



Building bridges

In this investigation we will look at the shape of 3 different bridges and decide how well a parabola fits their curves – and whether another function provides a better fit. The 3 bridges are:

A. The Clifton Suspension bridge



https://commons.wikimedia.org/wiki/File:Clifton_Suspension_Bridge_c1900_2.jpg

B. Twenty four Bridge in Yangzhou



https://en.wikipedia.org/wiki/Moon_bridge#/media/File:Twenty_four_bridge.JPG

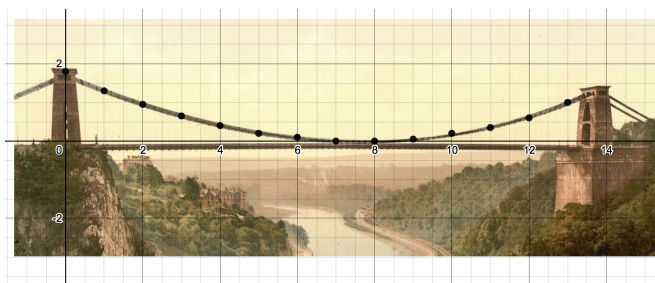
C. The Mathematical Bridge at Queens Cambridge



https://www.queens.cam.ac.uk/files/mathematical_bridge_0.jpg

1. Look at the 3 pictures above and decide which of these can be described by a parabola. Can you think of any other equations which might fit these curves?

A. The Clifton Suspension bridge



I imported the above picture into Desmos and chose some points that described the general curve. Note that the x and y axes are not scaled as we are simply interested in the shape. This gives the following data.

x	y
0	1.8
1	1.3
2	0.95
3	0.65
4	0.4
5	0.2
6	0.1
7	0
8	0
9	0.05
10	0.2
11	0.35
12	0.6
13	1

- A1. Plot these points on Desmos and fit a curve of the form:

$$y = a(x - p)^2 + q$$

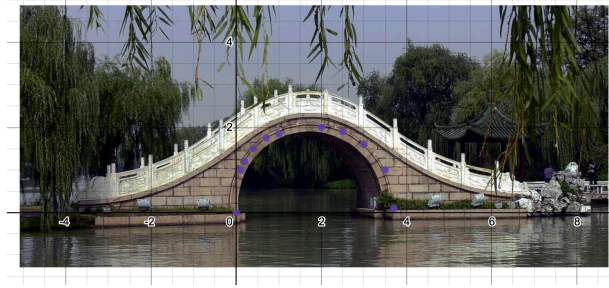
- A2. Use the Desmos regression tool to find a quadratic regression line. Compare this regression line to your answer for (2).
- A3. The ropes on a suspension bridge should hang in the form of a Catenary curve.

$$y = a \cosh\left(\frac{x - b}{a}\right) + c$$

(Here $\cosh(x)$ is the hyperbolic cosine which you might like to research).
Use Desmos to find a regression line with this form. Compare your result to (3).



B. Twenty four Bridge in Yangzhou



Following the same method as for A we get the following data:

x	y
0	0
0.1	1
0.2	1.2
0.4	1.5
0.7	1.75
1	1.85
2	2
2.5	1.9
3	1.6
3.5	1
3.7	0.1

B1. Plot these points on Desmos and fit a curve of the form:

$$y = a(x - p)^2 + q$$

B2. Use the Desmos regression tool to find a quadratic regression line. Compare this regression line to your answer for (2).

B3. The moon bridge should follow a semi-circular equation of the form:

$$y = \sqrt{r^2 - (x - a)^2} + b$$

Use Desmos to find a regression line with this form. Compare your result to (3).



C. The Mathematical Bridge at Queens Cambridge



Following the same method as for A and B we get the following data:

x	y
0	0
1	0.68
2	1.2
3	1.6
4	1.9
5	2.1
6	2.2
7	2.2
8	2.15
9	1.95
10	1.7
11	1.3
12	0.85
13	0.2

C1. Plot these points on Desmos and fit a curve of the form:

$$y = a(x - p)^2 + q$$

C2. Use the Desmos regression tool to find a quadratic regression line. Compare this regression line to your answer for (2).

C3. Compare the 3 bridges – which was best described by a quadratic curve? Research why a quadratic curve was used in many bridge designs.