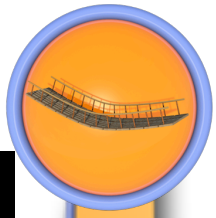
# Rope Bridge

## Episode 1: A Broken Bridge



Rope bridge 1 Broken bridge

## *Introduction*

In the Rope Bridge unit, students take role on internship engineers for a company which is commissioned to build various types of bridges around Kazakhstan. From the news, there is a broken bridge, which has been built since in the era of the Soviet Union and has been used for crossing the Kigash river between Kotyaevka village of Kurmangazy district, Atyrau region, Kazakhstan and Koshelevka village of Krasnoyarsk district, Astrakhan region, Russia. The villagers need it repaired. The company aims to involve the local people in the design of the bridge so you have been asked to explain the science behind the various possible bridges in a way that non-scientists can understand.

In this unit, students learn about the factors causing damage to the bridge, forces and result of forces acting on an object, how to calculate a resultant force, Newton's First Law of Motion, and the size of gravitational forces acting on an object.

Episode 1, *Broken bridge*, takes one hour. Teacher may evaluate students from their homework since there is not enough time available for them to complete the activity in class. Students learn the meaning of force and how a force can change the shape of an object when it acts on it.

## *Key words*

Force, Force acting on an object, gravity, weight, balanced forces.

## *Learning Objectives*

Students will:

- Explain the meaning of force.
- Summarise the advantages and disadvantages of different bridge designs.
- Carry out an experiment into the forces acting on bridges.

## *Learning Activities 110 min*

### Engage 20 min

Introduce students to the context and ask them to develop criteria for a good river crossing for the local people.

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| Slides 1-2 | Introduce the unit and explain the objectives for this episode to the students. If you have access to the uinternet you can find some video clips on YouTube or similar sharing sites showing damaged bridges in Kazakhstan or around the world. |
| Slides 3 - 4 | Introduce students to the chief engineer of the company that will repair or replace the broken bridge. Point out that simply replacing |

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| | the bridge with an identical one may not be the best strategy - maybe the local people might want a different way to cross the river. |
| Slides 5 -10 | Show the various images of ways to cross a river from around the world. |
| Slide 11 | Students should now work in groups to create a specification for the river crossing - encourage them to think creatively about what a good river crossing would be like not just list the things they have seen in the preceeding slides. |

## Explore 30 min

Students explore the forces acting on the bridge using a model in the laboratory.

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| Slide 12 | In groups students should explore the forces acting on the bridge. Show them how to use newton meters safely (make sure they do not pull the meters too hard) and then let them explore the forces acting on a rope bridge using Student Support Sheet 1 as a clue.<br><br>Most students will find the idea of a force pulling the bridge down quite easy to understand but will find it difficult to understand how an equal but opposite force is pulling it up. Give them time to play with the newton meters to find that forces come in pairs - if you connect two newton meters, hold one still and pull on the other both meters show the same force - its not just the one that you are pulling on. How does this relate to the forces acting on the bridge? |

## Explain 20 min

Students present their ideas and learn about how forces act.

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| Slide 13 | Let 2 – 3 groups of students present their ideas about forces from their work on SSS1: Forces acting on a bridge. Students' presentations should clearly answer these points:<br><br>What are the forces acting on the bridge?<br><br>How could these forces have damaged the bridge?<br><br>Encourage class discussion to recognise the idea of forces acting in pairs and that when two equal and opposite forces are applied the object does not move. This is a difficult, counterintuitive but important idea.<br><br>Discuss the notion of making the bridge stronger - by allowing the ropes, wooden platform and towers able to stand greater forces. Ask if the force the towers apply is greater when lots of people are crossing the bridge or when the bridge is empty. The force acting when people are crossing are larger. |

## Elaborate 30 min

The way a bridge manages the forces acting on it depends partly on the shape of the bridge. Students explore this with a simple experiment.

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| Slide 14 | Challenge students with the images of the different bridges. Which do they think would be the strongest shape for a bridge? Ask for predictions and then show them how to use a simple metal ruler to test their idea. Allow them to develop their own investigations here. |

## Evaluate 10 min

Students draw arrows to show the forces acting on a variety of possible bridge designs using ideas from their investigations.

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| Slides 15 -1 7 | Show the series of slides showing different possible bridges. Ask students to draw double-headed arrows to show the pairs of forces acting on the bridges. Student support Sheet 2: Force diagrams helps with this task and provides a useful record of their understanding. |

# *Assessment and differentiation*

**Formative assessment**
Take the opportunity to assess the students during questioning and whilst facilitating through questioning and observation when the students are completing the practical tasks.

**Differentiation**
Some students may require additional help and support when completing SS2.

# *Preparing for the Lesson*

## RESOURCES USED

Student support sheet 1: Forces acting on a bridge
Student support sheet 2: Force diagrams

## EQUIPMENT REQUIRED

**Engage**
Video clip: A broken bridge from YouTube for starting the unit.

**Explore**
For each group of students
Flat sticks to make rope bridge platform
String
Spring balances (at least 3 per group)
Student support sheet 1

**Explain**
None

**Elaborate**
For each group of students
Flexible steel ruler (30 cm)
Ruler used as symbol for starting point
Rope/rope yarn
2 spring balances

**Evaluate**
For each group of 2-4:
For each student:
Student support sheet 2