

## Civil Engineering

**CONTENT STANDARD:** Physical Science

**CONTENT TOPIC:** Civil Engineering

**CONCEPT:** Civil engineers build many types of things like bridges, buildings and roads.

**CONTENT OBJECTIVE:** To understand what a civil engineer is and what types of work they perform.

**INSTRUCTIONAL OBJECTIVES:** The learner will:

- define engineering and civil engineering
- identify and build a bridge or tower
- gain an understanding of teamwork and participate in a team

**OUTLINE OF CONTENT:**

- I. Engineering is the application of science to solve problems and create useful products (like the iPod, computer or DVD player) and projects (like a tunnel or bridge).
- II. Civil engineers create things like: bridges, dams, roads, water supply, buildings, and city planning.
- III. Engineers typically work in teams with each team member doing different things.
- IV. Students will work as a team to build different projects.

**GOAL:** To enable students to demonstrate ways of thinking and practicing science; and to exhibit an awareness of the historical and cultural contributions to the enterprise of science. Imagination and creativity contribute to the processes of science through ideas and inventions.

**STANDARD(S):** The learner will understand that:

Science is based upon suppositions derived from observations of natural phenomena.

**BENCHMARK:** Unknown or unobserved variables may lead to unanticipated results.

The critical assumptions behind any line of reasoning must be made explicit so that the validity of the position taken can be judged.

**BENCHMARK:** Prior learning must be accurate and free of incorrect assumptions.

**BENCHMARK:** Higher order thinking skills, when directed toward the process of science, may produce unique solutions or results.



**BENCHMARK:** Scientific truths must be supported by data in conjunction with logical evaluations.

## CLASSROOM CONNECTORS

**TIME REQUIRED:** 30 minutes

**MATERIALS:** Marshmallows, raw spaghetti, small weight, tape measure or ruler, paper and science notebooks.

### SET:

(Look around you.) What type of engineers do you think designed and built this school? The next time you are riding around in your car, look at the roads and bridges. Civil engineers designed and built all of these. Each one of these “things” had a team of people called “engineers” that designed and built them. What is an engineer? (See below for definition) Can you name some different types of engineers? (Bio-engineer, Ceramic, Chemical, Civil, Computer, Electrical/Electronic, Mechanical, Industrial, Metallurgical and many others). What type of things do these different engineers design and build?

### INSTRUCTION:

Engineering is an art requiring the judgment necessary to adapt knowledge to practical purposes, the imagination to conceive original solutions to problems, and the ability to predict performance and cost of new devices or process (*Encyclopaedia Britannica*).

**Kinder and 1<sup>st</sup>: Emphasis on: Triangles are stronger than squares. Engineers solve problems and build things. They do this by working in teams.**

***For older students:*** (Discuss different things an electrical engineer might work on.) Since many products made today are designed and built by teams, what different roles do you think engineers perform? Here is an example of a small design team:

1. One roll will be the project manager (PM). The PM’s job is to make sure that the team has all the people needed for the job and creates a plan. The PM then makes sure the team performs that plan.
2. Another role could be in charge of layout of the design.
3. Another role could be the application engineer that builds the design.
4. The last role could be in charge of testing the product.

### Structural Strength:

Which is stronger a triangle or a square? Why do you think so? Triangles may be found in many bridges, and help to make them strong, as we will shortly see. A square can be bent into many different forms (with many different angles), the triangle always keeps the same shape. It is the strongest *polygon* (Shapes that have sides that are all straight lines

are called Polygons). Why is that? The reason is because in the square, all of the angles can change. There is nothing to stop them. However in the triangle, the angles can not change once the triangle is built.. The angles are fixed. This is because a triangle has three sides and three angles, and each angle is fixed by the side opposite to it. Then make the different polygons with four, five, and six sides, and see how the triangle is the only one that can't be adjusted into a different shape once it is made.

Can the square be made stronger by adding triangles? (yes) If you start with a square, you can add a **diagonal** between opposite corners to make it very strong. The word **diagonal** means something that goes between two opposite corners. By adding a diagonal to a square, you actually make two triangles inside of the square. Since each triangle is strong, the new **reinforced** square is stronger as well. The word **reinforced** means to make stronger.

### ACTIVE PARTICIPATION:

Today we are going to act like an engineering team and build a tower. We are going to see who can build the tallest and strongest tower.

**Have the students form into 6 teams of 3 to 4 students in each team. Each team needs to assign a role to each person.**

#### Let's build a tower:

1. Have each team form up and decide on roles (max of 5 minutes)
2. Give each student team some marshmallows and spaghetti.
3. First have each team build a triangle and square. Have them compare the two. Can they make triangles out of the square? (add a diagonal)
4. Have the team come up with a plan to build their design (Max of 5 minutes)
5. Have the team build and test their design. (10 minutes)
6. During the last few minutes have each team present their project. Measure the towers and see how much weight they can hold.

### CLOSURE:

Today we have learned that there are many things that civil engineers design and build.

1. Can you name some things that you might like to build or work on?
2. Is it easier to work on things by yourself or in a team? Why? (a team will be easier because you have help and many experts to rely on)
3. Name some places you may have seen triangles being used in building: (Bridges, buildings, the Geodisk dome at Epcot Center, etc)