Semi-Annual Progress Report for University Transportation Centers

Submitted to	Office of the Assistant Secretary for Research and Technology
Federal Grant Number	69A3552348330
Project Title	Coastal REsearch And Transportation Education University Transportation Center (CREATE-UTC)
Center Director Name	Stacey Kulesza, Ph.D., P.E., Associate Professor, Ingram School of Engineering, Texas State University, sekulesza@txstate.edu, 512.245.2851
Submitting Official	Same as above
Submission Date	4/30/2025
DUNS	07-460-2368
EIN	74-6002248
Recipient Organization	Texas State University
Project / Grant Period	Start Date: June 1, 2023 End Date: May 31, 2029
Reporting Period Start Date	October 1, 2024
Reporting Period End Date	March 31, 2025
Report Term or Frequency	Six months
Signature	

1. ACCOMPLISHMENTS

1.1 What are the major goals of the program?

Coastal REsearch And Transportation Education (CREATE) is a Tier 1 UTC led by Texas State University. Our consortium partners include Texas State University (TXST), Oregon State University (OSU), Texas A&M University (TAMU), University of Miami (UM), and University of Puerto Rico at Mayagüez (UPRM). Coastal infrastructure faces unique challenges compared to inland infrastructure. From a durability perspective they must be designed, constructed, and maintained to withstand highly varied climatic conditions and multiple hazards including hurricanes, tsunami, and earthquakes. Intense coastal storms can result in damage or failure of multimodal transportation infrastructure due to surge, wave and debris impacts, scour, erosion, and landslides. All these take place with long-term environmental exposure to salt water and wind-borne salt spray that can produce corrosion and asset deterioration. Coastal areas also have very high population density, which results in highly constrained transportation networks that are often multimodal and intersectional between waterways, ports and harbors, rail, transit, ferries, and highways, and embrace urban, suburban, and rural communities. Thus, the objective of the CREATE UTC is to address coastal infrastructure durability challenges to support the US DOT's mission of safe and efficient movement of people and goods while engaging emerging technologies for transformative research to prepare for the future of transportation. This objective will be achieved through goals divided into four categories: research, leadership, education and workforce development, and technology transfer and collaboration.

1.1.1 Research

CREATE conducts research in four thrusts, which were formed to address the significant challenges of coastal infrastructure durability. Table 1 shows our quantitative annual goals and our progress during this reporting period. As Year One projects are nearing completion, research achievements during this period are the initial dissemination of products to advance transformative knowledge. Three Year One projects are complete, based on PI summaries ten additional projects will be complete in the next reporting cycle. More details about current CREATE funded projects are included in "Research Accomplishments." As noted in Table 1, we continue to exceed our annual metrics for peer-reviewed journal articles and research assistants, we have met our current collaborative goal across the center. We anticipate exceeding our annual goals for conference proceedings and final reports now that project cycles are ending. We will provide an average annual metric update in SAR 5.

Table 1: CREATE annual research performance metrics

Metric	Annual goals	SAR 4
Advance transformative knowledge	-12 peer-reviewed journal articles -15 final reports -20 conference proceedings	- 12 journal articles published/in review - 1 final report - 2 conference proceedings
Collaborations	-5 awarded joint projects	- 5 joint CREATE projects
Blue economy workforce	-20 undergraduate researchers -15 graduate research assistants	-24 undergraduate researchers -34 graduate research assistants

1.1.2 Leadership

CREATE researchers have strong records in leadership within the transportation, construction, materials, and coastal communities. Our leadership goals are to develop future leaders throughout the organization and operation of CREATE. Table 2 includes our leadership

performance metrics for the center. Leadership achievements during this period are the continued number of faculty/student mentorship programs and the increasing amount of technology transfer activities, including two CREATE wide events; see "Technology Transfer and Collaboration."

Table 2: Leadership performance metrics

Metric	Annual goals	SAR 4
Transform. research implementation	-5 implementation presentations w/stakeholders	Nothing to report
Efficient technology transfer	-10 short courses, webinars, or information sharing sessions	- 9 short courses, webinars, or information sharing sessions
Pathways to blue economy careers	-20 new faculty and student mentorships in CREATE	- 58 faculty / student mentorships

1.1.3 Education and Workforce Development

Transportation agencies and private industry will be increasingly challenged to find highly qualified and technically trained employees due to higher retirement rates, fewer entrants into the transportation field, and increased competition for skilled labor, engineers, and planners. CREATE education and workforce development goals will be addressed using existing programs and new activities. The rigorous and inclusive character of the programs at our member universities provide a natural environment to understand emerging challenges and develop new skills for our blue economy workforce. Table 3 includes the center metrics related to education and workforce development. Achievements during this period include the 225% increase in graduate student research presentations (26 during this reporting period) and hosting both a virtual and in person symposium.

Table 3: Education and workforce development metrics

Metric	Short-term goals	SAR 4
Ugrad Student Development	-5 course modules implemented with assessments to facilitate improvement	-3 new course modules
Grad Student Development	- 5 external committee members -15 graduate student presentations	- 2 external members - 26 graduate student presentations
Non-degree programs	-6 virtual webinars -50 non-affiliated CREATE symposium registrants	- 2 CREATE webinars - 1 virtual symposium (44 participants) - 1 in person symposium (32 participants)

1.1.4 Technology Transfer and Collaboration

We envision a strength of CREATE being the goal to serve as a hub for technology transfer, commercialization, and collaboration of coastal multimodal transportation infrastructure research. Our leadership team has a strong record of taking research through the implementation phase, including patents and commercialization. Highlights of our technology transfer plan include mandatory individual project advisory boards, entrepreneurial mindset training, and innovative information exchange mechanisms. The technology transfer and collaboration metrics are included in Table 4. We ensured that all projects have an external advisory board (EAB). CREATE researchers declared one invention, SEAHIVEs, for scouring protection during this reporting period. Though not highlighted in our goals, during this reporting period we hosted two-CREATE wide symposium events to share research activities, grew our social media presence, and initiated our first public engagement technology transfer activity (more details in "Technology Transfer and Collaboration" accomplishments).

