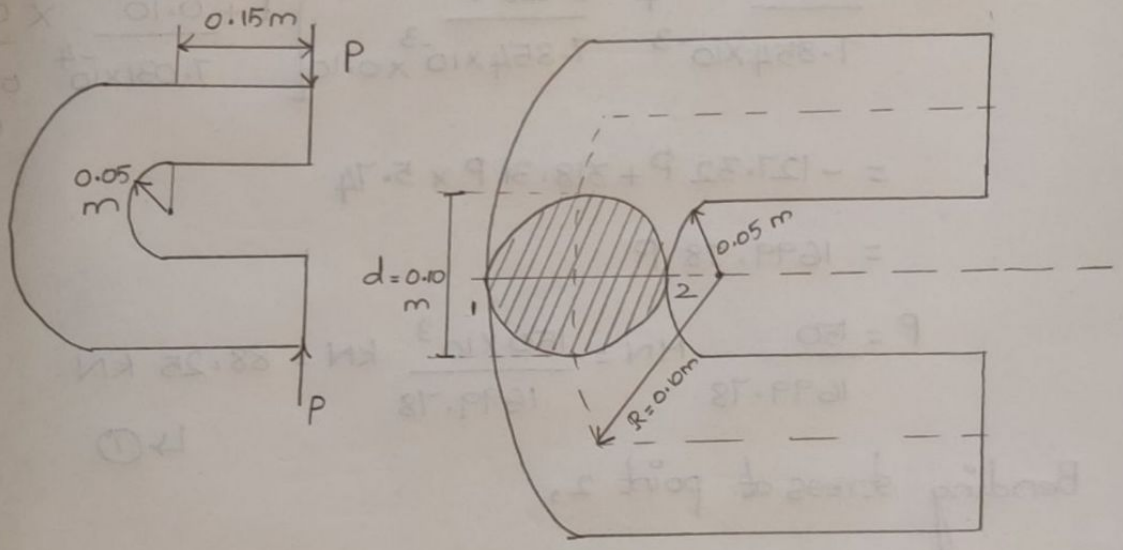
1) The Curved member shown in fig has a Solid Circular Cross-Section 0.10 m in Diameter. If the Max. tensile & Compressive stresses in the member are not to exceed 150 Mpa & 200 MPa respectively. Determine the Value of Load P that can be Safetly Carried by the Member.

$d = 0.10\ m \quad R = 0.10\ m, \quad \sigma_1 = 150\ Mpa = 150\ MN/m^2$ (tensile)

$\sigma_2 = 200\ Mpa = 200\ MN/m^2$ (Comp).



Ref to fig, Area of Cross-Section,

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} \times 0.10^2 = 7.854 \times 10^{-3}\ m^2$$

Bending Moment, $M = P(0.15 + 0.10) = 0.25\ P$

$$h^2 = \frac{d^2}{16} + \frac{1}{128} \frac{d^4}{R^2}$$

Substituting the Values, We have

$$h^2 = \frac{(0.10)^2}{16} + \frac{1}{128} \cdot \frac{(0.10)^4}{(0.10)^2} = 7.031 \times 10^{-4}\ m^2.$$

Direct stress, $\sigma_d = \frac{P}{A}$ (comp)

Bending stress at pt 1 due to M,

$$\sigma_{b1} = \frac{M}{AR}\left[1 + \frac{R^2}{h^2} \times \frac{y}{R+y}\right] \text{ (tensile)}$$

Total stress at pt 1

$$\sigma_1 = \sigma_d + \sigma_{b1}$$

$$150 = \frac{-P}{A} + \frac{M}{AR}\left[1 + \frac{R^2}{h^2} \times \frac{y}{(R+y)}\right] \text{(tensile)}$$

$$150 = \frac{-P}{7.854\times10^{-3}} + \frac{0.25\,P}{7.854\times10^{-3}\times0.10}\left[1 + \frac{0.10^2}{7.031\times10^{-4}} \times \frac{0.05}{0.10+0.05}\right]$$

$$= -127.32\,P + 318.31\,P \times 5.74$$

$$= 1699.78\,P$$

$$P = \frac{150}{1699.78}\ MN = \frac{150\times10^3}{1699.78}\ kN = 88.25\ kN$$

↳ (1)

Bending stress at point 2,

$$\sigma_2 = \sigma_d + \sigma_{b2}$$

$$200 = \frac{P}{A} + \frac{M}{AR}\left[\frac{R^2}{h^2} \times \frac{y}{R-y} - 1\right] \text{(comp)}$$

$$= \frac{P}{7.854\times10^{-3}} + \frac{0.25\,P}{7.854\times10^{-3}\times0.10}\left[\frac{0.10^2}{7.031\times10^{-4}} \times \frac{0.05}{0.10-0.05} - 1\right]$$

$$= 127.32\,P + 318.31\,P \times 13.22$$

$$= 4335.38\,P$$

$$P = \frac{200}{4335.38\ MN} = \frac{200}{4335.38} \times 10^3\ kN$$

$$= 46.13\ kN. \rightarrow (2)$$

From (1) & (2) the safe load P will be lesser of these.

Hence, $\boxed{P = 46.13\ kN.}$