BRIDGE UP!
ENGINEERING

LESSON 11 – GRADES 9-12

LESSON 11 – GRADES 9-12: Mastering Materials

Big Idea

Engineers must choose materials that will make a bridge stable, safe and durable.

Essential Questions

Which materials should be selected for the construction of bridges?

What are their properties and how can those properties be tested?

Background Information

The most common materials used for building bridges are steel and concrete. Engineers consider several factors when deciding on bridge designs, including location (cold climates) and the different kinds of loads it will carry – people, cars, trucks, or trains. Engineers also consider the distance the bridge must span.

Standards & Benchmarks

Minnesota Science Standards

9.1.2.1 Addressing Human Need

Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.

Benchmark 9.1.2.1.1 Refinement of Designs

Understand that engineering designs and products are often continually checked and critiqued for alternatives, risks, costs and benefits, so that subsequent designs are refined and improved.

9.2.2.2 Motion

An object's mass and the forces on it affect the motion of an object.

Benchmark 9.2.2.2.3 Action/Reaction

Demonstrate that whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted by the second object back on the first object.

9P.2.2.1 Forces

Forces and inertia determine the motion of objects.

Benchmark 9P.2.2.1.3 Gravity & Motions

Use gravitational force to explain the motion of objects near Earth and in the universe.

9.1.3.3 Society

Science and engineering operate in the context of society and both influence and are influenced by this context.

Benchmark 9.1.3.3.2 Persuasive Communications
Communicate, justify and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual or written means.

9.1.2.2 Practice of Engineering
Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.

Benchmark 9.1.2.2.2 Using Models in Designing
Develop possible solutions to an engineering problem and evaluate them using conceptual, physical and mathematical models to determine the extent to which the solutions meet the design specifications.

Activity Description

This activity will help students understand some of the processes that can be used to test materials. This activity will demonstrate shear force testing of some materials used to simulate members of a truss.

Vocabulary

Shear force – Force acting on a substance in a direction perpendicular to the extension of the substance, such as the pressure of air along the front of an airplane wing.

Compression – A pushing force usually shortening the object.

Tension – A stretching or pulling force usually lengthens an object.

Materials

- Spring scale
- Balsa wood (various thicknesses)
- Glue
- Spaghetti
- Other materials for snapping

Preparation

Laminate some of the samples with glue so that the thickness of the material is doubled.

Assessment

Student learning can be gauged by the accuracy of their data recording and how well their explanations reflect an understanding of forces they are applying to the materials in the activity.

Extensions

Use small snack cups, Portland cement, sand, small gravel, and water to conduct slump tests. Record data to find which combination of materials produce an adequate slump test for concrete.

Other Resources

How Bridges Work; Additional Bridge Forces: Torsion and Shear
http://science.howstuffworks.com/engineering/civil/bridge9.htm

Shear and Torsion on small scale bridge piers
https://www.youtube.com/watch?v=5UPJ3waHtp4

Name: _____
Date: _____
Period: _____

Shear Force Materials Testing Activity:

This activity will help you understand one of the processes used to test materials. Compression, tension and shear force all play a role in the design of a bridge. We will use spring scales to find shear forces required to snap various materials.

Define Shear Force:

Before you begin, you should have a sample of materials, 2 large wooden blocks and a spring scale at your station. The large blocks are your testing station. You will test your materials first at 20 cm separation and then at 10 cm separation of the blocks. Please reuse the materials for as many tests as possible.

Team members: Material tester, data recorder and spring scale observer.

Place the blocks so that they are separated by a distance of 20 cm. Your samples will be placed on top of the blocks. You will hook the spring scale to the sample and then SLOWLY pull down on the spring scale until the sample snaps.

The spring scale observer needs to carefully watch the scale so that they can capture the maximum force used just before the material snaps.

Find the maximum value just before the break and record it below.

Name of Material	20 cm	10 cm

Analysis: (Use complete sentences to answer the questions)

Were the values for double combinations equal to double the force required to break the singles? Explain your answer.

How would you use this data when deciding how to build a bridge?