# STRONG STRUCTURES

## Activity Pack -- FREE Resource

Ages 8-11 | No Prior Reading Required
Classroom, Library and Home Use

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# Forces on a Bridge

Every bridge has to handle four forces. Engineers choose materials that are good at handling each one -- and they often combine materials to get the best of both.

### Activity 1: Match the Force

Write the letter of the right description next to each force.

| Force | Letter | Descriptions |
|---|---|---|
| Compression | ____ | A. Pulls things apart |
| Tension | ____ | B. Twists something |
| Torsion | ____ | C. Slides one layer past another, like scissors |
| Shear | ____ | D. Pushes things together |

### Activity 2: Strong Materials

1. Concrete is great at handling _____ (pushing together).

2. Steel is great at handling _____ (pulling apart).

3. Steel rods inside concrete make _____ concrete.

4. When a beam bends, its top is squashed by _____ and its bottom is stretched by _____.

## Think About It

* Why do you think most bridges use reinforced concrete?

* What does 'structural fatigue' mean? What else wears out slowly?

# The Coin Test

Four bridges were built from index cards and tape over a 20-centimetre gap, then loaded with coins until they broke. Every failure taught the builder something.

### Activity 1: The Results

| Bridge | Design | Coins Held |
|---|---|---|
| Bridge 1 | Flat beam | **23** |
| Bridge 2 | Truss (triangles) | **81** |
| Bridge 3 | Arch | **157** |
| Bridge 4 | Arch and truss together | **214** |

### Activity 2: Compare the Bridges

1. How many more coins did Bridge 2 hold than Bridge 1? 81 - 23 = _____

2. How many more did Bridge 3 hold than Bridge 2? _____

3. How many more did Bridge 4 hold than Bridge 1? _____

4. Is Bridge 4 about 3 times, 9 times or 20 times stronger than Bridge 1? _____

5. The Tacoma Narrows Bridge fell in 1940. How many years ago was that? _____

## Think About It

* Which change made the biggest difference? How do you know?

* Why is it important to change only one thing at a time when you test?

# Triangle Power and Bridge 5

A triangle is the only shape that can't be pushed out of shape unless a side breaks. That's why engineers build **trusses** -- frameworks made of triangles -- to spread the load.

### Activity 1: Shape Test

Imagine each shape made from straws joined at the corners. Push on one corner. Does it hold its shape?

| Shape | Holds its shape | Squashes flat |
|---|---|---|
| Square | [ ] | [ ] |
| Triangle | [ ] | [ ] |
| Rectangle | [ ] | [ ] |
| Square with a diagonal straw | [ ] | [ ] |

### Activity 2: Design Bridge 5

**DRAW YOUR BRIDGE 5. LABEL THE TRIANGLES, ARCHES OR STRUTS:**

I predict it will hold _____ coins, because _____

## Think About It

* Where can you see triangles in buildings, towers or playgrounds?

* What would you change to make your bridge even stronger -- and why?

# When Things Break

**Note to students:**
This worksheet explores personal feelings. There are no right or wrong answers -- your thoughts are your own. Sharing is always optional. If any question brings up big feelings, please talk with a trusted adult.

When something we build breaks, it can feel disappointing. But every failure tells you something. Engineers expect things to break when they test them -- that's how they learn.

### Activity 1: Feeling Check-In

Circle the words that show how you feel.

**When something I made doesn't work, I feel:**
Frustrated Sad Curious Cross Okay Other: _____

**When I try again and it works better, I feel:**
Proud Excited Relieved Happy Other: _____

**When someone sees me fail, I feel:**
Embarrassed Okay Shy Fine Other: _____

### Activity 2: A Time Something Didn't Work

**DRAW A TIME SOMETHING YOU TRIED DIDN'T WORK:**

What it taught me: _____

## Think About It

* Is it true that every failure tells you something? Why?

* What could you say to a friend whose project just broke?

# Bend, Don't Break

The Golden Gate Bridge is built to sway several metres in strong winds. Bending spreads the stress out. Bamboo bends in a storm that would snap an oak tree. People can be like that too.

### Activity 1: Stiff or Flexible Thinking?

| What Someone Says | Stiff | Flexible |
|---|---|---|
| 'It broke. I give up.' | [ ] | [ ] |
| 'What did this teach me?' | [ ] | [ ] |
| 'Let's change one thing and try again.' | [ ] | [ ] |
| 'There's only one right way to do it.' | [ ] | [ ] |
| 'It broke in a new place -- there's more to learn!' | [ ] | [ ] |

### Activity 2: My Failure Log

| What Went Wrong | What It Taught Me | What I'll Change |
|---|---|---|
| | | |
| | | |
| | | |

## Think About It

* Where in your life could being a little more flexible make you stronger?

* What did engineers learn when the Tacoma Narrows Bridge fell in 1940?

# My Bend-Don't-Break Goals

The strongest structures aren't the ones that never bend -- they're the ones built to bend without breaking. Here is a challenge: when something goes wrong, ask what it taught you, then change one thing and try again.

## Activity 1: My Goals

Write or draw one goal for each time.

| Goal Tier | My Goal | How I Will Do It | When I Will Start |
|---|---|---|---|
| **THIS WEEK** | | | |
| **THIS TERM** | | | |
| **THIS YEAR** | | | |

## Activity 2: Bend-Don't-Break Tracker

Colour a star each day you do it.

| I did it! | Mon | Tue | Wed | Thu | Fri |
|---|---|---|---|---|---|
| I tried again after something went wrong | * | * | * | * | * |
| I changed one thing and tested again | * | * | * | * | * |
| I asked what a mistake taught me | * | * | * | * | * |
| I stayed flexible when plans changed | * | * | * | * | * |
| I built or tested a structure | * | * | * | * | * |

## Think About It

* Write your own 'bend, don't break' motto in 10 words or fewer.

