Network reveals large variations in shaking in LA basin after Ridgecrest earthquake

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The 2019 Ridgecrest earthquake sequence has revealed areas of the Los

Angeles basin where the amplification of shaking of high-rise buildings is greatest, according to a new report in *Seismological Research Letters*.

The 6 July 2019 magnitude 7.1 earthquake, located 200 kilometers (124 miles) north of Los Angeles, did not cause structural damage in the city. But there was significant shaking in some high-rise buildings in downtown Los Angeles—so much that their residents reported feeling nauseous from the movement.

All buildings have a natural "vibration" or sway, which civil engineers and seismologists refer to as the building's longest natural period since it marks the amount of time it takes for a building to move back and forth in one cycle in a plane parallel to the ground. High-rise buildings of 15 floors or more, long-span bridges and large diameter fuel storage tanks, among other structures, typically have natural periods of three seconds or more.

Using data from a network of seismic stations across the L.A. basin, Monica Kohler of Caltech and her colleagues determined that long-period buildings experienced the most amplification of shaking from the Ridgecrest earthquake.

But the effect was not the same throughout the basin. At six- and eight-second periods, the maximum amplification occurred in the western part of the L.A. basin and the south-central San Fernando Valley.

In the event of a future earthquake similar to Ridgecrest, a high-rise building in those areas could experience shaking four times larger than a building located in downtown Los Angeles, the researchers concluded. In a 52-story building, this means that the upper floors might sway back and forth as much as one meter (about 3 feet)—or as much as two meters in a magnitude 7.6 earthquake, straining the building's structural integrity.

When seismic waves enter the softer sediments that fill in a basin, they slow down and their energy "piles up," creating larger amplitude waves that lead to stronger shaking. Researchers around the world have found that in general, the deepest parts of the basin—those with the most sediment overlying bedrock—experience the most amplification.

However, Kohler and colleagues found only a partial correlation between basin depth and amplification in their study.

"There's always been this assumption that the deeper the sediments or the thicker the basin ... the more amplification you're going to see, and we thought we were going to see that with our results," Kohler said. "But the sites with the largest amplifications for these long periods of more than three seconds are not close to the deepest portion of the basin."

"That's of concern because the next generation building code is being developed so that it incorporates parameters that account for deep basin effects," she added, "and if you get the location of the amplification effects wrong, you're going to have an application of the building code that's not right for specific locations."

The scientists were able to see a pattern of site amplification after the Ridgecrest earthquake with the help of a network of more than 500 seismic stations across the region, including 360 stations belonging to the Community Seismic Network (CSN). The CSN consists of low-cost accelerometers placed throughout the Los Angeles area, most notably in Los Angeles Unified School District buildings. Data from the network can be processed at the sensor site or in the cloud, and Kohler calls it "a really great example of a citizen science project that has worked for a decade."

"The denser the seismic network you have, the better resolution, the better you can see small-spatial-scale variations in ground shaking," Kohler explained.

She compared the results to suddenly being able to pick individual stars' features out of a cosmic blur with a better telescope. "We're seeing a level of detail that is much greater than has been seen before."

It's likely that several phenomena contribute to variations in shaking amplification around the basin, Kohler noted. She and her colleagues are especially intrigued by one possibility: that shallow buried sediment deposits associated with historic waterways and oil and gas development might play a role.

"We're actively looking into whether there's a spatial correlation between where these ancient and current water systems associated with the L.A. river could be having an effect," Kohler said, "whether there's a relationship between where the water systems exist and used to exist, and the kind of amplification you see in ground motion."

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