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

**Federal Grant Number:** 69A3551847102

**Project Title:** Center for Advanced Infrastructure and Transportation (CAIT) Region 2 UTC Consortium Led by Rutgers, The State University of New Jersey

**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

**DUNS Number:** 001912864000

**EIN Number:** 1226001086A1

**Recipient Identifying Number or Account Number, if any:** Rutgers' account #824227

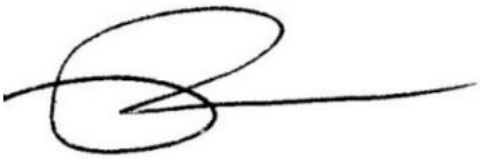
**Project/Grant Period:** June 05, 2018 through September 30, 2025

**Reporting Period End Date:** September 30, 2024

**Report Term or Frequency**: Semiannual

**Submission Date:** October 31, 2024

**Signature of Submitting Official:**



## Impact Statement

At the 2024 Council of University Transportation Centers Summer Meeting, CAIT was invited to present during the UTC Directors Meeting on the topic of using a UTC grant as a launching pad to develop a larger, sustainable research center. Associate Director Dr. Patrick Szary described how CAIT has fostered relationships with its key stakeholders to develop long-term research partnerships. This approach has allowed CAIT to work closely with transportation agencies, helping the center better align its research with the most pressing needs of the region. Close partnerships have also supported the center during uncertain economic times, from the COVID-19 Pandemic to subsequent hiring and employment shortfalls that have hit the transportation industry in recent years.

Throughout its time as the Region II UTC, CAIT has focused on enhancing these strong ties with local transportation agencies to develop multi-year programs. CAIT has leveraged its strategic location in this busy region by developing "living" testbeds and full-scale field laboratories to research real-world infrastructure. These field labs provide unique opportunities to test sensors, evaluate new materials, and deploy innovative technologies in actual conditions, ensuring that CAIT's research directly addresses the infrastructure challenges of the Northeast. Using UTC dollars as seed funds for pilot projects and investing in innovative technologies, CAIT has built and enhanced sustainable research programs with NJ Transit, NJDOL, NYMTC, NJDOT, NJEDA, Port Authority of New York and New Jersey and other major transportation stakeholders in the Northeast.

These programs, such as CAIT's DataCity with Middlesex County and NJDOT or the Low Carbon Concrete Pilot Program with Port Authority, are now generating outputs and outcomes that are having real-world impact on the regional transportation system. Select examples are highlighted below.

- **Developing Sustainable Construction Materials:** CAIT was recently awarded a 5-year, $5 million cooperative agreement from the USDOT to investigate the use of steel slag in concrete and cement, and its potential to help decarbonize the nation's transportation sector. Eight percent of annual global carbon dioxide (CO2) emissions are related to cement production, with a significant portion coming from building and maintaining transportation infrastructure. As recent transportation investments in the Bipartisan Infrastructure Law call for approximately 28 million metric tons of cement, extensive research into sustainable building materials is needed. Joined by a team of academic and industry partners, CAIT will study innovative materials that can support net-zero greenhouse gas emission goals, strengthen infrastructure resilience, and minimize adverse environmental impacts from the transportation industry.

  CAIT's past work helping the Port Authority of New York and New Jersey establish its Low Carbon Concrete Pilot Program gave CAIT the credibility to secure this new project. Using UTC funds, CAIT researchers identified 18 concrete mix designs that can reduce emissions by up to 37%. The Port Authority of NY and NJ now requires that CAIT's low-

carbon concrete mix designs be used throughout the agency's construction projects to achieve net-zero Greenhouse Gas Emissions by 2050

- **Preparing for the FIFA 2026 World Cup:** More than one million soccer fans will travel from across the world to the New York/New Jersey region in 2026, as MetLife Stadium hosts eight FIFA World Cup games including the international competition's prestigious final match. Transporting this many people to games and throughout the region is no small task and requires coordinated efforts across the state and region. In partnership with NJ Transit, Rutgers CAIT has now hosted two Large Event Planning Workshops, gathering transit leaders and event-planning experts from around the world to share insights and best practices for planning and executing large-scale events. These workshops brought together 150+ transit leaders from all World Cup Host Cities, as well as international experts responsible for planning the 2024 Paris Olympics and other major events. The workshops facilitated discussions on best practices for transportation safety, crowd management, system reliability, and other critical topics ahead of FIFA World Cup which will have a significant footprint in Region II.


