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Shake, rattle and test: Earthquake simulator rocks wood-frame house

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Ah science, the quiet contemplation of a star's path across the sky, lonely weeks and months spent raising fruit flies or decades-long battles with abstruse mathematics in search of an explanation for the universe.

Or those other times, like when a research team madly shakes a two-story house built inside their lab on a giant shaker table in a full-scale recreation of an earthquake.

Doubtless scientific recruiters would indulge in far less hand-wringing if every experiment was like the one taking place this week at the University at Buffalo's Structural Engineering and Earthquake Simulation Laboratory. There, a multi-university effort funded by the National Science Foundation has built a genuine two-story townhouse inside a laboratory building atop a pair of massive 23-foot by 23-foot "shaker tables", otherwise known as "earthquake simulators." The goal will be to shake the heck out of the house over the week to learn how to strengthen wood-frame houses in earthquake zones, says university engineering professor Andre Filiatrault, who is overseeing the shaking test.

"Wood structures as a whole, are poorly understood," Filiatrault says, particularly when it comes to earthquakes. California's 1994 Northridge earthquake was an "eye-opener" in this regard, he says, with much of the \$40 billion financial loss, along with 24 deaths, due to wood-frame houses collapsing. Because wood is the poor cousin of well-studied materials like steel and concrete, engineers need to start from basic principles to get a handle on just how much shaking wood structures can endure, he argues. Hence the need to shake the heck out of their test house this week.

The townhouse, a popular California style, has already undergone some preliminary shaking, says engineering professor Michael Symans of Rensselaer Polytechnic Institute in Troy, N.Y., who is testing internal "dampers," sideways shock absorbers for houses, during the experiment. To make it a real test, a genuine team of housing contractors built the 40-ton house atop a concrete slab identical to one that supports many houses without basements today. At about 1,800 square feet, the 31-foot-tall house has three bedrooms, two baths and a two-car garage. For later tests, the team will sheathe its walls in gypsum drywall, not typically considered part of a house's support, to see if the addition stiffens the structure. "We're thinking of moving it to San Diego and trying out the housing market when we're all done," Symans jokes.

The team has five settings for the shaking the house will undergo this week, based on motion data recorded, and estimated, from past earthquakes. Several hundred sensors and cameras distributed throughout the house record the effects, which have already been tested at the gentlest settings. Level 4 resembles the Northridge quake, an event engineers give a 10% chance of occurring to a house in a high-risk zone. Level 5 is the "maximum credible earthquake," says Filiatrault, resembling the devastating 1906 San Francisco earthquake.

Preliminary testing confirms the type of motion, not just the magnitude of the quake, drives damage to wood-frame houses, Symans says. After all, houses are built to support a substantial overhead weight, the roof, so up-and-down shakes matter less than sideways "shear" motions. Someday, houses in earthquake zones may come with sideways-mounted dampers like those being tested for just that reason.


The best part is you can see it all live on the Internet this week, starting July 5 at <http://nees.buffalo.edu/projects/NEESWood/video.asp>. The shaking test is just part of a larger NSF-funded project headed by John van de Lindt of Colorado State University. The team's goal is not only to figure out how new houses should be built to survive earthquakes, but to look at retrofitting solutions for older homes. Eventually the team hopes to advance wood-frame engineering enough to enable builders to safely create multi-story wood structures, four or five stories tall, in earthquake zones.

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