Table 4: Technology transfer and collaboration metrics

Metric	Annual goals	SAR 4
Stimulate coordination with stakeholders	-Document individual project EAB feedback and implementation status	-28 projects, 93% with individual EABs
Accelerate technology commercialization	- 10 trained future entrepreneurs	Nothing to report, entrepreneurial workshop scheduled SAR 5
Open, efficient information	-5 open access publications from CREATE research	-1 open access publication
CREATE collaboration	-3 supported projects with other UTCs	Nothing to report

1.2 What was accomplished under these goals?

The accomplishments that support the four center goals during this reporting period are completing one research project and submitting three final reports published to the ROSA P repository. We have also added a requirement for a final, five-minute video highlighting research outputs for each project. We held a hybrid and in-person symposium to strengthen our center collaborations and initiated our first public outreach event. We hold monthly meetings with the associate directors to ensure continuity across the center and held two in-person associate director meetings. Specific accomplishments under each goal are further described below.

1.2.1 Research

Research activities are underway for 25 projects, one project was completed during this reporting period and a final summary is included below. Two projects were completed during the last reporting period and have been removed from the summary activities below. All projects are included in the list of new research projects to the USDOT and posted in the Transportation Research Boards's Research in Progress database.

Thrust 1: Transformational coastal transportation infrastructure design and construction

COLLABORATION: SEAHIVE® solutions to mitigate bridge scour Phase I (TXST)
Stacey Kulesza and Salah Faroughi, Texas State University
Antonio Nanni and Landolf Barbarigos, University of Miami
9/1/2023 – 5/31/2025

The objective of this research is to design and optimize SEAHIVE® elements to mitigate bridge scour. TXST has established experimentally and numerically that when SEAHIVE® are placed horizontally in front of a circular monopile as a flow altering scour mitigation system, the ultimate scour around the monopile is significantly reduced. We have published one conference paper on the experimental setup and are preparing a manuscript on the results of the SEAHIVE® scour mitigation system. We will submit the final report in May with a one-year embargo through the publication process.

Biowaste materials as supplementary cementitious materials for coastal concrete applications
Xijun Shi, Texas State University
9/1/2023 – 5/31/2025

Ground waste eggshells were explored as alternative SCMs in portland cement concrete for coastal applications. TGA characterization revealed that eggshell powder contained organic impurities which impart superhydrophobic properties, inhibiting interaction between the mixing water and the blended cement. Rheological measurements showed that pastes with unincinerated eggshell powder exhibited higher static yield stress, indicating greater difficulty in pumping, spreading, and compacting. Heat treatment effectively denatured the organic content, mitigating these limitations. At 500°C, all organic impurities were eliminated, rendering the eggshell powder hydrophilic, similar to limestone powder. Scaling heat treatment to an industrial

level would incur minimal costs and carbon emissions compared to portland cement production. Thus, waste eggshells can be effectively valorized for blended cement, achieving a 35% portland cement replacement.

Composite mangroves for reducing soil erosion near transportation infrastructure
Anand Puppala and Nripojyoti Biswas, Texas A&M University
9/1/2023 – 8/31/2025
The objective of this project is to investigate the effectiveness of composite artificial mangroves in reducing incoming wave velocities and energies. This research aims to support efforts to mitigate overtopping and wave-induced erosion around coastal transportation infrastructure, including highway embankments and levees. To simulate wave action and study its effects on these structures, we have constructed a small-scale laboratory flume. We are currently designing experiments to evaluate how different mangrove configurations influence flow dynamics, wave attenuation, and soil erosion patterns under varying wave conditions.

COLLABORATION: SEAHIVE® solutions to mitigate bridge scour Phase II (UM)
Antonio Nanni and Landolf Barbarigos, University of Miami
Stacey Kulesza, Texas State University
6/1/2024 – 8/31/2025
Phase II focuses on the production of internally prestressed units using conventional precast beds currently available for producing 30-inch square piles. Using this technique, it will be possible to increase production efficiency and, as importantly, manufacture units of lengths up to 24 ft, which could be necessary for scouring applications in marine and riverine environments. We are also working on a paper related to the structural performance of 3D-printed SEAHIVE elements under compressive and flexural loading.

Cracking-resistant Concrete for Durable Coastal Structures
Xijun Shi, Anthony Torres, and Carlos Moro, Texas State University
9/1/2024 – 12/31/2025
The objective of this research project is to investigate the potential of synergetic utilization of internal curing (IC) agents and recycled steel fibers to develop crack resistant and durable concrete for coastal structures, with a specific focus on a continuously reinforced concrete pavement (CRCP). This is a collaborative project with the Texas Department of Transportation.

Self-Sealing Concrete to Enhance Durability and Longevity of Coastal Concrete Infrastructure under Corrosive Environment
Jung Yeon, Texas State University
9/1/2024 - 2/28/2026
This study aims to enhance the durability and lifespan of coastal concrete infrastructure by adding superabsorbent polymers (SAPs) into the concrete matrix. SAP characterization includes particle size analysis, SEM imaging, absorption tests in various solutions such as saltwater, desorption isotherms, and sorption isotherms. Preliminary results revealed significant variations in the absorption capacities of different SAPs, influenced by their chemical compositions and geometries. Mechanical testing of the self-sealing cementitious material is currently underway. Furthermore, a water flow test apparatus was constructed to assess self-sealing capabilities. One all results are finalized, we will propose an optimized mix design for the self-sealing cementitious system.

Vehicles over dunes: Biocementation-based coastal infrastructure for flood protection and beach access
Jens Figlus and Anand Puppala, Texas A&M University

9/1/2024–8/31/2025
The objective of this research is to evaluate biocementation (microbially- and enzymatically-induced carbonate precipitation) as a method of stabilizing beach dunes in order to support vehicular traffic and mitigate wave-induced erosion. Wave flume tests and geotechnical lab tests on both methods are ongoing.

