

Semi-Annual Progress Report for University Transportation Centers

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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 face 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 result in highly constrained transportation networks that are often multimodal and intersectional between waterways, ports and harbors, rail, transit, ferries, and highways, and embraces urban, suburban, and rural communities. These high-density regions have significant inequity gaps of infrastructure conditions in historically underserved communities. Thus, the objective of the CREATE UTC is to address coastal infrastructure durability challenges to support the US DOT's mission of safe, efficient, sustainable, and equitable movement of people and goods. 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 and to reduce inequities in the transportation system, including transportation careers. Table 1 shows our quantitative annual goals. In this period the initial 11 projects continued. We also reviewed 29 proposals and selected 15 to begin August 2024. More details about the 11 projects and current progress are included in "Research Accomplishments."

Table 1: CREATE annual research performance metrics

Metric	Annual goals	Year 1 progress
Advance transformative knowledge	-12 peer-reviewed journal articles -15 technology briefs, final reports -20 conference proceedings	Nothing to report
Collaborations	-5 awarded joint projects	- 2 awarded joint projects (year 1) - 3 awarded joint projects (year 2)
Blue economy workforce	-20 undergraduate researchers -15 graduate research assistants	- 21(14), undergraduate researchers* - 7(4), MS research assistants* - 7(2) PhD research assistants*

*Total(Number from underrepresented in engineering)

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 emphasize individual PI leadership achievements and new mentorship relationships through research projects.

Table 2: Leadership performance metrics

Metric	Annual goals	Year 1 progress
Transform. research implementation	-5 implementation presentations at stakeholder meetings	Nothing to report
Equitable technology transfer	-10 short courses, webinars, or information sharing sessions	- 7 (2 webinar, 5 short courses/info sessions)
Equitable pathways to blue economy careers	-20 new faculty and student mentorships in CREATE	- 40 new faculty and student mentorships initiated

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, progressive, and inclusive character of the programs at our member universities provide a natural environment to validate existing experiences, 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 establishing the center webinar series, faculty presenting CREATE research in external webinars, and graduate students presenting preliminary results in various venues.

Table 3: Education and workforce development metrics

Metric	Short-term goals	Year 1 progress
Ugrad Student Development	-5 course modules implemented with assessments to facilitate improvement	Nothing to report
Grad Student Development	- 5 external committee members -15 graduate student presentations at conferences	- 1 member - 4 (3 posters, 1 presentation)
Non-degree programs	-6 virtual webinars -50 non-affiliated registrants at annual symposium	- 2 CREATE webinars - 4 other webinar series

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. During this reporting period, we ensured all current projects have an advisory board and have required year 2 projects to establish their boards before starting in August.

Table 4: Technology transfer and collaboration metrics

Metric	Annual goals	Year 1 progress
Stimulate coordination with stakeholders	-Document individual project EAB feedback and implementation status	-10 projects with individual EAB
Accelerate technology commercialization	- 10 trained future entrepreneurs	Nothing to report
Open, equitable, efficient information	-5 open access publications from CREATE research	Nothing to report
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 11 active research projects with emerging outputs, including preliminary presentations by faculty and students. A significant accomplishment is the call for year two proposals. Ultimately, 30 proposals were submitted and reviewed; 18 were selected, one was removed as the faculty is leaving the institution. Year Two PIs will submit final project information by May 1, including data management plans and project requirement forms. We also established the CREATE webinar series and have speakers lined up through 2024 to hit our target six per year. We hold monthly meetings with the associate directors to ensure continuity across the center as we establish our center protocol. Specific accomplishments under each goal are further described below.

1.2.1 Research

Research activities are underway for 11 projects. 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. Project level objectives are described below within the four thrusts. Table 5 is a list of the 17 projects that will start in August.

