DURABILITY ISSUES AND IMPROVEMENT STRATEGY OF POST-TENSIONED BRIDGES IN THE UNITED STATES

Teddy S. Theryo
WSP │ Parsons Brinckerhoff
VP / Technical Director for Bridges

ABSTRACT

For half a century, since the construction of Walnut Lane Bridge in Philadelphia (1949-1950) – the first post-tensioned bridge in the U.S., this type of bridge became popular as an economical and durable structural system that requires minimal maintenance. After the findings of corrosion in post-tensioning tendons in some of Florida’s bridges in 1999 and 2000, durability of post-tensioned concrete bridges in the United States has become a great concern to owners and bridge engineers around the country. Other deficiencies of post-tensioned bridges such as cracked polyethylene ducts of external tendons and grout voids were also found in other states.

In the summer of 1999, one of the external tendons in the superstructure box girder of the Niles Channel Bridge in the Florida Keys failed due to corrosion. The bridge was constructed in early 1983 and is believed to be one of the first span-by-span segmentally erected concrete bridges in the United States.

In August 2000, during a routine inspection of the Mid-Bay Bridge located in Destin, Florida a post-tensioning tendon in Span 28 was found in a significant state of distress. The polyethylene external duct was cracked and several strands were fractured. Further inspection of the bridge revealed that a posttensioned tendon in Span 57 had failed completely at the north end of the tendon. The tendon pulled out from the expansion joint diaphragm as a result of severe corrosion of the tendon in the anchorage area. After extensive investigation and inspection, it was found that eleven tendons required replacement. The bridge was constructed in 1992 using span-by-span precast segmental construction.

In September 2000, during a special inspection of the high level approach columns in the Sunshine Skyway Bridge in St. Petersburg, Florida, it was discovered that severe corrosion resulted in the failure of eleven strands of the southeast external vertical tendon located in column 133 northbound. This finding triggered an extensive investigation of all other high level approach columns, the bridge superstructure, and cable anchorage of the main span bridge. The investigation of the rest of the columns revealed severe tendon corrosion in the anchorages and at the base of the columns, including cracked polyethylene duct, grout void, and grout chloride contamination. The 76 high level approach columns have been repaired, including deficiencies found in the superstructure external tendons. The bridge was constructed from 1982 to 1987 and utilized the precast segmental construction method, including for the high level approach columns.

The above deficiencies were the first wave of post-tensioned issues in the U.S. Following these issues US grout specifications were modified, including improving post-tensioned systems, detailing, and training.

The second wave of durability issues was the findings of soft grout and contaminated grout in Texas and Florida in 2010 and 2011, respectively. Two external tendons failed in a segmental bridge in Sarasota, Florida. After extensive investigations, fifteen more external tendons were replaced due to excessive section loss due to soft grout / segregated grout. In addition, similar deficiencies were also discovered in some other bridges in Florida and other states. The future improvement strategies for post-tensioned bridges by the bridge owners, industry, and FHWA in the U.S. will be presented.