FACT SHEET

Evaluating Bridge Behavior Using Digital Image Correlation (DIC): Applications in Bridge Inspection and Damage Assessment

PROJECT TITLE

Evaluating Bridge Behavior Using Ultra High Resolution Next Generation Digital Image Correlation (DIC): Applications in Bridge Inspection and Damage Assessment

STUDY TIMELINE

September 2017 – December 2020

INVESTIGATORS

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AGENCY CONTACTS/CHAMPIONS

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FURTHER RESOURCES

Video Summary Report

https://youtu.be/nOEAweMJ2W0

Introduction or Problem Statement

Due to heavy cost burdens, departments of transportation are increasingly seeking new technologies that can facilitate monitoring their bridge portfolios and reduce the need for costly interventions. Deformation measurements, such as bridge deflections, material strains, and crack progression under load and over time, are at the heart of damage and capacity evaluations for bridges. However, measuring the necessary structural deformations is currently time consuming, requires direct access to the structure, and often suffers from user-bias. Digital Image Correlation (DIC) is a non-contact technology that utilizes specialized digital cameras to deliver high-resolution deformation data between successive images and over large areas of a structure. The technology is advancing rapidly and has recently been proven in laboratory settings to possess the unique ability, amongst competing technologies, to deliver the necessary high-resolution deformation data that can greatly improve the accuracy and reduce the conservatism of structural evaluations. This project developed the hardware, software and calibration system for a new method of evaluating bridge behavior under load in a safer, faster and less expensive way and delivered a fully working system to TxDOT at the completion of the project.

Methodology or Action Taken

Structural deformation such as strains and deflections under load are important parameters used to evaluate the load carrying capacity of bridges by load testing. Dependably measuring these parameters is critical to arrive at accurate estimations of capacity through load testing. The Digital Image Correlation (DIC) system uses very sensitive cameras, targets on a bridge and software to measure deformation of a bridge in use as small as 1/1000 of an inch. These measured deformations are then used to back calculate

load carrying capacity of bridges. Visual targets can be applied to the bridge using an extension pole rather than bucket truck, scaffolding or snooper. The likelihood of needing traffic control and lane closures is significantly reduced compared to conventional methods. In the past, TxDOT has relied on expensive survey equipment to measure displacement and has relied on contracted teams to instrument bridges with a series of strain gages to determine the live load carrying capacity of bridges. This approach to load test and load rate bridges has been used when plans are not available for traditional load rating or to take advantage of capacity or load distribution that is not accounted for in traditional load rating calculations for bridges. TxDOT has utilized instrumentation and load testing to determine more accurate load capacity on bridge types including trusses, concrete slab spans, as well as foundations and bridge-class culverts. The conventional approach is noticeably more expensive and typically requires traffic control, lane closures, and working at heights from scaffolding, bucket truck or snooper. Turnaround time is usually measured in weeks, if not longer. This research project has equipped TxDOT with all the necessary tools to utilize the DIC system, including inhouse calibration standards. DIC will enable TxDOT to more rapidly perform accurate load testing and refined analysis using in-house personnel and equipment. DIC is an excellent new tool added to our toolbox for bridge evaluation and preservation.

Conclusions

- Safety improved for the driving public by elimination of lane closures.
- Safety improved for highway workers with reduced exposure to traffic and working at heights.
- Reduced impact to traffic flow by eliminating lane closures.
- Turnaround time – results in hours rather than weeks.
- Responsiveness – following implementation, in-house personnel can be deployed immediately to evaluate a potentially damaged bridge rather than waiting weeks to mobilize a contracted team to perform load evaluations.

Potential Impacts and Benefits

An implementation project is being developed to utilize the DIC system to evaluate 10 bridges by the end of FY22 while ensuring TxDOT personnel are thoroughly trained in using the DIC system.

The cost of this implementation plan is considerably less than the cost of load testing by a conventional method. Following the Implementation TxDOT Bridge Division will be able to perform DIC testing inhouse, with per-bridge costs reduced to little more than travel expenses as TxDOT owns the fully functional DIC system developed on 0-6950.