Project Requirements Form USDOT
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Center Lead: Texas State University; Texas State University

Research Project Name: Self-Sealing Concrete to Enhance Durability and Longevity of Coastal Concrete Infrastructure under Corrosive Environment (TXST)

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Partners:

Research Project Funding:
Federal: $99,991 Match: $50,031 (TXST)

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Project Description: This research study suggests an innovative way to use a functional infrastructure material known as “self-sealing concrete” to mitigate rebar corrosion in coastal concrete infrastructure. The developed material can be used on a variety of coastal infrastructure components, including seawalls, piers, concrete bridge decks, and structural and non-structural elements that require active protection against steel corrosion. Superabsorbent polymers, or SAPs, serve as a key component in performing this vital function. When present in concrete, SAPs’ exceptional capacity to absorb and hold huge volumes of water will significantly increase the water tightness of concrete by absorbing water, forming an expansive hydrogel, and sealing capillaries and cracks in the matrix. Because SAPs are economical, non-toxic, and easy to handle, it is anticipated that SAPs will offer a practical solution to the corrosion problem in coastal concrete infrastructure. Instead of using virgin SAPs, the proposed study will seek to use recycled SAPs to optimize the sustainability benefits. This research has the potential to revolutionize the design, construction, and maintenance practices of coastal infrastructure by developing self-sealing concrete technologies that are specifically tailored to the demands of corrosive coastal environments. Ultimately, the outcomes of this study are expected to improve the resilience of coastal communities to natural disasters and climate change.

US DOT Priorities: The proposed technology will mitigate the performance degradation of coastal infrastructure under a harsh coastal environment, making our transportation system *safer* for everyone. The proposed technology will contribute substantial tax dollar savings by helping create durable coastal infrastructure. In addition, the proposed technology requires background knowledge and skillsets from diverse disciplines, which will help create new job positions in different fields of expertise (*Economic Strength and Global Competitiveness*). The proposed idea will help promote the sustainability and resilience of coastal concrete infrastructure against recent global climate changes, such as rising sea levels and coastal flooding (*Climate and Sustainability*). The proposed research will provide an innovative way to meet the present and future challenges concerning recent global climate changes (*Transformation*).

Outputs: Rebar corrosion in coastal concrete infrastructure poses a significant and persistent challenge, driven by the corrosive nature of seawater and the harsh coastal environment. The high chloride content in seawater can penetrate reinforced concrete structures, eventually leading to the corrosion of rebars. This corrosion not only compromises the structural integrity of the infrastructure but also accelerates the degradation, necessitating costly repairs and maintenance to keep the infrastructure safe and functional. Incorporating SAPs into concrete introduces a remarkable pore-blocking effect that enhances the material's durability and performance. As these SAPs absorb water, they swell and form a gel-like substance within the concrete matrix, effectively blocking the interconnected capillary pores through which water and aggressive agents penetrate. This pore-blocking action not only reduces the permeability of the concrete but also limits the ingress of harmful substances such as chlorides and sulfates, which are known contributors to corrosion and deterioration. By mitigating moisture-induced damage and chemical attack, the pore-blocking effect of SAPs significantly extends the service life of concrete structures, particularly in harsh environments such as coastal regions, where corrosion risk is elevated.

Value propositions and market/trends were already analyzed, and potential customer segments that can benefit from self-sealing concrete technology were identified via preliminary interviews during the regional I-Corps hosted by TXST. Once a patent is registered with the outcomes of this research project, technology transfer will be pursued by forming strategic partnerships with the customer segments and bodies. To broaden partnerships with other stakeholders, the PI will plan to attend industry workshops, seminars, and webinars to introduce the benefits and applications of self-sealing concrete for coastal infrastructure resilience and to disseminate research findings and promote technology adoption within the industry.

Outcomes/Impacts: The proposed technology holds the potential for several anticipated products and practice changes that can significantly benefit the durability and resilience of coastal concrete structures. One anticipated product is the development of innovative concrete materials that autonomously repair non-structural cracks induced by environmental stressors such as moisture and chloride ingress. These innovative materials not only reduce the need for costly maintenance and repair but also enhance the longevity of coastal infrastructure by mitigating corrosion-induced deterioration. Additionally, utilizing SAPs in concrete mixtures can lead to producing novel corrosion-inhibiting admixtures or coatings that effectively protect steel reinforcements from corrosion, thereby prolonging the service life of coastal concrete structures. Furthermore, adopting SAP-enhanced concrete in coastal construction practices represents a fundamental practice change, promoting sustainable and resilient infrastructure design that withstands the challenges of climate change.

Final Research Report: URL to final Report will be provided upon completion.