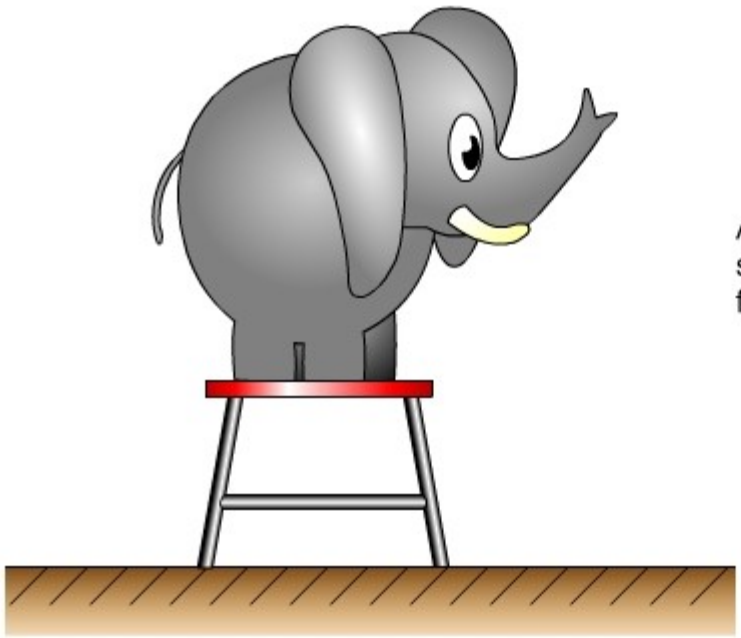
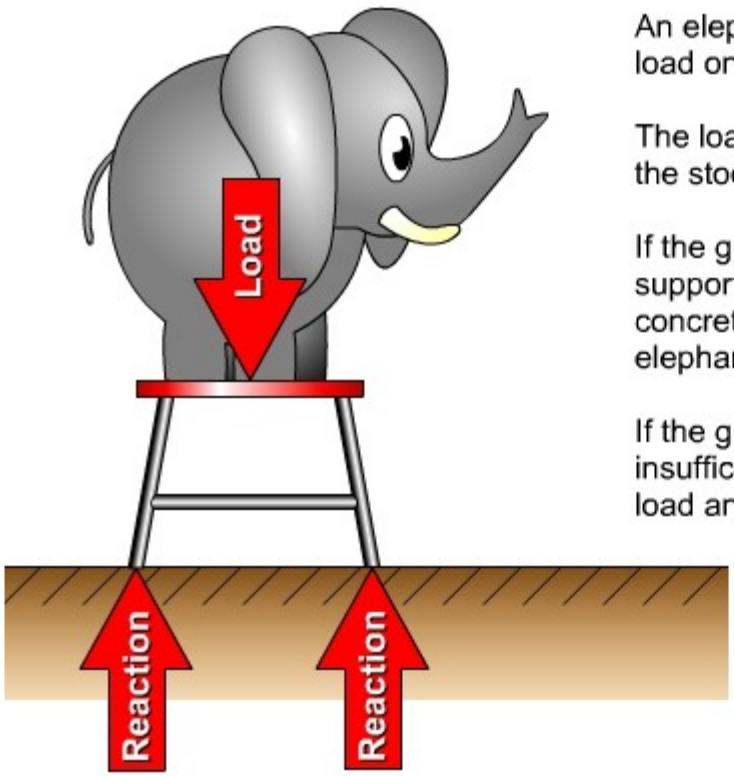
Forces

Compression Forces



An elephant standing on a stool exerts a compression force on the stool.

Compression Forces Explained



An elephant standing on a stool creates a load on the stool.

