Florida Department of Transportation Research

Use of Fiber Reinforced Polymer Composite Cable for Post-Tensioning Applications – Phase 2

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Current Situation

Post-tensioning is a method frequently used in construction of segmental bridges, continuous I-girder bridges, and piers. It involves using tendons, which are multiple strands, usually steel, installed through voids formed by ducts either inside or outside the concrete structure. These voids are then filled with a cementitious grout and sealed. In the past 15+ years, there has been a rise in durability issues related to post-tensioning tendons as a result of poor grouting practices or grout inconsistencies. These durability concerns can lead to expensive maintenance issues or possibly tendon failure, depending on the severity.

This Florida bridge depends on post-tensioning for its relative lightness and strength.

Research Objectives

Florida International University researchers assessed the feasibility of using innovative carbon-fiber-reinforced polymer (CFRP) tendons and developed design and construction guidelines for CFRP in post-tensioned bridge applications.

Project Activities

Use of CFRP tendons was investigated in a scale model segmental box girder bridge and pier. A scale model (3.5:1) of the Long Key segmental box girder bridge was post-tensioned with steel and two types of CFRP. A scale model (5.5:1) of a typical interior hammerhead pier of the San Antonio, TX, "Y" project was post-tensioned with two tendon arrangements — eight and six tendons — representing over- and under-designed conditions. Bridge and pier models were then loaded to examine stresses and behavior in the structures. Models simulated both dead and live loads. The segmental bridge model was tested at three prestress levels and in three loading configurations.

Long-term properties of CFRP materials were also examined, which required the development of an anchoring system. Anchoring is critical because, unlike steel, CFRP is not anchored with off-the-shelf components; usually, anchors are built into CFRP tendons by the manufacturer, making length adjustments in the field difficult.

Once an anchoring system was developed, the CFRP tendons were first tested to failure to understand the full behavior. Then, the CFRP tendons were stressed at 95% of the guaranteed capacity for 5 months using the developed anchoring system. There was no sign of rupture over the testing timeframe.

In the tested designs using scale models, CFRP performance was comparable to steel and demonstrated the feasibility of using CFRP in post-tensioning applications. In long-term tests, tendons and the anchoring system performed well. To further utilize CFRP for post-tensioning applications, a more efficient anchoring device is warranted.

Project Benefits

Replacing steel with CFRP, which is not subject to corrosion, in post-tensioning applications can lead to concrete structures with lower maintenance costs and greater durability.

For more information, please see dot.state.fl.us/research-center