Unit 5: Elasticity

Stress:

The restoring force set up per unit area inside the body is called stress.

$Stress = \frac{F}{A}$. The SI unit of stress is N/m^2

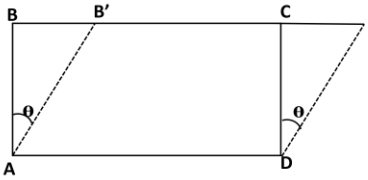
Strain:

Strain is the fractional deformation resulting from stress. It is measured by the ratio of the change in dimension of the body to the original dimension in which the change took place.

Longitudinal strain:

It is the change in length per unit length.
$Longitudinalstrain = \frac{l}{L}$

Shearing strain (ɵ): The angular deformation due to shearing stress is defined as the shearing strain.



Volume strain or bulk strain:

It is defined as the change in volume to the original volume. $Volumestrain = \frac{dv}{V}$

Hooks law:

Hooks law states that the strain produced in a body is directly proportional to the stress provided, the stress should not be too large.

$$\frac{Stress}{strain} = constant$$

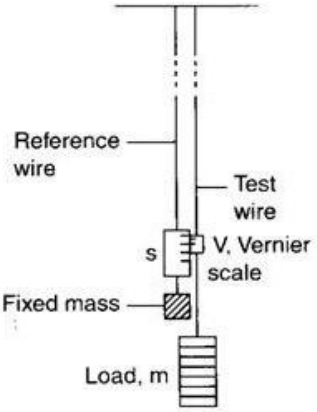
The constant is called modulus of elasticity and its SI unit is N/m^2, $1\ N/m^2 = 1$ pascal

Young's modulus:

Young's modulus is the ratio of the longitudinal stress to the longitudinal strain.

$$Stress = \frac{Force}{Area}$$
$$Stress = \frac{F}{A}$$
$$Strain = \frac{l}{L}$$
$$Young'smodulusY = \frac{(F/A)}{(l/L)} = \frac{FL}{Al}$$
$$Ifthebodyhascircularcrosssection, A = \pi r^2$$
$$HenceY = \frac{FL}{\pi r^2 l}$$

Determination of young's modulus of a wire by using Searle's method:



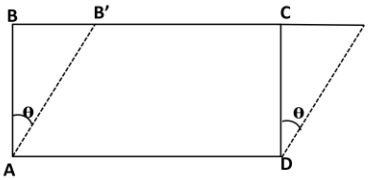
One end of the given wire AB along with the reference wire CD is to be hung on the ceiling tightly and the other end with the weight holder with a dead weight. A scale with millimeter precision is to be fixed on the reference wire and a vernier scale on the other wire. The initial reading is measured as C_0. The proceeding readings to be taken while both loading and unloading weights by the steps of 1 kg C_i. The mean value of C_0-C_i gives the extension for each load M. estimate the average value of M/l and apply in the equation of the young's modulus

$$Y = \frac{MgL}{\pi r^2 l}$$

$$Y = \frac{Lg}{\pi r^2}\left(\frac{M}{L}\right)$$

Rigidity modulus:

Rigidity modulus is the ratio of shearing stress to the shearing strain.



$$\eta = \frac{F/A}{\theta} = \frac{F}{A\theta}$$

Bulk modulus:

Bulk modulus is the ratio of the volume stress (pressure) to the volume strain

$$K = \frac{(F/A)}{(v/V)}$$

$$K = \frac{P}{v/V} = \frac{PV}{v}$$

Compressibility: The reciprocal of is known as compressibility. $Compressibility = \frac{v}{PV}$

Elastic behavior: An elastic body regains its original size and shape by the removal of deforming force applied. E.g. rubber.

Plastic behavior of solids: A plastic body cannot regain its original shape and size by removing the deforming force. E.g. putty, paraffin wax etc.

Elastic limit: It is the magnitude of applied force which produces maximum amount of recoverable deformation.

Breaking stress:

The maximum stress after which the wire begins to flow like a viscous liquid and break is called breaking stress.

Brittle substance: the material breaks soon after the elastic limit is called brittle substances. E.g. glass.

Ductile substance: the object which undergoes large deformation after elastic limit before breaking is called ductile substances. E.g. copper, iron etc

Elastic fatigue: The failure of an elastic material to withstand large fluctuations of stress is called the elastic fatigue.