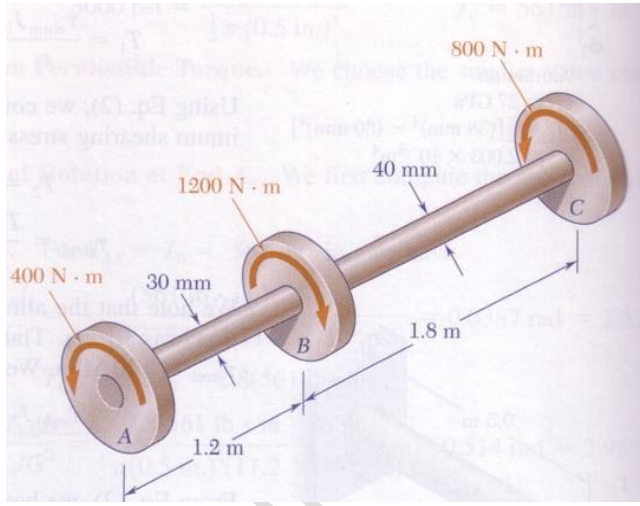
Q- The torques shown are exerted on the pulleys A, B, and C. Knowing that both shafts are solid and made of brass (G = 39GPA), determine the angle of twist between (a) A and B, (b) B and C.



As the two torques of 400 Nm and 800 Nm are applied, as both are in the same direction, will produce angular acceleration in the system. To balance these torque equal in magnitude and opposite to their direction is required and the 1200 Nm torque is providing this torque.

If the pulley B is clamped, due to the torques on A and B the clamps will experience the torque of 1200 Nm and hence will give equal and opposite reaction torque. Hence this 1200 Nm torque is behaving as this reaction of the clamp.

Now the modulus of torsion or torque per unit angular twist for a cylindrical rod is given by

$$\rho = \frac{\pi \eta a^4}{2l}$$

Here η is the modulus of rigidity, 'a' is the radius of the cylinder and *l* is the length of the cylinder.

Hence if the angular twist is θ then the twisting torque acting on the cylinder will be given by

$$\tau = \rho\theta = \frac{\pi \eta a^4 \theta}{2l}$$

Or $$\theta = \frac{2l\tau}{\pi \eta a^4}$$

(a) The twisting torque for this part between A and B is 400 Nm, hence

$$\theta_1 = \frac{2*1.2*400}{3.14*\left(39*10^9\right)*\left(15*10^{-3}\right)^4} = 0.155 \text{ Radian}$$

= 0.155*(180/π) = 8.88 deg.

(a) The twisting torque for second part between B and C is 800 Nm, hence

$$\theta_2 = \frac{2*1.8*800}{3.14*\left(39*10^9\right)*\left(20*10^{-3}\right)^4} = 0.147 \text{ Radian}$$

= 0.147*(180/π) = 8.43 deg.