Florida Department of Transportation Research

Durability Evaluation of Florida's Fiber-Reinforced Polymer (FRP) Composite Reinforcement for Concrete Structures

March 2017

Project Number
BDV31-977-01

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Current Situation

Fiber-reinforced polymer (FRP) composites, when applied to concrete bridge structures, are proven to increase strength and stiffness. They may also mitigate corrosion of the steel reinforcement in concrete members by reducing diffusion of chlorides into concrete. However, in the past, these repairs have been viewed as a very temporary bandage, and their durability has generally been evaluated using accelerated or theoretical methods. Long-term field exposure data which would help to determine the validity of accelerated testing are not readily available.

Before its replacement, this bridge developed severe corrosion concerns. The effectiveness of repairs made with FRP was shown in this project.

Research Objectives

University of Florida researchers evaluated the long-term effectiveness of FRP repairs on a number of Florida bridges.

Project Activities

The replacement of three Florida bridges previously repaired with FRP provided test specimens with various aged repairs, the oldest being 11 years. The beams represented a range of exposure conditions and were taken from bridges with different configurations. In two cases, the bridges were over water and regularly exposed to changing water levels by river or ocean tides. In the third case, the bridge was over an interstate highway and had been struck a number of times by overheight trucks and subsequently repaired with FRP composites.

First, the researchers investigated the extent of utilization of FRP reinforcement in Florida's bridges. They surveyed state and municipal transportation agencies across the state to gather information on FRP design documentation, availability of inspection reports before and after repairs, and reports from load tests. Site visits were conducted to selected bridges to document their condition. The results of this survey, as well as a thorough literature review, formed a background for examination and testing of recovered beams.

The recovered beams were subjected to a thorough program of tests, including infrared thermography, compressive strength, carbonation, chloride content, pull-off tests, and microscopic examination, among others. Results from the lab testing in this project were compared with theoretical calculations and field measurements, including those taken by the researchers and those taken by a local or state agency, as discovered during the survey.

The ultimate strength of the beams, measured during the tests, agreed well with theoretically computed values, indicating that the system had maintained its strength over the duration of its service life. Further testing also provided evidence that the intrusion of chloride ions was reduced in regions repaired with externally bonded FRP, which may indicate a protective effect.

Project Benefits

The use of FRP composites for repair and reinforcement is a valuable technique that extends the service life of bridges and forestalls expensive replacements. The findings from this study have shown that bonded CFRP repairs employing a quality system, on a well-prepared surface, using good installation techniques, can last upwards of 15 years and perhaps beyond.

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