DESIGN PROCESS

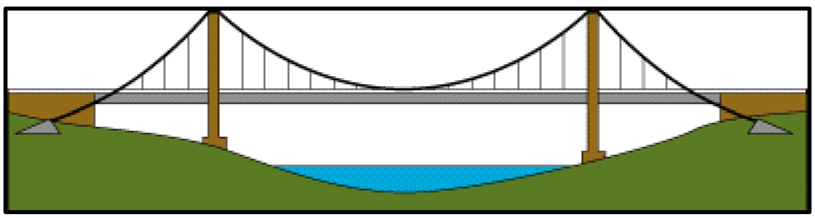
Identify the Need

In this assignment, we were given a bunch of wood. Using the wood, we had to create a bridge that would hold up to 10 kilograms of weight. Along with making a bridge, we even had to make a model of our bridge on Google Sketch Up.

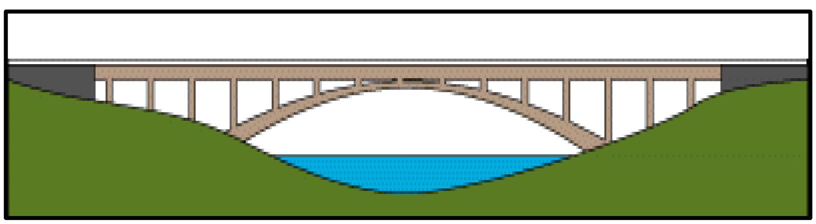
Research and Develop Solutions

There were four types of bridges that we came across:

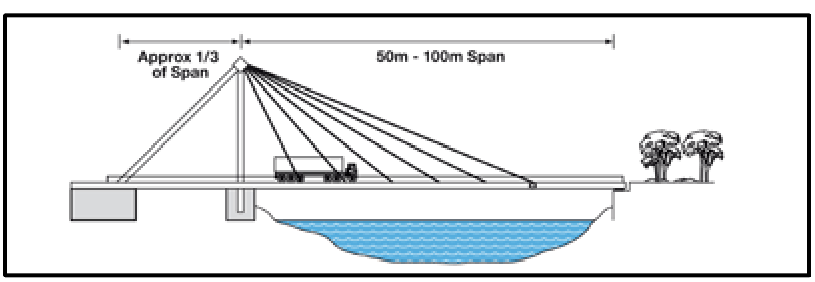
1. **Suspension Bridge:** this is a type of bridge which includes the use of cables in it. The cables are hung between two towers arched in smiling shape. These types of bridges are the longest than any other bridge.



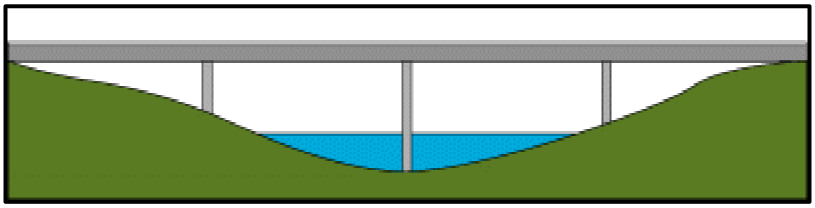
2. **Arch Bridge:** this type of bridge includes the use of wedges and keystones. The bridges have a shape of curve in a frowning shape. These types of bridges can be really wide.



3. **Cable-Stayed Bridge:** this type of bridge might look like a suspension bridge but they aren't the same. Cable-stayed bridge doesn't require the use of two towers. Instead, the cables run from the roadway to a single tower that takes all the weight by itself.



4. **Beam Bridge (also known as Girder Bridge):** this type of bridge is the simplest and most common of all the bridges. It consists of horizontal beams that are supported by 2 vertical piers on each end.



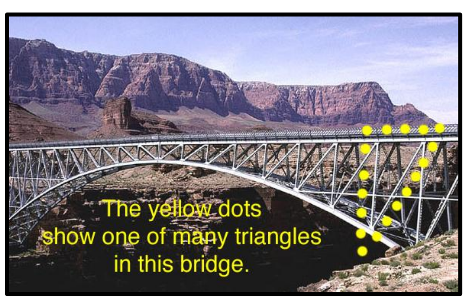
Every shape has special characteristics. So when we build things, we use different shapes depending on what would be best suited for a particular purpose.