Thrust 1: Transformational coastal transportation infrastructure design and construction

COLLABORATION: SEAHIVE® solutions to mitigate bridge scour

Antonio Nanni and Landolf Barbarigos, University of Miami

Stacey Kulesza and Salah Faroughi, Texas State University

The objective of this research is to design and optimize SEAHIVE elements to mitigate bridge scour. UM is working on characterization and production of the SEAHIVE® elements. Six elements were fabricated with the wet-cast technology and brought to the laboratory for testing. TXST is optimizing the SEAHIVE® flow characteristics for scour. TXST has established the flume setup and calibrated that computational model to match.

The computational team is optimizing the SEAHIVE® hole configurations while the experimental team is evaluating different SEAHIVE® configurations.

Biowaste materials as supplementary cementitious materials for coastal concrete applications

Xijun Shi, Texas State University

The objective of this project is to investigate the feasibility of using two bio-waste materials, sugarcane bagasse ashes (SCBA) and ground waste eggshells, as alternative SCMs in portland cement concrete for coastal applications. The eggshell material characterization confirms the hypothesis that it contains a similar chemical composition to limestone, making it a potential material to be included in cement. Preliminary data on the strength of mortar shows that the efficacy of eggshell as a supplementary cementitious material is comparable to that of limestone. However, different behavior in setting time and water demand were observed. The SCBA specimens showed decreased amounts of released heat compared to the reference sample based on heat of hydration testing, but the SCBA specimens have successfully met the strength activity index requirement.

Composite mangroves for reducing soil erosion near transportation infrastructure **Anand Puppala and Nripojyoti Biswas, Texas A&M University**

The objective of this research is to assess the potential of composite mangroves to mitigate soil erosion near transportation infrastructure. A lab-scale flume is being fabricated to emulate the effects of wave impacts on such structures, and the capability of composite mangroves to diminish wave energy will be examined, potentially contributing to reduced erosion rates. Future efforts will focus on calibrating a numerical model using wave parameters derived from experimental data, which will aid in predicting and enhancing the long-term efficacy of these engineered mangrove systems.

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

The objective of this research is to measure propeller wash dynamics and quantify resultant sediment suspension caused by deep-draft vessels. The durability of the nation's ports and shallow waterways relies on routine dredging maintenance. An extensive field campaign was conducted on January 30 which included fixed, bottom mounted as well as vessel-mounted instruments to collect detailed information on prop-wash plumes (velocity, suspended sediment concentration, free-surface fluctuations) for 24 vessels traversing the Houston Ship Channel. Data are being analyzed to create sediment flux quantifications. Experimental protocol for marine electrical resistivity is under development to add to the next field campaign, planned for summer.

Automated data knowledge graphs for life-cycle management of coastal bridge networks

Minghui Chen, University of Miami

To construct a digital twin, a prerequisite and a main challenge is to establish a knowledge graph. The objective of this project is to generate a city-scale knowledge graph to represent the relationships between the needed variables related to data-driven life-cycle risk analysis of a coastal bridge network. In contrast to existing knowledge graphs developed for digital twins, the knowledge graph in this project considered statistical correlations within a system and across different systems. We have finished the proposed computations. The result is a knowledge graph that connects all the bridges, river gages, and traffic count stations in Miami-Dade County for monitoring the risk. We are now preparing a manuscript for the journal paper and drafting the final report to USDOT.

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

This project develops and demonstrates a new concept for strengthening and preserving corrosion-damaged coastal transportation infrastructure. A system combining titanium alloy bars (TiABs) with a new mixed metal oxide surface coating and bonding material is to be developed. This multifunctional material application is novel for civil infrastructure applications. The research is focused on creating a mixed metal oxide (MMO) coating for the TiABs that will enable them to be used effectively in an impressed current cathodic protection (ICCP) system over long timescales. This novel work extends MMO coatings beyond prior scales and material archetypes and is required for civil infrastructure applications. It will characterize the long-term electrical (ICCP system characteristics) and mechanical characteristics of the treated TiAB bars (bar mechanical properties and bond).

