

Earthquake Building/Shaking Contest

Lesson Concept	Damage from an earthquake is dependent on local geology, the magnitude of the earthquake and building construction.
Link	The previous lessons established a variety of scales used to measure intensity or location of earthquakes. Lesson 6.11 explores how damage to structures is dependent on magnitude, geology and the building construction. Building construction is one variable that can be controlled by personal action. 6.12 establishes actions one can take to prepare “kits” of supplies for an earthquake.
Time	170 minutes (3 days see lesson for suggested break points)
Materials	<p><u>Whole class</u></p> <p>Computer lab – class set of computers or computer screen projected for the whole class.</p> <p>Three different sized washers</p> <p>Shake board/table (directions to make shake table are included in Purdue’s Earthquake Shaking—Building Contest...download (http://web.ics.purdue.edu/~braile/edumod/building/building.htm))</p> <p>Videos:</p> <ul style="list-style-type: none">• V1 (Resonance 1 - spag) - http://www.iris.edu/hq/files/programs/education_and_outreach/seismographs_in_schools/docs/14A.Resonance1_Spaghetti.mov• V2 (Resonance 2 – Manilla) http://www.iris.edu/hq/files/programs/education_and_outreach/seismographs_in_schools/docs/14B.Resonance2_ManillaPaper.mov• V3 (Resonance 3 – dowell) http://www.iris.edu/hq/files/programs/education_and_outreach/aotm/videos/Resonance3_BOSSmodel.mov• V4 (Building Strength Demo) http://www.iris.edu/hq/files/programs/education_and_outreach/seismographs_in_schools/docs/13_Building_Strength_Demo_Butler.mov <p><u>Per Group (groups of 2)</u></p> <p>4 – 8 x 8 cm Square (floors & roof)</p>

12 – 2 x 10 cm Strips (uprights)
12 – 1½ x 15 cm Strips (reinforcing)
1 – 30 x 8 cm Piece (cut and use as you wish)
100 cm Length of scotch tape (plan accordingly...this is all they get!)
Scissors
30 cm Ruler

Individual

H1 Earthquake-Resistant Structure worksheet
H2a-b Earthquake Building – Shaking handout)
3 Pieces of spaghetti per student (have students break them into three different sizes, small, medium, and tall)
6 Raisins each

Advance Preparation

1. Download Purdue's Earthquake Shaking—Building Contest... (<http://web.ics.purdue.edu/~braile/edumod/building/building.htm>)
2. Construct shake table
3. Download video list above
4. Cut paper lengths for building structures (use H3 (Earthquake Tag Board Image) template to save time when preparing the materials)
5. Gather spaghetti and raisins
6. View all videos
7. Locate internet or newspaper pictures of damage to buildings for the powerpoint in step 11.

Procedure:

Engage *(Day 1 - 30 minutes) Damage from an earthquake is dependent on local geology, the magnitude of the earthquake, and building construction.*

1. Ask students to think, pair, share why they think some buildings collapse in earthquakes and other buildings stay standing or have little damage? Share ideas.
2. Explain to students that they will be working with a partner to design and build their own earthquake resistant structures, but before they do, they will learn about the components for building an earthquake resistant structure.
3. Show students V1 (Resonance 1 - spag) "Modeling Resonance and Building" video.

4. Distribute 3 pieces of spaghetti and 6 raisins to each student. Ask students create their own model, break 3 pieces spaghetti into 3 sizes (small, medium and tall) and top each piece with 2 raisins, replicating the model in the video.
5. Instruct students to hold the pieces of spaghetti in one hand and hit them hard towards the bottom. Explain that this is an example of a local earthquake and point out how all the pieces shake.
6. Ask students shake model as follows:
 - a. Shake at a low frequency and ask students what did they notice? Which piece of spaghetti shook the most? (the tallest piece of spaghetti)
 - b. Shake at a medium frequency and ask students what did they notice? Which piece of spaghetti shook the most? (the middle piece of spaghetti)
 - c. Shake at a high frequency and ask students what did they notice? Which piece of spaghetti shook the most? (the smallest piece of spaghetti).
 - d. Show students V2 (Resonance 2 - Manilla) and V3 (Resonance 3 – dowell).
7. Ask students to think-pair-share how the Spaghetti model compares to the manilla folder model and the dowell model.
8. Ask students: How could these models help you predict what would happen to buildings of different sizes during an earthquake?
9. Ask students to discuss: What could help us prevent the destruction of buildings during an earthquake? Chart ideas

