Glass Fiber-Reinforced Polymer (GFRP) Reinforcement for Bridge Structures

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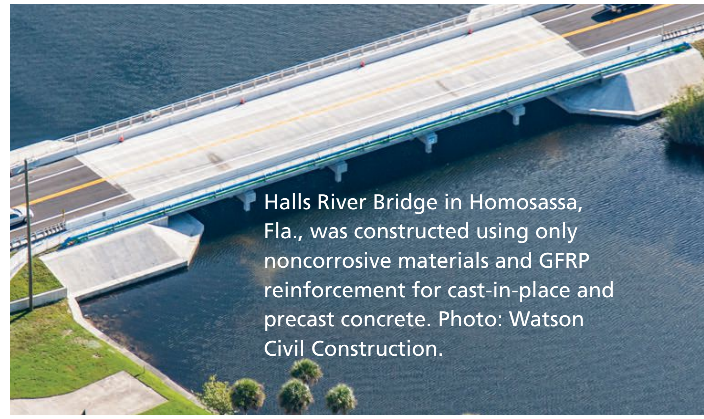

Halls River Bridge in Homosassa, Fla., was constructed using only noncorrosive materials and GFRP reinforcement for cast-in-place and precast concrete. Photo: Watson Civil Construction.

The development of comprehensive national bridge design standards is paramount to allow the broad and safe deployment of fiber-reinforced polymer (FRP) reinforced concrete in our transportation infrastructure. To respond to this need, the American Association of State Highway and Transportation Officials published the second edition of the *AASHTO LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete* (BDGS-GFRP) in December 2018.[1] Compared to the first edition,[2] changes were intended to achieve the following:

- Reflect state-of-the-art knowledge from peer-reviewed research
- Expand the application of GFRP reinforcement to all reinforced concrete bridge elements
- Improve the design economy of the existing provisions and address issues preventing designers from taking full advantage of the mechanical properties and durability of GFRP reinforcement
- Provide consistency with the *AASHTO LRFD Bridge Design Specifications*[3] for legacy construction materials to facilitate future incorporation of GFRP reinforcement
- Harmonize the BDGS-GFRP design philosophy with other authoritative national and international standards

In 2018, AASHTO also published *Guide Specifications for the Design of Concrete Bridge Beams Prestressed with Carbon Fiber-Reinforced Polymer (CFRP) Systems.*[4] This complementary guide specification is not as extensive in scope as BDGS-GFRP; however, it establishes the theoretical and practical design basis for prestressing concrete with materials that do not exhibit traditional yield behavior, and it provides a foundation for future code development efforts.

BDGS-GFRP is compatible with the eighth edition of the AASHTO LRFD specifications, sharing the same structure and organization and minimizing any differences in design equations to make BDGS-GFRP easier for designers to use. BDGS-GFRP diverges from the AASHTO LRFD specifications only to adjust design parameters and material properties to account for the different behavior of GFRP reinforcement compared with steel reinforcement. Importantly, the second edition of BDGS-GFRP refers to the GFRP reinforcing bar material specifications recently published by ASTM.[5]

A major limitation of the first edition of the BDGS-GFRP was that it addressed only bridge decks and open-post traffic railings. The second edition covers all reinforced concrete members in a bridge structure. The new edition is the first specification to cover GFRP-reinforced concrete substructures, and is arguably the most complete guide for GFRP-reinforced concrete design. Its provisions have been developed and implemented on a number of recently completed structures in Florida, such as the Innovation Bridge[6] and Halls River Bridge,[7] as well as several bridges under construction in southern Florida (for example, U.S. Highway 41 over North Creek and 23rd Avenue NE over Ibis Waterway), with more projects currently in final design (40th Avenue North over Placido Bayou, Barracuda Boulevard over Indian River North, County Road 30A over Western Lake, and West Wilson Street over Turkey Creek).

There are ample opportunities to further refine the current conservatism in the reduction factors for environmental degradation, fatigue, sustained load, and shear strain limits applied to GFRP-reinforced concrete design. Concurrently, manufacturers of GRFP reinforcement continue to improve the mechanical performance of their products by improving fiber content density, resin, and sizing formulations, thereby increasing both reinforcing bar strength and stiffness. These efforts can help increase the economy, durability, and sustainability of our infrastructure.

References

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Glass fiber-reinforced polymer reinforcement being placed in the form for a substructure element for the Halls River Bridge in Homosassa, Fla. Photo: Florida Department of Transportation.