SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Earthquakes Part 3 **Grade 5 – Forces Acting on Structures and Mechanisms**

Lesson Plan

Assessment	AFL, earthquake simulation
Cross-curricular	

Big Ideas

- Structures and mechanisms throughout our environment have forces that act on and within them.
- We can measure forces in order to determine how they affect structures and mechanisms. This information can be used to guide the design of new structures and mechanisms.

Learning Goals

- Develop inquiry-based understanding of how different structures behave in an earthquake.

Specific Expectations:

1.1 analyse the effects of forces from natural phenomena (e.g. earthquakes) on the natural and built environment
2.1 follow established safety procedures for working with tools and materials
2.3 use scientific inquiry/research skills to investigate how structures are built to withstand forces
2.4 use technological problem-solving skills to design, build, and test a frame structure that will withstand the application of an external force or a mechanical system that performs a specific function
3.4 describe forces resulting from natural phenomena that can have severe consequences for structures in the environment, and identify structural features that help overcome some of these forces

Description:

This is the **third** lesson out of a five-lesson unit on the forces of earthquakes. In this lesson students get to build an earthquake simulator and then test some structures they build on it.

Materials/Resources:

Poster paper (one for each group)
Elastics
Wooden building blocks
Masking tape

Safety Notes

Introduction

Explanation of activity

- Today you get a chance to build structures and test them in an "earthquake" that you create!
- We know that an earthquake creates a force on a structure. Now we want to see how that force affects the structure.
- You should work in small groups of 2 or 3 students.
- You will build a "simulator" – some sort of a platform that you can then place the structure that you will build on it, and then shake it.
- You will then use building blocks to build structures to test.
- Your task is to find out what types of structures survive earthquakes better and which ones do worse.

Action

Building the earthquake simulator

- The first step is to build your earthquake simulator. We are proposing two, the second one being slightly more involved to build but will potentially also yield more realistic shaking. Options:
    1. Shaking a piece of poster paper. Cut out a square about 20 cm on a side and bend up one edge enough so that you can hold on to it. You can build a structure on it and then shake it by hand.
    2. Using elastics and a chair. Tape elastics to opposite sides or corners of a piece of poster paper. Loop the elastics around the legs of a chair, so that they are nice and tight. You can now pull on the piece of poster paper and let it go to create a vibrating platform. Make sure you used enough tape that it won't rip off when you pull on the paper! To use this simulator you will pull the platform back and then release it, creating decaying oscillations. (see reference image below)
- Place a ruler along the edge of the simulator or make several marks a few cm apart. This is so you can tell in the next step how far you are shaking the simulator back and forth.

Building and Testing Structures

- Now it's time to build some structures and see how they do in an earthquake. Start by building whatever you want – a tower, a wall, arches, etc.
- Tape the BOTTOM most blocks to the poster paper for all of your structures. You want to make sure that the building actually shakes and doesn't just slide back and forth!
- When your structure is complete shake the simulator to see what happens. Rebuild your structure several times and try a few things:
    - Shake back and forth only a short distance (e.g. 1 cm) and compare to shaking back and forth over a much larger distance (e.g. 5 cm).
    - Shake back and forth slowly and compare to shaking back and forth faster.
    - Which scenario creates a greater force? Where is the structure's weak point? What could you do to make it better?
- Now try building a different structure and compare to your first one.
    - For example if you built something that is really hard to destroy, try building something that might not survive as easily.
    - If you build a really unstable structure, come up with a way to make it more stable.
    - Test again under SIMILAR CONDITIONS.

- Take notes on your project page for the day as you go
    - Include sketches of what you built and indicate where it broke.

Consolidation/Extension

Work on unit project:

- Describe how the force of the earthquake affected the structures.
- What internal forces might the building have, making it either more or less stable?
- Think about the compression of the building due to its weight etc.