Building for the Big One

Grade Level:
Grades 5 – 12

Activity Time:
Medium (1 hour)

Preparation Time:
30 minutes

Grouping:
3 – 4 youth per group

Skills:
Working as a group to solve a problem

*Adapted from:
The Tech Museum of Innovation, San Jose, CA

Activity provided courtesy of Techbridge (www.techbridgeyouth.org)

Objectives:

To design a structure that can withstand the shaking of an earthquake

To understand how soil type affects a buildings ability to withstand an earthquake

Materials:

1. 20 Popsicle© sticks per group
2. Hot glue gun (low temperature)
3. 2 stick of hot glue per group
4. 1 golf ball
5. 1 aluminum 8in circle baking pans per group
6. Play-Doh© (2 containers per "bedrock group")
7. Grape-nuts© (1 box)
8. Oobleck (1 ½ cup of cornstarch + 1 cup of water per "land group")
9. Graph paper
10. Ruler
11. Pens
12. Career labels
13. Soil cards
14. Shake table
15. Stop watch
16. Velcro© with adhesive backing

Directions:

1. The goal of this activity is to design and build a structure that can withstand a major earthquake, using only the materials supplied (20 craft sticks, glue gun, 2 stick of glue).
    - How many of you have experienced an earthquake?
    - What was it like?
    - What did you have to do?
    - What was important in terms of protecting yourselves?
    - What are things we should think about when trying to build something that can withstand a major earthquake?

2. After dividing the youth into groups, each youth in the group will be assigned one of three career roles: Structural Engineer (1 or 2), Geologist, and Architect.

    The **Geologist** in the group will be given the group's soil type: bedrock, alluvium, gravel, or landfill. Collect the following materials to develop the soil:
    - Bedrock Pan is filled with Play-Doh©
    - Alluvium Pan is filled with Grape-nuts© + enough water to soak them, but not fill the pan
    - Gravel Pan is filled with dry Grape-nuts©
    - Land fill Pan is filled with Oobleck (1 ½ cup of cornstarch + 1 cup of water)

    The **Architect** in the group will be given graph paper and a pen and design a structure that meets the following parameters:
    - **Parameters:**
        - Structures must be at least 25 centimeters (10 inches) tall.
        - Structures must hold a person (represented by a golf ball or film canister) without shaking them off or out of the structure.
        - Structures must fit on a pan.
        - Structures must be able to withstand 15 seconds of shaking without falling or collapsing (on shake table).
    - The **Architect** will work with the **Geologist** to determine if the Architect's design is feasible on 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.

Testing/Demonstration/Reflection:

1. The entire group will participate in testing their structure.
   - What will you need to know about the soil in order to make your structure?
   - How will you work with your team to create a design?

2. Structures should be placed into pans and shaken for at least 15 seconds.

3. 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.
   - Asking youth to think through what they have done and what they think engineers actually do to solve a problem.
   - What do you notice about the soil?
   - What will you have to do to make you structure stand on your soil type?
   - How will it need to be different than the other structures on different soil?
   - Do they think that people work alone to solve these critical problems or how do they think they might work?
   - Do you think engineers get it right the first time, how many times do you think it might take?
   - How many times did you have to try things? What did you learn that made you change things? What did the different roles add to the design?

Teaching points for the Design Challenge:

Ask questions to pull concepts out of youth such as:

- Which ways did you see the waves move (Love and Raleigh) What did they have to consider in their building (Foundation)
- Have you heard of Richter scale – what does that mean?
- Why is it important to measure in this way?

- What does it tell us?
  - There are two kinds of surface waves during an earthquake: Love (up and down) and Raleigh (side to side).
  - The energy released during an earthquake produces a force on the plates. This force has direction traveling spherically away from the point where energy is released (the focus). The force also has magnitude proportional to the amount of the energy released.

Look for the following features that affect building stability in various student designs:

- Foundation
- Shear
- Support/Reinforcement
- Triangles
- Wide to narrow (wide a base, narrow at top)
- Low center of mass

Questions to encourage teaching points:

- In what ways does the shake table move?
- What determines the magnitude of an earthquake? (The amount of energy released)
- If you were to draw the force released from an earthquake. In what direction or directions do you think it travels? Starting where? (Waves travel spherically away form the focus)
- How did your structure hold up to the various wave motions? What design changes or modifications will you consider for your next design?
- Did you try to find a way to keep your structure anchored in the ground? How did you do that? What do we call that part of the building? (foundation)
- What shapes were used to build the structures that were able to withstand the earthquake (shake table) most effectively?