Physical and mechanical properties of metals

Objectives: At the end of this lesson you shall be able to
- **name the different physical and mechanical properties of materials**
- **state the characteristics of the mechanical properties of metals.**

Properties of metals

Metals have different properties. Depending on the type of application, different metals are selected.

Physical properties of metals

- Colour
- Weight/Specific gravity
- Structure
- Conductivity
- Magnetic property
- Fusibility

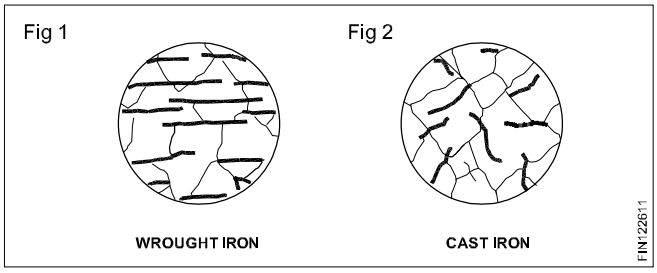
Colour

Different metals have different colours. For example, copper is of a distinctive red colour. Mild steel is of a blue/black sheen.

Weight

Metals differ based on their weight. A metal, like aluminium, weighs lighter (specific gravity 2.8) than many others, and a metal, like lead, is heavy (specific gravity 9).

Structure (Figs 1 and 2)



Generally metals can also be differentiated by their internal microstructure. Metals like wrought iron and aluminium will have a fibrous structure, and metals like cast iron and bronze will have a granular structure.

Conductivity

Thermal conductivity and electrical conductivity are the measure of the ability of a material to conduct heat and electricity. Conductivity will vary from metal to metal. Copper and aluminium are good conductors of heat and electricity.

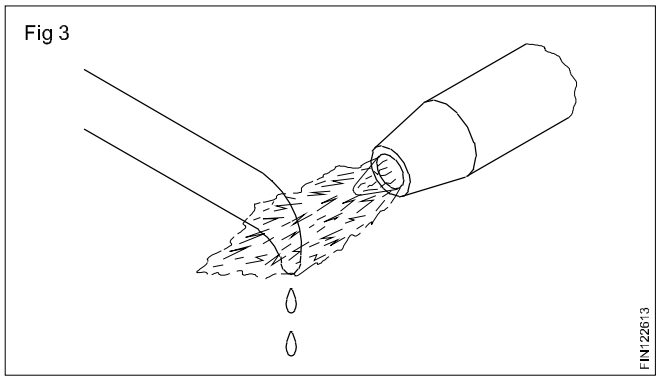
Magnetic property

A metal is said to possess magnetic property, if it is attracted by a magnet.

Almost all ferrous metals, excepting some types of stainless steel, can be attracted by a magnet and all non-ferrous metals and their alloys will not be attracted by a magnet.

Fusibility (Fig 3)

It is the property possessed by a metal by virtue of which it melts when heat is applied. Many materials are subject to the transformation in shape (i.e.) from solid to liquid at different temperatures. Tin has a low melting temperature (232ºC)and tungsten melts at a high temperature (3370ºC).



Specific gravity

It is the ratio between the weight of the metal and the weight of equal volume of water.

Mechanical properties

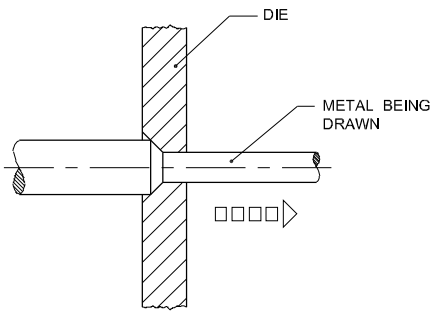
The mechanical properties of a metal are

- ductility
- malleability
- hardness
- brittleness
- toughness
- tenacity
- elasticity

Ductility (Fig 4)

A metal is said to be ductile when it may be drawn out in tension without rupture. Wire-drawing depends upon ductility for its successful operation. A ductile metal must be both strong and plastic. Copper and aluminium are good examples of ductile metals.

