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Engineers put earthquake-proof houses to the test

By Jennifer Kwan
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BUFFALO, New York (Reuters) - Engineers will not be surprised if months of work rattle to the ground this fall, jolted apart by a mock earthquake that mimics a deadly 6.7-magnitude quake.

Their handiwork, a two-story, 1,800-square-foot (167-square-metre) house built and placed on top of massive piston-powered shake tables, is an experiment after all.

But the experiment could change the way wood-frame buildings are designed and built, producing homes able to better withstand the effects of earthquakes from California to Japan.

A main reason is because engineers will use seismic dampers, essentially shock absorbers typically used in commercial buildings and bridges, to study how the earthquake's impact on a wood-frame house can be cushioned.

Engineers will pore over data from the big shake in November. The big test will follow a series of smaller jolt tests over coming months, done as part of the $1.2 million NEESWood (Network for Earthquake Engineering Simulation) project which began last year.

"Our model says the building will suffer significant damage," said Andre Filiatrault, an engineering professor at the University of Buffalo, which historically has been a center for earthquake research. "All the way to collapse perhaps."

The NEESWood project, which is developing quake-proof construction ideas, is focused on wood-frame houses because it is an untapped market despite wood being the most commonly used material in residential housing in some seismic zones.

In November, when the house is fully built and furnished engineers plan to subject it to an earthquake modeled on the 1994 quake that hit Northridge, California and killed 60 people.

The Northridge quake is believed to be the costliest in U.S. history with damages estimated at $40 billion, engineers say, and wood-frame construction losses accounted for half that figure.

As a result, Northridge forced architects and engineers to rethink ways to build tougher houses, said Michael Symans, associate professor of civil and environmental engineering at Rensselaer Polytechnic Institute in Troy, New York.

For one of the tests in November, engineers will ditch the shock absorbers, or dampers, because by then the 80,000-pound (36,288-kg) house would have been subjected to a number of shakes at various stages of construction to assess the impact on the dampers, as well as building materials such as gypsum, drywall and stucco.

A damper, about 20 inches long and 3 inches (7.6 cm) thick, is attached to the base of a triangular steel frame within the house's frame.

In an earthquake, the damper absorbs the moving house's energy and converts it to heat, with each damper capable of heating up to 200 degrees Fahrenheit (93 degrees Celsius) and able to dissipate about 15,000 pounds (6,800 kg) of force, or the equivalent of 20 car shock absorbers.

"You can think of the building like a big spring," said Symans. "If you don't pull it too much and let it go, it will vibrate but it won't be damaged.

"If you deform or strain the wood materials and their connections too much they can't come back to where they started. They're permanently damaged."

NEW WAY OF THINKING

"It's a new way of designing and thinking about how we design," said John van de Lindt, associate professor of the Colorado State University who heads the NEESWood project. "It's a philosophy,"

All this research will converge in Miki City, Japan, in 2009 when a house, possibly six stories, developed by NEESWood is rocked on top of E-Defense, the largest shake table in the world, he said.

Nicolas Luco, research structural engineer at the U.S. Geological Survey who is based in Golden, Colorado, said quake-proofing homes by, for example, using dampers would be well received in regions like California, which is located on the quake-prone San Andreas Fault.

"If it can be done with reasonable costs -- and I think these shake table tests will likely show they can reduce the earthquake response of the home and prevent damage -- then I think it's worthwhile," he said.

"A lot of it will come down the costs."

Douglas Taylor, chief executive of Taylor Devices Inc. which supplied the dampers being used in the shake tests, estimated it would cost about $15,000 to install the dampers in a home.

Commercial buildings and other structures, such as bridges, already have dampers installed, but the NEESWood tests could develop the first viable use of dampers in average homes.

North Tonawanda, New York-based Taylor Devices' dampers are currently installed in buildings and bridges around the world, including London's Millennium Bridge as well as the San Francisco-Oakland Bay Bridge and New York's Triborough Bridge.