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Center Director Name, Dr. Ali Maher, CAIT Director.
E-mail address: mmaher@soe.rutgers.edu **Phone number:** 848-445-0579

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@soe.rutgers.edu **Phone number:** 848-445-2999

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

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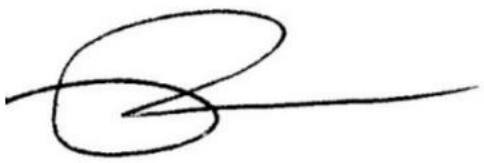


COVID-19 Impact on Consortium Activities

New Jersey and New York were the states hardest hit by the COVID-19 pandemic, especially early on both in terms of sickness and death related to the virus but also in terms of preventative measures taken to slow the spread. Even now in late October 2020, data from the Centers for Disease Control and Prevention shows the high toll that the Coronavirus is taking on New Jersey as it reports 182 deaths per every 100k population. As a result of this and limitations on public gatherings, work-from-home mandates, and more, the region has seen significant structural changes with how it operates during this global pandemic.

At the Rutgers Center for Advanced Infrastructure and Transportation (CAIT), the impacts of these changes have been felt on research and operations too. With partner institutions across New York, New Jersey, and Puerto Rico, CAIT realized early on that no two places are in the same situation. Across projects this was felt too. While some were able to continue as planned, others had to be extended or revisited to address behavioral changes as a result of the pandemic (such as lower traffic volumes). Since many CAIT laboratories support the construction industry and State agencies, CAIT requested that they be classified as essential, which resulted in the labs remaining operational but with numerous safety precautions including distancing, reduced occupancy, and staggered work schedules. That being said, many projects still required modified research plans to accommodate the "new normal." Furthermore, as per the University's safety precautions undergraduate students were not allowed to work on campus, including laboratories, for several months. This resulted in a shift of support away from undergraduate students over to graduate students and research staff. Unfortunately, this impacted the overall engagement of undergraduate students. Besides shifting research plans and extending end dates this ultimately resulted in delays starting some new projects due to limited staff resources as well as reduced field and lab access. Many faculty and researchers are able to work remotely, and the lab operations continue at a high functional level—but with some impact. All meetings, training classes, and academic classes have been remote/virtual since March 2020 and are expected to continue online until at least next year. All in all, CAIT found that the best path forward was to establish open lines of communication with all partners and practice leniency through extending projects when needed, recognizing and tracking ongoing challenges, and working together as a cohesive unit.

While the COVID-19 pandemic has brought about new challenges, it has also offered CAIT new opportunities for research, connecting with stakeholders, and sharing valuable information. For example, starting in June CAIT launched the CAIT Seminar Series—a set of monthly webinars on key topics ranging from port logistics to geotechnical asset management. CAIT has invited its own researchers as well as industry partners and stakeholders to present during these webinars and share information with the larger UTC community. CAIT Director Dr. Ali Maher has been actively involved with the NJ Governor's Restart and Recovery Council advising on transportation infrastructure funding prioritization aimed to spur recovery from COVID-19, create jobs, and improve the quality of life in the state. Additionally, CAIT-affiliated researcher Dr. James W. Hughes has been tracking the impact of COVID-19 on New Jersey's economic recovery through the CAIT-published "Fast Track Research Notes." To date, the six reports

published so far have been downloaded more than 7,500 times on the Rutgers University Library system. And finally, the pandemic has created some new research opportunities for CAIT as its local stakeholders look for new options to keep public transportation safe. Notably, NJ Transit commissioned a study by CAIT to analyze the use of ultraviolet-c for disinfecting the agency's bus fleet from the virus. This resulted in several new partnerships including The Rutgers School of Public Health Environmental and Occupational Health Safety Institute as well as several other State and Federal agencies. The information gained allowed the agency to make more informed asset management and safety decisions for its customers going forward.

In summary, although Region 2 has been one of the most significantly COVID-19 impacted regions it has adapted quite rapidly. CAIT has always been a dynamic organization—and given the situation—CAIT is still operating at near normal business and research levels.

1. **ACCOMPLISHMENTS** (What was done? What was learned?)

What are the major goals and objectives of the program?

The CAIT Region 2 UTC Consortium's research vision aligns with the ongoing national dialogue on the state of the U.S. transportation infrastructure, and the emerging consensus on the need for significant investment to fill condition gaps, improve/expand existing systems, and build for the future.

The Consortium's **primary research focus** will be on "Improving the Durability and Extending the Life of Transportation Infrastructure," with additional elements of "Preserving the Existing Transportation System," such as resilience. Using Region 2 as a complex infrastructure laboratory, the Consortium will contribute to: 1) extending the life of the region's legacy systems, 2) building future systems with consideration to changes in living patterns and where people and products will move to and from, and 3) the use of technologies and better design approaches to maximize the use of both old and new transportation infrastructure assets.

The Consortium will structure its **education and workforce development activities** around a "cradle to grave" approach, developing programs that attract more people to the transportation industry, fostering skills to sustain them within the industry, and provide the workforce with professional development.

Gaining and sharing knowledge is the critical first step toward developing a transportation system that improves the durability and extends the life of transportation infrastructure. To this end, the Consortium will conduct **technology transfer** of research through implementation projects, knowledge transfer activities, and exploration of patents.

What was accomplished under these goals?

Research

The peer-review panel has approved 5 projects during this cycle. Three research projects are currently under review.

