AAQIL AHMED

JEE QUESTION : SOLIDS

1) A wire of length L & cross-sectional area A is suspended. A mass M is hung from it causing an extension x. If the wire is replaced by another wire of same material but double the length & half the diameter, find the extension under the same load

ANSWER

$$x = \frac{FL}{AY} \qquad x' = \frac{FL'}{A'Y} = \frac{F(2L)}{(A/4)Y} = \frac{8FL}{AY}$$

$A = \pi r^2$

$$\Rightarrow x' = 8x$$

$L' = 2L$

$r' = \frac{r}{2}$

$A' = \pi\left(\frac{r}{2}\right)^2 = \frac{A}{4}$

2) A metal rod of length L & radius R is stretched by a tensile force F. Its poisson's ratio is σ. Find the fractional change in volume

ANSWER

Longitudinal strain :

$$\varepsilon_l = \frac{\Delta L}{L} = \frac{F}{YA}$$

Lateral strain :

$$\varepsilon_t = -\sigma\varepsilon_l$$

Fractional change in volume :

$$\frac{\Delta V}{V} \approx \varepsilon_l + 2\varepsilon_t = \varepsilon_l - 2\sigma\varepsilon_l = \varepsilon_l(1-2\sigma)$$

$$\Rightarrow \frac{\Delta V}{V} = \frac{F}{YA}(1-2\sigma)$$

AAQIL AHMED

3) Two wires of different materials, lengths L_1, L_2 & cross sectional areas A_1, A_2 are joined in series. Young's moduli $= Y_1, Y_2$. A load F is applied. Find the total extension of the system.

ANSWER

$$\Delta L_1 = \frac{FL_1}{Y_1 A_1}, \Delta L_2 = \frac{FL_2}{Y_2 A_2}$$

$$\Delta L_{total} = \Delta L_1 + \Delta L_2 = \frac{FL_1}{A_1 Y_1} + \frac{FL_2}{A_2 Y_2}$$

$$\Rightarrow \Delta L_{total} = \frac{FL_1}{Y_1 A_1} + \frac{FL_2}{A_2 Y_2}$$

Hazique Rizvi

2025-2026 Mechanical properties of Solid

Q A sample of a liquid is kept at 1atm. It is compressed to 5atm which leads to a change of volume of $0.8 cm^3$ If the bulk modulus of the liquid is 2 GPa, the initial volume of the liquid was ___ litre (Take $1atm = 10^5 Pa$)

Sol: Given, initial pressure of liquid $(P_1) = 1atm$

Final pressure of liquid $(P_2) = 5atm$

Change in pressure $(\Delta P) = P_f - P_i = 4atm$

$= 4 \times 10^5 Pa$

Change in volume $(\Delta V) = -0.8 cm^3$

Bulk modulus $= 2 \times 10^9 Pa$

Now, $B = \frac{-\Delta P}{(\Delta V/V)} \Rightarrow V = -B\left(\frac{\Delta V}{\Delta P}\right)$

$\Rightarrow V = -2 \times 10^9 \times \frac{(-0.8 \times 10^{-6})}{4 \times 10^5}$

$= 4 \times 10^{-3} m^3 = 4$ litre

Q The length of a light string is 1.4m when the tension on it is 5N. If the tension increases to 7N, the length of the string is 1.56m. The original length of the string is ______m

Sol: To find original length of the string, we use relationship between tension, elasticity constant (K) and change in length of the string

$T = K(l - l_0)$

$l \rightarrow$ length of string under tension, $l_0 \rightarrow$ original length

when $T = 5N$

$5 = K(1.4 - l_0)$

when $T = 7N$

$7 = K(1.56 - l_0)$

by setting up a ratio from the two equations

$$\frac{5}{1.4 - l_0} = \frac{7}{1.56 - l_0}$$

$$5(1.56 - l_0) = 7(1.4 - l_0)$$

$$7.8 - 5l_0 = 9.8 - 7l_0$$

$$2l_0 = 2$$

$$l_0 = 1m$$

$\therefore$ Original length of the string is 1m

Q Young's modulus of material of a wire of length 'L' and cross sectional area A is Y. If the length of the wire is doubled and cross sectional area is halved, then Young's modulus will be

Sol: Young's modulus depends on the material not length and cross sectional area. So youngs modulus remains same.

