Project Summary

Texas Department of Transportation

5-4124-01: Bridge Strengthening Through the Use of Post-Installed Shear Connectors

Background

The bridge evaluated in this study is an elevated section of I-345 near the interchange of I-45 and I-30 in downtown Dallas. This is a very busy interchange that plays a vital role in transporting vehicles to and from downtown Dallas. The bridge consists of two twin steel plate girder structures, one northbound and one southbound. Transverse floor beams frame over the two main girders and support the concrete slab, which is post-tensioned in both the longitudinal and transverse directions. Both the floor beams and the girders were designed to act noncompositely. The bridge was designed according to the 1965 and 1969 AASHTO Specifications.

Cracking was discovered on the bridge at the connection of the floor beams to the girders. The cracking was extensive, occurring at more than twenty locations on the structure. A retrofit to prevent further cracking at the detail was attempted in 2004. Subsequent inspections revealed that cracking was still occurring at many of the retrofitted details. The scope of study included: the evaluation of the stress level at the details by field tests, development of a three dimensional finite element model to evaluate the effect of bridge geometry upon its response, and a finite element analysis to determine the stress level local to the fatigue prone details to evaluate proposed retrofits upon expected fatigue stress levels.

What the Researchers Did

Two bridges were instrumented and subjected to controlled truck traffic. The controlled load tests were done at night using a rolling road block of TxDOT vehicles to hold off the traffic while two test trucks traversed the spans in prescribed lanes. The instrumentation consisted of strain gages and displacement transducers. The strain gages were installed on the flanges of the girders and floor beams to measure the global response of the structure and evaluate the participation of the bridge deck with the non-composite floor beams. The local stresses at the intersection of the floor beam to the girder web were also monitored. In addition, the service fatigue stresses were evaluated by monitoring the stresses for a 1 week period after the controlled truck testing. A three dimensional finite element model was constructed of each bridge. The stresses from the field tests and the model were compared. The floor beams were found to behave as composite with the bridge deck when the truck loads were near floor beams. The local stress at the critical sections was in reasonable agreement between the field and analytical results.

Research Performed by:

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What They Found

Two retrofits were incorporated into the model to determine their effectiveness. The first consists of adding knee brace plates over the existing bearing stiffeners, which are connected to the bottom floor beam flange using angle brackets and extend down to the bottom girder flange. The second involves cutting the existing bearing stiffeners in half in order to eliminate the previously mentioned small gap next to the bottom flange of the floor beam. The model shows that both retrofits were effective in reducing the stresses in these areas and also reduced the amount of out-of-plane bending of the girder web. However, these two retrofits are not effective in reducing the stresses near the top of this connection. The unsymmetrical support conditions of some of the girder units cause twisting of bridge sections. Adding of additional supports to make the bridge support symmetrical will also improve fatigue performance of the bridge.

What This Means

The combination of field testing with an analytical analysis of the bridge provided the research team and TxDOT the ability to determine the cause of the cracking that has been observed and the efficacy of proposed retrofits. The results of the field test provided a means of calibrating the analytical model, particularly the participation of the bridge deck with the floor beams. The use of the rolling road block in the field tests allowed the field tests to be done with minimum traffic interruption.

For More Information:

5-4124-01-1 Implementation Project: Strengthening of a Bridge near Hondo, Texas using Post-Installed Shear Connectors

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