Florida Department of Transportation Research

Replaceable Unbonded Tendons for Post-Tensioned Bridges

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Current Situation

Post-tensioning concrete is an efficient means of increasing the strength of bridges, allowing, for example, concrete girders to span greater distances with thinner sections with the option of using segmental construction methods. Conventional post-tensioning uses a duct placed either inside or outside the concrete section, and after concrete is installed or cast, cables are installed and stressed, and the duct is filled with grout. Several concrete segments can be post-tensioned together in the field to simplify construction of long bridge spans. In recent years, the use of inferior grout and improper grout installation has led to the corrosion of steel tendons, requiring maintenance and repair of some of Florida's high profile bridges. In response, the Florida Department of Transportation (FDOT) is implementing the use of flexible fillers in critical applications in place of grout.

Post-tensioned concrete is critical to many kinds of construction, such as this box girder bridge.

Research Objectives

University of Florida researchers investigated the use of flexible fillers with post-tensioned tendons, including performance testing of the materials and methods of installation and inspection.

Project Activities

In the first project phase, the researchers designed, constructed, and injected flexible filler into several full scale, post-tensioned mockups. Various injection rates and venting procedures were tested to find the most suitable methods for installation. In all cases, the tendons were well coated, and all filler products performed acceptably.

In the second phase, researchers studied the structural implications of using flexible fillers in place of grout. Using flexible fillers changes how the tension in tendons is transferred to the concrete, referred to as unbonded design. Concrete specimens were constructed using either grouted tendons, tendons with flexible filler, or a combination of the two types of tendons. Calculated and tested flexural strength agreed well for grout or flexible fillers in post-tensioned tendons, but differed somewhat when tendon types were combined. Fatigue testing was also carried out on unbonded tendons, resulting in no significant damage to the PT system.

In the third phase, researchers developed a robust, cost-effective monitoring system for unbonded tendons in post-tensioning systems. Methods of measurement and analysis were developed that reveal tendon damage if present, specifically, to identify broken wires within a cable at the earliest possible stage of deterioration. Finite element analysis was used to demonstrate and refine the method. The tendon monitoring method developed has many advantages over traditional inspection methods, including use of low-cost sensors, conventional data acquisition, minimal accessibility requirements, and easy sensor installation.

Project Benefits

Improved construction processes and protection of post-tensioned tendons were developed to prevent damage due to corrosion, helping to ensure that structures perform for their intended design lifetime with lower maintenance costs. If corrosion or other deleterious effects occur to the post-tensioning system during the service life of a structure, the use of flexible fillers results in early identification and a means for tendon replacement.

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