Relation connecting Young's modulus (Y), Bulk modulus (K), and modulus of rigidity (η):

~~In previous~~ notes we have relations given by

$$Y = 3K(1-2\sigma) \quad \text{--- (I)}$$

and $Y = 2\eta(1+\sigma)$ --- (II), where σ = Poisson's ratio

From equation (I)

$$\frac{Y}{3K} = 1-2\sigma \quad \text{--- (III)}$$

From eqn (II)

$$\frac{Y}{\eta} = 2(1+\sigma) = 2+2\sigma \quad \text{--- (IV)}$$

Next, adding equation (III) and (IV) we have

$$\frac{Y}{3K} + \frac{Y}{\eta} = 3$$

or $Y\left(\frac{1}{3K} + \frac{1}{\eta}\right) = 3$

$$\Rightarrow \frac{1}{3K} + \frac{1}{\eta} = \frac{3}{Y}$$

or $$\boxed{\frac{1}{K} + \frac{3}{\eta} = \frac{9}{Y}}$$

H.W.

Q.1 A bar of cross-section 8 mm x 8 mm is subjected to an axial pull of 7000 N. The lateral dimension of the bar is found to be changed to ~~7.9985mm x 7.~~ 7.9985 mm x 7.9985 mm. If the modulus of ~~elasticity~~ rigidity of the material is $0.8 \times 10^5 N/mm^2$, determine the Poisson's ratio and modulus of elasticity.

Q.2 Determine the Poisson's ratio and bulk modulus of a material, for which Young's modulus is ~~2.1~~ $1.2 \times 10^5 N/mm^2$ and modulus of rigidity is $4.8 \times 10^4 N/mm^2$

Q3 Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30 mm and length 1.5 m if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of $100 N/mm^2$. Take Young's modulus $Y = 1 \times 10^5 N/mm^2$.