Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Improving Michigan Department of Transportation's (MDOT's) Movable Bridge Reliability and Operations

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PROJECT COST: $292,400

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

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Limiting the negative impacts of movable bridge closures

Movable bridges in Michigan are critical for meeting the mobility needs of motor vehicles, marine traffic and nonmotorized users. However, these bridges periodically experience mechanical and electrical failures. These malfunctions are not only expensive to repair but also cause bridge closures that negatively impact vehicle and marine traffic. Preventing failures, or reducing the amount of time to remedy them, will allow the Michigan Department of Transportation (MDOT) to reduce malfunction-related expenditures and provide a higher level of transportation service.

PROBLEM

MDOT manages 12 movable bridges that are essential for roadway and marine traffic. However, mechanical and electrical malfunctions cause unscheduled bridge closures requiring emergency responses, resulting in navigational restrictions and road closures that disrupt traffic patterns. Further, unplanned repairs are expensive as they often require additional costs for expedited materials, equipment and labor.

By reducing the number and duration of movable bridge malfunctions, MDOT can save money and limit negative impacts on roadway and marine traffic.

While regular maintenance prevents most malfunctions, additional strategies could further reduce the frequency and duration of bridge failures. This project sought to examine MDOT's current bridge maintenance approach, identify best practices and develop preventive strategies by determining the primary causes of malfunctions and designing solutions to mitigate the negative impacts of future closures.

RESEARCH

This project began with a review of operation and maintenance manuals and preventive maintenance schedules for each bridge to identify the data and information needs associated with electrical and mechanical operations. Next, a review of published studies focused on maintenance approaches for movable bridges, and a survey of other state bridge owners identified best practices for maintenance. Interviews with

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"This research will lead to better preparation for malfunctions that will reduce the time needed to troubleshoot, as well as provide guidance for using technology, maintenance strategies and training to prevent malfunctions."

Mike Halloran, P.E.
Project Manager

MDOT maintenance staff, bridge operators, engineers and equipment suppliers further clarified bridge operations and maintenance protocols.

Investigators also reviewed existing bridge information and documents, including malfunction logs, inspection reports, repair projects and as-built plans. Potential traffic detours were analyzed along with communication strategies to effectively notify the public when closures occur. Researchers took an in-depth look at improvements to alternatives to hardware and reviewed new technologies for their effectiveness and application to specific bridges.

RESULTS

The evaluation of previous movable bridge malfunctions found that the bridge control system caused most of the failures. Limit switches were the most common component failure. Interviews revealed that bridges have different protocols for operation, maintenance and repairs, highlighting a need for improved consistency. While bridge staff typically performs varying degrees of cyclical maintenance, such as monthly and annual maintenance checks, implementing and documenting these practices could improve performance. Recommendations included developing a bridge-specific preventive maintenance checklist, malfunction logs that include previous solutions, an electronic tracking system for maintenance activities, and a spare equipment inventory for each bridge. The tracking system will allow staff to efficiently obtain pertinent bridge information for various maintenance and management tasks and is particularly valuable when bridge staff turnover occurs.

Further recommendations include creating communication plans and emergency action plans for each bridge, drafting movable bridge design guidelines and establishing procedures for updating as-built drawings.

Technology improvements could also reduce the number and duration of bridge closures by using advanced diagnostics, remote monitoring and remote troubleshooting. These tools can help staff identify where to begin troubleshooting activities for malfunctions, provide continuous monitoring for maintenance needs and allow off-site staff to effectively participate in proposing solutions when problems occur. For example, a smartphone app could provide readily available access to pertinent information for staff members who are not in the vicinity of the bridge.

Other products such as Ethernet-connected motor starters and I/O-Links can provide additional diagnostic information to MDOT to signal a need for preventive maintenance or proactive replacement, such as replacing limit switches before they malfunction.

Additionally, the report proposed specific traffic detours along with a social media and dynamic message sign strategy to relay real-time information that assists the traveling public when bridge closures occur. This communication is especially important when the public cannot access critical resources during closures, such as hospitals that are located on the other side of a bridge.

IMPLEMENTATION

MDOT indicated that it will incorporate the procedural recommendations such as improved communication plans, emergency action plans, detailed maintenance checklists, and malfunction logs with previous solutions. Additional technology solutions such as advanced diagnostics, Ethernet-connected motor starters and I/O-Links may be implemented as part of future bridge maintenance or rehabilitation projects or pilot projects.

Research Administration

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The final report is available online at MDOTjboss.state.mi.us/TSSD/tssdResearchAdminDetails.htm?keyword=SPR-1746.

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