Thrust 2: Coastal transportation infrastructure evaluation, prediction, and degradation prevention

COLLABORATION: Quantifying vessel propeller wash impacts on sedimentation in shallow bay ports and waterways
Jens Figlus, Texas A&M University
Stacey Kulesza, Texas State University
9/1/2023 – 05/31/2025
The project seeks to collect and analyze field data on hydrodynamics and suspended sediment concentrations associated with large vessels traversing a ship channel in a shallow bay system (Houston ship channel in Galveston Bay). Data from close to 50 vessel passages were collected over two separate field campaigns using a vessel-mounted 5-beam ADCP system and marine electrical resistivity. Analyzed ADCP data clearly show the captured prop wash plume features. We are calibrating acoustic backscatter signals with in situ sediment measurements. We developed a novel approach to process the marine electrical resistivity data to support the final sediment quantifications with real-time images of the suspended sediment. We are planning a final field campaign during the next reporting period.

Development and deployment of titanium alloy bars for strengthening and cathodic protection of corrosion damaged transportation infrastructure
Burkan Isgor and Christopher Higgins, Oregon State University
9/1/2023 – 5/31/2025
The research demonstrated and reported on the practical feasibility of using discrete near-surface mounted titanium alloy bars (TiABs) for both structural strengthening and ICCP. Results offer the potential for a novel multi-functional material application to common infrastructure preservation challenges that can restore structural strength and preserve the remaining reinforcing steel in corrosive conditions. The need for a mixed-metal oxide coating was identified as needed to ensure long service life of the titanium anodes. Partners were contacted to explore potential development of a coating type and application process. We have published one peer-reviewed article and are currently preparing the final report.

Development of deep learning based automated data collection technology for coastal highway pavements
Feng Wang, Texas State University
9/1/2023 – 5/31/2025
The three objectives of this research are: 1) To establish a library of pavement surface images from coastal areas, representing various combinations of pavement distress types and severity levels. 2) To develop AI/ML models and tools for coastal pavement condition assessment. 3) To test and validate the developed AI/ML models on coastal case studies. We have collected pavement surface image data, annotated the images, and developed the machine learning models. This is a collaborative research project with the Texas Department of Transportation.

Soil Innovations for Enhanced Coastal Infrastructure Durability: Durable Soil Stabilization
Pavan Akula, Oregon State University
9/01/2024–8/31/2025
The objective of this research is to optimize the current approach for chemical stabilization of soils in coastal environments, which are salt-rich, have dynamic pH, moisture fluctuations, and

temperature changes. This study will seek to improve the chemical composition of the stabilizer to encourage the development of strong strength-enhancing compounds (such as low calcium C-S-H) in coastal environments and enhance the density of compacted stabilized soil to reduce the infiltration of moisture and dissolved salts.

Risk-based assessment of ports and interconnected networks subjected to coastal hazards
Maria Koliou, Texas A&M University
9/1/2024 – 8/31/2025
The objective of this research is to probabilistically evaluate the resilience of port infrastructure accounting for system interdependencies. Creating a resilient transportation system has been identified as a priority by public and private organizations to address the risks of climate change and extreme weather events. Ports play an important role in the economy of coastal communities across the Gulf Coast and they are significantly impacted by weather-related events. This project will focus on addressing issues related to the resilience and recovery of port infrastructure in the Gulf coastal regions subjected to weather-related hazards and propose mitigation strategies.

Strengthening and corrosion protection of coastal transportation infrastructure with titanium alloy bars
Burkan Isgor and Christopher Higgins, Oregon State University
9/30/2024 – 8/31/2025
This research builds on Phase I that demonstrated the practical feasibility of using discrete near-surface mounted titanium alloy bars (TiABs) for both structural strengthening and ICCP. Results offer the potential for a novel multi-functional material application to common infrastructure preservation challenges that can restore structural strength and preserve the remaining reinforcing steel in corrosive conditions. In this phase, a mixed-metal oxide coating was applied to TiABs in partnership with De Nora NA. This is the first application of MMO coating to a Grade 5 titanium alloy bar. Electrochemical tests of the durability of the coating on the TiABs demonstrate an expected long service life of the titanium anodes and that ICCP operating conditions are practically achievable. The feasibility of producing MMO coatings to longer bars was shown to be possible. A swagged Ti coupler was designed; swagging studies are underway.

Thrust 3: Response to unprecedented coastal hazards

Transportation asset risk and resilience analysis in coastal communities
Ali Mostafavi, Texas A&M University
9/01/2023–2/28/2025 (*complete*)
This project aimed to create quantitative tools to identify and prioritize critical transportation assets, thus mitigating risks during coastal extreme weather events. A model was developed to simulate various flood scenarios, allowing for a comprehensive assessment of these impacts. We have successfully implemented a user cost model to estimate the financial burden on users under different scenarios. Additionally, the model to evaluate physical damage costs has been fully developed and assessed. The final report is complete and has been submitted for publication to close out the project.

Hydrodynamic Properties of a Large-Scale Bridge Model under Free and Forced Vibration
Harry Yeh, Oregon State University
9/01/2023–5/31/2025
This project examined test data collected for a 1:12 scale model of a prestressed girder bridge subjected to snap tests and solitary waves. We measured the dynamic response of the bridge superstructure subjected to varying levels of water submergence. The findings reveal the influence of different damping contributions to oscillatory motion, demonstrating that viscous

damping dominates when the structure is submerged. Additionally, the results showed that the experimentally measured added mass was much greater than the theoretical prediction. Water sloshing between girders in the partially submerged conditions contributed to response modification. The study provides new insights into the behavior of bridge superstructures in submerged conditions, with practical implications for predicting structural response due to wave and flooding forces. We have prepared the draft report with a final report release in May 2025.