Explore ***(Day 1 - 20 minutes) Damage from an earthquake is dependent on local geology, the magnitude of the earthquake, and building construction.***

10. Show students V4 (Building Strength Demo).
11. Show students “Earthquake Building Structure” powerpoint and/or real life examples in “Earthquake Damage” powerpoint.

<p><i>Teacher Note: The powerpoint pictures can be gathered from newspapers or internet.</i></p>
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12. Distribute **H1 (Earthquake-Resistant Structure worksheet)**. Ask students to work with a partner to sketch a design for your earthquake resistant building. Include ideas you have learned from the powerpoint and videos.

Explain ***(Day 1 - 10 minutes) Damage from an earthquake is dependent on local geology, the magnitude of the earthquake, and building construction.***

13. Instruct students to answer the questions at the bottom of the handout using the wordbank provided. *Why do you think your building will uphold the shaking of an earthquake? Explain using the scientific vocabulary provided in the word bank.*

Extend ***(Day 2 - 50 minutes) Damage from an earthquake is dependent on local geology, the magnitude of the earthquake, and building construction.***

14. Distribute **H2a & b (Earthquake Building – Shaking worksheet)** and review the materials and the post the building criteria.

Building Criteria:

- At least 30 cm high
- at least 3 stories high
- no central post or uprights (leave center of each floor open for weights)
- materials are limited
- building must be completed the 2nd day, and tested the 3rd day

15. Ask students to review their structure design from the previous day.
16. Distribute paper materials, tape, scissors, and ruler to each group of students. Ask students to build their structures based on the rules/criteria for the competition

Evaluate ***(Day 3 - 50 minutes) Damage from an earthquake is dependent on local geology, the magnitude of the earthquake, and building construction.***

17. Ask students to select an order in which team structures will be tested for resistance. List the order on a chart.

Teacher Notes:

If students did not follow rules, they are disqualified and structure will not be shaken.

Depending on size of shake table more than one building can be tested at a time.

