAIT planned this event for 250+ attendees representing NJDOT, academia, public and	This event brings together those with a strong interest in transportation research and

		meaningful impacts	private industry.	highlights recent projects, as well as fosters interest in new research.
	Hosted IHSDM Training for NJDOT	Generate knowledge and support implementation of IHSDM at the state level	CAIT hosted the four day FHWA training program for NJDOT	This event trained 30+ NJDOT personnel on the use and methodology of IHSDM software and analysis for transportation safety.
	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 NEWTC team, CAIT is leading the communication efforts for the project and developing and promoting tech transfer events.	CAIT developed and launched the NETWC website and established a 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
	Rutgers NJ Asphalt Paving Conference (March 2016)	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.
	BEAST Article	Promote the accomplishments of Drs. Maher and Szary in the development and implementation of the BEAST.	As a participating member of the Rutgers alumni community, CAIT drafted a well disseminated article about the BEAST.	Authored article to be disseminated to 55,000 Rutgers Alumni and 6000 Engineering Society members.

	Plan UN Emergency Event (June 2016)	Generate knowledge and support research projects that have significant and meaningful impacts	In collaboration with Cape May County and the Delaware River Bay Authority, a demonstration of technology applications in emergency situations will be performed.	Members of the United Nations will observe the necessity of the advancement of technological applications for rapid responses during emergency situations.
	Plan UAS Technology Demonstration (May 2016)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT will provide a demonstration of the applications of unmanned aerial vehicles to NJDOT personnel.	Transportation personnel will learn about technological advances that are of significance to transportation and infrastructure maintenance.

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., New Jersey Governor’s School programs, 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.

- **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 seven new research projects:

- “Multi-scale Condition and Structural Analysis of Steel Bridge Infrastructure” (University of Delaware)
- “Lean Construction Applications for Bridge Inspection” (University of Delaware)
- “Modeling the impacts of changes in freight demand, infrastructure improvements and policy measures on a metropolitan region” (NJIT)
- “Development & Implementation of NJ Transit’s Access Link Program” (Rutgers University)
- “The Hudson River Rail Tunnel Study Link” (Rutgers University)
- “Improving the Durability of the Inverted T-Beam Bridge System” (Virginia Tech)
- “Characterization and Modeling of Recycled Pavement Sections” (Virginia Tech)

Publications, conference papers, and presentations

Journal publications.

- Zolghadri, N., M.W. Halling, N. Johnson, and P.J. Barr (2016). Field Verification of Simplified Bridge Weigh-in-Motion Techniques. *J. Bridge Eng.*, 10.1061/(ASCE)BE.1943-5592.0000930, 04016063. Accepted March 2016.
- Maguire, M., Chang, M., Sun, Y., Collins, W. N. “Unbonded Tendon Database” *Journal of Bridge Engineering*. Submitted January 2016
- Chang, M., Maguire, M., Sun, Y. “Eliminating Human Bias from Explanatory Variable Selection for Bridge Management Systems” *Journal of Infrastructure Systems*. Submitted November 2015, First Review Received April: Very positive.
- Pettigrew, C., Barr, P., Maguire, M., Halling, M. “Behavior of 48-Year Old, Double-Tee Bridge Girders made with Lightweight Concrete”. *ASCE Journal of Bridge Engineering*. Accepted January 2016
- Maguire, M., Collins, W., Halbe, K., Roberts-Wollmann, C., (2016) “Multi-Span Members with Unbonded Tendons: Ultimate Strength Behavior and Recommendations.” *ACI Structural Journal* 113(2), 8 pp.
- Cook, W. and Barr, P.J. “Trends Among Collapsed Bridges in New York State.” Submitted to the *ASCE Journal of Performance of Constructed Facilities*. November 2015.

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

“Nothing to Report”

Other publications, conference papers and presentations.

- October, 14, 2015 - Abigail Clarke Sather and Arsha Tabrizi, “Bridge Retrofit or Replacement Decisions: Tools to assess Sustainability and Aid Decision-making” – University Transportation Center Brownbag
- November 11, 2015 – Israt Jahan, Sue McNeil and Joseph Trainor, “Using information at different spatial scales to estimate demand to support asset management decision making” – University Transportation Center Brownbag
- Ozden A., Faghri, A., Li, M., Tabrizi, K. (2016) Evaluation of Synthetic Aperture Radar Satellite Remote Sensing for Pavement and Infrastructure Monitoring. International Conference on

Sustainable, Design, Engineering and Construction (ICSDEC 2016), Tempe, Arizona (Paper #. 16-207).

