

Beam design for W18x50 grade A992

$$\Omega := 1.67 \quad \phi := 0.9$$

$$F_y := 50 \text{ ksi} \quad E := 29000 \text{ ksi} \quad D := 18 \text{ in} \quad t_f := 0.570 \text{ in} \quad S_x := 88.9 \text{ in}^3 \quad Z_x := 101 \text{ in}^3$$

$$C_w := 3040 \text{ in}^6 \quad c := 1.0 \quad J := 1.24 \text{ in}^4 \quad I_y := 40.1 \text{ in}^4 \quad r_y := 1.65 \text{ in}$$

$$L_b := 0 \text{ ft} \quad C_b := 1.0 \quad h_0 := D - t_f = 17.43 \text{ in}$$

Yielding per AISC F2.1

$$M_p := F_y \cdot Z_x = 420.833 \text{ kip} \cdot \text{ft}$$

Lateral Torsional Buckling per F2.2

$$L_p := 1.76 \cdot r_y \cdot \sqrt{\frac{E}{F_y}} = 5.828 \text{ ft} \quad r_{ts} := \sqrt{\frac{\sqrt{I_y \cdot C_w}}{S_x}} = 1.982 \text{ in}$$

$$L_r := 1.95 \cdot r_{ts} \cdot \frac{E}{0.7 \cdot F_y} \cdot \sqrt{\frac{J \cdot c}{S_x \cdot h_0} + \sqrt{\left(\frac{J \cdot c}{S_x \cdot h_0}\right)^2 + 6.76 \cdot \left(\frac{0.7 \cdot F_y}{E}\right)^2}} = 16.957 \text{ ft}$$

$$F_{cr}(L_b) := \frac{C_b \cdot \pi^2 \cdot E}{\left(\frac{L_b}{r_{ts}}\right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{S_x \cdot h_0} \cdot \left(\frac{L_b}{r_{ts}}\right)^2}$$

$$M_n := \begin{cases} \text{if } L_b \leq L_p & \\ \quad \left\| \begin{array}{l} \text{return } F_y \cdot Z_x \end{array} \right\| & = 420.833 \text{ kip} \cdot \text{ft} \\ \text{if } L_p < L_b \leq L_r & \\ \quad \left\| \begin{array}{l} \text{return } \min\left(C_b \cdot \left(M_p - (M_p - 0.7 \cdot F_y \cdot S_x) \cdot \frac{L_b - L_p}{L_r - L_p}\right), M_p\right) \end{array} \right\| & \\ \text{if } L_b \geq L_r & \\ \quad \left\| \begin{array}{l} \text{return } \min(F_{cr}(L_b) \cdot S_x, M_p) \end{array} \right\| & \end{cases}$$

LRFD:

$$\phi \cdot M_n = 378.75 \text{ kip} \cdot \text{ft}$$

ASD:

$$\frac{M_n}{\Omega} = 251.996 \text{ kip} \cdot \text{ft}$$