Bridge 2 Logbook

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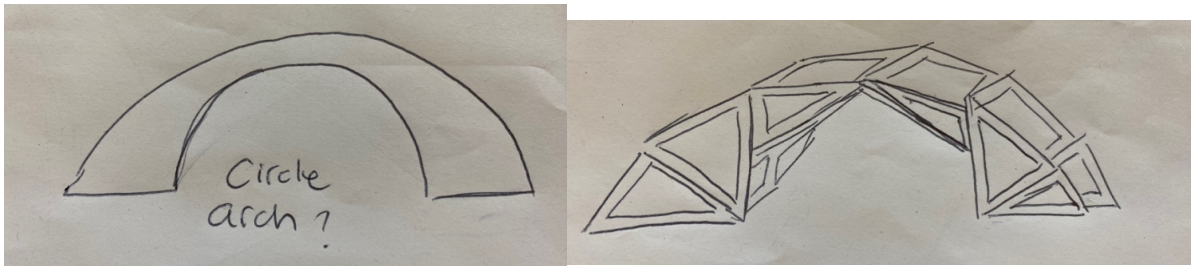
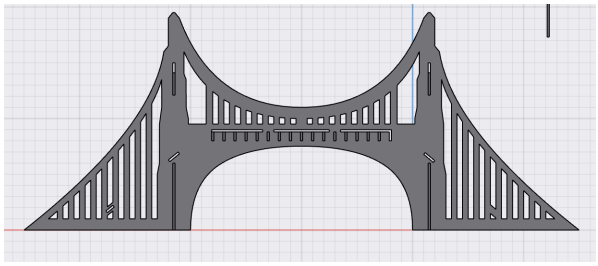
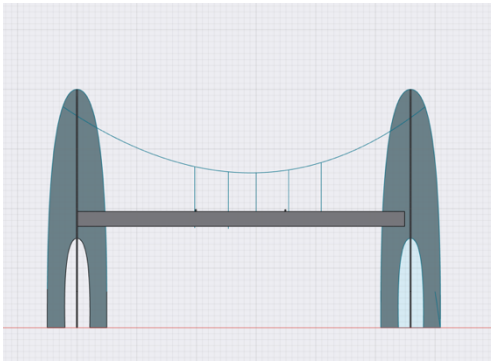
Initial concepts:



Two big towers with flat road in between and suspension bridge support using string or cardboard.





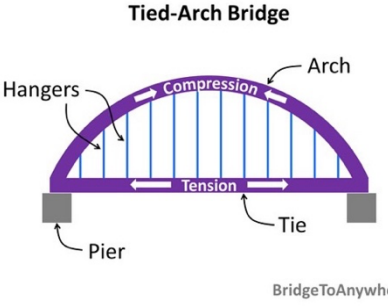
Using CAD for initial concepts

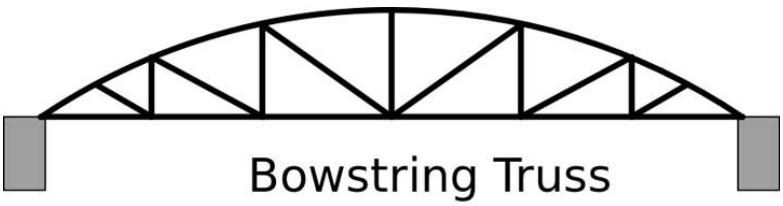
The main issue with all these concepts is the lack of material available. The chosen concept is much simpler in order to use less cardboard.

Chosen concept:

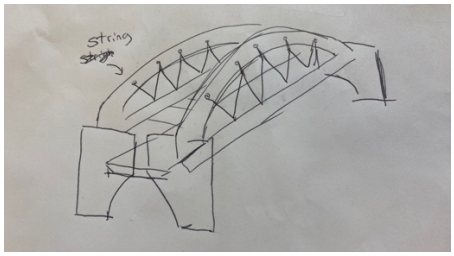
Arch above with string to support road.

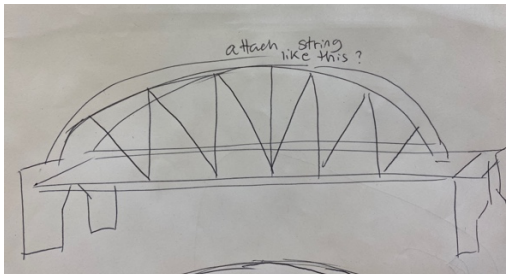
Going to experiment between straight down attached string and bowstring truss method.