Mechanical Properties Of Solids

Kranar Sudheer
Batch:- 2025-26

JEE Questions

Q.1) Two wires A and B are made of same material having ratio of lengths $\frac{L_A}{L_B} = \frac{1}{3}$ and their diameters ratio $\frac{d_A}{d_B} = 2$.
If both the wires are stretched using same force, what would be the ratio of their respective elongations? [JEE Main 2025]

(A) 3:4 (B) 1:12

(C) 1:3 (D) 1:6

Ans: (*) $3L_A = L_B$; $d_A = 2d_B$

Given that:- Same material, meaning their Young modulus's are equal $\{Y_A = Y_B\}$.

$\Rightarrow Y_A = Y_B$

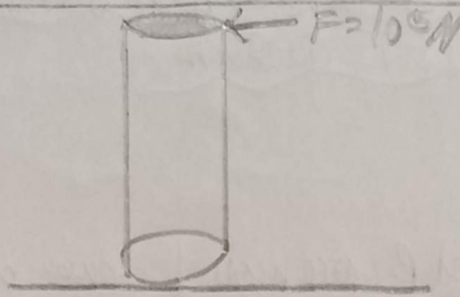
$\Rightarrow \frac{F L_A}{A \times \Delta l_A} = \frac{F L_B}{A \times \Delta l_B}$

$\frac{\Delta l_A}{\Delta l_B} = \left(\frac{L_A}{L_B}\right)\left(\frac{d_B}{d_A}\right)^2 \Rightarrow \left(\frac{1}{3}\right)\left(\frac{1}{2}\right)^2 \Rightarrow \frac{1}{3} \times \frac{1}{4}$

$\Rightarrow \frac{1}{12} \Rightarrow$ 1:12 (B)

Q.2) A cylindrical rod of length 1m and radius 4cm is mounted vertically. It is subjected to a shear force of $10^5 N$ at the top. Considering infinitesimally small displacement in the upper edge, the angular displacement θ of the rod axis from its original position would be :- $(G = 10^{10} N/m^2)$

Ans:- ⊛



Shear moduli $\Rightarrow \dfrac{\sigma_{shear}}{\theta}$

$$10^{\cancel{10}\,5} = \frac{10^8}{\pi \times 16 \times 10^{-4}} \times \frac{1}{\theta}$$

$$\boxed{\therefore\ \theta = \frac{1}{160\pi}\ \text{radian}}$$

Q.3) Young's modules of material of a wire of length 'L' and cross-sectional area A is Y. If the length of wire is doubled and cross sectional area is halved then 'Y' will be?

Ⓐ 4Y Ⓑ 2Y

Ⓒ Y/4 Ⓓ Y

Ans:- ⊛ The answer is Ⓓ Y, as young's modulus does not depend cross-sectional area and length. It depends on the material of the rod. So, it remains the same.

Mechanical Properties of Solids

1. Calculate structural compressive strain under a massive load. For a structural steel column (radius 0.3m inner, 0.6m outer) bearing a 50,000 Kg load (Mg), the compressive strain is $\sim 7.22 \times 10^{-7}$.

$\Rightarrow$ Mass, $M = 50000\,Kg$; $g = 9.8\,m/s^2$; Young's Modulus, Y
$Y = 2 \times 10^{11}\,Pa$; Inner radius $r = 0.3\,m$; Outer radius, $R = 0.6\,m$

Total force $= Mg = 50000 \times 9.8$
$= 490000\,N$

Force per column $= \frac{Mg}{4} = \frac{490000}{4} = 122,500\,N.$

Area, $A = \pi(R^2 - r^2) = \pi(0.6^2 - 0.3^2)$
$= \pi(0.36 - 0.09) = 0.27\pi\,m^2.$

Stress $(\sigma) = \frac{F}{A} = \frac{122500}{0.27\pi} = \frac{122500}{0.848} \approx 144,457\,Pa.$

Strain $(\epsilon) = \frac{\sigma}{Y} = \frac{144457}{2 \times 10^{11}} \approx 7.22 \times 10^{-7}$

$\therefore$ Final Result $\Rightarrow$ The compressive strain is 7.22×10^{-7}

2. A copper wire of length L and radius r is suspended vertically from a rigid support. If a mass m is attached to the free end of the wire, find the increase in length of the wire. Given: Young's modulus of copper is Y.

