

**PROGRAM PROGRESS PERFORMANCE REPORT**

**Awarding Federal Agency:** US Department of Transportation, Office of the Assistant Secretary for Research and Technology

**Federal Grant Number:** DTRT12-G-UTC16

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

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

**Submission Date:** January 31, 2017

**DUNS Number:** 001912864000

**EIN Number:** 1226001086A1

**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

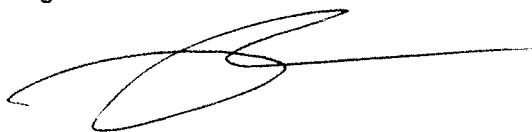
**Recipient Identifying Number or Account Number, if any:** Rutgers' account #434310

**Project/Grant Period:** January 1, 2012 through January 31, 2017

**Reporting Period End Date:** December 31, 2016

**Report Term or Frequency:** Semiannual (7/1/16-12/31/16)

**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 Tier I 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 and 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 a program that informs high school students about transportation studies and encourages undergraduates to pursue advanced transportation studies.

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 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.	Numerous projects have been completed, ongoing projects are in the process of being completed, and one project has recently been reviewed and approved.	No new research projects was approved, and all ongoing projects are completed or being finalized.

**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:**  
“NOTHING TO REPORT”
- **EDUCATION AND WORKFORCE DEVELOPMENT ACTIVITIES:**  
“NOTHING TO REPORT”
- **TECHNOLOGY TRANSFER ACTIVITIES:**  
“NOTHING TO REPORT”

**2. PRODUCTS: What has the program produced?**

**Research projects awarded**

No new project was awarded during this period.

**Publications, conference papers, and presentations.**

**Journal publications**

- Shariati, A. and Schumacher, T. (2016). Eulerian-Based Virtual Visual Sensors to Measure Dynamic Displacements of Structures. Structural Control and Health Monitoring. Online first on December 23. DOI: 10.1002/stc.1977.
- Walker, K., Miller, T. H., Gupta, R., Shariati, A., and Schumacher, T. (2016). Development of Virtual Visual Sensor Applications for Wood Structural Health Monitoring. ASTM Journal of Testing and Evaluation. Vol. 46 (1). DOI: 10.1520/JTE20160194.
- Binder, S. B., & Greer, A. (2016). “The devil is in the details: Linking home buyout policy, practice, and experience after hurricane Sandy.” Politics and Governance, 4(4), 97-106.

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

“Nothing to Report”

### Other publications, conference papers and presentations.

- Greer, A., and Brokopp Binder, S. (2016): "A Historical Assessment of Home Buyout Policy: Are We Learning or Just Failing?," Housing Policy Debate, DOI:10.1080/10511482.2016.12452094
- Chu, Pei, "Black Carbon as a Redox Catalyst and Microbial Electron Storage Medium for Stormwater Pollutant Degradation." December 2016, National Kaohsiung Marine University, Taiwan.
- McNeil, Sue, London, Mosi and Trimbath, Susanne. (2016). "Making connections at the state and regional level between infrastructure and economic growth : a perspective from the United States," Regional Cohesion Policies: a Comparison between Italy and United States, University of Calabria, Rende (Cosenza), October 18-19, 2016 organized by the Dipartimento di Scienze Politiche e Sociali, University of Calabria, and sponsored by the American Studies Center of Naples.
- Chiu, Pei, "Mechanisms and Applications of Biochar-Supported Microbial Transformation of Environmental Contaminants." August, 2016. The 252nd American Chemical Society (ACS) Fall National Meeting, Philadelphia, PA. Oral presentation.
- Chiu, Pei, "Removal of Nitrogen and Phosphorus from Stormwater in Bioretention Cells Using Zero-Valent Iron and Biochar." August, 2016. MATS-UTC Annual Meeting, Charlottesville, VA. Poster presentation.
- Schumacher, T. and Harris, D. K. (2016). "Monitoring of Concrete Bridges Using Digital Videos and Imagery." Session entitled Overview and Applications of SHM Technologies for Concrete Structures at the ACI Fall 2016 Convention. Philadelphia, PA. October 23-27.
- Schumacher, T. and Shariati, A. (2016). "Estimation of Bridge Cable Forces using Virtual Visual Sensors from Digital Videos." ASNT NDE/NDT for Highways and Bridges: Structural Materials Technology. Portland, OR. August 29-31.
- Tian, J., Jin, J., Saquing, J.M., Yu, Y., Chiu, P.C., Guo, M., and P.T. Imhoff (2016) "Biochar Addition to Stormwater Treatment Media for Enhanced Nitrogen Removal and Hydraulic Performance," US Biochar Initiative Biochar 2016, The Synergy of Science and Industry: Biochar's Connection to Ecology, Soil, Food and Energy, Portland. OR.
- Tian, J., Jin, J., Chiu, P., Guo, M., and P.T. Imhoff (2016) "The Impact of Biochar on Bioretention Nitrogen Removal and Hydrologic Performance," Fall Meeting of the American Geophysical Union.
- Herning, Gordana, Andres Roda, Ali Maher, and Sue McNeil, "Resilience Considerations in Transportation Infrastructure," Symposium on Current Issues of Architecture and Construction, Armenia, November 21 2016.
- Imhoff, P.T., Chiu, P., Maresca, J., Brown, J., Panta, S., Hegberg, C., and L. Trout, Reducing Stormwater Volume and Nutrients with Biochar, National Fish and Wildlife Foundation Chesapeake Bay Stewardship Fund Webinar, Annapolis MD, 2016.
- McNeil, S., Herning, G. and Maher, A., "Resilience, Performance Measurement, and Asset Management: Connecting the Concepts," TRB Webinar: Integrating Climate Change Resilience into Transportation Asset Management, October 13, 2016.
- "Repair of Damaged Prestressed Concrete Girders with FRP and FRCM Composites" by Vanessa Pino, Antonio Nanni, Carin Roberts-Wollmann and Thomas Cousins, Proceedings of the International Conference on Advanced Composite Materials in Bridges and Structures (ACMBS), Vancouver, British Columbia, Canada, August 24-26, 2016.

