4th grade: Earthquakes

Objective: Students will experiment with designs to build a structure that can withstand an earthquake.

Next Generation Science Standards: ESS3.B: Natural Hazards: A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) ETS1.B: Designing Solutions to Engineering Problems: Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2) Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)

Docent Lab Guidelines:

1. Schedule a date and time with your teacher to have the students come into the lab. Allow about an hour of class time for this lab.
2. Input the day and time into the Science Lab Master Schedule. Please make sure to include clean up and set up time, and add your name.
3. Allow about 30 minutes of set up time and 30 minutes of clean up time. The Jello used for the "shake tables" will need to be prepared the night before.

General Docent Information—for Reference

What causes earthquakes? Masses of rock shift below the Earth's surface, causing changes in pressure and seismic waves.
Show video: Earthquakes 101
http://education.nationalgeographic.com/media/earthquakes-101-wbt/

Materials:
1 8x8 pan of Jello per table (prepare the night before)
Each pair of students will need:
30 miniature marshmallows
30 toothpicks
Pencil and paper to draw which designs work best

Docent tips:
--Inform students that in a science lab or during science experiments, nothing should ever be put into their mouths. The marshmallows and Jell-O® are not for consumption. Instead, set some aside for a treat after the activity.
--The activity works best with fresh (soft) marshmallows. As the marshmallows sit out and dry out, they and the structures become stable and rigid.
--Do not leave the Jell-O® uncovered too long, as it dries out and becomes less fluid, which affects the activity results.

Procedure:

1.Tell students that today they are acting as if they are engineers. They will make models of buildings and conduct an experiment to test how well their structures stand up under the stress of an earthquake. Explain to them that this is similar to what some civil engineers do as their jobs.

2.Illustrate how to make cubes and triangles using toothpicks and marshmallows. Show students how to break a toothpick approximately in half. Explain that cubes and triangles are like building blocks that may be stacked to make towers. The towers can have small or large "footprints" (or bases).

3. Distribute 30 toothpicks and 30 marshmallows to each student. Explain that the Earth has limited resources, so therefore engineers also have limited resources when building structures.

4. For this engineering challenge, students are limited to using only the materials they have been given to make structures. They may make large or small cubes or triangles by using full-size or broken toothpicks. They may use cross bracing to reinforce their structures. (Note: For higher grade levels, give students more rules for their buildings. You can use one or more of the following rules or create your own: buildings must be at least two toothpick levels high, buildings must contain at least one triangle, buildings must contain at least one square, or buildings must contain one triangle and square.)

5. Place the structures on the pans of Jell-O®.

6. If aluminum pans are used, tap the pans on the bottom to simulate compression or primary waves. If glass baking dishes are used, shake them back and forth in a shearing motion to simulate S or secondary waves.

7. After students have tested their structures, have them redesign and rebuild them and finally test them again. What can they do to make it stronger? Did it topple? Should they make the base bigger? Make the structure taller or shorter? Let students design and rebuild as many times as the class period allows.

8.Have students draw and label the shapes in their designs (cube, triangle, etc). Which design worked best? Why?

Source:
Teach Engineering
https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_natdis/cub_natdis_lesson03_activity1.xml

Conclusion

Earthquake-proof buildings typically have cross bracing that forms triangles in its design geometry (like a bridge). Such buildings also typically have a large "footprint," or base, and a tapered shape, decreasing in size as the building gets taller (or simply, smaller at the top). Short buildings are more earthquake proof than tall ones. Why do you think that is? Have you ever climbed up a tree or been on top of a playground jungle gym in the wind? Do you sway more when you are up high than when on the ground? All buildings shake at the same frequency as the shaking of the Earth, but the movement is magnified as the building gets taller. Sometimes, as can be the case during earthquakes, buildings sway too much, crack and crumble and fall.

Construction techniques can have a huge impact on the death toll from earthquakes. An 8.8-magnitude earthquake in Chile in 2010 killed more than 700 people. On January 12, 2010, a less powerful earthquake, measuring 7.0, killed more than 200,000 in Haiti.

The difference in those death tolls comes from building construction and technology. In Haiti, the buildings were constructed quickly and cheaply. Chile, a richer and more industrialized nation, adheres to more stringent building codes.

Check out this website for more information about base isolation and modern construction techniques and to watch two videos of real-life shake tables:
http://imaginationstationtoledo.org/content/2011/03/can-you-build-an-earthquake-proof-building/