Florida Department of Transportation Research

Development of Tendon Imaging Sensor

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BDV25-977-24

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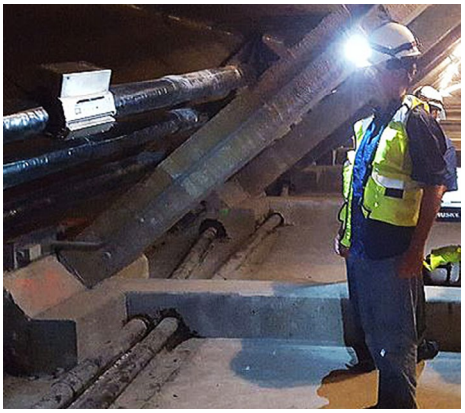
Current Situation

Many concrete structures rely on post-tensioning for their strength. In post-tensioning (PT), steel cables (strands) in PVC pipes (ducts) running through concrete construction components are highly stressed and then secured. The ducts are then back-filled with grout, which protects the steel and, once set, helps to couple the tension in the steel to the concrete. Together, strands, grout, and duct form a tendon. Voids in the grout that trap air or water can cause corrosion of the steel tendons, which can compromise their strength. Regular inspections of all bridges in Florida include inspections of PT tendons, but of course, the strands are no longer visible, so direct inspection is not possible. A nondestructive, noninvasive method of inspection is needed.



Inside a concrete structure, a worker uses a version of the device developed in this project to examine a post-tensioning tendon.

Research Objectives

University of South Florida researchers developed a noninvasive method and a working prototype to aid in detection of grouting anomalies in PT tendons.

Project Activities

The method developed by the researchers uses magnetic and electrical impedance measurements taken by a traveling sensor placed on the outer surface of the tendon duct. Magnetic data are used to map the strand bundle location within the duct. This information is then used with the impedance measurements to produce a color-coded image of the duct cross-section and provides immediate visual differentiation between sound and deficient grout locations. Partial voids and regions of unhydrated grout produced a signature pattern intermediate between that of full voids and sound grout.

The magnetic and impedance methods used for the researchers' method were selected after a review of several possibilities which have been previously studied. These methods include visual, magnetic, mechanical wave/vibration, electromagnetic wave, electrochemical, and penetrating radiation. Part of this review and development of the method itself were the subject of a concurrent FDOT research project (BDV25-977-52).

Two series of experiments were conducted. In the first series, the prototype device was used to detect discrete voids within tendons created for this purpose. In the second series, a much wider range of grout anomalies was examined and validated using gamma ray tomography. Tests of the prototype device demonstrated its effectiveness and usefulness in the detection of grout anomalies in external post-tensioning tendons.

Project Benefits

This rapid and economical method will aid in early detection of grout anomalies in the post-tensioning tendons, allowing maintenance at early stages of concern and helping to ensure the service life of post-tensioned components.

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