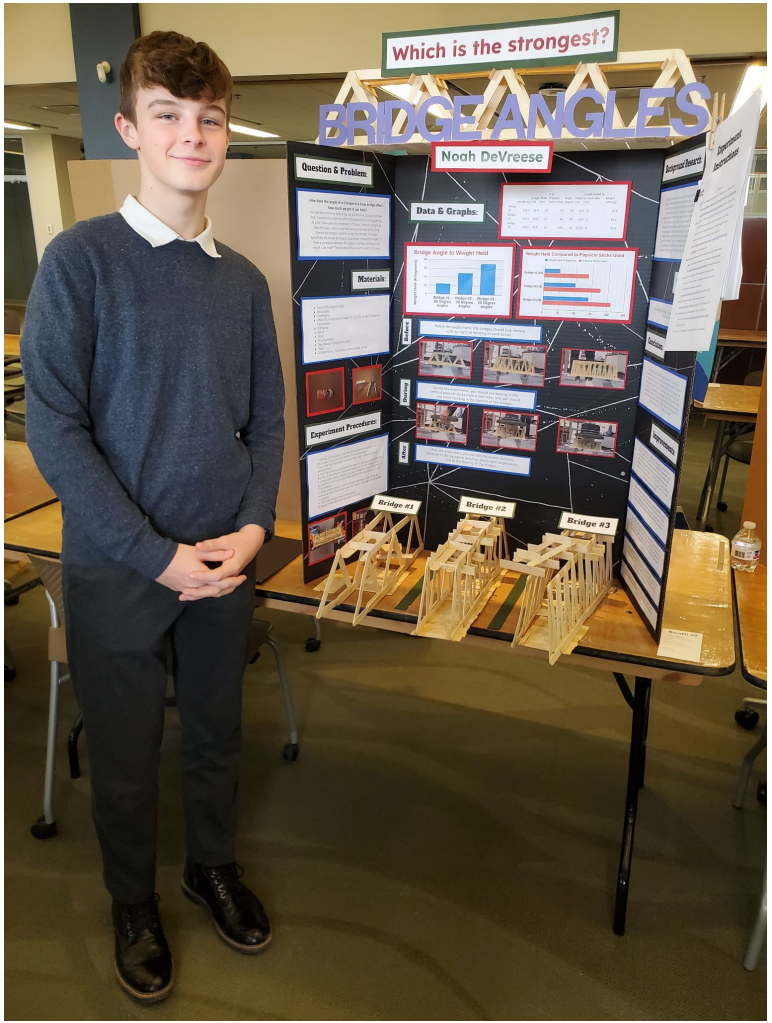
Bridge Angles: Which is the Strongest?



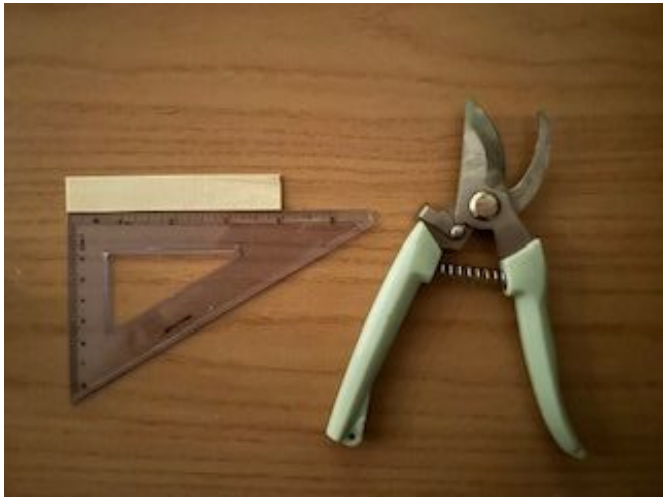
Question and Problem:

How does the angle of a triangle in a truss bridge affect how much weight it can hold?

