Florida Department of Transportation Research

Damage Detection and Repair Methods for GFRP Bridge Decks
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Glass fiber-reinforced polymer (GFRP) decks offer advantages as replacements for worn steel bridge decks because of their high strength-to-weight ratio and fast installation time. However, before GFRP decks can be put into service, methods to reliably evaluate their durability and field performance must be developed. These methods can assure the suitability of GFRP decks as replacements for steel decks and serve in the field monitoring and maintenance of the decks.

In this project, researchers from the University of Florida investigated nondestructive methods to inspect GFRP decks, specifically acoustic emission (AE) and infrared thermography (IRT). AE is used extensively in the inspection of pressure tanks and vessels. IRT is a relatively well-established tool with existing ASTM standards for detecting delaminations in reinforced concrete bridge decks and detecting defects in fiber-reinforced polymer composites used in aerospace structures.

Three commercial GFRP bridge decks were tested in both positive and negative bending in a three-point loading setup. Each specimen was subjected to sequential load tests consisting of service, ultimate, then service. Load steps were separated by a brief load reduction to allow observation of Kaiser and felicity effects during reloading. Two AE analysis methods, intensity analysis and relative ratio analysis, were used to evaluate the data. Intensity analysis did not provide sufficient discrimination between damaged and undamaged states, but relative ratio analysis provided sufficient discrimination to allow development of criteria for laboratory testing. A modified form of relative ratio analysis was also used to analyze selected AE data from a bridge load test.

Experimental testing was performed in a laboratory setting on both damaged and undamaged fiber-reinforced polymer bridge deck samples. Initial IRT work required finite element simulation of the heat transfer process to determine optimal heating and data acquisition

A section of GFRP deck is loaded to failure in a laboratory setup.

parameters that were used to inspect GFRP decks in the laboratory. IRT evaluation focused on identifying damage in the specimens that had been loaded to their ultimate flexural strength. IRT successfully detected severe delamination/debonding under ideal circumstances. Detection and characterization of damage such as blistering or other near-surface delaminations will require further development of IRT methods.

To evaluate the effectiveness of repairs to damaged decks, three repair procedures were developed and applied to one of the deck types: GFRP bars were placed in the cavities between the webs, and then the cavity was filled with concrete; wet layup GFRP was applied to GFRP webs; cavities were filled with grout, and GFRP was applied to the deck soffit. Testing showed that the decks repaired using the second and third procedures exceeded the capacity of the original deck.

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