Researchers shake California warehouse with 50 tons of force

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This building in El Centro, California, proved to be stronger than anticipated, although several walls were damaged in the November test. Credit: Andreas Stavridis

It's one thing to simulate an earthquake on a model structure inside a laboratory. It is another to rattle a standing California building with 50 tons of force.

A team led by University at Buffalo researcher Andreas Stavridis received the rare opportunity to test an earthquake-damaged building in El Centro, California, and bring it to the brink of collapse.

"People will not let you test and damage real buildings," says Stavridis, assistant professor in the Department of Civil, Structural and Environmental Engineering. "It's extremely rare to be able to put sensors and shakers in buildings that have been damaged and get the data we collected."

The study, done in collaboration with Tufts University, received a grant of more than $390,000 from the National Science Foundation's Civil, Mechanical and Manufacturing Innovation Division.

The researchers will use data from the tests to better understand how damaged buildings respond to vibrations and improve tools used by engineers to simulate their seismic performance. The data will also be used to improve damage identification techniques and help develop a damage index for identifying the state of structures before and after extreme loading events.

In November, the researchers layered a century-old former warehouse with cameras, more than a hundred sensors and a shaker borrowed from the University of California, Los Angeles. They then shook the two-story structure at resonance frequency – the building's natural frequency – which amplified the vibrations enough to feel the force from more than 200 yards away.

The structure was an ideal test subject due to its architecture and layout – a concrete and brick hybrid with brick walls between steel-reinforced concrete.

Red-tagged and deemed practically unrepairable after the 2010 Mexicali

earthquake, the warehouse proved to be stronger than the researchers anticipated, although several walls were damaged between tests.

The structural system is vulnerable to severe damage during earthquakes, says Stavridis. Although this type of construction was banned after the 1933 Long Beach Earthquake in California, hundreds of buildings with similar architecture remain in major cities across California, and the system is widely used in Latin America, Asia and the Mediterranean.

To gain permission to test the warehouse, Stavridis spent more than two years clearing red tape with the building's owners, lawyers, contractors, and city and university officials.

But for the most part, the researchers were fortunate. They wanted a real structure to test, and the owner, faced with a hefty demolition price tag, needed help tearing down part of the building.

"The situation was a win for everybody. The owners got help to demolish the building, and we got the chance to test a building we couldn't test under any other circumstances," says Stavridis.

Provided by University at Buffalo