As inspiration from my love of big city architecture, Chicago and New York, I wanted my project to reflect that passion for civil engineering. As a kid I was especially interested in Chicago's beautiful bridges by Lake Michigan, which would then become the basis of my 2026 Science Fair project. I wanted to test the strength of bridges, specifically the simple but strong truss bridge. I thought to myself, "Is there a correlation between the angle of a bridge, and how much weight it can hold?" That produced the project I would do this year.

Materials:

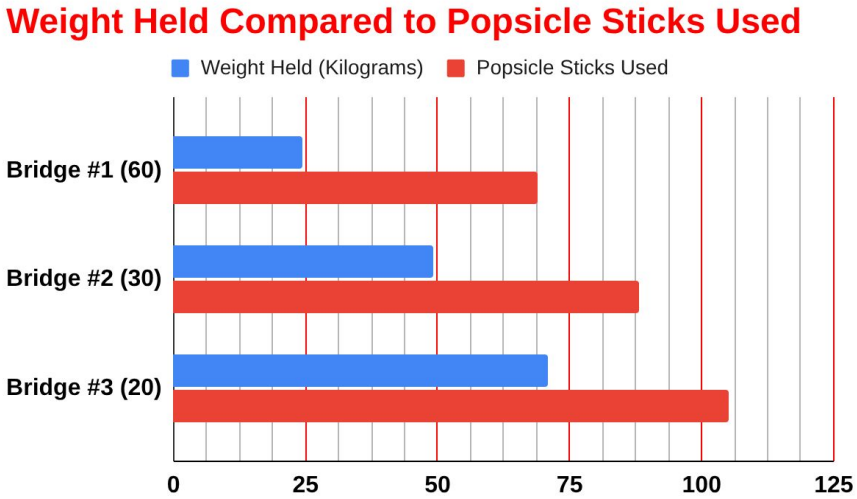
- About 300 popsicle sticks
- Wood Glue
- Clothespins
- About 72.5 kilograms of weight (1, 2.2, 4.5, 11, and 20 kilogram increments)
- Protractor
- Pencil
- Ruler
- Pruning Shears
- Box (About 7 centimeters wide)
- Tape
- 2 Supports (I.e. Textbooks, Gallon Buckets, Bricks)

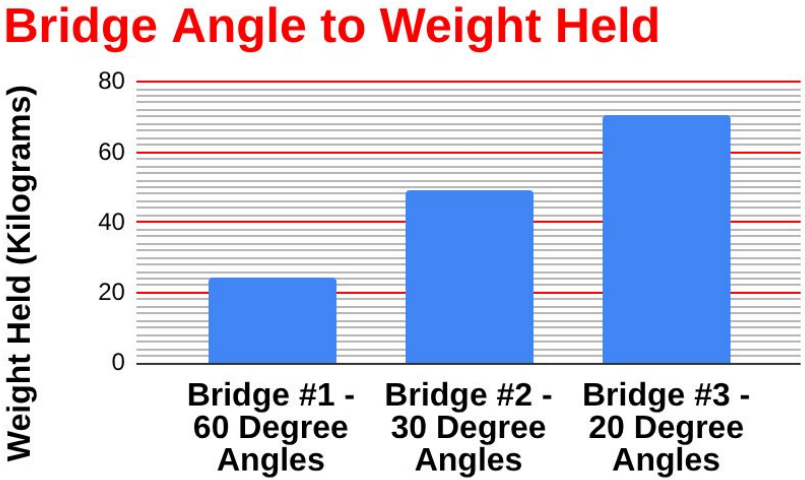


Experiment Procedures:

1. Starting with bridge #1, put the two supports on opposite sides of the bridge, 5 cm onto the bottom of the bridge edge.
Tip: After putting weight on the bridge, wait 10 seconds before adding more.
2. Start by putting a good balancing object on the top of the bridge for the rest of the weights. It shouldn't weigh very much (about ½ a kg).
3. Continue by adding weight in 2.2 kg increments, when it reaches 4.5 kg, switch to a 4.5 kg weight, then continue. Do this with 4.5, 11, and 20 kg weights.
4. While adding weight, look for bowing (bending) in the bridge to determine when the bridge is about to break, then start adding smaller increments.
5. When the bridge breaks, record data.
6. Repeat these steps with bridges #2 and #3.

