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Tech Brief

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EVALUATION OF BRIDGE SCOUR MONITORING METHODS

FHWA-NJ-2003-009 June 2003

HERE IS THE PROBLEM

Bridge foundation scour and stream stability problems occur due to the erosive action of flowing water, an excessive number of bridges fail due to scour around their abutments and piers. The resulting vertical and lateral changes in channel dimensions can jeopardize bridge foundations and integrity. There are 575,000 bridges in the United States and about 84 percent of them are over waterways and require scour mitigation. Periodic inspections may not detect scour activity as receding floodwater can refill scour holes with loose bed material.

AND, HERE IS THE SOLUTION…

Evaluation of bridge scour measuring instrumentation will reveal the most accurate methods and procedures for identifying severity of scour in bridge foundations. This project evaluated the use of a single system with two scour detection sensors: sonar and magnetic sliding collar (MSC). Each sensor complements the other to provide a complete and accurate picture of the scour activity.

THESE ARE OBJECTIVES OF THE STUDY…

- To evaluate the NCHRP designated systems and procedures for measuring scour at bridge piers.
- To provide a methodology which will enable New Jersey Department of Transportation (NJDOT) to successfully select the appropriate equipment and effectively evaluate and mitigate bridge scour.

HERE IS WHAT WE DID…

SYSTEM FEATURES

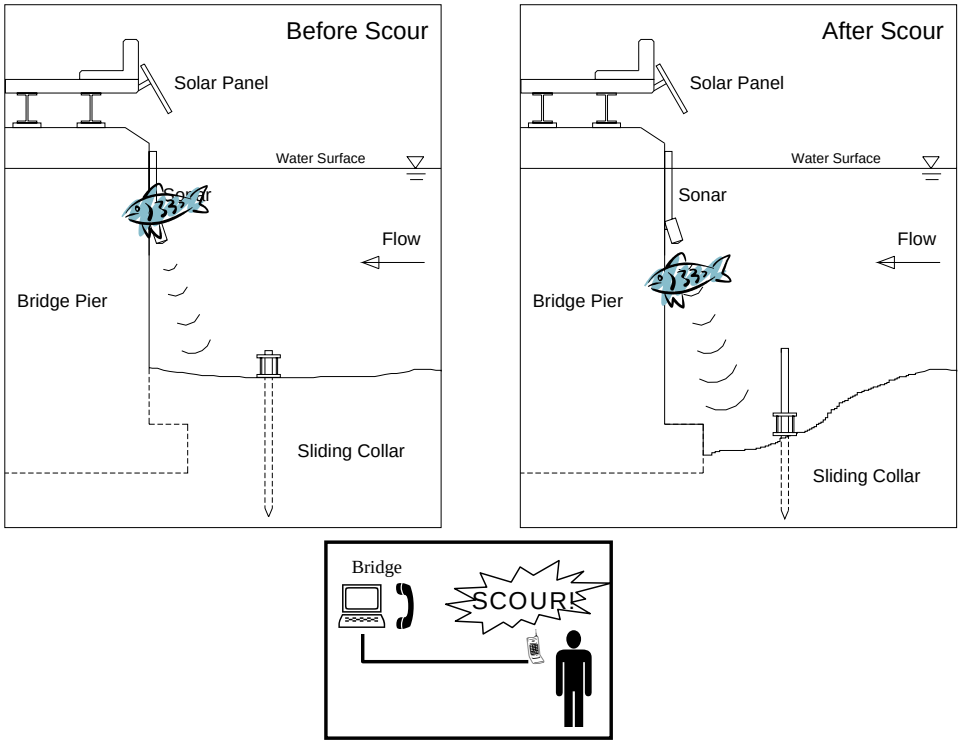

Figure 1. The scour monitoring system has the capability to dial out to an engineer's pager.

SYSTEM COMPONENTS

- **Lowrance 350A Sonar Fish Finder**. The same as the sport fisherman use to track deep water fish. The unit is connected to a sonar transducer that sends and receives ultrasonic pulses to the stream floor.
- **Magnetic Sliding Collar**. A stainless steel post driven into the streambed around which a metal ring is attached and free to fall down as the bed material is washed away. Inside the post are magnetic receptors that detect its position.
- **Sonic Stage Sensor**. The same idea as the fish finder, it sends an ultrasonic pulse through the air to determine the stream's stage height for flow measurements.
- **Datalogger**. Records data every hour for normal activity, and every 15 mintues during a scour event.
- **Telephone**. Each bridge in the project was outfitted with a landline connection. In the event of scour, the bridge can call an engineer's pager to warn of dangerous scour.

