

Chapter Dii: Arches – Ancient and Strong

AIMS & OBJECTIVES

- To recognise that centring was an important part of Roman arch building
- To demonstrate understanding by building an arch bridge

CONTEXT

The Romans specialised in the use of arch bridges. They joined them together to make long road bridges called viaducts and sometimes placed them on top of each other to make aqueducts to carry water over the valleys. Their arches were so strong and useful that some Roman arch bridges still survive today.

LANGUAGE OF BRIDGES:

Abutment: the structure that the ends of the bridge rest on and can be anchored by.

Arch: semi-circular curved structure.

Beam: the simplest form of bridge, consisting of a single span resting on abutments.

Centring: the temporary structure originally used by the Romans to support the arch during construction.

Compression: a force that tries to make things shorter or smaller (a squashing, pushing force).

Keystone: the most important, wedge-shaped stone in the very centre of the arch.

Mortar: a clay-based type of glue used to stick the stones together in an arch.

Piers: the upright columns that support the bridge.

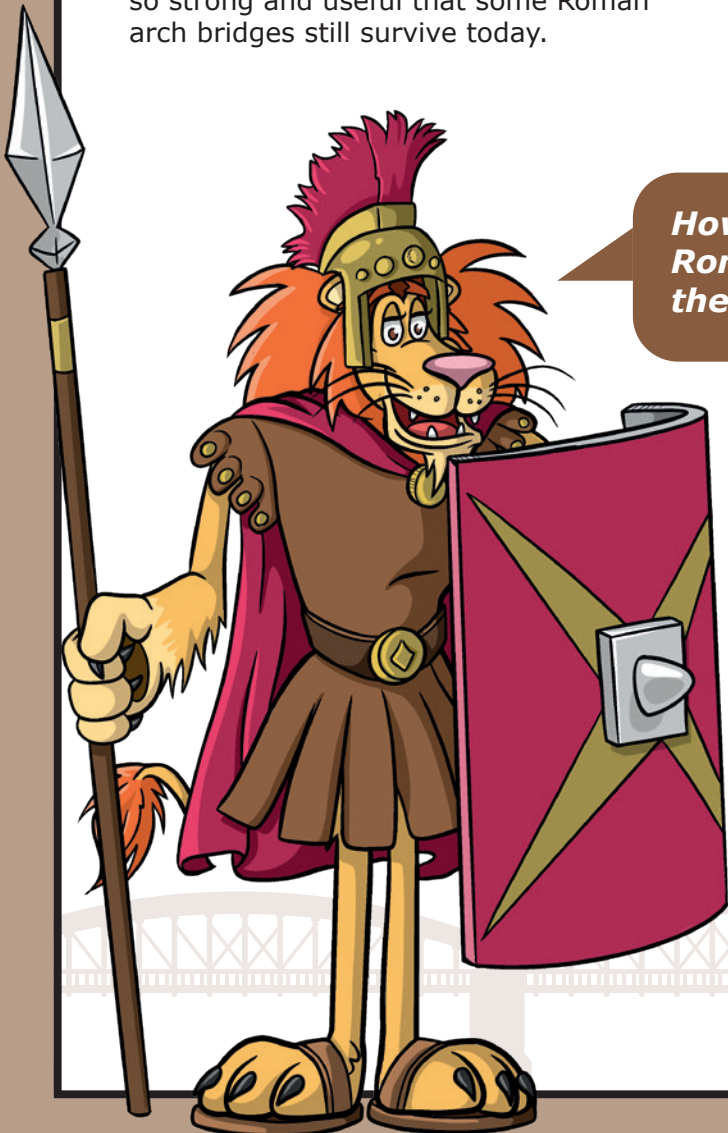
Span: the distance between bridge supports.

Tension: a force that tries to make things longer (a stretching, pulling force).

Total span: the full distance, from one side to the other, the bridge covers.

Vousoir: the special wedge-shaped pieces used in stone arches.

How did the Romans build their arches?





You will need...

- Handout: *Roman bridges*
- Arch Building Kit(s)
 - Large Arch Bridge Demonstration Kit (This can be borrowed from the Rochester Bridge Trust for schools local to Rochester. Email education@rbt.org.uk)
 - Small Arch Bridge kits (These can be borrowed from the Rochester Bridge Trust by local schools by emailing education@rbt.org.uk, or can be purchased online, search for Montessori Roman arch kits)
- Roman bridge building, per group:
 - Large cylinder (such as a Pringles® crisp tube)
 - Play-doh®, plasticine, modelling clay, or air-drying clay
 - Stones or pebbles of a similar size
 - Newspaper or covering to protect the work surface
 - Cardboard (optional, to act as a base if using air-drying clay)



Something to Try:

Arches are incredibly strong and were one of the earliest types of bridges constructed. They can often be found naturally occurring, with rock having been worn away by the elements. The earliest human-made arch structures can be found in ancient stone structures, such as tombs, where two large stones are placed diagonally against each other, creating an opening beneath.



