

## **Semi-Annual Progress Report for University Transportation Centers**

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<b>Signature</b>	

## 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. This period was used to establish various processes for managing the research goals of the center and to start 11 year one projects across the consortium. Note although we report six-month progress in Table 1, most research projects started September 1, 2023, and some started October 1. More details about the projects and current progress are included in "Research Accomplishments."

*Table 1: CREATE annual research performance metrics*

Metric	Annual goals	Six month 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
Blue economy workforce	-20 undergraduate researchers -15 graduate research assistants	-9(7), undergraduate researchers* -9(4), graduate 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	Six month progress
Transform. research implementation	-5 implementation presentations at stakeholder meetings	Nothing to report
Equitable technology transfer	-10 short courses, webinars, or information sharing sessions	Nothing to report
Equitable pathways to blue economy careers	-20 new faculty and student mentorships in CREATE	- 18 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 and connecting existing programs to the CREATE center.

*Table 3: Education and workforce development metrics*

Metric	Short-term goals	Six Month 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 -1 poster presentation
Non-degree programs	-6 virtual webinars -50 non-affiliated registrants at annual symposium	Nothing to report

### 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 have established the requirement and culture to have individual project external advisory boards during this first reporting period.

*Table 4: Technology transfer and collaboration metrics*

Metric	Annual goals	Six month 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 activities to run the center. We established the prime award and all subaward agreements with the consortium members. All have access to funds and have begun work. We developed and submitted the center's approved data management plan (DMP). Furthermore, we established our center advisory board and our center website. 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 started as soon as possible at each institution, ensuring all individual projects have individual DMPs in accordance with the center DMP, and that each project as an external advisory board. All projects were included in the list of new research projects to the USDOT and posted in the Transportation Research Boards's Research in Progress databased within 30 days of the start date. Project level accomplishments are initiating research activities as described below within the four thrusts.

#### 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**

**New Project:** 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. TXST is optimizing the SEAHIVE® flow characteristics using open FOAM to minimize scour. TXST is developing the experimental design for a flume study and manufacturing the scaled components.

## **Biowaste materials as supplementary cementitious materials for coastal concrete applications**

**Xijun Shi, Texas State University**

**New Project:** The objective of this project is to investigate the feasibility of using two bio-waste materials, i.e., sugarcane bagasse ashes and ground waste eggshells, as alternative SCMs in portland cement concrete for coastal applications. We have procured sugarcane bagasse ashes and waste eggshells and started reactivity tests.

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

**New Project:** The objective of this research is to use synthetic composite materials to mimic mangroves as a natural and nature-based features system. Mangroves can withstand wave energies and reduce wave velocities; this study will evaluate how synthetic mangroves mitigate coastal wave-induced erosion around transportation infrastructure.

## **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**

**New Project:** 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. Quantifying the contribution of large vessels on sediment transport will help engineers to plan dredging maintenance including the predicted vessel traffic.

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

**Minghui Chen, University of Miami**

**New Project:** 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 will consider statistical correlations within a system and across different systems.

## **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**

**New Project:** This project will develop and demonstrate a new concept for strengthening and preserving corrosion-damaged coastal transportation infrastructure. A system of titanium alloy bars (TiABs) combined with a surface coating and bonding system will be developed. The TiABs provide immediate strengthening and then are integrated into an

impressed current cathodic protection system to provide long-term durability of corrosion-damaged reinforced concrete structures.

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

**Feng Wang, Texas State University**

**New Project:** The objective of this research is 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.

### **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**

**New Project:** The objective of this study is to reduce societal risks to vulnerable populations due to disruptions in transportation infrastructure during coastal extreme weather events. The research approach focuses on identifying and developing methods and procedures for transportation assets risk and resilience assessment that enables identification, analysis, and evaluation of risks.

