Florida Department of Transportation Research
External Post-Tensioning Anchorage
BD550-11

The integrity of many concrete bridge components depends on post-tensioning (PT). This technology extends the material properties of concrete and gives engineers additional flexibility in bridge design. However, PT depends on the properties of steel, which can corrode, especially in bridge designs, which places PT parts in watery and, often, salty environments. This hazard was highlighted in 2000, when a routine inspection of the Mid-Bay Bridge over Choctawhatchee Bay in Okaloosa County revealed that the polyethylene duct of one of the bridge's tendons had cracked.

Building bridges like the 3.6-mile-long Mid-Bay Bridge in Okaloosa County depends on the design flexibility offered by post-tensioning technology.

Further inspection of the Mid-Bay Bridge found several fractured tendon strands. This prompted an inspection of all the bridge's 141 spans. One of the bridge's tendons had completely slacked. Work began immediately to determine failure mechanisms and to develop design procedures to provide an additional margin of safety in the design of segmental bridges, which typically employ post-tensioning. Better designs for bonded PT systems could provide secondary anchorage when primary anchorage fails, creating a safety margin and giving bridge owners time to properly address repair issues.

Researchers from the University of Central Florida studied PT systems with the goal of determining a reliable transfer length to provide anchorage for the PT tendons based on the grout interface with both tendons and steel casing pipe. The problem of anchoring the pipe in the expansion joint pier segment concrete is a separate problem.

In their literature review, researchers investigated the code provisions that control design of PT and prestressed systems and set limits on transfer lengths. Variables in the design equations that can affect transfer length were identified.

Previous work on tendon-cementitious material interfaces was also reviewed. These reviews set the parameters for the study, and a program of experiments was developed, including test fixture design, testing protocols, and data analysis. Experiments used 7-, 12-, and 19-strand tendons. In addition to testing different tendon sizes and different bonded lengths, tendons were stressed to different levels of the strand's guaranteed ultimate tensile strength to identify transfer and development behavior. In all, nine specimens with straight ducts housing the bonded tendons were tested.

Researchers concluded the study with recommendations about transfer lengths for 7- and 12-strand tendons that would provide secondary anchorage. Manufacturer-specified (VSL, Inc.) anchorages were able to develop a ductile failure mechanism in the specimens that experienced slippage (tendon in grout and grout in casing) during active loading. However, for 19-strand specimens, the casing pipe did not have sufficient strength to allow this mechanism to form, and brittle failure occurred with the given test setup.

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