PLTW Engineering

12/Design Challenge – Road Sign Support Structure

April 30, 2020

12/EDD

Lesson: **4/30/2020**

Objective/Learning Target: Students will be able to apply the design process to design, build, and test a model of a free-standing structure used to support overhead road signs.

Gather supplies needed

Find these or similar supplies to start the challenge:

- thick spaghetti noodles (uncooked) or drinking straws
- glue
- rulers
- file folders
- scissors
- index cards
- newspaper (to cover work space)
- small paper cups
- string
- small weights (marbles or coins)
- fan or hair dryer
- clay or cellophane tape

Prepare materials

Before getting started with the process, prepare these materials:

Cut file folders into 1 cm × 1 cm squares.

Tie string to paper cups so that they can be hung open side up from the final structures.

Define the problem

You will be designing, building, and testing models of the structures that support overhead highway signs.

The problem or challenge at hand is this:

Overhead sign supports often structurally fail, when the wind blows on the sign or when a heavy load is placed on it.

Brainstorm and Research the Problem

Research some structural supports for road signs that are already in place – you can find examples on the internet.

Brainstorm and Research the Problem

As you research and make notes of your findings, consider the following questions:

What factors must be considered before building a sign support? (Possible answers: It must be high enough so that trucks won't hit it; it must be strong; it must be stable)

Where have you seen signs and supports like these?

More Brainstorming questions

What type of sign support structures did you see?

Did they cross the road completely or overhang just part of it?

What do you think keeps them from collapsing or falling over?

What keeps the signs from twisting on their support so that they stay in an upright, readable position?

Explore ideas through sketching

Draw at least 3 pictures of the sign support structures that you want to build.

Be sure to stay within the following design specifications:
road width = 40 cm
maximum truck height = 15 cm
number of signs = 1 large or 2 small

Choose one of your designs for the prototype based on the scale of the design specifications.

Building the prototype

Cover your workspace with newspaper so your prototype doesn’t stick to the tabletop.

The structure should be built by gluing the material to the 1 cm × 1 cm squares.

This allows for easy cross-member attachment. The index cards are to be used as the signs.

Testing the prototype

The first test you should conduct is the wind load test. Tape the structure to a tabletop in a room with the ceiling fan. Turn the ceiling fan on low, medium, and high and make observations based on these questions:

Does the structure blow over or remain standing?

How strong a wind force can it withstand?

Testing the prototype

The next test is the weighted load test. For this test, set up the sign support structure again in the same manner as the wind load test.

Select a location farthest from the structure's vertical support(s) and attach a small paper cup by a string, so that the cup hangs straight down but does not touch the "ground."

Load the cup with weights (marbles or coins), one by one.

Testing the prototype

As you are doing the weighted load test, consider the following questions:

How much weight can the structure hold before collapsing?

Do the sections look as if they are acting in tension and compression, as predicted on your the sketch?

What would you do differently in your next design?

Were some steps in the engineering design process more important than others? Explain.

Reflection questions

What are the steps in the engineering design process?

What did you learn from your test results?

How was your design similar to or different from the designs you found during research?

What would you do next time to make your structure stronger or lighter?

Helpful links

Using triangles to design strong structures

Structural engineering fundamentals