$\Rightarrow F = mg$

Stress $= \frac{F}{A} = \frac{mg}{\pi r^2}$

$$Strain = \frac{\Delta L}{L}$$

$$Y = \frac{Stress}{Strain} = \frac{mg}{\pi r^2} \times \frac{L}{\Delta L}$$

$$\Delta L = \frac{mgL}{\pi r^2 Y}$$

3. A steel wire of length L, cross-sectional area A, and Young's modulus Y is stretched by a force F. If the wire is stretched by a distance x, derive an expression for the elastic potential energy stored in the wire

⇒ Hooke's Law

$$F = \frac{YA}{L} x$$

Elastic Potential Energy

$$U = \frac{1}{2} Fx = \frac{1}{2}\left(\frac{YA}{L} x\right)x$$

$$U = \frac{1}{2} \frac{YA}{L} x^2$$

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XI-A
Roll no. - 13

MECHANICAL PROPERTIES OF SOLIDS

Q.1 If the potential energy between two molecules is given by $U = -\frac{A}{r^6} + \frac{B}{r^{12}}$, then at equilibrium, seperation b/w molecules & potential energy =

Ans $U = \frac{-A}{r^6} + \frac{B}{r^{12}}$

$$F = \frac{-dU}{dr} = -A(-6r^{-7}) + B(-12r^{-13})$$

$$0 = \frac{6A}{r^7} - \frac{12B}{r^{13}}$$

$$\frac{6A}{12B} = \frac{1}{r^6} \Rightarrow r = \left(\frac{2B}{A}\right)^{\frac{1}{6}}$$

$$\therefore U = \frac{-A}{2B/A} + \frac{B}{4B^2/A^2}$$

$$= \frac{-A^2}{2B} + \frac{A^2}{4B} = \frac{-A^2}{4B}$$

Q.2. A 2kg mass is attached to a spring with spring constant k = 200 N/m, If the mass is displaced by 0.1 m, potential energy in spring = ?

Ans. $U = \frac{1}{2}kx^2$

$$= \frac{1}{2}(200)(0.01) = 1J$$

Q3. A wire of length L & radius r is clamped at one end. If its other end is pulled by a force F, length increases by l. If the radius of wire & applied force are reduced to half of their original values keeping original length constant, increase in length becomes:

Ans $l = \frac{FL}{AY}$

$A = \pi r^2$

$A' = \frac{\pi r^2}{4}$; $F' = \frac{F}{2}$

$$\therefore l' = \frac{\frac{F}{2}(L)}{\frac{\pi r^2}{4}(Y)} = \frac{FL(4)}{2\pi r^2 Y} = \frac{2FL}{\pi r^2 Y}$$

$\therefore$ Answer $\Rightarrow$ 2 Times

CamScanner

Sarthak Shinde
2025-26

Mechanical Properties Of Solids

Q) A man grows into a giant such that his linear dimensions increase by a factor of 9, density remains same, the stress in leg will change by factor of:

(A) 1/9 (B) 81 (C) 1/81 (D) 9

Sol.

initial stress $= \frac{F_0}{A}$ {Width & height of man as b & l respectively}

$S_0 = \frac{F}{l \times b}$

dimensions increase by 9 factor

$S_1 = \frac{F_1}{l' \times b'} = \frac{F_1}{9l \times 9b} = \frac{F_1}{81 lb}$

Since, $m = \rho V$ & $F_0 = mg$

$F_0 = \rho V g$, so, $S_0 = \frac{\rho V g}{lb}$

~~&~~ new volum $V_1 = V \times 9^3$ $(V = lbh$ & $V_1 = 9^3 \times lbh)$

$F_1 = \rho V_1 g = \rho V g \times 9^3$

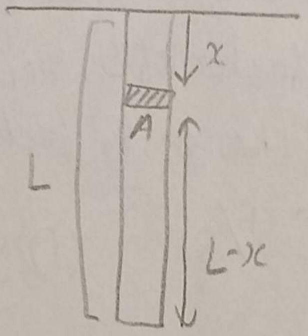
now, $S_1 = \frac{\rho V g \times 9^3}{81 lb}$

