Ex-1

A hollow steel tube with an inside of 100mm must carry a tensile load of 400kN. Determine the outside diameter of the tube if the stress is limited to 120 MPa.

$$\sigma = \frac{P}{A}$$

where, $\sigma = 120\,MPa$

$P = 400\,kN$

$$A = \frac{1}{4}\pi\left(D_o^2 - d_i^2\right) = \frac{1}{4}\pi\left(D_o^2 - 100^2\right)$$

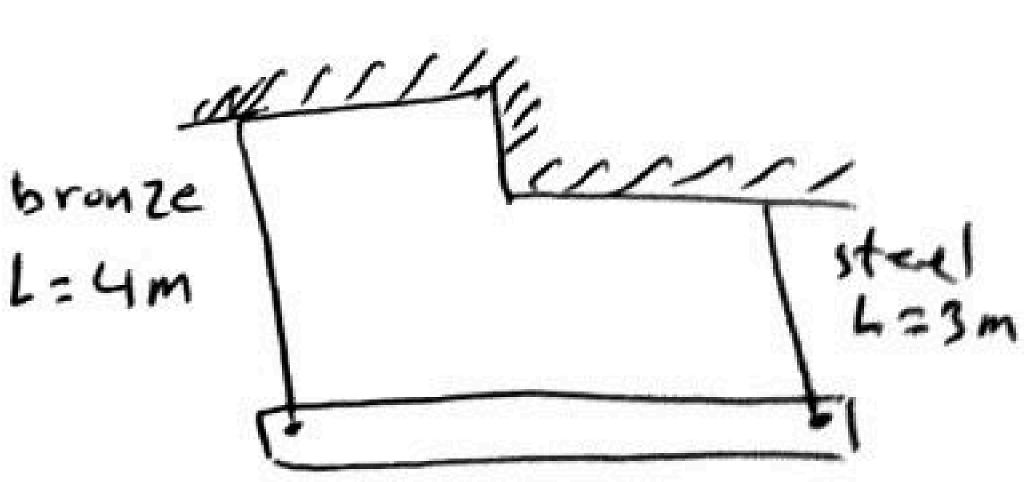
$$120\,MPa = \frac{400\times10^3\,N}{\frac{1}{4}\pi\left(D_o^2 - 100^2\right)}$$

$$D_o^2 = \frac{400\times10^3 + 300\,000\,\pi}{30\,\pi}$$ ~~300000π~~

$$D_o = 119.35\,mm$$

Ex-2

A homogeneous 800kg bar is supported at either end by a cable as shown in Fig. Calculate the smallest area of each cable if the stress is not to exceed 90 MPa in bronze and 120 MPa in steel.



$W = mg$

$= 800 \times 9.81 = 7848\,N$

$\Sigma F_y = 0$

$P_{br} + F_{st} = W$

$\Sigma M_A = 0$

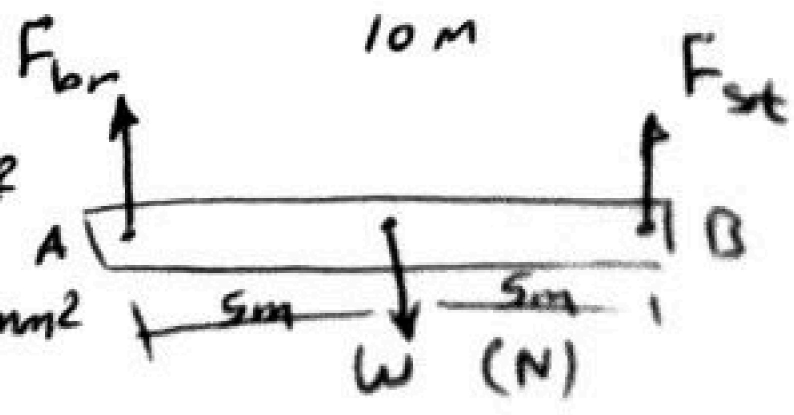
$5W = 10F_{st} \Rightarrow F_{st} = \frac{1}{2}W = 3924\,N$