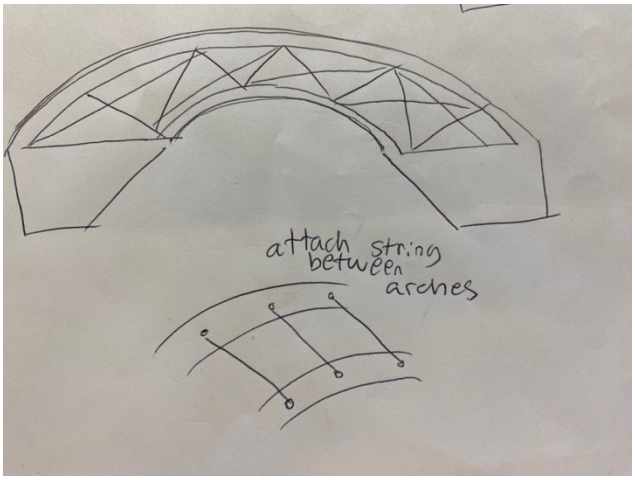




Development of concept:





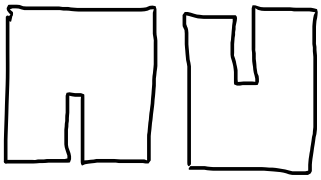


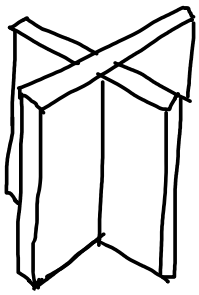
FMEA:

Component	***Risk of failure***	***Type of failure***	***Action to resolve***
Arch attached to base	*High*	*Tip over horizontally*	*Add horizontal pillars between to stabilise*
Base structure	*Low*	*Rotate inwards during high load*	*Make parallel to arch*
Straight road	*Medium*	*Collapse in middle or bend*	*Add additional strips of card and connect string to centre of road to reduce stress in middle.*
Horizontal supports	*Medium*	*Falling off during load*	*Make slots that fit into middle of arch, so they don't move.*

Different ways of joining pieces:

Double Slit:

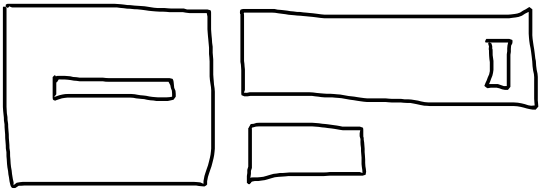


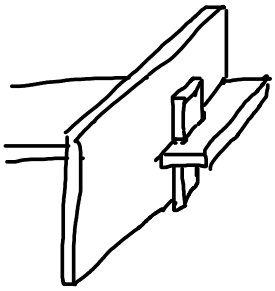


Very simple and strong.

(Weak if strips are too wide)

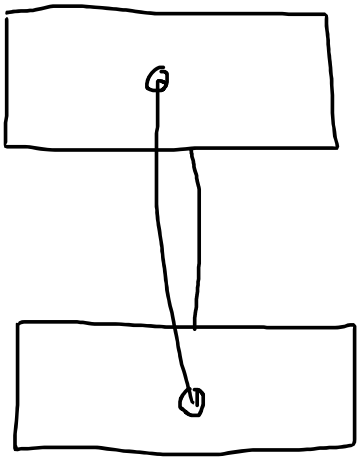
Slit with an extra hold:





This method ensures the bridge doesn't move around. > uses more cardboard.

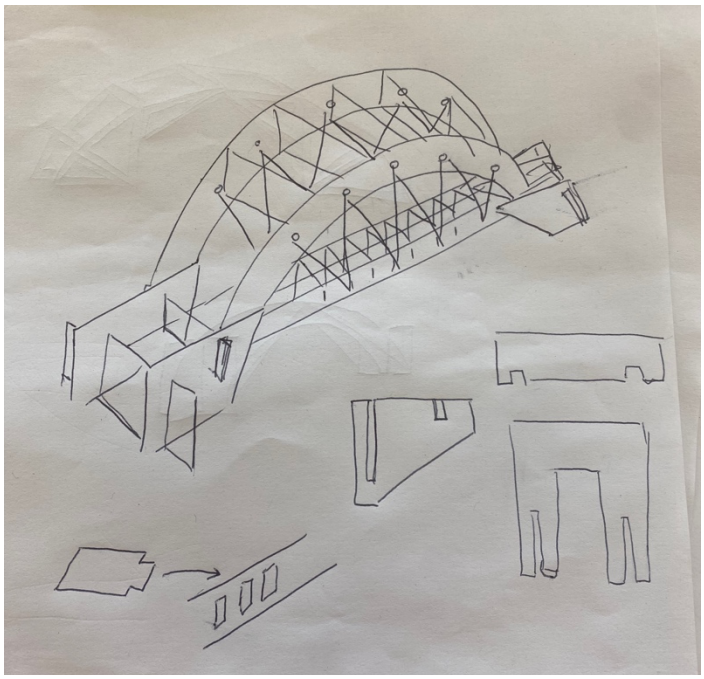
String attached to holes on cardboard.



