



### Activity title

## Stronger Structures

### Time required

2 hours

### Activity summary

Reinforcing structures and testing them to failure

### By the end of this activity, you will be able to:

- Make a model of a cuboid, a triangular prism and a cylinder.
- Understand how different shaped structures perform under load.
- Understand how structures can be strengthened and reinforced.

### What equipment will you need?

- 210 mm x 210 mm thin card
- Scissors
- Masking tape

### How to do it

Structures are all around us. They enable buildings, bridges and vehicles to withstand the stresses placed on them every day. Can you find out what shapes are the strongest, and how they can be made even stronger?

You are going to construct card models of a cuboid, a triangular prism and a cylinder. You will then place loads on each to see which is the strongest and record the results. You will learn about ways that structures can be strengthened and apply these to your models.



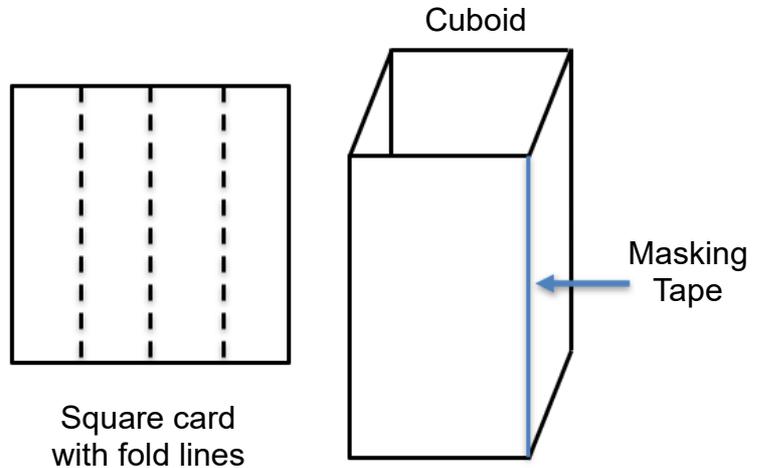
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### Now try this

Make sure you make two of each shape: One for testing without reinforcement, and the other for testing with reinforcement.

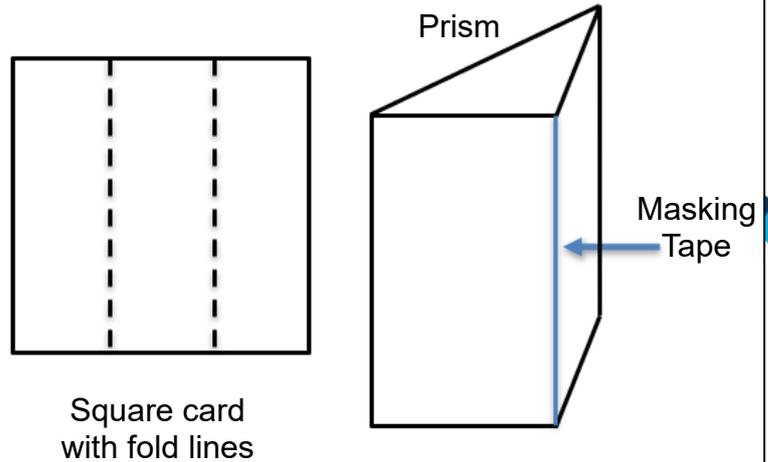
#### 1. Making a Cuboid

- Make four equally spaced fold lines on a square piece of card.
- Fold inwards along each line to form a hollow cuboid.
- Stick a piece of masking tape along the full length of the point where the end card pieces meet, to join them.



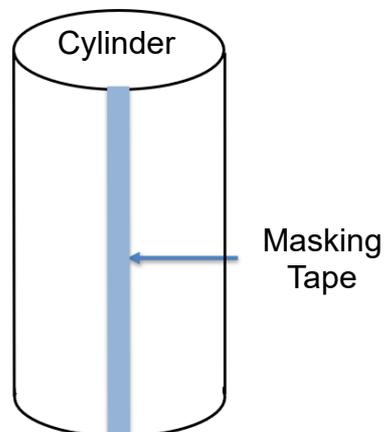
#### 2. Making a Prism

- Make three equally spaced fold lines on a square piece of card.
- Fold inwards along each line to form a hollow triangular prism.
- Stick a piece of masking tape along the full length of the point where the end card pieces meet,



#### 3. Making a Cylinder

- Fold a square piece of card inwards to form a hollow cylinder.
- Stick a piece of masking tape along the full length of the point where the end card pieces meet, to join them.



