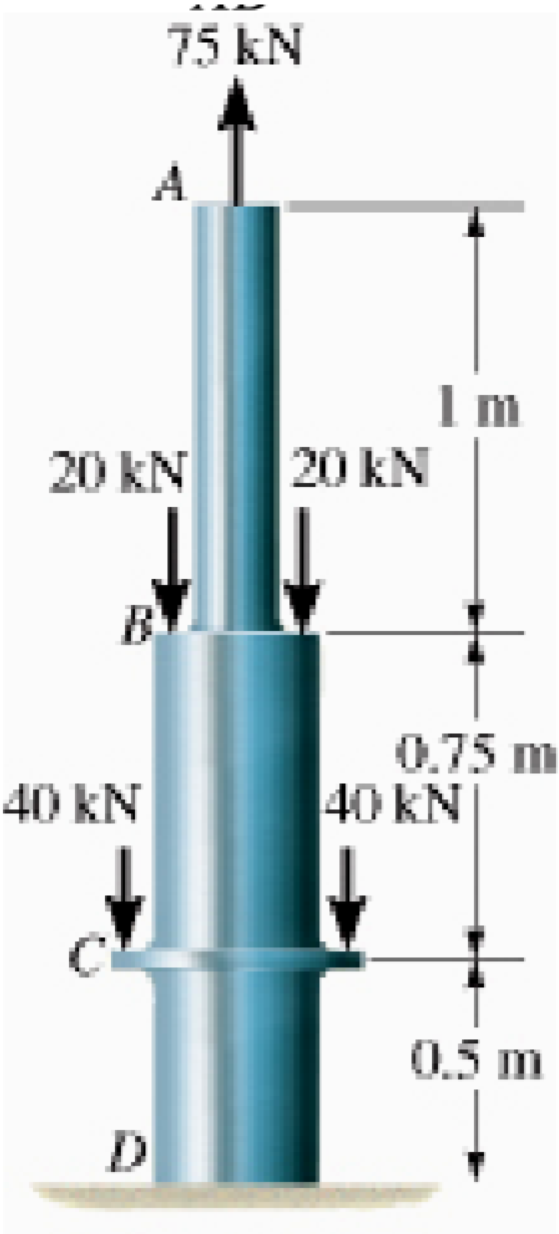
EX_2

EX 2.1

The composite A-36 steel bar shown made from two segments AB and BD. Cross section area $A_{AB} = 600mm^2$ and $A_{BD} = 1200mm^2$.

Determine the vertical displacement of end A and displacement of B relative to C.



(a)

$$\delta_A = \sum \frac{LP}{EA} \qquad E = 210\cancel{\times 10}\,GPa$$

$$= \frac{1}{E}\left(\frac{0.5 \times 75\,kN}{600\,mm^2} + \frac{0.75 \times 35\,kN}{1200\,mm^2} - \frac{0.5 \times 45\,kN}{1200\,mm^2}\right)$$

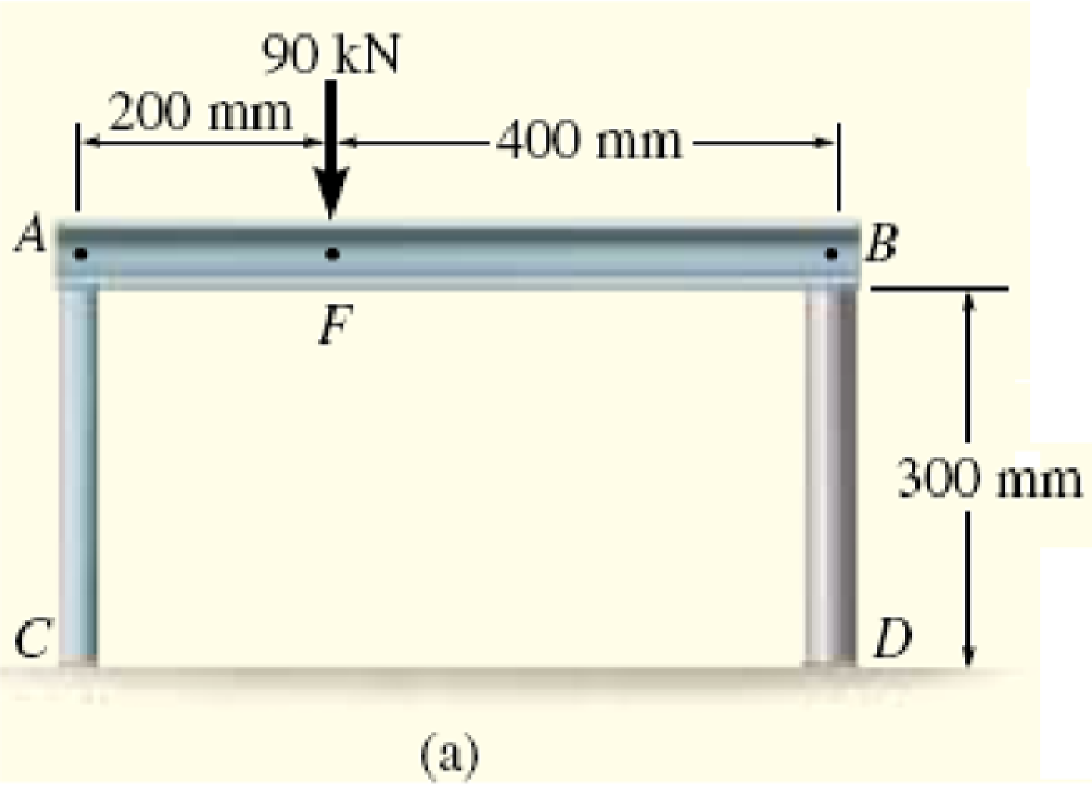
$$= 0.61\,mm$$

$$\delta_{BC} = \frac{0.75 \times 35}{1200 \times 210} = 0.104\,mm$$

EX 2.2

A rigid beam AB rests on the two short posts. AC is made of steel and has a diameter of 20 mm, and BD is made of aluminum and has a diameter of 40 mm. Take $E_{st} = 200GPa$, $E_{al} = 70GPa$

Determine the displacement of point F on AB uf a vertical load of 90 kN is applied over this point



(a)

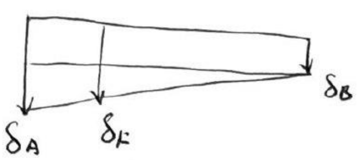
$$\sum F_y = 0$$
$$A_y + B_y = 90$$

$$\sum M_F = 0$$
$$200\,A_y = 400\,B_y$$

$$\Rightarrow \begin{cases} A_y = 60 \text{ kN} \\ B_y = 30 \text{ kN} \end{cases}$$

$$\delta_A = \frac{L \cdot A_y}{E_{st} \cdot A} = \frac{300 \text{ mm} \cdot 60 \text{ kN}}{200 \text{ GPa} \cdot \frac{1}{4}\pi (40)^2 \text{ mm}^2} = 0.286 \text{ mm}$$

$$\delta_B = \frac{L\, B_y}{E_{Al} \cdot A} = \frac{300 \text{ mm} \cdot 30 \text{ kN}}{70 \text{ GPa} \cdot \frac{1}{4}\pi (40)^2 \text{ mm}^2} = 0.102 \text{ mm}$$



$$\delta_F = \delta_B + \frac{2}{3}(\delta_A - \delta_B)$$
$$= \frac{1}{3}\delta_B + \frac{2}{3}\delta_A = 0.225 \text{ mm}$$

EX 2.3 (Explain in simple words)

1. BC elongates
2. AB shortens, therefore BC elongates

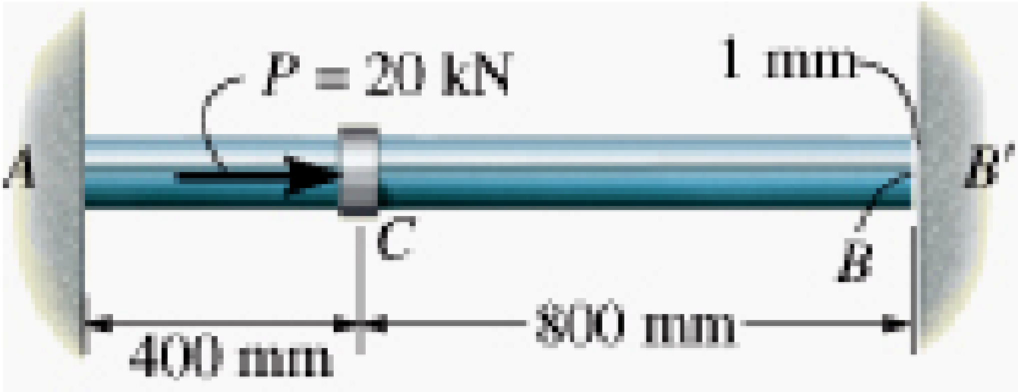
sum the displacements

EX 2.4

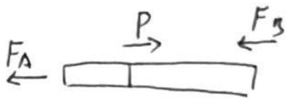
Steel rod shown has diameter of 5 mm. Attached to fixed wall at A, and before it is loaded, there is a gap between the wall at B and the rod of 1 mm.

Determine reactions at A and B' if rod is subjected to axial force of P = 20 kN

Neglect size of collar at C. Take Est = 200 GPa



(a)



$$\delta = \frac{L_A F_A}{EA} - \frac{L_B F_B}{EA} = 1\ mm$$

$$0.4 F_A - 0.8 F_B = 3927$$

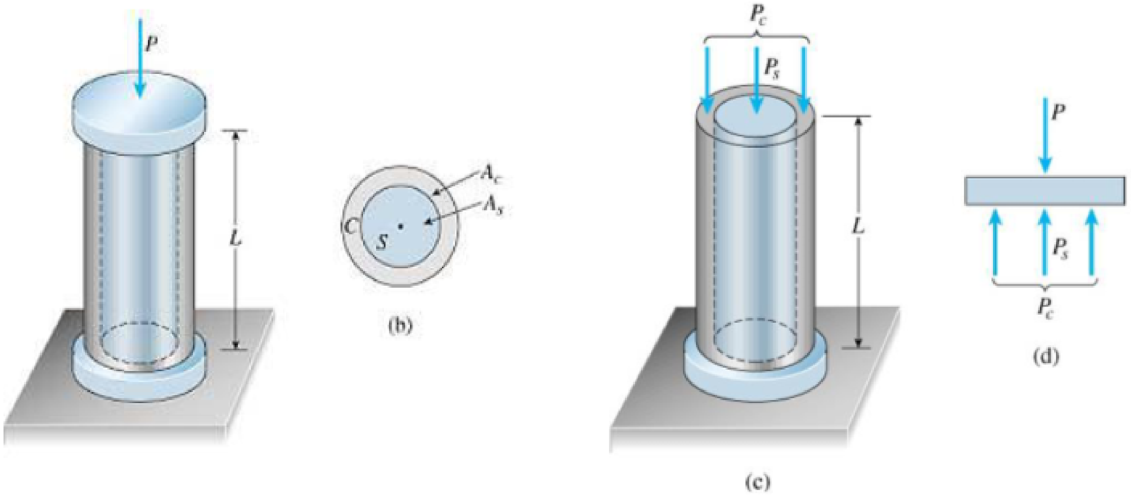
$$F_A + F_B = 20000$$

$$\Rightarrow \begin{cases} F_A = 16.61\ kN \\ F_B = 3.39\ kN \end{cases}$$

EX 2.5

A solid circular steel cylinder is encased by a copper tube C, Applied load = P.

Determine (a) The compressive forces P_s and P_c . (b) The corresponding stresses σ_s and σ_c. (c) The shortening δ of the assembly.



a)
$$\left.\begin{aligned} P_s + P_c &= P \\ \frac{P_s L}{E_s A_s} &= \frac{P_c L}{E_c A_c} \end{aligned}\right\} \Rightarrow \left\{\begin{aligned} P_s &= \frac{E_s A_s}{E_c A_c + E_s A_s} P \\ P_c &= \frac{E_c A_c}{E_c A_c + E_s A_s} P \end{aligned}\right.$$

b)
$$\sigma_s = \frac{P_s}{A_s} = \frac{E_s}{E_c A_c + E_s A_s} P$$

$$\sigma_c = \frac{P_c}{A_c} = \frac{E_c}{E_c A_c + E_s A_s} P$$

c)
$$\delta = \frac{PL}{E_c A_s + E_s A_s}$$

EX 2.6 (thermal elongation, skipped)