$\therefore \frac{S_1}{S_0} = \frac{\frac{\cancel{\rho V g} \times 9^3}{\cancel{lb} \times 81}}{\frac{\cancel{\rho V g}}{\cancel{lb}}} = \frac{9^3}{81} = \boxed{9}$

$\boxed{(D)\ 9}$

Q) A wire suspended vertically, if elongation due to its own weight is considered, find expression for total elongations. (given, density (ρ), length (L), area (A), Young's modulus)

Sol.



$F = mg$ {Force = weight on it}

$F = \rho V g$

$F = \rho A (L-x) g$

$Y = \dfrac{FL}{A\, d\Delta L}$ $\{L = dx\}$ $\longrightarrow$ $d\Delta L = \dfrac{F\,dx}{AY}$

$$d\Delta L = \frac{\rho A (L-x) g\, dx}{AY} = \frac{\rho g}{Y} \times (L-x)\, dx$$

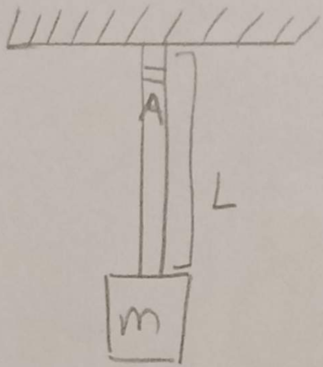
$$\int_0^{\Delta L} d\Delta L = \frac{\rho g}{Y} \int_0^{L} (L-x)\, dx$$

$$\Delta L = \frac{\rho g}{Y} \times L^2 - \frac{L^2}{2}$$

$$\boxed{\Delta L = \frac{\rho g L^2}{2Y}}$$

Q) A wire of length L and area A is stretched gradually by hanging a mass m. If mass is suddenly removed, find maximum contraction speed of wire.

Sol.



Elastic Potential Energy:

$$U = \frac{1}{2} F \Delta L \quad \left(\Delta L = \frac{mgL}{AY} \right)$$

$$U = \frac{1}{2} mg \Delta L = \frac{m^2 g^2 L}{2AY}$$

Elastic Potential Energy stored equal to kinetic energy

$$U_{extension} = K_{normal}$$

$$\frac{m^{\cancel{2}} g^2 L}{\cancel{2} AY} = \frac{1}{\cancel{2}} \cancel{m} v^2$$

$$\boxed{V = \sqrt{\frac{mg^2 L}{AY}}}$$

Abhishek

Properties of Solids

(Q1) Young's Modulus of material of a wire of lenght 'L' and cross-sectional Area A is Y. If the lenght of the wire is doubled and cross-sectional area is halved then Young's modulus will be:

Answer:-

$$Y = \frac{FL}{A\Delta L} \; ; \; Y' = \frac{F(2L)}{\left(\frac{A}{2}\right)\Delta L} = \frac{2FL \times 2}{A\Delta L} = \frac{4FL}{A\Delta L}$$

When geometry changes, extension ΔL also changes accordingly so the ratio stays the same.

$$\Rightarrow Y' = Y.$$

$\therefore$ Young's Modulus remains unchanged.

(Q2) A wire of lenght and radius r is clamped at one end. If its other end is pulled by a force F, its lenght increases by l. If the radius of the wire and the applied force both are reduced to half of their original values keeping original lenght constant, the increase in lenght will become:

Answer:-

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\frac{F}{\frac{\pi r^2}{L}}}{l/L.} = Y\pi r^2 \times \frac{l}{L} \quad \text{--(i).}$$

$$\therefore Y = \frac{\frac{F/2}{\pi r^2/4}}{\frac{\Delta l}{L}} = Y\frac{\Delta l}{L} \times 2 \times \frac{\pi r^2}{4}$$

