Florida Department of Transportation Research

Design and Detailing of Anchorages for Externally Bonded CFRP

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Current Situation

For over 20 years, the Florida Department of Transportation (FDOT) has used externally bonded carbon fiber-reinforced polymer (CFRP) to repair concrete bridges damaged by over-height vehicles, corrosion, or to increase shear capacity. Recently, there has been an increase in CFRP repairs to increase the shear capacity of concrete bridges.

Ideal CFRP shear strengthening methods require completely wrapping a beam in CFRP to enhance effectiveness. However, full wraps require full access to a bridge component, which is often not possible. Because of these challenges, a three-sided U-wrap is typically used. However, "debonding" of the CFRP often occurs with U-wraps before the concrete component or CFRP material fails. To improve performance, three-sided U-wraps must be anchored to prevent this debonding.

The spike anchor (cross-section shown) is the most common type of CFRP anchor used in Florida.

The most popular anchorage system is the spike anchor, which requires drilling into the concrete to install the anchor. This invasive method can be impractical and/or structurally compromise concrete sections, particularly concrete I-beams and U-beams. These anchors are sometimes installed at an angle, which can avoid compromising the sections, but this can also change the effectiveness of the anchor and concrete element.

Research Objectives

This project had two primary objectives: synthesize existing research on CFRP anchorage design with respect to externally bonded shear strengthening and other externally bonded end anchorage applications and modify current CFRP anchorage guidance.

Project Activities

The Florida Institute of Technology and Embry-Riddle Aeronautical University research team conducted a synthesis of existing research on CRFP anchorage and reviewed existing design guides on externally bonded CFRP. Additionally, the team reviewed and ranked anchor systems for CRFP based on previous studies conducted by various entities.

Project Conclusions and Benefits

Up to this point, there have not been enough tests conducted to prove the effectiveness of a CFRP anchor in preventing debonding, particularly for shear strengthening of prestressed concrete girders. Therefore, more tests are needed. Given the limited test data, the three most promising CFRP anchors were spike anchors, mechanical anchors, and CFRP strip details. However, they should be validated for performance. The research team recommended that FDOT should continue to adopt the American Concrete Institute's design standards but conduct more testing and collect additional data from prestressed concrete beam tests to evaluate design provisions.

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