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Project Requirements Form USDOT
CREATE UTC Contract Number 69A3552348330
Center Lead: Texas State University; Texas State University

Research Project Name: Strengthening and corrosion protection of coastal transportation infrastructure with titanium alloy bars (OSU)

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Partners: Perryman Company, Houston, PA, USA
De Nora Tech, Concord, OH, USA

Research Project Funding:
Federal: 114,444 Match: $57,222 (In kind from partners)

Project Start Date: 9/30/2024 **Project End Date:** 8/31/2026

Project Description: Strengthening reinforced concrete structures using the near-surface mounded retrofit (NSMR) technique is an established approach in structural engineering practice. Besides conventional fiber reinforced polymer-based retrofitting materials, in recent years, Grade 5 titanium alloy bars (TiABs) have been shown to effectively and economically increase shear and flexural strength of existing reinforced concrete structures. Mix metal oxides (MMO) coated Grade 1 or 2 titanium is a widely used anode in impressed current cathodic protection (ICCP) systems to mitigate reinforcement corrosion issues in existing structures. Grade 5 TiAB bars, even though they are not designed specifically to be used ICCP applications, have also been shown in preliminary studies to work as ICCP anodes. Integrating NSRM and ICCP applications provides a unique opportunity for a multi-functional (dual-purpose) solution that can provide immediate capacity restoration and mitigate future reinforcement corrosion issues in existing structures. However, the lack of surface coating might have implications with respect to their ICCP performance and durability, which requires further investigation. To address this gap, this project investigates the role of MMO coating of TiAB bas on their ICCP performance. The project involves benchtop scale electrochemical studies to investigate the role of MMO in maintaining a stable and long-term impressed current. The performance of these systems is further investigated when the MMO coated bars are embedded in cementitious systems as ICCP anodes. The results are compared against MMO-coated Grade 1/2 ICCP anodes and bare TiAB.

US DOT Priorities: The proposed project supports the following US DOT strategic goals and research priorities, especially related to durability: Safety – by making transportation infrastructure safer for all people using data-driven systems to strengthen and preserve existing surface transportation infrastructure; Economic Strength and Global Competitiveness – by creating and preserving supply chains reliant on existing infrastructure; and Transformation - by creating a new and novel technology for materials that can be deployed to serve everyone today and in decades to come.

Outputs: This research will produce new materials and methods to both strengthen deficient and corroded infrastructure and function as the anode in a cathodic protection system to ensure long-term functionality and durability of coastal transportation systems. The work will include partnerships with material suppliers, surface treatment producers, designers from engineering firms, and state transportation agencies. A current relationship is established with a US-based ICCP anode producer with a patented MMO coating technology. The current work involves collaboration with this organization.

Training and workshops will be produced and delivered to help educate specialty consultants and contractors in the methods. The PIs have experience developing codes (ACI, AASHTO-LRFD, and MBE) and standards (ASTM) and will produce reports, and peer-reviewed technical papers to support codification. As a part of the final report, design and construction specification language will be developed. The PIs will present findings to relevant AASHTO and ACI committees to help push the research into practice. The researchers will also work with state transportation agencies to identify proof-of-application demonstration projects.

Outcomes/Impacts: This research project aims to enhance concrete infrastructure rehabilitation by developing an innovative approach that integrates structural strengthening and cathodic protection using MMO-coated TiABs. By exploring the feasibility and optimizing the performance of this dual-purpose material, the project seeks to enhance the durability, safety, and longevity of aging concrete structures. The anticipated outcomes include a validated MMO-coated TiAB technology, an integrated rehabilitation methodology, and significant improvements in infrastructure safety, reliability, and durability. This novel research has the potential to transform the field of infrastructure preservation, offering an economic and efficient solution to address the complex challenges of aging concrete, ultimately contributing to a more durable transportation network.

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