Chapter 4
Testing Materials

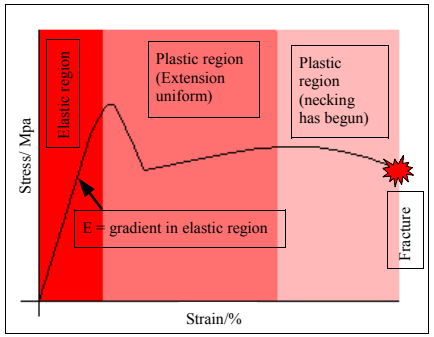
Compression and Tension

Object in Compression
Compressive forces squash the object.

Object in tension
Tensile forces stretch the object along its length.

Object bends
On the outside of the bend the object is in tension. On the inside of the bend bone is in compression.

Object breaks
A break happens when a crack develops in the surface which is in tension.



Elastic Limit (Yield point): point where metal becomes deformed.
Breaking stress: Point at which metal breaks

Type of Materials

- **Synthetic (Man made eg polymers)**
- **Natural (Occur naturally eg wood)**
- **Metals eg steel, lead**
- **Polymers eg polyethene, nylon**
- **Ceramics eg diamond, cement**
- **Composite (A material made of more than one substance in order to combine the desirable properties eg bone which is made of calcium phosphate crystals and collagen fibres)**

Conductivity and Resistivity

R Resistance ↔ G Conductance: $G = 1/R$

ρ Resistivity (Ωm) ↔ σ Conductivity ($\Omega^{-1}m^{-1}$ or Sm^{-}): $\rho = 1/\sigma$

$\rho = \frac{RA}{l}$ $\sigma = \frac{Gl}{A}$

Stress, Strain and Young modulus

Force (N)

Extension

Stress $\sigma = F/A$

Area (m)

Strain $\acute{\varepsilon} = x/L$

Length

Strain is a ratio of 2 lengths so has no units. Sometimes expressed as %

Force per unit area Pa or Nm^{-2}

Young modulus (Nm^{-2})

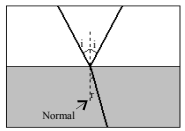
$\sigma/\acute{\varepsilon} = E$

Light

When light reaches a boundary between materials in which it travels at different speeds:

- part is reflected
- it refracts as it enters the new material

refractive index $n = \frac{\text{speed of light in a vacuum}}{\text{speed of light in material}}$



$n = \frac{\sin i}{\sin r}$

The gradient of a graph sini against sinr is the refractive index.
Total internal reflection occurs when the angle of incidence is greater then the critical angle.