  CAIT's relationship and master agreement with NJ Transit made this collaboration possible. Starting in 2020, CAIT launched a UTC project with NJ Transit to evaluate the performance of air filters on transit buses supporting the agency's response to the COVID-19 Pandemic. Other UTC projects have conducted community impact assessments on the construction of new NJT bus garages, evaluated Battery Electric Bus routes and charging systems, and more.

- **Fostering Innovation and Economic Success:** CAIT was recognized by Rutgers for its critical role in helping the University secure the prestigious "Innovation and Economic Prosperity" designation from The Association of Public and Land-grant Universities (APLU). Only 80 universities nationwide hold this designation. Rutgers highlighted CAIT's workforce development efforts as a driving force in securing the APLU recognition.

  Across its portfolio, CAIT trains more than 11,000 transportation professionals annually in everything from traffic incident management to heavy equipment operation. One of its more forward-thinking programs is the Rutgers Employment Success Program (RESP) that provides youth from historically underserved communities with pre-apprenticeship training to enter sustainable careers in the transportation industry. RESP was supported early on by the UTC project "Camden Career Pathways Initiative," and now has served over 300 youth and young-adult participants.

**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 ongoing national dialogue on the state of the U.S. transportation infrastructure, and the emerging consensus on the need for 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 providing 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?**

## *Fostering Diversity, Equity, & Inclusion*

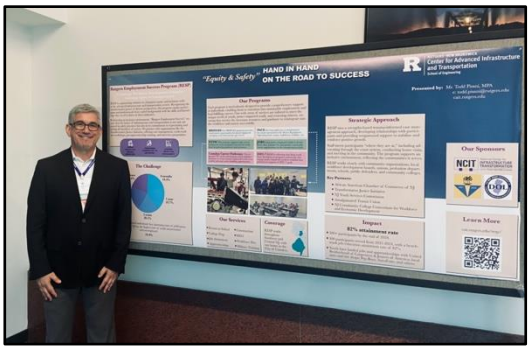
In the previous Semi-Annual Progress Report, CAIT's efforts in building Diversity, Equity, and Inclusion into its research and technology transfer programs over recent years were highlighted. Specifically, CAIT has aligned its work with Rutgers' University Diversity Strategic Plan that was established in 2022 and identifies actionable steps toward developing a diverse community, promoting inclusive scholarship, and developing the infrastructure to drive change.

The Rutgers Youth Success Program has grown into CAIT's premier effort in building equity in the transportation workforce. In the past 6 months, RESP leadership has participated in and led multiple events at the national and regional stage that demonstrate the programs impact to date. These events are described below.

- **Workshop to Broaden the Diversity of the Skilled, Technical Transportation Workforce:** In collaboration with Transportation Research Board's Committee on Women in Sciences, Engineering, and Medicine Board on Human-Systems Integration, CAIT's RESP helped organize this two-day workshop in Washington D.C. focused on expanding the talent pool of the transportation workforce through investing in historically underserved and diverse populations.


  Mr. Todd Pisani, director of CAIT's RESP led a panel discussion on Resources and Funding for establishing a training program that meets the needs of diverse populations. Mr. Antonne Henshaw, staff at RESP, participated in a panel discussion on the Recruitment of Diverse Populations and Addressing Employment Barriers.

- **Poster Presentations at Major Research Conferences:** RESP was selected to present during the poster session at the USDOT's inaugural Future of Transportation Summit this August. RESP highlighted its successful programs that have supported 300+ youth and young adults in returning to school, attaining apprenticeships with local unions in the construction industry, and securing employment at organizations such the Brotherhood of Carpenters and Joiners of America, local auto and tire shops, PEP Boys, AutoZone, and others. RESP equips youth and young adults from varied backgrounds, including justice-impacted individuals, with the skills and knowledge they need to thrive in the transportation industry.




  RESP was also selected to present a poster during the NJDOT's 26th Annual Research Showcase in October. CAIT continues to invest in RESP and believes that strengthening ties with state and local transportation agencies such as NJDOT and NJ Transit can help to propel equitable and diverse hiring in the transportation industry.

### *Research*

No new projects were approved by the peer-review panel during this cycle.