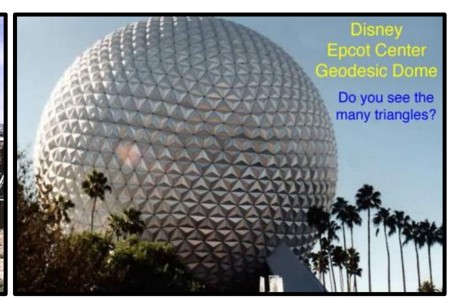
For example, cars use circles for its tires and not a square or triangle because a circle is smooth and turns nicely. While, have sharp edges which wouldn't allow it to move smoothly.

Another example would be of a house or building. To build walls in a house, squares and rectangles are used because they are stable, and they maximize the area.

Similarly, triangles are mainly to be found in **bridges**. Triangles are building designs for many structures because they are capable to bear large loads without deforming.

They help make the structure stronger. Here is some proof of how triangles make a structure strong:

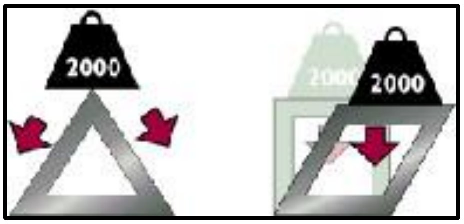




The strongest shapes:

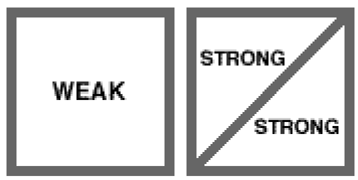
- Triangles
- Squares

If we add weight or press on the side of each shape, we see that the triangle resists but the square collapses. This is because the point where the force is added in a

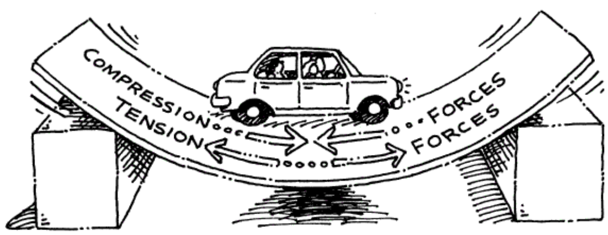


triangle, all the force equally goes sideways to the base on both sides. Which means the force is equally distributed throughout the. While in a square, the force added goes straight to the ground. It has a weak middle.

However, a square can be made stronger by adding triangles in it. A triangle can be made inside a square by a diagonal line between opposite corners. By adding this diagonal line, two triangles are created inside the square which makes it way stronger than a regular square.

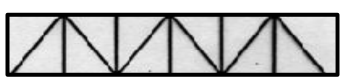


Normally when we think of making bridges, this is what we plan on making:

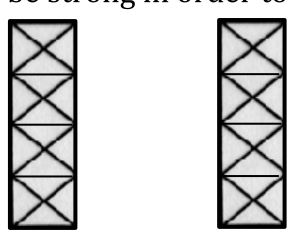


But actually this bridge design is really weak, like we see in the picture. The horizontal bar starts to bend because of the weight being applied in the centre. This design is a good beginner, but we have to go a step further and make it more complex.

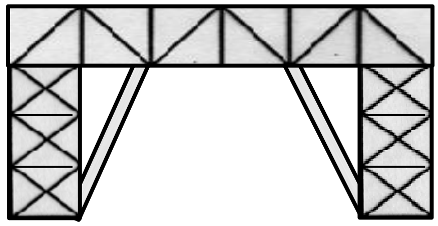
Firstly, adding triangles with vertical bars in the horizontal bar to give it more strength to hold things.



Secondly, distributing the two vertical bars into equal squares, and adding crosses inside them. The pillars have to be strong in order to support the horizontal bar.



