Earthquake Damage | Grade 5 – Forces acting on structures and mechanisms

Lesson Plan

Cross Curricular	N/A
Safety Notes	N/A

Big Ideas

Structures and mechanisms throughout our environment have forces that act on and within them.

Forces that result from natural phenomena have an effect on society and the environment.

Specific Expectations

1.1 analyse the effects of forces from natural phenomena on the natural and built environment.
2.3 use scientific inquiry/research skills to investigate how structures are built to withstand forces.
2.5 use appropriate science and technology vocabulary, including tension, compression, torque, system, and load, in oral and written communication.
3.1 identify internal forces acting on a structure and describe their effects on the structure.
3.2 identify external forces acting on a structure.
3.4 describe forces resulting from natural phenomena that can have severe consequences for structures in the environment.

Description

Students build a structure and do experiments to study the forces created internally when the structure experiences an earth quake. They also compare different shock absorbers as ways to reduce the impact of external forces on the structures.

Materials

Per student or group:

- Two pieces of cardboard
- 4 compression springs
- Building blocks or other things that can be stacked. E.g. Jenga blocks work well.
- Sponge
- Masking tape
- Ruler
- Play dough

Accommodations/Modifications

N/A

Introduction

Today we are looking at how we can protect a building from earth quake damage. Let's discuss a few things first.

- What is an earthquake?
- Are some earthquakes stronger than others (yes)
- Have you ever experienced an earthquake? (let that lead into discussion of earthquakes being more common in some parts of the world)
- The ground could shake back and forth or up or down.
- Buildings have to be protected from earthquakes. Let's see why!

Action

Distribute a few building blocks to every student. Also distribute a piece of cardboard.

Impact of Earthquakes (no protection)

Vertical shaking

- Build a small structure but this time place bits of playdough between each level (see example below).
    - Have one student place a hand on top of the building.
    - Have a second student shake the platform up and down
    - Discuss: what happened to the play dough? (It got compressed – note by how much). There are forces acting WITHIN the building. Otherwise play dough would not be deformed.

Horizontal shaking

- Build another small structure on the cardboard. (Could be as little as two stacked building blocks, no play dough this time)
- Shake the cardboard back and forth. Try it several times at several speeds (frequencies) and amplitudes.
    - Discuss: what happens? Building tumbles down or gets crooked. Depending on the speed of the shaking and how strong it is the building collapses sooner or later. External forces create forces WITHIN the building.
    - This is vertical movement. Now let's see what happens with vertical movement.

Protecting Buildings from Earthquakes

If you wish have students do these next experiments on their own using the attached worksheet. Or you can do it as a class with the instructions below:

If you did the lesson "Absorbing shock" you can start by using the shock absorber the students built in that lesson. If you don't have that use a sponge for this part:

Vertical shaking

- Build the same structure as above (with play dough between each level) but ON the shock absorbing platform or on a piece of sponge or foam.
- Repeat experiment of shaking up and down.
- Discuss: How has the impact changed? Is the play dough compressed as much (should be less)? Why? (External force is absorbed by the material as it compresses)

Building a Base isolation

Discuss how we could reduce the impact of horizontal shaking on a building. One way would be to allow the building to slide back and forth as the ground moves underneath it. This is called base isolation (see PowerPoint for examples). Let's build a base isolator to test (reference image below gives guidance):

- Tape four springs to the corners of one piece of cardboard. Then place the second piece of cardboard on top and also tape the corners to the springs.
    - NOTE: You can reuse the shock absorbing platform if you built one. Basically remove the skewers and then re-attach the springs using tape.

Horizontal shaking

- Build a small structure on the top cardboard.
- Now shake the BOTTTOM cardboard as you did earlier when no protection was present.
- Is the building affected as before? (if unsure, simply shake the top cardboard and see what happens)
- You should notice that depending on the frequency and amplitude of the shaking the building may stay almost perfectly at rest and won't collapse.
- By putting the springs between the ground and the base of the building you now allow the building to stay in place even as the ground moves. This is really being done for tall buildings – see examples in PowerPoint.

Consolidation/Extension

Look at some videos of buildings in earth quakes and the PowerPoint with examples of how buildings are protected from earthquakes.

Discuss how these natural forces affect buildings and lead to forces within them. Humans have to come up with technology to reduce the impact of these forces.

Additional Resources

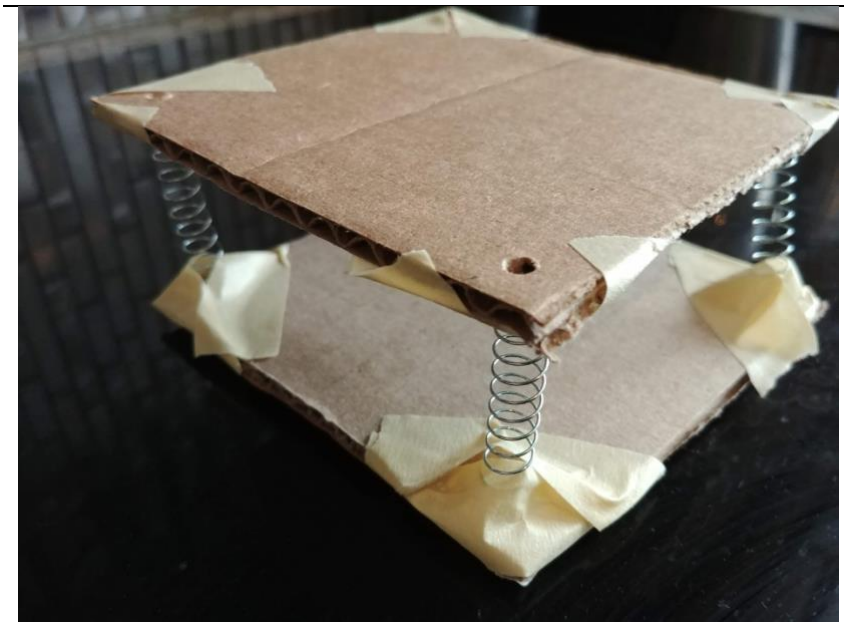
Videos

Earth quake testing, quite similar to this lesson but on a larger scale:
https://www.youtube.com/watch?v=d9qRjBh4hQA

High rises in Japan swaying after an earthquake:
https://www.youtube.com/watch?v=7Zw-BvKo0pI

Photos

Structure with play dough between levels



Base isolation model for experiments