Elasticity: The property of a body by virtue of which it regains to orginal shape and size after removal of externae force or deforming. ~~Elastic body~~ force is called Elasticity

- Elastic body :- Those material which can gain their orginal position after removal of deforming force are called elastic body for ex: quart'z crystal, Steel, Copper,

- Plastic body!- Those material which can't gain their orginal position after removal of deforming force are called plastic body

Plasticity :- The property of a body in which body can't regains to orginal shape and size after removal of external or deforming force is called plasticity

Rigidity :- The property of material which occurs resistance to a deforming force.

Rigid body:-

Reforming force :: Restoring force.

$$F_{ext} = F_R.$$

Stress: σ : The restoring force per unit area.

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

unit :- N/m^2. (Tensor quantity) # Rank: 2 (Scalar quantity for MCQ

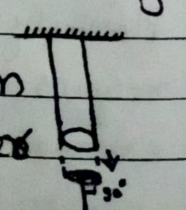
- Diffrence between Pressure AND Stress.

Pressure	Stress
① Pressure can be defined as the amount of force applied per unit area.	Stress can be defined as the internal resistive force to the deformation per unit area
⓪ pressure is always ↓ ~~Stress may be tensile, compressive & shear~~	Stress may be tensile, compressive, shear
⓪ Stress is developed internally	pressure is exerted externally
⓪ the pressure is always positive true	Stress can be either positive or negative

- Types of stress:

① longitudinal Stress OR Normal Stress: The force acting normally to the cross-sectional area

- The stress developed on an elastic body when normal deforming force acting on a body per unit area.



$$[ML^{-1}T^{-2}]$$

- Tensile stress :- The ~~deforming~~ ~~when~~ stress developed when The deforming force acting normally to the corr-sectional area of an elastic body to increase the length of the body. when

- Compression :- The stress developed when The ~~[illegible]~~ deforming force acting normally to the cross-sectional area of an elastic body to decrease the length of the body.

(ii) Bulk Stress :- The stress which is developed on entire surface of the body when deforming force when applied to change the Volume of the body is called bulk Stress.

It is also known as Volumetric stress.

(iii) Tangential or Shearing stress: The tangential stress is defined as the tangential force acting on an elastic body per unit area ~~is called~~ ~~tangential or she~~

=) defined as the ratio of force acting tangentially on the surface to the area of surface

Strain (ϵ)

The ration of change in confugiration to original configuration of an elastic body is called Strain.

$$\therefore \epsilon = \frac{\text{change in dimension}}{\text{original dimension}}$$

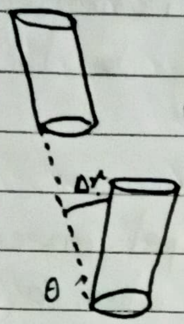
$$\text{or } \epsilon = \frac{\Delta L}{L} \quad \text{or may be} \quad \epsilon = \frac{\Delta V}{V}$$

Types of Strain

- longitudinal Strain :- The ratio of change in length to the original length $\epsilon_l = \frac{\Delta L}{L}$

- Bulk strain :- The ratio of change in Volume to the original Volume $\epsilon_B = \frac{\Delta V}{V}$ of a body due to deforming force is called Bulk strain.

(c) Sheer strain / tangential Strain :- The strain in which the angle between vertical line and surface gives tangential strain in presence of Sheer / tangential force.



$$\tan\theta = \frac{\Delta x}{x}$$

for very very small angle

$$\tan\theta \approx \theta$$

$$\theta = \frac{\Delta x}{x}$$

Hooke's law :- within the proportional limit, elongation produce on a body is directly proportional to restoring force

$$e \propto -f$$

$$e = \frac{1}{k}(-f)$$

$\therefore f = -ke$ where F = ~~resistance~~ restoring force.

k = force constant / spring constant

e = elongation,

(-ve) = restoring force.