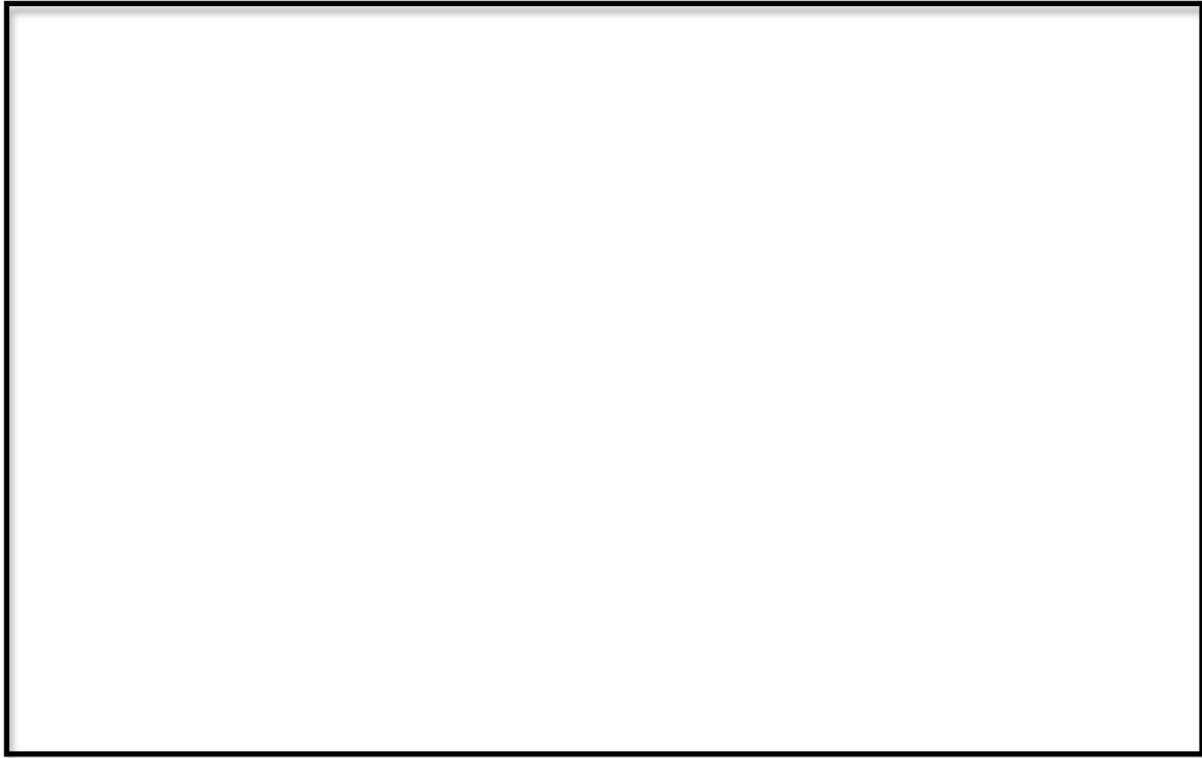
Be consistent with washer placement and shake time for each group.

If the building breaks, students are disqualified!

18. Have selected students/teams bring up their structures and tape the bases to the shake table.
19. Tape the smallest washer to the floor or the roof of the structure and shake for approximately 10-20 seconds.
20. Ask students to record their results after each shake.
21. Repeat steps 18-20 for each group of students/team.
22. Once all structures have been tested, have students answer questions at the bottom of H2b individually.

Earthquake-Resistant Structures

Directions: Sketch a version of your earthquake-resistant building. Then explain why you think that your building will uphold the shaking using scientific vocabulary in the word bank provided.



Word bank				
Shear walls	Base Isolator	Seismic Waves	P-waves	S-waves
Earthquake	Engineers	Force	Foundation	Cross-bracing

Why do you think your building will uphold the shaking of an earthquake? Explain using the scientific vocabulary provided in the word bank.

Name _____

Partner name _____

EARTHQUAKE BUILDING - SHAKING!

We will explore earthquake hazards and damage to buildings by constructing a model building and subjecting the buildings to ground vibrations (shaking similar to earthquake vibrations) on a small shake table. Buildings will be constructed by 2 person teams and then tested to see which designs and constructions are successful. View actual buildings damaged in an earthquake to formulate structure needs.

Materials:

- 4 – 8 x 8 cm squares (floors & roof)
- 12 – 2 x 10 cm strips (uprights)
- 12 – 1½ x 15 cm strips (reinforcing)
- 1 – 30 x 8 cm piece (cut and use as you wish)
- 100 cm length of scotch tape (plan accordingly... this is all you get!)
- scissors and 30 cm ruler

Rules:

Building must be at least:

- 30 cm high
- at least 3 stories high
- no central post or uprights (leave center of each floor open for weights)
- Materials are limited (realistic)
- Building must be completed 1st day, and tested 2nd day

Test results: Describe how your building moved for each weight.

1st test: (weight #1 _____) _____

2nd test: (weight #2 _____) _____

3rd test: (weight #3 _____) _____

After all buildings have been tested:

Describe features you noticed in structures that **were successful** in staying upright and together _____

Describe features you noticed in structures that **were not successful** in staying upright and together _____

Describe strengths and weakness in your building design. Use a drawing to point out parts and discuss them.