engineering

Structures: bridges and load

Lesson at a glance

Open with Irish bridge forms (stone arch, flat beam, Samuel Beckett Bridge) and ask why engineers use different shapes. Groups predict which of four card forms holds most load, then build flat, folded, arched and trussed bridges from one 8-strip budget across a fixed 20 cm span. They fair-test by stacking coins or washers at the centre one at a time, record counts on the Investigation Journal, and pool class figures into a four-bar chart on the IWB.

Learning objectives

- Build four bridges of different shapes from the same materials and span
- Fair-test how much load each shape holds before failure and compare the shapes using the evidence

Before the bell — prep

Cut A4 card lengthways into equal strips (~29.7 cm); bag 8 matching strips per group. Mark a 20 cm gap with tape or identical book stacks on each table. Set out scissors, tape for joins only, and a shared pile of coins or washers. Print the Investigation Journal page.

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Materials

Item	Qty	Per	Source	Low-cost substitute
card strips of equal size, long enough for a 20 cm span (e.g. A4 cut lengthways into matching strips)	8	group	classroom	cereal-box card cut into equal strips at least 25 cm long
scissors	1	group	classroom	teacher pre-cuts brace pieces if scissors are limited
masking tape	1	group	classroom	sticky tape
book stacks or wooden blocks as bridge supports	2	group	classroom	two identical boxes or tins of the same height
30 cm ruler (to set a 20 cm gap)	1	group	classroom	a marked 20 cm string or strip of paper
coins or metal washers for load testing	40	group	school kit	identical marbles or large metal nuts counted one by one
Investigation Journal page	1	pupil	provided printable	ruled paper for design choice, load counts and a short meaning note

Safety watch-point

Pupils stand back as a bridge fails — faces and fingers clear of snapping card and falling coins or washers. Scissors for truss cuts stay on the table; count weights back in at pack-away.

Teaching moves

- **Getting Started:** Show a stone-arch road bridge and the Samuel Beckett Bridge if you have photos; otherwise lean on the pupil text. Pose the key question and stop — do not hand out card or set the gap yet, or groups will start building while you talk.
- **Question and predict:** Sketch the four forms on the board. Agree fair-test rules aloud: same 20 cm span, same strip budget, centre loading one piece at a time, failure = sag to table or collapse. Say the material note clearly — flat, folded and arched use about one strip each; the truss may use the rest as braces. Take a quick show-of-hands prediction, then have groups write their ridge/triangle design choice on the Investigation Journal before any building.
- **Build the four bridges:** Model at the front with no loading: flat strip; thumbnail-creased zigzag ridges that still span 20 cm; gentle arch with thin end wedges only if ends slip; two simple triangles taped under a deck. Circulate with a ruler checking span. If a group stalls on the truss, point to the board how-to and ask for at least two clear triangles under the middle third. Remind: no scrap-box card; tape is for joins only.
- **Fair-test the load:** Model loading once on a flat strip only so the whole class sees the counting rule. Then insist: centre only, one coin or washer at a time, stop at the last count that still held. Prefer one clean trial of each shape over repeats of one. Part-way through, remind everyone to keep faces and fingers clear as card fails.
- **What the results mean:** Counts should already be on the page from testing. Circulate for a short meaning note — which shape held most, did it match the prediction — one or two sentences, not a rewrite of the table. Prompt: did the strongest shape also use more of the strip budget?
- **Pool the class results:** Drive the data-recorder with exactly four summary rows (class figure or average per shape). Show the bar chart, then ask which bar is tallest, whether every group ranked the same, what would make the test unfair, and how engineers weigh both shape and material. Link arches pushing load outward into supports and trusses sharing push and pull through triangles.

What it should show

Expect flat to hold least; folded and trussed usually beat flat; a well-made arch or truss often holds most. Results vary with build quality — weak folds, untaped triangle overlaps, or ends slipping off supports cut the count. A group whose flat strip somehow wins usually loaded off-centre or used extra card; re-check the budget and centre-loading rule.

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Misconceptions & interventions

- **Pupils think the 'strong' shapes are allowed thicker or longer card, or extra scrap from the box.** — Hold up the group bag of 8 strips and restate: everything for all four bridges comes from this budget only. Shape and arrangement change; the strip count does not.
- **Pupils concertina the folded strip into a short pack that no longer reaches both supports, or stack thick wedges under the arch like piers.** — Check span with the ruler at the table. Ridges must run along the span and still seat on both ends; arch wedges are thin slip-stops only, not stacked layers.
- **Pupils place coins near a support or drop several at once, then claim a high load count.** — Stop the trial and remodel centre-only, one-at-a-time loading on a flat strip. The recorded figure is the last count that still held before sag or collapse.

Differentiation

- {'emerging': ['Sit with the teacher table for the worked model; start with flat and folded only, then add arch and a two-triangle truss once those seat on the 20 cm span.', 'Use a partly pre-creased strip for the folded form so the group still spans both supports; they record one clean trial per shape.']}
- {'developing': ['If time allows a second trial on one shape, add the two counts and halve them (the mean) on the Investigation Journal.', 'Prompt: why did your strongest shape win — more ridges, more triangles, or more of the strip budget?']}
- {'proficient': ["Critique the fair test: name one change that would make a group's result unfair (span drift, end loading, extra card).", 'Link shape to real bridges — how an arch pushes load outward into the banks, and why a truss needs triangles.']}

Cross-curricular hook

Tie to Maths Data — pool four class load figures into the IWB bar chart and read which shape is the mode winner and the range of counts.