$\Rightarrow F_{br} = 3924\,N$

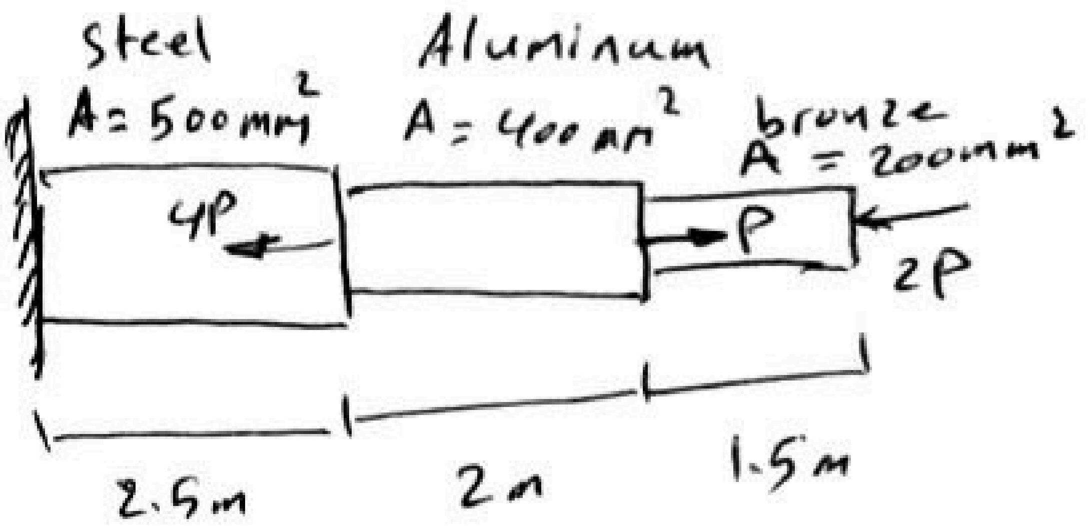
$\sigma = \frac{F}{A} \Rightarrow A = \frac{F}{\sigma}$

$A_{br} = \frac{3924}{90} = 43.6\,mm^2$

$A_s = \frac{3924}{120} = 32.7\,mm^2$

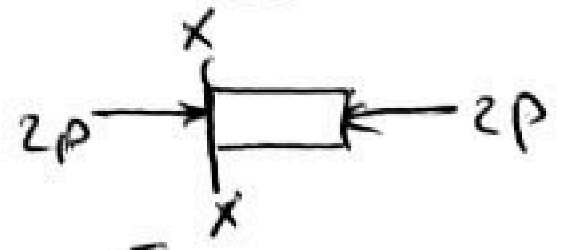


Ex-3 An aluminum rod is rigidly attached between a steel rod and bronze rod as shown in Fig. Axial loads are applied at the positions indicated. Find the maximum value of P tha will not exceed a stress in steel 140 MPa in aluminum 90 MPa, in bronze 100 MPa