- “Material Characterization of FRP and FRCM Systems for the Strengthening of Prestressed Concrete Girders” by Vanessa Pino, Antonio Nanni, Carin Roberts-Wollmann and Thomas Cousins, Proceedings of the International Conference on Advanced Composite Materials in Bridges and Structures (ACMBS), Vancouver, British Columbia, Canada, August 24-26, 2016.
- “Repair of Damaged Prestressed Concrete Girders with FRP and FRCM Composites” by Vanessa Pino, Antonio Nanni, Diana Arboleda, Carin Roberts-Wollmann and Thomas Cousins accepted to the ASCE Journal of Composites for Construction.

#### **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.**

Nothing to report.

#### **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. Soheil Nazarian (University of Texas at El Paso), Dr. Steven B. Chase (University of Virginia), Dr. Carin Roberts-Wollmann (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 Virginia**, Charlottesville, VA

**Virginia Polytechnic Institute**, Blacksburg, VA

### What other organizations have been involved as partners?

Organization Name	Location of Organization	Partner's contribution to the project
New Jersey Department of Transportation	1035 Parkway Ave., Trenton, NJ 08625	Financial support; Collaborative research; Personnel exchanges
WTS International	1701 K Street, NW, Suite 800, Washington DC 20006	Female participation in the transportation field
Utah Department of Transportation	4501 South 2700 West, Salt Lake City, UT 84114	Financial support; Collaborative research; Personnel exchanges; Facilities
Virginia Transportation Research Council (VTRC) (previously VCTIR)	530 Edgemont Road, Charlottesville, VA 22903	Financial support; Collaborative research; Personnel exchanges
Virginia DOT	Richmond, VA	Financial support; Collaborative research; Personnel exchanges
Oregon DOT	Salem, OR	Project customers/managers
Delaware Department of Transportation	Dover, DE	Project customers/managers
TxDOT	Austin, TX	Financial support; Collaborative research; Personnel exchanges
California DOT	Sacramento, CA	Project customers/managers
El Paso MPO	El Paso, TX	Financial support; Collaborative research; Personnel exchanges
Bridge Diagnostics Inc.	Boulder, CO	Collaborative research
The Biochar Company	Berwyn, PA	Collaborative research
Ramaiah Institute of Technology	Bengaluru, Karnataka, India	Personnel exchange
Old Dominion University	Norfolk, VA	Collaborative research
Metropolitan Transportation Commission	San Francisco Bay Area, CA	Collaborative research
Applied Research Associates Inc.	Panama City, FL	Collaborative research
Western Transportation Institute at Montana State University	Bozeman, MT	Collaborative research
reGenesis Consulting Services, LLC	Columbia, SC	Collaborative research
Technologies for Safe and Efficient Transportation	Pittsburgh, PA	Collaborative educational projects
Township of Sea Bright	Sea Bright, NJ	Financial support, in-kind support, facilities, collaborative research, personnel exchanges
Nexight Group	Silver Spring, MD	Workshop facilitator

