SELF-LED ACTIVITY
CANTILEVER CHALLENGE

KS2 KS3

Recommended for

KS2 & KS3 (Science, Design and Technology)

Learning objectives

- Examine/observe/measure and investigate/record the type of bridge that joins the headland and Island at Tintagel Castle.
- Identify the forces acting on the bridge and why the design of the bridge has been chosen (relate the load to how the land has changed over time).
- Compare, test and select materials based on their properties to build a model cantilever bridge.

Time to complete

60 minutes

A student building a cantilever.

SUMMARY

This activity will help students understand how the footbridge at Tintagel Castle is designed and engineered to help them to design their own bridge.

BEFORE YOUR VISIT

Before your visit, challenge your students to create the longest span possible out of lolly sticks/paint stirring sticks and washers/weights using only the edge of a table. Give the students minimal instruction and let them discover through experimentation how to distribute the weight of the washers to support the beam to as long a length as possible. This introduces the concept of a cantilever: a projecting beam fixed at only one end. The students will have discovered how a cantilever needs a reinforced anchor; the longer the span, the stronger the anchor needs to be. The weight on the beam can't be more than the cantilever can support, or it will bend and break.

AT THE CASTLE

During your visit to the castle, students should explore the bridge, making sketches of its design from the viewing platforms in the lower courtyard and/or from the beach **at low tide**. They should identify it from the list of bridge types. The bridge is made of two cantilevers meeting: it has a gap in the middle. The carbon steel piers are lightweight so they disappear when the bridge is viewed from a distance.

The activity below encourages students to explore the forces acting on a cantilever bridge, using just their bodies, some simple loads, and teamwork.

To discover how forces act on a cantilever bridge, ask your students to hold out one arm at a right angle from their body. The force of tension is along this arm, keeping it straight (the bridge beam).

Give them a school bag to hold out at arm's length. Ask them to gradually hold more and more weight (more school bags) until their arm drops: this is the compression force (between their hand/arm and the ground) becoming greater than the tension, and so their arm (the 'bridge') fails – the anchor (their shoulder) gives way.

Continued...

Ask the students how their arm could be strengthened: in pairs they can try to help each other. They should conclude that by holding up their partner's arm, the arm can hold more weight. They are countering the compression force with a strong support.

However, we couldn't put a support in the ground beneath the bridge, because it is a special site – the support has to come from the anchor. How could we design the bridge to make the anchors stronger? Ask students to try to do this with their bodies, still supporting the end of their partner's arm.

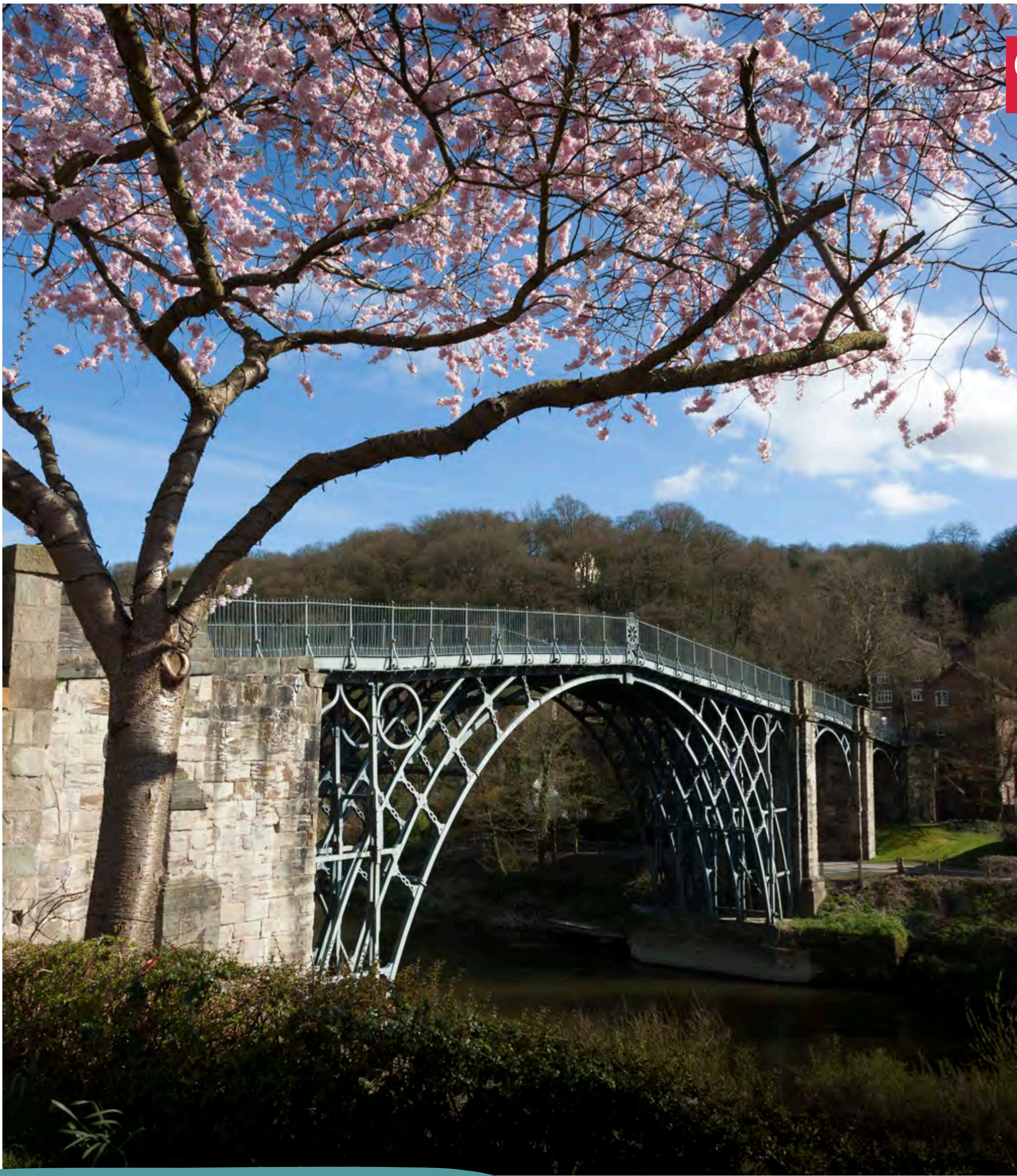
Once they have tried, show them the image of Iron Bridge from the 19th century: this demonstrates the large arched anchors/piers with trusses that support the bridge, making it very strong. Do they think this would suit Tintagel in the 21st century? Instead, our bridge has smaller piers: unlike the Victorians, engineers today can analyse materials to discover the best way to solve a design problem. We can model things on computers to test out and make calculations. Steel has been used to make the bridge at Tintagel because it is stronger (a very high yield strength) than wood or iron so the piers can be smaller and lighter than those of the Iron Bridge and can blend into the landscape better.

On their sketches, students should label how the force is acting on the footbridge: that is, **compression** (a force that pushes or squeezes inwards) on the anchor/abutment/pier is carefully balanced with **tension** (a force that stretches and pulls outwards) across the beam (deck). This balancing happens by channelling the load (the total weight of the bridge structure) onto the abutments (the supports at either end of the bridge) and piers (the supports that run under the bridge along its length). These forces are balancing each other out (until they don't and the beam collapses!).

MORE LEARNING IDEAS

Back in the classroom, students should design their own model cantilever bridge, testing out a variety of materials, analysing their properties to decide which will be the most suitable to support their chosen structure.

IRON BRIDGE



Iron Bridge has five arched rib supports, making it very strong.

BRIDGE BUILDERS

1 **Sketch** the footbridge at Tintagel Castle:

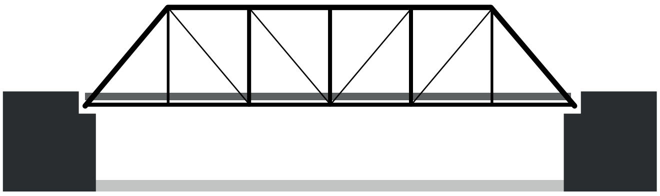
2 **Decide** what type of bridge it is from the list on the other side of this page. Label your drawing.

3 **Label** the direction of the forces (compression and tension) acting on the footbridge.

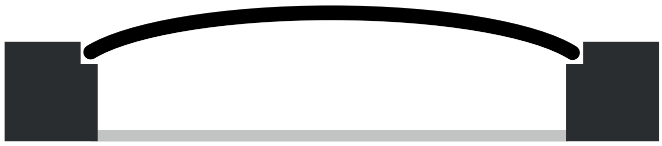
4 Find out what material was used and describe its properties:

BRIDGE BUILDERS

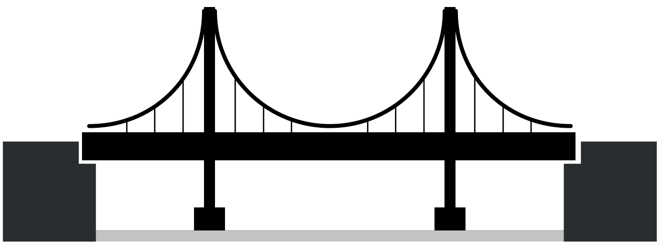
TRUSS



ARCH

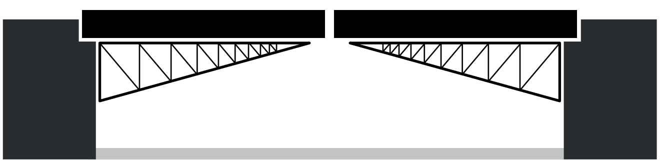


SUSPENSION



BEAM

CANTILEVER



CABLE STAYED