New Projects:

CAIT-UTC-REG35	NJDOT Flood Risk Visualization Tool *Abstract:* New Jersey's transportation system, which comprises a vast array of infrastructure, is vulnerable to a range of extreme weather and climate-related hazards including warming temperatures, temperature extremes, intense precipitation events, drought, rising sea levels, and storm surges. The impact of extreme weather and changing climate conditions on transportation infrastructure and assets will vary by mode and location but are likely to be very costly. The primary goal of this proposal is to work with NJDOT to develop a new visualization tool and enhanced capacity for NJDOT personnel to assess the flood vulnerability of its infrastructure and assets. The intended outcome of the project will include new tools and workflows designed to better inform NJDOT asset management and project development decisions as well as operations and maintenance procedures. The integration of flood hazard vulnerability data into existing capital planning and asset management processes will, over time, improve the overall durability and resilience of transportation infrastructure weather and climate hazards.	RU
CAIT-UTC-REG-36	Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing *Abstract*: The primary goal of this proposal is to leverage the testing being conducted by FHWA within the BEAST lab to develop a better understanding of the demands for which bridge decks are exposed to in service. The hope is that this work will ultimately contribute to improved design/material/construction approaches to produce more durable bridge decks. The intended outcome of the project is to determine the role of temperature gradients on structural response and deck stress. This knowledge will provide more accurate estimation of deck demands and ensure that new designs properly account for temperature effects thereby resulting in more durable bridge decks that are less prone to cracking. Results of this research will be presented to AASHTO for possible revision of bridge design specification. Results will also be made available to DOTs for incorporation into their design methodologies.	RU
CAIT-UTC-REG37	Impact of Recycled Plastic on Asphalt Binder and Mixture Performance *Abstract*: The primary goal of this proposal is to evaluate the compatibility of different plastics within asphalt and evaluate the resultant asphalt binder and mixture performance of the plastic-modified material. The intended outcome of the project is to develop a new material that would provide both a structural material for long, last asphalt pavements, as well as a potential end use for recycling plastics. It is anticipated that a series of webinars would be required to take place to state and local agencies. The webinars would provide information pertaining to the appropriate waste plastic stream products for asphalt binders and mixtures, methods and procedures on blending the recycled plastic with the asphalt materials, necessary changes and/or modifications to current mixture design procedures, and expected change to the handling and performance of plastic modified asphalt mixtures.	RU
CAIT-UTC-REG39	FDR Stabilizer Selection Using Simple Soil Tests *Abstract*: Full Depth Reclamation (FDR) is a commonly used technique to improve the quality of the base for local roads and streets. Stabilization is done using mechanical, chemical, or bituminous materials. One of the most important steps is choosing the correct stabilizer for the current road conditions. However, the choice of the material to be used is too often based upon discussions with a local vendor or other empirical methods. The most common soil tests that are used are grain size analysis and plasticity. While grain size is critical, the plasticity of most base gravels is very low and not an indicative method for which stabilizer will actually have the best chances of success. The primary goal of this proposal is to use the sand equivalent (SE) test with grain size analysis to overcome this limitation and provide a quick and economical method to allow the best stabilizer to be chosen.	Cornell
CAIT-UTC-REG41	Affordable On-Demand Testing of Water Contamination Using a Portable Nanoelectronic Lead Detector *Abstract:* The goal of this work is to develop and deploy a rapid, accurate lead sensing system for lead analysis in drinking water. The deliverable for this project will be the benchtop prototype itself along with a data report that will show the applicability of the system in a drinking water system. In addition to accuracy, it is also the goal of the team to demonstrate that the system can be used to sample a high volume of samples in a field setting with all of the difficulties that may come along with it. An on-site demonstration is expected to take place at the end of this project for stakeholders to inform them of the availability and potential benefits to this type of sensing system.	RU

NJDOT Flood Risk Visualization Tool

Photo @Metropolitan Transportation Authority

New Jersey has been no stranger to its share of storms this year, as Tropical Storm Isaias ripped through the Northeast region earlier this summer, leaving behind destruction and power outages across the state. It is as important now as ever to ensure that our transportation infrastructure is prepared for storms, extreme weather events, and potential natural disasters. A new UTC project at CAIT is developing a tool that can enhance capacity for NJDOT personnel to assess the flood vulnerability of its infrastructure and assets. The project includes development of tools and workflows designed to better inform NJDOT project development and asset management decisions as well as maintenance and operations procedures. The tool will enable NJDOT to integrate data about current and future flood hazard vulnerability into existing capital planning and asset management processes. Over time, the intent is to improve overall resilience of transportation infrastructure to weather and climate hazards.

Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing

As initial testing continues at CAIT's Bridge Evaluation and Accelerated Structural Testing (The BEAST) lab, it provides new opportunities for understanding the elements in-service bridge decks are exposed to. The primary goal of this research is to leverage testing being conducted by FHWA within The BEAST lab to better understand the demands for which bridge decks are exposed to while in service. The outcome of this project can help to determine the role of temperature gradients on structural response and deck stress. This knowledge will provide more accurate estimation of deck demands and ensure that new designs account for temperature effects resulting in more durable bridge decks that are less prone to cracking. Results from this research also have the potential to improve and develop design, material, and construction approaches to produce more durable bridge decks.

Ongoing Projects:

CAIT-UTC-REG 5	Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities	Atlantic Cape Community College
CAIT-UTC-REG9	Delivering maintenance and repair actions via automated/robotic systems	RU
CAIT-UTC-REG13	Virtual Tour (VT), Informational Modeling (IM), and Augmented Reality (AR) for Visual Inspections (VI) and Structural Health Monitoring (SHM)	PU
CAIT-UTC-REG15	Flood Vulnerability Assessment and Data Visualization for Lifeline Transportation Network	Rowan
CAIT-UTC-REG16	Fire In Tunnel Collaborative Project	PU/SUNY-Buffalo/NJIT
CAIT-UTC-REG24	Application of Advanced Analytic and Risk Techniques to Railroad Operations Safety and Management	RU
CAIT-UTC-REG25	Investigation of Balanced Mixture Design for New York State Asphalt Mixtures	RU
CAIT-UTC-REG26	Passenger Flow Modeling on Platform Tracks in Transit Stations	RU

