Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Improved asset management of reinforced concrete bridge decks with high-resolution imaging methods

Concrete bridge decks are routinely inspected as a requirement of the National Bridge Inspection Standards. This is typically a visual inspection, with deficiencies recorded from the shoulder of the roadway, outside of traffic flow. A new 3-D optical bridge evaluation system (3DOBS) allows inspectors to capture more detailed information about the condition of bridge decks at near-highway speeds without the need for lane closures or worker exposure to traffic. Researchers trained MDOT staff on the use of the vehicle-mounted camera and image analysis software, which will supplement traditional inspections on some bridges. The additional data will help MDOT optimize the timing of deck preservation treatments to prevent costly deterioration.

Project Information

REPORT NAME: Evaluation of Bridge Decks Using Non-Destructive Evaluation (NDE) at Near-Highway Speeds for Effective Asset Management – Implementation for Routine Inspection (Phase III)

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TOTAL COST: $211,938

COST SHARING: 20% MDOT, 80% FHWA through the SPR, Part II, Program

MDOT Project Manager

Brandon T. Boatman, P.E.

Big Bridge and Scoping Engineer
Bureau of Bridges and Structures

BoatmanB@Michigan.gov
517-242-5597

RESEARCH ADVISORY PANEL MEMBERS:

Jonathan Bruinsma, Eric Burns, Mike Halloran, Chad Skrocki, Michael Townley and Brian Zakrzewski.

PROBLEM

Damage to reinforced concrete bridge decks typically progresses from surface cracks to more severe forms of degradation. Cracks expose the steel reinforcement to road salt and water, causing corrosion, spalling and subsurface concrete fractures (delamination).

The 3DOBS vehicle-mounted camera system captures detailed data on bridge deck condition at near-highway speeds.

Traditional bridge deck inspections conducted from the shoulder may miss subtle hairline cracks. Non-destructive evaluation (NDE) tools can help provide a closer look at the deck. In Phases I and II of this project, MDOT tested several NDE technologies, including an earlier version of the 3DOBS camera system. Mounted on a

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"This project provided innovative technology to supplement routine bridge deck inspections while creating a safer working environment for bridge inspectors."

Brandon Boatman
Project Manager

moving vehicle, the camera captures a series of high-resolution images of the bridge deck. Sophisticated image analysis software allows inspectors to detect cracks at early stages, when maintenance can prevent the onset of significant structural degradation.

The goals of this project (Phase III) were to evaluate 3DOBS at higher vehicle speeds and train MDOT staff on implementing the new technology.

RESEARCH

Researchers tested an updated version of 3DOBS that uses a professional movie-grade camera called the RED 8K S35. The researchers studied whether the camera was capable of collecting high-quality video images and orientation-in-space data at near-highway speeds under field conditions. Data were captured during multiple vehicle trips across 10 different MDOT bridges, including freeway and non-freeway bridges and in high-traffic metropolitan areas. For these 10 bridges, the researchers compared the 3DOBS results to traditional inspection reports. Using this real-world data, the researchers automated the data processing steps and determined how to use the technology most efficiently for asset management and improved decision-making.

RESULTS

Tests demonstrated that the 3DOBS camera can record high-quality images (35.5 megapixels at up to 60 frames per second) and orientation-in-space data at near-highway speeds up to 45 mph. The typical data collection time for an average-sized bridge deck was 30 minutes or less. With the post-processing software, inspectors can generate two types of output: a 2-D mosaic, defined as a stitched image that combines many individual images, or a computationally more intensive 3-D model of the bridge deck.

Compared to traditional inspections, the 3DOBS system allows for collection of more accurate data without the need for lane closures, resulting in fewer impacts to the traveling public. 3DOBS also provides a safer work environment for inspectors by moving most of the inspection from the field into the office.

The 3DOBS system allows inspectors to identify specific locations of deck deficiencies – information that is useful to supplement National Bridge Inventory and element-level inspections. The imagery can also be used to monitor deterioration over time.

The researchers trained MDOT staff on the use of the camera and software and provided a user manual. They automated most of the data processing steps so that inspectors can focus on interpreting the 2-D mosaic or 3-D model. They also modified the software to generate element-level condition data as required for inspection reports.

IMPLEMENTATION

Since the majority (75 percent) of MDOT's highway bridges are at least 40 years old, utilizing sound asset management tools is important for system preservation. Using the 3DOBS system to supplement traditional inspections will be especially valuable for structures with large deck areas, which represent significant investments for MDOT. On these structures, timely preservation treatments are especially important to prevent deficiencies that could require a costly deck replacement. Routinely collecting imagery of these bridge decks with 3DOBS will help MDOT gain a better understanding of deterioration rates, allowing preservation treatments to be performed at the optimal time.

MDOT will continue to evaluate the 3DOBS technology. As this evaluation continues, regional offices can request to use the camera and will receive training on the system as needed.

One limitation is that neither the 3DOBS camera nor traditional visual inspections can detect delamination. This requires acoustic techniques, such as hammer sounding and chain dragging, or infrared technology. In the future, the 3DOBS system could be upgraded to detect surface and subsurface bridge deck distress features with thermal mosaic images.

Research Administration

Principal Investigator

Richard Dobson
Research Scientist
Michigan Tech Research Institute
Michigan Technological University
3600 Green Court, Suite 100
Ann Arbor, MI 48105

rjdobson@mtu.edu
734-913-6872

Contact Us

PHONE: 517-636-4555

E-MAIL: MDOT-Research@Michigan.gov

WEBSITE: Michigan.gov/MDOTResearch

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