Subject: Mechanics of Materials

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Lec. 3 / Simple Stress

Stress(σ):

the ratio of the applied force divided by the resisting area.

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

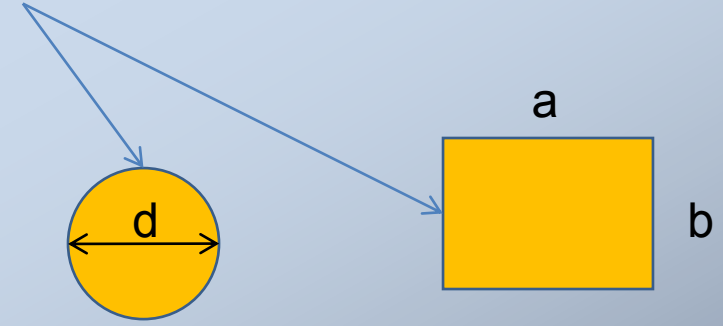
σ =stress(is called as Sigma)

P = External force or load

A = Cross-sectional area

Unit:

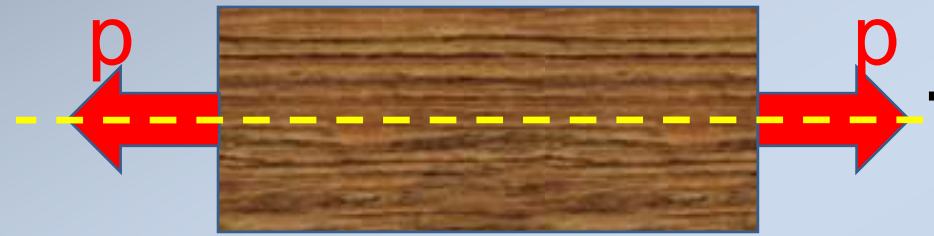
$N/m^2 = Pa$ (Pascal)



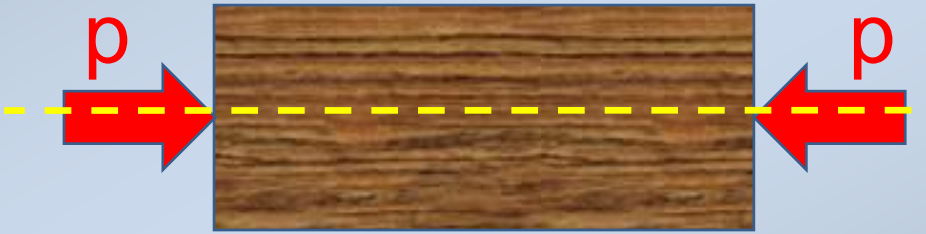
$$A = \frac{\pi}{4} d^2$$

$$A = ab$$

Normal Stress(σ):



Tension(+)



Compression(-)

Tension

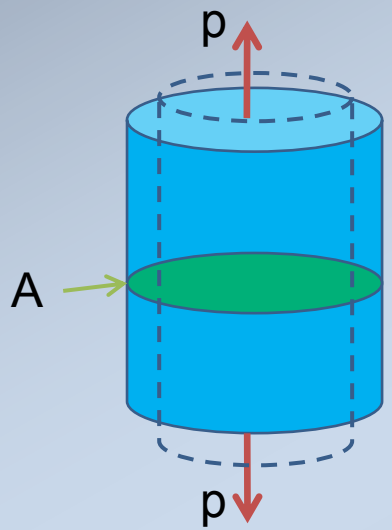
$$\sigma = +\frac{P}{A}$$

Compresion

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

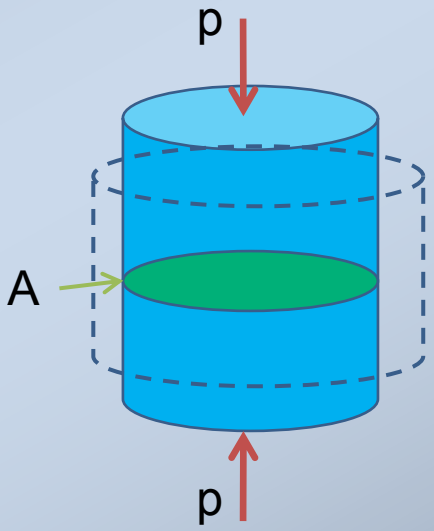
Normal Stress(σ):

Tension:



Tensile Stress makes the body longer(the area contraction).

Compression:



Compressive Stress makes the body shorter(the area expansion).

Units:

$$N/m^2 = Pa$$

$$N/mm^2 = MPa$$

$$KN/mm^2 = GPa$$

Note:

$$10^6 Pa = MPa$$

$$10^9 Pa = GPa$$

Note:

1m = 100cm

1m = 1000mm

1cm = 10mm

Normal Stress(σ):

Q/ A rod 150cm long and diameter 2cm is subjected to tensile stress 20kN,determine the stress?

Sol:

$$A = \frac{\pi}{4} d^2$$

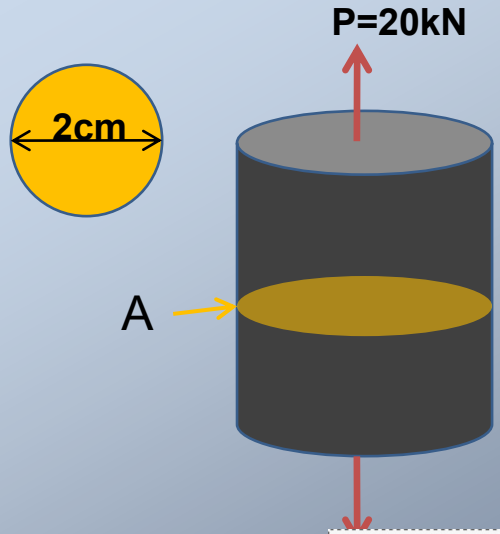
$$A = \frac{\pi}{4} (20)^2$$

$$A = 314 mm^2$$

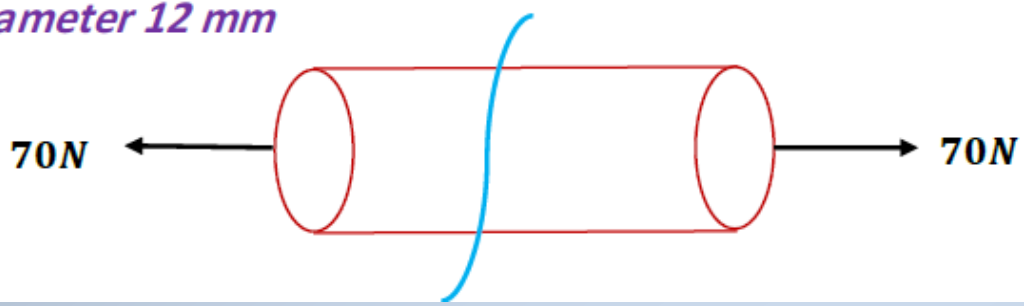
$$\sigma = \frac{P}{A}$$

$$\sigma = \frac{20x10^3}{314} \left(\frac{N}{mm^2}\right)$$

$$\sigma = 63.6\ MPa$$

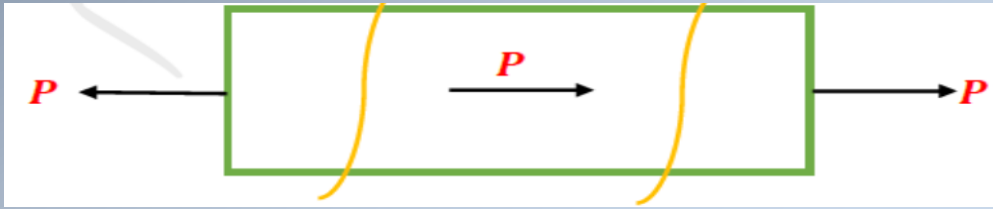


Q / Find the σ if diameter 12 mm



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

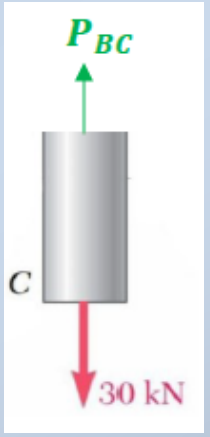
$$\sigma = \frac{70}{\frac{\pi}{4} \times (12)^2} \Rightarrow \sigma = 0.62Mpa$$

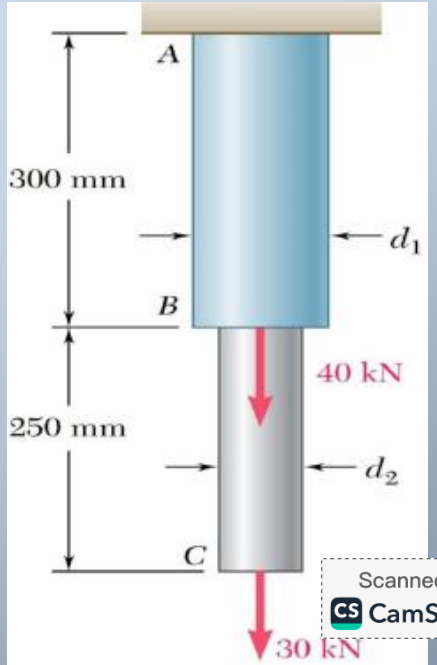


Q/Two solid cylindrical rods AB and BC are welded together at B loaded as shown . Known that the average normal stress must not exceed 140 MPa in each rod . Determine the smallest allowable value of d1 , and d2

$\uparrow^{+} \sum f_{y=} 0$

$P_{BC} - 30 = 0 \Rightarrow P_{BC} = 30KN$





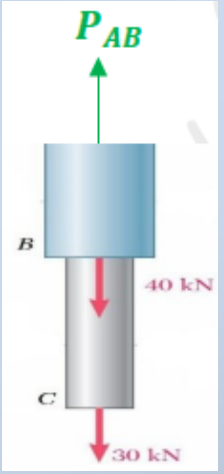
$$\sigma = \frac{P}{\frac{\pi}{4} \times d^2} \Rightarrow 140 = \frac{30 \times 10^3}{\frac{\pi}{4} \times d^2}$$

$$d_2 = 16.52\ mm$$

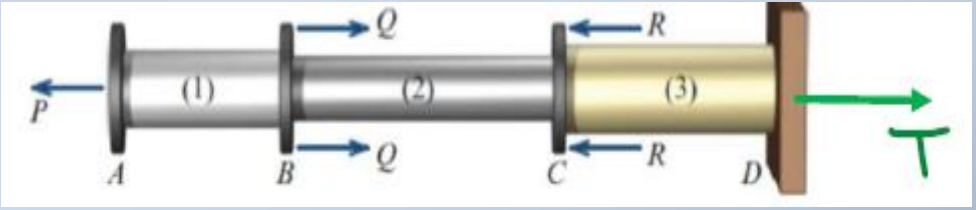
$$\uparrow^{+} \sum f_{y=}0$$

$$P_{AB} - 30 - 40 = 0 \quad \Rightarrow \quad P_{AB} = 70KN$$

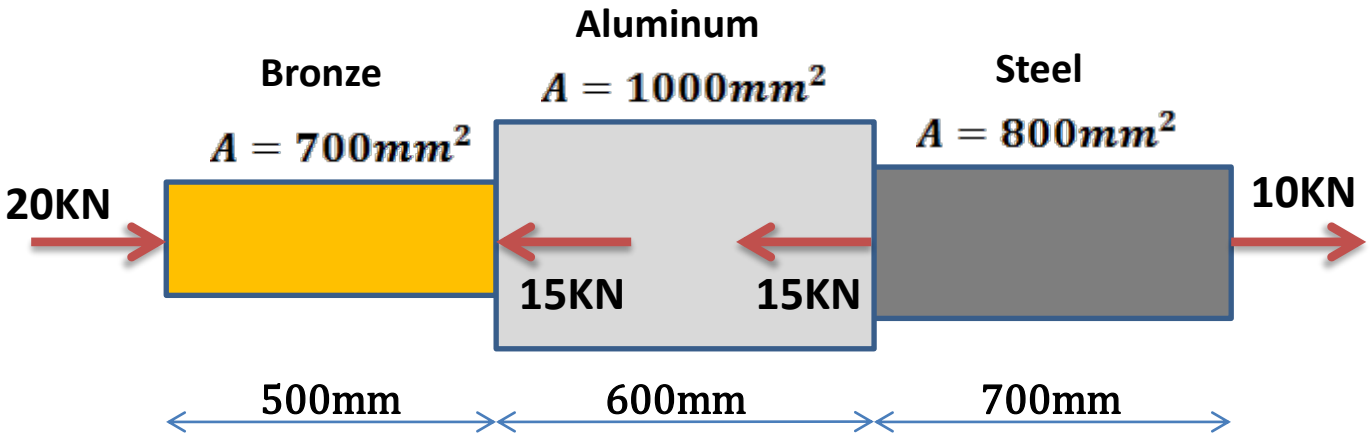
$$\sigma = \frac{P}{\frac{\pi}{4} \times d^2} \quad \Rightarrow \quad 140 = \frac{70 \times 10^3}{\frac{\pi}{4} \times d^2} \quad \Rightarrow \quad \boxed{d_1 = 25.2mm}$$



Q/Axial loads are applied with rigid bearing plates to the solid cylindrical rods shown in. One load of P = 30 kips is applied to the assembly at A, two loads of Q = 25 kips are applied at B , and two loads of R = 35 kips are applied at C. The normal stress magnitude in aluminum rod (1) must be limited to 20 ksi . The normal stress magnitude in steel rod (2) must be limited to 35 ksi . The normal stress magnitude in brass rod (3) must be limited to 25 ksi . Determine the minimum diameter required for each of the three rods

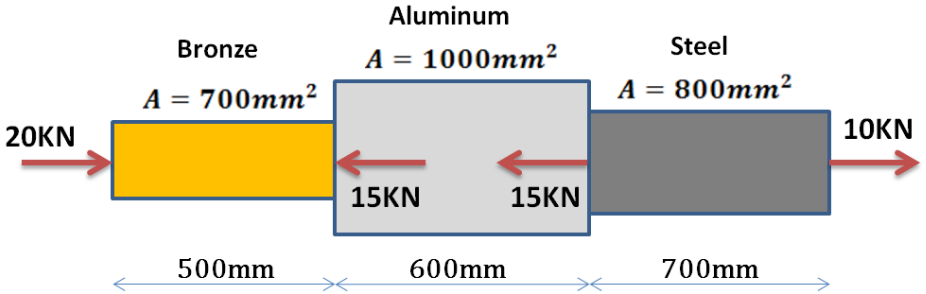


Q/ an aluminum tube is rigidly fastened between a bronze rod and a steel rod as shown in Figure. Axial loads are applied at the positions indicated. Determine the stress in each material?

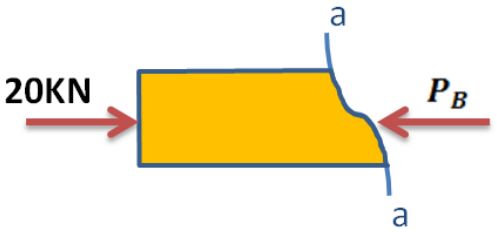


At segment (a-a):

$$\sum f_x = 0$$



$$20 - P_B = 0 \qquad \boxed{P_B = 20KN}$$



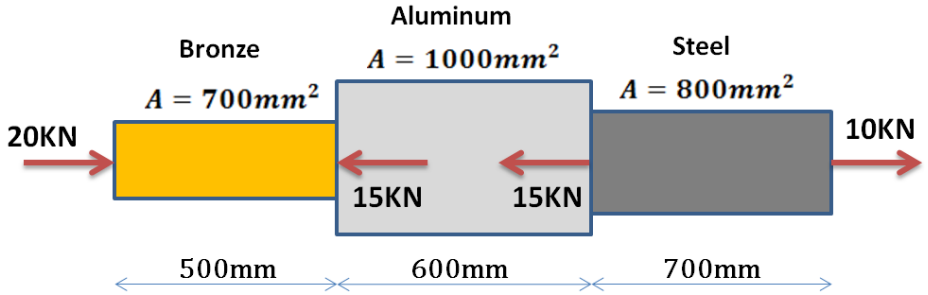
$$\sigma_B = \frac{P_B}{A_B}$$

$$\sigma_B = \frac{20x10^3}{700}\left(\frac{N}{mm^2}\right)$$

$$\boxed{\sigma_B = 28.6\,MPa}$$

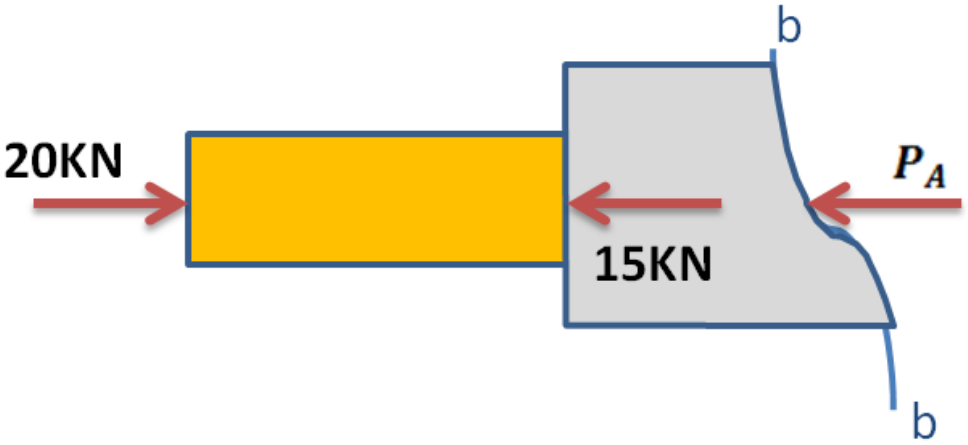
At segment (b-b):

$$\sum f_x = 0$$



$$20 - 15 - P_A = 0$$

$$\boxed{P_A = 5KN}$$



$$\sigma_A = \frac{P_A}{A_A}$$

$$\sigma_A = \frac{5x10^3}{1000}\left(\frac{N}{mm^2}\right)$$

$$\boxed{\sigma_A = 5\ MPa}$$

At segment (c-c):

$$\sum f_x = 0$$

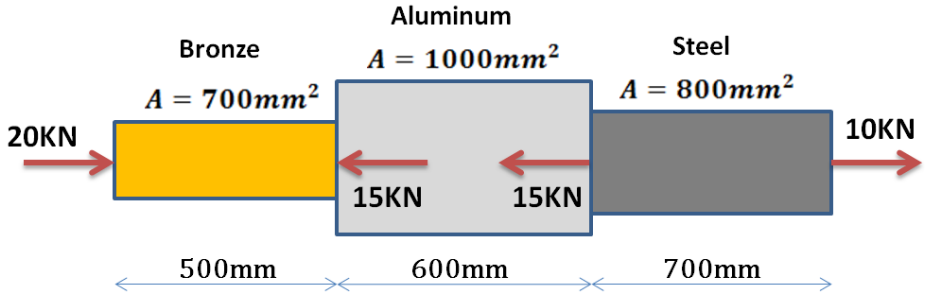
$$20 - 15 - 15 - P_S = 0$$

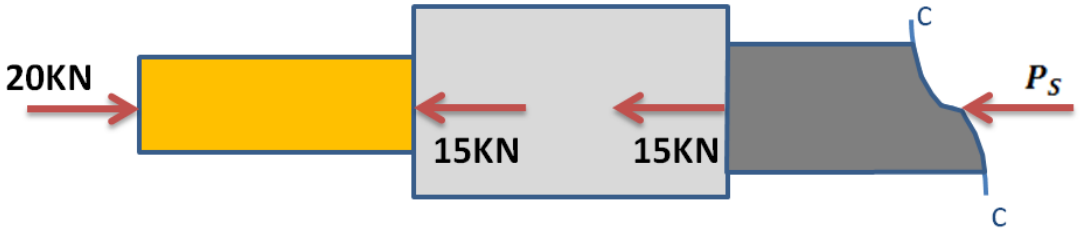
$$\boxed{P_S = 10KN}$$

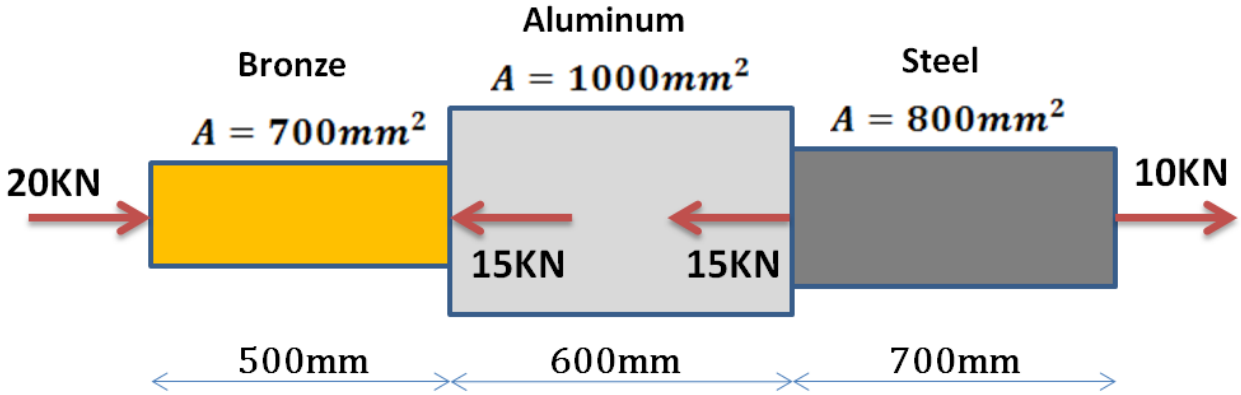
$$\sigma_S = \frac{P_S}{A_S}$$

$$\sigma_S = \frac{10x10^3}{800}\left(\frac{N}{mm^2}\right)$$

$$\boxed{\sigma_S = 12.5\,MPa}$$







$$\sigma_B = 28.6\ MPa$$

$$\sigma_A = 5\ MPa$$

$$\sigma_S = 12.5\ MPa$$