CAIT-UTC-REG27	Designing Concrete Mixtures with RCA	NJIT
CAIT-UTC-REG28	Cost-effective Bridge Decks for Improved Durability and Extended Service Life	RU
CAIT-UTC-REG29	Seismic Vulnerability Assessment of Deteriorated Bridges	SUNY Buffalo
CAIT-UTC-REG30	Durable and Electrified Pavement for Dynamic Wireless Charging of Electric Vehicles	RU
CAIT-UTC-REG31	Evaluating the Safety and Mobility Impacts of American Dream Complex: Phase I (Feasibility Study, and Data Acquisition)	Rowan
CAIT-UTC-REG32	Rotorcraft Landing Sites – An AI-Based Identification System	Rowan
CAIT-UTC-REG33	Real-Time Prediction of Storm Surge and Wave Loading on Coastal Bridges	SUNY Buffalo

Completed Projects:

CAIT-UTC-REG1	Augmented Reality (AR) in Life-Cycle Management of Transportation Infrastructure Projects	RU
CAIT-UTC-REG2A	Sustainability and Resiliency of Concrete Rapid Repairs Utilizing Advanced Cementitious Materials – Freeze/Thaw Loads	NJIT
CAIT-UTC-REG2B	Sustainable, Rapid Repair Utilizing Advanced Cementitious Materials	SUNY Buffalo
CAIT-UTC-REG3	Large-Amplitude Forced Vibration Testing for St-Id of Bridges and Foundation Reuse Assessment	RU
CAIT-UTC-REG4	Rail Track Asset Management and Risk Management	RU
CAIT-UTC-REG6	Airfield Pavement Management Framework using a Multi-Objective Decision-Making Process	RU
CAIT-UTC-REG7	MEMS Sensor Development for In-Situ Quantification of Toxic Metals in Sediment	RU
CAIT-UTC-REG8	Prioritizing Infrastructure Resilience throughout the Capital Planning Process	RU
CAIT-UTC-REG10	Policies, Planning, and Pilot Testing on Infrastructure Readiness for Electrical, Connected, Automated, and Ridesharing Vehicles	RU/Columbia
CAIT-UTC-REG11	Pavement Design for Local Roads and Streets	Cornell
CAIT-UTC-REG12	Laboratory Performance Evaluation of Pavement Preservation Alternatives	Rowan
CAIT-UTC-REG14	Performance-Based Engineering of Transportation Infrastructure Considering Multiple Hazards	SUNY Buffalo
CAIT-UTC-REG17	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part I - Analysis of failure of transportation signs due to Hurricane Maria	PUPR
CAIT-UTC-REG18	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part II – Analysis of pedestrian bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG19	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part III - Analysis of motor vehicle bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG20	Infrastructure Cybersecurity and Emergency Preparedness Academic and Non-academic Credential Development	SUNY Farmingdale
CAIT-UTC-REG21	Autonomous Vehicles: Capturing In-Vehicle Experience & Focus Group Follow-up with Persons with Autism and Other Disabilities at the 2019 Princeton University SmartDrivingCar Summit	RU
CAIT-UTC-REG22	Simulation of Degradation and Failure of Suspension Bridge Main Cables due to Natural and Anthropogenic Hazards	Columbia
CAIT-UTC-REG23	The Development of a Smart Intersection Mobility Testbed (SIMT)	RU
CAIT-UTC-REG34	Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events with the Convergence of Advanced Spatial Analysis, Infrastructure Modeling, and Storm Surge Simulations	RU

HIGHLIGHTS
Completed Projects

MEMS Sensor Development for In-Situ Quantification of Toxic Metals in Sediment (CAIT-UTC-REG7, Project Manager: Dr. Mehdi Javanmard)

Accomplishments: Researchers have developed a working prototype of highly accurate Microelectromechanical Systems chemical sensors, capable of detecting lead in sediment samples. This technology can rapidly (within 5 minutes) quantify lead in sediment samples. This will lower cost and increase speed that sites can be assessed for identifying toxic hotspots.
ROI: A technology that is capable of rapid and inexpensive identification and triaging of environmental-sediment hotspots in natural water sources. Rather than using brute force and costly approaches, the contaminated hotspots can easily be identified, which otherwise require dredging. This offers a more cost-effective method of environmental remediation. NJDOT has been contacted to showcase this technology and further discuss its capabilities.

Pavement Design for Local Roads and Streets (CAIT-UTC-REG11, Project Manager: Dr. David Orr)

Accomplishments: A user-friendly software tool, RoadPE: LHI, using mechanistic-empirical methods to assist local agencies with designing streets for various traffic spectra associated with low-volume roads has been developed. “Overall, I think it is a pretty impressive tool to use for pavement design,” said Tim Kelley, Engineering Technician at the Wyoming County Highway Department. Researchers also presented this product to a group of stakeholders as part of the CAIT Seminar Series this June.
ROI: Local highway departments in Preble, Hartland, Oswego, and more counties in New York State have been engaged. The tool allows local agencies to design roads properly for their required loads. “Experience,” budget constraints, and inappropriate tools often force towns to under-build roads, leading to premature failure and costly remediation.

Performance-Based Engineering of Transportation Infrastructure Considering Multiple Hazards (CAIT-UTC-REG14, Project Manager: Dr. Kallol Sett)

Accomplishments: Unless all components of a network are analyzed together, risks to the network may be underestimated. In this project, a novel risk-informed design framework that could enable a paradigm shift and the design of a resilient transportation network, moving away from the focus on individual components of a network, was developed.
ROI: This project can help reduce repair costs and downtime of highway infrastructure, reduce community impacts, and design safer, more economical transportation infrastructure.

Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part I - Analysis of failure of transportation signs due to Hurricane Maria (CAIT-UTC-REG17, Project Manager: Dr. Héctor J. Cruzado)

Accomplishments: Improvements in design and analysis of highway signs subjected to high winds and hurricanes. This project looked at damaged highway signs after Hurricane Maria and a design guide is expected as a result.
ROI: This project will increase the safety of the public during a hurricane and improve the resiliency of highway signs subjected to excessive wind.

Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part III - Analysis of motor vehicle bridges failures due to Hurricane Maria (CAIT-UTC-REG19, Project Manager: Héctor J. Cruzado)

Accomplishments: Improvements in design and analysis of motor vehicle bridges subjected to high winds and storms such as hurricanes. This project specifically looked at motor-vehicle bridge damage after Hurricane Maria, and a design guide was developed.
ROI: This project has the potential to increase safety of the travelling public during a hurricane event and improve the resiliency of motor vehicle bridges subjected to excessive wind.

Infrastructure Cybersecurity and Emergency Preparedness Academic and Non-academic Credential Development (CAIT-UTC-REG20, Project Manager: Kazem Oryani)

Accomplishments: This project designed and established academic credentials as well as non-credit short courses that will prepare participants to assess, mitigate, and plan for vulnerabilities related to transportation hubs.
ROI: The development of two new academic certificates fills an educational void in infrastructure cybersecurity and emergency preparedness, as well as promotes future workforce development and technology transfer activities through the credentials.

Autonomous Vehicles: Capturing In-Vehicle Experience & Focus Group Follow-up with Persons with Autism and Other Disabilities at the 2019 Princeton University Smart Driving Car Summit (CAIT-UTC-REG21, Project Manager: Cecilia Feeley)

Accomplishments: This project explored and documented the positive impacts autonomous vehicle transportation could have on persons with a broad array of disabilities and other transportation issues, as well as challenges that may hinder their successful usage of this revolutionary technology. This was done through the Princeton Summit that provided a unique opportunity to present AV to persons with disability to experience the technology first-hand.
ROI: This project allows for the experiences of users to be documented and shared with stakeholders such as policymakers, manufacturers, and others for analysis and decision-making.

Simulation of Degradation and Failure of Suspension Bridge Main Cables due to Natural and Anthropogenic Hazards (CAIT-UTC-REG22, Project Manager: Adrian Brugger)

Accomplishments: The goal of this project was to develop a well-defined methodology to estimate the remaining strength of a suspension bridge cable exposed to fire. The methodology will rely on a general-purpose Finite Element code (ABAQUS) that is commercially available and widely used in the profession.
ROI: A cable FEM model is being developed and calibrated using the extensive experimental data already available to the research team. This FEM model is expected to 1) provide high-confidence designs of new structures, 2) retrofit existing structures with novel hardening systems, 3) quantify more accurately hazards associated with traffic flow and access to cables, and 4) perform high-fidelity forensic investigations of structures subjected to fire events.

The Development of a Smart Intersection Mobility Testbed (SIMT) (CAIT-UTC-REG23, Project Manager: Peter Jin)

Accomplishments: This project is working toward establishing the pilot Smart Intersection Mobility (SIMO) testbed in downtown New Brunswick.
ROI: The testbed will be equipped with AV-grade LiDAR and computer vision sensors to collect real-time vehicle, pedestrian, and infrastructure change data. Data sharing and testing platforms will be built for testing and evaluating different mobility, safety, environmental, and energy applications.

Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events with the Convergence of Advanced Spatial Analysis, Infrastructure Modeling, and Storm Surge Simulations (CAIT-UTC-REG34, Project Manager: Jie Gong)

Accomplishments: To protect the security of public transportation infrastructure and the enormous amount of public assets, this project is developing a decision support tool that can assist infrastructure stakeholders in making decisions at the day-to-day operation level to protect communities from impeding flooding events as well as in making long-term decisions in mitigating future flood risks facing their current infrastructure assets and their future projects.
ROI: The expected outcome of this study is new software applications that are built for infrastructure resilience centered investigations. The software applications will be cloud-based which will allow infrastructure stakeholders such as DOT personnel, floodplain managers, and OEM coordinators to access and use it without any local installations on their computers.

Ongoing Projects

Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities (CAIT-UTC-REG 5, Project Manager: James Taggart)

Outputs: This proposal aims to design and develop training curricula including the development of assessment instruments for deriving both formative and summative learning outcomes.
Outcome: These curricula will evaluate the practical flight abilities of prospective UAS pilots. The team will also provide research into powered tether systems for long duration UAS flights. The team will evaluate UAS tether for use cases such as traffic monitoring.
Impacts: The project will evaluate UAS operations and make recommendations on procedures for inspection to assist decision making by regional agencies. This tool can significantly impact the quality of data and lower the risk portfolio for missions.

Delivering Maintenance and Repair Actions via Automated/Robotic Systems (CAIT-UTC-REG9, Project Manager: Dr. Jie Gong)

Outputs: Researchers held a workshop on identifying uses, characterizing research priorities in robotic systems, and aligning research visions on various identified research dimensions.
Outcome: The workshop featured a mélange of three communities: R+D, practitioners, and end-users. Several renowned speakers were invited.
Impact: The workshop informed infrastructure stakeholders and practitioners about available robotics tools to deliver infrastructure inspection and repair actions and provided critical

projection on future jobs in infrastructure maintenance. This will contribute to safer and more efficient infrastructure inspection and repair practices.

Virtual Tour (VT), Informational Modeling (IM), and Augmented Reality (AR) for Visual Inspections (VI) and Structural Health Monitoring (SHM) (CAIT-UTC-REG13, Project Manager: Dr. Branko Glisic)

Outputs: Virtual Tour (VT)/Informational Modeling (IM) prototype software and Image/Augmented Reality (AR) prototype software.
Outcome: A demonstration software that can be accessed on a mobile device, laptop, desk computer, virtual reality (VR) headset, or AR headset, depending on a user's needs. Validation will be performed on real structures, in particular Streicker Bridge in Princeton, NJ and/or the US202/NJ23 overpass in Wayne, NJ.
Impacts: This will have an impact on asset durability, resilience, and preservation, as the project method provides means to assist the actions that improves these three features.