The Romans were gifted engineers and built structures unrivalled for many centuries...

EXPLORING ROMAN ARCHES

The Romans realised that to build an arch bridge they would first have to build some wooden supports called centring. The centring was a bit like modern scaffolding. Once the centring was complete, they could start to add the specially shaped stones called voussoirs. Each voussoir is shaped like a wedge. The stone in the middle of the arch is called the keystone and is the most important part. It acts like a key to lock the other stones together. Without the keystone the arch would collapse. Only once the keystone had been put in place could the Romans remove the centring.

To see an animation depicting the 14th century construction of the Charles Bridge in Prague, search "Charles Bridge construction" on YouTube. Although this is much later than the Roman period, the technique is essentially the same.

**Links to Learning About
Bridges Chapter Di:
Arches – The Science of
Arches, Forces in arches**





Ask learners to look at the *Roman bridges* handout. Ask them to name the different features in some of the famous arch bridges, using the correct terminology.



Pont Flavien, France (Photo by Tanis13 via Wikimedia)



Alcantara Bridge, Spain (Photo by Dantla via Wikimedia)



Pont du Gard, France (Photo by Beth Lieu Song via Wikimedia)



Using the arch kits, encourage learners to work out how to build a strong and stable bridge using the pieces provided. Test the strength of the bridge by applying a load to the top, and test its weakness by removing a piece from underneath. Learners may realise that an arch bridge is very weak until it is complete. The centring is vital to hold it all up during construction, which means engineers have to build this type of bridge twice – once for the centring/falsework and again in the final material for the bridge. You might like to challenge learners to see which group can construct a stable arch bridge most quickly.



BUILDING AN ARCH BRIDGE WITH THE ARCH BUILDING KIT

1



The arch building kit with centring.

2



Stand the widest piece up on a flat surface. Add the supports for the centring between the two sides.

3



Place the arched piece on top of the supports. This will act as the centring.

4



Place the individual voussoirs on top of the centring one-by-one from the outside-in.

5



Add the final middle piece. This is the keystone.

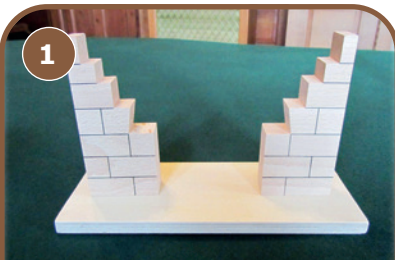
6



Remove the centring and the supports. You now have a freestanding arch bridge!

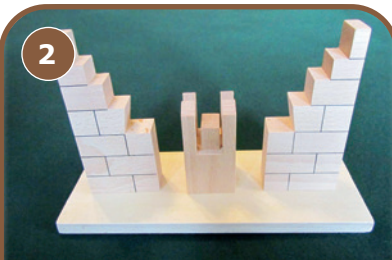
BUILDING AN ARCH BRIDGE WITH THE MONTESSORI ARCH BUILDING KIT

1



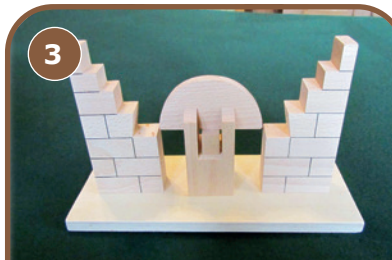
Stand the Montessori arch building kit base on a flat surface.

2



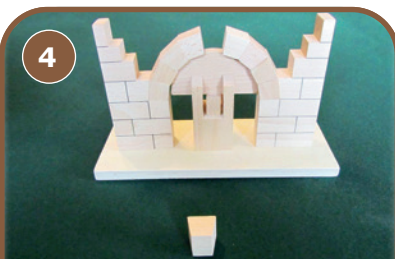
Add the support for the centring in the centre of the gap.

3



Place the arched piece on top of the support. This will act as the centring.

4



Place the individual voussoirs on top of the centring one-by-one from the outside-in.

5



Add the final middle piece. This is the keystone.

6



Remove the centring and the supports. You now have a freestanding arch bridge!

Challenge Time!