Fig 4



Malleability (Figs 5 and 6)

Fig 5

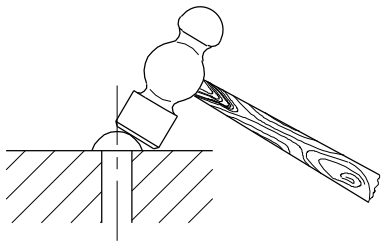
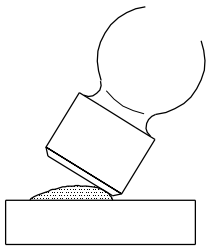


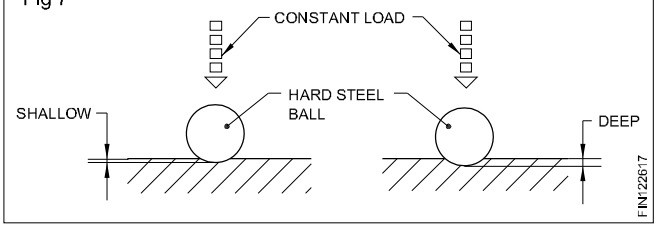
Fig 6



Malleability is the property of permanently extending in all directions without rupture by hammering, rolling etc. to change its size and shape. Lead is a very malleable metal.

Hardness (Fig 7)

Fig 7

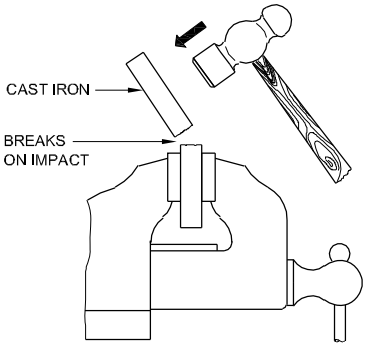


Hardness is a measure of a metal's ability to withstand scratching, wear, abrasion and penetration.

Brittleness (Fig 8)

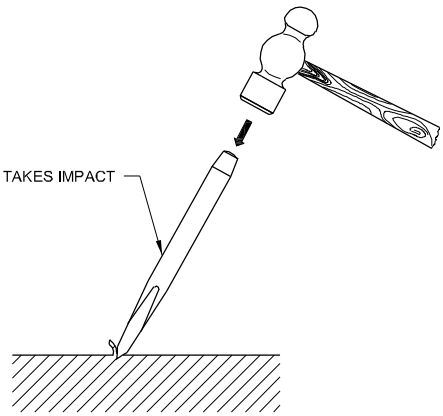
Brittleness is the property of a metal which permits no permanent distortion before breaking. Cast iron is an example of a brittle metal, and it will break rather than bend under shock or impact.

Fig 8



Toughness (Fig 9)

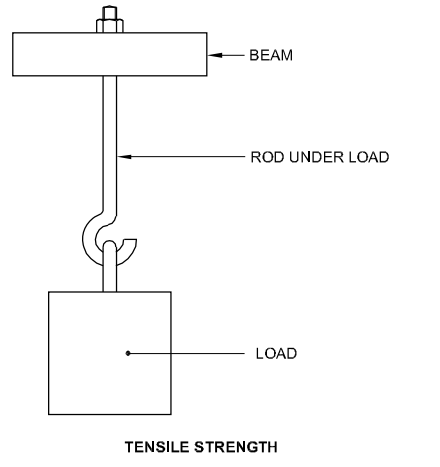
Fig 9



Toughness is the property of a metal to withstand shock or impact. Toughness is the property opposite to brittleness. Wrought iron is an example of a tough metal.

Tenacity (Fig 10)

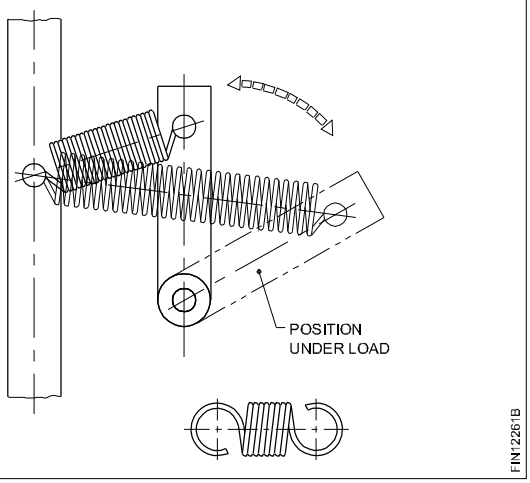
Fig 10



Tenacity of a metal is its ability to resist the effect of tensile forces without rupture. Mild steel, wrought iron and copper are examples of tenacious metals.

Elasticity (Fig 11)

Fig 11



Elasticity of a metal is its power of returning to its original shape after the applied force is released. Properly heat-treated spring is a good example of elasticity.

Specific gravity

It is the ratio between the weight of the metal and the weight of equal volume of water.