

## Engineering earthquake-ready buildings

Friday, February 1, 2008  
by Alison Ryan

Kent Yu has made a career of knowing how the built environment will react to shaking earth. The Degenkolb Engineers' associate principal has worked alongside researchers at the Earthquake Engineering Research Institute, studying the realities of earthquake aftermath.

He's taught graduate courses in earthquake engineering at state universities in Portland and San Francisco. And last April, the engineer joined the Oregon Seismic Safety Policy Advisory Commission, a state public policy group that guides education, outreach and legislative efforts to promote earthquake preparation.

Now, he's also leading the engineering team that's seismically retrofitting Portland's Fire Station 1.

**DJC:** We've been earthquake-proofing buildings for a long time. Has the way we protect buildings changed as technology has changed?

**Kent Yu:** The fundamental principle is identical. It's just that we use different materials to address the same problem. For example, in this area we have a lot of non-ductile concrete frame buildings, built in 1976. Those buildings are killer buildings. When an earthquake happens, those buildings would collapse and kill people.

In the old days, we were probably using concrete, which just makes the column wider and bigger, and adding concrete jacketing around it. Today, for making the column perform better, we just use carbon fiber, wrapped around.

**DJC:** Safening the building in the exact same way, just using different stuff?

**Yu:** We now understand better about how buildings behave, and we understand better how buildings behave after the building has been retrofitted.

The key is this – you need to go to the field to look at earthquake damage. Last August, I spent eight days in Peru, looking at the earthquake damage in those buildings. In Peru, the code they're using is very similar to ours in 1997. And we both have the subduction type of earthquake, and every 500 years, we're going to have a magnitude 9 subduction earthquake.

**DJC:** Outside that 500-year event, how much does Oregon have to worry about this?

**Yu:** Tremendously. The typical earthquake in California shook about 30 seconds or so. The earthquake we'll have here is going to shake 3 to 4 minutes. If you have a paper clip and you bend it back and forth a couple times, the paper clip won't break. But if you bend it back and forth many many times,

the paper clip is going to break. It's the same thing with an earthquake. We're counting on the building to dissipate the earthquake's energy, essentially like a paper clip.

The problem in this area is before 1986, we didn't know a whole lot about seismicity in the area.

**DJC:** Is that why Oregon got left out of the research? Not as many events as neighboring states?

**Yu:** For some reason, historically, we just knew Oregon didn't have as many earthquakes. We considered ourselves a low-seismicity region. Over the years, we're designing all buildings to Zone 2, or 2B, as opposed to 4 in California.

From 1986 to 1994, we discovered the Cascadia Subduction Zone off the Pacific Coast.

Afterwards, we upgraded ourselves from 2 or 2B to Zone 3. And essentially every building designed pre-1994 was under-designed.

**DJC:** The project that you are doing at Fire Station 1, is that typical of something that might be done to retrofit existing buildings?

**Yu:** The building was designed in the late 1940s, early 1950s. In an earthquake, the building is going to twist.

First thing, we need to get rid of this contortional response. That's bad. We're adding additional walls in the front, to restore the building, so it can move in a more or less uniform fashion. The second thing we did was, the beams and columns have a lot of eccentricity ... the center lines of the beams don't match up the columns. We mitigate that eccentricity by adding a couple of feet of concrete on each side. In addition to that, we have a lot of concrete columns inside, because we don't have a whole lot of horizontal reinforcement ties. So we're using carbon fiber, wrapping those columns. In the old days, we would have made the columns fatter. But that's not very good, because it's taking a lot of floor space.