Analyzing Pre- and Post-Coastal Hazard Pavement Conditions to Optimize Response Strategies for Coastal Infrastructure Resilience
Xiaohua Luo, Feng Wang, and Feng Hong, Texas State University
9/01/2024–2/28/2026
The objective of this research is to investigate the effects of coastal hazards on pavement conditions in Texas' coastal region and to optimize infrastructure response through network analysis. We will analyze historical pavement data before and after Hurricane Harvey to evaluate the impact of the hurricane on pavement distress and severity. Another objective is to assess the effectiveness of maintenance strategies implemented after coastal hazards, enhancing decision-making for future maintenance planning. Finally, the research aims to develop tailored strategies for improving infrastructure resilience by reviewing existing methods and conducting scenario analyses specific to Texas' coastal context. Ultimately, the findings are intended to inform maintenance decisions and contribute to strategies that enhance the resilience of coastal pavement infrastructure. Currently, we are working on finding the areas highly impacted by hurricane Harvey in Houston. We will analyze the pavement condition data of these areas to understand the pavement condition. This is a collaborative research project with the Texas Department of Transportation that builds on “Development of deep learning based automated data collection technology for coastal highway pavements.”

Identification of Unprecedented Coastal Flooding Hotspots for Highway Network Durability
Eunsang Cho and Subasish Das, Texas State University
9/1/2024 – 12/31/2025
The objectives of this project are to develop a super-resolution, physically-informed AI algorithm to improve flood hazard mapping on a road network scale, implement a data fusion approach to uncover social vulnerability in transportation systems, and transfer research outputs to operations for public benefits. The outcome of the project will be an interactive web-based highway network-level durability and flood risk assessment map. While this research will focus on Galveston, TX, as a testbed, the research framework is expected to apply to other coastal regions in the U.S.

Agent-based modeling for assessment of coastal transportation network resiliency
Amirali Najafi, Texas A&M University in collaboration with Joseph Louis, OSU
9/1/2024 – 8/31/2025
This research focuses on the vulnerability of communities to extreme weather impacts, particularly in coastal areas. It explores how infrastructure resilience planning can inadvertently worsen community disparities. The objective is to develop an agent-based model (ABM) framework that integrates infrastructure resilience, community vulnerability, agency decision-making, and climatic hazards. The ABM aims to inform engineering and decision-making policies.

Improving post-disaster access to critical facilities for coastal communities
Joseph Louis and Haizhong Wang, Oregon State University in collaboration with Amirali Najafi, TAMU
9/1/2024 – 6/14/2026
The overall goal of this project is to methodically plan for recovery operations after unprecedented hazard scenarios by linking them to what we know about hazards and infrastructure, by devising

methods to calculate recovery times that are dependent on hazard characteristics, equipment availability, and community demographics. Thus far, we have collected GIS data about hazards and roadway networks. We have developed a framework to integrate these data sources with Discrete Event Simulation for the case study of landslide clearance operations in Oregon. This will enable us to study connectivity after disasters as a function of equipment availability.

Present and future hazard scenario database for coastal infrastructural resilience and maintenance planning
Jame Kaihatu, Texas A&M University, in collaboration with Alberto Figueroa-Medina, UPRM
9/1/2024-8/31/2025
The objective of this research is to develop a hazard database for three locations along the Texas coast which can be used to help allocate repair and maintenance resources for coastal infrastructure. Existing work for Texas City and Galveston is being adapted, while Port Arthur is a new model under development. The overall product will be a set of maps delineating flooding risk and vulnerability. For selected infrastructure components of particular concern, a phase-resolved wave model, driven by flooding and wave events from hurricanes, can be used to simulate the time-dependent forces from hurricane-driven waves and help pinpoint potentially damaging conditions within hurricane events. Finally, the results will be used to evaluate the impact of flooding on evacuation and traffic flow as a collaboration with “Use of Enhanced Visualization Technology...”, see below.

Use of Enhanced Visualization Technology to Assess the States of Coastal Transportation Infrastructure
Alberto Figueroa-Medina, University of Puerto Rico Mayaguez in collaboration with James Kaihatu, TAMU
9/1/2024-8/30/2025
The overall project concept is to devise a mechanism that incorporates the needs and preferences of coastal communities in the development of a decision-making support tool that assesses risks for transportation corridors based on performance and that improves infrastructure and services in support of the blue economy. This project looks to enhance the transportation infrastructure of coastal communities through a methodology that assesses accessibility based on three states: perceived, actual, and designed, using mixed reality visualizations as educational tool. Additionally, UPRM will collaborate as part of Task 5 of “Present and Future Hazard Scenario Database…” (above) in evaluating the impacts of infrastructure damage on traffic flow conditions and performance, evacuation routing, and other transportation issues. During the reporting period, the base scenario was created using highway PR-466 in the Municipality of Isabela. The visualization is creating a flooding event at the coastal corridor.

Resilience Based Decision Support System for Critical Transportation Corridors
Ismael Pagan Trinidad, University of Puerto Rico, Mayaguez
9/1/2024-8/30/2025
The objective of this research is to determine the level of vulnerability of transportation corridors in coastal communities by applying USDOT's Vulnerability Assessment Scoring Tool (VAST). By considering both infrastructure vulnerabilities and the needs of vulnerable populations, this approach ensures that resources are targeted to areas where they will have the most significant impact. During the reporting period, we started identifying the main roadway characteristics of PR-466 & PR-4466 corridor in the coastal community of the Municipality of Isabela.

Thrust 4: Pathways to blue economy transportation careers

Capacity building and workforce development for coastal transportation infrastructure exposed to multi-hazards, Phase I
Alberto Figueroa Medina, Carla Lopez del Puerto, and Ismael Pagan Trinidad, University of Puerto Rico Mayaguez
9/1/2023-8/31/2025
The objectives includes the evaluation of the diverse experiences of transportation officials in coastal contexts, recognizing strategies for adaptation and change of transportation infrastructure, the identification of communication and information limitations for population in coastal communities, and study the challenges for attracting a workforce that can reflect the variety of perspectives of coastal communities and support planning and decision making in transportation infrastructure. A draft of the final report was prepared during this period and is ready for final review.

