

ScourWatch™

Sentinel for Iowa's bridges

As preliminary bridge engineer for the Iowa Department of Transportation (Iowa DOT), Dave Claman understands the importance of proactive measures in protecting the public when flooding threatens a bridge.

Claman directed the development of Iowa DOT's ScourWatch Flood Management System—a real-time, Web-based warning system. The system helps fulfill the requirement of the National Bridge Inventory System (NBIS) under section 650.313(3) for a plan of action (POA) for each of Iowa's scour-critical bridges.

"To protect the public from hazards due to potential catastrophic bridge failure during a flood, Iowa DOT engineers evaluated all 2,100 state waterway bridges," Claman said recently. "And in the past four years, the Iowa DOT classified approximately 180 of those as scour-critical. A bridge is defined as scour-critical when the bridge foundations have been determined to be unstable for calculated scour conditions."

Claman explained, "The evaluation of each bridge was developed using an interdisciplinary team of hydraulic, structural and geotechnical engineers. The team created a spreadsheet and criteria used to analyze each bridge site. Once a structure was identified as scour-critical, a bridge-specific action plan was developed for monitoring and inspection requirements. Scour countermeasures—riprap or articulated block mats—were constructed at various bridge sites to reduce the monitoring level and allow the bridges to stay open to traffic during a flood."



Dave Claman achieved his Bachelor of Science in Civil Engineering at Iowa State University in 1983. He has worked in hydrology and hydraulics his entire professional career. Currently, he is the preliminary bridge engineer in Iowa

DOT's Office of Bridges and Structures where he is responsible for determining the size and type of bridges and culverts needed for Iowa's highway system. Claman is also a member of the American Society of Civil Engineers (ASCE) and served as president of the Iowa Section in 2005.

The ScourWatch™ system is an application and implementation software. The Web-based program is designed to automatically alert key transportation and maintenance personnel when one of Iowa's scour-critical bridges is in potential danger of structural damage through flooding.

Claman became aware of the ScourWatch program at the Federal Highway Administration's (FHWA) 2003 Midwestern Hydraulic Engineering Conference in East Lansing, Mich. "Joe Scannell of USEngineering Solutions gave a presentation on this program and its real-time monitoring capabilities for scour-critical bridges," Claman said. "After his presentation, I indicated to him the program would be very beneficial for implementing POAs for Iowa's scour-critical bridges. I gave him my contact information and asked him to call me, and possibly make a presentation to my staff and management."

After exchanging information for about a year, and making presentations to management, the Iowa DOT decided to contract with USEngineering Solutions to implement the ScourWatch program in May 2004. By October 2005, the program was operational. The initial contract ended March 2007, but has been renewed for an additional two years, through March 31, 2009.

How does ScourWatch work?

ScourWatch identifies the potential occurrence of a flood, collects stream and weather data, and matches it against Iowa DOT's established bridge-threshold data. If weather conditions lead to significant rainfall or flooding, and thresholds established for a particular bridge are reached, the software sends an automatic notification by E-mail, pager or cell phone to key personnel notifying them where situations should be immediately evaluated. If necessary, personnel can be dispatched to the site to further evaluate the situation and mitigate any impacts due to scour. In summarizing, Claman said that ScourWatch:

- Quantifies and evaluates the number of scour-critical bridges in Iowa (implementing national standards).

- Develops, implements and maintains an Iowa threshold database for scour critical bridges.
- Improves forecasting technology, equipping key personnel with real-time data in the event of a flood, allowing personnel to focus on specific bridges approaching threshold levels, and avoid wasting time and effort inspecting structures not experiencing significant flooding.
- Evaluates the Web-based system and its usability and accuracy using beta tests.
- Implements the system during a flood situation and evaluates its thoroughness and accuracy.

Claman said, "During a flood a bridge is at possible risk of failure due to excessive erosion caused by flowing water carrying supporting materials away from streambeds, bridge piers and abutments. Factors affecting bridge scour include channel and bridge geometry, floodplain and flow characteristics, streambed materials, channel protection and stability, riprap placement, ice formation, and debris."



McGregor, Iowa Bridge, 2001 Flood — Photo by U.S. Geological Survey

Data sources

The ScourWatch system houses several internal data sources as separate databases within the central ScourWatch database. Iowa DOT's ScourWatch system consists of five primary databases. The first three consist of data provided by Iowa DOT: profiles, bridges and thresholds databases. The fourth database—gauges—consists of a list of real-time gauges interrogated by ScourWatch. The fifth database—events—is generated and updated using the system as an archive of active and recorded events.

ScourWatch can also be configured to include outside data sources, such as bridge-specific devices, road condition devices, seismic activities, snow accumulation information, and asset location and disposition information, in its calculations.

Architecture

The ScourWatch system architecture is comprised of three primary functional components residing within the system logic: data handler, database and subscription processor. System logic is a set of algorithms and scheduling management that makes up the brain of the system and effectively controls the three components.

