ENGR 3131 SI Session Worksheet 9/23/15 W Name: SOLUTIONS

1) GIVEN: A 4.8ft long steel wire with ∅0.25in is subjected to a 750-lb tensile load. ($E_s = 29\text{x}10^6$ psi)

REQ'D: (a) Elongation of the wire.

(b) Corresponding normal stress. (B9.1)

a) $\Delta L = \frac{PL}{AE} = \frac{750(4.8ft)(12\ in/ft)}{\frac{\pi}{4}(.25in)^2\ 29\times10^6 psi}$

$= \underline{0.03035\ in}$ LONGER

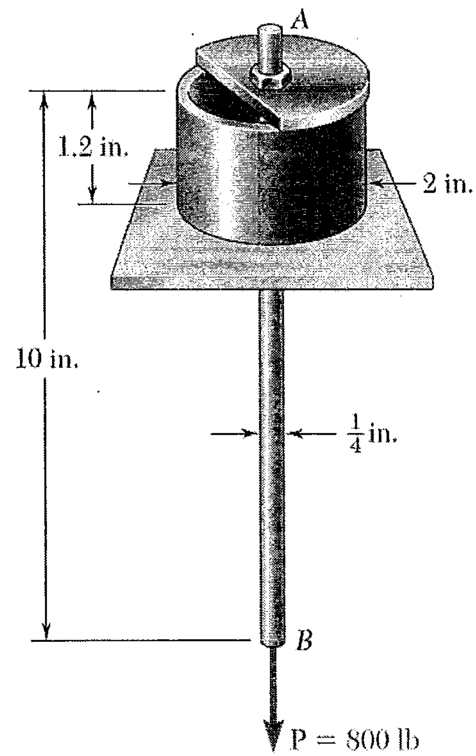
b) $\sigma = \frac{P}{A} = \frac{750\ lb}{\frac{\pi}{4}(.25in)^2} = 15279\ psi \Rightarrow \underline{15.28\ ksi\ (T)}$

2) GIVEN: For electrical insulation a ∅.25 steel hanger is supported by a rigid circular plate (shown cutaway) resting on a 1/8in wall thickness polystyrene tube. ($E_{poly} = .45\text{x}10^6$ psi)

REQ'D: (a) Elongation of rod *AB*

(b) Deflection of point *B*

(c) Normal stress in rod *AB*. (B9.17)



a) FOR ROD AB

$\Delta L_{AB} = \frac{P_{AB} L_{AB}}{A_{AB} E_{AB}} = \frac{800lb(10in)}{\frac{\pi}{4}(.25in)^2(29\times10^6 psi)}$

$= \underline{5.62\times10^{-3}\ in}$ LONGER

b) FOR POLY TUBE

$A_{TUBE} = \frac{\pi}{4}(OD^2 - ID^2)$

$= \frac{\pi}{4}[(2in)^2 - (2 - 2(.125in))^2]$

$= 0.7363\ in^2$

$\Delta L_{TUBE} = \frac{P_T L_T}{A_T E_T} = \frac{-800lb(C)(1.2in)}{0.7363in^2(.45\times10^6 psi)}$

$= 2.90\times10^{-3}\ in$ SHORTER

DEFLECTION AT B

$\Delta L_B = \Delta L_{TUBE} + \Delta L_{AB}$

$= 5.62\times10^{-3} in + 2.90\times10^{-3} in$

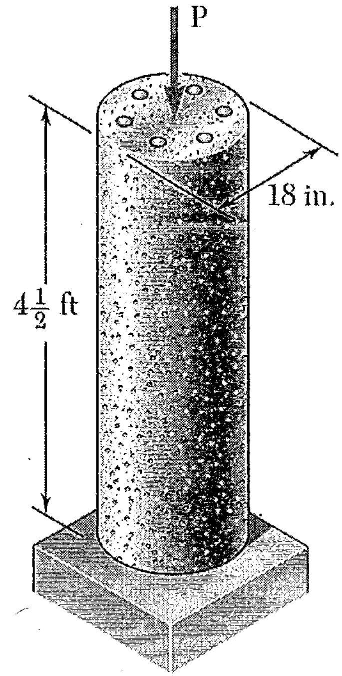
$= \underline{8.52\times10^{-3}\ in}$ LOWER

STRESS IN AB

$\sigma_{AB} = \frac{P_{AB}}{A_{AB}}$

$= \frac{800\ lb}{\frac{\pi}{4}(.25in)^2} = \underline{16.3\ ksi\ (T)}$

3) GIVEN: The concrete column is reinforced with six ∅1-1/8in. steel rods.
$E_s = 29 \times 10^6$ psi and $E_c = 4.2 \times 10^6$ psi.
REQ'D: Normal stresses in the steel and concrete if P = 350-kips. (B9.27)



$$\Delta L = \frac{P_c L}{E_c A_c} \qquad P_c = \frac{E_c A_c \Delta L}{L}$$

$$\Delta L = \frac{P_s L}{E_s A_s} \qquad P_s = \frac{E_s A_s \Delta L}{L}$$

$$P = P_c + P_s = (E_c A_c + E_s A_s)\underbrace{\frac{\Delta L}{L}}_{\varepsilon}$$

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

$$A_s = \frac{\pi}{4}(1.125\text{ in})^2 \times 6 = \underline{5.964\text{ in}^2}$$

$$A_c = \frac{\pi}{4}(18\text{in})^2 - \overbrace{5.964\text{ in}^2}^{A_s} = \underline{248.5\text{ in}^2}$$

$$\varepsilon = \frac{-350 \times 10^3\text{ lb (C)}}{(4.2 \times 10^6\text{ psi})(248.5\text{ in}^2) + (29 \times 10^6\text{ psi})(5.964\text{ in}^2)}$$

$$= \underline{-287.7 \times 10^{-6}}\text{ in/in}$$

$$\sigma_c = E_c \varepsilon = (4.2 \times 10^6\text{ psi})(-287.7 \times 10^{-6}) = \underline{\underline{-1.20\text{ ksi (C)}}}$$

$$\sigma_s = E_s \varepsilon = (29 \times 10^6\text{ psi})(-287.7 \times 10^{-6}) = \underline{\underline{-8.34\text{ ksi (C)}}}$$

4) GIVEN: ∅60mm bolts used to secure the top on a nuclear reactor vessel.
REQ'D: Tension in bolts when Δ∅ is 13μm. E =20$\hat{0}$GPa and ν = 0.29

$$\varepsilon_{TRANS.} = \frac{\Delta\varnothing}{\varnothing} = \frac{-13 \times 10^{-6}\text{ m}}{.060\text{ m}} = -216.7 \times 10^{-6}\text{ m/m}$$

$$\nu = \frac{-\varepsilon_{TRANS.}}{\varepsilon_{LONG.}} \Rightarrow \varepsilon_{LONG.} = -\frac{\varepsilon_{TRANS.}}{\nu}$$

$$= \frac{216.7 \times 10^{-6}}{.29}$$

$$= 747.13 \times 10^{-6}$$

$$\sigma = E\varepsilon$$
$$= (200 \times 10^9\text{ Pa})(747.13 \times 10^{-6})$$
$$= 149.43 \times 10^6\text{ Pa}$$

$$F = \sigma A$$
$$= 149.4 \times 10^6\text{ Pa}\left(\frac{\pi}{4}(.06\text{m})^2\right)$$
$$= 422 \times 10^3\text{ N}$$
$$\Rightarrow \underline{422\text{ kN}}\text{ (T)}$$