$\therefore$ from (i),

$$Y\pi r^2 \frac{l}{L} = Y \times \frac{\Delta l}{L} \times \frac{\pi r^2}{2}$$

$$\Rightarrow \boxed{\Delta l = 2l.}$$

(Q3) A 100m long wire with a cross-sectional area of $6.25 \times 10^{-4}\ m^2$ and Young's modulus $10^{10}\ Nm^{-2}$ is subjected to a 250N load. The elongation (ΔL) in the wire is 4×10^{-3} or (4mm).

$$\therefore Y = \frac{FL}{A\Delta L} \Rightarrow \Delta L = \frac{FL}{AY}$$

$$\therefore \Delta L = \frac{250 \times 100}{(6.25 \times 10^{-4}) \times (10)^{10}} = \frac{25000}{6.25 \times 10^{6}} = 0.004\,m.$$

KOUSHIK · B

Mechanical properties of solid

(Q1) A rod of linear mass density λ and length L is bent to form a ring of radius R. The moment of inertia of the ring about any of its diameter is:

(a) $\lambda L^3/12$ (b) $\frac{\lambda L^3}{4\pi^2}$ (c) $\frac{\lambda L^2}{12}$ (d) $\frac{\lambda L^3}{8\pi^2}$

Answer :- $I = \frac{MR^2}{2} = \frac{\lambda L}{2} R^2 \Rightarrow \frac{\lambda L L^2}{2 \times 4\pi^2}$ $\left[\because R = \frac{L}{2\pi}\right]$

$$\boxed{= \frac{\lambda L^3}{8\pi^2} \quad (d)}$$

(Q2) A uniform disc of radius R and mass M is rolling without slipping on a horizontal surface with velocity v. The kinetic energy of disc is :-

(A) $\frac{1}{4} mv^2$ (b) $\frac{1}{2} mv^2$ (c) $\frac{3}{4} mv^2$ (d) Mv^2

Answer :- Total KE = Translational KE + Rotational KE

$\frac{1}{2} Mv^2 + \frac{1}{2} I\omega^2$

Moment of inertia $I = \frac{1}{2} MR^2$

$\omega = \frac{v}{R}$

Rotational KE $= \frac{1}{2} \times \frac{1}{2} MR^2 \times \left(\frac{v}{R}\right)^2$

$= \frac{1}{4} mv^2$

Total KE $= \frac{1}{2} mv^2 + \frac{1}{4} mv^2$

$$\boxed{= \frac{3}{4} mv^2 \quad (c)}$$

(Q3) A solid sphere of mass M and radius R is rolling without slipping with a velocity v. Its local kinetic energy is :

(a) $\frac{2}{5}mv^2$ (b) $\frac{7}{10}mv^2$ (c) $\frac{1}{2}mv^2$ (d) Mv^2

Answer :- Moment of intoria $I = \frac{2}{3}MR^2$

translational KE $= \frac{1}{2}Mv^2$

Rotational KE $= \frac{1}{2}I\omega^2 = \frac{1}{2} \cdot \frac{2}{5} MR^2 \cdot \left(\frac{v}{R}\right)^2 = \frac{1}{5}Mv^2$

Total KE $= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{5}{10}mv^2 + \frac{2}{10}mv^2 = \frac{7}{10}mv^2$ (b)

$\boxed{\text{option (b) } \frac{7}{10}mv^2}$

Arun Sam Isac

2025 - 26

Mechanical properties of solids

Q.1 The elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400N load without exceeding its elastic limit?

Ans: $Stress = 400 \times \frac{4}{\pi d^2}$

$= 379 \times 10^6\ Nm^{-2}$

$d^2 = (400 \times 4)/(379 \times 10^6 \pi)$

$d = 1.15 mm$

Q.2 A man grows into a giant such that his linear dimensions increases by a factor of 9. Assuming that his density remains the same, the stress in the leg will change by a factor of?