Here, $f \propto e$ ---- (2)

$$\frac{F}{A} \propto \frac{e}{A}$$

$$\frac{F}{A} = \frac{ke}{A} \times \frac{l}{l} \qquad \therefore \frac{e}{l} = \frac{\Delta l}{l} = \varepsilon$$

$$\frac{F}{A} = \frac{kl}{A} \times \frac{e}{l}$$

$\therefore$ Stress $\propto$ Strain ---- (3)

$\therefore$ Stress = C × Strain

C = Stress / Strain ---- (4)

Hook's law is also defined as Stress produced on an elastic body is directly proportional to the strain within proportional limit

force constant is defined as deforming force per unit elogation It is constant quantity but depends on nature material.

$F = ke$

$y = mx$

$Slop\ (m) = \frac{F_2 - F_1}{e_2 - e_1}$

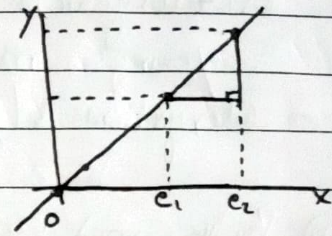


fig:- Fe curve....

$= \frac{\Delta F}{\Delta e}$

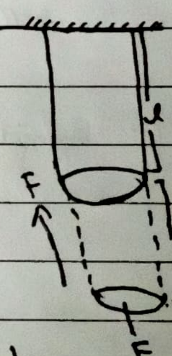
$\therefore k = \frac{\Delta F}{\Delta e}$ //

The slope of st line of fe curve gives force constant or spring constant.

Types of modulus of elasticity

ⓐ The ratio of normal stress to longitudinal strain of an elastic body is called young's modulus of elasticity.

$$Y = \frac{\text{Normal Stress}}{\text{longitudinal Strain}}$$



$$Y = \frac{F/A}{e/l}$$

$$\therefore Y = \frac{Fl}{Ae}$$

Young's modulus is constant quantity but depends on nature of materials. and it is only applicable in Solid. $\left[\text{unit is:- } N/m^2 \right]$

For perfectly elastic body

$e = 0$, $Y = \infty$

For perfectly plastic body

$e = \infty$, $Y = 0$.

why is steel more elastic than Rubber ?

=) Steel is more elastic than rubber because rate of elongation is lower than the rubber. Since, young's modulus is indirectly proportional to the elongation ($Y \propto 1/e$) so, steel is more elastic.

ⓑ Bulk modulus.

The ratio of Bulk stress to the Volumetric Strain can be defined as the bulk modulus.

It is applicable in all solid, liquid & gas

$$\text{Bulk modulus } (B) = \frac{\frac{F}{A}}{\frac{\Delta V}{V}} , \frac{F \times V}{A \times \Delta V}$$

$$\boxed{B = \frac{PV}{\Delta V}}$$

Compressibility :- $C = \frac{1}{B}$

$$\boxed{\therefore C = \frac{\Delta V}{PV}}$$

ⓒ Shear/tangential modulus of elasticity :- The ratio of ~~bulk str~~ Shear Stress to the Shear Strain is defined as Shear / tangential modulus.

$$\eta = \frac{\frac{F}{A}}{\frac{\Delta x}{x}} = \frac{F \times x}{A \times \Delta x}$$

$$=$$

$\eta \approx Y/3$

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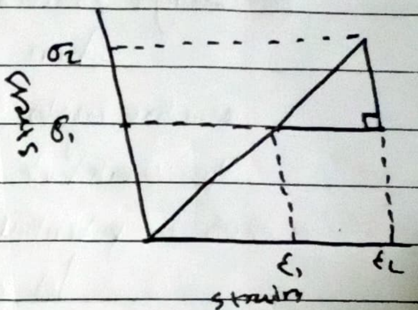
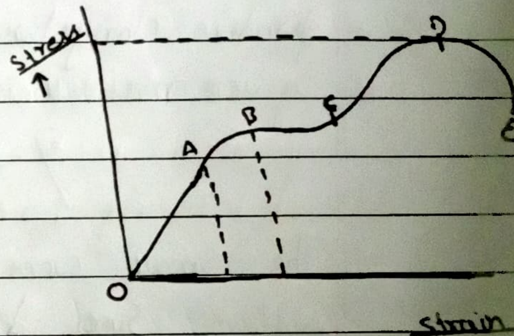
Stress - Strain Curve.

