Chapter 7, Problem 11

A cantilever *WF* aluminum alloy beam of yield strength S_y is loaded as shown in Figure P7.11. Using a factor of safety of *n*, determine whether failure occurs according to the maximum shear stress criterion.

Given: S_y = 320 MPa, n = 2, $I_z = 13.4 \bullet 10^6$ mm^4

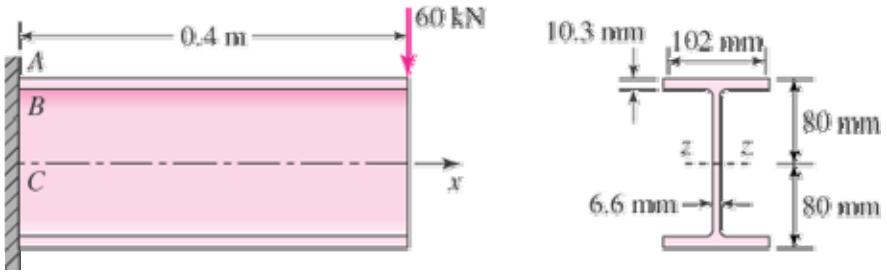

Figure P7.11

Chapter 7, Solution 11

$$Q_B = 102(10.3)(74.85) = 78.6 \times 10^3 \ mm^3$$
$$Q_C = Q_B + 6.6(69.7)(34.85) = 94.6 \times 10^3 \ mm^3$$

We have

$$\sigma_A = \frac{Mc}{I} = \frac{24(10^3)(0.08)}{13.4(10^{-6})} = 143.3 \ MPa, \qquad \sigma_B = \frac{69.7}{80}(143.3) = 124.9 \ MPa$$

and

$$\tau_B = \frac{VQ_B}{Ib} = \frac{60(10^3)(78.6\times10^{-6})}{13.4(10^{-6})(0.0066)} = 53.3 MPa, \ \tau_c = \frac{VQ_c}{Ib} = 64.2 MPa$$

Thus

$$(\sigma_{1,2})_B = \frac{124.9}{2} \pm [(\frac{124.9}{2})^2 + 53.3^2]^{\frac{1}{2}} = 62.5 \pm 82.1$$

or $\sigma_{1B} = 144.6 \ MPa \qquad \sigma_{2B} = -19.65 \ MPa$

$$(\tau_{\max})_B = 82.1 \ MPa$$

Hence

$$(\tau_{\max})_B = \frac{S_y}{2(2)} = \frac{320}{4}; \qquad 82.1 > 80 \qquad \therefore \ Fails$$

Alternatively, using Eq.(7.11), we have

$$[124.9^2 + 4(53.3)^2]^{\frac{1}{2}} = \frac{320}{2}; \qquad 164.2 > 160 \qquad \therefore \ Fails$$