$Stress = Force / L^2$

$S = (volume \times density) \times \frac{g}{L^2}$

$S = L^3 \times \rho g / L^2 = L\rho g$

stress $S \propto L$

$\frac{S_2}{S_1} = \frac{L_2}{L_1} = \frac{9L_1}{L_1} = 9$

Q.3 Two wires are made of the same material and have the same volume, wire 1 has a cross sectional area A and wire 2 has cross sectional area 3A. If the length of the wire 1 increases Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

$V = V_1 = V_2$

$V = A \times L_1 = 3A \times L_2 = L_2 = \frac{L_1}{3}$

$Y = \left(\frac{F}{A}\right)\left(\frac{\Delta L}{L}\right)$

$F_1 = YA\left(\frac{\Delta L_1}{L_1}\right), \quad F_2 = Y3A\left(\frac{\Delta L_2}{L_2}\right)$

Given $\Delta L_1 = \Delta L_2 = \Delta x$

$F_2 = Y3A\left(\frac{\Delta x}{\frac{L_1}{3}}\right) = 9\,\frac{YA\Delta x}{L_1} = 9F, = 9F$

2025-2026
Zaidshamsheeri
XI-A.

Mechanicalproperties of solid.

Q. A metallic bar of yoongs modolus $0.5 \times 10^{11} m^{-2}$ and coefficient of linear expansion $10^{-5}\,°C$ length 1m and area of cross-section $10^{-3} m^2$ is heated from $0°C$ to $100°C$ without expansion or bending.

Sol:

$$\sigma = y\alpha \Delta T$$

$$F = \sigma A = y\alpha \Delta T \cdot A$$

$$F = (0.5\times10^{11})(10^{-5})(100)(10^{-3})$$

$$\Rightarrow 5\times10^{5}\cdot 100 = 5\times10^{7}.$$

$$5\times10^{7}\times10^{-3} = 5\times10^{4} N$$

$$\boxed{50\times10^{3} N}$$

Q2. copper of fixed volome v is drawn into wire of length "l". when this wire is shown to constant force "f" extention produced is "l". which eqation is a straight line.

Sol:

$$A = V/L$$

$$\Delta L = \frac{FL}{AY}$$

$$\Delta L = \frac{F\cdot L}{Y(V/L)} = \frac{FL^2}{YV}.$$

$$\boxed{\Delta L \propto L^2}$$

Q3. wire of length "L". area of cross section "A" is hanging from a fixed support. The length of wire changes to L_1 when mass "M" is suspended at end.

Sol:

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L} = \frac{FL}{A\Delta L}$$

$$Y = \frac{Mg \cdot L}{A(L_1 - L)}$$

$$\boxed{Y = \frac{MgL}{A(L_1 - L)}}$$

D.S. Harini , 2025-26 Properties of Solids
XII-A

Q. A 100m long wire having cross-sectional area $6.25 \times 10^{-4} m^2$ & young modulus is $10^{10} Nm^{-2}$ is subjected to a load of 250N then the elongation in the wire will be: (JEE Main 2023)

Sol: Stress = y strain = $\frac{N}{A} = y\frac{\Delta l}{l}$

$\Delta l = \frac{Wl}{yA} \Rightarrow \Delta l = \frac{250 \times 100}{10^{10} \times 6.25 \times 10^{-4}}$

$\Delta l = 4 \times 10^{-3} m$

Q. The elastic limit of brass is 379 MPA. What should be the minimum diameter of a brass rod if its to support a 400N without exceeding its elastic element.

Sol: P/A = stress

$\frac{400 \times 4}{\pi d^2} = 379 \times 10^6$

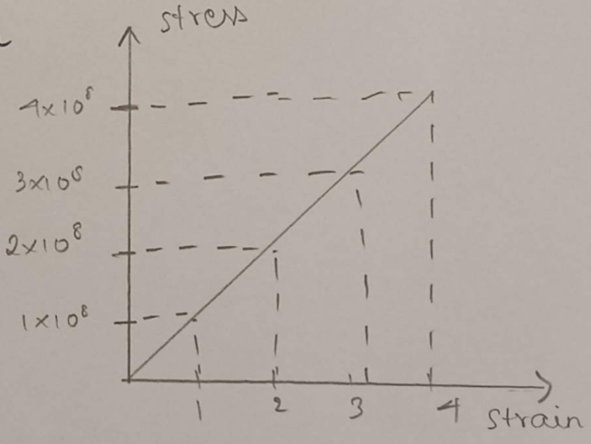
$d^2 = \frac{1600}{\pi \times 379 \times 10^6} = 1.34 \times 10^{-6}$