## Ongoing Projects:

| | | |
|---|---|---|
| CAIT-UTC-REG25 | Investigation of Balanced Mixture Design for New York State Asphalt Mixtures | RU |
| CAIT-UTC-REG40 | Zero Speed Profiler Assessment for Pavement Smoothness and Continuous Pavement Texture Measurements | RU |
| CAIT-UTC-REG56 | Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study | NJIT/Stevens |
| CAIT-UTC-REG59 | Durability of Low Carbon Concrete Mixtures | NJIT |
| CAIT-UTC-REG63 | State-of-the-art technologies for structural health monitoring of tunnels: an overview | PU |
| CAIT-UTC-REG64 | NJ Transit Northern Bus Garage Planning and Community Impact Evaluation | RU |
| CAIT-UTC-REG66 | Comparison Analysis of Charging System Designs for Battery Electric Bus | RU |
| CAIT-UTC-REG69 | Camden Career Pathways Initiative | RU |
| CAIT-UTC-REG70 | Developing Indicators for Comprehensive Evaluation of Equity in Transportation System | Rowan |
| CAIT-UTC-REG71 | Bio-mediated method for improving the erosion resistance of coastal embankment | Rowan |
| CAIT-UTC-REG72 | Planning Project for Initiating A Large-scale 3D Printing Facility | RU/PU |
| CAIT-UTC-REG73 | Asphalt Viability in Recycled Asphalt Pavement (RAP) Using the Gyratory Compactor | RU |
| CAIT-UTC-REG75 | Mitigating Cracks in Concrete Members for Durable Bridge Construction | UB |
| CAIT-UTC-REG76 | Advanced Testing and Modeling of Dredged Sediments for Beneficial Use | RU |
| CAIT-UTC-REG77 | Identification Potential of Microplastics from Recycled Plastic Modified Asphalt Mixtures | RU |
| CAIT-UTC-REG78 | Evaluation of the Effects of Superstructure Characteristics on the Performance of Bridge Decks under Traffic Loads | RU |
| CAIT-UTC-REG79 | Resilience and Mobility Accessibility in Underserved Communities | RU |
| CAIT-UTC-REG80 | Full-scale “Living Pavement Testbed” for Testing and Evaluation of Sustainable Pavement | RU |
| CAIT-UTC-REG81 | A Hydrologic Modeling Framework for Assessing Future Riverine Flood Risk of Critical Transportation Infrastructure | RU |
| CAIT-UTC-REG82 | Risk and Resiliency Analysis of Infrastructure by Improving RAMCAP Framework | Rowan |
| CAIT-UTC-REG83 | Assessment of Waterfront Asset Resiliency | RU |
| CAIT-UTC-REG84 | Test Bed Mesocosms for Improved Stabilized Sediment Laboratory Specimen Preparation and Field QA/QC | RU |
| CAIT-UTC-REG85 | Identifying the Effect of Bridge Deterioration on Load Distribution | RU |
| CAIT-UTC-REG86 | Development of A Digital Testbed for Connected Transit Technologies | RU |

## 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-REG5 | Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities | ACCC |

| | | |
|---|---|---|
| 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-REG9 | Delivering maintenance and repair actions via automated/robotic systems | 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-REG13 | Virtual Tour (VT), Informational Modeling (IM), and Augmented Reality (AR) for Visual Inspections (VI) and Structural Health Monitoring (SHM) | PU |
| CAIT-UTC-REG14 | Performance-Based Engineering of Transportation Infrastructure Considering Multiple Hazards | SUNY Buffalo |
| 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-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-REG24 | Application of Advanced Analytic and Risk Techniques to Railroad Operations Safety and Management | 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 |
| 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 |
| CAIT-UTC-REG35 | NJDOT Flood Risk Visualization Tool | RU |
| CAIT-UTC-REG36 | Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing | RU |

