Building, Predicting, & Testing for Earthquakes
2024 NHERI Large Performance Outdoor Shake Table 6
Michael Moreno, Saul Romero, Emmie Liauw, & Leah Seifert

Summary-
In this lesson, students will learn about the dangers of earthquakes and how engineers design structures to withstand them. Students will participate in a hands-on activity where they will create different types of foundations to be placed in a box of sand, predict which will perform the best during simulated shaking, and observe the results. Through this, students will understand the importance of engineering in ensuring the safety and stability of buildings during earthquakes.

Engineering Connection-
This lesson connects to civil engineering, specifically in the area of structural engineering and seismic design. Students will explore how engineers use different materials and designs to create foundations that can withstand the forces generated by earthquakes. By engaging in this activity, students will gain insight into the critical role of engineers in protecting communities from natural disasters

Audience-
Middle School (6-8th grade)

Lesson Objectives-
- Students will learn about the basics of the cause and effects of earthquakes.
- Students will understand how engineers design foundations to resist earthquake forces.
- Students will explore the relationship between foundation design and stability during an earthquake.
- Students will develop hypotheses and test them through hands on experimentation.

Educational Standards
Science (CA NGSS) Standards
Standard Identifier: MS-ESS3-2. Grade Range 6-8. Disciplinary Core Idea: ESS.3B: Natural Hazards

Material List-
- Large shallow box (plastic storage box)

- Sand (enough to fill the box about halfway)
- Small weights (washers or small blocks)
- Various materials for creating foundations (carboard, popsicle sticks)
- Paper and pencils for students to record predictions and results.
- Rulers

Introduction-
Begin by discussing the significance of earthquakes and their impact on buildings and communities and demonstrating the destructive power of earthquakes. Introduce the concept of seismic engineering and the importance of designing buildings that can withstand earthquakes. Explain that engineers use tools like the Large Performance Outdoor Shake Table to test and improve building designs. Inform the students that today, they will simulate their own earthquake test to see how different foundation designs perform.

Procedure-
Background knowledge
- Explain the basic mechanics of earthquakes, including how tectonic plates move and create seismic waves. Introduce the concept of forces and their impact on buildings. Discuss why the foundation of a building is crucial in resisting these forces, and how engineers must design them carefully to ensure safety.

Before the activity
- Divide the students into small groups and distribute the materials.
- Instruct each group to design and build foundations using the materials.
- Ask students to predict which foundation design will perform the best during an earthquake simulation and have them record their predictions.

During the activity
- Have each group place their foundation in the box of sand and place a small weight on top of each foundation.
- Shake the box manually to simulate an earthquake. Ensure the shaking is consistent through all tests.
- Observe the performance of each foundation (how much it shifts, tilts, or collapses) and record the results.

After the activity
- Gather the students and discuss the results as a class. Encourage them to share their predictions and compare them with the actual outcome.
- Analyze why some foundations performed better than others, focusing on the surface area, shape, and material of the foundations.
- Relate the findings back to real world engineering challenges and the importance of designing effective foundations for earthquake resistant buildings.

Assessment-

Evaluate the students based on their engagement in the activity, the accuracy of their predictions, and their ability to explain why certain designs performed better. You can also ask students to write a brief reflection on what they learned and how it relates to real world engineering.

Wrap-up-

Conclude the lesson by reinforcing the importance of engineering in protecting communities from natural disasters like earthquakes. Remind students that the experiments they conducted are similar to yest performed by engineers in the real world. Encourage them to think about how they might use this knowledge in future studies or careers.