Very strong in tension.

Can't compress.

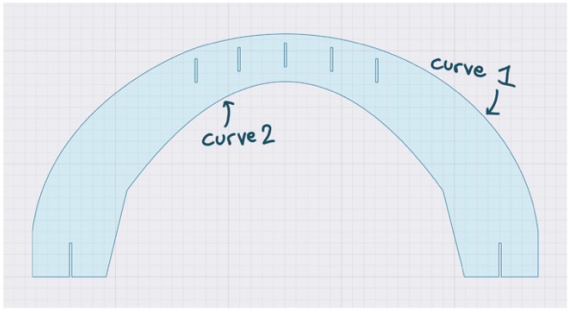
Final concept:



Attaching the pieces with simple slots as there is no force horizontally at these points.

Top and bottom Curve functions:

I did the top curve (curve 1), Zobia (my partner) did bottom curve (curve 2), here is all of our work combined:



Curve 1: Semi-Oval

$$\frac{x^2}{50176} + \frac{y^2}{30625} = 1$$

Curve 2:

$$y = -0.005x^2 + 98$$

Trapezium rule:

Curve 1: Seperate into 32 trapeziums $\longrightarrow h = \frac{448}{32} = 14\,mm$

Curve 2: Seperate into 20 trapeziums $\longrightarrow h = \frac{280}{20} = 14\,mm$

} Width of trapeziums

Curve 1																														
x	-224	-210	-196	-182	-168	-154	-140	-126	-112	-98	-84	-70	-56	-42	-28	-14	0	14	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224
f(x)	0	61	85	102	116	127	137	145	152	157	162	166	169	172	174	175	175	175	174	172	169	166	162	157	152	145	137	127	116	102	85	61	0

Curve 2																				
x	-140	-126	-112	-98	-84	-70	-56	-42	-28	-14	0	14	28	42	56	70	84	98	112	126	140
f(x)	-0	18	35	49	62	73	81	88	93	96	97	96	93	88	81	73	62	49	35	18	-0

Finding the Area

Area under curve 1:

$$\approx \frac{1}{2} \times 14\left(0 + 2\left(\left(61 + 85 + 102 + 116 + 127 + 137 + 145 + 152 + 157 + 162 + 166 + 169 + 172 + 174 + 175\right) \times 2 + 175\right) + 0\right)$$

$$\Rightarrow 61250\ mm^2$$

Area under curve 2:

$$\approx \frac{1}{2} \times 14\left(0 + 2\left(\left(19 + 35 + 50 + 63 + 74 + 82 + 89 + 94 + 97\right) \times 2 + 98\right) + 0\right)$$

$$\Rightarrow 18256\ mm^2$$

Total area of Arch : Area under 1 $-\left(\text{Area under 2} + \frac{1}{2} \times 38(280 + 298) + 40(65 + 75)\right)$

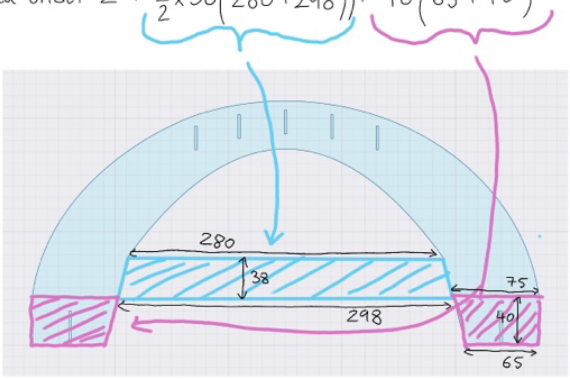
$$\Rightarrow 61250 - (18256 + 10982) = 32012$$

$$\Rightarrow 32012 + 5600 = 37612$$

(remove slots)

