



TriDurLE

**National Center for Transportation
Infrastructure Durability & Life-Extension**

UTC Project Information – National UTC TriDurLE	
Project Title	Protective Performance of Externally-Bonded, Nano-Modified FRP for Concrete
University	Washington State University
Principal Investigator	Xianming Shi, PhD, PE
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Funding Source(s) and Amount Provided (by each agency or organization)	\$ 90,428 from UTC National Center of TriDurLE \$ 90,428 in-kind match from WSDOT
Total Project Cost	\$ 180,856
Agency ID or Contract Number	
Start and End Dates	May 2022 to September 2023
Brief Description of Research Project	Externally bonded fiber-reinforced polymer (FRP) is a promising tool to use for either preserving the integrity of new concrete infrastructure or mitigating the deteriorations of aged concrete infrastructure. In cold climates, state and local roadway agencies are increasingly relying on the use of chloride salts for snow and ice control, which subject concrete bridge decks, piers, etc. to the combined action of freeze/thaw (F/T) cycling and possible chemical attack. In warm climates near coastal line, the concrete infrastructure is subjected to the ingress of chlorides from the marine environment and the FRP used to protect the concrete is subjected to the combined action of W/D cycling, thermal aging and ultraviolet (UV) aging. Due to its outstanding adhesive characteristics, epoxy resin is the most commonly used polymer for the externally bonded FRP, but without modification the hardened epoxy is generally vulnerable to the attack by moisture and UV. In this context, the overarching goal of this project is to investigate the protective performance of externally-bonded, nano-modified FRP for concrete in chloride environments, with the focus on resistance to F/T cycles and chloride-based deicers, W/D cycles and UV exposure, respectively. To achieve this goal, this study aims to: 1) investigate the influences of modifying an epoxy resin with

	nanomaterials (montmorillonite nanoclay, graphene oxide, or nanosilica) and UV-resistant polymer (polyester, aliphatic polyurethane, or polymethyl-methacrylate), individually or in combination, on the mechanical properties and durability performance of FRP/concrete composites under simulated cold or warm climates; 2) both before and after exposure tests, characterize the physical microstructure and chemical composition of the resin and the FRP/concrete interface, as well as their transport properties; and 3) elucidate the role of nano-materials and polyester on the improved resistance against various deterioration distresses, at the micron and nanometer scales.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The deliverables will include periodical teleconferences with team members or stakeholders on a need basis, and a final project report that documents the study background, approach, results, discussion, conclusions, and recommendations. The PI will develop one webinar to communicate the value and findings of this research to potential stakeholders. This project will produce at least one peer-reviewed paper for presentation at the Transportation Research Board (TRB) annual meeting and one publication in a peer-reviewed journal (e.g., Composites Part B, Journal of Materials in Civil Engineering). One patent application may be filed out of this project.
Impacts/Benefits of Implementation (actual, not anticipated)	The protective performance of such externally bonded FRP for the underlying concrete will be periodically evaluated. Prospective users of the research product include highway agencies, concrete infrastructure related companies (e.g., 10 Simpson Strong-Tie), and other stakeholders interested in extending the service life of concrete structures and components in cold or warm climates.
Web links <ul style="list-style-type: none"> • Reports • Project website 	