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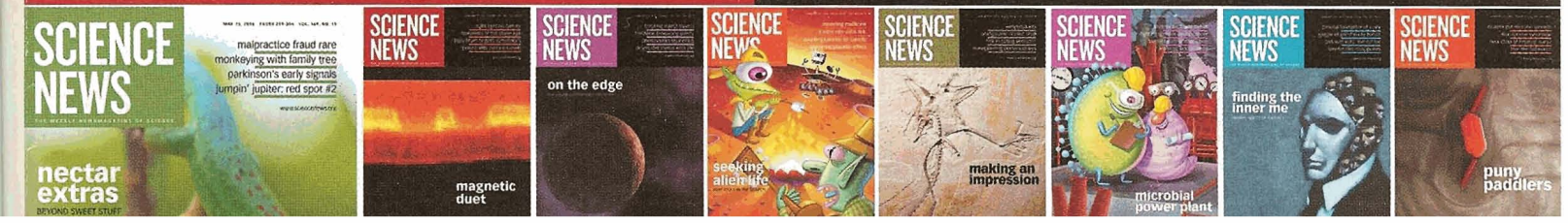

ROCKING THE HOUSE

Seismic tests of a life-size, wood home

BY SID PERKINS

On Jan. 17, 1994, about 2 hours before sunrise, a magnitude-6.7 earthquake struck Southern California's San Fernando Valley. The temblor, which originated beneath Northridge, occurred along a previously inactive and unknown fault zone. In a quake that generated an estimated $10 billion in damages—the United States' costliest earthquake to date—dozens of bridges collapsed, hundreds of buildings were destroyed, and 57 people died.

Last month, that quake struck again—this time, it rumbled through a corner of a lab at the State University of New York at Buffalo. In a building the size of an airplane hangar, scientists used computer-controlled hydraulic equipment to recreate the ground motions of the Northridge quake. The team applied the tremors to a two-story wood-frame townhouse that members of a five-university consortium had constructed atop two large platforms called shake tables.

"This is the first time that a wooden building this size has been [seismically] tested anywhere in the world," says Andre Filiatrault, a civil engineer at the university.

November's experiment, the latest in a series of seismic shakedowns conducted by the researchers, will shed light on how wood-frame structures behave in earthquakes, says Filiatrault. Results of these tests and of an even larger test scheduled for 2009 may lead to improvements in construction techniques, building materials, and building codes—all of which could end up saving lives.

MOTION PICTURE — The blur in this image results from the shaking of the townhouse, not the camera. Researchers simulated a magnitude-6.7 quake to better understand how wood-frame structures behave in such temblors.

SU Y BUFFALO

MODEL HOME Of the 24 people who died in buildings during the Northridge quake, most perished in wood-frame structures. Sixteen of those fatalities resulted from the collapse of a single apartment building. In that structure, much of the floor space at ground level was occupied by garages. The walls, weakened by the garage's large doorways and the open space within the structure, didn't provide strong support for the living areas on the upper floors, permitting them to move back and forth and quickly collapse, flattening the building's bottom level.

While that particular architectural design is no longer used for new construction in California anymore, plenty of older buildings have such open spaces at ground level. A garage, even with reinforced walls, is one of the weakest areas in a structure, says Filiatrault.

More than 80 percent of buildings and more than 90 percent of the residences in the United States have wood-frame structures, but engineering students are offered few courses about the design of such structures, says Filiatrault. Furthermore, "scientists don't really understand how wood-frame buildings perform in a quake," he says.

When researchers do test such structures, they typically use small-scale models, says John W. van de Lindt, a civil engineer at Colorado State University in Fort Collins. However, those models, which have been used in seismic simulations for decades, aren't perfect stand-ins for the structures they're meant to represent. For one thing, scaled-down versions of wooden buildings are in many ways stiffer than the real things, he notes. If researchers try to correct for that trait by loosening connections between structural components in a model, then the structure may bend and flex correctly but not vibrate at the appropriate frequencies.

It's particularly difficult for scale-model tests to accurately depict the damage that a full-size wooden structure will experience. Although researchers can carve a miniature version of a wooden two-by-four, they can't scale down the size of the wood cells in that board.

Van de Lindt, Filiatrault, and their colleagues avoided such problems by building the real thing: a 1,800-square-foot townhouse. They followed construction methods typical of those used in Southern California during the early 1990s.

The full-scale model had a skeleton of two-by-fours, interior walls clad with drywall, and external walls sheathed with large sheets of glued-together wood chips and covered by three layers of stucco. The three-bedroom, two-bath home, with a small alcove leading to a patio was designed to represent the central dwelling in a three-unit row of townhouses. Its construction followed the California building codes in place when the Northridge quake occurred. Many of the houses that people live in today were built during that era. Many of the houses damaged by the Northridge earthquake, by contrast, had been built at a time when building codes were less stringent.

The test townhouse didn't have plumbing and had only a few runs of electrical wiring for lighting fixtures. "Neither of those [features] adds much structural integrity in a real home," explains van de Lindt.

To ensure that the structure didn't collapse completely and