### 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 partners have plenty of communications and virtual meetings through the year.
  - Delaware Environmental Institute, University of Delaware

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

- Dr. Toni Nanni, University of Miami: Collaborated with Virginia Tech on the VCTIR repair project.
- Vanessa Pino, University of Miami: Collaborated with Virginia Tech on the VCTIR repair project.
- Charles H. Hegberg, reGenesis Consulting Services
- Applied Research Associates Inc.: On the project entitled “Performance Determination of Precast Concrete Slabs Used for the Repair of Rigid Pavements”, ARA collaborated in data collation and through the sharing of historical data.
- Metropolitan Transportation Commission: On the project titled “Multi-objective Sustainable Model for Transportation Asset Management Practices”, MTC allowed access to the pavement management system and shared historical data.
- Jason Arndt, Bridge Maintenance Engineer, Delaware Department of Transportation
- Ioannis Koutromanos has served as a Co-PI from the VCTIR matching project for the UTC project “Evaluation of Repair Techniques for Impact Damaged Prestressed Beams”, and has served in an advisory role to students performing finite element analysis on this project.

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

- Dr. Ramappa Prabhakara, Professor and Department Head, Civil Engineering, Ramaiah Institute of Technology, Bangalore, India: Dr. Prabhakara has collaborated on the project titled “Guidelines for Embedment Length of Carbon Fiber Reinforced Polymer (CFRP) Strips in Near Surface Mount (NSM) Retrofitted Concrete Structures”.
- Rutgers CAIT is a partner in the project entitled “Sustainable Design and Management of Industrial Assets through Total Value and Cost Ownership” awarded to Politecnico di Milano in collaboration with the University of Cambridge and the Universidad de Sevilla by the MARIE SKŁODOWSKA-CURIE ACTIONS Research and Innovation Staff Exchange (RISE). Rutgers is part of the project academic partnership which includes other institutions of higher education such as the University of Pretoria, South Africa, India Institute of Technology, Pontificia Universidad Catolica de Valparaiso, Chile and Pontificia Universidad Catolica del Peru as well as experts from industrial companies. The involvement will be achieved through the hosting of interviews and workshops related to how life cycle management is possible thanks to total value and cost of ownership with the goal of providing the asset owner with the capability of developing a sustainable factory according to economic and environmental requirements of the local industry.

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

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

#### **RESEARCH PROJECTS COMPLETED**

<b>Outputs</b>	<b>Expected Outcomes</b>	<b>Impacts</b>
“COLLABORATIVE PROPOSAL: Big Data: Opportunities and Challenges in Asset Management” (Rutgers University, University of Delaware and Utah State University)	The overall objectives of this project are to define "big data" for asset management purposes and to identify opportunities for data integration, data mining, visualization, meta data and other techniques for data aggregation.	The product of this research will be a catalog of tools and techniques to support asset management.