Data/Graphs:


Weight Held Compared to Popsicle Sticks Used
Weight Held (Kilograms)
Popsicle Sticks Used
Bridge #1 (60)
Bridge #2 (30)
Bridge #3 (20)
0
25
50
75
100
125

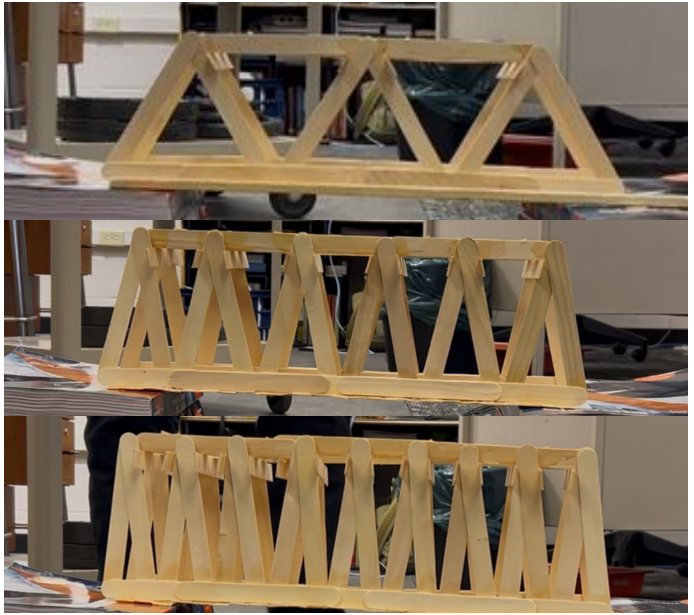

Bridge Angle to Weight Held
Weight Held (Kilograms)
80
60
40
20
0
Bridge #1 - 60 Degree Angles
Bridge #2 - 30 Degree Angles
Bridge #3 - 20 Degree Angles

Background Research:

My background research included using media such as engineering videos, university research, teaching lesson plans, and other sources, which all proved to be helpful in learning about truss bridges. The videos helped build basic concepts and visual support when researching the different bridge types, in the end helping me single out the truss bridge, which is known for its strength. The lesson plans assisted in learning vocabulary, and the university research furthered my knowledge with more advanced topics in geometry. Other sources helped me learn about the claimed "45° sweetspot" which engineers use in truss bridges. Through my research I also learned about tension and compression, both forces that act on how much weight a bridge can hold, and the points of a bridge that are affected by these forces.

Hypothesis:

If the angles of a triangle in a truss bridge are more acute, then the bridge will hold more weight.



Conclusion:

After testing my hypothesis in my experiment, I found that my hypothesis was correct! The angle of a bridge does affect the amount of weight held by the bridge; especially the more acute the angle, the more weight that will be held by the bridge. I came to this conclusion according to my experiment, as the bridge with the 20° angle held the most weight, with the 30° and 60° angles holding less and less weight. In real world applications, when building a truss bridge, the angle of a bridge is stronger when the angles are smaller.

Improvements:

- For future experiments, I would like to pinpoint the variable of the number of popsicle sticks used. To isolate this factor, I want to design bridges that would use the same amount of popsicle sticks, but keep the same angle requirements.
- In order to spread the weight more evenly onto the bridge, I would like to rebuild the bridge and make sure that the top and bottom of the bridge are level, this way the weight would not tip to one side of the bridge during the experiment.
- Lastly, I would like to further test over the summer other forces on bridges like wind, how the resonance of bridges affects the weight held, how far apart the trussels are, and how to get the material count matched with the weight held.