ROMAN BRIDGE BUILDING

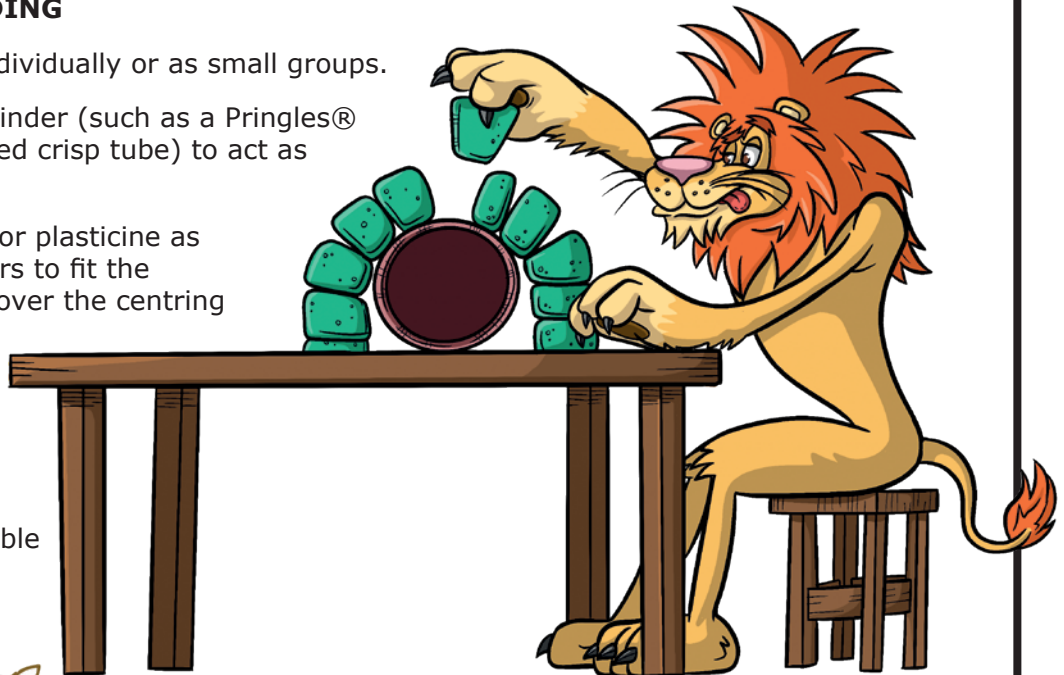
This can be completed individually or as small groups.

Learners need a large cylinder (such as a Pringles® tube, or other non-branded crisp tube) to act as the centring.

Using the modelling clay or plasticine as mortar, encourage learners to fit the pebbles/stones together over the centring to form the arch bridge.

When firmly in place, remove the centring.

If air-drying clay and a cardboard base are used, the bridges should be stable enough to be displayed.

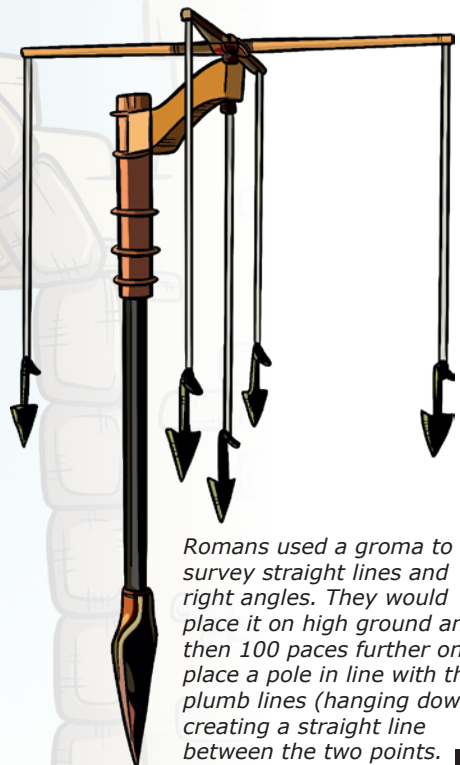


HOT TOPICS!

The first bridge built at Rochester was Roman. Although it was a beam bridge, the more common form of bridge built in the northern European settlements, Roman arch bridges are very common in southern Europe.

The Romans built a network of roads across their empire to move their troops and goods across long distances. They were built very straight to form the most direct route, and therefore be the shortest, quickest way to get anywhere, and safely!

You could explore how Romans built their roads, building models using rocks, pebbles and sand. Perhaps you could find out how Roman surveyors made sure the route was straight, using a groma – a type of surveying equipment. You could even build a model groma.



Romans used a groma to survey straight lines and right angles. They would place it on high ground and then 100 paces further on, place a pole in line with the plumb lines (hanging down), creating a straight line between the two points.





BUILDING A BRIDGE WITH LEGO®

Can you build an arched bridge with Lego®? Using some standard Lego® or Duplo® bricks, is it possible to form a Roman-style arch?



DID YOU KNOW?

The Pont du Gard is an ancient Roman aqueduct, built in the first century AD to carry water to the Roman colony, over the river Gard in southern France. It is the highest of all Roman aqueducts and one of the best preserved, and was added to the UNESCO list of World Heritage Sites in 1985 because of its historical importance.



If you look at a map of Britain, can you spot any Roman roads? How will you know which ones are Roman roads? Are there any Roman roads near you?



Pont Du Gard Moritz-Kindler on Unsplash



Langdon presents:

- *Roman bridges handout*

Handouts can be found at www.rochesterbridgetrust.org.uk