UTSA® PROJECT SUMMARY

Texas Department of Transportation

5-6950-01: Implementation of Evaluating Bridge Behavior Using Ultra-High Resolution Next-Generation Digital Image Correlation (DIC): Applications in Bridge Inspection and Damage Assessment

Background

The Civil Infrastructure Vision (CIV) system is an integrated software/hardware system that can be used to monitor surface deformations on structural components ranging from small-scale material-test coupons to full-scale bridge members. In the Bridge Calibration edition, the CIV system is calibrated for measuring deformations on large-scale specimens that are 40 to 110 feet away from the cameras. The horizontal fields of view corresponding to those offset distances range from 17 to 47 feet.[1] The non-contact system offers several advantages over traditional contact measurement methods, including ease and speed of setup, reduction of traffic disruptions, and distributed measurements over large areas of a structural system (as opposed to point measurements).

The system is based on principles of Digital Image Correlation (DIC) and spatial triangulation, which are used to determine the 3D spatial coordinates of user-selected targets. In the CIV system, targets can be selected at any point on the surface of the structural system being monitored. A CIV system was delivered to TxDOT following research project 0-6950, and this implementation project (5-6950-01) was geared towards training TxDOT personnel on using the system and processing the data that originates from it.

What the Researchers Did

The researchers load tested ten bridges over a period of one year. The bridges showed inadequate load rating when evaluated using the AASHTO LFR procedures, typically for specialized hauling vehicles or emergency vehicles. However, the bridges that were considered had capacities within 10% of those required by the procedures, indicating that load testing may be beneficial in removing load restrictions for those bridges. All bridges were in relatively good condition and did not exhibit damage or deterioration that would indicate reduced capacities. All bridges carried two lanes of traffic; in some bridges the traffic lanes were for opposite-direction traffic, and in others for traffic in the same direction (see Figure 1-1).

Throughout this project, procedural improvements were made to accelerate load testing and minimize traffic disruptions. In the end, the team was able to complete the full process, from arriving to a site through finishing repacking equipment, in less than two hours. Gained efficiencies allowed the project team and TxDOT to conduct three load tests in one day on bridges that were a few miles apart (bridges 07, 08, and 09) without having been on site prior to testing day. This is a much faster process than using traditional instruments, with which a load test could take several days and require direct access to a bridge underside.

What They Found

While not the focus of this report, data delivered from the CIV system allowed several of the bridges to be alleviated from load posting. The results demonstrated the potential of load rating improvement from load testing for concrete flat slab bridges and multi-girder steel bridges, which are the most common types of bridges that are load posted without showing signs of structural distress in Texas.

The three most prevalent bridge types that are load-posted in Texas are steel I-beam (803 bridges, 394 of them sub-standard for load-only [SSLO]), concrete flat slab (388 bridges, 221 of them SSLO), and concrete

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Figure 1-1. The 10 load-tested bridges

slab and girder pan formed (191 bridges, 106 of them SSLO). Between these bridge types, 721 SSLO bridges are load-posted in the state.

What This Means

Based on results from this study, load testing of the two most prevalent SSLO bridge types can produce gains in load rating of up to 25%. Typically SSLO bridges do not pass the required load rating by a small margin, particularly for heavier loads from specialized hauling vehicles or emergency vehicles; thus, the research team postulates that up to 30% of SSLO bridges may be found to have adequate load capacity based on load testing results and therefore can benefit directly from the CIV system produced by this project.

1. Ghannoum W. M., Diaz M., Rajae S., Banjade S., Chapagain B., Hogsett G., "CIV - Civil Infrastructure Vision© v1.0: Bridge Calibration User Manual and Validation Manual." Center for Transportation Research (CTR), FHWA/TX-21/0-6950-1, 2021, 85.

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