On August 9, 2001 a heavy thunderstorm caused flooding, and subsequently, scour activity on the Passaic River.

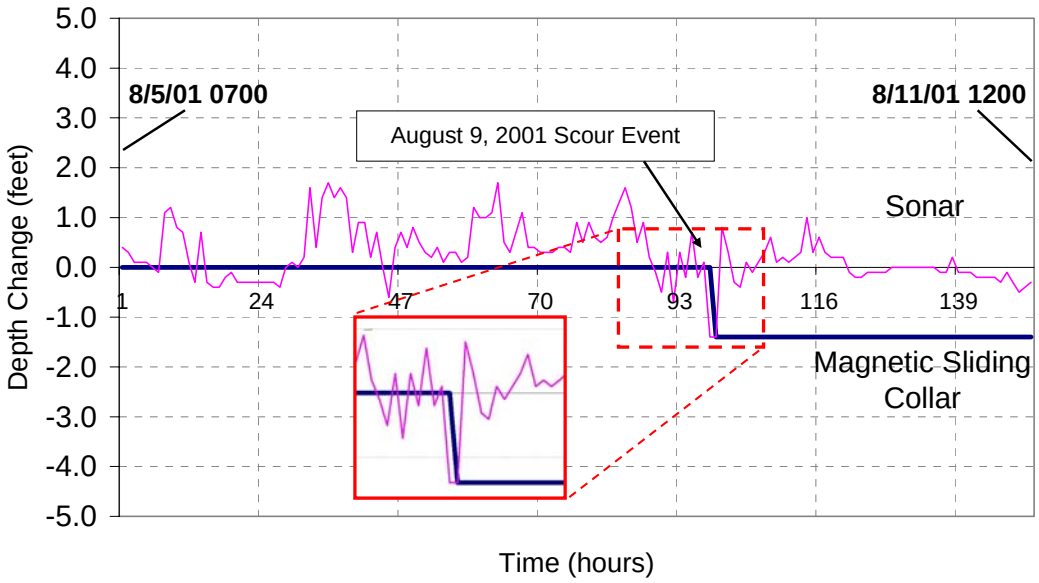

Figure 2. Passaic Bridge sonar and MSC data for a scour event.

The storm caused a scour hole of 1.2 feet deep to occur, not too dangerous for the bridge, but enough to prove that the system works.

INSTALLED BRIDGES

Currently two New Jersey Bridges are instrumented with the state of the art scour monitoring systems:

- State Route 35 over Matawan Creek, Town of Aberdeen, Monmouth County.
- US Route 46 over Passaic River (Dundee Lake), City of Paterson, Passaic County.

CONCLUSION…

Many bridges are affected by scour. It is not feasible to immediately repair or replace all of these bridges for financial reasons and the difficulty in observing a slow developing process such as scour. It is important to develop continuous scour monitoring techniques, which will enable us to decide which bridge needs rapid repair or replacement. The sonar and magnetic sliding collar systems used in the research were successful in recording continuous scour data from the study bridges.

There are many different types of bridge configurations; therefore, two different methodologies were evaluated in this research. Each instrument has its advantages and limitations, and these factors must be considered in selecting the best one for different bridge sites.

The main disturbances to these systems are vandalism, ice, and debris. Both systems are vulnerable to ice and debris. False scour measurements may be recorded when foreign matter accumulates between the transducer and the streambed or around the collar. However, both instruments are strongly resistant to physical damage due to debris and ice. Considerations should be given to protect the system from vandalism. Moreover, frequent visits to check on the equipment are needed to ensure continuous operation. Perhaps installed a camera on site would be useful in identifying vandals.

WHAT IS THE NEXT STEP?

The automatic scour monitoring system implemented here is only a part of what is to come. Smart bridges will soon be able to monitor themselves continuously for stress, corrosion, fatigue, ice, traffic, and scour. Each system will be fed into a central control box at each bridge. When trouble arises a call to the state department of transportation will be made and the bridge's problems will be known in a matter of minutes instead of weeks.

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A final report is available online at
http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for: EVALUATION OF BRIDGE SCOUR MONITORING METHODS.

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