4.4-1 An HSS $10 \times 8 \times {}^{3}/_{16}$ **(HSS 245 × 203.2 × 4.8)** is used as a compression member with one end pinned and the other end fixed against rotation but free to translate. The length is 12 feet **(3,650 mm)**. Compute the nominal compressive strength for A500 Grade C steel ($F_y = 50$ ksi) **(345 MPa)**. *Note that this is a slender-element compression member, and the equations of AISC Section E7 must be used.*

HSS $10 \times 8 \times 3/16 \Rightarrow A = 6.06\,in^2 \quad r_x = 3.88\,in \quad r_y = 3.28\,IN$

$b/t = 43.0 \quad h/t = 54.5 \quad t = 0.174\,in$

$K = 2$

$$\frac{L_c}{r} = \frac{2(12ft)(12IN/ft)}{3.28in} = 87.80$$

$$4.71\sqrt{E/F_y} = 4.71\sqrt{\frac{29{,}000ksi}{50ksi}} = 113.43$$

$$\frac{L_c}{r} < 4.71\sqrt{E/F_y} \Rightarrow \text{USE EQ E3-2}$$

$$F_e = \frac{\pi^2 E}{(L_c/r)^2} = \frac{\pi^2(29{,}000ksi)}{(87.80)^2} = 37.13\,ksi$$

$$F_n = F_y\left(0.658^{F_y/F_e}\right) = 50ksi\left(0.658^{(50/37.13)}\right) = 28.46\,ksi$$

$$P_n = F_n A_g = 28.46\,ksi(6.06\,IN^2) = \underline{172.45\,k}$$

* CHECK WIDTH-THICKNESS RATIOS TABLE B4.1a (16.1-21)

$$h/t = 54.5 \quad \lambda_r = 1.40\sqrt{E/F_y} = 1.40\sqrt{\frac{29{,}000ksi}{50ksi}} = 33.72$$

h/t & $b/t > \lambda_r$ ELEMENT ARE <u>SLENDER</u> USE EQ. E7-3

4.4-1

$$b_e = b\left(1 - c_1\sqrt{\frac{F_{el}}{F_n}}\right)\sqrt{\frac{F_{el}}{F_n}}$$

$c_1 = 0.2$ TABLE E7.1

$$c_2 = \frac{1-\sqrt{1-4c_1}}{2c_1} = 1.38$$

$$F_{el} = \left(c_2 \frac{\lambda_r}{\lambda}\right)^2 F_y = \left(1.38 \frac{33.72}{54.5}\right)^2 50\text{ksi} = 36.45\text{ksi}$$

$$b = 10 - \underline{\underline{3t}} = 10\text{in} - 3(0.174\text{ in}) = 9.48\text{in.}$$

$$b_e = 9.48\text{IN}\left(1 - 0.2\sqrt{\frac{36.45\text{ksi}}{28.46\text{ksi}}}\right)\sqrt{\frac{36.45\text{ksi}}{28.46\text{ksi}}} = 8.30\text{ IN}$$

FOR $b/t = 43.0$

$$\lambda_r\sqrt{\frac{F_y}{F_n}} = 33.72\sqrt{\frac{50\text{ksi}}{28.46\text{ksi}}} = 44.69$$

$$b/t < \lambda_r\sqrt{F_y/F_n} \Rightarrow b_e = b \quad \text{EQ. E7-2}$$

$$\Rightarrow A_e = A_g - \sum(b - b_e)t$$

$$= 6.06\text{in}^2 - 2(9.48\text{in} - 8.30\text{in})(0.174\text{ in}) = 5.65\text{ IN}^2$$

$$P_n = F_n A_e = 28.46\text{ksi}(5.65\text{ in}^2) = \underline{\underline{160.78\text{k}}}$$