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matically generates products for direct use in Google Earth®, ArcGIS®, and Excel®.

Caltrans operates ShakeCast on two redundant servers at the Transportation Laboratory in Sacramento, supporting a group of responders who perform postearthquake bridge inspections. The servers operate 24 hours a day, 7 days a week, and rely on a robust system of Caltrans e-mail servers to distribute the notifications.

For events greater than magnitude 4.0, ShakeCast automatically determines the shaking value at the locations of more than 12,700 bridges and facilities, compares the values with the threshold preestablished for each facility, and distributes e-mails to designated responders within 15 minutes of the event. The e-mails contain general information about the event and a table of bridges sorted by inspection priority.

Each bridge in the system’s database has a unique fragility determined with bridge damage models originally published by Basöz and Mander (1) and implemented in the Hazards U.S. (HAZUS) software of the Federal Emergency Management Agency. The fragility models employ 1-second peak-spectral accelerations and take into account bridge geometry, such as span lengths, number of spans, column heights, and skew; the years of design, construction, and retrofit; and the component material types.

Although the fragility methodology generates probabilities that a structure will be at a defined damage level, the results are presented in the context of inspection prioritization, to avoid any perception that the analysis represents actual damage. Because of the uncertainties in the range of ground motions and the assumptions made in bridge fragility computations, the tool is considered effective in prioritizing resources if the bridges with actual damage in an earthquake were flagged in the top 10 percent of the ShakeCast analysis. Inspection priorities are coded red, orange, yellow, and green, corresponding to high, medium, and low priority for full engineering assessment.

Application
The July 2008 earthquake near Chino Hills was magnitude 5.4; only one bridge sustained significant damage. The damage included concrete spalling and transverse displacement of a deck span at the center pier (see photo, this page).

The initial Caltrans ShakeCast notification identified the bridge as the 30th highest inspection priority after assessing more than 400 bridges. Although not considered a major event, the Chino Hills earthquake provided an opportunity to exercise the capabilities of ShakeCast during the test deployment phase and to build confidence in the system.

The Golden Guardian earthquake preparedness exercise in November 2008 deployed ShakeCast to generate assignments for Caltrans bridge inspections. The exercise scenario hypothesized a magnitude 7.8 earthquake on Southern California’s San Andreas Fault to test the coordination efforts of regional responders. The Golden Guardian exercise gave Caltrans responders valuable insight into the potential impacts of a severe event would have on the highway infrastructure because of bridge damage.

Benefits
The test deployment phase of the ShakeCast software already has realized benefits. The ShakeCast system has proved a valuable tool for Caltrans in postearthquake response during real events and in scenario planning exercises.

ShakeCast facilitates the complicated assessment of potential damage to widely distributed facilities. The system compares the complex distribution of the shaking with the bridge inventory’s damageability—which can be highly variable—and provides a simple, hierarchical list with maps of the structures and facilities most likely affected. By focusing inspection efforts on the most critically shaken areas, ShakeCast has drastically reduced Caltrans’ response time to assess potentially damaged structures after an earthquake.

For more information, contact Loren L. Turner, Senior Transportation Engineer, Caltrans, Division of Research and Innovation, 5900 Folsom Blvd., MS 5, Sacramento, CA 95819; telephone 916-227-7174; e-mail loren_turner@dot.ca.gov.

Reference

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Suggestions for “Research Pays Off” topics are welcome. Please contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).