| | | |
|---|---|---|
| CAIT-UTC-REG37 | Impact of Recycled Plastic on Asphalt Binder and Mixture Performance | RU |
| CAIT-UTC-REG38 | Risk and Resilience Analysis Tool for Infrastructure Asset Management | RU |
| CAIT-UTC-REG39 | FDR Stabilizer Selection Using Simple Soil Tests | Cornell |
| CAIT-UTC-REG41 | Affordable On-Demand Testing of Water Contamination Using a Portable Nanoelectronic Lead Detector | RU |
| CAIT-UTC-REG42 | Enhanced Maritime Asset Management System (MAMS) | RU |
| CAIT-UTC-REG43 | Artificial Intelligence-Aided Rail Transit Infrastructure Data Mining | RU |
| CAIT-UTC-REG44 | Assessment of Solidification / Stabilization as a Remedial Strategy for PFAS Contaminated Transportation Sites | RU |
| CAIT-UTC-REG45 | The Development of the Digital Twin Platform for Smart Mobility Systems with High-Resolution 3D Data | RU |
| CAIT-UTC-REG46 | Driving behavioral learning leveraging sensing information from Innovation Hub | Columbia |
| CAIT-UTC-REG47 | Remote Sensing System Enhancement for Digital Twinning of the Built Infrastructure to Support Critical Infrastructure Protection Research | RU |
| CAIT-UTC-REG48 | Linking Physics-Based Deterioration Model to Field-Based Condition Assessments for Improving Asset Management | SUNY Buffalo |
| CAIT-UTC-REG49 | Post-fire Damage Assessment of Concrete Tunnel Liners | SUNY Buffalo |
| CAIT-UTC-REG50 | Post-disaster Damage Assessment of Bridge Systems | SUNY Buffalo |
| CAIT-UTC-REG51 | Real-Time Decision Support System for Transportation Infrastructure Management under a Hurricane Event | SUNY Buffalo |
| CAIT-UTC-REG52 | Bridge Deck Surface Profile Evaluation for Rapid Screening and Deterioration Monitoring | Rowan |
| CAIT-UTC-REG53 | A Real-Time Proactive Intersection Safety Monitoring System Based on Video Data | Rowan |
| CAIT-UTC-REG54 | Rotorcraft Landing Sites Identification – Scaling and Generalization of the AI Model | Rowan |
| CAIT-UTC-REG55 | JFK Cargo View: A system to speed Truck Traffic Flow at JFK Airport | RU/ SUNY Farmingdale |
| CAIT-UTC-REG57 | Comparative analysis of rapid chloride penetration testing for novel reinforced concrete systems | NJIT |
| CAIT-UTC-REG58 | Supplemental Study of Filter Technology Efficacy for Transit Vehicles to Combat the Spread of COVID-19 and Other Respiratory Infections | RU |
| CAIT-UTC-REG60 | Low-Carbon Concrete Pilot Program | PU |
| CAIT-UTC-REG61 | QAD (Quality Assurance Division) Inspection Reporting and State of Good Repair (SGR) Planning | RU |
| CAIT-UTC-REG62 | AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico | RU/PUPR |
| CAIT-UTC-REG65 | Development of a Geometric Extraction Tool as Part of a Pilot Digital Twin Framework for Open-Deck Rail Bridges | RU |
| CAIT-UTC-REG67 | Enhancing the resilience of coastal box girder bridges through geometric modifications | PU |
| CAIT-UTC-REG68 | A Machine Learning Decision-Support System for Selecting Optimal Innovative Project Delivery Methods for Bundled Transportation Projects | NJIT |
| CAIT-UTC-REG74 | Rapid Damage Assessment in Infrastructure Systems using Vibration Measurements within a Machine Learning Framework | Columbia |

***Highlights***

**Completed Projects** (select highlights from recently completed projects)

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

Accomplishments: CAIT researchers developed a partially magnetized pavement design of electrified pavement that is durable and has efficient charging functionality. In September 2024, this work was highlighted by the American Society of Civil Engineer's (ASCE) Civil Engineering Source Magazine in a broader article covering the potential for energy harvesting from urban roads and sidewalks.

ROI: This innovative design provides a potential solution for wireless charging integrated into existing roadway pavements. Results show a 1.5-13.3% improvement in charging efficiency over conventional pavements for wireless power transfer.

### Low-Carbon Concrete Pilot Program (CAIT-UTC-REG60, Project Manager: Dr. Reza Moini)


Accomplishments: This pilot project helped CAIT develop expertise in evaluating low carbon building materials, which was critical in securing a $5M cooperative agreement with USDOT to study cement alternatives that can reduce GHG emissions.

ROI: CAIT and consortium partners NJIT and Princeton identified 18 concrete mix designs that can reduce GHG emissions by up to 37% for the Port Authority of NY & NJ. Port Authority has implemented this research and updated sustainability standards into its Low Carbon Concrete Program. Port Authority continues to work with the CAIT UTC consortium in support of its agency-wide greenhouse gas reduction target of 80% by 2050.

### AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico (CAIT-UTC-REG62, Project Manager: Dr. Roger Wang)

Accomplishments: Rutgers researchers developed a state-wide flood mapping solution using the Height Above Nearest Drainage (HAND) framework, and invented a series of key methods using computer vision to correct catchment discontinuities in HAND modeling. This provides transportation stakeholders with a seconds-level fast model that can revolutionize real-time forecasting and emergency responses. UTC dollars were critical to the development of this innovative mapping tool.

ROI: This development can help transportation agencies plan for major flooding events, establish emergency response plans for worst-case scenarios, and address the impacts of climate change in an informed and data-driven manner.

**Ongoing Projects** (select highlights from active projects)

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

Outputs: A non-proprietary final report covering the work performed under this research study.
Outcomes: Training and specifications will be developed and implemented within NY State.
Impacts: Study results will help NYSDOT improve mixture design and testing programs.

