

## 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)

**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

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**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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**Submission Date:** October 31, 2014

**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
<p><b>Research</b></p>	<p>Research Selection</p>	<p>Select projects that make significant and meaningful impacts during the lifetime of the grant</p>	<p>Several new projects have cleared the pre-proposal stage and are now being developed by the PI for full submission and review.</p>	<p>The Research Advisory Board has already reviewed and approved <b>eleven research projects.</b></p>
	<p>Development of accelerated infrastructure testing facility: Bridge Evaluation Using Accelerated System Testing (BEAST)</p>	<p>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.</p> <p>The conditions simulated in the BEAST facility are experienced in each region of the country, so findings from the first full-scale experiment have the potential to impact each of the 600,000 bridges in the United States. Bridge owners will gain a reliable means to forecast deck performance and safety and understand the durability of technologies and applied preservation techniques to enhance serviceability and performance. Finally, owners would be in a</p>		<p>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.</p>

		<p>far more informed position to manage maintenance and replacement activities as they continue to deal with difficult trade-offs and dwindling financial resources.</p> <p>The team will complete the design and construction of the facility in 2014; the BEAST will be up and running in January 2015.</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 System 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 site for the equipment is currently under construction the utilities have been relocated and excavations have begun. The main excavation work to construct the foundation for the equipment will begin soon. Since full scale bridge decks are going to be tested, the foundations have been designed using the same design criteria for bridge abutments in real world conditions. Due to the heavy loads and the environmental loading, the footings, walls, and floor of the chamber had to be designed to withstand the unusual conditions and extreme environment.



Construction of the equipment is underway. The following images show some of the larger components being fabricated off-site. Once the system is complete it will be disassembled and transported to Rutgers for final commissioning.



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.

<b>Education and Workforce Development</b>	ITS New Jersey "Data Sharing" Workshop (June 2014)	Generate knowledge and skills to foster a world class workforce for the transportation sectors	The consortium will provide an interactive workshop led by transportation data experts to help professionals address data gaps and challenges.	96 transportation professionals were instructed on how to overcome obstacles to traffic data collection and analysis used in road improvement plans.
	New Jersey Governor's School (July 2014)	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.	17 students participated in this weeklong summer program that provided hands-on training and insights on asset management.

	T.A.R.G.E.T. - The Academy at Rutgers for Girls in Engineering (July 2014)	Generate knowledge and skills to K-12 students to cultivate a world class workforce for the transportation sectors	The consortium 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 19 aspiring female engineers from New Jersey high schools about different engineering disciplines and career avenues.
	National Summer Transportation Institute - NEXGEN (July 2014)	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 51 underprivileged incoming Rutgers engineering freshmen in technical transportation engineering topics and software.
	Work Zone Traffic Impact Analysis (May 28-29, 2014)	Generate knowledge and skills programs to cultivate a world class workforce for the transportation sectors	CAIT provides transportation professionals with advanced training on the analysis of work zones.	35 NJDOT personnel were trained on the types of analytical tools available that will allow them to analyze and understand the impact a work zone will have in application.
	Work Zone Strategies (June 18-19, 2014)	Generate knowledge and skills programs to cultivate a world class workforce for the transportation sectors	CAIT provides transportation professionals with advanced training on the design strategies of work zones.	35 NJDOT personnel were trained on design strategies available to work zone designers to improve work zone safety and mobility.
<b>Technology Transfer</b>	CAIT Update eNews (May/June 2014)	Generate knowledge and support research projects and programs that have significant and meaningful impacts	CAIT recorded and electronically delivered newsworthy items to showcase since September 2013.	Disseminated information about transportation research initiatives, applications, and training opportunities to 6,000 practicing professionals.