$d = \sqrt{1.34} \times 10^{-3}$

$= 1.15 \times 10^{-3} m$

Q. The stress v/s strain graph of a material is shown. Find the Young's modulus of material. (JEE Main 2026)

Sol: Strain = 4
Stress = $4 \times 10^8 N/m^2$
Y = stress / strain
$Y = 4 \times 10^8 / 4$
$Y = 10^8 N/m^2$



Q.) A cube has side length 5cm and modulus of rigidity $10^5 N m^{-2}$. The displacement produced by a force 10N in the upper face of cube is ____ mm

Ans

$L = 0.05m$

$\eta = 10^5 N/m^2$

$F = 10N$

$A = 10^{-3} \times 2.5$

Stress $= F/A = 4000 Nm^{-2}$

Strain $= \frac{\Delta x}{l}$

$\eta = \frac{F/A}{\Delta x / l} = \boxed{\Delta x = 2mm}$

Q.) The youngs modulus of steel wire of radius 'r' and length 'l' is Y. If the radius r and length L of the wire are doubled then the value of 'Y'

(A) increases by 2 times

(B) reduces by half

(C) remains unchanged.

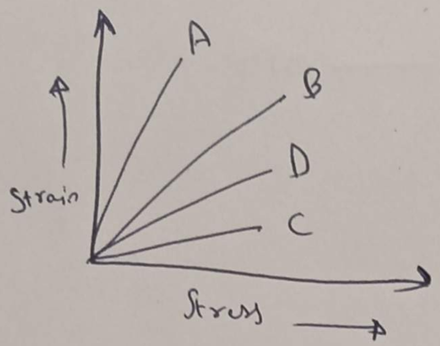
(D) becomes one fourth

Ans →

Youngs modulus is intrinsic property of material of wires

Y → (C) remains unchanged

Q. The Strain Vs stress for materials A, B, C and D is shown. Which material has largest Young's modulus



(A) D

(B) B

(C) C

(D) A

Ans :

(C)

SAANVI

Mechanical Property of Solids.

Q. Two wire A and B are made of the same material and have the same length

- Radius A = r
- Radius B = 2r

Wire A support a mass M
Wire B support a mass 4M
Find ratio of elongation $\Delta L_A : \Delta L_B$

$\Rightarrow$

$\Delta L = \frac{FL}{AY}$ $\quad$ $\Delta L \propto \frac{F}{A}$ (since material has same length and material)

For wire A:

$F_A = Mg$, $A_A = \pi r^2$

$\Delta L_A \propto \frac{Mg}{\pi r^2}$

For wire B:

$F_B = 4Mg$; $A_B = \pi (2r)^2 = 4\pi r^2$

$\Delta L_B = \frac{4Mg}{4\pi r^2} = \frac{Mg}{\pi r^2}$

$$\frac{\Delta L_A}{\Delta L_B} = \frac{\cancel{Mg/\pi r^2}}{\cancel{Mg/\pi r^2}} = \frac{1}{1} \Rightarrow \Delta L_A : \Delta L_B = 1:1$$

Q. A uniform wire of length L and cross-sectional area A is fixed at the top. Two masses m and 2m attached at distance L/3 and 2L/3 from the top respectively.
Find the total elongation of the wire:

$\Rightarrow$ $F_1 = (m + 2m)g = 3mg$

length = L/3

$$\Delta L_1 = \frac{3mg(L/3)}{AY} = \frac{mgL}{AY}$$

$F_2 = 2mg$

length $= L/3$ $\qquad \Delta L_2 = \dfrac{2mg(L/3)}{AY} = \dfrac{2mgL}{3AY}$

$$\Delta L = L_1 + L_2 = \frac{mgL}{AY} + \frac{2mgL}{3AY}$$

$$\boxed{\Delta L = \frac{5mgL}{3AY}}$$

Q. A cube of side 10cm is subjected to uniform pressure P. If its volume decreases by 1cm³, find P. Given bulk modulus $K = 1\times10^{11}$ Pa