$$\Rightarrow 37612 - ((30 \times 2) \times 2 + (21 \times 2) \times 5)$$

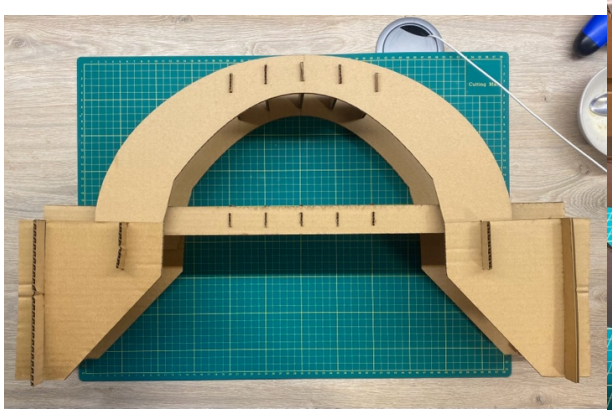
$$\Rightarrow \underline{37\,282\ mm^2}$$

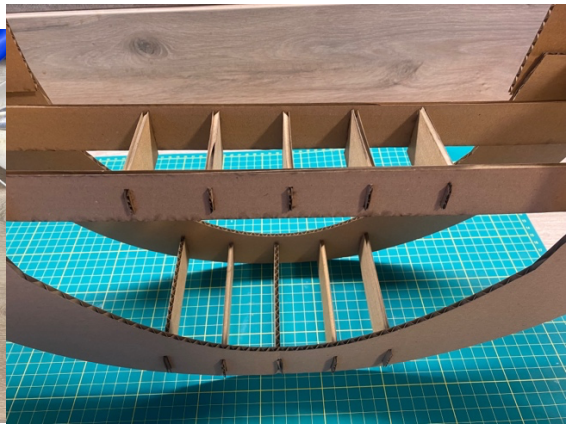


Half scale model:

This model is strong and can hold good amount of weight. Considering the cardboard type is different, the final bridge will be even stronger. With this half scale model, I found out that that the arch is serving no purpose for the strength of the bridge. So, string must be used to relieve tension in the road to the arch.

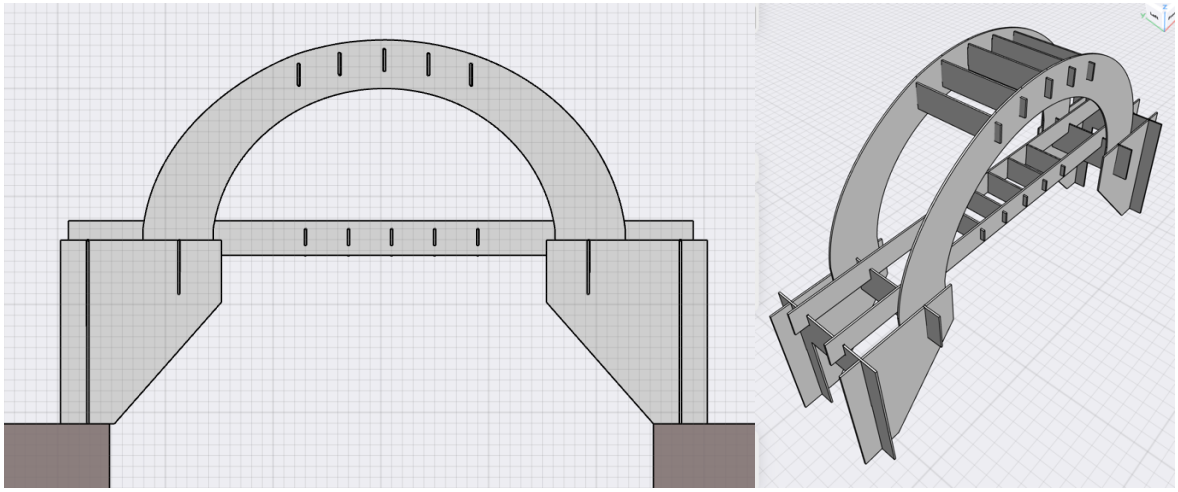
My suspicion is that the bridge will fail Horizontally due to the swaying of the bridge.





CAD Model:

Cad model to ensure all pieces of bridge will fit together.



