Research Project Name: Ultra-high performance concrete composite decks for long-span coastal bridges (OSU)

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Partners: HNTB, New York City, NY

Research Project Funding:
Federal: $100,000 Match: $50,000 (OSU)

Project Start Date: 01/01/2026 **Project End Date:** 12/31/2026

Project Description: Coastal and marine environments present some of the most aggressive conditions for bridges, due to exposure to salt spray, high humidity, chloride ingress, and cyclic wet-dry cycles. Many of the nation's longest span bridges are in and around tightly constrained coastal regions and these bridges commonly employ orthotropic steel decks (OSD) to reduce dead weight and improve structural efficiency. Conventional orthotropic steel plate decks are vulnerable to fatigue cracks in welded joints, deck plate corrosion, and deterioration of overlays under harsh environmental loading. Many of these OSDs are failing well short of their intended design lives. To overcome these limitations, this project will develop and validate a novel UHPC-composite steel rib deck system as a replacement for conventional OSDs for long-span bridges. Ultra-high performance concrete (UHPC) offers high compressive strength, ductility, low permeability, and durability. We propose to make relatively thin UHPC slabs composite with strategically embedded structural steel ribs to produce a direct replacement for conventional OSDs but with reduced weight, equivalent or better stiffness and load carrying capacity while mitigating past persistent fatigue and corrosion issues.

The research consists of four (4) phases. First, conceptual design and modeling: we will create analytical and finite element models of composite deck panels, varying parameters such as rib geometry, spacing, shear connectors, UHPC thickness, and interface behavior. Second, fabrication and laboratory testing of prototype panels that will be constructed and tested under repeated load cycles modelling wheel loads on the deck surface, environmental (freeze/thaw, chloride exposure), and static failure tests to measure structural performance characteristics including stiffness, crack patterns, fatigue life, and ultimate capacity. Third, interface and connection optimization where shear connections between the UHPC and steel ribs will be optimized to produce reliable composite action and minimal slip under repeated loading. Fourth, develop design guidelines using test data to produce simplified design rules and apply the system concept to a real long-span bridge as a case study.

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 will produce new systems, structural prototypes, test data, and design tools specific to UHPC-steel composite decks. Specifically, deliverables will include: (1) UHPC mixtures for a deck composite with structural steel ribs having characterized mechanical and bond properties; (2) physical prototype test specimens (slab with ribbed orthotropic deck panels) with shear connectors/bonding details; (3) experimental datasets from static and fatigue

loading tests under representative bridge loadings to quantify stiffness, load transfer, crack initiation/propagation, fatigue life, and interface degradation; (4) analytical models that couple structural mechanics and interface behavior to predict long-term performance, stress distributions, and fatigue life; and (5) design recommendations, detailing guidelines for UHPC thickness, rib size and spacing, and composite connector details. In addition, through our partnership with a large national bridge design firm (HNTB) we will develop a prototype replacement deck design for an in-service bridge.

Outcomes/Impacts: The proposed UHPC deck system with embedded structural steel sections has the potential to improve long-span bridge performance in several ways. UHPC's high compressive strength, low permeability, and crack-bridging capabilities mitigate fatigue cracking, corrosion initiation, and deck deterioration, combined with the composite steel sections that provide improved structural capacity and stiffness will improve the durability of bridge decks. The proposed system eliminates welding and fitup requirements to enhance fatigue life relative to conventional OSDs thereby reducing the chance of progressive deck failure from fracture. From a cost and life-cycle perspective, the system costs could be lower than conventional steel OSDs while reduced maintenance, fewer overlays, and longer intervals between rehabilitation provide even more incentives for adoption. The system also minimizes traffic disruptions from reduced reconstruction needs. Together, these benefits position the UHPC composite with steel rib decks system as a next-generation alternative deck compared to conventional OSDs for demanding long-span and coastal applications.

Replacing conventional orthotropic steel plate decks that are not achieving their expected design lives with the proposed UHPC-steel composite system directly advances CREATE's objectives of increasing lifespan and reducing maintenance burdens, especially in congested and challenging coastal environments. The project's deliverables, including experimental data, design models, and guidelines support CREATE's mission to translate innovative research into practice.

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