### **Vehicular safety during wave-overtopping of coastal highways**

**Daniel Cox, Oregon State University**

**New Project:** 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.

### **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**

**New Project:** This project will evaluate the diverse experiences of coastal contexts, recognize strategies for adaptation and change of transportation infrastructure, identify communication and information limitations of coastal communities, and study the challenges for attracting a diverse workforce that reflect the variety of perspectives of coastal communities and support equitable planning and decision making in transportation infrastructure.

### **National Summer Transportation Institute at Texas State University**

**Xiaohua Luo, Feng Wang, and Yihong Yuan, Texas State University**

**New Project:** 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 a different modes (highway,

air, rail, water, or transit) of transportation with an associated theme each day for two weeks.

### *1.2.2 Leadership*

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

- Antonio Nanni, President, American Concrete Institute
- Anand Puppala, ASCE Geo-Institute Board Member; TRB Infrastructure Group Member
- Ali Mostafavidarani, ASCE Infrastructure Resilience Division Member
- Stacey Kulesza, Chair ASCE Geo-Institute Outreach and Engagement Committee
- Xijun Shi, Secretary of ACI Committee 555; Chair of ACI Sub-Committee 555-A
- Alberto Figueroa-Medina, Member of Oversight Panel for NCHRP 07-29 (Green Book)
- Ismael Pagan-Trinidad, Vice President, Large, Latin American and Caribbean Consortium of Engineering Institutions
- Daniel Cox, Chair ASCE 24 Standard for Flood Resistant Design
- Burkan Isgor, Chair ACI Committee 222

### *1.2.3 Education and Workforce Development*

All project PIs teach transportation related courses at the graduate and undergraduate level. During this reporting period we initiated activities with an on-going National Summer Transportation Institute at Texas State University. Twenty-five faculty, five of which are affiliated with CREATE, offered educational modules to 20 students over the two-week camp. The cohort included seven women and 75% of the students were from underrepresented minorities in engineering. Figure 1 shows the cohort at a facilities tour and CREATE director discussing mechanically stabilized earth design before students built model walls.



Figure 1: July 2023 National Summer Transportation Institute at Texas State University

Nine undergraduate students have been hired to work on CREATE research projects, of which seven are from underrepresented demographics including Hispanic students, military veterans, and women. Nine graduate research assistantships have been created to work on research projects, of which four are from underrepresented demographics in engineering. As many research projects are just starting, student recruitment is ongoing.

#### *1.2.4 Technology Transfer and Collaboration*

CREATE will exchange 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](http://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 herein are posted on our website as well as in TRB's Research in Progress database. We have created accounts for Twitter, LinkedIn, and Facebook.

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. 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 during this reporting period with the following five members:

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

### **1.3 How have the results been disseminated?**

Nothing to report.

### **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:

- Research updates for the 11 projects listed herein. Projects are anticipated to have held initial advisory board meetings and stakeholder updates.
- We have disseminated the call for proposals for AY 2024 – 2025. We will have received proposals, conducted external reviews, and alerted successful PIs of future projects by the next reporting period. We initiated this early to allow faculty

time to recruit student researchers and to build a meaningful external advisory board.

- Our first Center webinar will be November 8, 2023. The focus of the first webinar is how to address our USDOT strategic goal of Transportation Equity through CREATE research. We anticipate hosting at least two additional webinars before the next reporting period.
- We will host our first external advisory board meeting to discuss current projects in early December.

## **2. Participants & Collaborating Organizations**

### **2.1 What organizations have been involved as partners?**

Florida Department of Transportation

- Tallahassee, FL
- Collaborative research

NestFresh Eggs

- Denver, CO
- In-kind support

Perryman Company

- Houston, PA
- In-kind support
- Financial support
- Collaborative research

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?**

- Texas State interdisciplinary collaboration, civil engineering and agricultural science.
- UTC transportation infrastructure durability focus group.

### **3. Outputs**

#### **3.1 Publications, conference papers, and presentations**

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**

Nothing to report.

#### **3.4 Inventions, patent applications, and/or licenses**

Nothing to report.

### **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 supporting 18 students with research fellowships 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.

### **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.