The data handler extracts and processes relevant device, hydrologic and weather-related data from external data sources, and generates system products for verification and alert notification through the subscription processor and storage in the database. The database houses all the profiles, bridges, events, and threshold data for use by the system. The subscription processor employs algorithms to identify matches between products and user-specified subscription parameters, resulting in specific alert notifications being sent by the system.

Implementation

Accessibility

Resulting information from ScourWatch is presented using geographic information systems' (GIS) applications and active server pages (ASPs) accessible from a secured Web site. Authorized personnel can access scour-potential information from any location and evaluate potential bridge failure situations. Determination for the need of visual inspection and bridge closure can be made confidently and quickly – important benefits when initiating calls to alert transportation and law officials.

User profile notifications

Iowa DOT user information is maintained in the profiles database. Each Iowa DOT user has a unique profile consisting of user-specific information. Each profile contains a user name, product subscriptions, and contact information (cell phone, pager, fax, and E-mail). ScourWatch's subscription processor cross-references the profile database to disseminate alert notifications when real-time event information is processed and products are generated. For example, ScourWatch identifies a warning or event that results in the generation of an alert notification. ScourWatch then determines which user subscribes to the warning or event, and processes the appropriate alert notification based upon the user's profile. User profiles are updated quarterly by Iowa DOT's bridge design unit. ScourWatch displays profile information from the profiles database to the user via the system interface.

Beta testing

Iowa DOT beta tested ScourWatch in the autumn of 2006; results were encouraging. Beta testing of the ScourWatch program can be done at any time. This test simulates a rainfall or U.S. Geological Survey (USGS) gauge event to test whether district personnel are receiving cell phone text messages and E-mails. During an early 2007

spring beta test, district maintenance managers were instructed in program application and usage, and the system was tested to make sure all contact information was current. Simulations of the alerts are documented within the program.

Actual events

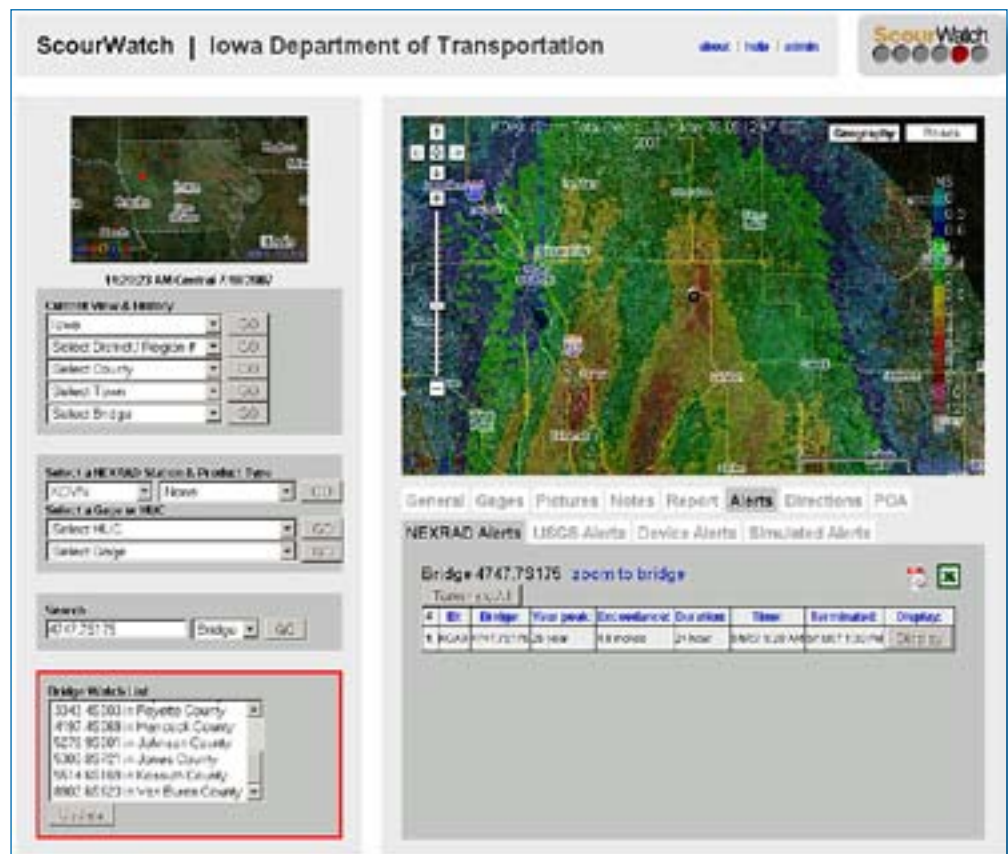
Claman emphasized that significant widespread flooding did not occur in Iowa during the spring and summer of 2006 to test the system. “However, during the spring and summer of 2007, Iowa experienced significant flooding, especially in southwest Iowa,” Claman said. “The ScourWatch system was a valuable tool in resource management during the heavy rains and subsequent flooding that occurred in May 2007. Scour-critical bridges are scattered throughout many river basins in southwest Iowa and most of these basins received heavy rain.”