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

Outputs: This project is developing cost-effective standard open rib SOBD to promote increased implementation of SOBD for short and medium span highway bridges.
Outcomes: Potential design specifications to be incorporated into AASHTO Specifications.
Impacts: The research findings have the potential to be adopted by steel bridge fabricators for streamlining production, economizing fabrication, and competitive advantage.

### Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study (CAIT-UTC-REG56, Project Manager: Dr. Matthew Bandelt)

Outputs: This project aims to increase safety and minimize the risks of building major underground infrastructure systems by enhancing existing methods for risk assessment.
Outcomes: A framework for global large-scale tunneling projects able to determine hazards.
Impacts: This interactive decision support system will have the potential to be used in the design and construction of different tunnels in the US by local, regional, and federal agencies.

### NJ TRANSIT Northern Bus Garage Planning and Community Impact Evaluation (CAIT-UTC-REG64, Project Manager: Dr. Peter Jin)

Outputs: This project will help NJ TRANSIT create a complete roster of the 500-bus capacity Northern Bus Garage and determine critical facility metrics.
Outcomes: Several modules for bus dispatching, including data archiving, processing and visualization, will be developed and integrated with the NJ TRANSIT bus scheduling system.
Impacts: Data generated will provide insights into the impact of the new garage, specifically on improvements to NJ TRANSIT bus operations within the service areas.

### Comparison Analysis of Charging System Designs for Battery Electric Bus (CAIT-UTC-REG66, Project Manager: Dr. Hao Wang)

Outputs: A robust charging system for battery electric buses considering economic and environmental impacts will be developed and analyzed through this research project.
Outcomes: This project is developing a methodology to help NJ TRANSIT select the best charging system design with less life-cycle cost and carbon footprint.
Impacts: The results will help NJ TRANSIT develop its deployment strategy for charging infrastructure and refine its garage modification plans to support zero-emission bus systems.

### Developing Indicators for Comprehensive Evaluation of Equity in Transportation System (CAIT-UTC-REG70, Project Manager: Dr. Mohammad Jalayer)

Outputs: An evaluation technique to assess and maintain equity principles in transportation planning and construction processes, and further incorporate them into decision-making.
Outcomes: Indicators for transportation agencies to better consider equity in projects.
Impacts: These guidelines will help industry adopt more equitable transportation practices.

### Planning Project for Initiating A Large-scale 3D Printing Facility (CAIT-UTC-REG72, Project Manager: Dr. Meiyin Liu)

Outputs: This project will identify the roadmap towards a successful and sustainable large-scale 3D printing facility to be used in construction of durable components of infrastructure.
Outcomes: a comprehensive review of 3D printing for transportation and/or general civil infrastructures, which can work as a fundamental knowledge base for decision-making process.
Impacts: This research has the potential to advance the manufacturing process for improvements towards sustainable and resilient civil infrastructure using 3D.

### Asphalt Viability in Recycled Asphalt Pavement (RAP) Using the Gyratory Compactor (CAIT-UTC-REG73, Project Manager: Dr. Thomas Bennert)

Outputs: This project will evaluate the viability of asphalt binder in RAP materials using a simplified procedure with the gyratory compactor.
Outcomes: The intended outcome of the project is to provide a quick and accurate means of evaluating RAP that can be utilized back into new asphalt materials.
Impacts: The researchers will generate a proposed parameter and recommended thresholds that would allow asphalt mixture suppliers to determine maximum RAP contents based on existing asphalt binder grades, softer binder grades, and recycling agents.

### Advanced Testing and Modeling of Dredged Sediments for Beneficial Use (CAIT-UTC-REG76, Project Manager: Dr. Tyler Oathes)

Outputs: This project will generate modeling approaches for the beneficial use of raw and stabilized sediments in engineering applications.
Outcomes: Guidance and methodologies will be developed for modeling sediments in engineering applications using approaches tailored to different beneficial uses.
Impacts: There are a wide range of potential beneficial uses that require varying levels of engineering performance and modeling breadth, which this project will support.

### Identification Potential of Microplastics from Recycled Plastic Modified Asphalt Mixtures (CAIT-UTC-REG77, Project Manager: Dr. Thomas Bennert)

Outputs: This project will evaluate the potential release and detection of micro-plastics from hot mix asphalt modified with recycled plastic modifiers.
Outcomes: Training products, such as a webinar and/or training classes, will be developed and distributed to industry members investigating the use of plastic waste in roadway paving.
Impacts: This research will help the asphalt industry identify when potential release of microplastics from asphalt mixtures can occur. As asphalt mixes using plastic waste are investigated, it is important to ensure their safety and environmental sustainability.