Flood Vulnerability Assessment and Data Visualization for Lifeline Transportation Network (CAIT-UTC-REG15, Project Manager: Rouzbeh Nazari)

Outputs: A state of the art flood map for New Jersey towns that offers a unique picture of flood hazards, lifeline infrastructure, vulnerability assessments, and resiliency measures.
Outcome: This project provides more detailed, reliable, and current data on flood hazards resulting in a better picture of the New Jersey towns most likely to be impacted by flooding and a better foundation from which to make key legislative decisions/changes.
Impacts: This project assists decision makers and coastal communities with understanding the magnitude of flood s, quantifying impacts, and assisting with mitigation and resiliency planning.

Fire in Tunnel Collaborative Project (CAIT-UTC-REG16, Project Manager: Negar Khorasani)

Outputs: This project develops a methodology to achieve acceptable fire safety and minimize economic losses in a tunnel fire and will improve structural safety guidelines.
Outcome: The intended outcome of this project is to improve modeling techniques, make recommendations, and propose design guides for structural fire resistance of railway tunnels.
Impacts: Resilience of a tunnel subjected to fire is measured by expected downtime and loss of functionality following an event. If a key tunnel in an infrastructure network is shut down for repairs, and there is no redundancy in the system, the freight or people that need to go through that tunnel get affected. Repairs can take months, which could mean millions of dollars in economic losses. This research will allow engineers to design and evaluate tunnels subjected to fire and implement proper mitigation actions.

Application of Advanced Analytic and Risk Techniques to Railroad Operations Safety and Management (CAIT-UTC-REG24, Project Manager: Dr. Trefor Williams)

Outputs: A prototype system that complements and improves the current tools and DSS used by the cooperating railroads.
Outcomes: The intended outcome is a DSS and dashboard prototype system to support short line railroad in prioritizing maintenance activities, operational, and investment decisions.

Impacts: It is anticipated the DSS will lead to improved decision processes with railroad management, including the use of empirically derived likelihood estimates of risks and potential outcomes associated with maintenance activities, operational and investment decisions.

Investigation of Balanced Mixture Design for New York State Asphalt Mixtures (CAIT-UTC-REG25, Project Manager: Dr. Thomas Bennert)

Outputs: A non-proprietary/non-confidential final report covering all aspects of the work performed under this research study. The report shall include information on the following subjects: Observations and findings and recommendations; Project results and lessons learned regarding configuration, capabilities, and benefits of the project; and Energy and economic benefits, and implementation scenarios associated with such.
Outcomes: Training and specifications around the new design method will be developed and implemented within NY State. Technical presentations are proposed for the annual NY State Materials Conferences and the National Asphalt Pavement Association meetings.
Impacts: It is anticipated that the results of the study will help NYSDOT improve their mixture design and performance testing programs to result in longer lasting asphalt pavements.

Passenger Flow Modeling on Platform Tracks in Transit Stations (CAIT-UTC-REG26, Project Manager: Dr. Xiang Liu)

Outputs: This research aims to model and simulate passenger flows in transit stations using computer vision and agent-based simulation technologies.
Outcomes: The research outcomes can potentially be used by the NJ Transit Capital Planning Program in preparing proposals to apply federal grants to improve infrastructure.
Impacts: The information from this project can be used by NJ Transit to understand the benefit of infrastructure design or upgrade in terms of changing passenger flow and less congestion.

Designing Concrete Mixtures with RCA (CAIT-UTC-REG27, Project Manager: Dr. Matthew P. Adams)

Outputs: A novel RAC design methodology through experimental and computational methods.
Outcomes: The results of the pilot RAC slab program completed as a part of this research will constitute one of the major outcomes of this work.
Impacts: This pilot program can be used by other agencies as a proof of concept.

Cost-effective Bridge Decks for Improved Durability and Extended Service Life (CAIT-UTC-REG28, Project Manager: Dr. Sougata Roy)

Outputs: The primary goal of this proposal is to develop cost-effective standard open rib SOBD demonstrating similar performance as CRD to promote increased implementation of SOBD for short and medium span highway bridges for improving durability, extending service life and safe operation of US bridge infrastructure; and to enable domestic bridge design and fabrication industry to be productive and competitive.
Outcomes: The new design specifications for open rib SOBD to be developed in this study are expected to be incorporated into the AASHTO Bridge Design Specifications. Additional companion design guide for implementation of small and medium span bridges will be developed as AASHTO/NSBA Collaboration document.

Impacts: The research findings and standardization could be adopted by steel bridge fabricators for streamlining production, economizing fabrication, and competitive advantage.

Seismic Vulnerability Assessment of Deteriorated Bridges (CAIT-UTC-REG29, Project Manager: Dr. Ravi Ranade)

Outputs: The goal of this project is to demonstrate seismic vulnerability assessment of a group of NY state bridges subjected to deterioration due to corrosion or other factors. Assessment will be done using a systematic framework to combine effects of corrosion and seismic hazards.
Outcomes: The intended outcome of the project is the demonstration of the assessment methodology on a small group of bridges, recommendations for the NYSDOT Seismic Vulnerability Assessment Manual to incorporate the effects of degradation, and recommendations for bridge inspectors to identify damage that is critical for seismic resilience.
Impacts: The framework that will be demonstrated in this research can be similarly used to update the procedures of other state DOTs (especially in the neighboring USDOT regions).

Durable and Electrified Pavement for Dynamic Wireless Charging of Electric Vehicles (CAIT-UTC-REG30, Project Manager: Dr. Hao Wang)

Outputs: The primary goal of this research is to develop a new design of electrified pavements that have durable performance while providing efficient charging functionality.
Outcomes: The intended outcome of the project is to provide an innovative solution on wireless charging techniques integrated in existing roadway pavements.
Impacts: The research results will contribute to the development of electrified roadways that provide energy sources for electric vehicles.

