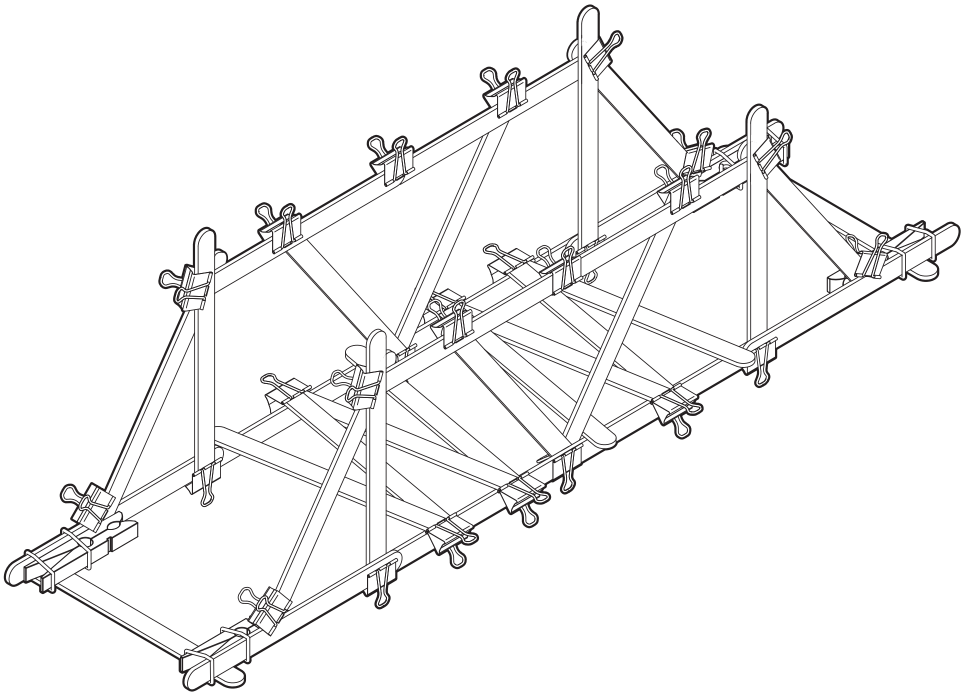


BRIDGE BONANZA WORKSHEET

GETTING STARTED

5-10m

This bridge building STEM activity will get you thinking about the foundations of bridge building and what creates a strong structure.

This build requires you to work well as a team and challenges you to carefully consider the most effective use of materials available to you.

It's up to you and your team to create the strongest bridge you can. Are you ready to build?

VOCABULARY

Strut - A rod or bar designed to increase strength. Lollipop sticks make excellent struts.

Load - The weight or forces that are put on a bridge. On large bridges, this may be the number of cars; for this challenge, we will use any weights available, such as pens or books.

Truss Bridge - A bridge made primarily of triangles to give them strength.

Beam Bridge - Horizontal beams supported at each end by piers.

Arch Bridge - These are arch-shaped and have abutments, structures to support the arches, at each end.

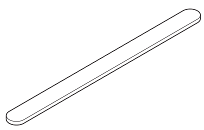
Cantilever Bridge - Built using cantilevers, which are horizontal beams that are supported on only one end.

Suspension Bridge - Bridges that are suspended from cables.

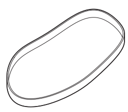
Cable-stayed Bridge - Similar to suspension bridges, as they are held by cables. However, the difference is that less cable is required and the towers holding the cables are proportionately shorter.

Polygon - Any two-dimensional shape with straight lines. The name tells you how many sides the shape has. For example, a triangle has 3 sides.

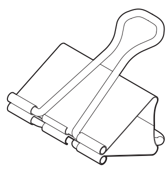
EACH TEAM WILL NEED



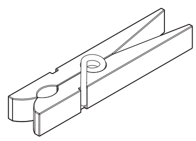
Lollipop Stick
30



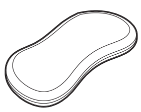
Elastic Band
20



Bulldog Clip
16



Clothes Peg
10



White Tac

WARM-UP ACTIVITIES

A

5-10m

Draw a picture of some bridges that you have seen or been across, either on foot or in a car. Have a think why they may be particularly strong?

B

10-15m

Using paper and cardboard, pick one bridge to make a prototype of the bridge designs that you and your teammates drew in warm-up activity **A**.

MAIN CHALLENGE

30-40m

The challenge is to work together as a team to build a strong bridge across the gap in front of you using the materials provided.

Great engineers always create designs of what their final masterpiece will look like. Sketch out different options and experiment with different approaches.

The bridges must span at least 45cm and hold each weight for at least 10 seconds.

Don't forget to think about the design principles you can find in the six main bridge types and remember, if you can make the bridge symmetrical, you're less likely to have weak points.

Once completed and tested, there will be a class discussion about your findings.

