

Introduction Worksheet **Key**

Designing a Building in an Earthquake Zone

How do earthquakes affect people? In highly populated areas, buildings and infrastructure (such as highways) can fail and crush people to death during an earthquake. In California, there are strict building codes (such as using earthquake-resistant concrete) to prevent large numbers of deaths. Why? In 1986, an earthquake of 7.1 on the Richter scale hit near San Francisco, killing 40 people. By contrast, in 2010, a 7.0 earthquake hit Haiti, a very poor country with no earthquake-resistant building codes, resulting in 250,000 deaths. This demonstrates the effectiveness of building codes.

1. Earthquakes generate waves that can destroy buildings. The buildings that collapse can kill people. Engineers work to make buildings safer in earthquake zones. The following video explains what causes buildings to fail.
https://www.youtube.com/watch?v=H4VQul_SmCg
 - a. The video shows that in 1985, Mexico City had a devastating earthquake that caused some buildings to fail, while others remained standing. What was the issue that caused some buildings to collapse?
Example answer: Resonance. The frequency of the earthquake's seismic waves happened to match the natural frequency of the midsized buildings. Each additional seismic wave from the earthquake amplified the building's vibration in its current direction, causing it to vibrate more and more with each wave.
 - b. How could the collapses be avoided?
Example answer: Engineers work with geologists and seismologists to predict the frequency of earthquake motions at building sites to prevent resonance-induced collapses. They consider factors such as soil type and fault type, as well as data from previous quakes. Engineers have also devised ways to absorb shocks and limit deformation using innovative systems such as base isolation and tuned mass damper systems.
2. Go to the following website to look at how engineers stabilize buildings in earthquake zones. <https://www.bigrentz.com/blog/earthquake-proof-buildings>.
 - a. Which types of structures would help most to keep a building safe in an earthquake.
Example answer: Earthquake-proof buildings may have the following structures/modifications: a flexible foundation; dampening systems such as hydraulic pendulums or vibration control devices; concrete and plastic rings underneath the building to shield it from vibration; structural reinforcements such as shear walls, diaphragms, and movement-resistant frames; earthquake-resistant materials such as structural steel, wood, and futuristic materials such as memory alloy or bamboo.

Name:

Date:

Class:

- b. Which ideas do you think would be the most cost-effective?
Answers will vary. Allow students to explain their reasoning in the class discussion.
- c. Which would be the most expensive?
Answers will vary. Allow students to explain their reasoning in the class discussion.