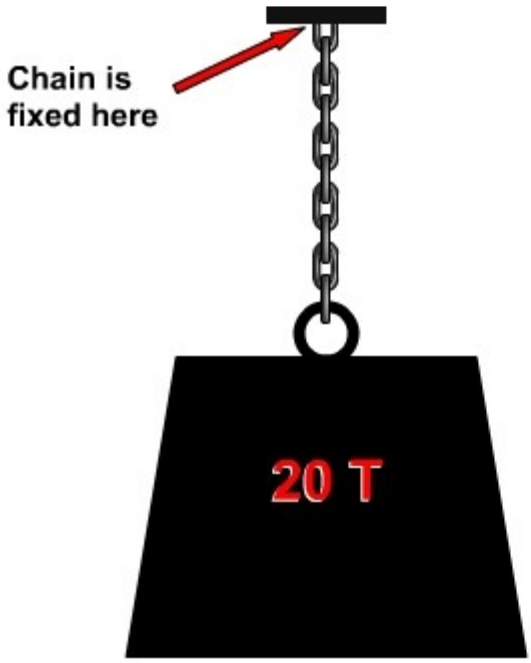
The load is transmitted through the top of the stool and down the legs to the ground.

If the ground is hard, like concrete, it will support the load. A reaction force in the concrete resists the load imposed by the elephant and the stool.

If the ground is soft, there will be an insufficient reaction force to support the load and the stool will sink into the ground.

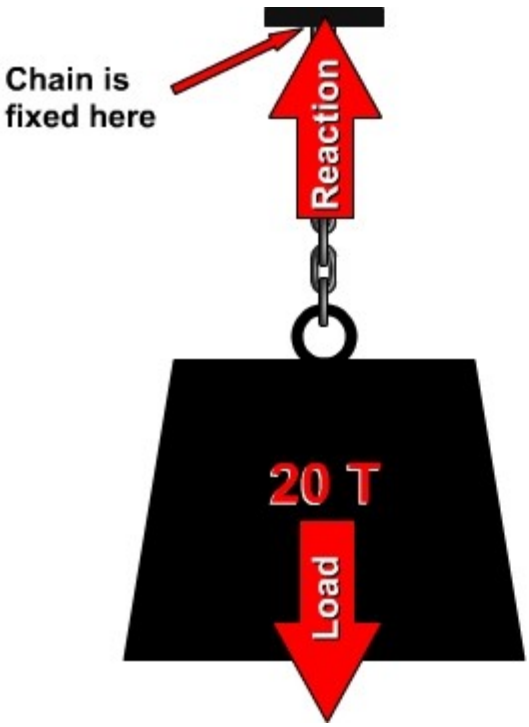
The load created by the elephant and the reaction force from the ground results in a compressive force on the stool.

Tension Forces



The 20 Tonne weight exerts a tension force in the chain.

Tension Forces Explained



One end of a chain is attached to a fixed point, the other end of the chain is attached to a 20 Tonne weight.

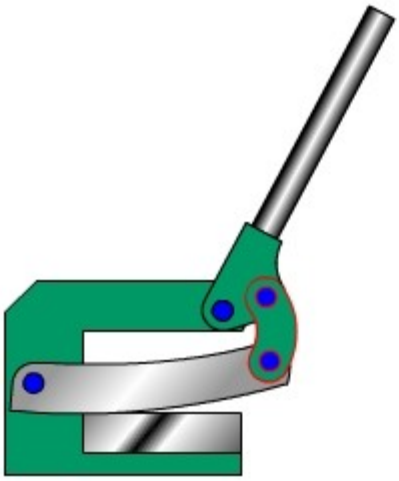
The load from the 20 Tonne weight is transmitted through the chain to the fixed point. There is a reaction force at the fixed point that supports the load imposed by the weight and the chain.

The load from the 20 Tonne weight and the reaction force at the fixed point creates a tension force in the chain.

