MECHANICAL ENGINEERING SCIENCE

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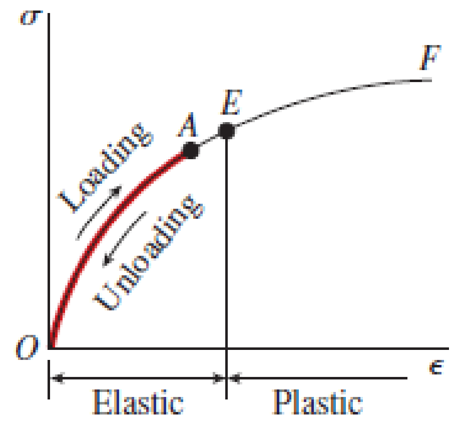
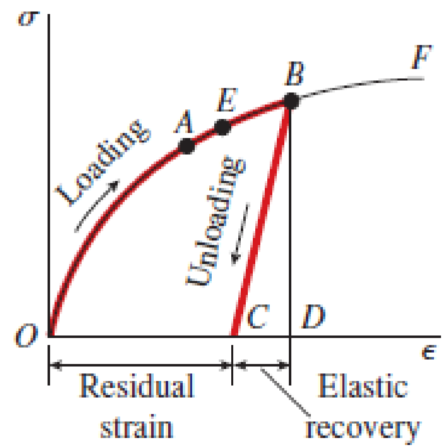
MECHANICAL PROPERTIES OF ENGINEERING MATERIALS

1) **Strength**: ***Strength is defined as the ability of the material to resist, without rupture, external forces causing various types of stresses.***
Depending upon the type of stresses induced by external loads, strength is expressed as tensile strength, compressive strength or shear strength. The terms yield strength and ultimate strength have been explained previously.



2) **Elasticity**: ***Elasticity is defined as the ability of the material to regain its original shape and size after the deformation, when the external forces are removed.***



3) **Plasticity**: ***Plasticity is defined as the ability of the material to retain the deformation produced under the load on a permanent basis.***

4) **Stiffness**: ***Stiffness or rigidity is defined as the ability of the material to resist deformation under the action of an external load.***

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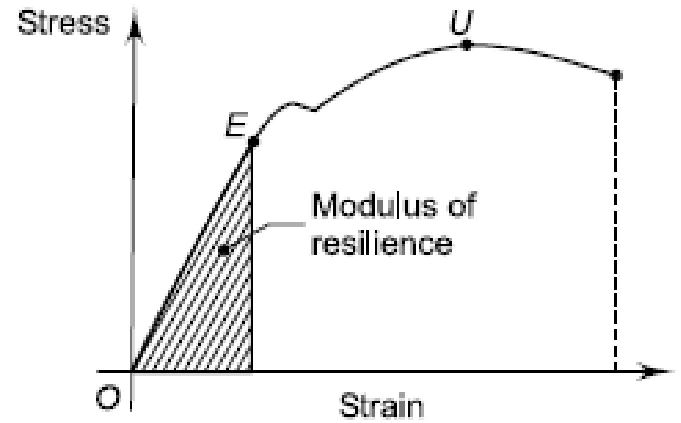
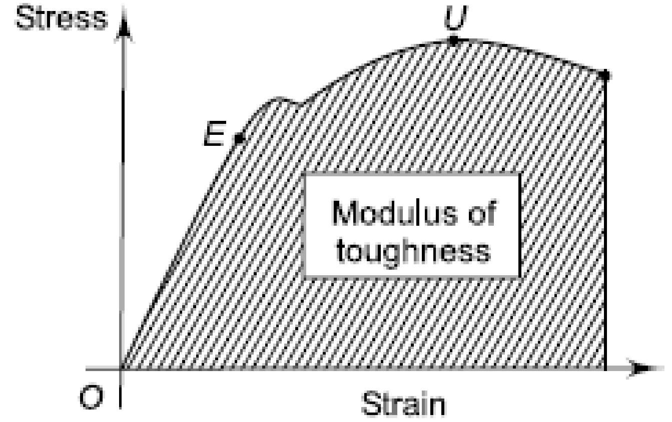
5) Resilience: *Resilience is defined as the ability of the material to absorb energy when deformed and to release this energy when loaded.*
This property is essential for spring materials. It is measured by a quantity called **modulus of resilience** which is represented by the area under stress strain curve from the origin to the elastic limit.



(a)

6) Toughness: *Toughness is defined as the ability of the material to absorb energy before fracture takes place.*
This property is essential for machine components which are required to withstand impact loads. It is measured by a quantity called **modulus of toughness**. Modulus of toughness is the total area under stress – strain curve in a tension test.



(b)

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7) Malleability: *Malleability is defined as the ability of a material to deform to a greater extent before the sign of crack, when it is subjected to compressive force.*

8) Ductility: *Ductility is defined as the ability of a material to deform to a greater extent before the sign of crack, when it is subjected to tensile force.*

9) Brittleness: *Brittleness is the property of a material which shows negligible plastic deformation before fracture takes place.*

10) Hardness: ***Hardness is defined as the resistance of the material to penetration.***
It usually indicates resistance to abrasion, scratching, cutting or shaping. It is an important property in the selection of material for parts which rub on one another such as pinion and gear, cam and follower, rail and wheel and parts of a ball bearing. Wear resistance of these parts is improved by increasing surface hardness by case hardening.

DEFORMATIONS OF MEMBERS UNDER AXIAL LOADING

- Consider a homogeneous rod BC of length L and uniform cross section of area A subjected to a centric axial load P.

- If the resulting axial stress σ = P/A does not exceed the proportional limit of the material, Hooke's law applies and

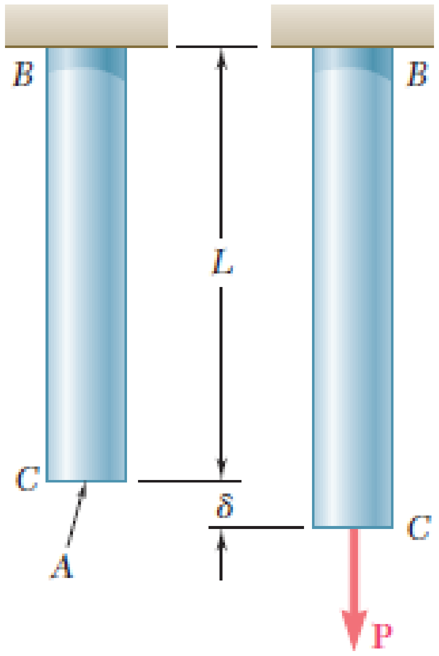
$$\sigma = E\epsilon$$

from which

$$\epsilon = \frac{\sigma}{E} = \frac{P}{AE}$$

- Recalling that the strain ε = δ/L and substituting for ε

$$\boxed{\delta = \frac{PL}{AE}}$$



DEFORMATIONS OF MEMBERS UNDER AXIAL LOADING

- Equation above can be used only if the rod is homogeneous (constant E), has a uniform cross section of area A, and is loaded at its ends.

- If the rod is loaded at other points, or consists of several portions of various cross sections and possibly of different materials, it must be divided into component parts that satisfy the required conditions for the application of above Eq.

- Using the internal force Pi , length Li , cross sectional area Ai, and modulus of elasticity Ei , corresponding to part i, the deformation of the entire rod is

$$\delta = \sum_i \frac{P_i L_i}{A_i E_i}$$

THANK YOU

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