Decision support system guides response to damaged bridges

Collisions and severe weather may leave highway bridges with impact damage, fire damage, fatigue cracking or scour that structurally impair these spans. According to the NCHRP, vehicle collisions inflict damage on about 200 prestressed concrete bridges annually, 80 percent of these caused by over-height trucks. A Texas DOT study found that on all types of bridges in that state, collisions increased at a rate of 50 incidents per year between 1987 and 1992, and 14 percent of structures were seriously damaged.

What’s the problem?

When accidents involve structures, emergency personnel call in transportation officials to assess damage and determine the need for road closures. In 2005 a backhoe/excavator struck the Mason Street Bridge in Green Bay, resulting in extensive damage to several concrete girders. The debris scattered the roadway and struck another vehicle behind the truck. Traffic was closed temporarily until transportation officials cleared the roadway debris and determined the bridge was still structurally sound.

WisDOT representatives called to crash scenes are not always bridge engineers or inspectors. A decision support system consisting of data on bridges, past incidents and maintenance history could expedite reopening of roadways, when appropriate, by transportation officials.

Research objectives

The primary objective of the study was to build upon the Phase I study, which collected data from 16 bridges in a Bridge Incident Response Database (BIRD), by developing a DSS linkable to BIRD that would assist transportation officials responding to bridge incidents. Specific objectives were to develop an easily used Bridge Emergency Expert System (BEES) based upon expert knowledge from Wisconsin case histories, and to merge BIRD with BEES.

Methodology

LITERATURE REVIEW Researchers executed this work by reviewing both bridge management systems and DSSs in use around the country as well as in Canada and Europe. Investigators then consulted WisDOT’s Highway Structures Information System to identify bridge types, and the WisDOT Emergency Traffic Control and Scene Management Guidelines to identify and prioritize DSS goals and incident classifications. The team also reviewed national and state crash studies and reports to identify the types of damage to which bridges like those in Wisconsin may be subject.

PROTOTYPE DEVELOPMENT AND TESTING The research team then worked with two commercial open-source software packages to develop the WisDOT system:

- Python, an object-oriented programming language.
- CLIPS, an expert system development program.

The team drew on Wisconsin bridge data, reports from bridge incidents and civil engineering principles to create rules and facts written as if-then expressions in a forward-chain process. Python and CLIPS were employed to develop the user interface and to implement the rules and facts. The research team developed and tested suggestions from the prototype BEES against the recommendations implemented in nine bridge case histories from BIRD.

Results

Researchers found that none of the bridge management systems in use around the world could be considered fully developed; all would need some improvement in terms of inspection modules, data processing or effective expert systems.
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