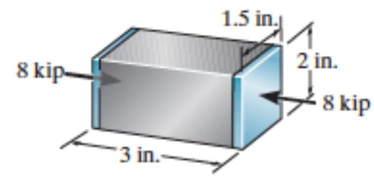
CE 270
Fall 2011
Solutions – Problem Set 3

•**3–29.** The aluminum block has a rectangular cross section and is subjected to an axial compressive force of 8 kip. If the 1.5-in. side changed its length to 1.500132 in., determine Poisson's ratio and the new length of the 2-in. side. $E_{al} = 10(10^3)$ ksi.



$$\sigma = \frac{P}{A} = \frac{8}{(2)(1.5)} = 2.667 \text{ ksi}$$

$$\varepsilon_{long} = \frac{\sigma}{E} = \frac{-2.667}{10(10^3)} = -0.0002667$$

$$\varepsilon_{lat} = \frac{1.500132 - 1.5}{1.5} = 0.0000880$$

$$\nu = \frac{-0.0000880}{-0.0002667} = 0.330 \qquad \textbf{Ans.}$$

$$h' = 2 + 0.0000880(2) = 2.000176 \text{ in.} \qquad \textbf{Ans.}$$

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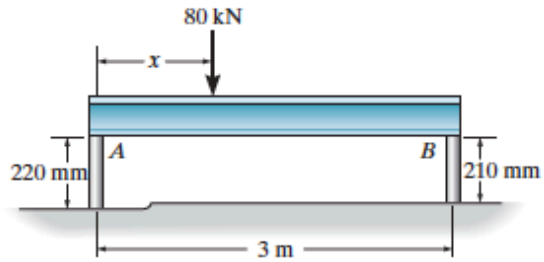
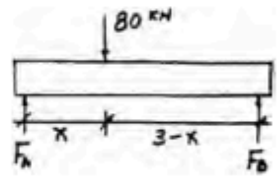
3–39. The rigid beam rests in the horizontal position on two 2014-T6 aluminum cylinders having the *unloaded* lengths shown. If each cylinder has a diameter of 30 mm, determine the placement x of the applied 80-kN load so that the beam remains horizontal. What is the new diameter of cylinder A after the load is applied? $\nu_{al} = 0.35$.





$$\zeta + \Sigma M_A = 0; \quad F_B(3) - 80(x) = 0; \quad F_B = \frac{80x}{3} \quad \textbf{(1)}$$

$$\zeta + \Sigma M_B = 0; \quad -F_A(3) + 80(3 - x) = 0; \quad F_A = \frac{80(3 - x)}{3} \quad \textbf{(2)}$$

Since the beam is held horizontally, $\delta_A = \delta_B$

$$\sigma = \frac{P}{A}; \quad \varepsilon = \frac{\sigma}{E} = \frac{\frac{P}{A}}{E}$$

$$\delta = \varepsilon L = \left(\frac{\frac{P}{A}}{E}\right) L = \frac{PL}{AE}$$

$$\delta_A = \delta_B; \quad \frac{\frac{80(3-x)}{3}(220)}{AE} = \frac{\frac{80x}{3}(210)}{AE}$$

$$80(3 - x)(220) = 80x(210)$$

$$x = 1.53 \text{ m}$$ **Ans.**

From Eq. (2),

$$F_A = 39.07 \text{ kN}$$

$$\sigma_A = \frac{F_A}{A} = \frac{39.07(10^3)}{\frac{\pi}{4}(0.03^2)} = 55.27 \text{ MPa}$$

$$\varepsilon_{long} = \frac{\sigma_A}{E} = -\frac{55.27(10^6)}{73.1(10^9)} = -0.000756$$

$$\varepsilon_{lat} = -\nu\varepsilon_{long} = -0.35(-0.000756) = 0.0002646$$

$$d'_A = d_A + d\,\varepsilon_{lat} = 30 + 30(0.0002646) = 30.008 \text{ mm}$$ **Ans.**

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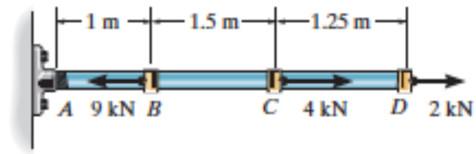
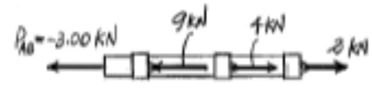
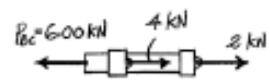
***4-4.** The A-36 steel rod is subjected to the loading shown. If the cross-sectional area of the rod is 50 mm^2, determine the displacement of *C*. Neglect the size of the couplings at *B*, *C*, and *D*.



The normal forces developed in segments *AB* and *BC* are shown the *FBDS* of each segment in Fig. *a* and *b*, respectively. The cross-sectional area of these two segments are $A = \left(50\ \text{mm}^2\right)\left(\frac{1\ \text{m}}{10.00\ \text{mm}}\right)^2 = 50.0\ (10^{-6})\ \text{m}^2$. Thus,



(a)



(b)

$$\delta_C = \Sigma \frac{P_i L_i}{A_i E_i} = \frac{1}{A\, E_{SC}}\left(P_{AB}\, L_{AB} + P_{BC}\, L_{BC}\right)$$

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

$$= 0.600\ (10^{-3})\ \text{m} = 0.600\ \text{mm}$$ **Ans.**

The positive sign indicates that coupling *C* moves away from the fixed support.

(For fundamental problem solutions please see the back of your course textbook)