

# Research Spotlight

## Project Information

**REPORT NAME:** The Use of Element-Level Data and Bridge Management Software in the Network Analysis of Big Bridges

**START DATE:** November 2015

**REPORT DATE:** October 2017

**RESEARCH REPORT NUMBER:** SPR-1667

**TOTAL COST:** \$330,477

**COST SHARING:** Pooled-fund study TPF-5(308) involving Iowa, Minnesota, New Jersey, New York, Pennsylvania, Wisconsin and Michigan as the lead state.

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## Updating management and inspection practices for large bridges

For structures both large and small, MDOT bridge inspectors follow guidelines in the AASHTO Manual for Bridge Element Inspection (MBEI). While effective for small bridges, the MBEI works less well for large bridges, which often include many types of material and complex interconnections between elements. In this pooled-fund research project, MDOT partnered with six other states to develop guidelines for inspecting large bridges and recommend improvements to bridge management practices.

### Problem

Large bridges differ from small bridges in more ways than just scale. Some large bridges consist of multiple structure types that essentially function as a network of adjacent structures, with complex interactions between the components.

Bridge management software and strategies, however, tend to treat large bridges essentially the same as less complex small bridges. Capturing location-specific defects across the sheer volume of elements in a large bridge can prove challenging using software and management strategies designed for small bridges, which typically present bridge conditions in general, summary terms. Structural elements in large bridges may also entail a variety of materials and interactions that are simply unanticipated by software and guidelines for small bridges.

Big bridges also pose other unique challenges for inspectors. For small bridges,



Large, complex bridges require inspection methods such as the use of underbridge inspection units (UBIUs) that reach from above deck to below.

an inspector may be able to assess bridge condition on foot using a handful of tools. Large bridges, however, may require the use of ropes and harnesses or unmanned aerial vehicles (drones) to investigate structural elements. Inspectors may also use equipment such as an underbridge inspection unit (UBIU), which lowers inspectors below the bridge deck. The range of elements that need inspection, as well as the quantity of elements, can be exponentially greater than for small bridges.

*“Most bridge management looks at a network of smaller bridges, and applies this approach to big bridges as well. But the cost, importance and inspection challenges of these big structures can’t be rolled in and compared with smaller bridges.”*

**Rebecca Curtis, P.E.**  
Project Manager

## Research

MDOT partnered with six other state DOTs to oversee a pooled-fund research project to evaluate how large bridges are currently being inspected, analyzed and managed, and to recommend improved practices at state agencies and changes to national guidelines. MDOT served as the project’s lead agency.

First, the project investigators reviewed research on bridge element-level data, bridge management software and management of bridge inventories. They gathered inspection reports from around the country, and surveyed state departments of transportation and bridge authorities to identify what current bridge management systems do well and what they miss.

The research team then followed up with phone interviews of selected large bridge managers to collect additional detail on their management practices. Investigators evaluated bridge management software packages, including AASHTOWare BrM and packages used in Canada, Europe and Asia.

Researchers then developed guidelines for inspecting large bridges to optimize the collection and use of element-level data.

They identified additional bridge elements for inclusion in large bridge inspection plans, and made recommendations for how to divide structural elements into individual subunits for analysis and management.

## Results

The research team recommended a number of new bridge elements to be added to the AASHTO MBEI, including cable protective systems, post-tensioning assemblies and deck drainage systems. Researchers developed guidelines for breaking up large bridge systems into a network of smaller structural units – subunits for which data can be collected and organized. The guidelines describe how to record data on subunits, emphasizing tracking defects in terms of type and location rather than summarizing defects in general terms. This allows damage to be better managed and tracked over time. The team also proposed a framework for changes to the AASHTO-Ware BrM software.

Researchers also reviewed the use of nondestructive evaluation methods in large bridge inspections, examining the potential for advanced and emerging remote sensing tools, such as lidar, thermography, 3-D optical sensing and at-speed ground penetrating radar, to gather large amounts of data efficiently.

Researchers recommended that agencies collect and collate inspection data on large bridges in bridge-specific inspection manuals. This will help engineers develop more useful deterioration models for specific bridges and optimize management of the unique network of subunits each large bridge entails.

## Value

This research will give bridge owners in Michigan and nationwide a more informed perspective on how bridge elements are performing, allowing them to make timely decisions about repair and rehabilitation

needs. By weighing element-level recommendations and the individual defect enumeration suggestions, bridge owners will be able to tailor management and inspection protocols to the needs of individual large bridges in their networks, gaining more accurate inspection data and improved opportunities for more effective and efficient bridge care and management. This will help lead to improved bridge performance and durability and cost savings through effectively extending bridge life.

Most large bridges in Michigan have their own maintenance and management crews, which presents opportunities to manage bridges with bridge-specific inspection manuals and deterioration models.

## Research Administration

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### This final report is available online at

[www.michigan.gov/documents/  
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617493\\_7.pdf](http://www.michigan.gov/documents/mdot/SPR-1667_Final_Report_617493_7.pdf).

Research Spotlight produced by  
CTC & Associates LLC, March 2018.