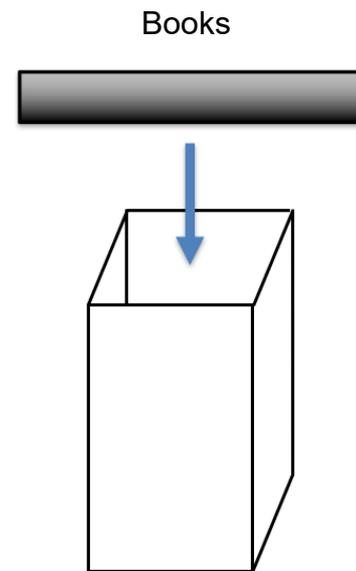
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### 4. Load testing each structure

It is best if the structures are stood on the floor for testing, as the books will fall off when failure occurs

- For each shaped structure that you have built:
- Place books on top of the structure, one at a time.
- Write down how many books can sit on top of the structure before it fails
- Which is the strongest and which is the weakest structure?



This type of testing is called 'destructive testing' – testing the structure to failure. To ensure fair testing, you should use the same books and place them on top in the same order for each structure (as some may have more mass than others).

### 5. Results of structural testing

For each shaped structure that you have built record the results in the table below:

Shape	Number of books that can be placed on top before failure
Cuboid (square top)	
Prism (triangular top)	
Cylinder (circular top)	

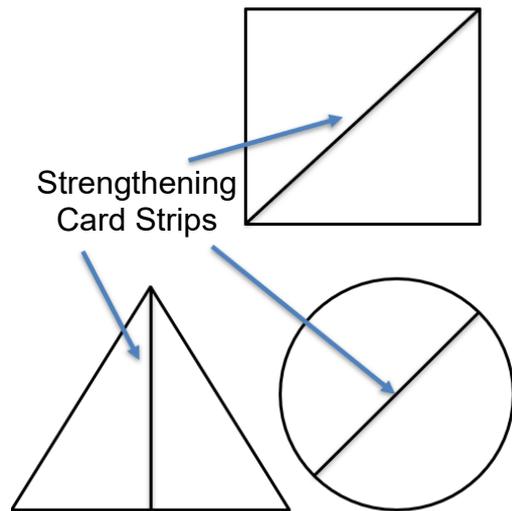
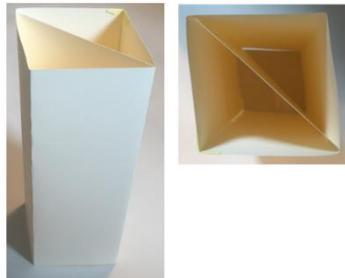


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### 6. Reinforcing each structure

- Cut 210 mm long strips of card that would fit exactly through the centre of each shape.
- Place the strips of card through the centre of each shape and tape in place.
- Repeat the load testing. What difference does this reinforcing make?
- Add further reinforcement and test its effect.



Strengthening Card Strips

For examples of making a paper tower:

YouTube – Paper book tower experiment: Video showing the load testing of a paper cylinder  
<https://www.youtube.com/watch?v=UeB5XhQ2FL4>

### You could also

Plot your load test results as a bar chart.

### Further activities you could carry out

You could research examples of the use of 'triangulation' in structural systems.

For examples of triangulation in structures:  
Technology Student – Triangulation: Examples of the use of triangulation in different structures.  
<http://www.technologystudent.com/struct1/triag1.htm>

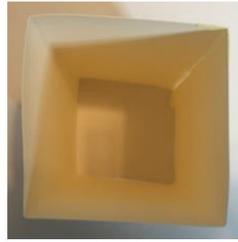


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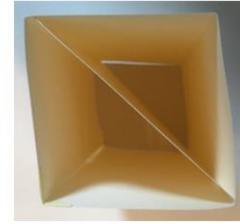


What results were expected?

Example of a cuboid structure before and after strengthening:



Non-Strengthened



Strengthened

