Higher Properties of Materials

Most common properties to be considered include:

1. **STRENGTH** - the ability of a material to resist force, the bigger the force it can resist the stronger the material.

2. **ELASTICITY** - the ability of a material to return to its original shape or length once an applied load or force has been

removed.

3. **PLASTICITY** - the ability of a material to change its shape or length under a load and stay deformed even when the

load is removed.

4. **DUCTILITY** - the ability of a material to be stretched without fracturing and be formed into shapes such as very thin

sheets or very thin wire.

5. **BRITTLENESS** - the property of being easily cracked, snapped or broken.

6. **MALLEABILITY** - the ability of a material to be shaped, worked or formed without fracturing.

Stress

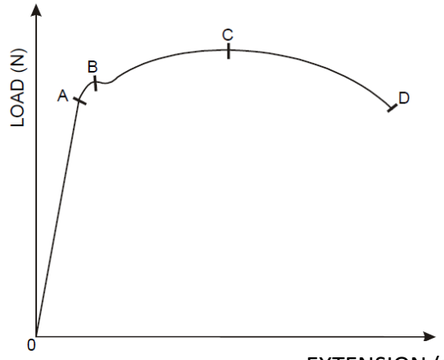
$$Stress = \frac{Force}{Area}$$

$$\sigma = \frac{F}{A}$$

Strain

$$Strain = \frac{Change\ in\ Length}{Original\ Length}$$

$$\varepsilon = \frac{\Delta L}{L}$$



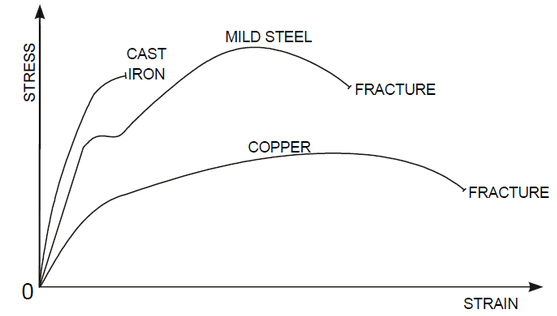
'A' - Limit of Elasticity and any loading beyond this point results in plastic deformation of the sample.

'B' - yield point and a permanent change in length results even when the load is removed.

Loading beyond this point results in rapidly increasing extension. Between points ' B' and ' D' the material behaves in a plastic or ductile manner.

'C' - maximum or ultimate tensile force that the material can withstand is reached.

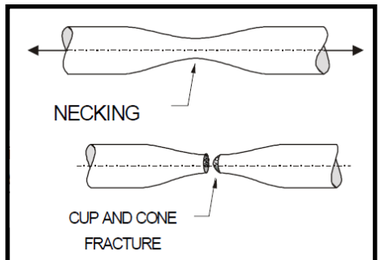
Between 'C' and 'D' the cross-sectional area of the sample reduces or 'necks'. 'Necking' reduces the cross-sectional area of the specimen, which in turn reduces the strength of the sample. The sample eventually breaks or **fractures at point ' D'.**



1. Yield Stress is the maximum stress that can be applied to a structural member without causing a permanent change in length.

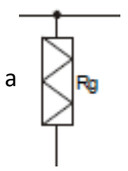
2. Yield Strain is the maximum percentage plastic extension produced in a material before it fails under loading.

3. Ultimate Tensile Stress (UTS) of a material is the maximum stress the material can withstand before it starts to fail.



Strain Gauge

Converts a change in force into a change in resistance. Used in voltage divider circuits.



Elastic Strain Energy

Es = ½Fx

Factor of Safety

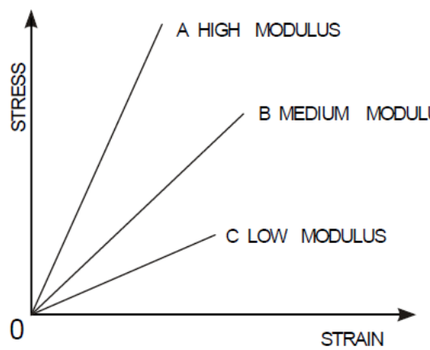
$$Factor\ of\ Safety = \frac{Ultimate\ Load}{Safe\ Working\ Load}$$

$$Factor\ of\ Safety = \frac{Ultimate\ Stress}{Safe\ Working\ Stress}$$

Young's Modulus

$$E = \frac{Stress}{Strain}$$

$$E = \frac{\sigma}{\varepsilon}$$



Material	Young's Modulus kNmm^{-2}	Yield Stress Nmm^{-2}	Ultimate Tensile Stress Nmm^{-2}	Ultimate Compressive Stress Nmm^{-2}
Mild Steel	196	220	430	430
Stainless Steel	190-200	286-500	760-1280	460-540
Low-alloy steel	200-207	500-1980	680-2400	680-2400
Cast iron	120	-	120-160	600-900
Aluminium alloy	70	250	300	300
Soft Brass	100	50	80	280
Cast Bronze	120	150	300	-
Titanium alloy	110	950	1000	1000
Nickel alloys	130-234	200-1600	400-2000	400-2000
Concrete (steel reinforced)	45-50	-	-	100