Earth Science 3rd Quarter Project: Earthquake-proof Buildings

Activity suggested by Natasha Hazell

This project will require you to use your imagination and ordinary objects to design and build model house that can withstand earthquakes of various intensities.

Seismic tests will be held on the project due date.

The Setup:

You are an engineer working for development team at "1% Inspiration Labs". Your company is sponsoring a contest to see which team or individual can build a model house that can withstand earthquakes of various intensities.

** To make the contest fair the following rules must be followed:

1. The dimensions (length, width and height of your model house must be greater than or equal to 6 inches and less than or equal 1.5 feet.
2. Your house must have a foundation or a flat base.
3. Your house must be an enclosed structure.
4. The weight of your house (including objects inside of it) cannot be greater than 3 pounds.

Project Phases:

1. ***Read through this handout carefully***: Take notes as you read and pay attention to the hints and guidelines given. Begin to plan your project as you read.

2. ***Think about how you can use your knowledge of seismology in your design:*** Think about the measurements and observations you will have to make and plan how you will do it. Be sure to consider any possible safety issues. Do background research on earthquakes and earthquake engineering. The following websites are good *starting points*:

   The USGS Earthquake Education Site: http://education.usgs.gov/common/secondary.htm#earthquakes

   Ask-A-Geologist: http://walrus.wr.usgs.gov/ask-a-geologist/

   MCEER—Multidisciplinary Center for Earthquake Engineering Research: Frequently asked questions: http://mceer.buffalo.edu/infoservice/Reference_Services/faqs.asp

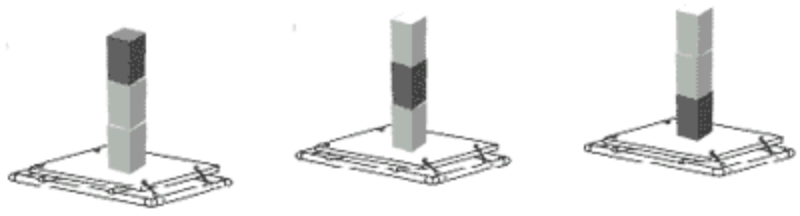
   Earthquake Engineering Research, University of California, Berkeley http://www.eerc.berkeley.edu/

   National Earthquake Information Service for Earthquake Engineering http://nisee.berkeley.edu/

3. There are four factors that should be considered when designing a durable structure:

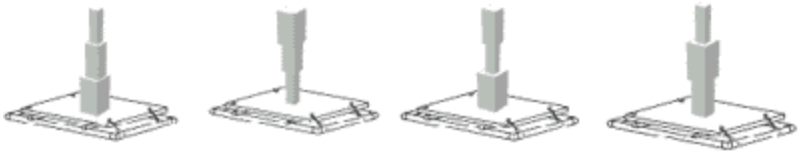
   - Factor 1: Distribution of weight

     How does the distribution of weight within a structure affect its stability during an earthquake? The darker block is heavier than the other two- which design will be more stable? Why?



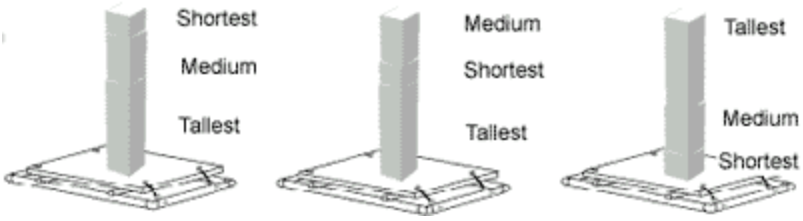
   - Factor 2: Variation in shape

     How does variation in shape and placement of objects within a structure affect its stability during an earthquake? Predict which structure has the best chance of withstanding an earthquake and explain why.



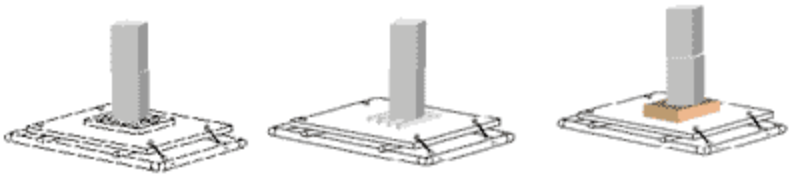
- Factor 3: Variation in height

  How does the variation in the height of each structural element and its placement affect the structure's stability during an earthquake? Predict which structure has the best chance of withstanding an earthquake and explain why.



