CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

5-6719-01: Bridge Strengthening Design and Load Testing for a Continuous Steel Girder Bridge with Post-Installed Shear Connectors

Background

Many older bridges in the state of Texas were constructed with floor systems consisting of a non-composite concrete deck over steel girders. While the individual elements in these bridges are often still in satisfactory condition, the structures often do not satisfy current load requirements and thus may need to be load posted, strengthened, or replaced. A potentially economical method for strengthening these bridges is to develop composite action by attaching the existing concrete deck to the steel beams using post-installed shear connectors. This provides an increase in strength and stiffness primarily in regions of the bridge dominated by positive flexural demands. To address strength deficiencies near the interior supports of continuous bridges, which are dominated by negative flexural demands, inelastic moment redistribution can be utilized. These strengthening concepts were developed in TxDOT Research Project 0-6719.

In Implementation Project 5-6719, a non-composite continuous steel girder bridge located in Lakeport, Texas, will be strengthened using techniques developed in TxDOT Research Project 0-6719. This implementation project is intended to demonstrate the strengthening technique, evaluate potential difficulties in design and construction and suggest solutions, and evaluate structural effectiveness and cost effectiveness of this bridge strengthening technique.

What the Researchers Did

The bridge selected for this implementation project is located in Lakeport, Texas, and provides a crossing for State Highway 149 over the Sabine River. A three-span continuous steel unit comprises the portion of the bridge that crosses the river. A four-girder, two-lane bridge was originally constructed at this location in 1943, and was symmetrically widened to an eight-girder, four-lane bridge in 1961. Modifications are currently planned for this bridge that include widening of the sidewalk, replacement of the exterior railing, and the addition of a new barrier between the traffic lanes and the sidewalk. Load rating of the bridge indicates that after the modifications are completed, load posting of the bridge will be required. To avoid the need for load posting, this bridge will be strengthened using the techniques developed in TxDOT Project 0-6719, as described above.

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This implementation project was divided into two phases. As of August 31, 2016, Phase I has been completed, and is summarized herein. Phase I of the Implementation Project included selection of a non-composite continuous girder bridge in Texas for strengthening, detailed design of the strengthening system, detailed finite element analysis of the un-strengthened and strengthened bridge designs, and field load testing of the un-strengthened bridge to obtain baseline data on the behavior of the existing bridge for later comparison with field load testing data for the strengthened bridge. Phase II, which will be conducted later, will include monitoring construction operations during the installation of post-installed shear connectors, collecting information on construction costs and difficulties, and field load testing of the bridge after strengthening is completed, to verify the effectiveness of the strengthening system.

What They Found

Analysis of the Lakeport bridge showed that after planned sidewalk and railing modifications are completed, the inventory load rating of the bridge will be HS 11.5. As part of this implementation project, a strengthening system was designed that included installation of post-installed shear connectors and allowance for limited flexural yielding at interior supports. To strengthen the Lakeport Bridge to achieve an inventory load factor rating of HS 20, a total of 372 post-installed adhesive anchor shear connectors must be installed. This represents an increase of nearly 75% in the load rating from the existing non-composite bridge.

Based on predicted future truck traffic, it is expected that these connectors will have a minimum of 32 years of fatigue life once installed on the bridge, which exceeds the desired extension of the service life of the bridge of 25 years. In addition to the post-installed shear connectors, a total of ten new cross frames and four sets of double-sided bearing stiffeners must be installed on the bridge to ensure that moment redistribution can occur in accordance with requirements in the AASHTO LRFD Bridge Design Specifications.

What This Means

Strengthening continuous non-composite steel I-girder bridges with post-installed shear connectors can provide a significant increase in the load-carrying capacity. In the case of the Lakeport Bridge, a 75% increase in the load rating was attained using this method, thereby eliminating the need to load-post the bridge with restricted axle weights. The design process is straightforward and based on rational concepts of structural behavior. Detailed design calculations for the Lakeport bridge are included in the implementation project final report, and can serve as a basis for strengthening designs for other similar bridges.

For More Information

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