Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Unmanned Surface Vessels for Bridge Scour Monitoring

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TOTAL COST: $570,588

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

MDOT Project Manager

Chad Skrocki, P.E.

Assistant Bay Region Bridge Engineer

SkrockiC@Michigan.gov
989-220-9633

RESEARCH ADVISORY PANEL MEMBERS:

Brandon Boatman, Frank Boston, Andrew Bouvy, Eric Burns, Rebecca Curtis, Jason DeRuyver, Mike Halloran, Elizabeth McCann, Michael Townley, and Brian Zakrzewski.

Remote-controlled vessel provides safe and accurate inspection for bridge scour

MDOT routinely inspects bridges for scour around abutments and piers. These inspections are typically conducted from a boat during high-flow events, with inspectors probing the channel bottom or using sonar techniques to determine the extent of the scour. This can be very dangerous for bridge inspectors. As an alternative, an unmanned surface vessel (USV) equipped with sonar allows inspectors to capture these measurements and images from the shore. MDOT deployed USV units in the field to measure bridge scour and inspect bridges and culverts where access is limited. Using this tool is safer, less labor-intensive and, in some cases, less costly than techniques and equipment that require hands-on operation.

PROBLEM

Scour occurs when high-velocity water movement removes sediment around the substructure of a bridge, typically exposing the footings or piles. When the streambed is washed away, the footings and piles can no longer properly support the structure, creating a significant safety hazard.

A remote-controlled USV equipped with a sonar unit can maneuver around bridge piers and abutments during a high-flow event.

Inspecting for scour is vital in determining the stability of the bridge, but scour can be difficult to detect since it occurs below the water surface. Ideally, scour inspections are conducted during high-water-flow events, when most scour occurs. However, turbulence and fast-moving debris in the water can endanger workers using traditional tools like piloted boats and under-bridge inspection equipment. These methods also cannot be used in locations with limited vertical clearance, such as beneath a bridge when water levels are high, and they take time to deploy.

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"Using the USV is much safer and less labor-intensive than traditional inspection methods for detecting scour. It provides a great deal of information, in real time, to the inspector about what is occurring to the channel bottom below the water surface around the bridge substructures."

Chad Skrocki, P.E.
Project Manager

RESEARCH

To address these issues, researchers investigated alternative techniques for monitoring bridge scour during high-flow events. Investigators reviewed applicable scour monitoring research, considered alternative access methods (under-bridge inspection vehicles with boom arms that allow the inspector to access the underside of the bridge from the top of the bridge deck, and tethered and remote-controlled vessels), and scoped commercially available products.

Central to the study was identifying the circumstances when MDOT would use the equipment, understanding what equipment was available (and at what cost), and then determining which equipment met the agency's needs. This meant finding a system that could work in swift-moving water near piers, could read water depths from 3 to 50 feet, and could transmit real-time data to shore.

After reviewing online product evaluations, investigators conducted phone interviews and site visits with several vendors. These site visits gave investigators the opportunity to conduct hands-on hardware testing on the candidate products to assess their capabilities.

RESULTS

Investigators recommended a USV from Hydronalix called Sonar EMILY, which is equipped with a sonar unit that can measure water depths and produce side-scan and down-scan images of the substructure units and the streambed. The system also has a topside camera to view the underside of bridges.

This system, which uses post-processing software called SAR Hawk, was the most effective and cost-efficient setup to meet MDOT's requirements. The cost of the USV, laptop control unit and running gear was estimated at $50,000.

VALUE

This research indicated that a USV equipped with a sonar unit can accurately transmit real-time water depth readings and below-water images during high-flow events to bridge inspectors who are safely on shore. The equipment provides a consistent and accurate stream of data to inspectors and allows for quick and efficient mobilization between multiple bridges that may require inspection.

In addition, the research showed that the USV can be used not only for bridge scour but for other types of inspections in the stream environment, including difficult-to-access locations such as bridges and culverts with limited clearance between the waterline and the structure.

IMPLEMENTATION

MDOT is strategically placing four USVs equipped with sonar units throughout the state to inspect bridges for scour during high-flow events. In addition, the agency plans to use the technology for other inspection applications as appropriate.

To support the use of USVs, MDOT offered training to bridge inspectors in April 2019. The equipment is relatively straightforward when compared to similar systems. Personnel without prior knowledge of this specific equipment learned to operate the vessel and understand the data outputs.

Project investigators also wrote a user manual to help facilitate training. More hands-on training on operating USVs will be made available as the need arises.

Research Administration

Principal Investigator

Brian Schroeder, P.E., ITL, CWI

Supervisor – Structural Inspection
Ayres Associates Inc.
3433 Oakwood Hills Parkway
Eau Claire, WI 54701

SchroederB@AyresAssociates.com
715-831-7689

Contact Us

PHONE: 517-636-4555

E-MAIL: MDOT-Research@Michigan.gov

WEBSITE: Michigan.gov/MDOTResearch

This final report is available online at
https://www.michigan.gov/mdot/-/media/Project/Websites/MDOT/Programs/Research-Administration/Final-Reports/SPR-1682-Report.pdf.

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