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OFFICE OF TRANSPORTATION SYSTEM MANAGEMENT

TECHNICAL SUMMARY

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PROJECT COST:
$38,233

On the Minnesota River Bridge, MnDOT personnel installed tethered switches buried in the soil near piers.

Continuous Scour Monitoring Improves Bridge Safety

What Was the Need?

The leading cause of bridge failures in the United States is bridge scour, in which rapidly moving water erodes riverbed sediment from around bridge abutments or piers. Because installing scour countermeasures can be prohibitively expensive and may not be necessary, transportation agencies often choose to monitor a scour critical bridge instead. MnDOT currently monitors 45 scour critical bridges, and local Minnesota agencies have 360 more. Up until now, scour monitoring has been performed using portable scour monitoring equipment.

The use of fixed scour monitoring equipment will allow MnDOT to monitor scour critical bridges where portable devices are difficult to deploy, saving time and money, improving the accuracy of scour data and increasing public safety by detecting problems earlier.

However, portable scour monitoring systems can be difficult and dangerous to deploy from the bridge deck or boat in fast moving water. Getting inspectors quickly to sites in areas that are subject to flash flooding can also be difficult. A better alternative in such situations is to use fixed scour monitoring devices that continuously monitor scour and send data wirelessly to bridge personnel, alerting them when scour reaches a dangerous level. MnDOT has not historically made use of fixed scour monitoring equipment, but as advances in technology make these devices more affordable and reliable, the agency has become interested in exploring their use at locations where using portable equipment is problematic.

What Was Our Goal?

The objective of this project was to install and maintain remote fixed scour monitoring equipment on two Minnesota bridges over the course of three years to determine the effectiveness, reliability and robustness of fixed scour monitoring deployments and to provide MnDOT with the necessary technical information for future deployments. One test for robustness was to try different ways of installing the equipment so it was not damaged by ice or debris.

What Did We Implement?

This project implements MnDOT research project 2010-14, Bridge Scour Monitoring Technologies: Development of Evaluation and Selection Protocols for Application on River Bridges in Minnesota, which developed a scour monitoring decision framework and devised a work plan for installing fixed scour monitoring equipment on two Minnesota bridges.

How Did We Do It?

Researchers installed fixed scour monitoring equipment on two bridges in Minnesota: the Minnesota River Bridge, where Trunk Highway 14 crosses the Minnesota River at Mankato; and the Winona Bridge, where TH 43 crosses the Mississippi River at Winona. These bridges were selected because they are scour critical and difficult to monitor with portable devices. Both systems were operated for three years, with some outages due primarily to power and communication issues.

Equipment on the Minnesota River Bridge included:

- An underwater sonar device to monitor the elevation of the riverbed, which indicates how deep scour is in relation to bridge foundations.

continued

"This project gave us the familiarity and technical background we needed to start using fixed scour monitoring equipment on bridges that warrant it."

—Andrea Hendrickson,
State Hydraulics Engineer,
MnDOT Office of Bridges and Structures

"Properly implemented fixed scour monitoring equipment can provide automated warnings to personnel when potential scour events occur as well as increase confidence in bridge safety during flood events."

—Matthew Lueker,
Assistant Engineer,
St. Anthony Falls Laboratory

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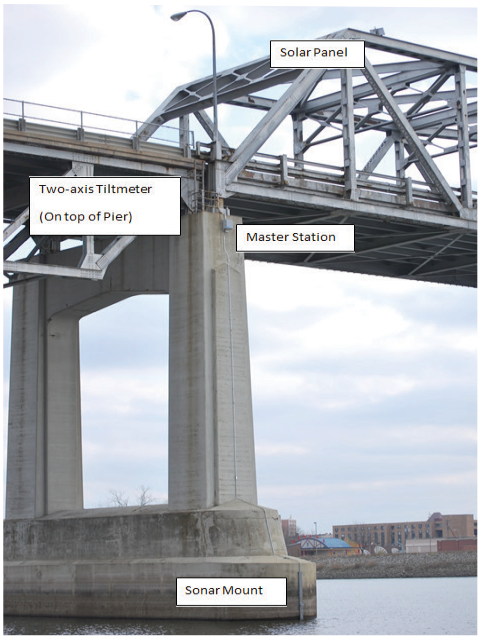

On the Winona Bridge, sonar and tiltmeter data are relayed to a master station for wireless transmission. The system is powered by a solar panel.

- A radar stage sensor, which monitors river water levels by detecting the distance between the sensor and the river surface.
- Two wireless float-out sensors, which are buoyant devices buried in the soil adjacent to piers. If floodwaters scour away the streambed holding a float-out in place, it is released, floats to the surface and transmits a signal to a local datalogger.
- Two tethered switches, which are buried in the soil near piers and send a signal if the soil is removed as a result of scour.

Equipment on the Winona Bridge included:

- Two underwater sonar devices.
- An underwater pressure stage sensor, which uses pressure to measure the distance to the river surface.
- A two-axis tilt sensor, which shows whether there is movement in the bridge substructure due to scour.

These sensors wirelessly transmitted data to an off-site database for viewing by personnel via a Web-based interface. Based on criteria set for scour depth and other variables, the system sent warning messages and alerts to bridge maintenance personnel via email.

What Was the Impact?

This project helped establish valuable lessons for future scour monitoring installations, including having an installation plan with adequate details, testing equipment before installation and collaborating closely with signal technicians and electricians. MnDOT has used this knowledge to install monitoring equipment on two additional bridges: the Old Hastings Bridge (TH 61 over the Mississippi River), on which float-outs were installed, and the Dresbach Bridge (Interstate 90 over the Mississippi River), which had a tiltmeter and underwater sonar device installed.

What's Next?

In addition to the technical knowledge gained from this effort, researchers also stored the data collected during the project so that the insight it provides can be used in future designs and research.

This Technical Summary pertains to Report 2014-37, "Scour Monitoring Technology Implementation," published September 2014. The full report can be accessed at http://www.lrrb.org/PDF/201437.pdf. *The research being implemented via this project can be found mainly in Report 2010-14, "Bridge Scour Monitoring Technologies: Development of Evaluation and Selection Protocols for Application on River Bridges in Minnesota," published March 2010. This report can be accessed at* http://www.lrrb.org/PDF/201014.pdf.