$$m = \frac{\sigma_2 - \sigma_1}{\epsilon_2 - \epsilon_1}$$



$$Y = \frac{\Delta \sigma}{\Delta \epsilon} = \frac{\text{change in stress}}{\text{change in strain}}$$

The curve which is obtained by plotting stress on y-axis and strain on x-axis is called stress-strain curve.



OA region :- Hooke's law is obeyed

AB region :- shows elastic nature but doesn't obey hooke's law

BC : Strain increases rapidly but stress is almost constant

CD :- Strain and stress increases rapidly.

DE :- Strain increases but stress decreases.

A :- proportional limit (Stress $\propto$ Strain)

B :- elastic limit

C :- yield point

D :- Breaking point.

E :- fracture point.

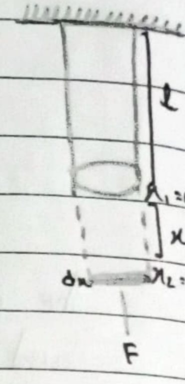
=> The maximum limit up to which an elastic body shows nature of elasticity is known as elastic limit beyond this limit. A body shows plasticity

=> Breaking stress :- The maximum stress which is required to cause the actual break of the body is called Breaking stress. It depends on nature of materials but not on dimension.

$$\sigma_{max} = \frac{\text{Breaking force}}{\text{Area}} = \text{UTS (ultimate tensile stress)}$$

Enery Stored in wire.

When tensile force is applied in a wire then a wire gets stretched and stress is produced on wire, the workdone against internal restoring force is stored as a potential energy or strain energy



Let a consider a uniform wire of length (l) and cross-sectional area (A) is suspended from rigid support, let (f) be the force applied on the wire to produce elongation as (x) now, the young's modulus of given material is given by

$$Y=\frac{Fl}{Ae} \quad \text{or} \quad Y=\frac{F}{A}\frac{l}{x} \quad \text{(i)} \qquad \therefore F=\frac{YAx}{l} \quad \text{(ii)}$$

The small work done from $x=0$ to $x_2=e$ is given by

Sine, $dW = f \times dx$

$$\cancel{dw=\frac{Fl}{Ax}} \quad dW=\frac{YA}{l}x \times dx \quad \text{(iii)}$$

$$\text{or} \quad W=\int_0^e \frac{YA}{l}x\,dx$$

$$\text{or} \quad W=\frac{YA}{l}\int_0^e x\,dx$$

$$\text{or} \quad U=\frac{YA}{l}\left[\frac{x^2}{2}\right]_0^e \qquad \therefore U=\frac{YA}{l}\left(\frac{e^2}{2}-\frac{0^2}{2}\right)$$

$$U=\frac{YA}{l}\times\frac{e^2}{2}$$

$$U=\frac{1}{2}\frac{YAe}{l}\times e$$

$$U=\frac{1}{2}\times F\times e,$$

This is required eq^n of energy stored in as stressed wire as a potential energy.

Energy density:- energy density is defined as energy stored in a wire per unit Volume

$$u = \frac{U}{V} = \frac{U}{A \times l}$$

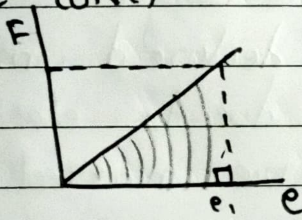
$$= \frac{\frac{1}{2} \times F \times e}{A l}$$

$$= \frac{1}{2} \times \frac{F}{A} \times \frac{e}{l}$$

$$= \frac{1}{2} \times \text{stress} \times \text{strain},$$

This is required eqⁿ for energy density. It is found that energy density is the half of product of stress & strain.