National Summer Transportation Institute at Texas State University
Xiaohua Luo, Feng Wang, and Yihong Yuan, Texas State University
9/1/2023-8/31/2026
Texas State University organizes a National Summer Transportation Institute program to introduce the broad field of transportation to high school students. These students are introduced to concepts associated with the application of high technology to transportation engineering and transportation infrastructure. The two-week residential program includes daytime and evening activities for the students to have authentic college experiences. The curriculum focuses on a different mode of transportation with an associated theme each day. Throughout the program, related transportation careers are highlighted. The CREATE Center, TXST, and the NSTI collaborate with the Federal Highway Administration, the Texas Department of Transportation, and Austin Capital Metro to provide guest lectures, field trips, laboratory tours, and/or investigations.

National Summer Transportation Institute at University of Miami
Ali Ghahremaninezhad, University of Miami
6/1/2024-5/31/2025
The objective of this project was to encourage K-12 students toward the STEM disciplines by educating them on transportation engineering career opportunities. Participants showed increased interest and awareness about the STEM and the transportation industry following the 2024 summer camp.

Capacity Building and Workforce Development for Coastal Transportation Infrastructure Subjected to Multi-hazards (Phase 2)
Carla Lopez del Puerto, University of Puerto Rico Mayaguez
9/1/2024-8/31/2025
The ongoing project focuses on the characterization of a coastal community in the municipality of Isabela, PR, in terms of vulnerability, demographics, access to transportation, and the aspects of blue economy present (or with potential development) in the community. These will be assessed, aided by GIS tools, and possible areas of best practice of transportation infrastructure will be suggested. This project involves the community in a collaborative exchange of ideas to deliver a more cohesive result. During this reporting period, the GIS analysis was initiated with information about flooding and other natural hazards as well as sociodemographic information.

1.2.2 Leadership
Individual project PIs are engaged in national and international leadership, our roles are unchanged since SAR 3 and therefore not listed herein. We led a symposium at Texas State

University on March 6, 2025, which included a one-hour hybrid meeting with USDOT. During this time, we presented our center overview, highlighted two research projects, discussed upcoming technology transfer events, and had five student poster presentations. Following the virtual meeting, our in-person symposium continued with four additional student presentations and a faculty collaboration meeting to outline year 3 research priorities. As shown in Figure 1, all partner institutions had at least one faculty researcher and two graduate student researchers present, including one student representative from our Student Leadership Council (SLC). The SLC coordinated an onsite student posters session and half-day technical writing session for all students at the symposium.

Figure 1: March 6, 2025 Hybrid USDOT Meeting and CREATE Symposium at TXST

1.2.3 Education and Workforce Development

All project PIs teach transportation related courses at the graduate and undergraduate level. During this reporting period CREATE faculty taught 28 undergraduate and 20 graduate courses in Departments of Civil Engineering, Civil Engineering and Surveying, Civil and Architectural Engineering, Ocean Engineering, Ocean Sciences, and Concrete Industry Management. Since the start of CREATE, 47 graduate research assistantships and 32 undergraduate research assistantships have been created to work on research projects. Outside of the university, faculty led four workshops and one certification programs as listed below:

- ACI Certification Field Testing I, San Marcos, TX, October 26, 2024. 45 participants
- Coastal Engineering & Nature-Based Solutions short course, Galveston, TX, September 16-20, 2024. 60 participants
- Educating Tomorrow's Professionals for Coastal Resiliency, February 2025, UPRM, 60 students.
- Coastal Flood Exposure Mapper, October 14, 2024, UPRM, 60 students.
- Puerto Rico Hazards and Risks Portal, October 28, 2024, UPRM, 60 students.

1.2.4 Technology Transfer and Collaboration

CREATE exchanges information with the public through six mechanisms: CREATE website, databases, communication materials, sponsored exhibits, social media, and science on tap. We have published our website, create.engineering.txst.edu, which we will continue to build as we generate content and update on an on-going basis. We have created accounts for Twitter, LinkedIn, Facebook, and YouTube Channel. The YouTube Channel archives all CREATE Webinars and will archive final project summary videos. Table 5 includes details of the CREATE webinar series. All webinars have attracted attendees from outside our UTC consortium including participants from state DOTs outside the consortium states (e.g. Wisconsin, Michigan), engineers from the private sector (e.g., HDR, SMH Consultants), public agencies (e.g., FEMA), and other universities (e.g., Rutgers, NC A&T).

Table 5: Year 2 CREATE supported webinars

Date	Title	Speaker	Attendees	Thrust
6/3/24	Integrated Approach for Geotechnical and Hydrodynamic Analyses in Coastal Residential Built Infrastructure: A Holistic Perspective	Nripojyoti Biwas, PhD	39	Trust 1 Thrust 2
8/29/2024	Automated assessment of transportation infrastructure condition using sensor technology and imaging processing	Robin Huang, PhD	22	Thrust 2
10/24/2024	CREATE Virtual Symposium	Stacey Kulesza, PhD, PE; Steven Nolan, PE; Jack Cadigan, PhD; Eileen Velez Vega, PE	44	All
11/12/2024	Concrete Petrography and Image Analysis: The What, Why and How	Joe Qiao, PhD, PE	43	Thrust 2
2/7/2025	Recent Updates on Plient and SEAHIVE® - CREATE Sponsored Transferable Concrete Products	Landolf Rhode-Barbarigos, PhD; Charles Donnelly, PhD	20	Thrust 1, Thrust 2

The virtual symposium in Table 5 included a panel discussion from our advisory board, project overviews for all projects listed herein, a ‘faculty mixer’ to ignite cross consortium collaborations, and a virtual student poster session for all Year One projects. The virtual student posters included:

- Castillo, R. and Akter, S. (TXST). Evaluation of a Nature-Based Solution to Mitigate Bridge Scour
- Chong, B.W. (TXST). Waste Eggshell as Limestone Alternative in Portland Cement Composites.
- Krishnan, N. (OSU). Cathodic Protection and Structural Strengthening of RC Infrastructure using MMO-Coated Titanium Alloy Bars.
- Kumar, A. (TAMU). Composite Mangroves for Reducing Soil Erosion near Transportation Infrastructure.
- Lawrence, A. (TAMU) and Gombac, A. (TXST). Novel Techniques to Image Sediment Resuspension form Deep Draft Vessels.
- Mirdarsoltany, A. (UM). Evaluating Structural Performance of FRP-Wrapped Reinforced Concrete Elements.
- Puligese, D. (UM). Automated Knowledge Graphs for Complex Systems (AutoGraCS).

