Massive earthquake simulation could lead to stronger, safer wooden buildings

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Rensselaer Associate Professor Michael Symans and incoming Dean of Engineering David Rosowsky are among the team of researchers who will converge in Japan next week to perform the largest earthquake simulation ever attempted on a wooden structure. The multi-university team has placed this seven-story building on the world's largest shake table and will expose it to the force of an earthquake that hits only once every 2,500 years. Credit: Colorado State University

A destructive earthquake will strike a lone, wooden condominium in Japan next week, and Rensselaer Polytechnic Institute Professor Michael Symans will be on site to watch it happen.

Symans is among the team of researchers who will converge in the Japanese city of Miki to perform the largest earthquake simulation ever attempted on a wooden structure. The multi-university team, led by

Colorado State University, has placed a seven-story building - loaded with sensing equipment and video cameras - on a massive shake table, and will expose the building to the force of an earthquake that hits once every 2,500 years.

The experiment will be Webcast live on Tuesday, July 14 at 11 a.m. EDT at www.nsf.gov/neeswood, and should yield critical data and insight on how to make wooden structures stronger and better able to withstand major earthquakes.

"Right now, wood can't compete with steel and concrete as building materials for mid-rise buildings, partly because we don't have a good understanding of how taller wood-framed structures will perform in a strong earthquake," said Symans, associate professor in Rensselaer's Department of Civil and Environmental Engineering. "With this shaking table test, we'll be collecting data that will help us to further the development of design approaches for such structures, which is one of the major goals of the project."

The 1994 magnitude 6.7 earthquake in Northridge, Calif., and 1995 magnitude 6.9 earthquake in Kobe, Japan, clearly demonstrate the seismic vulnerability of wood-framed construction, Symans said. The shake table experiment will offer researchers a chance to better understand how wood reacts in an earthquake, he said, and the resulting data could lead to the advancement of engineering techniques for mitigating earthquake damage.

As the ground shakes, the energy that goes into a building needs to flow somewhere, Symans said. Typically, a large portion of this energy is spent moving - and damaging - the building. There are proven engineering techniques for absorbing or displacing some of this energy in order to minimize damage, but the technology for doing so has not yet been thoroughly evaluated for wooden structures. Next week's shake should produce sufficient data to allow the research team to develop accurate computer models of mid-rise wood buildings, which can subsequently be used to advance and validate some of these seismic protection techniques.

As one example, Symans is working on the application of seismic damping systems for wooden buildings. These systems, which can be installed inside the walls of most wooden buildings, include metal bracing and dampers filled with viscous fluid. A portion of the energy generated by the earthquake is spent shaking the fluid back and forth in the dampers, which in turn reduces the energy available to damage the wall or building structure. Recently completed shaking table tests at Rensselaer on wooden walls outfitted with such a damping system have demonstrated the viability of such an approach to mitigating damage in wooden buildings.

"The system allows a significant portion of the wood-frame displacement to be transferred to the dampers where the energy can be harmlessly dissipated," Symans said. "With dampers in place, we have a better ability to predict how a structure will react to and perform during an earthquake."

In the 1994 Northridge earthquake, all but one of the 25 fatalities caused by building damage occurred in wooden buildings, and at least half of the $40 billion in property damage was attributed to wood buildings. The quake resulted in nearly 50,000 housing units rendered uninhabitable, most of them wood-framed buildings. The advancement of seismic protection systems could help to save lives and prevent or limit damage in similar future earthquakes, Symans said. This is particularly important considering that most residential structures in the United States, even in seismically active areas, have wooden frames.

The Miki shake is the capstone experiment of the four-year NEESWood project, which receives its primary support from the U.S. National Science Foundation Network for Earthquake Engineering Simulation (NEES) Program. NEESWood is led by Colorado State University, in collaboration with Rensselaer, the University at Buffalo, the University of Delaware, and Texas A&M University. One intended end result of NEESWood is the development of new tools, software, and best practices that result in building code revisions and allow engineers and architects to design wooden structures which can better withstand earthquakes.

The seven-story structure has been built with new seismic design methods informed by NEESWood research for mid-rise wood frame construction. The tests in Miki, to be performed at the Hyogo Earthquake Engineering Research Center, home of the world's largest seismic shaking table, will be used to evaluate the performance of the building and, in turn, the new design methods.

David Rosowsky, who will join Rensselaer in August as the new dean of engineering, is also a co-investigator of the NEESWood project and will attend the shake in Miki next week.

"NEESWood aims to develop a new seismic design philosophy that will provide the necessary mechanisms to safely increase the height of wood-frame structures in active seismic zones of the United States, as well as mitigate earthquake damage to low-rise wood-frame structures. When this challenge is successfully met, mid-rise wood-frame construction will be an economic option in seismic regions in the United States and around the world," said Rosowsky, currently the head of the Department of Civil Engineering at Texas A&M.

"It's exciting for Rensselaer to be a part of the international team participating in the NEESWood project. This project has already brought tremendous visibility to the School of Engineering at Rensselaer which, with its geotechnical centrifuge facility, already is a part of the NEES network of world-class laboratories for earthquake engineering," Rosowsky said.

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