

Towers and Bridges

Civil Engineering

Objective

This lesson introduces students to Civil Engineering, specifically Structural Engineering. They will create a structure (a bridge or a tower) and test it to learn how they can apply a greater normal force to counter act the weight and gravitational forces that act on their structure.

Standards and Objectives

- 8th Grade Standard 4, Objective 2
- Physics Standard 2, Objective 1

Learning Outcomes

Students will learn:

1. About normal and gravitational forces
2. About math and science principles that govern the way structures are created
3. That structural engineering is based on math and science rather than trial and error
4. That engineers have to test their structures to ensure they are designed based on sound theories
5. How to create a project design with computer software
6. What types of forces are considered when creating a structure

Essential Questions

1. What kind of math would you use as a Structural Engineer?
2. How do you use Google Sketchup?
3. How do you account for the forces that act on buildings?
4. How do engineers use math and science?

Time Required (Itemized)

1. Introduction to forces and structures (15 minutes)
2. Introduction to the activity (15 minutes)
3. Time to work on the project (60 minutes)
4. Time to test the project (40 minutes)

Assessments

The students will be graded on how well their structure holds 93 pounds. They will not receive extra credit for over-engineering their structure because the challenge is to create an economical structure that holds at least the minimum weight (see attached worksheet for guidance).

Materials

1. Balsa wood, popsicle sticks, or toothpicks
2. Glue

3. Computers with Google Sketchup (free download)
4. Notebook paper
5. Testing device (sling with 2.5 pound weights or other apparatus)

Lesson Description

Decide whether your students will be building towers, bridges, or either. Determine the minimum and maximum dimensions that will be used for your class.

Review the forces that are acting on your students as they sit in their desks: what is holding us onto the earth's surface? (Gravity.) What is keeping us from falling to the center of the earth? (The floor.) The floor is applying the normal force.

Ask the students if they have ever seen a building fall into a sink hole? Why does that happen? (Voids in the surface.) How do we get rid of voids? (Have they ever seen heavy machines that compact the soil? That's what gets rid of them.)

Towers: Structural engineers have to consider the weight of buildings as well as the weight that will be applied to the interior structure (thousands of people on the inside that add additional forces).

Bridges: Structural engineers have to consider the traffic that will cross the bridges they design—trains, buses, hundreds of cars at once, etc.

Ask the students what structural components have they seen that make structures stronger (trusses, joints, etc.) Explain that these are all based on science, math, and testing.

Please see “Tower Project” worksheet for instructions for building the towers.

Have students create groups of 2 or 3 as they work to create either a tower or a bridge. Provide class time as necessary for construction.

Testing: to create an inexpensive bridge or tower crusher, use a block of wood that will sit on the structure, hooks that are distributed across the length of the block, and a sling that will be used to add weight to the structure (see picture).

Add 2.5 pounds to the sling (up to 93 pounds), until either the structure passes the test, or fails.

Have students make observations about structural components that caused success or failure in the design. Discuss these with the class.