- Yin, K. (TAMU). Transportation Asset Risks and Resilience Analysis.
- Romero, J. (OSU). Hydrodynamic Properties of a Large-Scale Bridge Model Under Free and Forced Vibration.
- Sanabria, A. (UPRM). Capacity Building and Workforce Development for Coastal Transportation Infrastructure Subjected to Multi-Hazards.
- Sanchez, C. (TXST). Deep Learning Modules for Pavement Surface Distresses in Coastal Regions.

We held an in-person student professional development workshop on March 6, 2025 for the 14 CREATE graduate student researchers who attended the symposium at Texas State. The workshop, “Write your big ideas” was an active workshop to offer meaningful insights for students in all phases of writing, from PhD proposals to future grants. The workshop, shown in Figure 2 was led by TXST Creative and Technical Writer, Rachel Bomberger.

Figure 2: Student Professional Development Workshop at March 6 CREATE Symposium

We hosted our first “Science on Tap” information exchange on March 6, 2025 at Zelicks Ice House. Four faculty researchers gave five-minute overviews of how they became interested in engineering, specifically their subdisciplines, and how their research addresses transportation durability challenges. They then dispersed to talk to attendees and answer any additional questions in an informal setting. We collected quantitative and qualitative data from the public, with a goal of engaging people outside of engineering. We are still processing these data; however, a preliminary highlight of one qualitative question is shown in Figure 3. Before this session, 24% of the survey respondents were not familiar with any of the presentation topics. Non-engineering participants included a line cook, an event planner, a high school student, and an accountant. We similarly spoke at a *Pintata de Piedras* painting event in a Park in Mayagüez on April 5 and plan to add these highlights in SAR 5.

"[Today I learned]

- How consumer behavior affects roads and infrastructure
- How different types of soils can affect how we design.
- How can engineers make our commute easier, making going from point A to B easier
- I learned about repairing existing bridges using more durable materials. I also learned that people do analysis of road rage type things"

Figure 3: March 6 Science on Tap, example public engagement

1.3 How have the results been disseminated?

Results have been disseminated through final reports, workshops, student poster sessions, seminars (Table 5), presentations and publications listed in Section 3.0 Outputs.

1.4 What do you plan to do during the next reporting period to accomplish the goals?

There is no change to the center plans. Expected highlights of the next reporting period include:

- Highlights from Plient Fiber Reinforcement for Pavement and Floors, a new technology showcase event
- Highlights from Innovation and Entrepreneurship Workshop: From Lab to Market
- Final reports and technology brief videos for the remaining year 1 projects
- Brief updates on current project activities
- Output updates from completed projects via dissemination in journal articles, conference presentations, and webinars

2. Participants & Collaborating Organizations

2.1 What organizations have been involved as partners?

Table 6 lists CREATE partners and the type of support by each. We added "Echo Ocean Science, LLC" as a partner organization in this reporting period.

Table 6: CREATE partner organizations

Organization	Location	Support
Circle Concrete Tech	Austin, Tx	In kind support
De Nora Tech	Concord, OH	In-kind support, Collaborative research
Echo Ocean Science, LLC	Houston, TX	In-kind support; Facilities
Florida Department of Transportation	Tallahassee, FL	Collaborative Research
Perryman Company	Houston, PA	Collaborative research
Municipality of Isabela	Isabela, PR	In-kind support
NestFresh Eggs	Denver, CO	In-kind support
Rio Grande Valley Sugar Growers, Inc	Santa Rosa, TX	In-kind support
Texas Department of Transportation	Austin, TX	Financial support
University of Maryland	College Park, MD	Collaborative research

2.2 Have other collaborators or contacts been involved?
CREATE has an external advisory board that provides feedback and recommendations on CREATE operations. Additionally, CREATE faculty collaborate with colleagues at other institutions and other departments within our own institutions on CREATE research.

3. Outputs

3.1 Publications, conference papers, and presentations during this reporting period
Peer reviewed journal articles (12)
Cheng, M., Shah, S (**undergraduate student**), Nanni, A., and Gao, O. (2024). Automated knowledge graphs for complex systems (AutoGraCS): Applications to management of bridge networks. *Resilient Cities and Structures*, 3(4), 95-106. https://doi.org/10.1016/j.rcns.2024.11.001

Chong, B. (**PhD student**), Gujar, P., Shi, X., Suraneni, P. Valorization of Waste Eggshell as a Limestone Alternative for High-Volume Incorporation in Portland Cement, *ASCE Journal of Materials in Civil Engineering.* (Under review)

Geng, Z. (**PhD Student**), Zhang, C., Jiang, Y., Pugliese, D., and Cheng, M. (2025). Integrating multi-source data for life-cycle risk assessment of bridge networks: a system digital twin framework. *Journal of Infrastructure Preservation and Resilience*, *6*(1), 9. https://doi.org/10.1186/s43065-025-00121-7

Gombac, A. (**PhD Student**), Almikati, A. Kulesza, S. Efficacy of marine electrical resistivity surveys to determine maximum scour depth and scour infill. *Transportation Research Record*. (*in press*).

Liu, B., Guo, H. and Wang, H. An AI-driven approach to extract interrelationships between disasters, *International Journal of Disaster Risk Reduction*, 121, 105417.

Luo, X., Mahajan, G. (**PhD student**), Wang, F., Gong, H., Hong, F., and Tao, J. Precision Assessment of Automated Pavement Condition Data Collection Using Annual Rating Data. *International Journal of Transportation Science and Technology*. (*in press*).