Solution:-

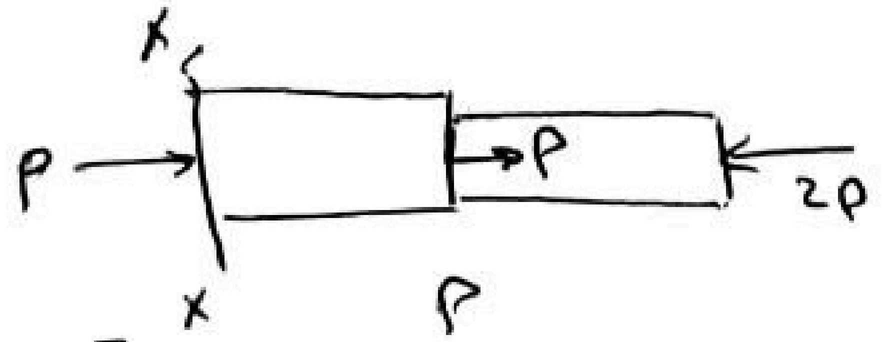
For bronze



$$\sigma = \frac{F}{A}$$

$$100\,MPa = \frac{2P}{200\,mm^2} \Rightarrow P = 10,000\,N$$

For Aluminum

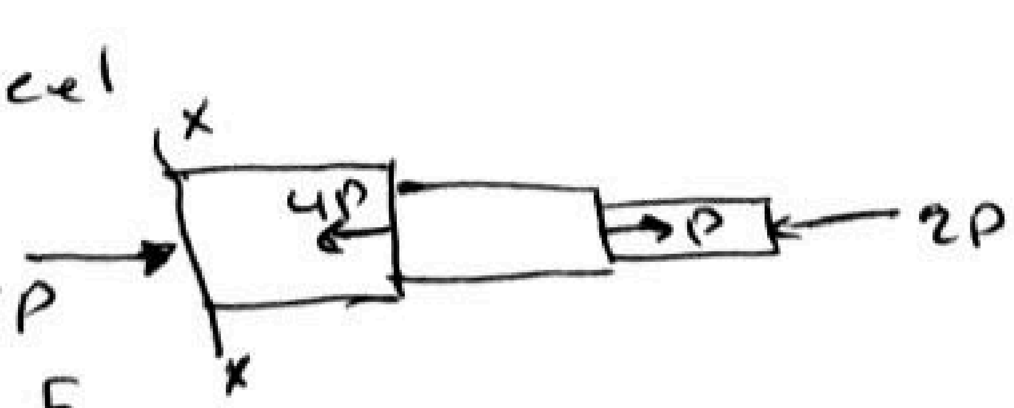


$$\sigma = \frac{F}{A} = \frac{P}{A}$$

$$90\,MPa = \frac{P}{400\,mm} \Rightarrow P = 36,000\,N$$

∴ For safe P use $P = 10,000\,N$

For steel

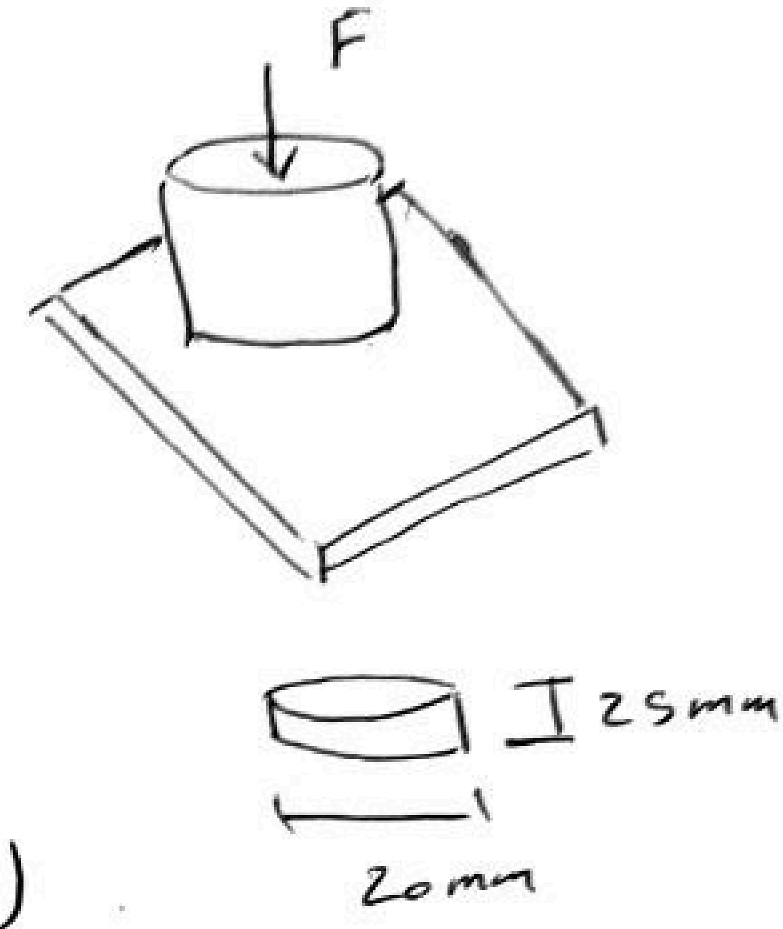


$$\sigma = \frac{F}{A}$$

$$140\,MPa = \frac{5P}{500} \Rightarrow P = 14000\,N$$

Ex-4

What force is required to punch a 20 mm diameter hole in a plate that is 25 mm thick? The shear strength is 350 MPa.



$$\tau = \frac{F}{A_s}$$

$$A_s = \pi D t$$

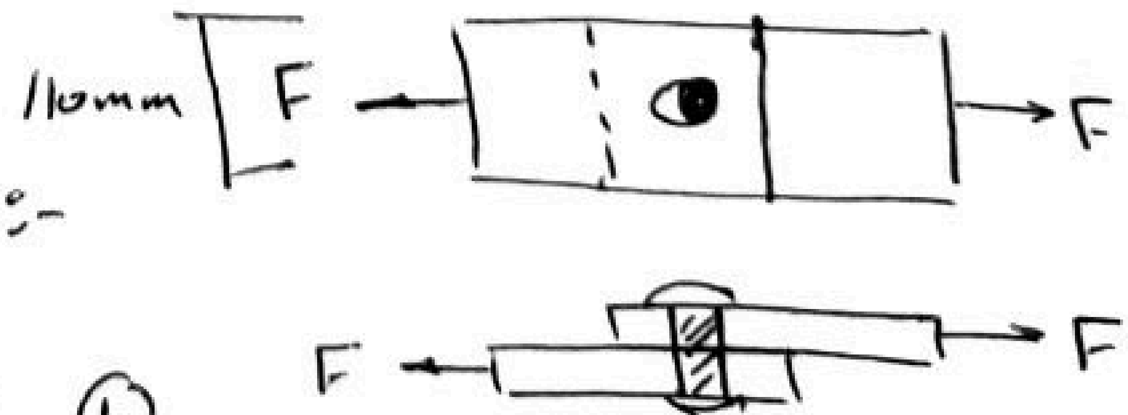
$$= \pi (20)(25)\ mm^2$$

$$\tau = 350\ MPa$$

$$\therefore\ F = \tau A_s = 350\ MPa\ \pi (20)(25)$$

$$= 549778.7\ N \simeq 549.8\ kN$$

Ex-5- In Fig. assume that a 20 mm diameter rivet joins the plates that are each 110 mm wide. The allowable stresses are 120 MPa for bearing in the plate material and 60 MPa for shearing of rivet. Determine ⓐ the minimum thickness of each plate and ⓑ the largest average tensile stress in the plates.



Solution

a From shearing of revit:-

$$\tau = \frac{F}{A_s}$$

$$F = \tau A_s = 60\ MPa \left(\tfrac{1}{4}\pi D^2\right)$$

$$= 6000\pi\ N$$

From bearin of plate:-

$$\sigma_b = \frac{F}{A_b} \qquad 120\ MPa = \frac{6000\pi}{20t} \Rightarrow t = 7.85\ mm$$

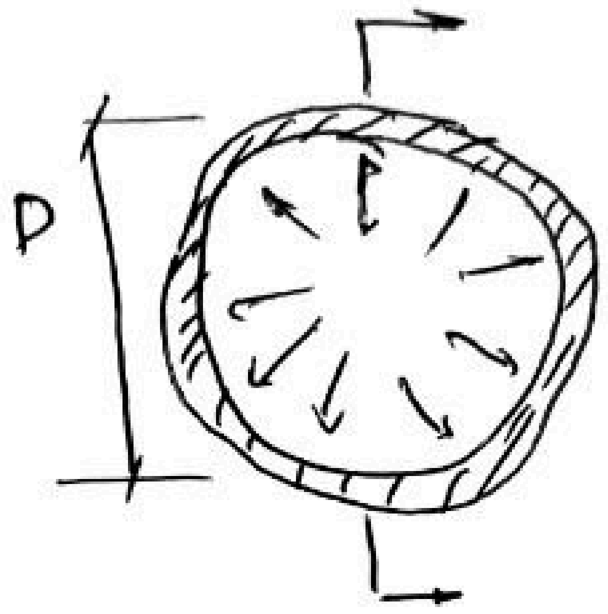
ⓑ largest tensile $\quad d = 20\ mm$

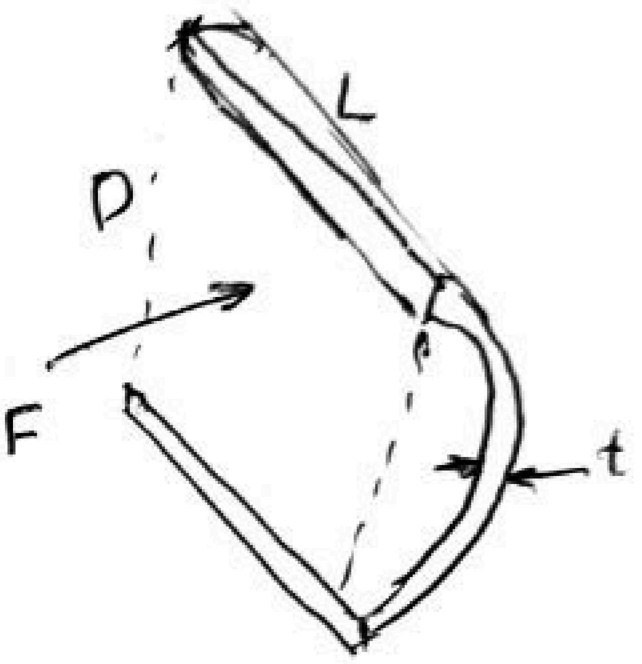
$$\sigma = \frac{F}{A_t} = \frac{6000\pi}{7.85(110-20)} = 26.67\ MPa$$

Thin Wall Pressure Vessels

A tank or pipe carrying a fluid or gas under a pressure is subjected to tensile force, which resist bursting, developed a cross longitudinal and transverse sections.

Tangential stress (Circumferential stress) (σ_t or σ_θ)





$$\sigma_\theta = \frac{F}{A}$$

$$F = pA = pDL$$

$$A = 2tL$$

$$\sigma_\theta = \frac{pDL}{2tL} = \boxed{\frac{pD}{2t}}$$

p = pressure

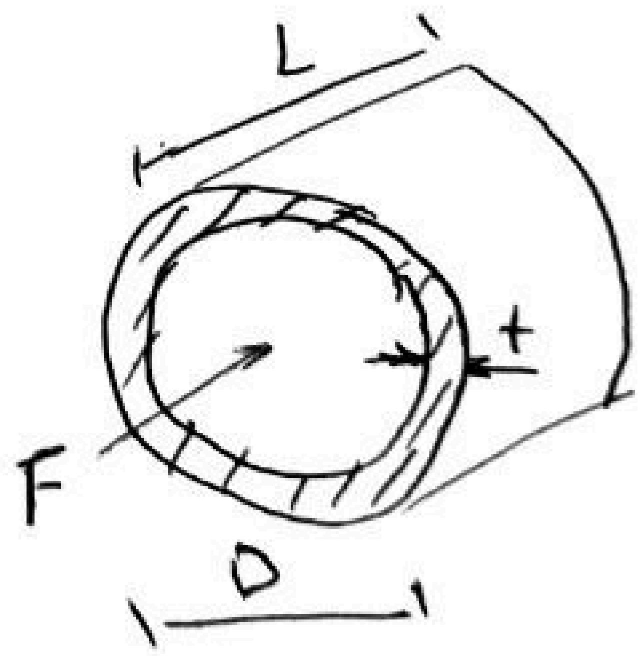
Longitudinal stress (σ_L)

$$\sigma_L = \frac{F}{A_L}$$

$$F = p\,\frac{\pi D^2}{4}$$

$$A = \pi D t$$

$$\sigma_L = \frac{p\,\pi D^2}{4\pi D t} = \boxed{\frac{pD}{4t}}$$



$$\Rightarrow \boxed{\sigma_{t(\theta)} = 2\sigma_L}$$