Development of deep learning based automated data collection technology for coastal highway pavements

Feng Wang, Texas State University

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 under different coastal environmental conditions. 2) To develop AI/ML models and tools for coastal pavement condition assessment based on pavement surface images. The AI/ML models will have sufficiently high accuracy for detecting distresses under coastal environments. 3) To test and validate the developed AI/ML models on actual pavement case studies representing coastal environmental conditions. We conducted pavement condition data analysis to compare the roadway conditions of coastal vs. non-coastal areas using the TxDOT PMIS database. Coastal pavement networks with representative distresses were identified. Pavement surface image data were collected from a concurrent TxDOT project and from driving our data collection vehicle in field trips to Texas, Louisiana, and Mississippi.

Thrust 3: Equitable response to unprecedented coastal hazards

Transportation asset risk and resilience analysis to reduce societal risks to vulnerable populations

Ali Mostafavi, Texas A&M University

This project aims to create quantitative tools to identify and prioritize critical transportation assets, thus mitigating risks during coastal extreme weather events. Utilizing hydrodynamic simulation data, we have pinpointed the empirical distribution of flood inundation for each element within the transportation assets. The next steps involve estimating both user cost (measured by increased travel time) and agency cost (measured by repair expense) derived from the simulated flood event, providing a comprehensive gauge of coastal flood risk.

Vehicular safety during wave-overtopping of coastal highways**Daniel Cox, Oregon State University**

Overtopping is of increasing concern due to sea level rise and climate changes to the intensity, duration, and number of storm events. Using test data from recent wave overtopping experiments conducted at the Hinsdale Wave Research Laboratory at Oregon State University, this study will assess safety of different types of vehicles coincidentally travelling on coastal highways subjected to overtopping. We are currently evaluating the hydro-dynamic forces produced on bridges during hurricanes and tsunamis, including the uncertainty of added mass during a dynamic response.

Thrust 4: Pathways to blue economy transportation careers**Capacity building and workforce development for coastal transportation infrastructure exposed to multi-hazards****Alberto Figueroa Medina, Carla Lopez del Puerto, and Ismael Pagan Trinidad, University of Puerto Rico at Mayaguez**

The objectives include the evaluation of the diverse experiences of transportation officials in coastal contexts, to recognize strategies for adaptation and change of transportation infrastructure, to identify communication and information limitations in coastal communities, and to study the challenges for attracting a diverse workforce that can reflect the variety of perspectives of coastal communities and support equitable planning and decision making in transportation infrastructure. We conducted a literature review during the reporting period and developed a preliminary theoretical framework for measuring equity for the development of infrastructure durability. The next steps include developing survey instruments that will assist us to acquire the perceptions and opinions of the community, decision-makers, and transportation professionals related to the equity component and the vulnerability issues of the transportation infrastructure in coastal areas.

National Summer Transportation Institute at Texas State University**Xiaohua Luo, Feng Wang, and Yihong Yuan, Texas State University**

Texas State University organizes a National Summer Transportation Institute program to introduce the broad field of transportation to a diverse group of motivated high school students. The curriculum focuses on different modes (highway, air, rail, water, or transit) of transportation with an associated theme each day for two weeks. We have begun planning for summer 2024 activities, including a trip to Corpus Christi, TX to see the Harbor Bridge construction and to visit the port.