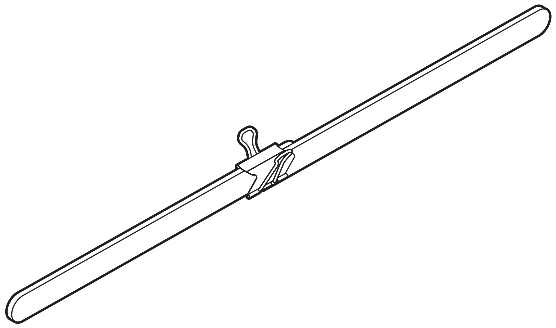
BUILDING YOUR BRIDGE

There are many ways to build a bridge using the materials provided. Use your creativity to form innovative, load bearing structures!

TECHNIQUES TO TRY

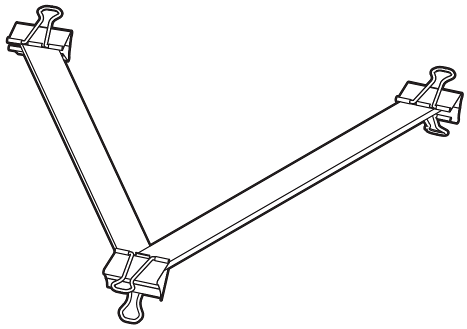
STRAIGHT JOINT

Join two lollipop sticks together in a line using a bulldog clip. Be sure there is an overlap between both lollipop sticks to ensure a strong joint.



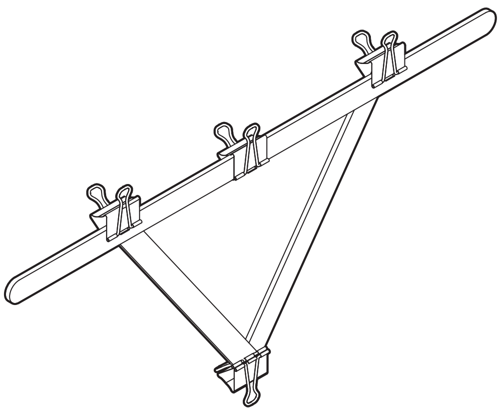
ANGLED JOINT

Angled sections can be joined together as shown below:



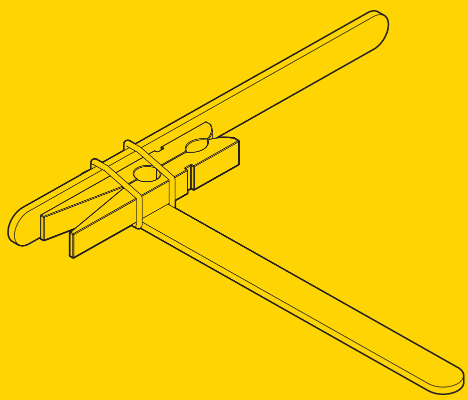
TRUSS

By combining these techniques, you're able to create a truss. Trusses are excellent at distributing the load applied to your bridge. Several trusses can be joined together using the provided materials to create strong, stable structures. Use these techniques to get building!



