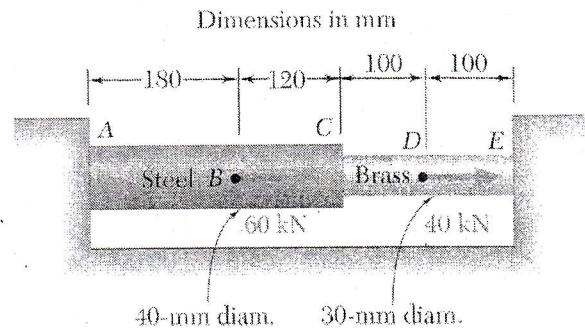


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1. (8 points)

Two cylindrical rods, one of steel and the other of brass, are joined at C and restrained by rigid supports at A and E. For the loading shown and knowing that $E_{st} = 200 \text{ GPa}$ and $E_{br} = 105 \text{ GPa}$, determine the reactions at A and E.



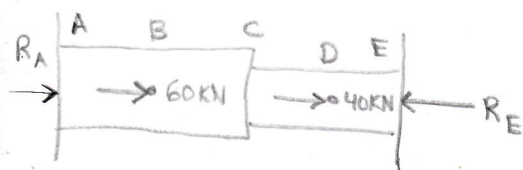
Given: $E_{st} = 200 \text{ GPa}$

Find: $R_A, R_E = ?$

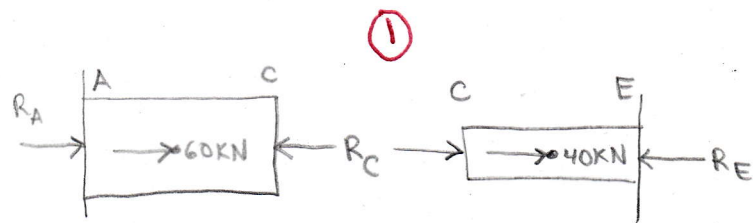
$E_{br} = 105 \text{ GPa}$

~//

Free Body Diagram



(+)



$$\sum F_x = 0 \Rightarrow R_A + 60 + 40 - R_E = 0$$

$$\therefore R_A + 100 = R_E \quad (1)$$

Compatibility Condition

$$\delta = \frac{PL}{EA} \Rightarrow \delta_{st} = \delta_{FB} - \delta_{RC}$$

(1)

$$\delta_{br} = \delta_{FD} + \delta_{RC}$$

with

$$\delta_{FB} = \frac{(60 \times 10^3) \text{ N} (180 \times 10^{-3}) \text{ m}}{(200 \times 10^9) \text{ Pa} \left(\pi \left(\frac{1}{2} (40 \times 10^{-3}) \right)^2 \right) \text{ m}^2}$$

$$\Rightarrow \delta_{FB} \approx 4.297 \times 10^{-5} \text{ m}$$

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$$\delta_{FD} = \frac{(40 \times 10^3) \text{ N} (100 \times 10^{-3}) \text{ m}}{(105 \times 10^9) \text{ Pa} \left(\pi \left(\frac{1}{2} (30 \times 10^{-3}) \right)^2 \right) \text{ m}^2}$$

$$\approx 5.389 \times 10^{-5} \text{ mm} \quad \left(\frac{1}{2} \right)$$

$$\delta_{RC})_{st} = \frac{(-R_C) (300 \times 10^{-3}) \text{ m}}{(200 \times 10^9) \text{ Pa} \left(\pi \left(\frac{1}{2} (40 \times 10^{-3}) \right)^2 \right) \text{ m}^2}$$

$$\text{OR} \quad \left(\frac{1}{2} \right)$$

$$\delta_{RC})_{br} = \frac{(R_C) (200 \times 10^{-3}) \text{ m}}{(105 \times 10^9) \text{ Pa} \left(\pi \left(\frac{1}{2} (30 \times 10^{-3}) \right)^2 \right) \text{ m}^2}$$

Since both ends are fixed,
no extension is allowed.

$$\Rightarrow (\delta_{FB} - \delta_{RC})_{st} - (\delta_{FD} + \delta_{RC})_{br} = 0 \quad (1)$$

$$(4.297 \times 10^{-5} - 1.193 \times 10^{-6} R_C) - (5.389 \times 10^{-5} + 2.694 \times 10^{-6} R_C) = 0$$

$$\Rightarrow R_C \approx -2.809 \text{ kN} \quad (1)$$

From FBD,

$$R_A + 60 = R_C \Rightarrow R_A = -62.809 \text{ kN OR } 62.809 \text{ kN} \leftarrow \text{Directions} \quad \left(\frac{1}{2} \right)$$

$$R_E = R_C + 40 \Rightarrow R_E = 37.191 \text{ kN OR } 37.191 \text{ kN} \leftarrow \quad \left(\frac{1}{2} \right)$$