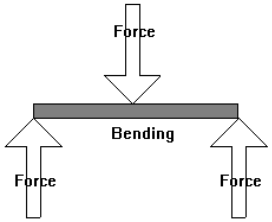
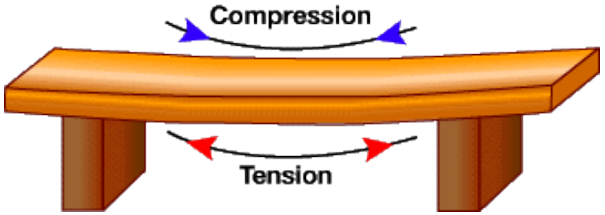
Specialist Technical Principles
Forces and stresses

A: Bending

Bending forces act at an angle to an object and make it bend. Placing too many books or very heavy objects on a shelf can apply forces that make it bend.

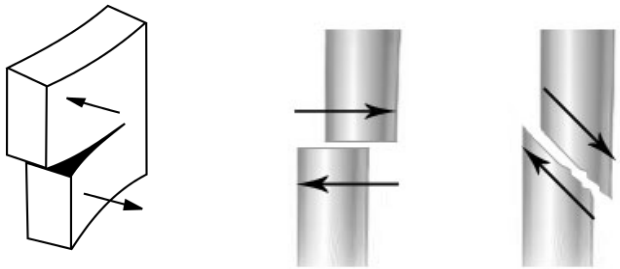


When an object bends it is under tension and compression at the same time. As seen in the diagram below, the top of the bench is experiencing compression and the bottom of the bench is under tension.



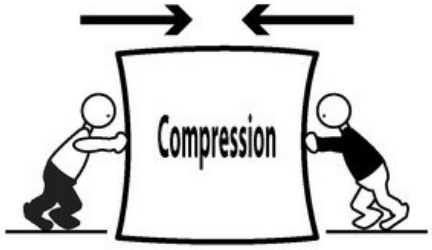
B: Shear

Shear forces act across a material by acting near to one another but not directly opposite each other. A shearing force cuts the object by pushing it sideways in opposite directions. Scissors and garden shears have a shearing action that causes paper or grass to be cut by making one piece slide across the other, creating two pieces.



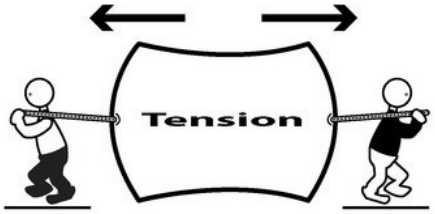
C: Compression

Compression forces are pushing forces that squeeze an object. An example might be when you stand on a drinks can and squash it. Table and chair legs are under compression when an object is placed on the table or someone sits on a chair.



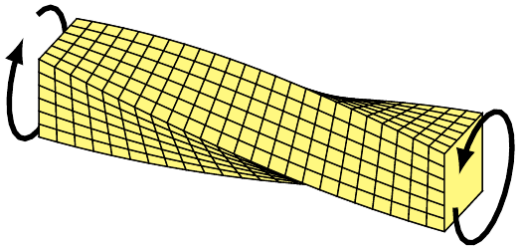
D: Tension

Tension forces are pulling forces that cause an object to be stretched or pulled apart. A rope in a tug of war competition is under tension as each side tries to pull the other.



E: Torsion

Torsion forces occur when a material is being twisted. The two ends of the material rotate in opposite directions creating a twist - like wringing out a wet towel.
Many structures and objects, including cars driving on uneven road surfaces and boats riding over waves, are subject to torsion.



F: Enhancing materials

Materials can be enhanced to resist and work with forces and stresses, to improve their functionality. Many robust items are made from what we consider weak materials - they just need to be strengthened, like in this corrugated card chair.

To strengthen or enhance a material you first need to consider the forces and stresses that it will have to resist when in use. Knowing this allows the designer to strengthen only the parts that need it, saving materials, energy and time.

Reinforcing

A way of strengthening a material or an object by adding material to it to improve its ability to withstand forces and stress.

Concrete is a material that is very good at resisting compressive forces, but not very good when in tension. To overcome this it can be reinforced with steel bars, which are embedded in the concrete before it sets. Steel bars are very good at resisting tension forces and so the combination produces a material which is excellent for use in bridge and building construction due to its ability to resist both tension and compression forces.

Stiffening

Some forms of reinforcement involve stiffening a material through manipulation. Folding and bending techniques can be used to improve the mechanical and physical properties of a material.

Timber may be stiffened by the process of laminating. Thin layers or 'ply' of timber are glued together to shape and stiffen the material in the manufacture of chairs and other furniture.

Laminated timber is also used in the construction industry. By laminating a number of small pieces of timber together into a single large beam it is given greater strength to resist the forces that create bending, compressive and tensile loads in structures.

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G: Keywords

- Tension: a pulling and stretching force
- Compression: a pushing and squashing force
- Torsion: a twisting force
- Shear: a force which cuts an object by pushing it sideways in both directions
- Bending: a force which is acting at an angle to an object
- Reinforcing: adding material to strengthen and stiffen a product
- Stiffening: reinforcing a material by manipulation

H: Video and web-links

- How it works - skyscraper: https://www.youtube.com/watch?v=YjJJeB4x5go

Revision Checklist

I can recognise and characterise the five different types of force that can act upon structures	
I understand the impact of different forces and stresses on materials	
I understand how materials may be enhanced to resist and work with forces and stresses to improve functionality	

Test yourself

1. Give three examples of materials under tension.

2. Draw a diagram to show the direction of the forces when a material is under torsion.

3. What **two** forces are acting when a material is being bent?

4. What will happen to a material if it is subjected to greater tensile force than it can withstand? e.g. A rope in a tug of war.

5. Which of the following are examples of a shear force?

   a. a pencil lead breaking when being pressed too hard [ ]

   b. a fence post snapping in a storm [ ]

   c. a car tow bar breaking [ ]

6. Give a specific example of how bending or folding a material can add strength or functionality to a product.