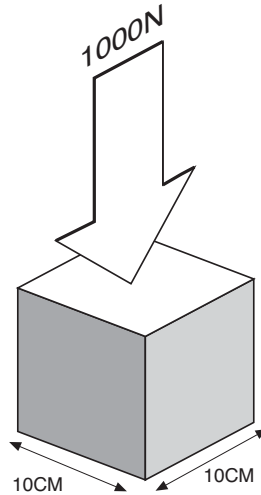


# STRESS STRAIN AND ELASTIC MODULUS

In everyday conversation, the words 'stress' and 'strain' are used as if they mean the same thing - e.g. 'the stress and strain of travelling'. In engineering, these terms have a very distinct meaning and must be used correctly.

## STRESS ( $\sigma$ )

Stress is defined as load (or force) per unit area. If a load acting on the block shown exerts a force of 1000 N, the stress is given as:

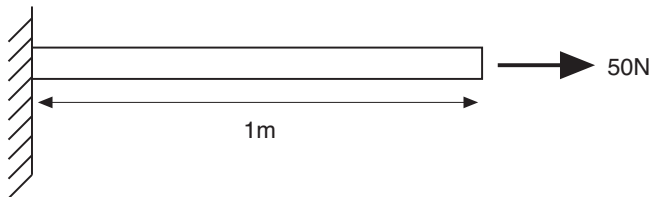


$$\text{Stress } (\sigma) = \frac{\text{force}}{\text{area}} = \frac{1000 \text{ N}}{100 \text{ cm}^2} = 10 \text{ N/cm}^2$$

There is a force of 10 N acting on every square cm of the block. In engineering, stress is normally expressed in units of MN/m<sup>2</sup> (1,000,000 Newtons per square metre).

The ultimate tensile stress (UTS) for a range of materials is shown in Study File 3. This is the greatest tensile ('pulling apart') force per unit area that the materials can withstand before failing.

## STRAIN ( $\epsilon$ )



Strain is the change in unit length that a material undergoes when subject to a load (or force). If a load on the bar shown exerts a force of 50 N, and as a result the bar extends in length from 1 m to 1.1 m, the strain is given as:

$$\text{Strain } (\epsilon) = \frac{\text{change in length}}{\text{original length}} = \frac{0.1 \text{ m}}{1 \text{ m}} = 0.1 \text{ (or a change of 10\%)}$$

Strain is a fraction of the original length and is simply expressed as a number; it does not have units.

## ELASTIC MODULUS (E)

'Elastic modulus' or 'modulus of elasticity' of a material is a measure of its stiffness. Elastic modulus is given by:

$$E = \frac{\text{stress}}{\text{strain}}$$

When stress (measured in m<sup>2</sup>) is divided by strain, the resulting number is still expressed in the units for stress. The approximate elastic modulus for several common materials is:

Steel	210,000 MN/m <sup>2</sup>
Aluminium	72,000 MN/m <sup>2</sup>
Wood	15,000 MN/m <sup>2</sup>
Rubber	7 MN/m <sup>2</sup>

Of these materials, rubber is the least stiff and steel the most stiff.