Mechanical Properties of Metals:

A. Strength

The strength of metal is its ability to withstand various forces to which it is subjected during a test or in service. It is usually defined as tensile strength, compressive strength, proof stress, shear strength, etc. Strength of materials is a general expression for the measure of capacity of resistance possessed by solid masses or pieces of various kinds to any cause tending to produce in them a permanent and disabling change of form or positive fracture.

B. Elasticity:

A material is said to be perfectly elastic if the whole of the stress produced by a load disappears completely on the removal of the load, the modulus of elasticity of Young's modulus (E) is the proportionally constant between stress and strain for elastic materials.

C. Plasticity:

Plasticity is the property that enables the formation of permanent deformation in a material. It is reverse of elasticity; a plastic material will retain exactly the shape it takes under load, even after the load is removed. Gold and lead are the highly plastic materials. Plasticity is used in stumping images on coins and ornamental work.

D. Ductility:

It is the ability of a metal to withstand elongation or bending. Due to this property, wires are made by drawing out through a hole. The material shows a considerable amount of plasticity during the ductile extension. This is a valuable property in chains, ropes etc., because they do not snap off, while in service, without giving sufficient warning by elongation.

E. Malleability:

This is the property by virtue of which a material may be hammered or rolled into thin sheets without rupture. This property generally increases with the increase of temperature.

F. Toughness

Toughness (or tenacity) is the strength with which the material opposes rupture. It is due to the attraction which the molecules have for each other; giving them power to resist tearing apart.

The area under the stress-strain curve indicates the toughness (i.e., energy which can be absorbed by the material upto the point of rupture). Although the engineering stress-strain curve is often used for this computation, a more realistic result is obtained from a true-stress curve. Toughness is expressed as energy absorbed (Nm) per unit volume of material participating in absorption (m^3) or Nm/m^3. This result is obtained by multiplying the ordinate by the abscissa (in appropriate units) of stress-strain plot.

H. Hardness:

Hardness is usually defined as resistance of material to penetration. Hard materials resist scratches or being worn out by friction with another body.

I. Fatigue:

When subjected to fluctuating or repeating loads (or stresses), materials tend to develop a characteristic behaviour which is different from that (or materials) under steady loads. Fatigue is the phenomenon that leads to fracture under such conditions.

Fracture takes place under repeated or fluctuating stresses whose maximum value is less than the tensile strength of the material (under steady load). Fatigue fracture is progressive, beginning as minute cracks that grow under the action of the fluctuating stress.

J. Creep:

"Creep" is the slow plastic deformation of metals under constant stress or under prolonged loading usually at high temperature. It can take place and lead to fracture at static stresses much smaller than those which will break the specimen by loading it quickly. Creep is specially taken care of while designing I.C. engines, boilers and turbines