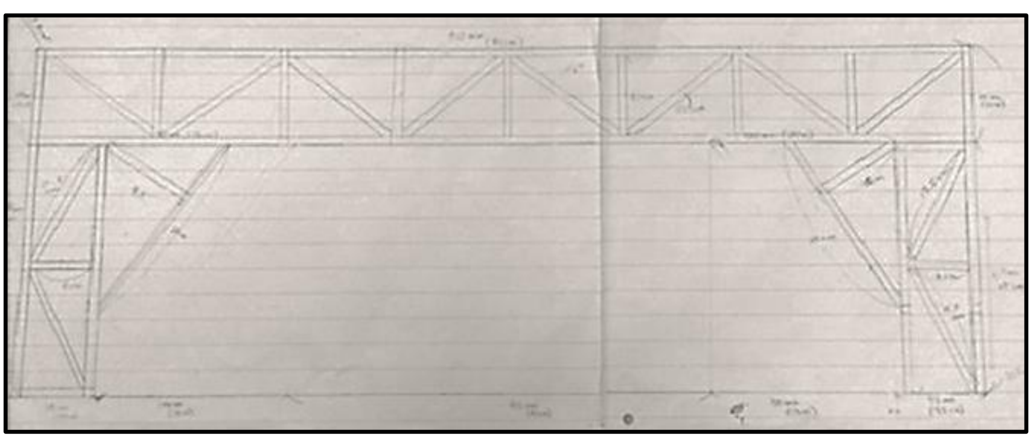
Thirdly, adding supporters that go from each vertical bar to the horizontal bar. These supporters will take a part of the pressure from the thing that is placed on the horizontal bar.



Evaluate Solutions and Select the Best One

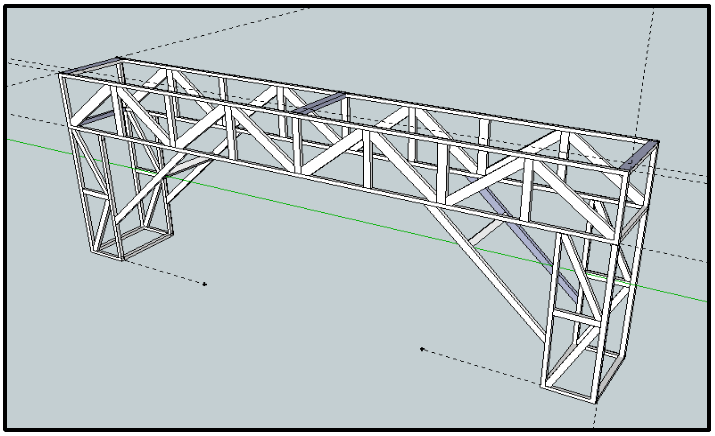
Based on the research, we sketched out a design our bridge. We chose the design of a Beam Bridge for this project, and were inspired by these two bridges.

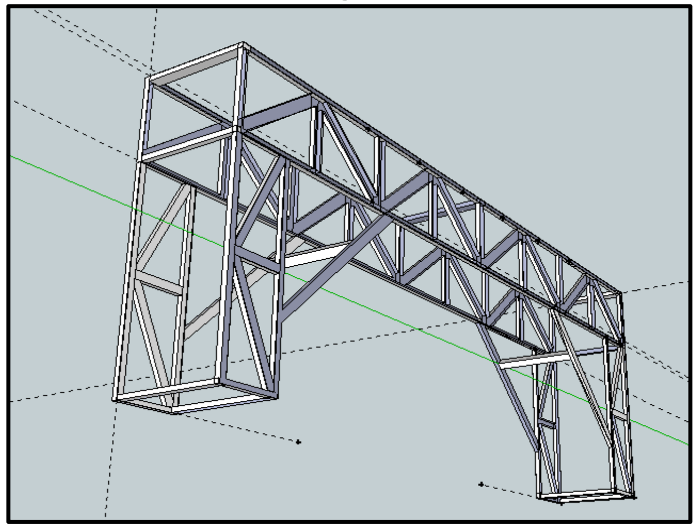
Beam bridges are mostly composed of crosses and triangles, because it is the strongest form of constructing bridges. However while we were sketching out our design with precise measurement, we had to make they wouldn't require more than 15 wood. Unfortunately, while creating the triangles we needed numerous amount of wood, and we didn't have enough woods. So due to lack of wood, we removed truss on some parts of bridge which made our structure a bit weaker. We kept decreasing until we finally got the right amount of measurements according to the woods we had. This was the sketch we finally made:

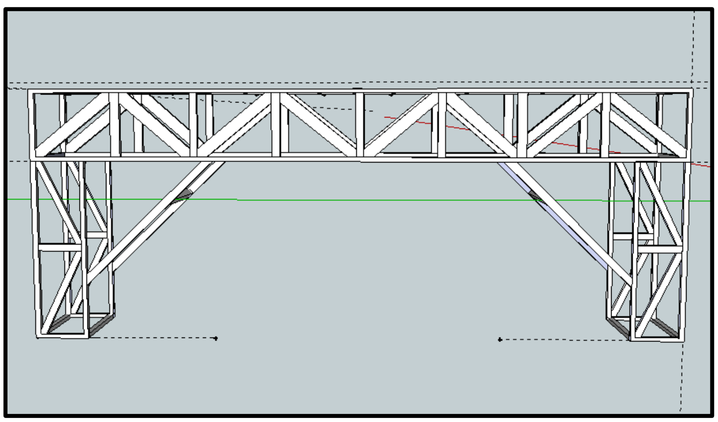


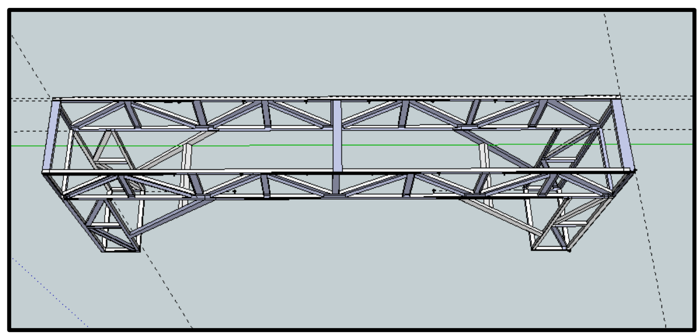
Sketches/Prototypes/Models

Before constructing the actual bridge, we first made a scaled-sketch of our bridge design on paper (with measurements). However, the design only displayed the front part of the bridge. So in order to get a 3D model view of our bridge, we created our bridge on Google Sketch up with the same measurements as our bridge.

