Plymouth Avenue Bridge

by Jason Caravello, Dywidag Systems International USA Inc.

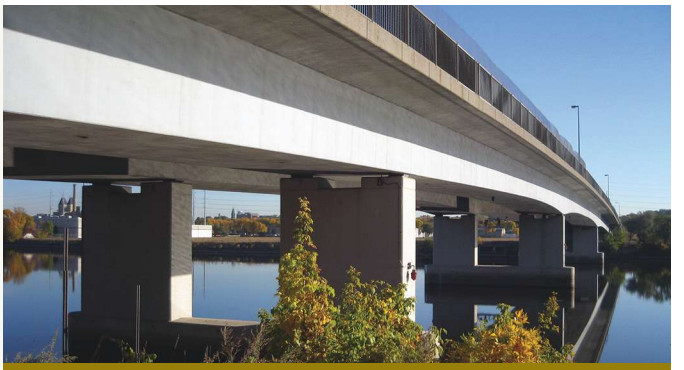
The Plymouth Avenue Bridge is a four-lane, four-span, twin-box, segmental, box-girder bridge carrying Plymouth Avenue over the Mississippi River on the north side of Minneapolis, Minn. The bridge boasts a total length of 943 ft with the longest span reaching 143 ft. Built in 1983, it was the first segmental bridge in Minnesota and it was built using a form traveler for cast-in-place concrete construction.

During a 2010 routine inspection, the bridge was closed after corroded post-tensioning tendons were discovered, among other forms of deterioration. After a careful review and performance of an inspection analysis, the bridge was deemed adequate for pedestrian and bicycle traffic only. In early 2011, the bridge was closed to vehicular traffic until a repair plan could be implemented.

Upon further evaluation and a root-cause analysis, it was determined that the cause of the corroded post-tensioning tendons was the failure of the bridge's drainage system. The system was designed in such a way that the drainage pipes were brought inside the box girders. A failure occurred in the system that led to deicing chemical leakage accumulating and ponding in the interior of the box, thereby corroding the reinforcing bars and post-tensioning tendons in the bottom slab regions.

The Fix

The Minnesota Department of Transportation was in need of a viable strengthening solution that allowed for a long-term, economical approach to return the bridge to carrying vehicle traffic over the Mississippi River. To accomplish this, they engaged a bridge consultant to design the solution. Upon careful review of all the contributing conditions and factors, it was determined that an external, supplemental multi-strand, post-tensioning system would be installed within the interior of the box girders. Additional repairs were also performed such as epoxy injection, concrete repair, and drain modifications.



Looking west from the northeast. Photo: Jason Carvello.

The general contractor chose a post-tensioning partner who could provide the required resources for this technically demanding project. The design required five new tendons with twelve 0.6-in.-diameter strands to be installed inside both the eastbound girder and the westbound girder for a total of 10 new draped tendons. Each tendon was anchored in new concrete blisters created at each end of the bridge and was run through new concrete deviators cast at box floor locations. All exposed ducts were made of high-density polyethylene (HDPE), while the embedded pipes in the deviators were steel. After tensioning, all tendons were grouted. Repairs to the bottom of the box included partial and full depth concrete demolition, replacement in select areas that had sustained damage, and epoxy injection of the cracks. This concrete repair work was performed by another contractor.

Challenges

The design required embedded steel ducts to deviate tendons in two planes. It was difficult to obtain field measurements for the production and installation of these components. In addition, the concrete anchor blisters installed at the upper regions of the girder interior left little space to maneuver a multi-strand jack into position to stress the new tendons. As is very common with repair and strengthening related projects, these types of access issues are common and need to be overcome in the field operations. Therefore, the post-tensioning contractor was tasked with developing a unique stressing protocol, which called for stressing each strand individually with single strand jacks. As a result, a special stressing system was developed to accomplish this, which proved to work very successfully.

In the end, this project was completed safely, on time, and on budget. The bridge once again serves as a vital link across the Mississippi River in Minneapolis.

Jason Caravello is a business development manager in the Repair and Strengthening Division of Dywidag Systems International USA Inc. (DSI) in Bolingbrook, Ill.