Research Project Name: Mixed metal oxide-coated titanium alloy reinforcement for ultra-durable coastal transportation infrastructure -> bridging toward infinity (OSU)

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Partners: Perryman Company, Houston, PA, USA
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Research Project Funding:
Federal: $140,000 Match: $60,000 (In kind from partners)

Project Start Date: 9/30/2024 **Project End Date:** 9/1/2025

Project Description: The proposed research will develop and validate a novel class of **mixed metal oxide (MMO)–coated titanium alloy structural bars** (TiABs) for coastal transportation applications. The bars combine high mechanical performance with integrated corrosion resistance to deliver next-generation, ultra-durable infrastructure. Conventional reinforcing steel is prone to chloride-induced corrosion that requires ongoing maintenance and remediation costs leading to shortened service life and more frequent replacement. This proposal seeks to protect conventional steel bars by integrating them with MMO-coated TiABs. TiABs naturally form a stable passive oxide film that provide exceptional corrosion resistance. By adding MMO coatings to them, including RuO_2 or IrO_2 formulations that are widely used in cathodic protection systems, the TiAB coated bars are expected to have high conductivity, low consumption rates, and remain structurally stabile over decades. Combining and leveraging the MMO and TiAB properties, the proposed approach will provide load-bearing elements and long-life corrosion-resistant members and can function as active, dimensionally stable anodes within an impressed-current cathodic protection scheme to protect a bridge from corrosion damage.

The research will (1) design and fabricate titanium alloy bars with MMO coatings with endurable integrity; (2) characterize the mechanical, fatigue, and electrochemical performance under simulated bridge service environments (chloride exposure, wet/dry cycling, combined mechanical stresses); (3) test large-scale structural elements (column specimens) incorporating the coated bars, to evaluate structural performance and durability; and (4) develop design guidelines, life-cycle cost models, and construction details tailored to field implementation. Success in this project would produce a structural reinforcement technology capable of dramatically extending bridge service life, reducing maintenance costs, and improving resilience for the especially harsh marine environments. Through testing, modeling, and design, this work aims to establish a viable path for adoption of titanium + MMO systems in next-generation infrastructure to provide exceptionally long-lived bridges.

US DOT Priorities: *Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026.*

Outputs: The proposed project is expected to produce several high-impact outputs. First, it will produce a novel structural titanium bar system with optimized mixed metal oxide (MMO) coating, including fabrication protocols, performance data, and durability metrics under realistic environmental and mechanical loading. Second, the effort will result in design guidelines, and analytical models. Third, large-scale prototype specimens will demonstrate efficacy for future

field implementation. Fourth, the project will generate peer-reviewed publications and technical reports suitable for guiding future service applications. In terms of partnerships, we are collaborating preeminent US titanium alloy and MMO coating manufacturers to advance real-world implementation.
Outcomes/Impacts: The proposed TiAB + MMO structural bar system promises significant impacts including: safety and reliability by dramatically reducing corrosion-driven degradation, the system minimizes hidden section loss and loss of capacity, thereby enhancing long-term structural safety and performance; durability as TiABs natural passive oxide layer offers excellent baseline corrosion resistance while the added MMO coating serves as a durable barrier for using the TiABs to protect conventional reinforcing steel in the bridge members; life-cycle savings, while initial costs will be higher than conventional steel, life-cycle costs should be reduced due to less frequent maintenance, longer service life, and fewer replacement cycles; enhanced durability as structures built with this technology would better resist harsh or marine changes.
Final Research Report: URL to final Report will be provided upon completion.