Building for the Big One – LAB SUMMARY

How do architects and structural engineers design buildings to stand up to the power of earthquakes? Your students will find out as they build and test structures while learning about the earthquakes that shake them!

Grade Levels: 4-8

Educational Outcome(s):

1. Students will gain a hands-on understanding of the affects of an earthquake by building and testing their own structures.
2. Students will understand the difference in how various soil types react to an earthquake.
3. Students will get a first-hand experience in making design decisions and trade-offs similar to those made in the real world.

Estimated Time: 1.5 hours

- **Introductory Science Discussion:** 10 minutes
- **Introductory Design Challenge:** 20 minutes
- **Reflection and Building Science Discussion:** 15 minutes
- **Design Challenge 2:**
  - **Building -** 20 minutes
  - **Exhibit and Test -** 10 minutes
  - **Reflection -** 10 minutes
- **Wrap-up and Clean-up -** 5 minutes

California Science Content Standards Connections:

- **Grade 6** - Earth Science: 1c, 1d, 1e, 1f, 2d
- **Grade 8** - Physical Science: 2a, 2b
- **All grades** - Investigation and Experimentation: Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations.

California Math Content Standards Connections:

- **Grade 4** – Measurement and Geometry: 3.7
- **Grade 7** – Measurement and Geometry: 3.6

Pre-Visit Vocabulary

These are words and concepts that we will discuss in the lab. Your students' lab experience will be enhanced if they are familiar with these terms prior to your visit.

- Core: the central portion of the earth, having a radius of about 2100 mi. (3379 km) and believed to be composed mainly of iron and nickel in a molten state
- Creep: Slow fault slip, occurring along a fault, without producing earthquakes.
- Crust: the outer layer of the earth, about 22 mi. (35 km) deep under the continents and 6 mi. (10 km) deep under the oceans
- Earthquake: A sudden movement of the earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity
- Epicenter: The point on the Earth's surface directly above the focus of an earthquake.
- Fault: A fracture of zone of fractures in rock along which the two sides have been displaced relative to each other parallel to the fracture.
- Focus (hypocenter): The place at which an earthquake begins or ruptures.
- Force: Any influence that tends to accelerate an object; a push or a pull; force = mass x acceleration (F = ma: Newton's 2nd law).
- Mantle: the portion of the earth, about 1800 mi. (2900 km) thick, between the crust and the core
- Plate tectonics: A geological model in which the Earth's crust and uppermost mantle (lithosphere) are divided into a number of segments (plates).
- Tsunami: A long ocean wave usually caused by movements of the ocean floor during an earthquake.

Tech Museum Gallery Connections:

- Exploration Gallery: Living on a Restless Planet
  - Experience an Earthquake
    - Students experience a simulation of real historical earthquakes, and test measuring tools of seismic activity.
  - Quake Watch
    - Students view recent seismic activity in the Bay Area
  - Seismometers
    - Students can make their own earthquake by tip-toeing, stepping, and stomping near a seismometer, and can gauge how strong an earthquake they create
  - Sensing Earthquakes
    - Students can push against stone blocks. Seismometers detect movement. Can students feel any movement?

Post-Lab Activity: Make your Own Shake Table (outside of class, instructions on following page)

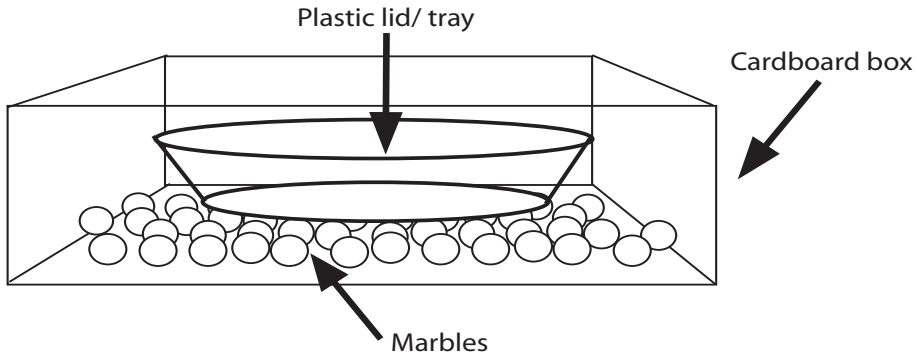
Post-Lab Activity: Make your Own Earthquake (1 class session of 30 minutes, handout available in Tech lab classroom)

Students draw upon their understanding of plate tectonics to simulate an earthquake using 2 wooden blocks and clay.

- Students will demonstrate their knowledge of plate tectonics.

Two Easy Shake Tables[1]

1. Marble Shake Table

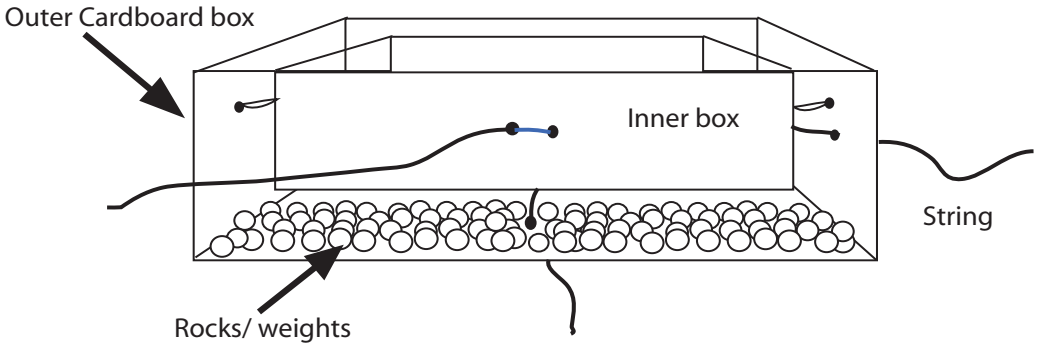


Materials:
Marbles (about 100), plastic tray/lid, box lid (about 1/2" depth)

Procedure:
1. Put marbles into cardboard box. Experiment with varying amounts and sizes.
2. Place plastic lid on top of marbles.
3. Place structures into the plastic lid and simulate an earthquake

- First do back and forth motion to imitate P waves (more accurate if very rapid)
- Next do vertical or side to side motions to imitate S waves (more accurate if very rapid)
- Surface waves with a gentle, rolling motion-arrive later

2. Shake Table



Materials:
Outer cardboard box, inner cardboard box, string or twine, paper clips (4 large size, 4 butterfly), rubberbands (4 heavy size) ruler, scissors, 3 washers, rocks /weights for base box

Procedure:
`1. Cut small holes in the base of both boxes and run a string through the holes. Tie a washer to the end of the string in the inner box to hold in place.
2. Repeat step 1 for 2 of the 4 sides of the boxes.
3. Cut 2 holes in 2 sides of the inner and outer boxes. Thread the rubber bands through inner and outer box holes and secure with paperclips and butterfly clips (see diagram).
4. The movement of the shaker board is done by pulling on the kite string from each end and underneath the box. The rubber bands also help simulate movement and shaking.

[1] Adapted from the MCEER shake table suggestions for educators: http://mceer.buffalo.edu/education/k-12/exercises/shtable.asp