## Evaluation of the Effects of Superstructure Characteristics on the Performance of Bridge Decks under Traffic Loads (CAIT-UTC-REG78, Project Manager: Dr. Sharef Farrag)


Outputs: This project will assess stresses exhibited by the deck under traffic loads.
Outcomes: Researchers will conduct a parametric study evaluating the extent to which varying bridge superstructure and deck aspects contribute to the deterioration of the bridge deck.
Impacts: This research will reveal which type of bridges are more prone to mechanical/vibration damage as opposed to those that exhibit electrochemical deterioration.

## Resilience and Mobility Accessibility in Underserved Communities (CAIT-UTC-REG79, Project Manager: Dr. Peter Jin)

Outputs: This project will identify the existing traffic, safety, and environmental problems caused by pass-through traffic and natural calamities in New Brunswick, NJ.
Outcomes: New partnerships with local agencies and communities will be formed to better understand their mobility, safety, and transportation needs.
Impacts: This research will boost the local transportation system's resilience and efficiency, ensuring its longevity and that it is serving the community in an equitable and effective way.

## Full-scale "Living Pavement Testbed" for Testing and Evaluation of Sustainable Pavement (CAIT-UTC-REG80, Project Manager: Dr. Thomas Bennert)

Outputs: This project will study the impacts of both common and innovative construction techniques on pavement performance and durability in a living environment on the Rutgers University Busch Campus.
Outcomes: Industry will better understand the impacts of common and innovative construction methods such as milling, "Cold in Place Recycling," and High Friction Surface Treatments.
Impacts: This research can develop best practices for innovative construction techniques that help to address climate and sustainability challenges. It also opens the door for advanced, hands-on training at the living lab of DOT staff and other pavement professionals.

## A hydrologic modeling framework for assessing future riverine flood risk of critical transportation infrastructure (CAIT-UTC-REG81, Project Manager: Dr. Efthymios Nikolopoulos)

Outputs: This research will develop a high-resolution distributed hydrologic model for NJ.
Outcomes: The model will provide space-time information of streamflow during flood events and will be calibrated/validated against USGS streamflow stations.
Impacts: Researchers will use this model to identify "hot spots" in the region for future riverine flood risk, and will engage local stakeholders to disseminate this information.

### Risk and Resiliency Analysis of Infrastructure by Improving RAMCAP Framework (CAIT-UTC-REG82, Project Manager: Dr. Seyed Hooman Ghasemi)

Outputs: This project will develop a comprehensive risk and resilience assessment framework for critical transportation and coastal infrastructure using the RAMCAP framework.
Outcomes: The framework will identify potential risks to the infrastructure and analyze its resilience against natural and artificial hazards.
Impacts: This research can provide valuable insights into critical transportation and coastal infrastructure risks and develop a comprehensive framework for assessing these factors.

## *Education and Workforce Development Activities*

The consortium has trained 702 professionals during this period.

- **Classes, Seminars, and Educational Opportunities**
  In June, CAIT Associate Director Dr. Patrick Szary gave a presentation during the CUTC Summer Meeting on how to use the UTC grant as a starting point for growing a larger transportation research center. CAIT shared its decades of knowledge with the UTC community, in an effort to highlight best practices that can help the program as a whole reach its goals.

  CAIT hosted two more "North American Regional Training Center" courses with UITP and NJ Transit. These advanced rail training classes covered Public Transport Fundamentals and Bus Operations, and brought international experts to New Jersey to share best practices and exchange information. CAIT trained nearly 100 transportation professionals across these two courses, including staff from NJ Transit, Metro-North Railroad, Transdev, and other transit companies.


  In April, CAIT helped organize a two-day National Academies/TRB workshop titled "Workshop to Broaden the Diversity of the Skilled, Technical Transportation Workforce." Staff from CAIT's Rutgers Employment Success Program led a panel session on how to sustain funding and resources for workforce training programs that focus on equity and diversity, and well as session on best practices for recruiting diverse populations.

- **Technology and Tools**
  Stemming from a UTC project, CAIT researcher Dr. Roger Wang developed a state-wide flood mapping solution using the Height Above Nearest Drainage (HAND) framework, and invented a series of key methods using computer vision to correct catchment discontinuities in HAND modeling. This provides transportation stakeholders with a seconds-level fast model that can revolutionize real-time forecasting and emergency responses.