Luo, X., Tao, J., Wang, F, Faieq, A. (**MS student**), Gong, H., Hong, F. (2024) Enhancing Reliability in Automated Pavement Condition Data with a Data Quality Check Approach for Highway Agencies. *Transportation Research Record*, https://doi.org/10.1177/03611981241246247

Mojabi, S., Mirdarsoltany, M. (**PhD Student**), Subacchi, C., and Nanni, A. (2024). Structural Performance of GRFP-Wrapped Concrete Elements: Sustainable Solution for Coastal Protection. *Sustainability*, 16(22), 9775. https://doi.org/10.3390/su16229775

Mirdarsoltany, M. (**PhD student**), Hussain, Z., Khodadadi, N. and Nanni, A. Strength Performance of Hexagonal, Hollow and Perforated Concrete Units. *Journal of Construction Building Materials*. (Under review after addressing minor revisions)

Opanasopit, C. (**PhD Student**) and Louis, J. Automated Detection of Roadway Obstructions to Assess Vehicle Accessibility Using Aerial and Reference Images, Submitted to *ASCE Journal of Computing in Civil Engineering* (Under review).

Sanchez, C. (**MS student**), Wang, F., Bai, Y., and Gong, H. (2025). Detection of Flexible Pavement Surface Cracks in Coastal Regions Using Deep Learning and 2D/3D Images, *Sensors*, 25(4), 1145. https://doi.org/10.3390/s25041145

Slawinski, A. (**MS student**), Higgins, C., and Isgor, B. Impressed Current Cathodic Protection with Near-Surface Mounted Ti Retrofit Bars. *ACI Materials Journal*, 122(2), March-April.

Meeting/Conference presentations/posters made by key researchers and students during this reporting period (13)

Castillo, R. (**MS Student**). Experimental investigation for a novel bio-inspired scour countermeasure. Presented at Geotechnical Frontiers 2025, Louisville, KY, March 4, 2025.

Cheng, M. A framework for managing life-cycle risk of coastal bridge networks using digital twin technology, Presentation at 2025 NHERI Computational Symposium, February 5, 2025.

Cheng, M. A system digital twin framework for life-cycle risk assessment of bridge networks using Bayesian networks, Presentation at Symposium on Community-Smart infrastructure innovations & implementation (CSi3), March 2, 2025

De Caso, F. Climate Change and Community Engagement. Presented at National Academy of Engineering, Washington DC, Nov. 14, 2024

Figueroa-Medina, A. and López del Puerto. Fostering Transportation Workforce Development for the Blue Economy. 2024 IEEE Frontiers in Education Conference, Washington DC. October 14, 2024

Figueroa-Medina, A. Capacity Building for Resilient Transportation Infrastructure Subjected to Multi-Hazards: Mitigating the Risks of Coastal Communities. Natural Hazards and Resilient Infrastructure Session, 2024 Puerto Rico Symposium on Microgrids. UPRM Coastal Resilience Center, University of Puerto Rico at Mayagüez, December 5, 2025.

Gombac, A. (**PhD Student**) Efficacy of Marine Electrical Resistivity Surveys to Determine Maximum Scour Depth and Scour Infill, Presented in the 2025 TRB meeting, January 6, 2025

Joubert, J. (**PhD Student**) Contributions of primary and secondary vessel wake to suspended sediment concentration in shallow bay systems. Presented at the American Short and Beach Preservation Association (ASBPA) National Conference, Galveston, Texas, October 7, 2025.

Kulesza, S., Higgins, C., Sanchez, C. (**MS Student**), Addarich, L. (**MS Student**), Romero, J. (**PhD Student**), Kumar, A. (**PhD Student**), Mirdarsoltany, M. (**PhD Student**). CREATE University Transportation Center: Center Progress, Research Updates, and Student Summaries. Presented at Hybrid CREATE Symposium to USDOT and UTC Leadership, March 6, 2025.

Luo, X. Precision Assessment of Automated Pavement Condition Data Collection Using Annual Rating Data., Presented in the 2025 TRB meeting, January 7, 2025

Momin, M.S.M.I. (**MS Student**), High-Resolution Hydrodynamic Modeling for Coastal Flood Hazard Mapping for Galveston Island: Model Development and Validation, Presented at the TXST STEM Conference, March 28, 2025

Rhode-Barbarigos, L. SEAHIVE Implementation. University of South Florida, March 1, 2024

Rhode-Barbarigos, L. SEAHIVE Implementation. Presented at USACE CSRM Back Bay Scoping Workshop, Cutler Bay, FL, November 12, 2024.

Scouten, A. (**MS student**) Deep Learning Pipeline for Modeling Pavement Cracks from Unbalanced Image Classes, Presented in the 2025 TRB meeting, January 6, 2025

Shi, X. Assessment of waste eggshell powder as a limestone alternative in Portland cement. Presented at the 15th International Association of Chinese Infrastructure Professionals (IACIP) Annual Workshop, Washington D.C, January 5, 2025.

Conference proceedings (2)
Castillo, R. (**MS Student**), Kulesza, S., Rhode-Barbarigos, L. (2025). Experimental investigation for a novel bio-inspired scour countermeasure. *Geotechnical Frontiers 2025*. https://doi.org/10.1061/9780784485996.044

Figueroa-Medina, A., Pagan, I., López del Puerto, C., Dieppa, J. (**MS Student**), and Alicea, J. (**MS Student**). Fostering Transportation Workforce Development for the Blue Economy. 2024 IEEE Frontiers in Education Conference, Washington DC. https://doi.org/10.1109/FIE61694.2024.10893413

3.2 Website(s) or other Internet site(s)
https://create.engineering.txst.edu/ - CREATE UTC website. The website currently includes our leadership directory, the advisory board, a description of research thrusts, current projects, final project reports, and webinar information. We continue to add content as the center grows, in the next reporting period we will add the final project videos for a brief overview of the posted reports.