Table 5: Year 2 Research Projects

CREATE Thrust	Title	PI
Transformational coastal transportation infrastructure design and construction	Collaborative: <i>Cracking-resistant concrete for durable coastal structures</i>	Shi, TXST Collaboration (1)
	Collaborative: <i>Soil Innovations for Enhanced Coastal Infrastructure Durability: Durable Soil Stabilization with Computational Insights</i>	Akula, OSU Collaboration (1)
	Collaborative: <i>SEAHIVE solutions to mitigate bridge scour, Phase II</i>	Nanni, UM Collaboration w/TXST in Phase I
	<i>Self-sealing concrete to enhance durability and longevity of coastal concrete infrastructure under corrosive environment</i>	Yeon, TXST
Coastal transportation infrastructure evaluation, prediction, and degradation prevention	<i>Risk Based Assessment of Ports & Interconnected Networks Subjected to Coastal Hazards</i>	Koliou, TAMU
	<i>Transportation Access Over Dunes: Nature-Based Coastal Infrastructure for Flood Protection and Beach Access</i>	Figlus, TAMU
	<i>Strengthening and Corrosion Protection of Coastal Transportation Infrastructure with Titanium Alloy Bars, Phase II</i>	Higgins, OSU
Equitable response to unprecedented coastal hazards	Collaborative: <i>Agent-based Modeling for Assessment of Coastal Resiliency and Climate Change Equity</i>	Najafi, TAMU, Collaboration (2)
	Collaborative: <i>Improving Post-Disaster Access to Critical Facilities for Underserved Coastal Communities</i>	Louis, OSU Collaboration (2)
	Collaborative: <i>Present and Future Scenario Database for Coastal Infrastructure Resilience & Maintenance Planning</i>	Kaihatu, TAMU, Collaboration (3)
	Collaborative: <i>Use of Enhanced Visualization Technology to Assess the Equity States of Coastal Transportation Infrastructure</i>	Figueroa Medina, UPRM, Collaboration (3)
	<i>Analyzing pre- and post-coastal pavement conditions to optimize response strategies for coastal infrastructure resilience</i>	Luo, TXST
	<i>Identification of Unprecedented Coastal Flooding Hotspots for Highway Network Durability and Social Justice</i>	Cho, TXST
Pathways to blue economy transportation careers	<i>University of Miami's NSTI</i>	Ali, UM
	<i>Texas State University's NSTI</i>	Luo, TXST
	<i>Capacity Building and Workforce Development for Coastal Transportation Infrastructure Subjected to Multi-hazards</i>	Lopez del Puerto, UPRM
	<i>Equity and Resilience Based Decision Support System for Critical Transportation Corridors</i>	Pagan Trinidad, UPRM

1.2.2 Leadership

Individual project PIs are engaged in national and international leadership. Current notable leadership roles are:

- Alberto Figueroa-Medina, Member Oversight Panel for NCHRP 07-29 (Green Book); Member National Institute for Congestion Reduction Executive Committee
- Ali Mostafavidarani, ASCE Infrastructure Resilience Division Member
- Anand Puppala, ASCE Geo-Institute Board Member; TRB Infrastructure Group Member
- Antonio Nanni, President, American Concrete Institute, Editor-in-Chief *Journal of Materials in Civil Engineering*
- Burkan Isgor, Chair ACI Committee 222
- Christopher Higgins, Academic Director of the Western Bridge Preservation Partnership, Member World Steel Bridge Symposium Organizing Committee
- Daniel Cox, Chair ASCE 24 Standard for Flood Resistant Design
- Ismael Pagan-Trinidad, Vice President at-Large, Latin American and Caribbean Consortium of Engineering Institutions
- Landolf Rhode-Barbarigos, Associate Editor, *International Journal of Space Structures*
- Nripojyoti Biswas, ASCE Geo-Institute Committee of Sustainability in Geotechnical Engineering webmaster
- Stacey Kulesza, Chair ASCE Geo-Institute Outreach and Engagement Committee
- Xijun Shi, Secretary of ACI Committee 555; Chair of ACI Sub-Committee 555-A

We established the CREATE Student Leadership Council (SLC) during this reporting period. Figure 1 is a photo of the first meeting, each institution nominated one graduate student to serve on the council. The students are responsible for coordinating at least one graduate student activity on their campus each semester, supported by CREATE. Additionally, the students are coordinating virtual training sessions for all CREATE affiliated students on topics of interest. Potential topics include making effective posters and using various engineering software. The SLC will attend the first CREATE symposium at TXST in October 2024 and are coordinating the onsite student poster session. Additionally, there is a half-day leadership training course planned for the SLC and other interested students at the symposium. Lastly, the SLC members serve as the student voices from their respective campuses; they report successes and challenges each semester to the Director.

