

Structures: Where Does It Actually Fail?

Lesson at a glance

Open by lowering a bean tin onto one newspaper tube so the class watches it fold in the middle, then name buckle, splay and twist with quick demos. Groups sketch a free-standing tower, build from newspaper, tape, straws and card (string held aside), and load weights one at a time until it fails — recording load held and failure type in the Investigation Journal. They add one matching tie or strut at the failure spot, re-test, then pool before/after loads on the IWB chart and talk about matching the fix to the force.

Learning objectives

- Load a tower to failure and name how it failed (buckle, splay or twist)
- Add one tie or strut where the structure actually failed, then compare the load held before and after

Before the bell – prep

Night before: gather newspaper, masking tape, drinking straws, card offcuts and string per group, plus bean tins or 200 g masses as shared test weights. Pre-roll one tight newspaper tube for the demo. Clear smooth desk space so splay is visible; keep scissors adult-supervised.

**Materials**

Item	Qty	Per	Source	Low-cost substitute
newspaper	6	group	brought from home	any scrap paper or old flyers
masking tape	1	group	classroom	sticky tape
drinking straws	10	group	supermarket	tightly rolled paper tubes
card offcuts	4	group	classroom	cereal-box card cut into strips
string for ties	1	group	classroom	wool or garden twine
test weights — about ten identical small items to add one at a time (bags of 20 washers, 100 g masses, or small bean tins)	10	group	school kit	ten matching pebbles or full glue sticks; anything the same weight as each other
metre stick	1	group	school kit	a 30 cm ruler used end over end
round-tip scissors	2	group	classroom	one shared pair per group

Safety watch-point

Adult supervises scissors and makes awkward cuts. Pupils stand back as towers collapse; mind eyes and fingers under falling weights and frames.



Teaching moves

- **Getting Started:** Roll one newspaper tube, stand it up and lower a bean tin onto the top so it bows and folds. Ask only where it went — top, bottom or middle — take a few guesses, and keep the folded tube for Step 2. Do not name the three failures yet.
- **Three ways a tower gives way:** Demo each failure before naming it: fold the saved tube for buckle; let two straw feet skid apart for splay; push a straw square so it leans for twist. Put only the five words on the board. Think aloud through the tube: predict middle fold, load it, name buckle, so the strut goes across the middle — not more tape at the top.
- **Sketch your tower and mark the weak spot:** Two minutes sketching on the Design Brief section of the Investigation Journal, one minute marking the predicted weak spot. Nudge specificity only: a predicted splay should already eye the feet; a predicted buckle should eye the middle. Do not hand them the fix.
- **Build the tower:** String stays unused in the middle of the table. Show one tight newspaper roll to any group whose tubes are floppy. Adult makes awkward scissor cuts. Keep builds free-standing and taller than wide.
- **Load it until it gives way:** Load one weight at a time with the group counting together; pupils stand back as it fails. Insist they name the failure out loud — buckle, splay or twist — not just ‘it broke’. Check both the load number and the failure type are on the Investigation Journal page before you leave the table.
- **One fix, exactly where the force was:** Keep the decision tree on the IWB: feet slid → tie; middle folded → strut; twisted → diagonal strut. One part only, at the failure spot. Re-test the same way with the same weights so before/after can be compared fairly, and get the new load written beside the first.
- **Pool the class results:** Drive the IWB recorder yourself while groups call out their two numbers. Note each group’s failure type as you go and ask whether the matching fix earned the extra load — a tie should lift a splay; a strut a buckle. Press the chart button so the after bars show where the fix worked.
- **Make sense of it:** Display-only talk: the right fix matches the failure; engineers add material where the force is, not everywhere. Link to the Samuel Beckett Bridge — cables as ties in tension, deck squashed like a strut. Tidy tape and offcuts; recycle newspaper.

What it should show

Expect most towers to fail by buckle (tall thin tubes fold mid-height), splay (feet skate out on a smooth desk) or twist (square frames rack sideways). A matching fix should raise the load held — tie across splayed feet, strut across a fold, diagonal strut against twist. Little or no gain usually means the wrong fix type or the fix was not placed on the actual failure spot; re-identify and re-test once.

**Misconceptions & interventions**

- **‘Just put more tape everywhere and it’ll hold more.’** — Hold up the failed tower and point at the spot that moved first. Remind them engineers add one part where the force actually is — that is why a bridge is full of gaps, not a solid block. Send them back to the decision tree.
- **Pupils write ‘it broke’ instead of naming buckle, splay or twist.** — At the moment of collapse, freeze the group and ask: did it fold in the middle, spread at the feet, or turn over? Have them say the word out loud before they record it.
- **A group adds a tie to a buckle (or a strut to a splay) and expects a big gain.** — Point at the chart pattern: the fix only works when it matches the failure. Ask what the failed part was doing — folding, sliding or leaning — then match tie or strut to that action and re-test.

**Differentiation**

Emerging	Developing	Proficient
• Offer a simple four-tube tower brief and sit with the group to name the failure together from the three words on the board before they record. • Partly mark the Investigation Journal row so they only fill load-before, failure type, and load-after.	• Nudge a more specific weak-spot prediction on the sketch (feet vs middle vs corner) before the first load. • After the fix, ask why that one part matched the force they saw.	• Allow a triangular or braced base and a prediction of a different failure mode. • Stretch: critique another group’s before/after pair — did the fix match the failure, and what would a second matched part do?

**Cross-curricular hook**

Tie to Maths Data — read the class before/after bar chart for the biggest gain and the typical improvement.