Evaluating the Safety and Mobility Impacts of American Dream Complex: Phase I (Feasibility Study, and Data Acquisition) (CAIT-UTC-REG31, Project Manager: Dr. Mohammad Jalayer)

Outputs: The primary goals of this project are 1) to coordinate with stakeholders to identify traffic and safety issues associated with this complex and 2) to collect relevant data to develop an analytics framework using machine learning algorithms to identify conflicts between road user groups.
Outcomes: It is expected that the results obtained from this Phase I project will provide a framework for larger data collection and analytics with the aim of developing effective and innovative solutions to alleviate traffic congestion and motor vehicle crashes/near crashes around this complex.
Impacts: New Jersey has the worst traffic bottleneck in the country. With the opening of the second largest retail and entertainment complex in the country, local officials estimate that the American Dream complex will make congestion and safety even worse. This project aims to provide a framework for alleviating traffic congestion and vehicle crashes near the complex.

Rotorcraft Landing Sites – An AI-Based Identification System (CAIT-UTC-REG31, Project Manager: Dr. Ghulam Rasool)

Outputs: The goal here is to create AI-based algorithms to automate landing-site identification.

Outcomes: The intended outcome is to generate an AI algorithm that will automate the process of identification of landing sites from video data as well as satellite images. The researchers hope to achieve landing site identification accuracy equal to or higher than that of a trained human operator at a fraction of the time and resources. Once developed, the AI system would allow FAA to update its databases of landing sites regularly without delays.
Impacts: There is currently a lack of information about landing sites for helicopters and other rotorcrafts, and acquiring, verifying, and updating this information is no small task. This project aims to create an AI-based system to identify landing site infrastructure from various datasets.

Real-Time Prediction of Storm Surge and Wave Loading on Coastal Bridges (CAIT-UTC-REG33, Project Manager: Dr. Teng Wu)

Outputs: The primary goal of this proposal is to lay the groundwork for the development of tools and techniques for rapid prediction of storm surge and wave effects on coastal bridges.
Outcomes: The intended outcome is to develop a computational platform for the rapid prediction of joint storm surge and wave loadings on coastal bridges. The computational tool could also be used in real time by first responders in the event of storm-surge flooding due to extreme windstorms such as hurricanes, by DOTs and state and local Offices of Emergency Services for scenario planning, and by engineers and planners for risk assessment.
Impacts: This research project is resilience-oriented, with the long-term goal of making wise, science- and engineering-based decisions and investments in new and existing coastal bridges, with explicit considerations of multiple hazards and retrofit strategies.

Education and Workforce Development Activities

The consortium has trained more than 550 professionals during this period.

- **Classes, Seminars, and Educational Opportunities**

CAIT established and launched the CAIT Seminar Series this June. Dr. David Orr, UTC partner and director of the Cornell Local Roads Program gave a presentation on the thickness design of low-volume roadway pavements as part of the CAIT Seminar Series. The webinar reviewed inputs needed for LVR pavement design and discussed ways for local agencies to design their LVRs. This included the new RoadPE: LHI software recently developed through a UTC project.

On July 13th, CAIT-affiliated researcher Dr. Dan Barone gave a presentation on the beneficial use of dredged materials for coastal resilience as part of the CAIT Seminar Series. This webinar analyzed opportunities, barriers, and case studies, as well as highlighted successes related to the beneficial use of dredged materials for coastal resilience.

Retaining walls, slopes, and subgrades are types of geotechnical assets that can adversely influence the performance of transportation and other infrastructure systems, particularly with increasing age as deterioration and the consequences from deferred maintenance are realized. This August, the CAIT Seminar Series hosted Mark Vessely, principal engineer with BGC Engineering, to discuss this during a presentation on geotechnical asset management.

CAIT-affiliated researcher Dr. Nenad Gucunski gave a presentation on the state-of-the-art in NDE and other technologies for assessing concrete bridges in September to more than 60

attendees. This presentation was also part of the CAIT Seminar Series and provided an overview of advances in NDE technologies.

- **Technology and Tools**

CAIT-affiliated researchers have created a miniature device for measuring trace levels of toxic lead in sediments at the bottom of harbors, rivers and other waterways within minutes – far faster than currently available laboratory-based tests, which take days.

CAIT-affiliated researcher Dr. Roger Wang created a 3D video model of the Edenville Dam failure using new technology stemming from augmented reality and connected vehicles. He was able to develop a new way to analyze infrastructure failures despite a lack of available data.

UTC partners at Rowan University and Atlantic Cape Community College have partnered on an NSF award to examine ways to improve artificial intelligence systems and machine learning algorithms in a project called "Self-Assessment and Continual Learning on Edge Devices."

Technology Transfer

- **Presentation and Events**

CAIT Director Dr. Ali Maher gave a presentation this May on resilience as part of the ITRC's Seminar Series on "Resilience and Sustainability of Urban Transportation Infrastructure." The presentation highlighted the economic impact of climatic change on critical infrastructure.

On September 23rd, UTC partners at Farmingdale State College hosted an event on mobilizing safe and sustainable transportation that covered many topics including research on Parking Stall Demand Reduction and Transit-Oriented Development as well as the COVID-19 pandemic.

CAIT-affiliated researcher and executive director of the Alan M. Voorhees Transportation Center, Mr. Jon A. Carnegie, organized a UTC-sponsored virtual peer exchange that brought together more than 100 transportation planning professionals to discuss resilience.

- **Research and Publications**

A study led by CAIT researcher Dr. Yun Bai helped provide an analysis of the economic impacts associated with the NJ Transit Raritan River Bridge Replacement project. The study found the one-time total economic impact of the project for the NJ economy will be $1.0 billion including direct, indirect and induced impacts, supporting 5,740 jobs and $352.5 million in earnings.