The CREATE SLC members are:

- Jorge Romero, Oregon State University
- Amlan Majumder, Texas State University
- Kyrah Williams, University of Miami
- Kyle Parr, Texas A&M University
- Hernan Vega, University of Puerto Rico Mayaguez

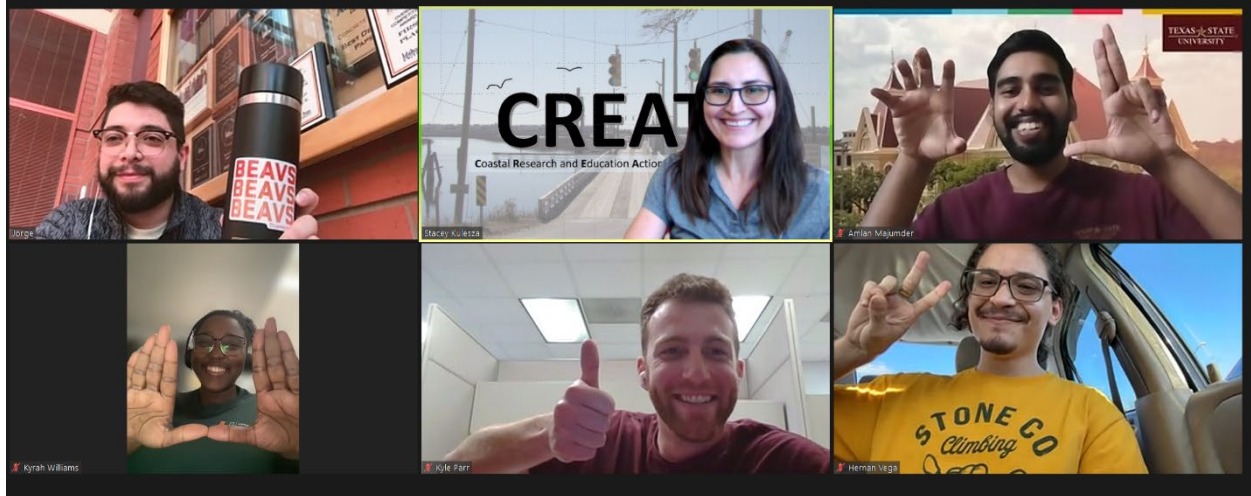


Figure 1: CREATE Student Leadership Council

1.2.3 Education and Workforce Development

All project PIs teach transportation related courses at the graduate and undergraduate level. Oregon State launched the first teaching module based on CREATE research, Corrosion Challenges for Coastal Reinforced Concrete Bridges. The faculty tailored the module for undergraduate and graduate classes. Such modules will be shared on our website as we develop and evaluate best practices for implementation.

During academic year 2023-2024, 27 undergraduate students have been hired to work on CREATE research projects, of which 16 are from underrepresented demographics including Hispanic, African American, military veterans, and women students. Five of these undergraduate researchers continued from fall to spring semesters and one undergraduate researcher will transition to a graduate researcher fall 2024. Seven MS and nine PhD graduate research assistantships have been created to work on research projects, of which eight are from underrepresented demographics in engineering. Faculty are recruiting new graduate research assistants to work on the projects that will start August 2024.

Within this last reporting period, we kicked off our CREATE webinar series. Table 6 includes details of the webinars. 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 6 also includes seminars/webinars by CREATE faculty on current research to outside audiences.

