

### HOW DO EARTHQUAKES CAUSE DAMAGE?

Earthquakes cause damage as a result of the different waves that they produce as the earthquake energy moves through and on the Earth. The way that the ground responds to the energy of earthquake waves as they pass through depends on the geology of the area. A hard rock, like granite or limestone, may vibrate very quickly with short movements, but not break apart significantly. A wet sand or silt, on the other hand, could be shaken enough that the pressure of the water in the soil builds up enough to make the soil behave like a liquid. This is called liquefaction, and is responsible for much earthquake damage in low-lying wet areas.

Damage to the ground during an earthquake usually takes place in one of the following ways.

- Shaking: moves the ground in place. This does not usually cause significant damage to the ground itself, but often results in major damage to structures in or on the ground. This can include, not only buildings, but water, gas and sewer lines, train tracks, and roads.
- Landslides: ground is moved (displaced) to somewhere else
- Liquefaction: strength of the ground is removed, causing the ground and objects on it to sink. Any heavy objects sitting on liquefied ground will rapidly sink. This includes all types of natural features as well as structures. Liquefaction can result in depressions, a type of landslide called a lateral spread, and the formation of sand blows. Sand blows are geysers or volcanoes of sand expelled from cracks or holes in the ground due to high water pressure in the saturated sand during earthquake shaking. Sand blows have been known to open large fissures, create large depressions, and cover large areas of land with several inches of sand. This can impact roads and infrastructure, as well as bury large areas of farmland, making it unable to sustain crops.



The damage to structures can depend on the material that the structure is made out of, the type of earthquake wave (motion) that is affecting the structure, and the ground on which the structure is built. Wood structures respond to earthquakes differently than brick or masonry structures, because wood can bend, and masonry tends to shatter. Likewise, buildings with reinforced steel in their walls tend to stand better than unsupported buildings during shaking. The taller a building is the more the top of the building moves relative to the bottom of the building; however all buildings sway during an earthquake.

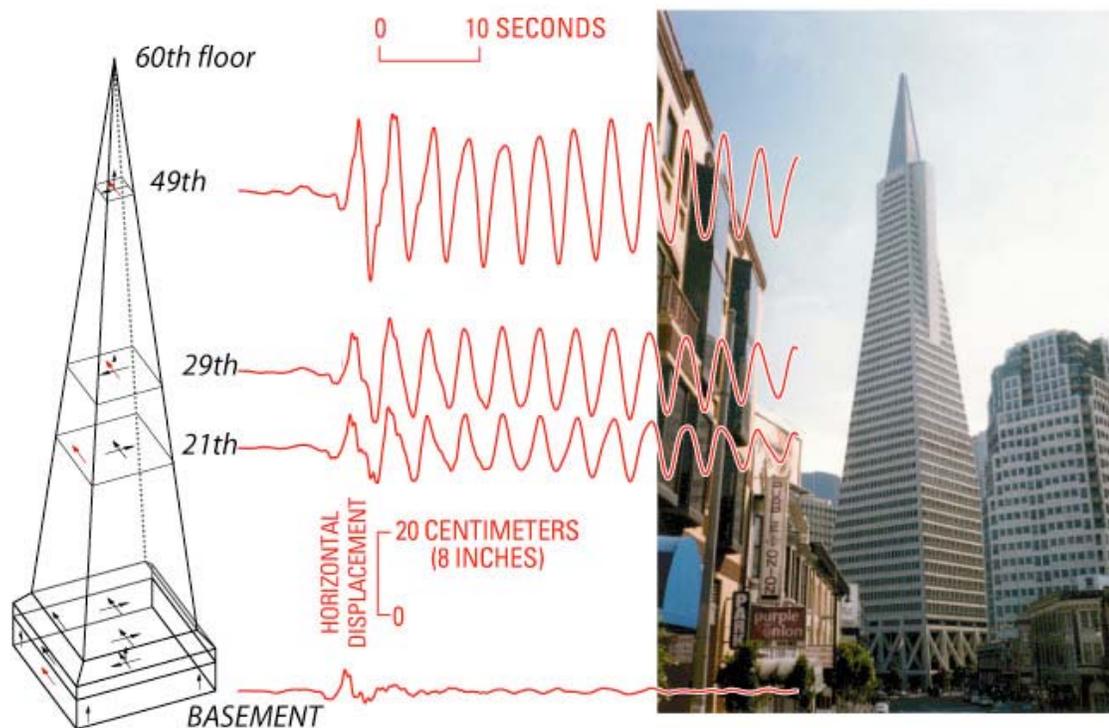
Structures tend to respond to earthquakes in one of the following ways: bending, breaking, sinking and shaking. Buildings are complex structures though. They are made of multiple elements and components that are stressed and interact with one another when shaken by an

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earthquake. Buildings vary widely in size, geometry, structural system, construction material, and foundation characteristics. These attributes influence how a building performs when the ground shakes.

The 1989 Loma Prieta earthquake (magnitude 6.9) set San Francisco's Transamerica Pyramid swaying and rocking. An array of 22 sensors (small arrows) installed by the U.S. Geological Survey in the steel-frame structure documented that the horizontal displacement on the 49th floor of the building was five times the inches measured in the basement, as indicated by the recordings (red lines). No significant twisting of the building was measured due to the symmetry of the building about its vertical axis.



## Activities

Sweet Jello Waves

[http://scifiles.larc.nasa.gov/docs/guides/guide2c\\_02.pdf](http://scifiles.larc.nasa.gov/docs/guides/guide2c_02.pdf)

Liquefaction in a Cup

<http://mceer.buffalo.edu/info-service/Education/soilLessonPlan.asp>

National Science Education Standards Addressed (5-8 and 9-12):

- Science as Inquiry
- Physical Science
  - Transfer of Energy and Interactions in Energy and Matter
- Earth and Space Science
  - Changes in the Earth
  - Energy in the Earth System
- Science in Personal and Social Perspectives
  - Natural and Human-induced Hazards
- History and Nature of Science
  - Historical Perspectives