Rutgers CAIT assisted with advancement of the Portal North Bridge Replacement project by providing a cost benefit analysis to secure federal funding for the substation to help strengthen resilience. The Portal North Bridge carries an average 450 trains and 200,000 passengers daily.

NJ Transit partnered with CAIT this summer to conduct new research on the use of ultraviolet light and best practices to disinfect agency buses. Using this technology is one of many potential sanitation strategies currently being examined amid the ongoing COVID-19 pandemic.

- **CAIT Researchers Win Awards**

CAIT-affiliated researcher Dr. Mehdi Javanmard received the DARPA Young Faculty Award (YFA) for the project titled "Lab-on-a-Microparticle: Injectable Wirelessly Powered Label-free Nanowell Sensors for In Vivo Quantification of Protein and Small Molecules."

NJ Assembly Speaker Craig Coughlin established a 34-member coronavirus-recovery Economic Advisory Council this summer that included CAIT-affiliated researcher Dr. James Hughes. The council was designed to provide input to New Jersey's State Legislature on COVID-19 recovery.

NJ Governor Phil Murphy announced the Restart and Recovery Advisory Council, a team of statewide business and municipal leaders helping to organize plans to restart the state's economy. CAIT Director Dr. Ali Maher was selected on the Transportation and Infrastructure sector.

UTC Partners at Atlantic Cape Community College were recently selected among a group of 15 new schools to participate in the FAA's Unmanned Aircraft Systems Collegiate Training Initiative. the UAS-CTI program allows educational institutions to collaborate with the FAA to help students pursue careers in aviation.

How have the results been disseminated?

CAIT has established the Consortium internet site: https://cait.rutgers.edu/

CAIT has distributed The CAIT Update, its monthly E-newsletter, to subscribers throughout the UTC community, industry, academia, and media members. CAIT has also disseminated results to the general public through news media. Select coverage includes:

Politico

ROI-NJ

MLive.com

NJ.com

Mass Transit Magazine

Railway Track and Structures

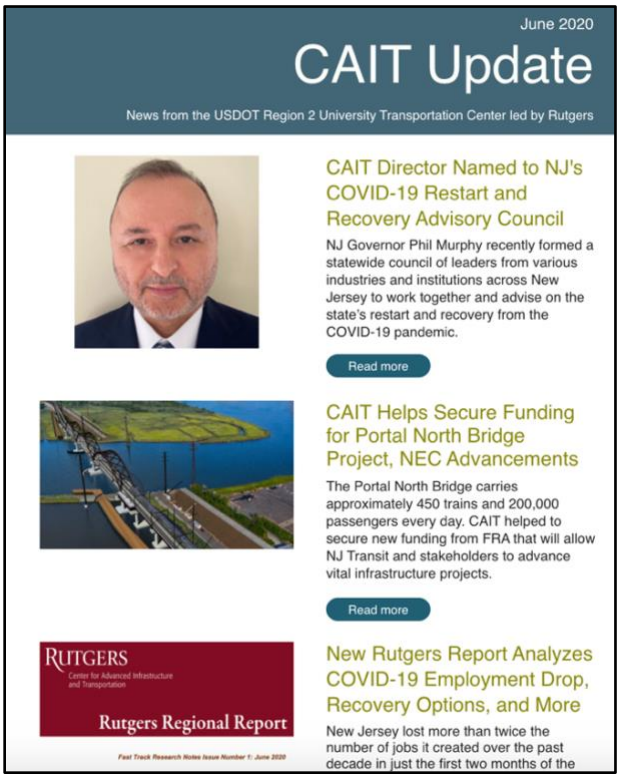
NJBiz.com

AASHTO Daily Transportation Update

U.S. News & World Report

NJ101.5

Newsletter
CAIT has distributed The CAIT Update, its E-newsletter, on a monthly basis to more than 5,000 subscribers.



What do you plan to do during the next reporting period to accomplish the goals and objectives?
No change to plan and process to accomplish our goals.

2. **PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS** (Who has been involved?)
   Consortium Universities Involved
   Rutgers, The State University of New Jersey • Piscataway, NJ 08854 (**LEAD**)
   Atlantic Cape Community College • Mays Landing, NJ 08330
   Columbia University • New York, NY 10027
   Cornell University • Ithaca, NY 14853
   New Jersey Institute of Technology • Newark, NJ 07102
   Polytechnic University of Puerto Rico • San Juan, Puerto Rico 00918
   Princeton University • Princeton, NJ 08544
   Rowan University • Glassboro, NJ 08028
   SUNY–Farmingdale State College • Farmingdale, NY 11735
   SUNY–University at Buffalo • Buffalo, NY 14260

- ***What organizations have been involved as partners?***

New Jersey Department of Transportation	Trenton, NJ	Financial support and collaborative research on multiple projects, personnel resources, knowledge exchange

