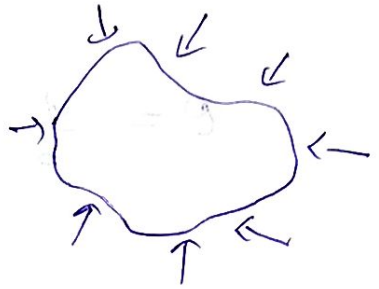
Elasticity IV

Bulk modulus:

Ratio of volume stress over the volume strain is defined as Bulk modulus (B).



$$B = \frac{\text{Volume stress}}{\text{Volume strain}}$$

$$B = \frac{-P/A}{\frac{\Delta V}{V}}$$

P/A is same as pressure, $\boxed{B = \frac{-P}{\frac{\Delta V}{V}}}$

On applying pressure volume decreases, therefore there is a minus sign in the above expression.

Generally, change in volume is measured with respect to change in pressure. Therefore, we define B as

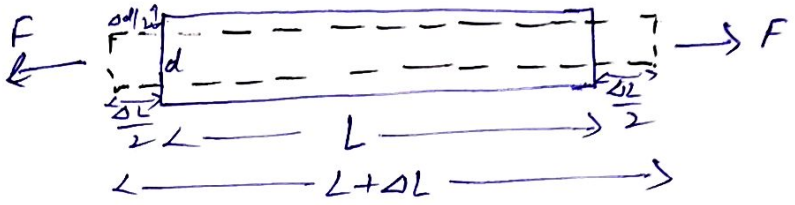
$$B = \frac{-\Delta P}{\Delta V/V}$$

or $\boxed{B = -V\frac{dP}{dV}}$

Reciprocal of the bulk modulus is called as compressibility K

$$\boxed{K = \frac{1}{B} = -\frac{1}{V}\frac{dV}{dP}}$$

Poisson's ratio: If a rod/bar or a wire is subjected to a longitudinal stress (tensile stress), there will be increase in length in the direction of tensile force. At the same time, there will be decrease in length at right angles to tensile force.



$$\text{Poisson's ratio } (\sigma) = \frac{\text{lateral strain}}{\text{longitudinal strain}}$$

$$\sigma = \frac{-\Delta d/d}{\Delta L/L}$$

Minus sign ensures the Poisson's ratio σ to be positive.

H.W.

Q.1 A steel wire of original length 1 m and cross-sectional area 4.00 mm^2 is clamped at the two ends so that it lies horizontally and without tension. If a load of 2.16 Kg is suspended from the middle point of the wire what would be its vertical depression?

Q.2 A copper wire of cross sectional area 0.01 cm^2 is under a tension of 20N. Find the decrease in the cross-sectional area Young's modulus of copper = $1.1 \times 10^{11} N/m^2$ and Poisson's ratio = 0.32.