- Zolghadri, N., M.W. Halling, and P.J. Barr (2016). Effects of Temperature Variations on Structural Vibration Properties. Proc. of the ASCE Geotechnical and Structural Engineering Congress, Phoenix, AZ, February 2016. (Contributed, Oral Presentation)
- Olsen, J., Maguire, M. (2016) "Pushoff Shear Testing of Composite Sandwich Panel Connectors" Proceedings of the PCI National Bridge Conference, Washington DC.
- Cook, W., Barr, P.J. "Pre-Collapse Bridge Condition Ratings and Appraisals." Proceedings, Annual Transportation Research Board, Washington, D.C., January 2016.
- Zolghadri, N., M.W. Halling, P.J. Barr (2016). Effect of Temperature Changes on Vibration Characteristics of Bridge Structures. TRB Field Testing and NDE of Transportation Structures Committee (AFF40), Washington D. C. Jan 2016. (Oral Presentation)
- Halling, M.W., N. Zolghadri (2015). Field Verification of a Simplified Bridge WIM Technique. Proc. of the UCONN Bridge Weigh-in Motion (BWIM) Workshop, Mystic, CT, Oct 2015. (Oral Presentation)

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
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.

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 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 team is developing plans for the initial experiment. The team is also fine-tuning the equipment to provide the needed environmental and physical loading conditions. The team is evaluating Load response from the carriage onto a fabricated structural-steel girder-pair, as well as establishing maximum attainable temperature deltas inside the environmental chamber. This has resulted in a number of facility optimizations being implemented.

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).**

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
“Modeling the Impacts of Changes in Freight Demand, Infrastructure Improvements and Policy Measures on a Metropolitan Region” (NJIT)	The objective of the proposed study is to develop a modeling framework that would be able to ascertain the magnitude of impacts that an infrastructure improvement or a policy in conjunction with the changes in truck traffic might have on a regional and local level as well.	The goal of every State DOT is to preserve transportation system investments, protect the environment, and utilize public resources in a responsible manner. The proposed framework can assist NJDOT to identify and elevate the opportunities and challenges associated with the movement of goods in New Jersey to the level of

		importance attached to the movement of people.
“Multi-Scale Condition and Structural Analysis of Steel Bridge Infrastructure” (University of Delaware)	The primary anticipated results of this research are the identification and quantification of the structural factors that are associated with significantly above- or below-average structural condition, and the exploration of structural behaviors that can be correlated to these observed condition trends.	It is envisioned that the research results could find application in the real world through enhanced recommendations for visual inspection practices and/or more durable future bridge designs. Similarly, the knowledge gained via this research could inform best practices for bridge retrofits on aging infrastructure.
“Lean Construction Applications for Bridge Inspection” (University of Delaware)	The desired outcomes are recommendations for improved and “lean” bridge inspection that could be used as content for a guide and online training for State DOTs and other relevant organizations that carry out bridge inspections.	By applying the concepts resulting from this research, State DOTs and bridge owners can improve the efficiency of their bridge inspections by cutting costs, improving safety, and reducing the impacts to the environment.
“Development & Implementation of NJ TRANSIT’s Access Link Program” (Rutgers University)	Having a workforce and community that is able to make their own decisions for a transportation has been a good goal since the implementation of the Americans with Disabilities Act in the 1990s. By examining and analyzing the basis of the start of the program and its original goals and challenges, we can see how far it has come and where it needs to go.	By observing and documenting the historical record of NJ Transit’s Access Link, policy makers are able to observe the significance of recognizing the value of inclusion and the process of demarginalization through a government program, which in turn could influence the direction of future policies.
“The Hudson River Rail Tunnel Like Study” (Rutgers University)	A summary academic report will be compiled and made available to planners and policymakers which will present an overview of the state of public opinion on the awareness of the need, the perceived importance of, and the willingness to pay for the refurbishing/replacement and/or supplementation of the North River Rail Tunnel links.	Public support for refurbishing and/or replacing these links is essential for transportation planners and policymakers. This effort will document the public opinion data to inform planners and policymakers.
“Improving the Durability of the Inverted T-Beam Bridge System” (Virginia Tech)	Inverted-T Beam systems have already been deployed, and VDOT is interested in future deployments and the development of standard	This project will develop further refinements to VDOT’s new Inverted-T Beam system for rapidly constructed, highly durable short-

