Building for the Big One

In this activity, students will try to build a structure that can withstand a simulated earthquake.

Grade Level	Grades 5 - 12
Activity Time	1 hour
Preparation Time	30 minutes
Grouping	3 - 4 girls per group

Objective

As a result of this activity the students will be able to:

- Design a structure that can withstand the shaking of an earthquake
- Understand how soil type affects a building's ability to withstand an earthquake

Materials

Per Class:

- Shake table
- Stop watch
- Playdough (2 containers)
- Grape nuts (1 box)
- Water
- Oobleck (cornstarch and water)
- Measuring cup

Per Group:

- 20 popsicle sticks
- 1 hot glue gun
- 2 stick of hot glue
- 1 golf ball
- 1 aluminum 8in circular baking pan
- 1 ruler
- Several sheets of scratch paper and a pencil
- **Soil Types** Handout
- A set of Job **Description Tags**

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Directions

1. Divide the students up into group of 3 or 4.
2. Explain to students that today they will work as a team to build a structure that can withstand a major earthquake using only a limited amount of materials. Each team of students will be building their structure on a different type of soil and will need to adapt their structure in order to be as stable as possible on that particular type of soil.
3. Pass out the **Job Description Tags** to each group and have each student in the group take on one of the three roles (geologist, architect, or structural engineer). If there are 4 students in the group, have two of the students be structural engineers.
4. Carefully explain the different jobs to the students so that they all know what they will be responsible for.
    - The **Geologist** must research the group's soil type by reading the Soil Types handout. Based on that information, he or she will advise the architect and structural engineer on the structure design. The geologist will be the lead in the making of the soil inside of the aluminum pan.
    - The **Architect** will design the structure based on the required specifications. He or she will work with the geologist to determine if the design will work with the group's specific soil type.
    - The **Structural Engineer(s)** will build the structure based on the architect's design and the geologist's recommendations.
5. Explain the following rules & specifications for their structures:
    - The structure can only be built with 20 popsicle sticks, and 2 hot glue sticks
    - The structure must be at least 2 popsicle sticks tall
    - The structure must hold a person (represented by a golf ball) without shaking them off or out of the structure
    - The base of their structure must fit into their aluminum baking pan
    - The structure must be able to withstand 15 seconds of shaking without falling or collapsing (on the shake table).
6. Assign each group one of the four soil types (bedrock, alluvium, gravel, or landfill). Provide all of the necessary materials listed below and pass out the **Soil Types** handout to the geologist so they can research their particular type of soil.
    - Bedrock – fill the pan with Playdough
    - Alluvium – fill the pan with Grape Nuts and enough water to soak them, but not to fill the pan
    - Gravel – fill the pan with dry Grape Nuts
    - Landfill – fill the pan with Oobleck (1 ½ cup of cornstarch + 1 cup of water)
7. Give each group 20 minutes to design and build their structures.
8. Have all of the groups gather around the shake table and call up each group to test their structure. The entire group should participate in testing their structure. Structures should be placed into their pan (filled with the correct soil type) and shaken for at least 15 seconds.
9. After testing each structure, ask each group about some of their design decisions, whether certain features made their building more stable, and what they might change/add if they were to rebuild again.
10. If time permits, have each group re-design and build their structure to be more stable.

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Discussion Questions

- What determines the magnitude of an earthquake?

  Answer: Magnitude is a measure of the amount of energy released during an earthquake. The force is proportional to the amount of the energy released. This force travels spherically away from the point where energy is released (the focus).

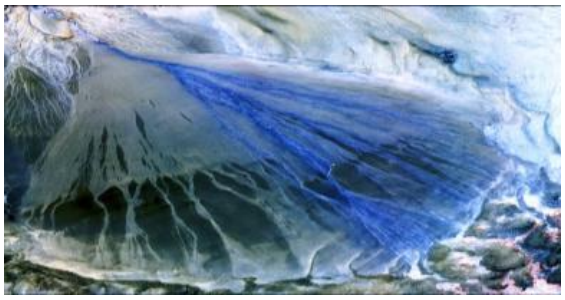
- What types of features affect building stability?

  Answers: Foundation, shear force, support/reinforcement, triangles, wide to narrow (wide at base, narrow at top), low center of mass.

- How do different structures hold up during earthquakes and how does what the building is built on affect how much damage it takes? What design changes or modifications will you consider for your next design?

Handout: Soil Types

Bedrock is the solid unweathered rock that makes up the Earth's crust. The Earth's outermost surface is called the crust. Bedrock may be composed of various elements from region to region. There are three major groups of bedrock: sedimentary, metamorphic, and igneous, each made of different sets of minerals.



Alluvium is young sediment—freshly eroded rock particles that have come off the hillside and been carried by streams. Alluvium is pounded and ground into finer and finer grains each time it moves downstream. Alluvium is typically made up of a variety of materials, including fine particles of clay and larger particles of sand and gravel.

Gravel is any loose rock that is at least 2mm and no more than 75mm. It can be a mixture of sand, clay, and small pieces of rock. It is sedimentary rock and usually found where there is, or were, rivers, lakes, and glaciers. It happens where rocks have been weathered by wind or water or eroded.

A **landfill** is a site for the disposal of waste materials by burial such that it will be isolated from groundwater and will not be in contact with air. Under these conditions, trash will not decompose much. Unless landfills are stabilized, these areas may experience severe shaking in a large earthquake.

Handout: Job Description Tags

Directions: Cut out and laminate the cards below and then attach them to a lanyard.

Geologist	The **Geologist** in the group will research and create the group's soil type: bedrock, alluvium, gravel, or landfill. Soil Recipes: • Bedrock = Playdough • Alluvium Pan = Grapenuts + enough water to soak them, but not fill the pan • Gravel Pan = Dry Grapenuts • Land fill = Oobleck (1 ½ cups of cornstarch + 1 cup water)
Architect	The **Architect** in the group will design a structure that meets the following parameters: Parameters: • Structures must be at least two Popsicle sticks tall. • Structures must hold a golf ball without shaking it out of the structure. • Structures must fit in a pan. • Structures must be able to withstand 15 seconds of shaking without falling or collapsing (on shake
Structural Engineer	The **Structural Engineer(s)** will build the structure using popsicle sticks and 2 hot glue sticks. Their structure must be based on the **Architect's** design and the **Geologist's** recommendations.