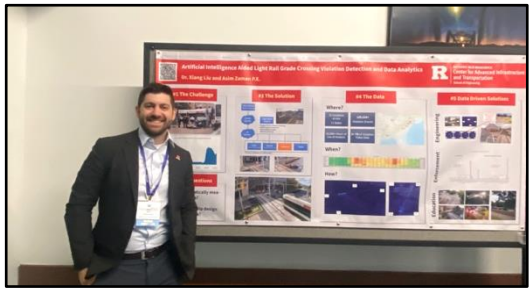
## *Technology Transfer*

- **Presentation and Events**
  In preparation for the FIFA 2026 World Cup, CAIT hosted its second Large Events Workshop this fall in collaboration with NJ Transit. More than 75 transit professionals representing all of the Host Cities came to Rutgers to talk about security, crowd management, contingency plans, and best practices to successfully move thousands of people during a major sporting event. Expert international speakers, including planners from the 2024 Paris Olympics, were brought in to lead the discussion.

  In May, CAIT presented during Middlesex County's inaugural Transportation Symposium. CAIT Director Dr. Ali Maher was invited to give a keynote speech about the DataCity Smart Mobility Testing, and the impact that this innovative project is having on the region.

  The Federal Transit Administration hosted a "Spotlight on Rail Transit Safety" webinar in September during rail safety week. Rutgers researcher Dr. Asim Zaman gave a presentation during the webinar on his work with CAIT using Artificial Intelligence to detect grade-crossing violations and develop data-driven safety countermeasures.

- **Research and Publications**
  Rutgers CAIT researcher Dr. Asim Zaman was also invited to share his Artificial Intelligence and rail-grade crossing work during the USDOT's inaugural Future of Transportation Summit in August. Dr. Zaman presented during the poster session. His work in this innovative area has been supported by USDOT UTC funds as well as by the FRA, FTA, NJDOT, and NJ Transit.



  CAIT researcher Dr. Hao Wang supported NJDOT on a pothole repair project that received High Value Research and Supplemental Awards by the AASHTO Research Advisory Committee. The project, Innovative Pothole Repair Materials and Techniques, was recognized in the Maintenance, Management, and Prevention supplemental categories. Dr. Wang served as Principal Investigator on the project.

- **Rutgers Students Win Awards**
  Rutgers student Vivek Dsouza was selected by the New York Metropolitan Transportation Council (NYMTC) to participate in the council's 9/11 Memorial Scholarship program. Rutgers CAIT helps to coordinate the 9/11 Memorial Scholarship program in collaboration with NYMTC. Vivek is a masters student studying the intersection between the built environment and health, with a focus on transportation equity and planning.

**How have the results been disseminated?**
CAIT established the Consortium internet site: https://cait.rutgers.edu/. CAIT has distributed The CAIT Update, its monthly E-newsletter, to subscribers in the transportation industry. CAIT has also shared results to the general public through news media. Select media coverage of CAIT and affiliates of the Center includes:

*ASCE "Civil Engineering Source" Magazine*

*CBS News New York Climate & Infrastructure Segment*

*AASHTO Daily Transportation Update (9/25/2024)*

*Roads and Bridges Magazine*

*USDOT Climate Week Briefing (9/26/2024)*

*NJ Business Magazine*

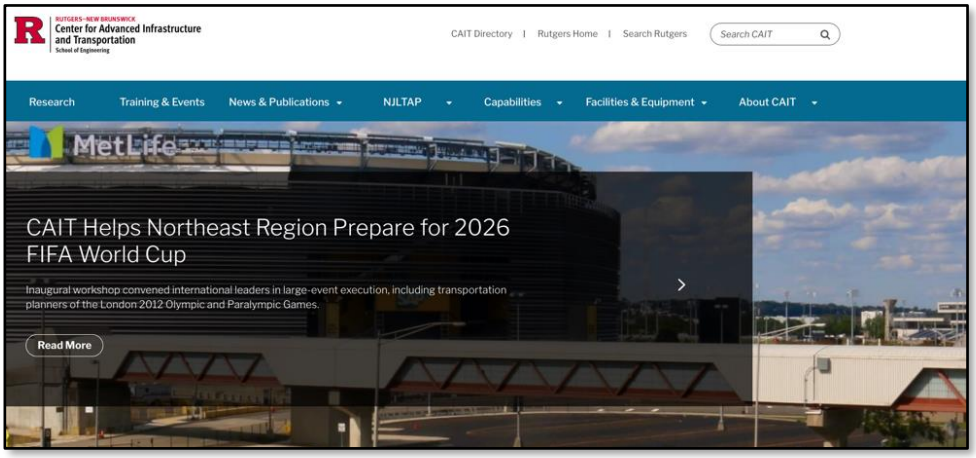
*APLU News Release*

*Transportation Today*

*American Infrastructure Magazine*

## Newsletter

On a regular basis, CAIT has distributed *The CAIT Update*, its monthly E-newsletter, and *The CAIT Seminar Series* to a regional transportation audience of 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.