	details. Several cross-sections will be developed and standardized, and the topping mixture will be optimized to minimize cracking.	to-medium span bridges.
“Characterization and Modeling of Recycled Pavement Sections” (Virginia Tech)	State DOTs are very interested in the use of recycling as a viable pavement rehabilitation procedure. This research will be a step forward in the understanding on the behavior and performance of recycled materials and recycled pavement sections. Furthermore, VDOT is planning to use the results of the associated project and this supplemental effort to guide on the adoption (or not) of the tested pavement materials.	As part of the VDOT Accelerated Pavement Testing Program, VDOT has constructed recycled test sections. VDOT has been monitoring the performance of these sections, and the data collected from this effort will be used to understand the response and performance of recycled materials. This will allow engineers to better design more environmentally friendly and sustainable pavement solutions.

ONGOING RESEARCH PROJECTS DURING CURRENT REPORTING PERIOD

Outputs	Expected Outcomes	Impacts
“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.
“Load Testing and Analysis of 48 Year Old Out-of-Service Double Tee Girder Bridge” (Utah State University)	Recommendations will be developed to aid stakeholders in understanding the effects of deteriorated double tee bridges in their inventory.	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.
“Carbon Fiber Shear Reinforcement for Prestressed Bridge Girders” (Virginia Tech)	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.	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.
“Bridge Health Monitoring using a Machine-Learning Strategy” (Columbia University)	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.	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.
“Bridge Retrofit or Replacement Decisions: Tools to Assess Sustainability and Aid Decision Making” (University of Delaware)	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.	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.
“Using Information at Different Spatial Scales to Estimate Demand to Support Asset Management Decision Making” (University of Delaware)	The purpose of this research is to develop a framework for integrating and synthesizing data for demand forecasting with respect to asset management.	Asset management at local and 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.
“Arrangement of Sensors and Probability of Detection for Sensing Sheets Based on Large-area Electronics for Reliable Structural Health Monitoring” (Princeton University)	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.	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.
“Unmanned Aerial Vehicle (UAV) based Traffic Monitoring and Management” (Rutgers University)	A prototype Air traffic monitoring systems will be developed with all hardware and software components fully validated with a full user manual.	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>“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>“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 with multifunction to eventually generate renewable energy.</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 functions for future applications or environments.</p>
<p>“Port Authority of New York and New Jersey Resiliency Initiative” (Rutgers University)</p>	<p>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.</p>	<p>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.</p>
<p>“A Study on 3D Printing and its Effects on the Future of Transportation” (Rutgers University)</p>	<p>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.</p>	<p>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.</p>

PROJECTS COMPLETED DURING CURRENT REPORTING PERIOD

Outputs	Expected Outcomes	Impacts
<p>“Optimization of Pavement Surface Characteristics” (Virginia Tech)</p>	<p>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.</p>	<p>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.</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>“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>

What is the impact on other disciplines?

- “Development & Implementation of NJ Transit’s Access Link Program” (Rutgers University): The aim of this project is to observe and document the historical record of NJ Transit’s Access Link. Through the observation of Access Link from this perspective, it provides the opportunity to trace the impacts of the program since its inception. In addition to the collaboration with historians, this project has the potential to be applicable to sociology as it enables us to observe the value and impacts of programs that seek inclusion and demarginalization. Additionally, the potential for collaboration with economic principles is present as the transportation is critical to the health of the nation’s economy.
- “Modeling the impacts of changes in freight demand, infrastructure improvements, and policy measures on a metropolitan region” (NJIT): The objective of the proposed study is to develop a modeling framework that would be able to ascertain the magnitude of impacts that an infrastructure improvement or a policy in conjunction with the changes in truck traffic might have on a regional and local level as well. As this project deals with freight motion, this model could be potentially applicable to fields such as supply chain management.

Previously Report Impacts on other disciplines:

<p>“Bridge Health Monitoring using a Machine-Learning Strategy” (Columbia University)</p>	<p>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.</p>
<p>“Piezoelectric Energy Harvesting in Airport Pavement” (Rutgers University)</p>	<p>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.</p>
<p>“Arrangement of Sensors and</p>	<p>The development and application of sensors and sensing sheets couples concepts</p>

Probability Detection for Sensing Sheets Based on Large-area Electronics for Reliable Structural Health Monitoring” (Princeton University)	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.
“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.

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”