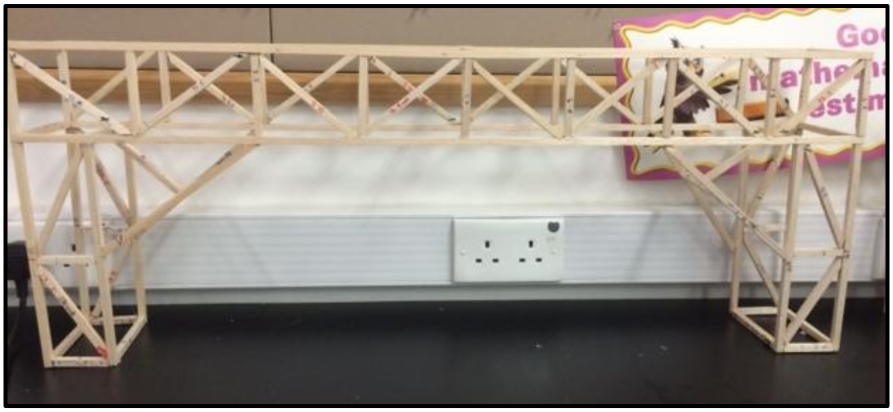


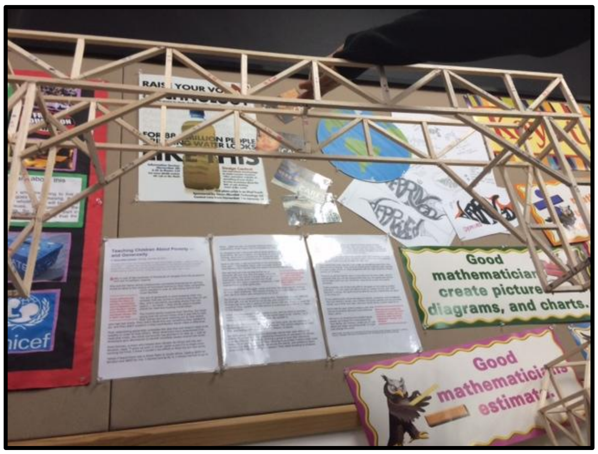






Having these things together, we started constructing the actual bridge with wood. Firstly, we started with the top part of the bridge. We made a rectangle shape that is 91cm long and 8.5 cm wide. Then to make it strong, we added truss in between that were 13.5 cm long. Secondly, we made two pillars on its sides, to support the top part. These pillars were 25 cm long and 6 cm wide. And then to make it strong, we added truss that were 13.5 cm long. Furthermore, we combined these pillars with the top part. In order to get these two strong together, we added supports on both sides that we 20 cm long. Thirdly, for making our bridge 3D, we doubled of what we did above, and got together with 12 cm long wood (the width of the bridge).
So at the end, this is how our bridge looked:



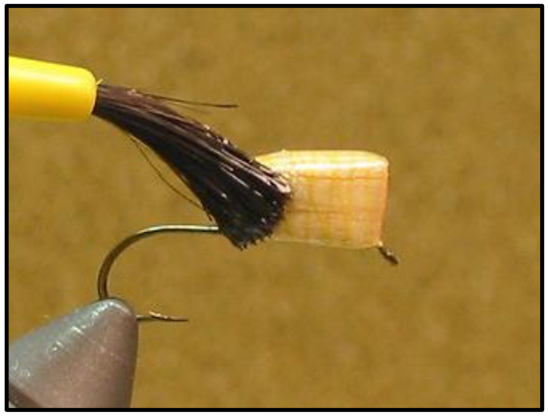


Test Evaluate and Communicate

After we were done, our bridge was ready to test. Our bridge was expected to hold 5 kilograms of weight. The testing started with 1 kg of weight, and then it moved to 3 kg. Finally after our bridge took these weights, we were ready to test 5kg. Fortunately, our bridge took 5 kilograms of weight! So our bridge met the expectations. But just as a challenge, we tried the 10 kg weight. And, as soon as the 10 kg of weight was hung on our bridge, it failed to take the weight. We noticed it was because one of the pillars in the bridge collapsed.

Redesign

If we could make our bridge all over again, there are a lot of things we would change. Firstly, we would make it capable of carrying 10 kg of weight. To do this, we would make our pillars stronger, by adding truss on its sides. Secondly, put more glue between two woods, so that they are tightly bonded together. Finally, the wood we were given was balsa wood, so it was really light, weak and sometimes broken with heavy weight applied on it. Therefore, we would put a coat of nail polish over the wood which would make it stronger.



Bibliography

"Background information for "Structures and Shapes"." *Background information for "Structures and Shapes"*. N.p., n.d. Web. 10 Dec. 2013. <http://www.sciencetech.technomuses.ca/english/schoolzone/Info >.

"Bridges." *Bridges* . Np, ND Web. 12 Dec. 2013. <http://schools.tdsb.on.ca/winona/DTWeb/Bridge.html>.

"Bridge Designing Video Tutorials." *How to design a bridge*. N.p., n.d. Web. 12 Dec. 2013. <http://www.aboutcivil.org/Bridge-designing.html>.

"Building Strong Shapes with Triangles."*Building Strong Shapes with Triangles*. N.p., n.d. Web. 12 Dec. 2013. <http://www.rogersconnection.com/triangles/index.html>.

"How Bridges Work." *HowStuffWorks* . Np, ND Web. 9 Dec. 2013. <http://science.howstuffworks.com/engineering/civil/bridge.htm>.

"Why is the Triangle the Strongest Shape." *Reference.com* . Np, ND Web. 12 Dec. 2013. <http://www.reference.com/motif/science/why-is-the-triangle-the-strongest -shape>.