

## **Not My Fault: Of basketball and earthquakes: the complex business of safe public structures**

Lori Dengler/For the Times-Standard  
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I'm not a big basketball fan, but I have many friends who are and I know it's playoff season. While they were rooting for the Warriors or the Trailblazers, my mind went elsewhere. I began wondering about their arenas. A closer look reveals they sit in remarkably similar seismic hazard zones.

The Warrior's Oracle Arena is 2.3 miles west of the Hayward fault, a fault that produced a mid M 6 range quake in 1868 and is the Bay Area fault most likely to rupture in the next thirty years. Moda Center, the home of the Trailblazers, sits less than a mile from the Portland Hills fault. This fault has produced no major earthquake in the relatively short time of written history, but paleoseismic studies suggest it has produced earthquakes as large as magnitude 7 in the past.

The USGS is tasked with identifying sources of large earthquakes and has compiled a catalog of scenarios for faults deemed of highest concern. A scenario is a pretend earthquake. Seismologists specify rupture parameters (fault, depth, slip) and calculate the likely ground shaking depending on regional geology, giving planners a picture of the impacts and providing information for emergency management.

Scenarios for the Hayward and the Portland Hills faults show comparable ground motions at the sites of the arenas. Shaking intensity is projected to be in the Modified Mercalli VII to VIII range, about what Ferndale experienced in the 1992 earthquakes. Both sites could also be affected by other regional earthquakes.

The shaking hazard is just one consideration in seismic safety. Design and construction are just as important. Buildings can be engineered to withstand very strong shaking. New buildings should suffer little structural damage in either California or Oregon. Any building in Portland or the Bay Area built in the past twenty or so years meets comparable seismic design requirements.

Earthquake considerations first enter US construction guidance after the 1906 earthquake when "wind loads"

became part of the building code. But California was very shy to admit to its seismic problems at the time and it took several more strong quakes before the word "seismic" is written into the codes. The tipping point (literally and figuratively) was the 1933 M6.4 Long Beach earthquake that toppled many brick buildings, killing 120 people. Among the damaged/destroyed buildings were 120 schools.

The Field Act was passed a month after the 1933 earthquake, requiring that all public K-12 schools meet strict seismic design standards. The Riley Act, passed at the same time, required earthquake design for all new buildings. California continued to modify building code requirements with successive earthquakes. Other seismically active states like Washington began to do the same.

It wasn't until 1976 until earthquake considerations were applied nationally. The Applied Technology Council was tasked with assessing the seismic hazard of the entire country. I was in grad school when their first map came out delineating the hazard by contours showing the probability of strong shaking in the next 50 years.

The 1976 map defined five hazard zones. Almost all of coastal California from the Baja border to Humboldt County was in the highest zone with a finger reaching into Nevada and a small hotspot centered in the Yellowstone area. Areas of Utah, Washington State and Missouri were in the next highest zone and moderate hazard areas were identified in other regions. About half of the country in the map shows up as white, or no hazard, including Florida, most of Texas the upper Midwest and, surprisingly, almost all of Oregon.

The 1976 map was based on historic earthquakes as recorded on instruments or noted in written records. That is a relatively short window from a geologic perspective – a few hundred years on the east coast and half that in the west. National standards for seismic design were incorporated in building codes based on the expected threat.

At almost the same time as the new hazard maps were released, a handful of geologists were finding evidence of older quakes and the field of paleoseismology was born. No longer were we limited to the short historic record to learn about past earthquakes and a record of earthquakes hundreds or thousands of years in the past began to emerge.

The 1976 seismic hazard map has been updated many times and now fully incorporates the results of paleoseismology research. The latest seismic hazard maps show seven levels of hazard. Humboldt County and most of coastal California continue to sit atop the hazard list, but coastal Oregon moved from no hazard into the top three risk categories and no part of the state has zero hazard. The problem for Oregon and other states without a history of recent earthquakes is the large number of buildings built before seismic codes were in place.

Which brings me back to the Western Conference playoffs. Moda Center was built in 1995, which means it should be pretty up to date in terms of seismic resilience. Oracle Arena is much older, constructed in 1966 it is the oldest arena in the league. Oracle underwent extensive renovation in the 1990s, partly to incorporate more luxury features but also to strengthen seismic performance.

It's extremely unlikely I will ever learn which stadium will do better in a strong earthquake. Portland is now out of the playoffs and there are only three games (at most) that the Warriors will ever play at Oracle again. Next year they move to Chase Center in San Francisco, a site that will incorporate all the latest in seismic design and luxury sports experience. The odds are tiny that the next strong shaker will coincide with a game – but some of us still remember 1989, right?

Note: you can view all the USGS fault scenarios at <https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=14d2f75c7c4f4619936dac0d14e1e468>

Each scenario includes information on location and size of the fault rupture and the calculated ground motions it would produce. 15 scenarios have been compiled for the North Coast area.

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