

Request for Research Funding for FY 2023-2024

Project Number (Research Center Use Only): STR-24-03

Requesting Office	CO Structures Design	Priority	3 of 5
Proposed Title	Waterline Pile Cap Footings for Bridges using Large Diameter FRP Reinforcing – Material Characterization and Design		
Justification	<p>In the state of Florida, the most critical zone for corrosion of steel reinforcing in coastal bridges is within the tidal zone. Waterline pile cap footings supporting bridge piers and columns are intentionally located in this zone to protect the piling from corrosion but are currently not designed with FRP reinforcing. If corrosion damage and deterioration occur, the repair is costly and time consuming. FRP reinforcing bars are corrosion resistant and so repair costs could be avoided if they are used for original construction of the waterline pile cap. Pile cap footings are often very large and thick elements with large loads requiring large diameter reinforcing bars. Traditionally, pile cap footings are reinforced with bars up to #11, but no standard for accepting #11 FRP bars currently exists.</p> <p>The current AASHTO LRFD Bridge Design Guide Specifications for GFRP–Reinforced Concrete allows for the design of pile cap footings using GFRP bars, thus removing the problem of corrosion. However, before implementation of this idea, the design of a typical waterline pile cap footing has to be conducted to unequivocally demonstrate that its implementation is possible and practical with only the current maximum bar sizes (#10 straight bars and #8 bent bars).</p>		
Impact	<p>The availability of these bars and design examples of typical pile cap footings would allow for implementation in future bridge foundation projects, improving the durability for a longer service life. The application could be later expanded to pier columns and pier caps located in the splash zone.</p> <p>Additionally, this research would inform FDOT whether further research is required to facilitate the use of straight FRP bars larger than #10 diameter and bent FRP bars larger than #8 diameter in waterline pile cap footings.</p>		
Affected Offices	CO Structures Design Office, CO Structures Maintenance Office, CO Construction (Structures)		
Existing Work	<p>Salaheldin Mousa, Hamdy M. Mohamed, & Brahim Benmokrane. (2018). Flexural Strength and Design Analysis of Circular Reinforced Concrete Members with Glass Fiber-Reinforced Polymer Bars and Spirals. Structural Journal, 1353-1364.</p> <p>Zahra Kharal, Shamim Sheikh. (2017). Tension Stiffening and Cracking Behavior of Glass Fiber- Reinforced Polymer-Reinforced Concrete. Structural Journal, 299-310.</p> <p>Wu, Jiantao, Li, Guowei, Liu, Chaoquan, Ge, Wanming, & Transportation Research Board. (2015). Effect of Loading Rate and Chemical Corrosion on Mechanical Properties of Large-Diameter Basalt-Glass Fiber-Reinforced Polymer Bars. Transportation Research Board 94th Annual Meeting.</p> <p>Chen, Y, Visintin, P, & Oehlers, D J. (2015). Extracting Size-Dependent Stress-Strain Relationships from FRP-Confined Concrete Cylinders for Varying Diameters and Heights. Journal of Materials in Civil Engineering. 28(5).</p> <p>AASHTO. AASHTO LRFD Bridge Design Guide Specifications for GFRP–Reinforced Concrete, 2nd Edition, GFRP-2. American Association of State Highway and Transportation Officials, Washington, DC, 2018.</p>		
Keywords Used In Existing Work Search (Cannot leave blank)	Large diameter GFRP/FRP		
Related Contracts (Give contract numbers)			
Funding Request	\$100,000	Anticipated Duration	1 year
Project Manager	Steven Nolan	Contracting Method	Direct contract with University of Miami

Equipment	N/A	
Urgency	3	This project scored third in a rating of 25 research ideas by FDOT's Central and District Structures Design Offices.
Implementability	3	GFRP and FRP are already being used in Florida bridge projects. Design guidance in the AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete is available. If this research proves that waterline pile cap footings can be designed with #10 straight and #8 bent FRP bars, implementation is likely. If not, further research will be required.

Project Benefits (Succinct, complete explanation)

This research will give FDOT necessary information to be able to expand the use of corrosion resistant materials to a structural component which is particularly vulnerable to corrosion in Florida's environment.

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits
<input type="checkbox"/> Materials Enhancement		Better corrosion resistance means less maintenance and traffic impacts.
<input type="checkbox"/> Materials Savings		Improved standards means better design options and material savings.
<input type="checkbox"/> Time Savings		Lighter-weight FRP bars are easier to handle in the field, resulting in construction time savings.
<input type="checkbox"/> Lives Saved/Injuries Prevented		Less corrosion means bridge safety is enhanced. Lighter-weight FRP bars are easier to handle in the field, resulting in fewer worker injuries.
<input type="checkbox"/> Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores