ACCREDITED RESOURCE CREST AWARDS

Canal & River Trust | STEM

Bridging the Gap
Engineering and the Environment

canalrivertrust.org.uk/stem

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Learning objectives

By the end of the workshop, you will be able to:

- Identify and summarise different types of bridges and forces
- Understand the responsibilities, considerations and challenges when building and maintaining bridges
- Apply design and engineering principles to build a bridge which holds a load
- Test, reflect and evaluate your structure and design choices

Overview of Canal & River Trust

Maintaining Waterways and Infrastructure

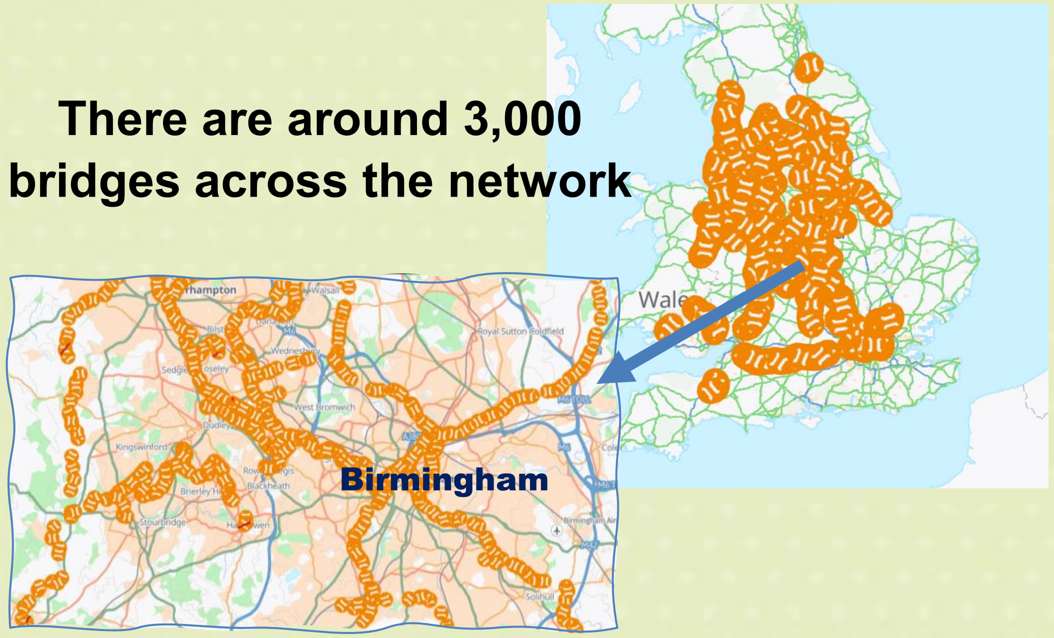
Our role

Maintain: Inspect and repair to ensure they are safe for public use

Restoration and conservation: Many bridges are historical structures which need specialist restoration work for preservation

Sustainability: Make sure bridges and any works have minimal environmental impact

There are around 3,000 bridges across the network



Bridges are important for:

- **Transport:** Connecting communities, allowing travel without disrupting the natural environment
- **Accessibility**: Pedestrian bridges allow access to outdoor spaces, recreational spaces, businesses and homes
- **Environmental Protection:** Protects local ecosystems and waterways. It supports sustainable transport such as cycling, walking, and boating.

Introduction to Bridge Engineering

Beam Bridge

Simplest type of bridge

Suspension Bridge

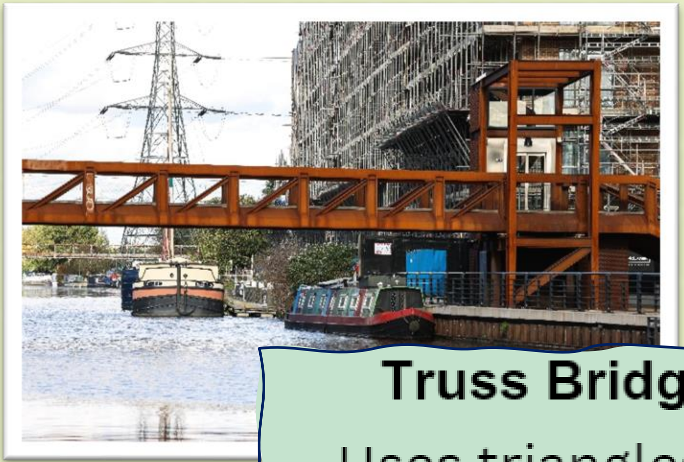
Walkway is suspended by steel cables

Swing Bridge

Swing on a pivot until parallel with the bank

Arch Bridge

Invented by the Romans



Truss Bridge

Uses triangles as supports to increase the bridge strength

Cantilever Bridge

Made from horizontal structures which are supported on one end

Lift Bridge

Uses counterbalance (or now hydraulics) to lift the bridge

Forces in Bridge Engineering

Load: The weight or forces that are put on a bridge.

Dead load: Weight of a structure and its components before a live load is added.

Live load: Non-permanent moving loads, bridge users.

Tension: A force that acts to stretch or elongate an object.

Compression: A force that acts to shorten or compress an object.

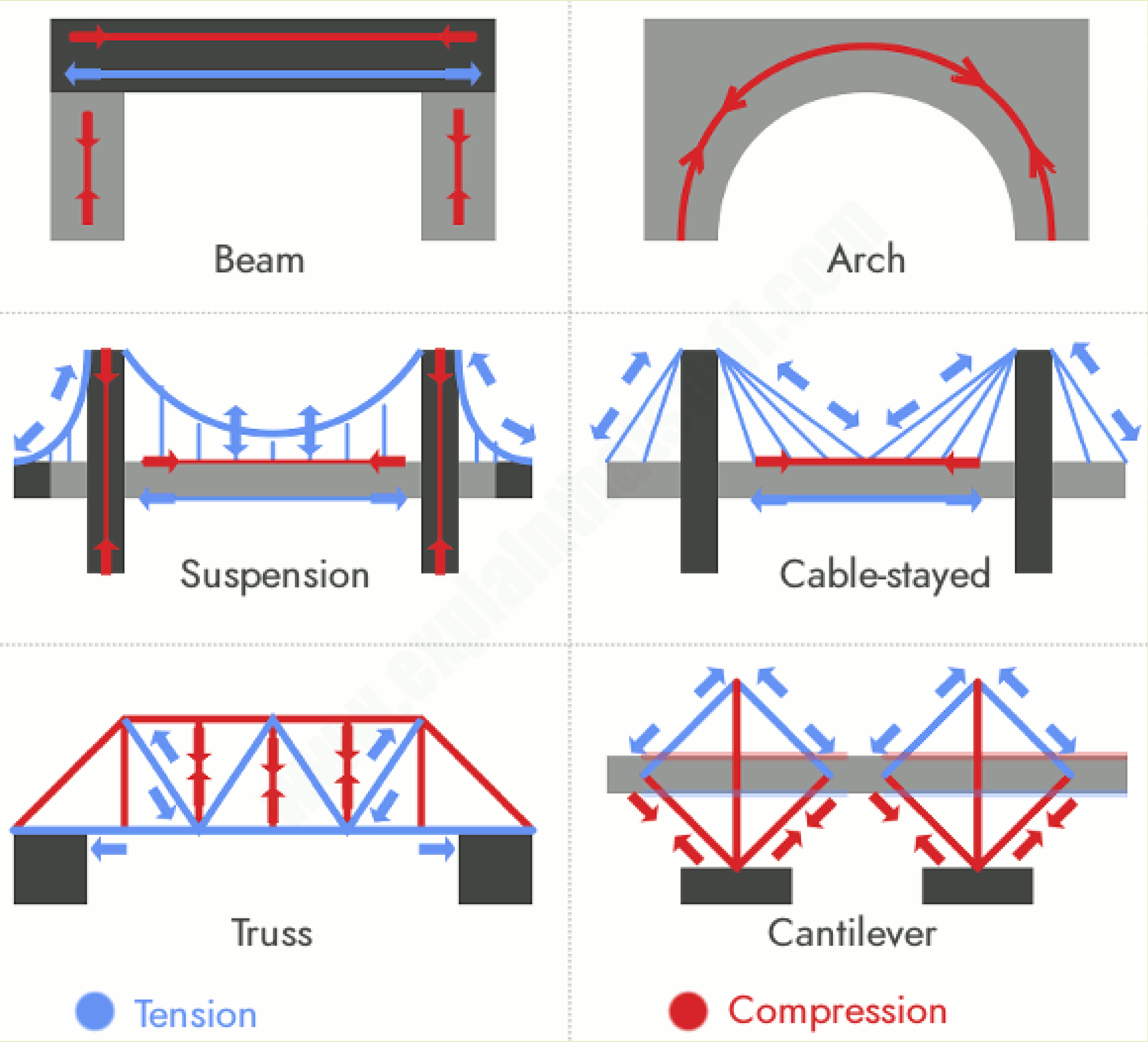
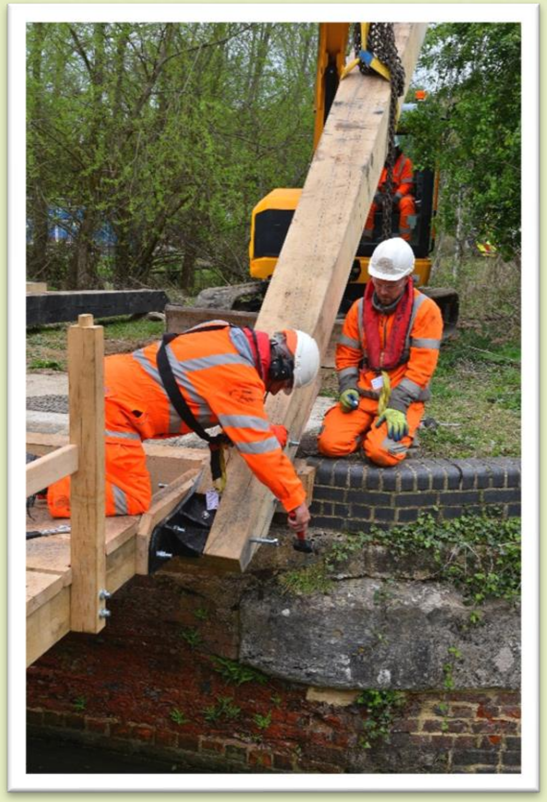


Image sourced from: Woodford, Chris. (2000/2020) Bridges. Retrieved from https://www.explainthatstuff.com/bridges.html. [Accessed (20/12/2024)]

Real-World Considerations

Load-Bearing Capacity: The amount of weight a bridge can safely support, including vehicles, pedestrians, and environmental factors like wind and snow.
Considerations:
- Engineers must calculate both the **live load** (traffic and moving weight) and the **dead load** (the bridge's own weight).
- Safety margins are built into the design to ensure the bridge can handle unexpected weight.

Materials: Common materials include **steel**, **concrete**, **wood**, and **composite materials**.
Considerations: Engineers choose materials based on **strength**, **durability**, **cost**, and **environmental factors**.
- **Steel** is often used for its tensile strength.
- **Concrete** is favoured for its compressive strength.
- **Wood** or **composites** may be used for smaller or more environmentally integrated structures.



Environmental impact and challenges

Environmental Impact

- **Ecosystems**: Engineers must ensure bridges do not disrupt local habitats, protected species, water flow, or wildlife migration. This is especially important near rivers and canals.
- **Waterways**: Bridges over rivers and canals need to account for **flooding risks**, **water current** dynamics, and the **preservation of water quality**.
- **Water Flow and Hydrology**: Engineers must ensure that bridges do not negatively impact the natural flow of rivers and canals, which can lead to erosion, flooding, or water quality issues.
- **Sustainability**: Using eco-friendly materials, minimising waste during construction, and designing for **energy efficiency** (e.g., using low-energy lighting) are key to reducing the environmental footprint of bridge projects.




Practical Challenges: Engineers must overcome challenges such as fluctuating water levels, soil conditions, and ensure bridge foundations are strong enough to handle both environmental and traffic stresses.

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STEM Careers

Civil Engineers

Structural Engineers

Environmental scientists

Mechanical Engineers

Surveyors (Land and Quantity Surveyors)

Construction Workers

Health and Safety Officers

Maintenance Technicians

Ecologists

Hydrologists

Heritage Conservation Specialists

Electricians

Planners and Permit Officers

Crane Operators and Heavy Equipment Operators

Geotechnical Engineers

Build a bridge challenge objectives

- Design and build a bridge across your canal
- It must be able to fit a canal boat underneath
- It must be able to support a minimum weight

20 mins: Use the materials provided to design and build a prototype bridge

Test: Preliminary bridge testing with weight

20 mins: Make any adaptations needed to your bridge

Present: Share your design choices and how you addressed challenges

Test: Testing maximum strength

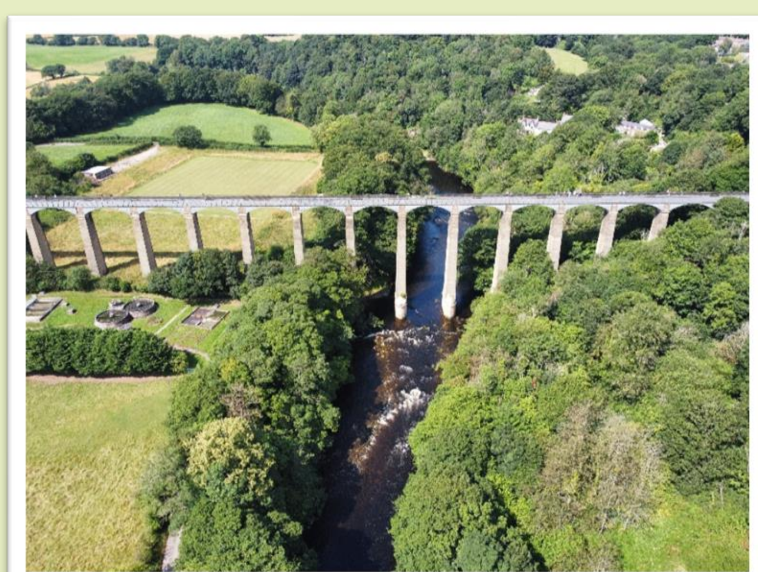
Design goal = structural integrity and creativity in design

Testing your bridge

Strength Test

Add weight carefully – and examine how your bridge handles the load

- Look at where there is compression and tension, is it buckling under the weight? If so, how can you balance this?
- How can you further strengthen your bridge?
- Is your bridge wide enough for the canal?
- Will it allow the boat to pass safely underneath?



Evaluation Criteria

Structural integrity – testing to maximum load

or

Creativity in design – the most aesthetic bridge design

Reflection and discussion

Team Presentations

Share your design and explain your choices

Key Questions

- How did you address structural challenges?
- Why did you make the design choices you did?
- What other factors did you consider?
- What worked well?
- Is there anything that your group found challenging?
- Is there anything you would do differently?