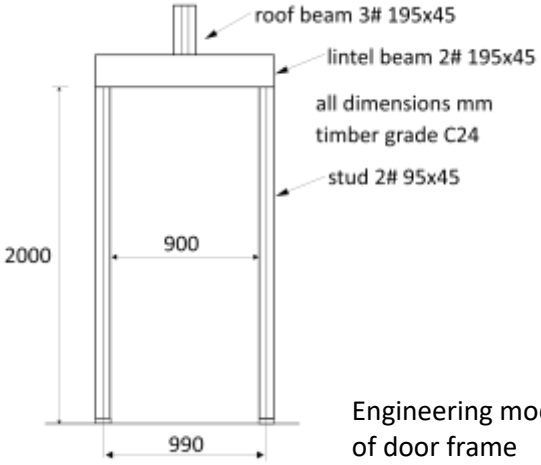
Shear forces in a lintel beam

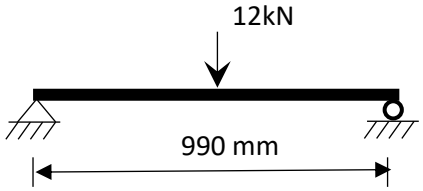
Basic principle - vertical equilibrium. The sum of the upward forces is equal to the sum of the downward forces for: (a) a structure, (b) a part of a structure and (c) at an interface between parts of a structure.

Door lintel beam supporting a roof beam



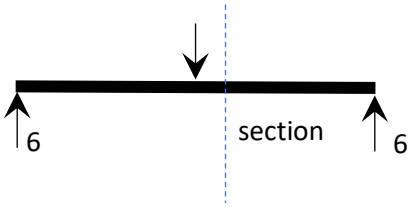
Engineering model of door frame

Vertical equilibrium of the lintel beam Calculate the values of the reactions



Analysis model
Central point load
Pin support on left and roller support on right.

The structure is assumed to behave according to the theory of bending



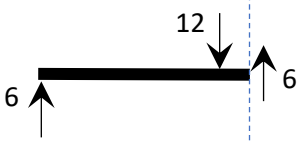
Forces on the structure
Free body diagram (FBD) of the structure

The central vertical load must be balanced by 6 kN end forces at the supports. Due to symmetry they are equal.

Calculate the shear force at a section

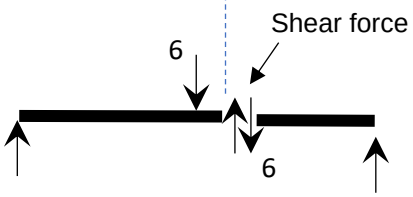
FBD of part of structure to right of the section

The right-hand end force needs to be balanced by a downward force at the section.



FBD of part of the structure to the left of the section

The sum of the load and the end force needs to be balanced by an upward force at the section



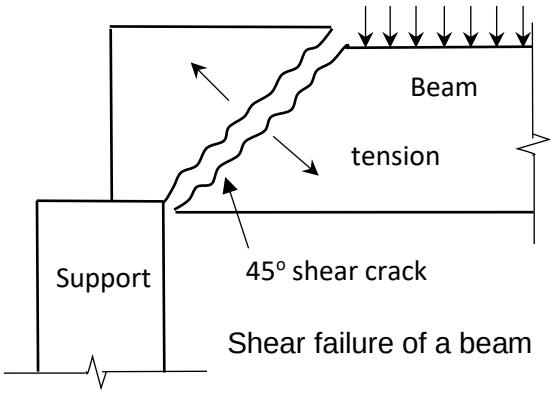
Forces at an interface
For vertical equilibrium there must be a pair of shear forces at the section.

This is the *shear force* - an internal force action in the member. It can be thought of as a pair of equal and opposite shear forces at a section.

The value of a shear force at a section of a horizontal beam is the sum of the vertical forces on the part of the beam to one side of the section.

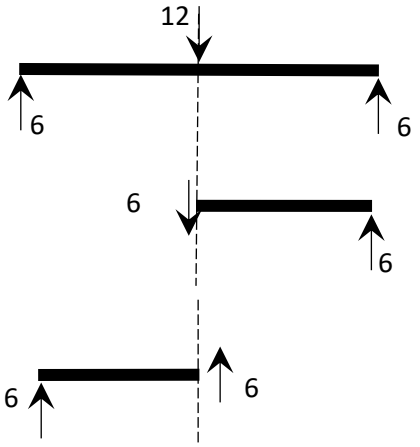
Shear failure

Excessive shear force in a member can cause shear failure. A shear crack can form at a 45° angle at positions of higb shear force in a beam. It is therefore important to find out the position of the highest shear force in a beam.
A *shear force diagram* is drawn for this purpose.



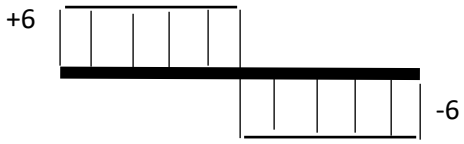
Shear failure of a beam

Shear force diagram



Section at the centre of the beam
Beam the right of the section.
The sum of the forces to the right of the section is 6kN upwards

Beam to the left of the section. The sum of the shear force to the left of the section in 6kN up to the left



The shear force diagram
Sign convention A common sign convention for shear force is positive if the force is upwards to the left and hence downwards to the right.
To the left of the load the shear force is constant +6kN and to the right it is constant -6kN.

Definitions

Shear force a force in a direction that is parallel to the surface on which it is considered to act; an internal force action at a section of a member that acts parallel to the section. The value of a shear force at a section of a horizontal beam is the sum of the vertical forces on the beam to one side of the section.

Vertical equilibrium the vector sum of the vertical forces is zero or the sum of the upward forces is equal to the sum of the downward forces for: (a) a structure, (b) a part of a structure and (c) at an interface between parts of a structure.

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