Fe curve,



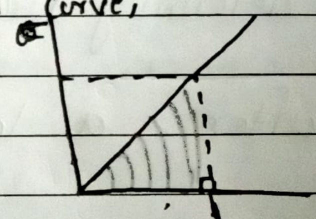
$A = \frac{1}{2} \times b \times h$

$= \frac{1}{2} \times e \times F$

= Energy stored or work done,

Slope = $\frac{\Delta F}{\Delta e}$ = Spring constant,

σf curve,



$A = \frac{1}{2} \times b \times h$

$= \cancel{\frac{1}{2} \times \sigma \times}$. $\frac{1}{2} \times \text{stress} \times \text{strain}$

= energy density,

Slope = $\frac{\Delta \sigma}{\Delta F}$

After 1st term.

It values range from -1 to 0.5, similarly practically. It values mostly lies betn 0.2 to 0.4 or 0.5

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Elastic After effect.

Elastic after effect is the highest for glass & least for quartz, phospher, bronze.

⇒ The temporary delay in regaining it's original position after removal of deforming force is called elastic after effect.

⇒ while phospher-brone is used in glavanometer.

Elastic Fatigue :- The loss of elastic strength of an elastic material due to frequent alternating deforming force is called elastic fatigue

Effects: The bridge is declared unsafe after a long continous use due to elastic fatigue. The spring balance incorrect reading after a continous use.

Question: The bridge is declared as ~~safe~~ unsafe after a long use. The spring balance shows incorrect reading after a long use.?

The ratio of change in diameter (Δd) to original diameter (d) is called lateral strain.

$$\beta = -\left(\frac{\Delta d}{d}\right) \qquad \Delta d = d_0 - d_1$$

define diameter decreasing.

The ratio of ~~charg~~ lateral strain to the longidutunal strain of an elastic body is called Pisson's Ratio (σ)

$$\sigma = \frac{\frac{\Delta d}{d}}{\frac{e}{l}} = \frac{\Delta d}{d} \times \frac{l}{e}$$

$$\therefore -\frac{\Delta d\, l}{de}$$

factors effecting elasticity.

(i) Tempr (Annealing)

$$Y = F / A \alpha \Delta \theta$$

(ii) Hammering & Rolling ↑

(iii) Impurity.

⇒ The bridge is declared as unsafe after a long use because the metal used in construction of bridge lose the elastic gradually due to continous use due to which the probability of fracture in bridge and accident gets higher. So, to minimize the accident bridge are declared unsafe.

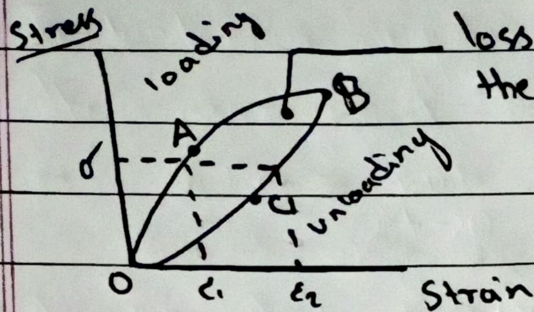
⇒ The spring balance shows incorrect reading after a long use because the spring made of elastic material losse elastic nature due to which high elongation is produced on a spring at a minimal force. So, the spring become incorrect.

Elastometer :- Elastometer is a material that doesn't obey Hooke's law within elastic limit for eg: Rubber.

The stress is lagging behind of strain is called Elastic hysteresis. It is due to elastic after effect.

- The loading & unloading path of material can't be retraced

The shaded part represents loss of energy in the form of heat.



loss of energy in the form of heat,

Question The tyre of a car is made by using synthetic rubber. why?

Question why are O used as vibration absorber?

=> The tyre of a car is made by using synthetic rubber because the material made up of synthetic rubber