Florida Department of Transportation Research

Bridge Girder Alternatives for Extremely Aggressive Environments

Febraury 2018

Project Number
BDV22-977-01

Project Manager
William Potter
FDOT Structures Office

Principal Investigator
Jeffrey Brown
Embry-Riddle Aeronautical University

Current Situation

Fiber-reinforced polymer (FRP) has been used in bridge construction and repair as bridge decks, reinforcement (FPR rebar), or externally bonded concrete reinforcement. However, the tensile strength of FRP, which can be greater than steel, offers the possibility of using FRP in the main structural elements of bridges. FRP is more stable in marine environments than concrete or steel, which might mean less maintenance and result in longer service lives. Some FRP systems developed for complete bridge spans have been in service for up to 20 years.

FRP girders await the next step in construction of this bridge.

Research Objectives

Researchers from Embry-Riddle Aeronautical University investigated existing FRP systems that could be used in spans up to 75 feet in aggressive environments, such as Florida's coastal waters.

Project Activities

The researchers reviewed current bridge design standards and specifications as well as various FRP systems, their material constituents, and manufacturing methods. They also reviewed the state-of-practice for FRP bridge girders including flat-slab FRP composite panel bridges, pultruded FRP bridge girders, FRP U-girders, concrete-filled FRP tubes, and Hillman composite beams. FRP is of great interest in the aerospace industry because of FRP's high strength and low weight. The researchers utilized background in FRP use within the aerospace industry to better optimize the systems being evaluated.

With this extensive background investigation, the researchers selected three FRP technologies as the most likely candidates for application in Florida: concrete-filled hybrid-FRP U-girders; concrete-filled hybrid-FRP tubes (CFFT); and the pultruded glass-carbon hybrid-FRP bridge girder (the Strongwell DWB36). Both resin-infused and filament-wound FRPs were used were applicable. Spans of 30, 40, 50, 60, and 75 feet were used in simulated bridge designs incorporating FRP technologies. An eight-inch reinforced concrete deck was used in all designs. The researchers performed a complete design, economic, and technical analysis for each bridge incorporating an FRP technology. Bridges were designed for each span length.

Extensive analysis of the FRP types and designs produced a detailed ranking according to design, manufacturing, construction, maintenance, and service life. Several of these areas were broken down into more detailed levels. This analysis resulted in the best ranking for the FRP U-girder. Current research indicates that FRP technologies would readily meet the FDOT goal of a 75-year service life, even in an environmentally aggressive setting.

Project Benefits

Use of FRP materials in bridge construction for Florida's coastal areas has the potential to offer significant cost savings in maintenance and replacement costs, while assuring reliability.

For more information, please see www.fdot.gov/research/.