

- 3.5-13.** (a)  $(A_1)_{\min} = 1.093 \text{ in}^2$ ,  
 (b) Equilibrium:  $10F_1 + 6F_2 = 8P$   
 Compatibility (with  $E_1 = E_2$ ):  $\frac{F_1 L_1}{A_1} = \frac{5}{3} \frac{F_2 L_2}{A_2}$   
 Thus, all values are independent of the magnitude of  $E$ .  
**3.5-15.** (a)  $\sigma_1 = \left( \frac{15\sqrt{10}}{2(5\sqrt{5}+8\sqrt{2})} \right) \frac{W}{A}$ ,  $\sigma_2 = \left( \frac{6\sqrt{10}}{5\sqrt{5}+8\sqrt{2}} \right) \frac{W}{A}$   
 (b)  $\delta_D = \left( \frac{30\sqrt{10}}{5\sqrt{5}+8\sqrt{2}} \right) \frac{Wb}{AE}$   
**3.5-17.** (a)  $F_1 = 11.58 \text{ kN (T)}$ ,  $F_2 = 7.37 \text{ kN (T)}$ ,  
 $F_3 = 1.053 \text{ kN (T)}$ , (b)  $u_B = 0.379 \text{ mm}$

**3.6-1.** (a)  $\sigma(x) = \frac{-2E\alpha\Delta T_A}{3}$ , (b)  $u\left(\frac{L}{2}\right) = \frac{\alpha L\Delta T_A}{8}$

**3.6-3.**  $\Delta T = 29.2^\circ\text{C}$

**3.6-5.** (a)  $\sigma_1 = -13.40 \text{ ksi}$ ,  $\sigma_2 = -7.44 \text{ ksi}$ ,  
 (b)  $u_B = -2.13(10^{-3}) \text{ in.}$

**3.6-7.**  $F_2 = \frac{-\alpha L\Delta T(kAE)}{AE + kL}$

**3.6-9.**  $\Delta T = 10.42^\circ\text{C}$

**3.6-11.**  $\sigma_1 = \left( \frac{E_1 E_2 A_2}{A_1 E_1 + A_2 E_2} \right) (\alpha_2 - \alpha_1) \Delta T$ ,

$\sigma_2 = \left( \frac{E_1 E_2 A_1}{A_1 E_1 + A_2 E_2} \right) (\alpha_1 - \alpha_2) \Delta T$ ,

$\delta = \left( \frac{A_1 E_1 \alpha_1 + A_2 E_2 \alpha_2}{A_1 E_1 + A_2 E_2} \right) L \Delta T$

**3.6-13.** (a)  $\sigma_1 = \sigma_2 = 4.713 \text{ ksi}$ ,

(b)  $\sigma_1 = 3.142 \text{ ksi}$ ,  $\sigma_2 = 6.283 \text{ ksi}$

**3.6-15.** (a)  $\sigma_1 = 1.950 \text{ ksi (T)}$ ,  $\sigma_2 = 3.90 \text{ ksi (C)}$ ,

(b)  $V_D = -97.5 \text{ lb}$ ,  $M_D = -488 \text{ lb}\cdot\text{in.}$

**3.6-17.**  $\sigma_1 = \frac{E\alpha\Delta T}{3}$ ,  $\sigma_2 = -\frac{E\alpha\Delta T}{3}$ ,

$\sigma_3 = \frac{E\alpha\Delta T}{6}$

**3.7-1.** (a)  $\sigma_1 = -\frac{3E\bar{\delta}}{5L}$ ,  $\sigma_2 = -\frac{2E\bar{\delta}}{5L}$ , (b)  $u_B = \frac{2\bar{\delta}}{5}$

