Florida Department of Transportation Research

Magnetic Flux Leakage (MFL) Method for Damage Detection in Internal Post-tensioning Tendons

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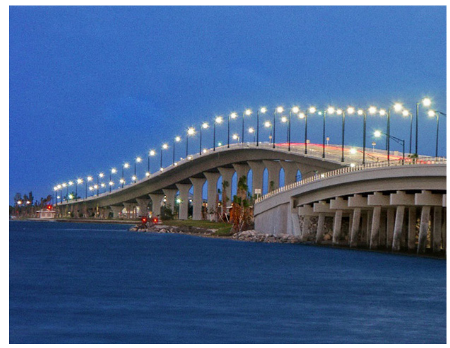
Current Situation

Concrete girders are often reinforced by steel cables that run through plastic or steel ducts in the concrete. Tightening the cables after the concrete sets provides tension that strengthens the concrete – this method is called post-tensioning (PT). Because PT cables are steel, they can be affected by corrosion despite construction procedures designed to prevent it, and because PT cables are critical to the strength of concrete girders, it is important to detect corrosion as soon as possible. However, the cables are sealed within their ducts and cannot be directly inspected. Therefore, methods are needed that can detect corrosion from outside the girder. One such method, called magnetic flux leakage (MFL), involves strong magnets and detecting how much of the magnetism "leaks back" from the girders. Where more magnetism leaks back, a deficit in the steel and the possibility of corrosion are indicated.


Post-tensioning cables are critical to the strength of many bridges in Florida.

Research Objectives

Florida International University researchers developed a modified magnetic flux leakage system to detect corrosion in embedded PT cables. They tested this method in the laboratory and in the field with the goal of developing a fully functional prototype that can detect damage in embedded PT cables.

Project Activities

First, the researchers examined an earlier version of the MFL device and identified its deficiencies. These were addressed with new sensors, microelectronics, and digital devices, as well as a new magnet. The improved device can scan horizontal surfaces, allowing measurements on deck slabs, box girders, etc. While the earlier MFL device was able to detect damaged cables in the lab, the improved device had to demonstrate its effectiveness in the field. The plans of a bridge with a known defect were used to construct laboratory mock-ups. Tests on these mock-ups showed that placing the magnetizing unit and the detector on opposite sides of the girder gave the best results, and methods to compensate for the presence of other steel reinforcement were developed.

The improved device and procedures were next tested on a segment taken from a decommissioned bridge. Because both intact and damaged cables could be placed in the empty duct of this segment, it was possible to test a variety of variables, such as the effect of magnetization depth, section loss, and location of other steel reinforcement. PT cable defects were successfully detected.

The MFL system was then tested on an existing bridge that has been in service for more than 50 years that has PT cables in five spans. Extensive testing determined how MFL should be adapted for this specific bridge. Possible defects or undetermined structures were found in two spans. The results were repeatable. Additional simulations were conducted to further understand the field results, especially when additional steel reinforcement was present.

Project Benefits

Improved methods for inspecting the PT cables of bridges can help detect issues at early stages when repairs and maintenance are less intrusive and less costly and less likely to take the bridge out of service.

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