New building design withstands earthquake simulation (Video)

February 26 2009

Engineers constructed a four-story, 40-percent replica of a building in a laboratory to test their new technique for bracing high rise buildings in earthquake zones. They simulated an earthquake by pushing and pulling the building with hydraulics. Image: Remy Lequesne

(PhysOrg.com) -- Researchers at the University of Michigan simulated an off-the-charts earthquake in a laboratory to test their new technique for bracing high-rise concrete buildings. Their technique passed the test, withstanding more movement than an earthquake would typically demand.

The engineers used steel fiber-reinforced concrete to develop a better kind of coupling beam that requires less reinforcement and is easier to construct. Coupling beams connect the walls of high rises around openings such as those for doorways, windows, and elevator shafts. These necessary openings can weaken walls.

"We simulated an earthquake that is beyond the range of the maximum credible earthquake and our test was very successful. Our fiber-reinforced concrete beams behaved as well as we expected they would, which is better than the beams in use today," said James Wight, the Frank E. Richart Jr. Collegiate Professor in the U-M Department of Civil and Environmental Engineering.

Working with Wight on this project are Gustavo Parra-Montesinos, an associate professor in the Department of Civil and Environmental Engineering, and Remy Lequesne, a doctoral student in the same department.

Today, coupling beams are difficult to install and require intricate reinforcing bar skeletons. The U-M engineers created a simpler version made of a highly flowable, steel fiber-reinforced concrete.

"We took quite a bit of the cumbersome reinforcement out of the design and replaced it with steel fibers that can be added to the concrete while it's being mixed," Parra-Montesinos said. "Builders could use this fiber-reinforced concrete to build coupling beams that don't require as much reinforcement."

The engineers envision that their brand of beam would be cast off the construction site and then delivered. Nowadays, builders construct the beams, steel skeletons and all, bit by bit as they're building skyscrapers.

Their fiber-reinforced concrete has other benefits as well.

"The cracks that do occur are narrower because the fibers hold them together," Parra-Montesinos said.

The fibers are about one inch long and about the width of a needle.

The engineers performed their test in December on a 40-percent replica of a 4-story building wall that they built in the Structures Laboratory. They applied a peak load of 300,000 pounds against the building, pushing and pulling it with hydraulic actuators.

To quantify the results, they measured the building's drift, which is the motion at the top of the building compared with the motion at the base. In a large earthquake, a building might sustain a drift of 1 to 2 percent. The U-M structure easily withstood a drift of 3 percent.

The new beams could provide an easier, cheaper, stronger way to brace buildings in earthquake-prone areas.

The researchers are now working with a structural design firm to install the beams in several high rises soon to be under construction on the west coast.

Provided by University of Michigan

Citation: New building design withstands earthquake simulation (Video) (2009, February 26) retrieved 20 March 2024 from https://phys.org/news/2009-02-earthquake-simulation-video.html