	Planning for CUTC Summer Meeting	Support collaborative efforts and technology transfer	This event, hosted by CAIT, will facilitate communication between UTC administrators nationwide, generate cross-country research collaborations, and create new policies and products founded on UTC research.	UTC researchers and administrators will attend the conference to network with other university researchers, learn how to maintain research collectives that align with USDOT goals, and produce meaningful research projects that have national applications
	Sponsorship of 2014 Accelerated Bridge Construction Conference	Support collaborative efforts and technology transfer	The consortium sponsored the 2014 ABC Conference, hosted by Florida International University.	The consortium will create knowledge about ABC technologies for engineers and researchers within and outside the UTC network.
	Planning Unmanned Aerial Vehicle Bridge Demonstration (Spring 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT is planning to give a demonstration on the application of unmanned aerial vehicles to bridge inspection.	This demonstration will generate awareness about the technological progression, and the application of up-and-coming technological developments to current transportation issues.
	Planning TRB Reception (January 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT is planning a reception at the Transportation Research Board 94 <sup>th</sup> Annual Meeting.	This event will generate networking between transportation professionals from across the nation.
	Planning Bridge Evaluation Accelerated Structural Testing Facility Dedication Event (Spring 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 Advisory Board Meeting (November 2014)	Generate knowledge and support research projects that have significant and meaningful impacts	The Advisory Board consists of members drawn from government sponsors, agency partners, and industry/professional colleagues.	The Advisory Board meets to keep us informed on both industry climate and customer needs on a myriad of areas in transportation and infrastructure.
	Planning for Transportation Committee (October 2014)	Generate knowledge and support research projects that have significant and meaningful impacts	The consortium will host a Transportation Committee meeting to discuss transportation related issues within the state of New Jersey.	NJ lawmakers and transportation professionals will discuss the current state of transportation and infrastructure issues within the state of New Jersey.
	Planning for State-of-Good-Repair Summit (November 2015)	Generate knowledge and support research projects that have significant and meaningful impacts	The consortium will host this event to promote the maintenance of a state of good repair to transportation professionals and decision makers.	This event will bring together transportations professionals and decision makers to explore applicable concepts of asset management and condition monitoring best practices to keep the infrastructure in a state of good repair.
	Bringing ITS to the Locals (September 2014)	Generate knowledge and support research projects that have significant and meaningful impacts	CAIT promotes the implementation of intelligent transportation systems to local community personnel.	75 local transportation employees were informed on the applications of intelligent transportation systems for local communities.

**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 NEXGEN, 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 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:**

- Plan the annual State of Good Repair summit.
- 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 eleven new research projects:

- “Load Testing and Analysis of 48 Year Old Out-of-Service Double Tee Girder Bridge” (Utah State University)
- “Carbon Fiber Shear Reinforcement for Prestressed Bridge Girders” (Virginia Tech)
- “Bridge Health Monitoring Using a Machine-Learning Strategy” (Columbia University)
- “Satellite Assessment and Monitoring for Pavement Management” (University of Delaware)
- “Bridge Retrofit or Replacement Decisions: Tools to Assess Sustainability and Aid Decision-Making” (University of Delaware)
- “Using Information at Different Spatial Scales to Estimate Demand to Support Asset Management Decision Making” (University of Delaware)
- “Arrangement of Sensors and Probability of Detection for Sensing Sheets Based on Large-Area Electronics for Reliable Structural Health Monitoring” (Princeton University)

- “Unmanned Aerial Vehicle (UAV) Based Traffic Monitoring and Management” (Rutgers University)
- “Developing a Low Shrinkage, High Creep Concrete for Infrastructure Repair” (Utah State University)
- “Development of Protocols and Instrumentation Plan for Accelerated Structural Testing Facility” (Rutgers University)
- “Live-Load Testing and Finite-Element Modeling of a Fracture Critical Bridge” (Utah State University)

**Publications, conference papers, and presentations**

- Y. Yao and B. Glisic. “Probabilistic Damage Detection Based on Large Area Electronics Sensing Sheets,” *The 7th European Workshop on Structural Health Monitoring*, Nantes, France, July 2014.
- Y. Yao, S-T. Tung and B. Glisic. “High-resolution sensing sheet for damage detection based on large area electronics,” *The 7th International Conference on Bridge Maintenance, Safety and Management*, Shanghai, China, July 2014.

**Journal publications.**

- Y. Yao and B. Glisic (2014). “Sensing sheets: optimal arrangement of dense array of sensors for an improved probability of damage detection”. (Submitted to *Structural Health Monitoring*, under review)

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

“Nothing to Report”

**Other publications, conference papers and presentations.**

“Nothing to Report”

**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.

**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

**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.

Specific project collaborations for this reporting period include:

**Rutgers' Edward J. Bloustein School of Public Planning and Policy**  
***Transportation Options for Individuals with Autism Spectrum Disorders***

Sponsored by a grant from the New Jersey Governor's Council and the New Jersey Department of Health and Senior Services, CAIT and Bloustein are collaborating on a project to develop and implement an assessment tool designed to determine if paratransit is appropriate of an adult on the autism spectrum, and if so, what type of paratransit service is appropriate. 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.

