Classroom Teacher Preparation

Engineering 7: Earthquake-Resistant Buildings

Please use the following to prepare for the next SfS lesson.

Description:

This module focuses on model testing of various earthquake-resistant designs. Students will build different block configurations and test them using shake tables to determine which model provides the best protection in a simulated earthquake. Students will then identify benefits and drawbacks of our models.

Lesson Objectives – SWBAT ("Students Will Be Able To…"):

3rd-8th

- Explain the benefits of using models in the design process
- Test how different designs affect the stability of a model in a simulated earthquake

Disciplinary Core Idea (DCI)

ETS1 Engineering Design - ETS1.C Optimizing the Design Solution

- (3rd-5th) Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.
- (6th-8th) Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process – that is, some of those characteristics may be incorporated into the new design.

ESS3 Earth and Human Activity – ESS3.B Natural Hazards

- (3rd-5th) A variety of hazards result from natural processes; humans cannot eliminate hazards but can reduce their impacts.

Science & Engineering Practice (SEP)

Constructing Explanations and Designing Solutions

- (3rd-5th) Apply scientific ideas to solve design problems.
- (6th-8th) Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

Crosscutting Concept (CCC)

Structure and Function:

- (3rd-5th) Substructures have shapes and parts that serve functions.
- (6th-8th) Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Preparation:

The knowledge of the eight steps of the Engineering Design Process (covered in some of our related Engineering modules) can be helpful but is not required. The lesson can also be taught as an introduction to testing using models.

Room Set Up for Activities:

This activity is station-based. There are 3 different stations at which students will test structures made of different block arrangements for their stability when subjected to shaking. There are two sets of each station, so students will need to be put into six groups to maximize the efficiency of moving from station to station.

Safety:

There are no safety concerns with this lesson.

Related Modules:

This lesson may be taught as part of a sequence or group of related modules on **Engineering** or **Earth Science**, particularly Earthquakes. Other modules in this sequence include:

Engineering 3: (Re)-Building a Bridge – Students design, build, and test prototype bridges that can transport a defined number of people, modeled by weights. During testing, they identify the failure points of their models and use these data to improve their designs, rebuild, and retest.

Engineering 4: Engineering Redesign w/ Legos – Focuses on the redesign step of the Engineering and Design process. Students must redesign a flawed prototype based on certain constraints (i.e., redesign and rebuild a Lego bookcase in order to easily transport it from classroom to classroom).

Earth Science 2: Introduction to Tectonics – Students review how tectonic plates move and model plate movement w with sponge models.

For other module sequences and groups, look here: www.sciencefromscientists.org/sequences

Standards Covered:

Please click the following link to our website to review the standards covered by this lesson, listed by state: www.sciencefromscientists.org/standards/

Lessons are matched to both national NGSS and local state standards.

After Our Visit:

Extend this lesson by building a continuous structure with marshmallows and toothpicks, and then perform similar shake table tests as in class.

Access this Extension activity by visiting the Classroom Post found on our website at sciencefromscientists.org/cohorts. Use the name of your school/cohort and password to log in.

To help Evaluate, check out our Open Response questions online at sciencefromscientists.org/open-response-questions. They are freely available for all of our lessons for current teachers. Use the password supplied by your instructor to log in.

Additional Resources:

- 5 tips to building an earthquake-resistant structure: https://safetymanagement.eku.edu/resources/articles/5-tips-to-building-an-earthquake-resistant-structure/
- More detailed explanation on how earthquake-resistant buildings work: https://science.howstuffworks.com/engineering/structural/earthquake-resistant-buildings.htm
- NOVA special on Hagia Sophia: http://mass.pbslearningmedia.org/resource/nvhs-sci-hagiasophia/nova-building-wonders-hagia-sophia-modeling-for-earthquakes-at-hagia-sophia/
- Liquefaction demonstration (1:13): https://www.youtube.com/watch?v=cONq231dn6w
- Top 5 earthquake-resistant structures from around the world: https://interestingengineering.com/top-5-earthquake-resistant-structures-around-world
- Simulating earthquakes with a shaking table (4:59): https://www.youtube.com/watch?v=7hoSqazNmfY