$\Longrightarrow$

$$V = (10)^3 = 1000\ cm^3$$

$$\frac{\Delta V}{V} = \frac{1}{1000}$$

$$K = \frac{P}{\Delta V/V} = \quad P = K \times \frac{1}{1000}$$

$$P = 10^{11} \times 10^{-3} = \boxed{10^8\ Pa}$$

Deepinder

Q1) Determine the volume contraction of a solid copper cube, 10 cm on an edge, when subjected to hydraulic pressure 7×10^6 Pa

A) $l = 0.1\,m$, $p = 7 \times 10^6$ Pa, $B = 140 * 10^9$ Pa

$$B = \frac{P}{\frac{\Delta V}{V}}$$

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

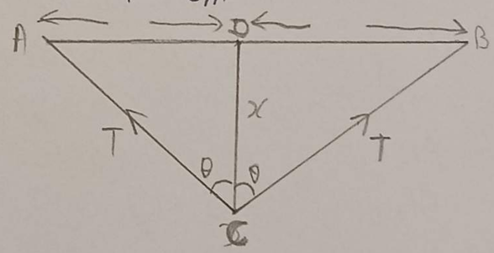
$$= \frac{pl^3}{B}$$

$$= \frac{7 \times 10^6 \times (0.1)^3}{140 \times 10^9} = 5 \times 10^{-8}\,m^3 = 5 \times 10^{-2}\,cm^3$$

Q2) A mild steel wire of length 1.0 m and cross-sectional area $0.5 \times 10^{-2}\,cm^2$ is stretched, within its elastic limit, horizontally between two pillars. A mass of 100g is suspended from the mid-point of wire. Calculate depression at midpoint

A) Given, $m = 100g = 0.1\,kg$, $l = 1m$, $A = 0.5 \times 10^{-2}\,cm^2$

$CD = x$



$AB = BD = l = 0.5m$

$AD = BD = \sqrt{l^2 + x^2}$

$\Delta l = AD + BD - AB = 2AD - AB$

$$= 2\sqrt{l^2 + x^2} - 2l$$

$$= 2l\left(1 + \frac{x^2}{2l^2}\right) - 2l$$

$$= 2l\left(1 + \frac{x^2}{2l^2} - 1\right) = \frac{x^2}{l}$$

$$\text{Strain} = \frac{x^2}{2l^2}$$

$2T\cos\theta = mg$

$T = \frac{mg}{2\cos\theta}$

$\cos\theta = \frac{x}{\sqrt{l^2 + x^2}} = \frac{x}{l\sqrt{1+\frac{x^2}{l^2}}} = \frac{x}{l\left(1+\frac{x^2}{2l^2}\right)}$

$(x \ll 1)$:

$1 + \frac{x^2}{2l^2} \sim 1$

$\cos\theta = \frac{x}{l}$

$T = \frac{mgl}{2x}$

$\text{stress} = \frac{T}{A} = \frac{mgl}{2Ax}$

$Y = \frac{mgl}{2Ax} \times \frac{2l^2}{x^2} = \frac{mgl^3}{Ax^3}$

$x = l\left(\frac{mg}{AY}\right)^{\frac{1}{3}}$

$x = 0.5\left(\frac{0.1 \times 10}{2.0 \times 10^{11} \times 0.5 \times 10^{-6}}\right)^{\frac{1}{3}} = 0.01074\,m$ //

Depression $= 0.01074\,m$

Q3) A peice of copper having a rectangular cross-section of 15.2 mm x 19.1 mm is pulled in tension with 44,500 N force, producing only elastic deformation. Calculate resulting strain. ($\eta = 42 \times 10^9\ Nm^{-2}$)

A) $l = 19.1\,mm = 19.1 \times 10^{-3}\,m$, $b = 15.2\,mm = 15.2 \times 10^{-3}\,m$

$A = lb = 19.1 \times 10^{-3} \times 15.2 \times 10^{-3} = 2.9 \times 10^{-4}\,m^2$

$F = 44500\,N$

$\eta = \frac{\text{stress}}{\text{strain}} = \frac{\frac{F}{A}}{\text{strain}}$

$\text{strain} = \frac{F}{A\eta} = \frac{44500}{2.9 \times 10^{-4} \times 42 \times 10^9} = 3.65 \times 10^{-3}$ //