**Utah State University**  
***Accelerated Bridge Construction Education***

Utah State University provided financial support and resources for the 2014 Accelerated Bridge Construction (ABC) conference hosted by Florida International University to provide a meaningful exchange about ABC technologies to engineers and researchers within and external to the UTC network. The conference will attract bridge engineers and decision-makers to learn about expedited and cost-effective construction techniques for safe and resilient new bridges.

**Rutgers University-School of Engineering hires two new professors with transportation-related research specialties**

*Jing (Peter) J. Jin, Assistant Professor*  
*Civil and Environmental Engineering*  
*PhD, Civil Engineering, 2009*  
*University of Wisconsin-Madison*

Peter Jin joins Rutgers Civil and Environmental Engineering as an assistant professor and as an affiliated member of the Center for Advanced Infrastructure and Transportation (CAIT). His expertise lies in Intelligent Transportation Systems with special interests in mobile sensor data, connected vehicles, and active transportation and demand management. His recent research interests include transportation Big Data analytics, vehicle-to-infrastructure communications, and unmanned airborne vehicle (UAV) application in traffic monitoring and incident management. Prior to joining Rutgers, he worked at the Center for Transportation Research at the University of Texas at Austin as a research associate.

*Xiang Liu, Assistant Professor*  
*Civil and Environmental Engineering*  
*PhD, Transportation Engineering, 2013*  
*University of Illinois at Urbana-Champaign*

Xiang Liu was most recently a postdoctoral research associate at the Rail Transportation and Engineering Center (RailTEC) at UIUC where his focus was integrated risk management of rail transport of hazardous materials. His work has laid out a comprehensive framework for optimizing multiple risk management strategies to maximize rail safety in the most cost-efficient manner. Some of his research results have been used by the Association of American railroad industry in development of several rail safety policies and practices. At Rutgers, he aims to develop innovative approaches to improving the safety and efficiency of transportation systems in New Jersey and the nation, in partnership with his colleagues and sponsors.

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

**Oregon Transportation Research and Environmental Center (OTREC), Portland State University STEM Career Education for Young Women**

The consortium collaborated with another National UTC, OTREC, to create a hands-on engineering Challenge project for the Women’s Transportation Seminars (WTS) 2014 Transportation YOU Summit in Washington, D.C., to encourage female high school students from around the country to enter into the STEM career fields. Each year, the highlight is the Challenge Project, which gives the students a close-up look into the daily job functions, responsibilities, and societal impacts of a transportation engineer; the project also introduces them to USDOT mission and focus areas. The 2014 Challenge Project was design by CAIT and OTREC, and CAIT and OTREC staff will also serve as professional mentors. Aligning with USDOT focus areas of equality, access, and economic growth, the students will survey underprivileged sectors (Anacostia and U Street) of Washington, D.C., and perform a neighborhood equality and access analysis. The students will then work in teams to identify issues of inequality and propose solutions that improve access and economic growth. The Challenge Project took place during the WTS 2014 Transportation YOU Summit on June 27, 2014.

**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.

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

The Transportation Safety Resource Center (TSRC) at CAIT is investigating the feasibility of building a crash data analysis software that will help safety engineers working for the nation of Qatar to create proactive road improvement plans in advance of a major international sporting event.

**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**

<b>Outputs</b>	<b>Expected Outcomes</b>	<b>Impacts</b>
“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. In turn, this would provide them with the opportunities for a significantly more thorough analysis of the condition of the bridge as time progresses.
“Satellite Assessment and Monitoring for Pavement Management” (University of Delaware)	The goal of this study is to investigate the capability of remote sensing satellite data for use in advanced infrastructure monitoring.	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.
“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	The purpose of this research is to develop a framework for	Asset management at local and state DOTs will be able to make

<p>Decision Making” (University of Delaware)</p>	<p>integrating and synthesizing data for demand forecasting with respect to asset management.</p>	<p>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-</p>	<p>It is expected that the live-load</p>	<p>The procedure can be more</p>



Element Modeling of a Fracture Critical Bridge” (Utah State University)	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.	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.
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**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.

**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”