* Who do you know who bends without breaking? What do they do?

# Teacher's Companion

**No Prior Reading Required**
This pack is fully standalone. No book or characters are referenced. Any student can complete these worksheets without prior reading. Suitable for classroom, library, and home learning programmes. This pack is an excerpt of a full book-specific learning pack available with purchase at **learningsmart.au**

## Australian Curriculum Alignment

| Learning Area | Strand | Year Level | Content Description (summary) |
|---|---|---|---|
| Science | Physical Sciences | Yr 3-6 | Forces (push, pull, twist, shear) act on structures; materials suit different forces (WS1) |
| Science | Science Inquiry | Yr 3-6 | Plan fair tests, change one variable, record and compare results (WS2, WS3) |
| Mathematics | Number and Statistics | Yr 3-6 | Subtract to compare; estimate multiples; interpret data (WS2) |
| Design and Technologies | Engineering Principles | Yr 3-6 | Shapes and structures that resist forces; design and test (WS3) |
| Health and PE | Personal, Social and Community Health | Yr 3-6 | Resilience and coping with setbacks (WS4, WS5) |
| Gen. Capabilities | Personal and Social Capability | Yr 3-6 | Persist, reflect on mistakes and adapt (WS5, WS6) |
| Gen. Capabilities | Critical and Creative Thinking | Yr 3-6 | Evaluate designs and improve them (WS3) |

## 16 Key Strong Structures Lessons

| # | Lesson |
|---|---|
| 1 | Every bridge handles four forces: compression, tension, torsion and shear. |
| 2 | Compression pushes together; tension pulls apart. |
| 3 | Torsion twists; shear slides one layer past another. |
| 4 | Concrete is strong in compression; steel is strong in tension. |
| 5 | Reinforced concrete combines both, so it is strong both ways. |
| 6 | Structural fatigue: tiny cracks grow slowly until a material gives way. |
| 7 | The failure you can see is often just the last step. |
| 8 | A triangle can't be pushed out of shape unless a side breaks. |
| 9 | Trusses are frameworks of triangles that spread the load. |
| 10 | Arches turn the load into compression along the curve. |
| 11 | Combining designs can make a structure much stronger. |
| 12 | Change one thing at a time when you test. |
| 13 | Every failure tells you something. |
| 14 | Engineers learned from the Tacoma Narrows Bridge collapse in 1940. |
| 15 | Bending spreads stress out; being stiff piles it up in one spot. |
| 16 | Big idea: The strongest structures bend without breaking. |

## Answer Keys and Discussion Guidance

**WS1 -- Forces on a Bridge (Answers)**
Compression = D; tension = A; torsion = B; shear = C. Activity 2: 1. compression; 2. tension; 3. reinforced; 4. compression, tension.

**WS2 -- The Coin Test (Answers)**
1. 58; 2. 76; 3. 191; 4. about 9 times (23 x 9 = 207); 5. answer depends on the current year (e.g. 2026 - 1940 = 86).

**WS3 -- Shape Test (Answers)**
Holds its shape: triangle; square with a diagonal straw (it becomes two triangles). Squashes flat: square; rectangle.

**WS4 -- Sensitivity Note for Educators**
Some students find failure very distressing. Do NOT require sharing of personal failures. Model your own 'useful failures'. If a student discloses a concern, follow your school's wellbeing and child safety protocol.

**WS5 -- Stiff or Flexible? (Answers)**
Stiff: 'I give up'; 'only one right way'. Flexible: 'What did this teach me?'; 'change one thing and try again'; 'more to learn'. Failure log: no right answers.

**WS6 -- Challenge Tracker**
There are no correct scores. Celebrate every attempt; any day left blank is a chance for a gentle reminder, not correction.

**Upsell Note for Educators**
This generic pack is based on the Learning Smart book series. The full book-specific learning pack -- which references the characters, story moments, and adventure narrative -- is available with book purchase or subscription at **learningsmart.au**. Book-specific packs significantly increase student engagement and reading motivation.

## Differentiation Strategies

| Level | Strategy | Example Application |
|---|---|---|
| Below Level (support) | Reduce written output; use sentence starters; allow verbal responses; pair with peer. | WS2: use a calculator or number line for the larger subtractions. WS4: use feeling faces instead of writing. |
| On Level (standard) | Complete all activities as written. Use discussion partner for Think About It sections. | Standard completion with class debrief of Think About It questions. |
| Extension (enrichment) | Run the index-card coin test in teams; graph the results and present the winning design. | WS3: research a famous bridge and identify its trusses, arches or cables. |

## 7 Discussion Questions

1. What are the four forces that act on a bridge?
2. Why can't a triangle be pushed out of shape -- and why does that help engineers?
3. Why did the Tacoma Narrows Bridge fall -- and what did engineers learn from it?
4. Does every failure tell you something? Is that true for things other than bridges?
5. What does 'structural fatigue' mean? Can you think of anything else that wears out slowly?
6. Where in your life could being a little more flexible make you stronger?
7. Why do engineers test things until they break?

## Classroom Display Ideas

**Coin Test Leaderboard:** A class chart of bridge designs and the coins each one held.

**Four Forces:** A poster showing compression, tension, torsion and shear with arrows.

**Triangles Everywhere:** Photos of trusses found in towers, cranes, roofs and playgrounds.

**Bridge 5 Gallery:** Display the WS3 designs with students' predictions.

**Useful Failures:** A wall where students share what a failure taught them.

**Bend, Don't Break:** A bamboo-and-oak display with flexible-thinking phrases.

## Want the Full Adventure?

This free activity pack is inspired by the **Learning Smart book series** -- everyday adventures about character, confidence and growing into a kind, capable leader.

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