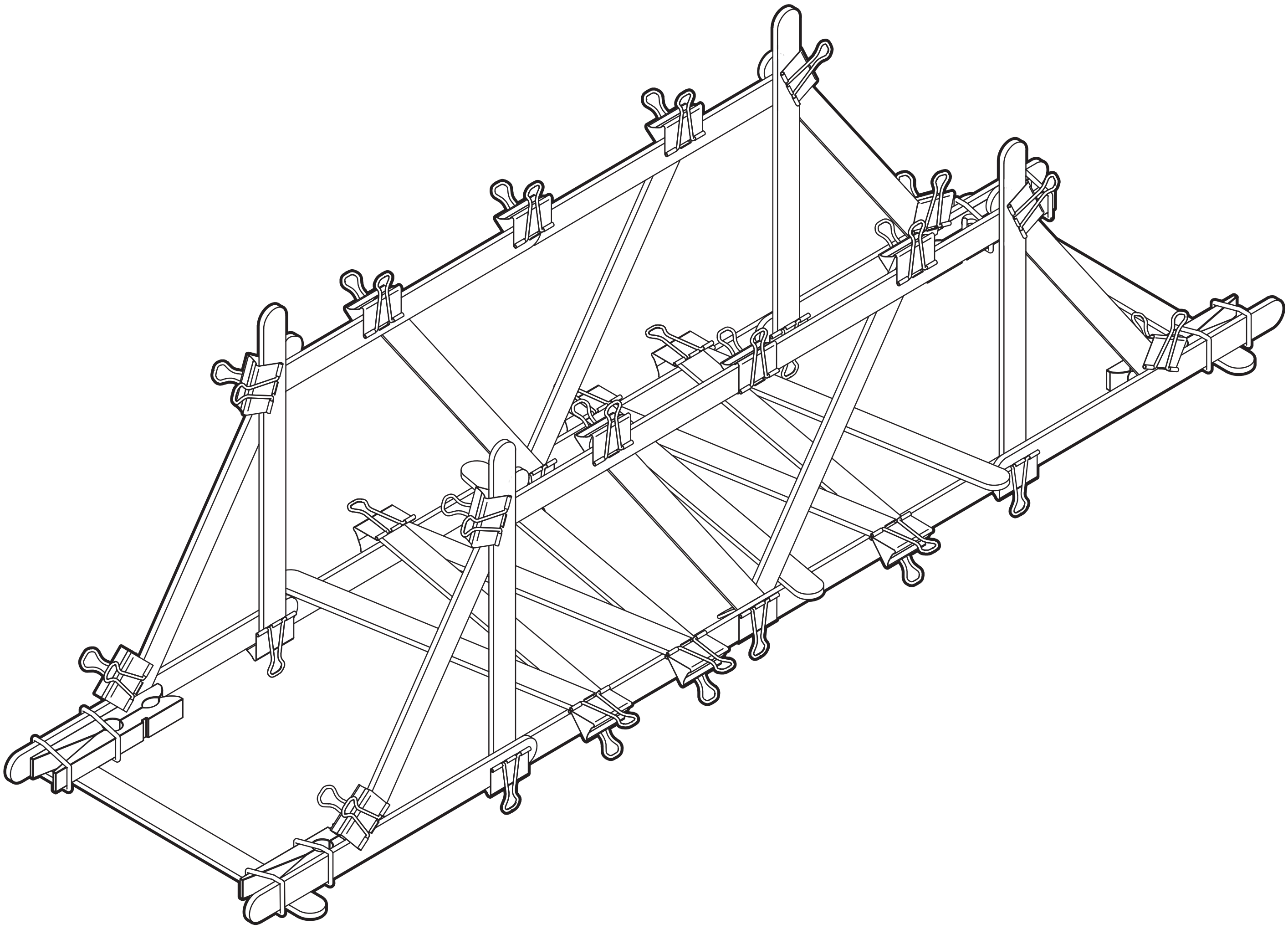
ADVANCED TECHNIQUE

Perpendicular faces can be created by fixing two lollipop sticks to a clothes peg using a rubber band, as shown here. This can be particularly useful when constructing the sides of the bridge.



EXAMPLE BRIDGE

We created a bridge using only these techniques. Think about where you want the load to be applied on your bridge. Be as creative as you can!



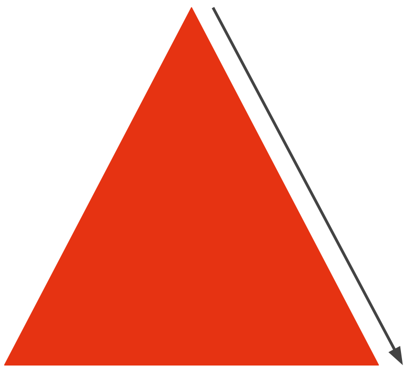
BRIDGE BONANZA

STRENGTH OF TRIANGLES

10-15m

KS1/2 PROOF OF CONCEPT

Take a look at the square in the image to the right. If you were to push hard enough on one corner, it would collapse into a rhombus shape and could even fall flat. Not ideal for bridge building!



However, if you push on one corner of a triangle, the force travels down the edges and keeps the shape rigid. This is why triangles are considered the strongest shape.

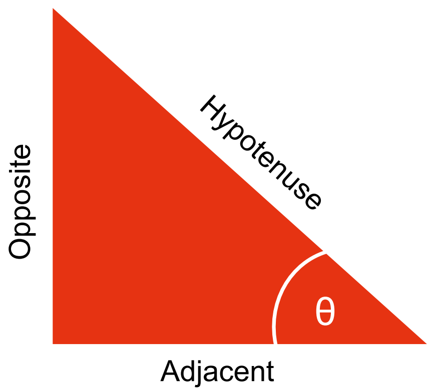
Got your heart set on a bridge that uses squares? Not to worry, you can use triangles to create a more stable square. Have a look at the ideas below to give you some inspiration.

KS3/4 DEEPER LEARNING

All polygons are not created equal, meaning they aren't all as strong as the triangle. This is because the angles in each corner are not dependent on the length of each edge for most shapes.

For example, a square and a strutted diamond have the same number of edges and vertices, and the length of the edges can be identical to each other, however the angles at each vertex could make it a different shape.

This is where triangles are unique - the length of each edge is dependent on the angle at each corner. Think about using trigonometry and remember to use **SOH**, **CAH**, and **TOA** to help.



$$\sin \theta = \frac{opp}{hyp} \qquad \cos \theta = \frac{adj}{hyp} \qquad \tan \theta = \frac{opp}{adj}$$

Because of these relationships, if we apply a force on the triangle, the opposing edges are always applying a reaction force in order to keep the shape, hence keeping the triangle rigid and intact.

Have you made sure to use triangles in your bridge?

QUIZ

15-20m

What shape is a truss bridge primarily made up of?

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....

Why is symmetry important in bridge design?

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....

What do engineers do before starting construction?

....

....

Why are triangles often found in bridge designs?

....

....

How important are the materials we use when building a bridge?

....

....

QUIZ

What is the difference between a cable-stayed bridge and a suspension bridge?

....

....

Can you name a famous suspension bridge - or draw what one would look like?

....

....

If you could choose other materials to build your bridge from, what would you choose and why?

....

....

If you had to build your bridge to cover a wider gap, other than making your bridge longer, what else would you need to think about changing?

....

....

How does the weight of a bridge impact the final design?

....

....