**3.7-3.** (a)  $\sigma_1 = 14.59 \text{ ksi}$ ,  $\sigma_2 = 45.4 \text{ ksi}$ ,

(b)  $u_B = 0.0243 \text{ in.}$

**3.7-5.** (a)  $\bar{\delta} = \frac{PL}{6AE}$ ,  $u_B = \frac{PL}{2AE}$

**3.7-7.** (a)  $\sigma_1 = 9.85 \text{ ksi}$ ,  $\sigma_2 = 30.6 \text{ ksi}$ ,

(b)  $u_B = 0.0327 \text{ in.}$

**3.7-9.**  $\bar{\delta} = 0.10 \text{ mm}$ , (b)  $u_B = 0.1667 \text{ mm}$ , (c) —

**3.7-11.**  $\sigma_1 = 12.93 \text{ ksi}$ , (b)  $\theta = 1.379(10^{-3}) \text{ rad}$

**3.7-13.**  $\sigma_1 = 2.51 \text{ ksi (C)}$ ,  $\sigma_2 = 6.91 \text{ ksi (T)}$

**3.8-1.** (a)  $u_B = 1.185(10^{-2}) \text{ in.}$ ,

(b)  $\sigma_1 = 4.44 \text{ ksi (T)}$ ,  $\sigma_2 = 1.975 \text{ ksi (C)}$

**3.8-3.** (a)  $u_B = 5.25(10^{-3}) \text{ in.}$ ,  $u_C = 5.42(10^{-2}) \text{ in.}$ ,

(b)  $\sigma_1 = 5.25 \text{ ksi (T)}$ ,  $\sigma_2 = 16.32 \text{ ksi (T)}$ ,

$\sigma_3 = 10.84 \text{ ksi (C)}$

**3.8-5.** (a)  $u_B = -2.13(10^{-3}) \text{ in.}$ ,

(b)  $\sigma_1 = 13.40 \text{ ksi (C)}$ ,  $\sigma_2 = 7.44 \text{ ksi (C)}$

**3.8-7.** (a)  $u_B = -\frac{4}{7}\alpha L\Delta T_2$ ,  $u_C = \frac{2}{7}\alpha L\Delta T_2$

(b)  $\sigma_1 = \frac{2}{7}E\alpha\Delta T_2 \text{ (C)}$ ,  $\sigma_2 = \frac{1}{7}E\alpha\Delta T_2 \text{ (C)}$ ,

$\sigma_3 = \frac{2}{7}E\alpha\Delta T_2 \text{ (C)}$

**3.8-9.** (a)  $u_B = 0.380 \text{ mm}$ ,

(b)  $\sigma_1 = 38.0 \text{ MPa (T)}$ ,  $\sigma_2 = 12.00 \text{ MPa (C)}$

**3.8-11.** (a)  $u_B = 0.0327 \text{ in.}$ , (b)  $\sigma_1 = 9.85 \text{ ksi (T)}$ ,

$\sigma_2 = 30.6 \text{ ksi (T)}$

**3.8-13.**  $e = -0.1198 \text{ mm}$ ,  $\sigma_1 = 47.9 \text{ MPa (C)}$ ,

$\sigma_2 = 16.77 \text{ MPa (C)}$

**3.8-15.** (a)  $\theta = 8.60(10^{-5}) \text{ rad}$ ,

(b)  $\sigma_1 = 6.45 \text{ ksi (T)}$ ,  $\sigma_2 = 2.58 \text{ ksi (T)}$

**3.8-17.** (a)  $\theta = 5.76(10^{-4}) \text{ rad}$ ,

(b)  $\sigma_1 = 20.2 \text{ MPa (T)}$ ,  $\sigma_2 = 28.8 \text{ MPa (T)}$ ,  $\sigma_3 = 19.59 \text{ MPa (T)}$

**3.8-19.** (a)  $u_A = \frac{1}{3}\alpha L\Delta T$ ,  $u_C = \frac{7}{3}\alpha L\Delta T$

(b)  $\sigma_1 = \frac{1}{3}E\alpha\Delta T \text{ (T)}$ ,  $\sigma_2 = \frac{1}{3}E\alpha\Delta T \text{ (C)}$ ,  $\sigma_3 = \frac{1}{6}E\alpha\Delta T \text{ (T)}$

**3.8-21.** (a)  $\theta = 2.65(10^{-3}) \text{ rad}$ ,

(b)  $\sigma_1 = 92.6 \text{ MPa (T)}$ ,  $\sigma_2 = 157.4 \text{ MPa (T)}$

**3.8-23.** (a)  $u = 4.19(10^{-3}) \text{ in.}$ , (b)  $\sigma_1 = 2.51 \text{ ksi (C)}$ ,

$\sigma_2 = 6.91 \text{ ksi (T)}$

Problems 3.8-25 and 3.8-27 require the writing of computer programs.