Table 6: Year 1 CREATE supported webinars and related seminars by CREATE faculty

Date	Title	Speaker	Attendees	CREATE Thrust
11/8/23	Unpacking and responding to USDOT Mission and Strategic Goals for Equity	Kristina Henry-Collins, PhD	36	T3 Equitable response; T4 pathways to blue economy careers
3/8/24	Optimizing the Location and Configuration of Disaster Resilience Hubs Under Transportation and Electric Power Network Failures	Daniel Rodríguez-Román, PhD	26	T3 Equitable response to unprecedented hazards
4/22/24	Shoreline & Foundation Protection with SEAHIVE Technology	Steven Nolan, PE; Amin Mirdarsoltany, PhD Student	31	T1 Design/Construction; T2 Evaluation, Prediction, Prevention
6/3/24	Integrated Approach for Geotechnical and Hydrodynamic Analyses in Coastal Residential Built Infrastructure: A Holistic Perspective	Nripojyoti Biwas, PhD	-	T1 Design/Construction; T2 Evaluation, Prediction, Prevention
Date	Title	CREATE Faculty	Attendees	Venue
9/1/23	Module on Ports and Harbors	Jens Figlus, PhD	~65	Coastal Engineering and Nature-Based Solutions Short Course
1/22/24	Artificial Intelligence for Pavement Condition Assessment from 2D/3D Surface Images	Feng Wang, PhD, PE and Haitao Gong, PhD	~50	FHWA seminar
2/16/24	SEAHIVE - Idea to Implementation	Landolf Rhode-Barbarigos, PhD	~40	University of Miami, Civil and Architectural Engineering 2023-2024 Seminar Series
2/20/24	Maybe for Golf Clubs, but isn't Titanium too Expensive for Infrastructure?	Chris Higgins, PhD, PE	unknown	DuRe-Transp UTC Webinar Series
3/1/24	Protecting Coastlines and Preserving Ecosystems - The SEAHIVE® Paradigm	Landolf Rhode-Barbarigos, PhD	~30	USF Environment & Water Resources Engr Grad Seminar Series

1.2.4 Technology Transfer and Collaboration

CREATE exchanges information with the public through six primary 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. The 11 research projects described herein are posted on our website as well as in TRB's Research in Progress database. We have created accounts for Twitter, LinkedIn, Facebook, and a YouTube Channel. The YouTube Channel archives all CREATE Webinars as well as our podcast, CREATE Conversations. Currently CREATE Conversations is a preliminary interview with webinar presenters, however we plan to expand to interview current students and others affiliated with the UTC program.

Our collaboration goals include collaborating within the center, with other UTCs, and with external agencies. We emphasize collaboration within CREATE and currently have two collaborative projects. Three year two projects are collaborative. The CREATE Director is an active member of the newly formed UTC Transportation Infrastructure Durability focus group, from which we seek collaborative opportunities with other UTCs. The group is currently working towards collaborative workforce development activities.

The CREATE external advisory board was formed and met during this reporting period (Figure 2). We will have our spring meeting upon submission of this report. Current advisory members include:

- Jack Cadigan, US Army Corps of Engineers
- Steven Nolan, Florida Department of Transportation
- Helga Sommers, Port of Miami
- Eilee Velez Vega, Secretary of Puerto Rico Department of Transportation
- In memory of Ramon Carrasquillo, Carrasquillo Associates



Figure 2: CREATE External Advisory Board

1.3 How have the results been disseminated?

Preliminary results have been disseminated through seminars as shown in Table 6 and conference presentations 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:

- Final reports and technology briefs for some year 1 projects
- Research updates for remaining year 1 projects
- Summary of best practices for project level advisory board meetings

- Research updates for the 17 year 2 projects, which will begin in August.
- Student progress updates
- TXST and UM National Summer Transportation Institute Reports from summer 2024
- Highlights of the first CREATE symposium, scheduled for October 24, 2024
- First technology transfer budgeted report

2. Participants & Collaborating Organizations

2.1 What organizations have been involved as partners?

De Nora Tech

- Concord, OH
- In-kind support
- Collaborative research

Florida Department of Transportation

- Tallahassee, FL
- Collaborative research

Perryman Company

- Houston, PA
- Collaborative research

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

2.2 Have other collaborators or contacts been involved?

- Cornell University Professor Oliver Gao
- Texas State interdisciplinary collaboration, civil engineering and agricultural science.
- University of Texas Professor Jorge Prozzi
- UTC transportation infrastructure durability focus group.