<p>“Asphalt : Rheology and Strengthening through Polymer Binders” (University of Delaware)</p>	<p>The goal of this project is to work cross-discipline (pavement engineering and mathematical science) to carry out experiments (laboratory and field studies) and couple those results with mathematical modeling to better understand the properties of polymer modified asphalts.</p>	<p>An attempt will be made to introduce the proposed methodology as part of a mechanistic pavement design approach. A series of numerical and design examples will be provided to guide engineers in selecting the inputs for analysis.</p>
<p>“Performance Life of HMA Mixes” (University of Texas at El Paso)</p>	<p>This project focuses on evaluating and validating the performance lives of common mixes.</p>	<p>The product of this research will provide a comprehensive tool relating the HMA mix to performance by means of linking the mix type, design and construction information, and pavement management information data.</p>
<p>“Evaluation of Uncertainty in Determination of Neutral Axis and Deformed Shape of Beam Structures” (Princeton University)</p>	<p>The overall objective is to research and develop universal SHM methods based on strain monitoring using series of parallel long-gauge fiber-optic sensors.</p>	<p>The creation of robust data analysis algorithms for damage identification and structural identification will be useful to (1) owners or managers of structures that implement and benefit from SHM system (e.g., FHWA, DOTs); (2) providers of SHM solutions (e.g. companies that provide instrumentation and data analysis solutions for SHM) and (3) researchers in the area of SHM.</p>
<p>“Addressing the Issue of Insufficient Information in Data-Based Bridge Health Monitoring” (Columbia University)</p>	<p>The goal is to develop, investigate and validate, through numerical and experimental test data, techniques to address the issues and consequent limitations related to scarcity of measured data in data-based bridge health monitoring.</p>	<p>Through this new approach, bridge engineers will be able to create more reliable data-based models using the same amount of recorded data.</p>
<p>“Environmental Assessment of Airport Pavement Design and Construction Alternatives” (Rutgers University)</p>	<p>The proposed research is to develop an environmental assessment tool to quantify the emission during the construction and maintenance phases of airport pavement.</p>	<p>This environmental assessment tool can help airport authorities incorporate environmental sustainability into their decision-making process.</p>
<p>“Cookbook for Rheological Models – Asphalt Binders” (University of Delaware)</p>	<p>The goal of this effort is to develop a guidebook that provides guidelines for using appropriate rheological models of asphalt binders.</p>	<p>This guidebook will present the effective practices for using rheological (binder) models in pavement analysis and design, and will identify the key advantages/disadvantages of each model.</p>
<p>“Nondestructive Evaluation of Four Sister Bridges in Virginia Using Manual NDE Technologies and Robotic Platform RABIT” (Rutgers)</p>	<p>Four sister bridges will be tested using manual NDE technologies and the robotic platform RABIT to quantify the influence of bridge</p>	<p>The utilization of automated platforms for non-destructive evaluation can streamline to process of bridge condition</p>



University)	design and traffic on the performance of concrete bridge decks and to evaluate the performance of the RABIT platform in relation to manual NDE technologies.	evaluation, and could lead to the adoption of automated platforms in numerous other applications.
“Development of an Online Platform for Streamlining Highway LIDAR Data Collection, Sharing, and Processing” (Rutgers University)	This project aims to develop an online platform for sharing, visualizing, and analyzing lidar data to support typical DOT data needs.	An effective data infrastructure for lidar technology offers potential to drastically improve state DOTs’ design, operation, and maintenance practices.
“COLLABORATIVE PROPOSAL: Evaluation of Biotechnologies for Flexible Pavement Applications” (Rutgers University, University of Delaware and University of Texas at El Paso)	The main goal of the project is to conduct an evaluation/approval of bio-based materials that will enhance the performance of flexible pavements or used in substitution of current materials at a considerable cost reduction that is environmentally beneficial.	A Best Practices document describing the benefit of bio-based materials in the construction of flexible pavements and a Technical Brief, presenting the mathematical model development and its potential use/application will be generated for distribution.
“Collaborative Proposal: Resilience: Definitions, Measurement, Tools and Research Opportunities” (Rutgers University)	The objective of this research is to develop a research roadmap that documents relevant current and ongoing research, key concepts and gaps in our knowledge that require research.	The proposed research will contribute to a safe and economically competitive transportation system by providing a better understanding of the measure of resilience, what is needed to measure resilience, and how to operationalize these concepts.
“Understanding the Relationships between Household Decisions and Infrastructure Investment in Disaster Recovery: Cases from Superstorm Sandy” (University of Delaware)	The focus of this exploratory project is to connect the qualitative data provided by adult members of households that sustained substantial damages from Hurricane Sandy to the quantitative data that are used in the planning and infrastructure decision making process.	A workshop with representatives of impacted communities, Federal and state Emergency Management Agencies, the relevant MPOs, and state DOTs will be held to better explore the integration of the qualitative data into the household decision making process.
“Life Cycle Cost Reduction Study” (Rutgers University)	The objective of this research is the development of a guideline on life cycle cost reduction, which will address the challenge and provision of critical decision-making tools to optimize both network-level and project specific improvements.	Asset owners will be able to gain a better understanding for the techniques being used by industry, familiarize themselves with available methodologies and choose a level that aligns with their agency’s philosophy and policy.
“Modeling of interaction between steel and concrete in continuously reinforced concrete pavements” (University of Texas, El Paso)	The results of this project will be implemented into NYSLAB to expand its capabilities and to be able to analyze CRCPs as well as JPCPs.	The work proposed will lead to the development of better modeling tools providing DOTs with the necessary tools to assess the performance of pavement structures under various loading conditions.

