

Structures: Where Does It Actually Fail?

Lesson at a glance

Open by folding a rolled newspaper tube under a bean tin and asking pupils to watch WHERE it gives way. Introduce three failures — buckle, splay, twist — plus tie and strut, with quick hand demos. Groups sketch and mark a predicted weak spot on their Investigation Journal, build a tower from newspaper, tape, straws and card, then load it to failure and name the failure type. They add ONE tie or strut where it actually failed, re-test, and call out before/after loads for the class chart on the IWB.

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

Roll one tight newspaper tube ahead so your Step 1 demo folds cleanly — loose rolls just flop. Set out newspaper, tape, straws, card and string per group, but keep string aside until Step 6. Have identical test weights ready (tins of beans or stacked textbooks work). Set up the class before/after recorder on the IWB. Have scissors and an adult for awkward cuts.

**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

Tell pupils to stand back and mind eyes and fingers when a loaded structure collapses. Adult supervises scissors and makes any awkward cuts.



Teaching moves

- **Getting Started:** Lower the bean tin onto the newspaper tube and tell pupils to keep their eyes on the spot that moves first. Don't name the three failures yet — just take a few guesses about top, bottom or middle, then keep the folded tube for Step 2.
- **Three ways a tower gives way:** Show each failure with your hands BEFORE naming it: fold the tube (buckle), skid two straw feet apart (splay), rack a straw square sideways (twist). Then think aloud the full loop — wonder, predict, test, observe, fix — so groups have the cycle to copy. Head off 'more tape everywhere': engineers add material only where the force is.
- **Sketch your tower and mark the weak spot:** Give two minutes to sketch on the Design Brief section and one minute to mark the X and name the predicted failure. Nudge specificity — a group predicting splay should be thinking tie, one predicting buckle should be thinking strut — but don't hand them the fix.
- **Build the tower:** Show any group with floppy tubes how a tight roll makes a far stronger tube, and leave the string unused in the middle of the table. Supervise the scissors as they work, making any awkward cuts yourself.
- **Load it until it gives way:** Load one weight at a time with everyone counting aloud, and tell pupils to stand back as it goes. The moment it fails, name it out loud together — folded middle, spread feet, or turned over. Don't let any group write just 'it broke'; the failure name is the whole point.
- **One fix, exactly where the force was:** Hold each group to ONE tie or ONE strut, placed at the spot that failed and with no extra tape. Keep the decision tree on the IWB — feet slid → tie, middle folded → strut, twisted → diagonal strut — so groups can self-check. Re-test the same way with the same weights, so the before and after compare fairly.
- **Pool the class results:** Drive the recorder yourself while groups call out their two numbers from their desks. Note each group's failure type as you go, then draw out the pattern: a tie helps a splay, a strut helps a buckle — the fix works when it matches the failure.

What it should show

Every fixed tower should hold more weight than before — but only clearly so when the fix matched the failure. A splayed tower gains a lot from a tie across the feet; a buckled one gains from a mid-height strut; a twist needs a diagonal to triangulate. A group whose fix barely helped usually mis-named their failure (tie on a buckle), or loaded unevenly the second time — re-check the failure type against the decision tree.

**Misconceptions & interventions**

- **Pupils think the way to make a tower stronger is to add tape everywhere.** — Point to the folded newspaper tube and ask where it actually gave way — the middle, not the ends. Show that one strut at the fold does the job, and link it to why a bridge is full of gaps, not a solid block.
- **Pupils treat any fix as good** — 'I added a string, so it's stronger.' — Ask what would happen if you tied the feet of a tower that BUCKLED in the middle. Use the IWB decision tree to match fix to failure: a tie does little for a buckle.

**Differentiation**

Emerging	Developing	Proficient
• Build a simple four-tube tower and focus on naming just one failure type out loud. • Pair with the teacher table to mark the predicted weak spot before building.	• Predict a specific failure and justify which fix — tie or strut — will match it before testing. • Load a second re-test after the fix to check the improvement holds.	• Try a triangular or braced base and predict a different failure type. • Critique a group whose fix barely helped: was the failure mis-named, or the second load uneven?

**Cross-curricular hook**

Link to the Maths Data strand — pupils read the before/after bar chart and compare which fix earned the most extra load.