Port Authority of New York and New Jersey	New York, NY,	Collaborative research on multiple projects, personnel resources, knowledge exchange, financial support
New Jersey Board of Public Utilities	Trenton, NJ	Financial support and collaborative research on multiple projects, including PHMSA State Damage Prevention Grant
New York State Department of Transportation	Albany, NY	Financial support, personnel resources, knowledge exchange
New York City Department of Transportation-Division of Sidewalk and Inspection Management	New York, NY	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange
Port Authority Trans-Hudson	Jersey City, NJ	Personnel resources, knowledge exchange
New York State County Highway Superintendents Association	Oneida and Chemung Counties	Personnel resources, knowledge exchange
New York Association of Town Superintendents of Highways	Canaan, NY	Personnel resources, knowledge exchange
Mistras Group	Princeton Junction, NJ	Personnel resources, knowledge exchange
Arup	New York, NY	Personnel resources, knowledge exchange
New Jersey Department of Community Affairs	Trenton, NJ	Personnel resources, knowledge exchange
Arora and Associates, P.C.	Lawrenceville, NJ	Personnel resources, knowledge exchange
Pennsylvania Department of Transportation	Bridgeville, PA	Personnel resources, knowledge exchange
Puerto Rico Highway and Transportation Authority	San Juan, PR	Personnel resources, knowledge exchange
Federal Highway Administration, Puerto Rico Division	San Juan, PR	Personnel resources, knowledge exchange
North Jersey Transportation Planning Authority	Newark, NJ	Personnel resources, knowledge exchange
Monmouth County Division of Engineering	Freehold, NJ	Personnel resources, knowledge exchange
Rotorcraft	Atlantic city, NJ	Personnel resources, knowledge exchange
The Everett Railroad	Duncansville, PA	Personnel resources, knowledge exchange
NJ Transit Corporation	Newark, NJ	Personnel resources, knowledge exchange
American Institute of Steel Construction	Lancaster, PA	Personnel resources, knowledge exchange
Monmouth County Sheriff's Office	Freehold, NJ	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange

- ***Have other collaborators or contacts been involved?***
  Nothing to report

3. OUTPUTS (What new research, technology or process has the program produced?)
Publications, conference papers, and presentations

- Alsaadi, Israa & Wang, Hao & Chen, Xiaodan & Lu, Pan & Jasim, Abbas. (2020). Multi-objective optimization of pavement preservation strategy considering agency cost and environmental impact. International Journal of Sustainable Transportation. 10.1080/15568318.2020.1821413.

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- Das, S., Dutta, A., Dey, K., Jalayer, M., & Mudgal, A. (2020). Vehicle involvements in hydroplaning crashes: Applying interpretable machine learning. Transportation Research Interdisciplinary Perspectives, 6, [100176]. https://doi.org/10.1016/j.trip.2020.100176
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- Jalayer, Mohammad & Patel, Deep & Szary, Patrick & Hamas, Keith. (2020). An Observational Analysis of Pedestrian Safety Campaign: A Case Study in New Jersey. 182-193. 10.1061/9780784483145.016.
- Jayasuriya, Anuruddha & Adams, Matthew & Bandelt, Matthew. (2020). Generation and Numerical Analysis of Random Aggregate Structures in Recycled Concrete Aggregate Systems. Journal of Materials in Civil Engineering. 32. 04020044. 10.1061/(ASCE)MT.1943-5533.0003113.
- Napolitano, R., Hess, M., Glisic, B. (2020). Quantifying the differences in documentation and modeling levels for building pathology and diagnostics, Archives of Computational Methods in Engineering, 27: 1135–1152. https://doi.org/10.1007/s11831-019-09350-y.
- Napolitano, R., Glisic, B. (2020). Hybrid physics-based modeling and data-driven method for diagnostics of masonry structures, Computer-Aided Civil and Infrastructure Engineering, 35(5): 483-494. https://onlinelibrary.wiley.com/doi/full/10.1111/mice.12548.
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- **Policy Papers**
  Nothing to report
- **Website(s) or other Internet site(s)**
  https://www.facebook.com/RutgersCAIT/
  https://www.instagram.com/rutgerscait/
- **New methodologies, technologies or techniques**
  Incorporated into earlier sections of this report
- **Inventions, patents, and/or licenses**
  Nothing to report
- **Other products**

Outputs	Annual Goal	Annual Metric
1) a traditional or online training program.	3	4
2) a presentation and/or webinar.	10	19
3) a demonstration and/or pilot project.	3	7
4) a guidebook or similar publication in addition to an academic report.	8	10
5) a new specification.	1	1
6) new software or an app.	3	2
7) a new material and/or tangible product.	1	1
8) a potential patent or otherwise marketable product.	2	2
9) Primary or secondary customers will be tracked.	15	27
10) Implementation stakeholders will be tracked.	15	39
11) Implementation stakeholders that identify in each of the following will be tracked.	Customer / Implementer	Customer / Implementer
a. Sponsors of research and T2	2 / 2	4/10
b. Researchers and/or developers	1 / 5	3/10
c. Early adopters and problem owners	5 / 5	12/17
d. Late adopters that follow the technology's development	3 / 5	5/19
e. Deployment team	3 / 3	8/13
f. Others, e.g., trade organizations, regulators, suppliers, etc.	1 / 3	3/13
12) Conceptual methodologies to calculate actual impact. How the PI expects to calculate the actual impact that a customer will realize by implementing the results.	15	30
13) The number of projects that help meet each USDOT Strategic Plan goal	-	-
a. Safety: Reduce transportation-related fatalities and serious injuries across the transportation system.	5	4
b. Infrastructure: Invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses.	5	15

c. Innovation: Lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the nation's transportation system.	5	14
d. Accountability: Serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability.	2	5

4. OUTCOMES (What outcomes has the program produced? How are the research outputs described in section (3) above being used to create outcomes?

Outcomes	Annual Goal	Annual Metric
1) MOU/letters of commitment indicating a customer's commitment to adopt or that they have adopted/used	5	9
2) full-scale adoption of a new technology technique, or practice, or the passing of a new policy, regulation, rule making, or legislation including commercialized or patented product	5	6

5. IMPACT (What is the impact of the program? How has it contributed to improve the transportation system: safety, reliability, durability, etc.; transportation education; and the workforce?)

Impacts	Annual Goal	Annual Metric
1) cost savings (time, money, or life-cycle performance)	$280k year one - $2.575M each subsequent year	$3,551,601
2) durability and/or resilience and/or preservation	Zero in year one - 30 years each subsequent year	31 years
3) workforce proficiency or documented success stories	4 success stories	10

6. 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.***
  See COVID-19 statement on page 1.
- ***Changes that have a significant impact on expenditures.***
  Nothing to report
- ***Significant changes in use or care of animals, human subjects, and/or biohazards.***
  Nothing to report