<p>“Prototype development of an piezo-heating array for deicing applications on bridges” (Rutgers University)</p>	<p>The objective of this research is to develop and construct a model prototype that demonstrates how piezo-heating arrays can be embedded in bridge approach slabs, generating sufficient heat for deicing operations.</p>	<p>This technology offers highway departments a new method of mitigating winter conditions with lower annual costs, reduced deterioration of structures and pavements while improving the environment.</p>
<p>“Pilot Test Smart Phone/Tablet App for Paratransit Demand-Response Passenger Pick-up Alerts to Assist Passenger with Disabilities and Reduce No-Shows and Vehicle Dwell Times” (Rutgers University)</p>	<p>The product of this project will be a smart phone/tablet application for alerting ADA paratransit passengers 5 minutes prior to the arrival of the vehicle.</p>	<p>The proposal work could be of great use to the ADA Complementary paratransit service. It would increase the efficiency of the their system by allowing a higher level of connectivity between the drivers and passengers.</p>
<p>“Evaluation of Repair Techniques for Impact Damaged Prestressed Beams” (Virginia Polytechnic Institute)</p>	<p>The objectives of this research are to evaluate existing methods of repair of impact damaged precast, prestressed bridge beams, and develop guidelines for best methods for evaluation and repair.</p>	<p>It is envisioned that the policy developed will be adopted by VDOT for their use in evaluating and repairing impact damaged prestressed concrete bridge beams.</p>
<p>“Investigation of Sediment Suspension Technology” (Rutgers University)</p>	<p>The aim of this project is to investigate current existing in-situ sediment suspension measurement technologies and to provide guidance on the scaling up of the technology.</p>	<p>Environmental managers would be able to measure the potential erodability of the sediments in and around harbor systems.</p>
<p>“Tracking Housing Recover in Sea Bright, NJ and the Relationship to Infrastructure Renewal” (University of Delaware)</p>	<p>The objective of this study is to determine how household decisions evolve over time by resurveying the residents of Sea Bright, NJ.</p>	<p>The results of this project would produce a unique database of housing recovery information following a major storm, which would be of great value to disaster researchers and decision-makers.</p>
<p>“Traffic Safety Measures Using Multiple Stream Real Time Data” (Rutgers University)</p>	<p>The main objective of this project is to build advanced analytics to estimate a composite traffic safety risk measure that change temporally and spatially, and take into account driver behavior, roadway quality conditions and historical safety characteristics of roadways.</p>	<p>The proposed analytics opens up a new frontier for the connected vehicle and smart car technologies by creating an environment where drivers and vehicles act in a closed loop in the roadway and externalities and allows for these drivers to respond to traffic risks that may be ahead.</p>
<p>“HMA Pay Adjustment” (Rutgers University)</p>	<p>The major goal of this study is to search and critically evaluate the literature to determine how the HMA quality characteristics can best be incorporated into the existing NJDOT HMA pavement specification to produce a comprehensive and effective multi-characteristic acceptance specification.</p>	<p>Improve the state-of-good repair of multimodal transportation infrastructure systems.</p>

Final research reports for projects completed during this reporting period will be posted on Center's websites and distributed to designated repositories.