- Factor 4: Variation in foundation material

  How does variation in foundation material affect the stability of a structure during an earthquake? Predict which structure has the best chance of withstanding an earthquake and explain why.



ball bearings in a shallow box	short wooden dowels	large sponge

4. ***Design your house-*** Detailed drawings/ diagrams must be made of your design before you begin construction! A preliminary list of building materials and design drawings must be approved before you begin construction-

5. ***Collect the materials you will need*** – most of the materials you will use are household items. Some suggested materials include, but are not limited to: corrugated cardboard, wooden dowels, foam poster board, pipe cleaners, wire hangers, bamboo skewers, drinking straws, popsicle sticks, balsa wood etc…

6. ***Build your house***- keep a journal of the progress of your project each time you work on your model. Journal entries need to be submitted with your completed report. For example, a journal entry might read:

   Collected bamboo skewers for frame of house and foam board for the walls. Using super glue, built frame and foundation for house." A diagram or photo of your project in this phase can be included with the journal entry.

7. **Write the results of your project as a lab report. The following outline describes all of the sections that your *typewritten* report should include:**

Date:
Title: ***Earthquake Proof House***
Inventor(s): *Your Name and Your Partner's Name Here*

Photo of your Model House

Background Information: *Has anyone been able to design an earthquake proof building? How do engineers design bridges, buildings, etc in earthquake prone areas? How are older buildings retrofitted to protect them during earthquakes? What area of science is your invention related to? Be specific!*

Drawings and Diagrams: *Diagrams, blueprints/ floor plans and schematics of your house should be placed here – be sure to clearly label your diagrams and describe each drawing and any reference numbers used in the diagrams.*

Description of Model: *Describe your model house & how it was constructed, including the materials used.*

Operation of Model: *How does it work? Are there any science equations or concepts related to the design of your house? Discuss how you used the four factors that contribute to durability in your design. (See step 3 of Project Phases)*

Discussion Questions*:*
1. Review the four variables that contribute to the durability of a building: distribution of weight, variation in shape, variation in height, and the type of material used for the foundation. Discuss what is needed to create earthquake-proof buildings. For example, what would happen if a building was constructed properly but was built on a sandy foundation? What issues do builders face when constructing very tall buildings?

2. There have been many severe earthquakes in the 20th century. The 1985 earthquake in Mexico City and the earthquake in Kobe, Japan, in the late 1990s are two examples. Research a serious earthquake. What caused the most damage? What strategies could be implemented so that the damage is not as great the next time?

3. Based on what you have learned about earthquake-proof buildings, in what kind of building would you like to be during an earthquake? Describe its features and why you think it would be safe.

4. One of the largest freestanding domed structures on Earth is the Hagia Sophia in Istanbul, Turkey. It has survived all magnitudes of earthquakes for nearly 1,500 years. Using the Internet or library for research, do a structural analysis of the Hagia Sophia. What are some of the theories proposed about why this structure appears to be earthquake proof?

5. Discuss some of the structural features that are being incorporated into modern buildings to help them withstand earthquakes registering on the high end of the Richter and Moment- Magnitude Scales?

6. Below are three different approaches for preparing for future earthquakes. Discuss the value of each approach. Is one better than the others? Would you be more likely to invest in one approach over the others? Or do you think that all three should be implemented simultaneously? Give evidence to support your ideas.

-Support and encourage engineers to design better buildings that have a greater chance of withstanding an earthquake.

-Support and encourage engineers and scientists to learn more about earthquakes, enabling them to better predict when they will take place. This increased knowledge will help people be more prepared when the earthquake does hit.

-Support public information campaigns that educate people about the safest places to build homes and discourage them from building in areas at the greatest risk for earthquakes.

Bibliography *All sources used for information must be documented using the MLA style. Check* **http://www.liu.edu/cwis/cwp/library/workshop/citmla.htm** *for a guide on how to cite different sources*

Appendix*: Attach Journal Entries to the end of your report.*

*****Remember to keep detailed notes as you build your project- this will make your report easier to write!**