Earthquake simulation shows off the potential for safer bridges (w/ Video)

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(PhysOrg.com) -- With a series of computer-controlled earthquakes, simulating some of the most devastating in recent memory, Berkeley engineers Wednesday showed off new technology designed to keep bridges not just from collapsing in a catastrophic temblor but open to traffic.

A 30-foot scale-model bridge, set up on the shake table (earthquake simulator) at the Richmond Field Station, was the star of the show, put on by Berkeley's Pacific Earthquake Engineering Research Center (PEER).

In a series of simulated quakes, which ranged from moderate to severe, the bridge trembled, shook and rocked violently— but the deck stayed intact and settled back on its supports after each event.

"What we're doing today is looking at some new technology that we think will be very good for California," said Steve Mahin, director of PEER and Wednesday's master of ceremonies. PEER is a consortium of nine West Coast universities, affiliated with other campuses abroad and industry partners, that was set up in 1996 to research seismic safety for buildings and structures.

The demonstration, and a second one held later in the day, attracted some 100 engineers and bridge-safety officials, some from as far away as Japan and Canada, plus members of the media.

What they came to see was how three pieces of technology, working together, solved a problem that has kept bridges from being able take advantage of seismic-safety breakthroughs used in buildings for the last 20 years.

The model bridge was built in segments, like many of the major bridges in the Bay Area as well as those supporting elevated freeways and the ones envisioned for a new high-speed rail system proposed for California.

Joints where the segments meet have been a challenge for engineers, said Mahin. In a quake, each segment shakes and rolls independently, severely stressing a roadway or rail line sitting on top.

The three devices tested Wednesday — two types of isolators plus a new "lockup guide" — were designed to keep the segments moving together during a quake, while also allowing enough movement to keep the bridge from shaking apart.

Isolators have long been used to allow a building to move separately from its foundation, but they've been difficult to adapt to bridges, Mahin explained. While they're effective in separating the motion of a bridge's columns from its deck, the deck remains in jeopardy because its segments move in different directions.

The lockup guide, which constrains motion between segments, is the newest piece of the puzzle, and its use with the isolators was what was on display Wednesday. The devices were developed by PEER engineers working with Earthquake Protection Systems, a manufacturer of seismic isolation equipment in Vallejo.

The trials mimicked the ground motion of four modern quakes that are considered historic: California's 1989 Loma Prieta, with a magnitude of

6.9, and 1994 Northridge (6.7); Japan's 1995 Kobe quake (6.9); and Chile's 1985 temblor (7.8).

Eleven times, a big, noisy hydraulic system set the bridge shaking according to various sets of computerized commands governing the size, direction and acceleration of the "quake." Each time, the roadway and tracks on the model bridge's deck moved as a piece.

For some of the tests, a rail car was lowered onto the tracks. When the shake table was set in motion, the rail car pitched and rolled but stayed but on the tracks.

Mahin pointed out that bridges are essential pieces of the Bay Area's infrastructure.

"After an earthquake, they're even more vital to speed response and recovery," he said. "You don't want them to be part of the problem."

But engineers have been slow to adopt modern earthquake technology to bridges, he said.

The new methods put through their paces on Wednesday not only have the potential to keep people safer and bridges intact, but they're less expensive and more environmentally sustainable than the old ones, he added. Without solving the isolator problem, bridges have been made stronger by building them bigger — which uses more materials. And preventing damage to bridges saves the cost involved in post-quake repairs, Mahin said.

More design research and testing will be done over the next year, according to Mahin.

"The next generation of research is about bridges not only staying up," he said, "but staying open."

Provided by University of California - Berkeley