Formulas Used:-

① Stress $\sigma = \frac{Load}{Area} = \frac{P}{A}$ N/mm²

② Tensile (or) Longitudinal Strain } $e_l = \frac{\delta l}{l}$.

③ Lateral Strain $= e_L = \frac{\delta d}{d}$ (or) $\frac{\delta t}{t}$ (or) $\frac{\delta b}{b}$.

④ Volumetric Strain, $e_v = \frac{\delta V}{V}$

⑤ Poisson's ratio $= e_t / e_l$.

⑥ Young's modulus $E = \sigma / e_l$. N/mm²

⑦ $E = 2G(1+\mu)$

$E = 3K(1-2\mu)$

$E = \frac{9KG}{G+3K}$.

⑧ Volumetric Strain of a rectangula
Subjected to an axial force (P)

$$e_v = \frac{\delta V}{V} = \frac{\delta l}{l}(1-2\mu)$$

⑨ Volumetric strain of a cylindrical rod
Subjected to an axial force (P) is giv

$$e_v = \frac{\delta V}{V} = \frac{\delta l}{l} - 2\frac{\delta d}{d}.$$

1) A Solid circular bar of diameter 20 mm when subjected to an axial tensile load of 40kN, The Reduction in diameter of the Rod was absorbed as 6.5×10^{-3} mm The Bulk Modulus of the Material of the bar 67 gPa Determine the following

i) Young's Modulus
ii) Poisson Ratio
iii) Modulus of Rigidity
iv) Change in length Per meter
v) Change in Volume Per length

Given Data:-

$D = 20\ mm$

$P = 40kN = 40 \times 10^3 N$

$\delta D = 6.4 \times 10^{-3} mm$

$K = 67\ GPa = 67 \times 10^3 N/mm^2$

Solution:-

$A = \pi/4\ D^2 = \pi/4 \times 20^2 = 314.15 mm^2$

$\sigma = P/A = \frac{40 \times 10^3}{314.15} = 127.39\ N/m^2$

$K = \frac{\text{Direct Stress}}{\delta V/V}$

$K = \sigma / \delta V/V$

$\frac{\delta V}{V} = \frac{\sigma}{K} = \frac{127.39}{67 \times 10^3}$

$\delta V/V = 1.9 \times 10^{-3}$

$V = \text{Area} \times \text{Length}$

$= 314.15 \times 1000$

$V = 314.15 \times 10^3 \, mm^3$

$\delta V = 1.9 \times 10^{-3} \times V$

$= 1.9 \times 10^{-3} \times 314.15 \times 10^3$

$\delta V = 596.91 \, mm^3$

Volumetric strain for circular bar given by

$\delta V = \frac{\delta l}{l} - 2(\delta D/D)$

$= \frac{596.91}{314.15}$

$\frac{\delta D}{D} = \frac{6.4 \times 10^{-3}}{20} = 3.2 \times 10^{-4}$

$\delta l = 2.54 \, mm$

$\mu = $ Lateral strain

$$= \frac{3.2 \times 10^{-4}}{2.5 \times 10^{-3}}$$

$\mu = 0.125$

$E = 3k(1-2\mu)$

$= 3 \times 67 \times 10^{3}(1-(2 \times 0.125))$

$E = 150.75 \times 10^{3}$

$E = 2G(1+\mu)$

$$G = \frac{E}{2(1+\mu)} = \frac{1.5 \times 10^{5}}{2(1.125)}$$

$G = 66 \times 10^{3}\ N/mm^{2}$

Result:

$E = 150.75 \times 10^{-3}$

$\mu = 0.125$

$G = 66 \times 10^{3}\ N/mm^{2}$

$\delta l = 2.54\ mm$

$\delta v = 596.91\ mm^{2}$