Torsion Force

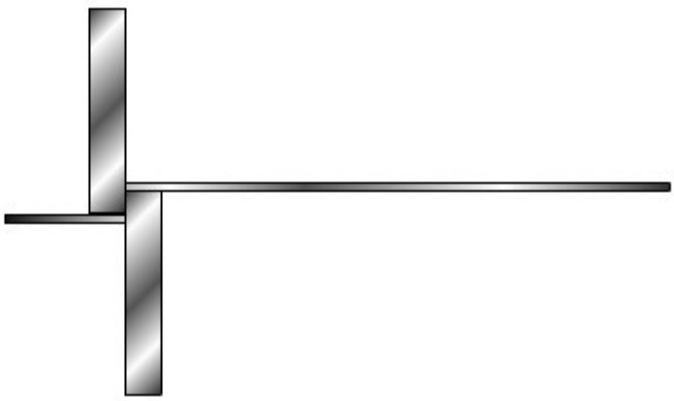
A torsion force is a twisting force in a structure.

Shear Force

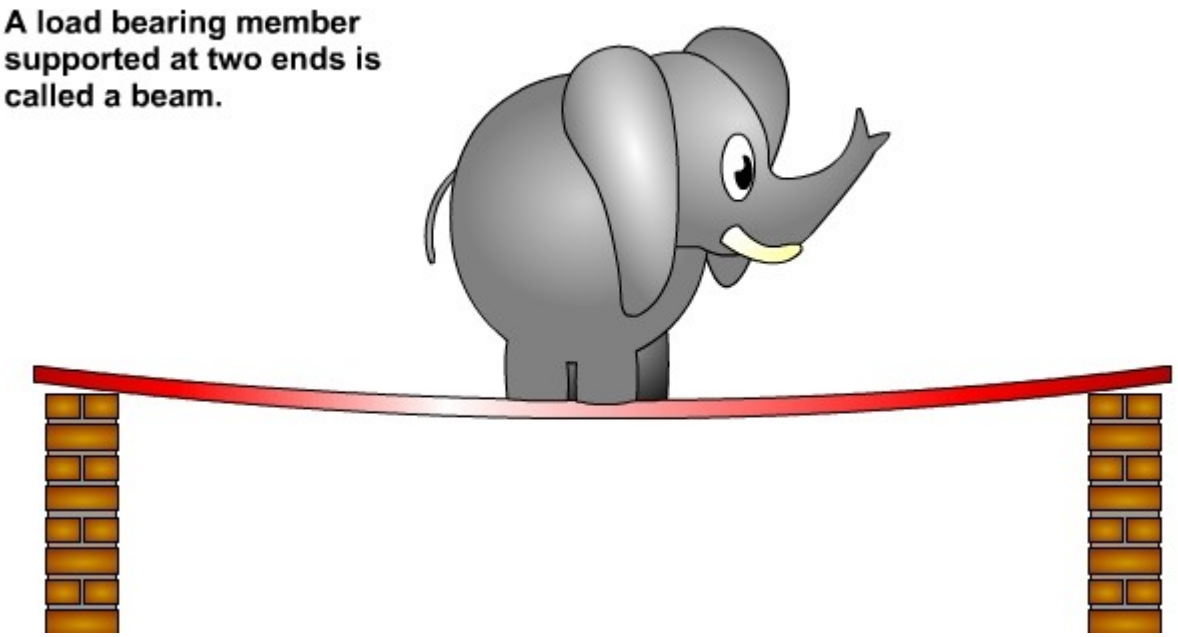


Bench Shears

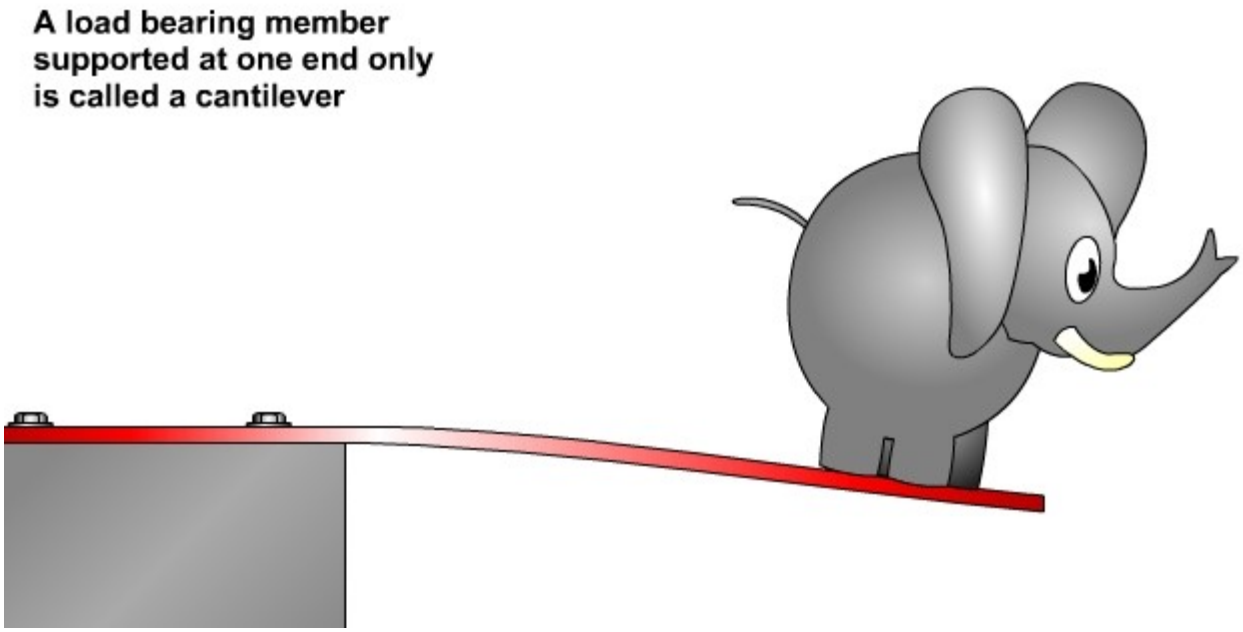
A shear force is created in anything that gets between a part that slides past another part.



Bending Force on a Beam



Bending Force on a Cantilever



What is a force?

A force is a pushing, pulling, twisting, shearing or bending effect on an object.

External forces

External forces are forces applied to an object by people, tools, machines or other objects.

Internal forces

Internal forces within materials are the molecular bonds within materials and their reactions to external forces. All materials are composed of elements or compounds. Each element has its own distinct chemical and physical properties that make it a solid, liquid or a gas, hard, soft, ductile or malleable, a metal or non-metal etc.

The materials we use to make products retain their shape because of the strength of their internal molecular bonds. These internal bonds resist external forces to various degrees, depending on the element and the strength of its internal molecular bonds. The shape of the material will not change unless a force greater than the strength of the material's internal molecular bonds is applied to it.

The strength of a material's internal molecular bonds can be weakened in some cases by:

- **heating**: e.g. heat causes metals to expand and weaken the molecular bonds holding the metal in its original shape. When a metal is red hot, or white hot, it can easily be hammered, bent and twisted into new shapes. If the metal is heated further, its molecular bonds weaken to the point that the metal turns to a liquid and flows.

- **work hardening**: work hardening occurs when a metal is hammered or bent repeatedly and stresses are created in the metal. The metal first gets very hard at the point where it was hammered or bent repeatedly, due to the strain imposed on the material's molecular bonds. If hammering or bending continues, the metals molecular bonds will be strained to breaking point.

These internal stresses can be relieved in metals by processes called annealing and normalising. These processes involve heating a metal to a point at which the metal will expand, its molecules move further apart and the stresses between the molecular bonds are relieved. On cooling, the metal contracts, the molecules move closer together and settled in equilibrium, i.e. in an unstressed state. It remains in its hammered, bent or twisted shape but the stresses between the molecules have been relieved.

Measuring Forces

The Newton (N) is the standard unit used for measuring a force. One Newton (N) is the amount of force required to support 100g.

Describing Forces

A force is described by its:

- magnitude, i.e. the size of the force
- direction
- location, i.e. where the force is applied.