The rainfall event created seven scour-critical bridge alerts where significant flooding was possible. The alerts allowed maintenance personnel to inspect the sites before significant flooding occurred. ScourWatch also identified other basins where significant flooding might have occurred, even though the rainfall was located in areas where there were no scour-critical bridges.

District 4 Maintenance Manager Jim Bane had this to say about the program, “By alerting maintenance personnel to specific bridge issues, it allows us to better focus resources on potential problems and, just as importantly, to not use these valuable resources monitoring scour-critical bridges that are unlikely to reach a critical elevation.”

The ScourWatch program has become an invaluable tool for Iowa DOT’s maintenance personnel in implementing FHWA’s mandated POAs for scour-critical bridges. ScourWatch provides the most cost-effective way of insuring public safety for bridges susceptible to scour. Iowa is the only state in the nation to incorporate drainage basins for each bridge within the ScourWatch program. This provides a better method of calculating the accumulation of rainfall within the basin of the scour-critical bridge and will reduce false alerts to maintenance staff.

Claman strongly supports the continued use of the program. “When alerts are received, monitoring can begin immediately,” he said. “This provides valuable time to evaluate specific bridges for scour damage, and allows the Iowa DOT to be proactive in protecting the traveling public from the potentially harmful effects of scour and monitor infrastructure to assure safe passage.”



ScourWatch™ bridge threshold alert, May 6, 2007

Editor's Note: Some information for this article was taken from a previously published online article written by Dena Gray-Fisher and Dave Claman, P.E., M. ASCE, published at GoBridges.com May 1, 2006, titled "Iowa's proactive approach to bridge scour monitoring," and from information provided by Joe Scannell, President, USEngineering Solutions Corporation, Hartford, Conn.

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U.S. Geological Survey's streamflow gauging program

Information on the flow of rivers is a vital national asset that safeguards lives and properties, and ensures adequate water resources for a healthy economy. The USGS operates about 7,000 streamflow gauging stations that keep watch on the nation's rivers—147 of those are in Iowa.

USGS' real-time gauges provide important information that the Iowa Department of Transportation (Iowa DOT) utilizes when monitoring scour-critical bridges. The data is incorporated into a Web-based program called Scour-Watch. The program was developed in conjunction with UEngineering Solutions. ScourWatch monitors National Weather Service Doppler radar rainfall accumulation, as well as USGS streamflow gauge data. The program alerts district maintenance personnel when the potential for flooding at a scour-critical bridge occurs. This allows the Iowa DOT to be proactive in protecting the public from the potential danger of flooding at scour-critical bridge sites.

The vast majority of USGS streamflow gauging stations are jointly funded in partnerships with more than 800 state, local, tribal and federal agencies. The USGS network provides real-time and long-term historical streamflow information that is accurate, unbiased, and meets the requirements of diverse users, including private citizens who access the streamflow data when planning recreational activities.



A typical USGS streamflow-gauge with satellite telemetry

Streamflow information is a requirement for:

- Flood forecasting and flood-prone area mapping.
- Planning and managing water supplies, and upholding interstate compacts.
- Developing water quality standards and monitoring changes in flow.
- Designing structures, such as dams, levees, bridges, and highways.

A streamflow-gauge is a structure located beside a river that contains a device to measure and record the water level of the river. Generally, these measurements occur automatically every 15 minutes with the data sent via satellite to the USGS office once every four hours, or more frequently when flooding is imminent.

In addition to the gauging station network, the USGS maintains a statewide system of peak-stage recording gauges on small drainage basins for the Iowa DOT. Data from this program is used to determine flood frequency and discharge data for the numerous small, ungauged drainage basins in Iowa. State and county transportation engineers use flood-frequency and discharge data to design bridges and other structures.

Flow and gauge-height data sets describing the average conditions, long-term variations and trends in flow are available on the USGS Web site <http://waterdata.usgs.gov/ia/nwis/sw>.

Editor's Note: Portions of this article were provided by USGS.

New Research and Technology Bureau logo and 2008 Calendar hot off the presses!

Just in time for 2008, the Iowa DOT Research and Technology Bureau proudly presents its new logo and first-ever calendar!



We've developed a new logo and 2008 calendar to provide the Iowa DOT community and others with useful tools, and to remind everyone we are always looking for good research ideas. If you have a potential research idea and would like to

share it with us, visit our Web site at www.operationsresearch.dot.state.ia.us/ihrb/iowa_highway_research_board.html for more information. All ideas submitted will be considered by our team; and, if feasible, someone will work with you to help you determine how to proceed in gaining funding and with development of a problem statement or proposal.

A supply of 2008 calendars will be sent to Iowa DOT district offices. REMINDER: If you have comments, suggestions or are able to take high-resolution, media-quality images of a current project and would like those considered for next year's (2009) calendar, please e-mail Mary Starr at mary.starr@dot.iowa.gov.



The Bureau of Research and Technology enhances the Iowa DOT's ability to deliver efficient and effective transportation services by actively promoting research partnerships, knowledge and technology transfer, intelligent transportation systems, and information technology.

For more information, see www.operationsresearch.dot.state.ia.us/reports/reports.html or call Mary Starr at 515-239-1590.

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