3. Outputs

3.1 Publications, conference papers, and presentations

Mirdarsoltany, A. and Nolan, S. "Low Impact Secant Pile Seawall for Protecting SR-A1A along Lower Flagler & Upper Volusia Co.", *Student Presentation*. 2024 National Conference on Beach Preservation Technology, February 7-9, 2024.

Sanchez, C. "Artificial Intelligence/Machine Learning Model for Distress Detection of Pavement Surfaces in Coastal Regions." *Student Poster Presentation* at 103rd Transportation Research Board annual meeting, Washington DC, January 7-11, 2024

Dieppa, J., Figueroa, A., Pagan, I., and Lopez del Puerto, C. "Capacity Building for Infrastructure Subjected to Multihazards: Mitigating the Risks for the Aerospace Technology Industry during Natural Events." *Student Poster Presentation* at Forward Research and Innovation Summit: Science & Space Edition; Puerto Rico Science, Technology & Research Trust; November 30, 2023.

Castillo, R., Kulesza, S., and Faroughi, S. "SEAHIVE Solutions to mitigate bridge scour – Phase I." *Student Poster Presentation* at San Antonio Geo-Institute Meeting, September 15, 2023.

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, and webinar information. We plan to add content as the center develops including workforce development projects, research project reports, UTC reports, and outreach activities including a center podcast.

3.3 Technologies or techniques

The high-strength titanium alloy bars with MMO coatings for multi-functional applications will likely lead to a new material for commercialization. These coated bars are intended for corrosion prevention and strengthening. The city-scale knowledge graph research generated a user interface where users can modify the graph (add/remove nodes or edges), input data, and query the nodes.

3.4 Inventions, patent applications, and/or licenses

COLLABORATION: SEAHIVE® solutions to mitigate bridge scour, Antonio Nanni and Landolf Barbarigos, University of Miami, working on invention declaration for scouring protection.

4. Outcomes

Nothing to report.

5. Impacts

5.1 What is the impact on the effectiveness of the transportation system?

Nothing to report.

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. First, these investments provide limited resources towards coastal infrastructure; they address critical, but complimentary, needs including hazard prediction and enhancing / rebuilding the resilience of natural coastal features like sand dunes and reefs. Second, resilience is not the same as durability. Durability targets the overall service life of infrastructure, whereas resilience primarily focuses on design for extreme events. In fact, durability includes resilience, but we argue not vice versa. Thus, this Center will allow the US DOT to contribute critical research, education, and workforce development needs to supplement other national missions for coastal communities.

5.4 What is the impact on transportation workforce development?

CREATE is currently supporting 16 graduate students with research fellowships and 23 undergraduate researchers to work on the projects herein. Many of the graduate students are also receiving tuition support as part of their research positions for advanced coursework required for their degrees.

The summer 2023 TXST NSTI program provided 20 high school students with authentic undergraduate engineering experiences. Students stayed in dorms on campus, had engineering lectures, and engaging laboratory sessions. All sessions emphasized transportation and gave students the opportunity to experience “typical” engineering lectures and topics. Most of the students (75%) were from underrepresented backgrounds in engineering. TXST and UM will host NSTI programs in summer 2024. We anticipate supporting a larger cohort of students in 2024.

The high-strength titanium alloy bars will likely lead to a new material which will require a skilled workforce for manufacturing, engineering design, and construction.

An existing Interactive Learning Hub (IL-HUB), developed for hosting a broad scope interactive learning platform for improving the education of resiliency for coastal infrastructure (<https://crc-uprm-dhs-lms.uprm.edu/>), will be the host of a Transportation Interactive Learning HUB (TIL-HUB) for workforce development. The TIL-HUB will capitalize the foundations already developed to focus on the capacity building and education outcomes from this project. The TIL-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 CREATE. Reports, case studies, presentations, webinars, and other materials will be classified based on their level of complexity and will indicate the target population (e.g., academics and researchers, professionals, community members). 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

Nothing to report.

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.