4.8-1 Compute the nominal compressive strength for a WT10.5 × 91 **(WT 265 × 136)** with an effective length of 18 feet **(5,500 mm)** with respect to each axis. Use A992 steel ($F_y = 50$ ksi **(345 MPa)**) and the procedure of AISC Section E4 (not the column load tables).

FROM TABLE 1-8 (1-62)

$r_x = 3.07\,in \quad A_g = 26.8\,in^2$

$r_y = 3.00\,in \quad J = 15.3\,in^4$

$$\frac{L_{cx}}{r_x} = \frac{18\,ft\,(12\,in/ft)}{3.07\,in} = 70.35 \qquad 4.71\sqrt{\frac{E}{F_y}} = 113.43$$

$$\frac{L_{cx}}{r_x} < 4.71\sqrt{\frac{E}{F_y}} \quad * \text{COLUMN INELASTIC EQ E3-2}$$

$$F_e = \frac{\pi^2 E}{(L_{cx}/r_x)^2} = \frac{\pi^2(29{,}000\,ksi)}{(70.35)^2} = 57.82\,ksi$$

$$F_n = F_y(0.658^{F_y/F_e}) = 50\,ksi\,(0.658^{50/57.82}) = 34.82\,ksi$$

$$P_n = F_n A_g = 34.82\,ksi\,(26.8\,in^2) = \underline{933.06\,k}$$

FLEXURAL-TORSIONAL BUCKLING

$$\frac{L_{cy}}{r_y} = \frac{18\,ft\,(12\,in/ft)}{3.00} = 72.0$$

FROM AISC DATABASE *

$r_o = 4.64\,in \quad H = 0.859$

USING E4-6

$$F_{ey} = \frac{\pi^2 E}{(L_{cy}/r_y)^2} = \frac{\pi^2(29{,}000\,ksi)}{(72.0)^2} = 55.21\,ksi$$

4.8-1

$$F_{e_z} = \frac{GJ}{A_g \bar{r}_o^2} = \frac{11{,}200\,ksi\,(15.3\,in^4)}{26.8\,in^2\,(4.64\,in)^2} = 296.99\,ksi$$

USING E4-3

$$F_{ey} + F_{e_z} = 55.21\,ksi + 296.99\,ksi = 352.20\,ksi$$

$$F_e = \frac{F_{ey} + F_{ez}}{2H}\left[1 - \sqrt{1 - \frac{4F_{ey}F_{ez}H}{(F_{ey}+F_{ez})^2}}\right]$$

$$= \frac{352.2\,ksi}{2(0.859)}\left[1 - \sqrt{1 - \frac{4(55.21\,ksi)(296.99\,ksi)(0.859)}{(352.2\,ksi)^2}}\right]$$

$$= \underline{53.55\,ksi}$$

$$\frac{F_y}{F_e} = \frac{50\,ksi}{53.55\,ksi} = 0.934 < 2.25 \quad * \text{ USE E3-2}$$

$$F_n = F_y\left(0.658^{F_y/F_e}\right) = 50\,ksi\left(0.658^{0.934}\right) = 33.83\,ksi$$

$$P_n = F_n A = 33.83\,ksi\,(26.8\,in^2) = \underline{906.52^k}$$

* FLEXURAL-TORSIONAL BUKKLING CONTROLS *

$$\underline{\underline{P_n = 906.52^k}}$$