#### **RESEARCH PROJECTS REPORTED PREVIOUS PERIODS**

- "Defining and Quantifying State of Good Repair (SGR) for the Pedestrian Network" (University of Delaware)
- "Biochar as a Rechargeable Geobattery to Promote Nitrogen Removal in Stormwater from Roadways" (University of Delaware)
- "Research Challenges Toward the Implementation of Smart Cities in the United States" (University of Texas at El Paso)
- "A Multi-objective Sustainable Model for Transportation Asset Management Practices" (University of Texas at El Paso)
- "Evaluating the Effectiveness of Traffic Diversion and Managed Lanes on Highway Work Zones" (NJIT)
- "Effects of Temperature on Bridge Dynamic Properties" (Utah State University)
- "Aerodynamic Flow Deflector to Increase Large Scale Wind Turbine Power Generation by 10%"
- "Performance Determination of Precast Concrete Slabs used for the Repair of Rigid Pavements" (University of Texas at El Paso)
- "COLLABORATIVE PROPOSAL: Numerical Simulation of Intelligent Compaction Technology for Construction Quality Control" (University of Texas at El Paso and Rutgers University)
- "COLLABORATIVE PROPOSAL: Multi-Sensor Sheets Based on Large-Area Electronics for Advanced Structural Health Monitoring of Civil Infrastructure" (Princeton University, University of Delaware, and Columbia University)
- "COLLABORATIVE PROPOSAL: Feasibility of Bridge Structural Health Monitoring Using Short Term, Data Acquisition System" (Utah State University, Virginia Polytechnic Institute and Columbia University)
- "Highly Efficient Model Updating for Structural Condition Assessment of Large-scale Bridges" (University of Texas at El Paso)
- "Forensic Testing of Post Tensioned Concrete Girders" (Utah State University)
- "Bridge Responses Due to Temperature Variations" (Utah State University)
- "Combining Model Based and Data Based Techniques in a Robust Bridge Health Monitoring Algorithm" (Columbia University)
- "Exploration of Video-Based Structural Health Monitoring Techniques" (University of Delaware)
- "Forensic Testing of a Double Tee Bridge" (Utah State University)
- "COLLABORATIVE PROPOSAL: Analyzing Asset Management Data Using Data and Text Mining" (Rutgers University and Utah State University)
- "Mixing and Compaction Recommendations for Warm Mix Asphalt (WMA) with Recycled Asphalt Shingles (RAS)" (Rutgers University)
- "Development of a Real-Time Vibrator Tracking System for Intelligent Concrete Consolidation" (Rutgers University)
- "3D Laser Scanning for Quality Control and Assurance in Bridge Deck Construction" (Rutgers University)
- "Quantifying Impact of Port Truck Traffic on Highway Operations Using GPS-Based Speed Data" (NJIT) "COLLABORATIVE PROPOSAL: Analysis of Interactions between the Marine Terminal and Highway Operations" (Rutgers University and NJIT)
- "Railroad Operations Research and Training" (Rutgers University)
- "Life Cycle Assessment of Asphalt Pavement Maintenance" (Rutgers University)

- “Mathematical Modeling and Experimental Responses of Polymer Modified Asphalt” (University of Delaware)
- “Multi-Resolution Information Mining and a Computer Vision Approach to Pavement Condition Distresses” (University of Delaware)
- “Better State-of-Good-Repair Indicators for the Transportation Performance Index” (University of Delaware)
- “Virginia Bridge Information Systems Laboratory” (University of Virginia)
- “Development for Transportation Asset Management Inventory & Management Tools” (Utah State University)
- “Improved Connection Details for Adjacent Prestressed Bridge Beams” (Virginia Polytechnic Institute)
- “ABC Deck Panel Testing” (Utah State University)
- “Forensic Testing of Prestress Concrete Girders after Forty Years of Service” (Utah State University)
- “Fiber Optic Monitoring Methods for Composite Steel-concrete Structures Based on Determination of Neutral Axis and Deformed Shape” (Princeton University)
- “Correlation between Hurricane Sandy Damages along NJ Coast with Land Use, Demographic and Other Local Characteristics” (Rutgers University)
- “Quantitative Acoustic Emission Monitoring of Fatigue Cracks in Fracture Critical Steel Bridges” (University of Delaware)
- “Elevated Temperature Properties of Weathering Steel (Princeton University)
- “Warehouse Location and Freight Attraction in the Greater El Paso Region” (University of Texas at El Paso)
- “Development of a Bridge Resource Program for the New Jersey Department of Transportation” (Rutgers University)
- “COLLABORATIVE PROPOSAL: Enhancing Nitrogen Removal in Stormwater Treatment Facilities for Transportation” (University of Delaware and Rutgers University)

#### **DISCONTINUED RESEARCH PROJECTS**

- “The Effects of Network Characteristics on Traffic Flows and Emission” (Rutgers University)
- “Guidelines for embedment length of carbon fiber reinforced polymer (CFRP) strips in near surface mouth (NSM) retrofitted concrete structures” (University of Delaware)

#### **What is the impact on other disciplines?**

“Nothing to report.”

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

“Nothing to Report”

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

“Nothing to Report”

#### **What is the impact on technology transfer?**

- It is anticipated that all projects will lead to the adoption of new practices or inform policy.

**What is the impact on society beyond science and technology?**

<b>Outputs</b>	<b>Outcomes/Impacts</b>
Results of ongoing research projects	Increased safety of structures and saving of public funds through sustainable preservation and maintenance planning of existing infrastructure made possible by knowledge and understanding of true structural behavior.

**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"