1. **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 |
| NYCDOT-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 | Financial support, 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 |
| Federal Aviation Administration | Washington, DC | Personnel resources, knowledge exchange |
| Middlesex County | Middlesex, NJ | Financial support, Personnel resources, knowledge exchange |
| JFK International Airport | Queens, NY | Personnel resources, knowledge exchange |
| Gateway JFK | Queens, NY | Personnel resources, knowledge exchange |
| AAA Mid-Atlantic | Wilmington, DE | Personnel resources, knowledge exchange |
| Verizon | New York, NY | Personnel resources, knowledge exchange |

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

2. **OUTPUTS** (What new research, technology or process has the program produced?)

**Publications, conference papers, and presentations**

- Bazzett, David & Marxen, Lucas & Wang, Ruo-Qian. (2024). Advancing regional flood mapping in a changing climate: A HAND-based approach for New Jersey with innovations in catchment analysis. Journal of Flood Risk Management. 10.1111/jfr3.13033.

- Sukel, Kayt. (2024) The Renewable Energy Source Right Beneath our Feet. American Society of Civil Engineers, "Civil Enegineering Source." [Interview with CAIT researcher Dr. Hao Wang.] https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/issues/magazine-issue/article/2024/09/the-renewable-energy-source-right-beneath-our-feet

- Al-Qadi, Imad & Bennert, Thomas & Bhasin, Amit & Habbouche, Jhony & Hajj, Elie & Mogawer, Walaa & Sharma, Brajendra & Underwood, Shane & Yin, Fan. (2024). Roadmap for Repurposing Waste Plastics in Asphalt Mixes. 10.1061/9780784485545.

- Hajj, Elie & Bennert, Thomas & Jamrah, Anas & West, Randy & Moore, Nathan & Aschenbrener, Tim. (2024). Adjustment to Asphalt Mixtures to Meet Performance Testing Requirements and Allow Innovations. 10.13140/RG.2.2.18940.14720.

- Fan, Jin & Shao, Yi & Bandelt, Matthew & Adams, Matthew & Ostertag, Claudia. (2024). Sustainable reinforced concrete design: The role of ultra-high performance concrete (UHPC) in life-cycle structural performance and environmental impacts. Engineering Structures. 316. 118585. 10.1016/j.engstruct.2024.118585.

- **Policy Papers**
  Nothing to report
- **Website(s) or other Internet site(s)**
  https://www.facebook.com/RutgersCAIT/
  https://www.linkedin.com/company/center-for-advanced-infrastructure-and-transportation-cait
- **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 | 11 |
| 2) a presentation and/or webinar. | 10 | 15 |
| 3) a demonstration and/or pilot project. | 3 | 5 |
| 4) a guidebook or similar publication in addition to an academic report. | 8 | 7 |
| 5) a new specification. | 1 | 1 |
| 6) new software or an app. | 3 | 3 |
| 7) a new material and/or tangible product. | 1 | 5 |
| 8) a potential patent or otherwise marketable product. | 2 | 4 |
| 9) Primary or secondary customers will be tracked. | 15 | 4 |
| 10) Implementation stakeholders will be tracked. | 15 | 5 |
| 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 | 1/2 |
| b. Researchers and/or developers | 1 / 5 | 2/4 |
| c. Early adopters and problem owners | 5 / 5 | 1/3 |
| d. Late adopters that follow the technology's development | 3 / 5 | 3/2 |
| e. Deployment team | 3 / 3 | 0/3 |
| f. Others, e.g., trade organizations, regulators, suppliers, etc. | 1 / 3 | 1/2 |
| 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 | 3 |
| 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 | 1 |
| b. Infrastructure: Invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses. | 5 | 0 |
| 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 | 1 |
| d. Accountability: Serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability. | 2 | 1 |

3. **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 | 7 |
| 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 |

4. **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 | $5,375,726 |
| 2) durability and/or resilience and/or preservation | Zero in year one - 30 years each subsequent year | 63 years |
| 3) workforce proficiency or documented success stories | 4 success stories | 12 |

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.***
  A decline in international students prolonged by the pandemic has at times caused delays in engaging students on research. Labor shortages have also caused project management delays for research stakeholders, at times pushing back project timelines. CAIT has mitigated these challenges by building diverse teams, maintaining close communication with stakeholders, and efficiently leveraging resources throughout the Region II Consortium.
- ***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