**3.9-1.** (a)  $\sigma_1 = 4.44 \text{ ksi (T)}$ ,  $\sigma_2 = 1.975 \text{ ksi (C)}$

(b)  $u_B = 1.185(10^{-2}) \text{ in.}$

**3.9-3.**  $P_F = -\frac{17}{20}P$

**3.9-5.** (a)  $F_1 = 33.9 \text{ kN}$ ,  $F_2 = 10.17 \text{ kN}$ ,

(b)  $e = 0.323 \text{ mm}$

**3.9-7.** (a)  $F_1 = 11.58 \text{ kN}$ ,  $F_2 = 7.37 \text{ kN}$ ,  $F_3 = 1.053 \text{ kN}$ ,

(b)  $u_B = 0.379 \text{ mm}$

**3.9-9.**  $\sigma_1 = 0.753 \text{ ksi (T)}$ ,  $\sigma_2 = \sigma_3 = 2.34 \text{ ksi (T)}$

**3.9-11.**  $\sigma_1 = \frac{1}{3}E\alpha\Delta T \text{ (T)}$ ,  $\sigma_2 = \frac{1}{3}E\alpha\Delta T \text{ (C)}$ ,

$\sigma_3 = \frac{1}{6}E\alpha\Delta T \text{ (T)}$

**3.9-13.**  $\sigma_1 = 38.0 \text{ MPa (T)}$ ,  $\sigma_2 = 12.00 \text{ MPa (C)}$

**3.9-15.**  $\sigma_1 = 92.6 \text{ MPa (T)}$ ,  $\sigma_2 = 157.4 \text{ MPa (T)}$

**3.10-1.** (a)  $\sigma_1 = 7.32 \text{ ksi (T)}$ ,  $\sigma_2 = 6.40 \text{ ksi (C)}$ ,

(b)  $u_C = -0.0226 \text{ in.}$ ,  $v_C = -0.0860 \text{ in.}$

**3.10-3.** (a)  $\sigma_1 = 133.5 \text{ MPa (T)}$ ,  $\sigma_2 = 7.41 \text{ MPa (T)}$ ,

(b)  $u_C = 5.22 \text{ mm}$ ,  $v_C = 4.57 \text{ mm}$

**3.10-5.** (a)  $(A_1)_{\min} = 4010 \text{ mm}^2$ ,  $(A_2)_{\min} = 222 \text{ mm}^2$ ,

(b)  $u_C = 0.1587 \text{ mm}$ ,  $v_C = 9.05 \text{ mm}$

**3.10-7.** (a)  $\sigma_1 = 9.04 \text{ ksi (T)}$ ,  $\sigma_2 = 2.86 \text{ ksi (C)}$ ,

(b)  $u_C = 0.0238 \text{ in.}$ ,  $v_C = -0.0413 \text{ in.}$

**3.10-9.** (a)  $\sigma_{AC} = 52.0 \text{ MPa (T)}$ , (b)  $e_{AC} = 1.352 \text{ mm}$ ,

(c)  $v_D = -3.52 \text{ mm}$

**3.10-11.**  $\theta = 75.0^\circ$

**3.10-13.** (a)  $u_A = \frac{125}{253} \frac{PL}{AE}$ ,  $v_A = 0$ ,

(b)  $F_1 = \frac{80}{253} P$ ,  $F_2 = \frac{125}{253} P$ ,  $F_3 = \frac{80}{253} P$

**3.10-15.** (a)  $u_A = \frac{375}{887}(\alpha_2 L\Delta T)$ ,  $v_A = \frac{500}{2661}(\alpha_2 L\Delta T)$ ,

(b)  $F_1 = \frac{320}{887}(\alpha_2 AE\Delta T)$ ,  $F_2 = -\frac{512}{887}(\alpha_2 AE\Delta T)$ ,

$F_3 = \frac{320}{887}(\alpha_2 AE\Delta T)$

**3.10-17.** (a)  $u_A = 1.875 \text{ mm}$ ,  $v_A = -0.217 \text{ mm}$ ,

(b)  $F_1 = 37.5 \text{ kN}$ ,  $F_2 = 22.5 \text{ kN}$ ,  $F_3 = -22.5 \text{ kN}$