3.3 Technologies or techniques
Project update on Self-Sealing Concrete: Integrating recycled superabsorbent polymers (SAPs) into concrete offers transformative commercial opportunities. By enhancing concrete's ability to retain moisture, SAPs improve durability and reduce cracking, which is essential for the longevity of infrastructure. This innovation promotes efficient construction practices and lowers maintenance costs, benefiting public transportation agencies focused on maintaining the built environment and construction firms that require stringent quality control. With their ability to deliver multiple benefits, SAP-enhanced concrete can significantly contribute to the creation of smarter, more resilient built environments. As agencies and businesses increasingly prioritize infrastructure durability and sustainability, the use of SAPs in concrete construction stands to make a timely significant impact in the market.

3.4 Inventions, patent applications, and/or licenses
COLLABORATION: SEAHIVE® solutions to mitigate bridge scour, Antonio Nanni and Landolf Barbarigos, University of Miami, invention declared for scouring protection.

4. Outcomes
Nothing to report.

5. Impacts
5.1 What is the impact on the effectiveness of the transportation system?
Self-Sealing Concrete: Traditional concrete curing methods (i.e., external curing) often lead to inconsistent hydration, resulting in shrinkage and cracking of concrete structures. Our approach

integrates recycled superabsorbent polymers (SAPs) directly into the concrete mixture, allowing them to absorb and release water, which ensures optimal hydration from within and maintains consistent internal moisture levels. This method eliminates the need for external curing and minimizes premature distress, resulting in higher-quality and longer-lasting concrete. This approach not only preserves the functional benefits of SAPs but also reduces resource consumption and production costs, offering a more sustainable alternative for the construction industry. The intellectual merit of this approach lies in its potential to revolutionize concrete production practices by advancing eco-friendly and cost-effective solutions, thereby supporting circular economy principles in infrastructure construction and maintenance.

COLLABORATIVE Quantifying Vessel Propeller Wash, there is the Potential for the Port of Houston to use the project outcomes to determine contributions of large vessels to channel shoaling. Understanding, and potentially predicting shoaling would enable more proactive channel management to maintain open operations and effective transportation of goods through the shipping channel.

5.2 What is the impact of technology transfer on industry and government entities, on the adoption of new practices, or on research outcomes which have led to initiating a start-up company?
Nothing to report.

5.3 What is the impact on the body of scientific knowledge?
CREATE focuses on improving durability and extending the life of coastal transportation infrastructure. Although there have been recent investments in coastal resilience (e.g., DHS Coastal Resilience Center, NOAA Climate Ready Coasts), there remains a need for targeted research in coastal transportation infrastructure durability. All research projects contribute to the body of scientific knowledge.

5.4 What is the impact on transportation workforce development?
Three CREATE universities held Summer Transportation Institute (STI) camps and are preparing for activities in summer 2025 which will be reported in SAR 5. Within our own institutions, all projects support and engage student researchers, from undergraduates through PhD Students. We developed and presented two course modules in this reporting period for undergraduate students. Outside of our institutions we delivered one ACI Field Testing Certification Program and four workshops to approximately 290 participants.

The Transportation Interactive Learning Hub will contain a repository of training and learning modules that will be of interest to a broad range of transportation stakeholders and will function as a vehicle to store, preserve, and disseminate the materials developed by this project and as well as from other CREATE projects. Reports, case studies, presentations, webinars, and other materials will be classified based on their level of complexity and will indicate the target population (i.e., academics and researchers, professionals, community members, etc.). The interactive component will allow participants to answer questions throughout the presentations to be able to continue watching the webinar, increasing participant engagement. The TIL-HUB will contribute to institutionalizing the long-term permanence of operational activities and leadership on capacity building at CREATE and will contribute to position our Center as a leader in multi-hazard education, capacity building, and workforce development for the durability of coastal transportation infrastructure. The CREATE project will leverage efforts with the CRC IL-HUB to broaden and strengthen the audience that will be impacted by CREATE and UPRM-CRC.

(https://www.uprm.edu/inci/crc/).

6. Changes/Problems

6.1 Changes in approach and reasons for change

Nothing to report.

6.2 Actual or anticipated problems or delays and actions or plans to resolve them.

Based on Federal Executive Orders 14091 and 14092 and then Texas Executive Order GA 55 (https://gov.texas.gov/news/post/governor-abbott-directs-state-agencies-to-ban-dei-policies) we were required to remove any language flagged for noncompliance from our website because it is on the Texas State Platform. Therefore, to comply we filed a request to change our center name to Coastal Research And Transportation Education (CREATE). Furthermore, we modified five project names with approval from the PI. Table 7 highlights the changes and justifications:

Table 7: CREATE UTC Name Modifications

Original Name	Updated Name	Justification
Coastal Research and Education Actions for Transportation Equity (CREATE)	Coastal REsearch And Transportation Education (CREATE)	"Equity" Flagged for DEIA language
Use of Enhanced Visualization Technology to Assess the Equity States of Coastal Transportation Infrastructure	Use of Enhanced Visualization Technology to Assess the States of Coastal Transportation Infrastructure	"Equity" Flagged for DEIA language
Equity and Resilience Based Decision Support System for Critical Transportation Corridors	Resilience Based Decision Support System for Critical Transportation Corridors	"Equity" Flagged for DEIA language
Transportation Assets Risk and Resilience Analysis to Reduce Societal Risks to Vulnerable Populations	Analytical Approach for Transportation Assets Risk and Resilience Analysis	"Societal Risks to Vulnerable Populations" flagged for DEIA language
Identification of Unprecedented Coastal Flooding Hotspots for Highway Network Durability and Social Justice	Identification of Unprecedented Coastal Flooding Hotspots for Highway Network Durability and Community Resilience	"Social Justice" flagged for DEIA language

As an infrastructure durability center, all research was and remains focused on transportation infrastructure, not DEIA, therefore we did request, nor find need, for PIs to change the scope of their approved projects. We similarly do not plan to change our research agenda for the CREATE center.

6.3 Changes that have a significant impact on expenditures.

Nothing to report.

6.4 Significant changes in use or care of human subjects, vertebrate animals, and/or *biohazards*

Nothing to report.

6.5 Change of primary performance site location from that originally proposed.

Nothing to report.

7. Special Reporting Requirements

Nothing to report.