UC San Diego Engineers Lead National Effort to Save Lives and Buildings During Earthquakes

January 7, 2011

Andrea Siedsma

Several major earthquake events around the world over the last few years have led to significant damage and loss of lives. Many of these quakes caused buildings to collapse related to the construction quality of those structures. Here in the United States, engineers are working to ensure that the quality of buildings is much better than those that have collapsed due to earthquakes in recent years.

For example, earthquake engineers from UC San Diego, University of Texas at Austin and Washington State University are joining efforts to make buildings such as hotels, schools, apartments and hospitals safer. To do this, the researchers will put a three-story reinforced masonry structure with shear wall systems through a series of rigorous earthquakes beginning Jan. 10. This three-story masonry structure represents a basic, repetitive part of common apartment or hotel buildings made of reinforced, bearing-wall masonry. It will be the first time this type structure has been tested at this scale on a shake table. The series of two-week tests will be performed at the UC San Diego Englekirk Structural Engineering Center, home of the world's largest outdoor shake table. The engineers will model the simulated shakes after historic earthquakes such as the 1994 Northridge, which measured a 6.7 magnitude.

The engineers are expected to simulate earthquakes all the way up to a 7.0 magnitude and perhaps above during the tests. The project is mainly funded by a $1.5 million grant from the National Institute of Standards and Technology through the American Recovery and Reinvestment Act program. The shake table tests are supported by the National Science Foundation through the Network for Earthquake Engineering Simulation (NEES) Program.

Reinforced masonry construction is common across the country. While many people believe that earthquakes mainly happen in California, there is also significant seismic risk in the Midwest and Eastern United States, said Benson Shing, a UC San Diego structural engineering professor who is leading the project.

"We have low probability, high consequence events in those parts of the countries, so the performance of reinforced masonry structures in earthquakes is very important," Shing said.

Shing said these types of structures demonstrated good performance in the 1994 Northridge Earthquake. The structure being tested has been designed according to the latest building code requirements. In theory, Shing said, it should perform even better than those built before Northridge. However, neither current nor pre-Northridge designs have been tested in an extraordinarily strong earthquake or with a large scale shake table test like this one.

"The building design code has been changing over the years," Shing said. "We want the structure to have a low probability of collapse under an extreme earthquake event. The shake table tests will provide good data to see if we could achieve such a goal. The data will also enhance our confidence on analytical tools, which can be used for future evaluation studies of buildings with different design details and configurations.

"If we find that there is some room for improvement we will recommend improved design details for these structures. Of course, if we find problems with existing structures we will think about how we could improve the performance of these structures by using some retrofit techniques," he added.

In the second phase of the project, Shing and his colleagues will test, in early 2012, a two-story, low-rise masonry structure with smaller window openings. "This type of building is difficult to analyze so it presents a major challenge in design," Shing said. "You can't reliably assess the performance of these structures with analytical methods normally used by engineers. Hopefully we can use our data to develop better design methodologies and analytical tools."

While life safety is high on the list for protecting these structures from severe earthquake damage or collapse, economics is also an important consideration. Shing said it's critical to minimize the life cycle cost of the buildings by avoiding costly repairs after major earthquakes.

"Civil structures are very different from airplane structures," Shing said. "We don't have a standard prototype to work with. Every structure is unique and different; the design of this type of structure is an art. How it performs in an earthquake is sometimes very difficult to predict. Testing the structure at full scale under realistic conditions is a very rare opportunity. So that's why we are very excited about this type of research."

Here is a link to a video of Shing explaining the national significance of these shake tests.

Media Contacts: Andrea Siedsma, or 858.822.0899