All components in 800mmx450mm (Screenshot):

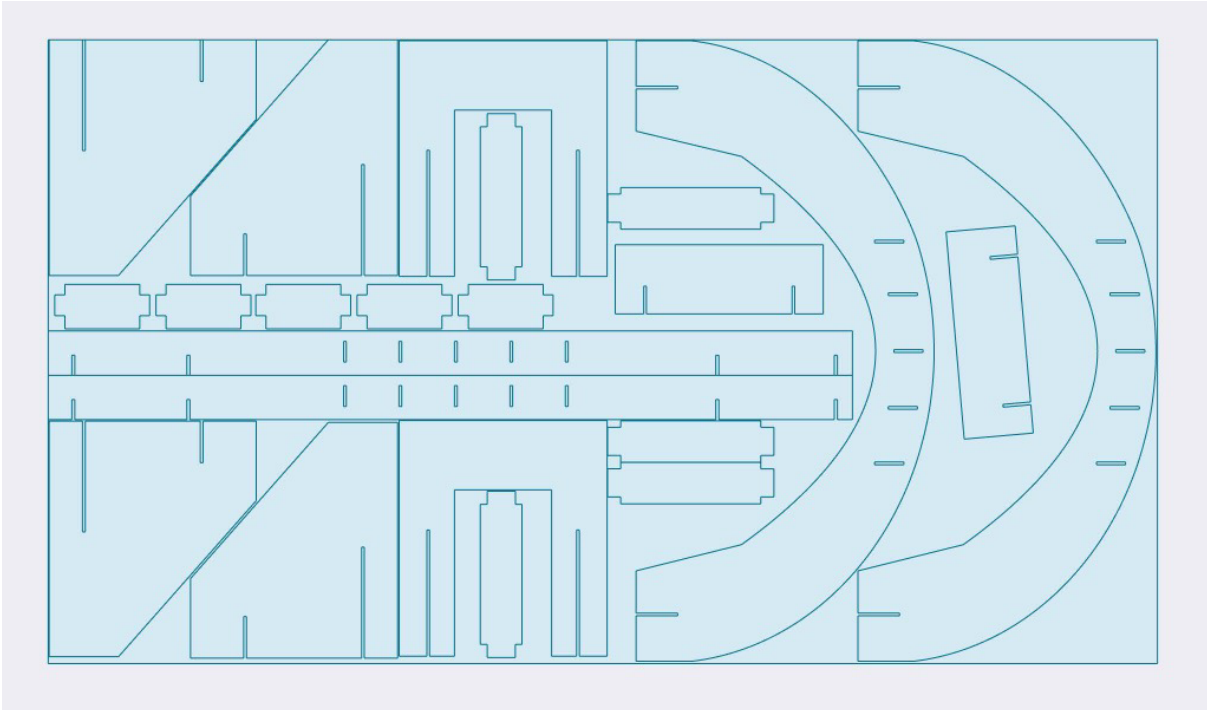
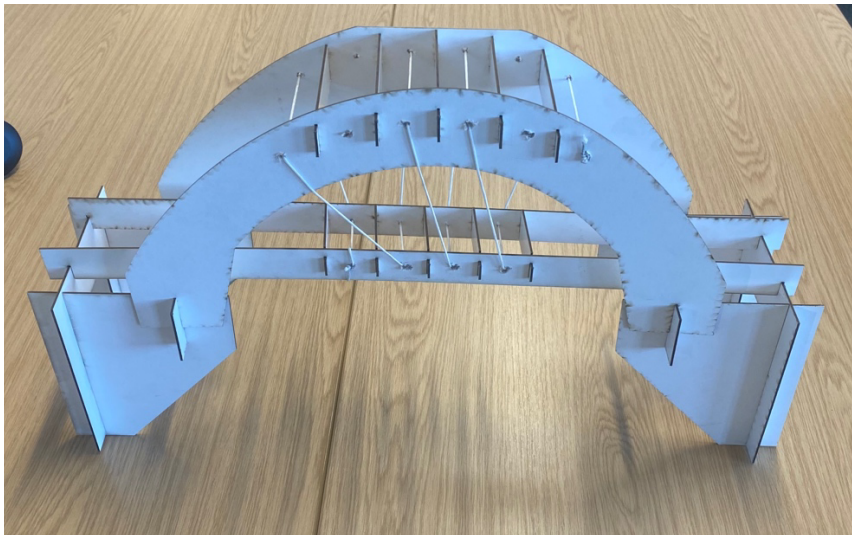


Photo of final bridge:



Bridge failed due to horizontal weakness. The slight sway of the bucket caused the bridge to tip over.

What to improve for next time: *Make the base of the bridge wider to prevent tipping over.*

Join both sides of the bridge using triangles rather than straight pieces to strengthen horizontally, like this: