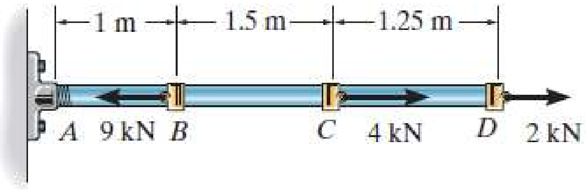
The A-36 steel rod is subjected to the loading shown. If the cross-sectional area of the rod is 50 mm^2, determine the displacement of its end D. Neglect the size of the couplings at B, C, and D.

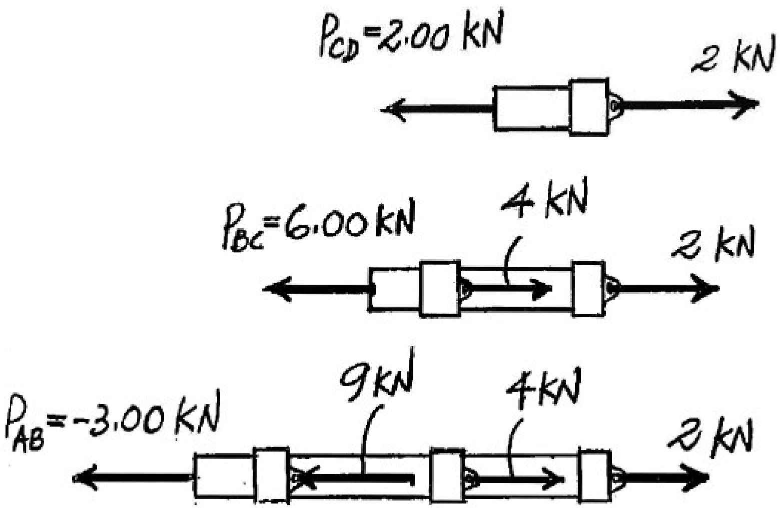


$$\delta_D = \Sigma \frac{P_i L_i}{A_i E_i}$$

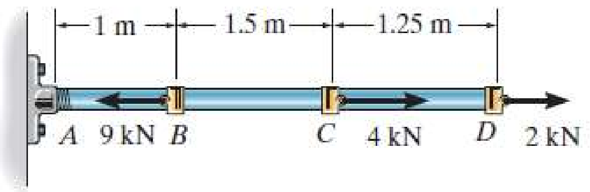
$$= \frac{1}{A\,E_{SC}}\left(P_{AB}\,L_{AB} + P_{BC}\,L_{BC} + P_{CD}\,L_{CD}\right)$$

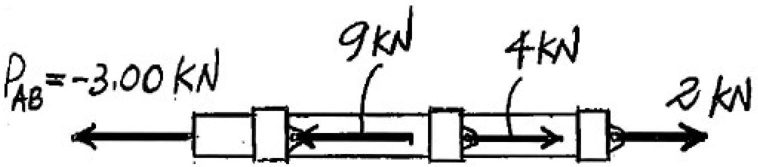
$$= \frac{1}{50.0(10^{-6})\left[200(10^{9})\right]}\left[-3.00(10^{3})(1) + 6.00(10^{3})(1.5) + 2.00(10^{3})(1.25)\right]$$

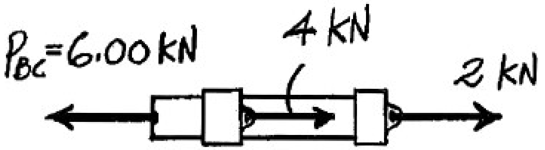
$$= 0.850(10^{-3})\text{ m} = 0.850\text{ mm}$$



The A-36 steel rod is subjected to the loading shown. If the cross-sectional area of the rod is 50 mm^2, determine the displacement of C. Neglect the size of the couplings at B, C, and D.







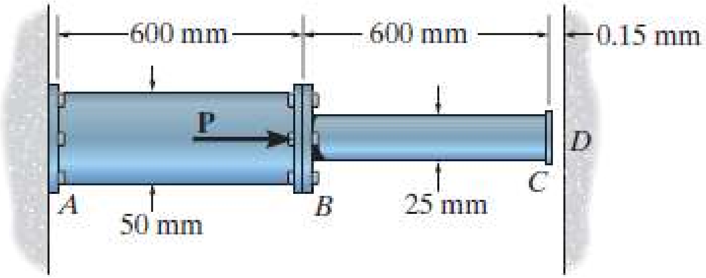
$$\delta_C = \Sigma \frac{P_i L_i}{A_i E_i}$$

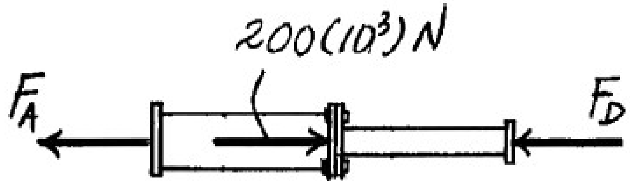
$$= \frac{1}{A\,E_{SC}}\left(P_{AB}\,L_{AB} + P_{BC}\,L_{BC}\right)$$

$$= \frac{1}{50.0(10^{-6})\left[200(10^9)\right]}\left[-3.00(10^3)(1) + 6.00(10^3)(1.5)\right]$$

$$= 0.600\,(10^{-3})\text{ m} = 0.600\text{ mm}$$

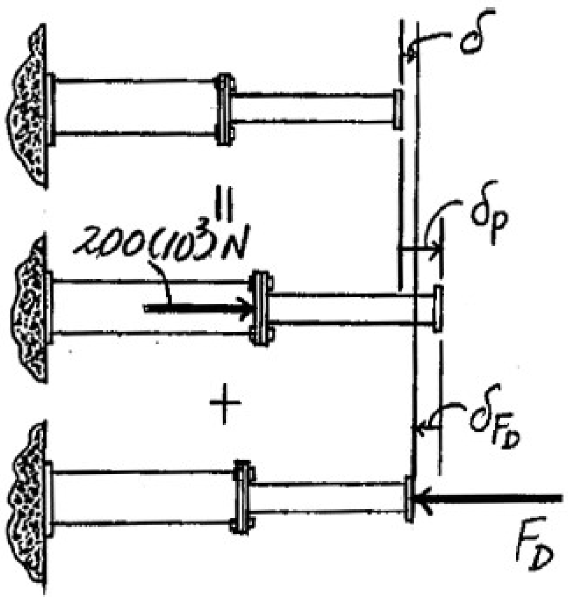
If the gap between C and the rigid wall at D is initially 0.15 mm, determine the support reactions at A and D when the force $\mathbf{P}$ = 200 kN is applied. The assembly is made of A36 steel.





$$\xrightarrow{+} \Sigma F_x = 0;$$

$$200(10^3) - F_D - F_A = 0$$



Compatibility Equation

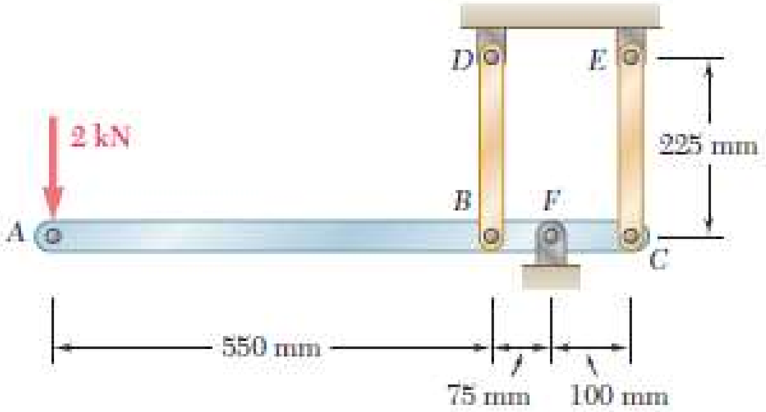
$$\delta = \delta_P - \delta_{F_D}$$

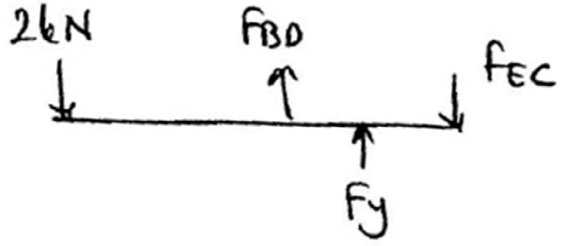
$$0.15 = \frac{200(10^3)(600)}{\frac{\pi}{4}(0.05^2)(200)(10^9)} - \left[\frac{F_D(600)}{\frac{\pi}{4}(0.05^2)(200)(10^9)} + \frac{F_D(600)}{\frac{\pi}{4}(0.025^2)(200)(10^9)}\right]$$

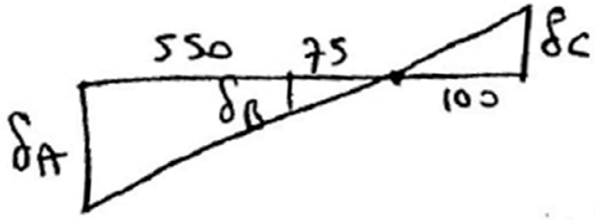
$$F_D = 20\,365.05 \text{ N} = 20.4 \text{ kN}$$

$$F_A = 179\,634.95 \text{ N} = 180 \text{ kN}$$

Each of the rods *BD* and *CE* is made of brass (E = 105 GPa) and has a cross-sectional area of 200 mm^2. Determine the deflection of end *A* of the rigid member *ABC* caused by the 2-kN load.







$\circlearrowleft + \Sigma M_F = 0$:

$$2(0.625) - F_{BD}(0.075) - F_{EC}(0.1) = 0$$

$$\boxed{0.75 F_{BD} + F_{EC} = 12.5} \quad -(1)$$

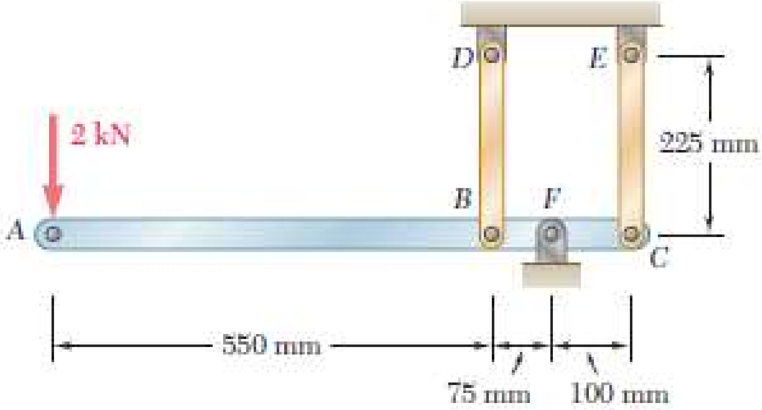
$$\frac{\delta_B}{\delta_C} = \frac{75}{100}$$

$$\delta_B = 0.75\,\delta_C$$

$$\frac{F_{BD} \cdot \cancel{L_{BD}}}{\cancel{EA}} = 0.75 \cdot \frac{F_{EC}\,\cancel{L_{EC}}}{\cancel{EA}}$$

$$\boxed{F_{BD} = 0.75 F_{EC}} \quad -(2)$$

Each of the rods BD and CE is made of brass ($E = 105$ GPa) and has a cross-sectional area of 200 mm^2. Determine the deflection of end A of the rigid member ABC caused by the 2-kN load.



$\boxed{0.75 F_{BD} + F_{EC} = 12.5}$ — ①

$\boxed{F_{BD} = 0.75 F_{EC}}$ — ②

Solving ① and ② $F_{BD} = 6$ kN $F_{EC} = 8$ kN

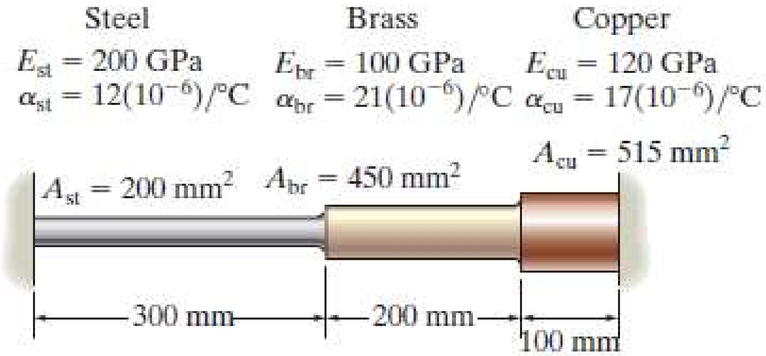
$$\delta_B = \frac{(6 \times 10^3)(0.225)}{(105 \times 10^9)(200 \times 10^{-6})}$$

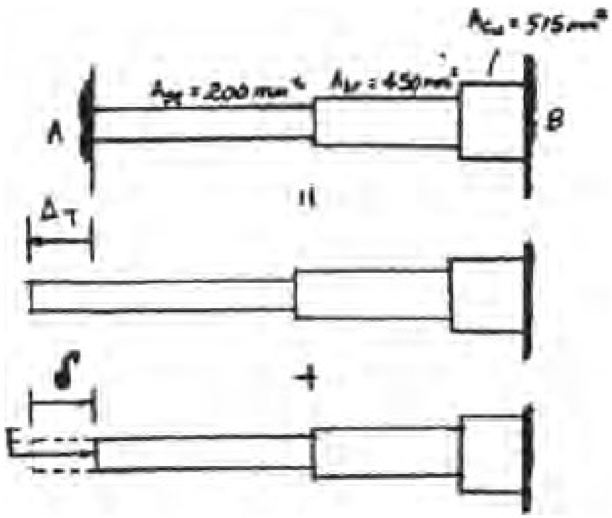
$$= 6.429 \times 10^{-5} \text{ m}$$

$$\frac{\delta_B}{\delta_A} = \frac{75}{625} \qquad \delta_A = \delta_B \cdot \frac{625}{75}$$

$$\delta_A = 5.357 \times 10^{-4} \text{ m} \qquad \boxed{\delta_A = 0.536 \text{ mm} \downarrow}$$

Three bars each made of different materials are connected together and placed between two walls when the temperature is $T_1 = 12°C$. Determine the force exerted on the (rigid) supports when the temperature becomes $T_2 = 18°C$. The material properties and cross-sectional area of each bar are given in the figure.





$\delta_T = \alpha.\Delta T.L$

$(\overset{+}{\leftarrow})$ $0 = \delta_T - \delta_R$

$$0 = 12(10^{-6})(6)(0.3) + 21\,(10^{-6})(6)(0.2) + 17\,(10^{-6})(6)(0.1) - \frac{F(0.3)}{200(10^{-6})(200)(10^9)} - \frac{F(0.2)}{450(10^{-6})(100)(10^9)} - \frac{F(0.1)}{515(10^{-6})(120)(10^9)}$$

$$F = 4203\text{ N} = 4.20\text{ kN}$$