W18x50

$h := 18\ in = 457.2\ mm$
$b_f := 7.5\ in = 190.5\ mm$
$t_f := 0.57\ in = 14.478\ mm$
$t_w := 0.355\ in = 9.017\ mm$

$$A_g := 2 \cdot t_f \cdot b_f + \left(h - 2 \cdot t_f\right) \cdot t_w = \left(9.378 \cdot 10^3\right)\ mm^2$$

$$I_x := \left(2 \cdot \left(b_f \cdot \frac{t_f^{\ 3}}{12} + b_f \cdot t_f \cdot \left(\frac{\left(h - 2 \cdot t_f\right)}{2} + \frac{t_f}{2}\right)^2\right) + t_w \cdot \frac{\left(h - 2 \cdot t_f\right)^3}{12}\right) = \left(3.294 \cdot 10^8\right)\ mm^4$$

$$S_x := \frac{I_x}{\left(\frac{h}{2}\right)} = \left(1.441 \cdot 10^6\right)\ mm^3$$

$$Z_x := b_f \cdot t_f \cdot \left(h - t_f\right) + \frac{1}{4} \cdot \left(h - 2\ t_f\right)^2 \cdot t_w = \left(1.634 \cdot 10^6\right)\ mm^3$$

$$r_x := \sqrt{\frac{I_x}{A_g}} = 187.421\ mm$$

$$I_y := 2 \cdot \left(t_f \cdot \frac{b_f^{\ 3}}{12}\right) + \left(h - 2 \cdot t_f\right) \cdot \frac{t_w^{\ 3}}{12} = \left(1.671 \cdot 10^7\right)\ mm^4$$

$$S_y := \frac{I_y}{\frac{b_f}{2}} = \left(1.754 \cdot 10^5\right)\ mm^3$$

$$Z_y := \frac{1}{2} \cdot b_f^{\ 2} \cdot t_f + \frac{1}{4} \cdot \left(h - 2 \cdot t_f\right) \cdot t_w^{\ 2} = \left(2.714 \cdot 10^5\right)\ mm^3$$

$$r_y := \sqrt{\frac{I_y}{A_g}} = 42.21\ mm$$

$$c_w := \frac{\left(h - t_f\right)^2 \cdot b_f^{\ 3} \cdot t_f}{24} = \left(8.174 \cdot 10^{11}\right)\ mm^6$$

$$J := \frac{2 \cdot b_f \cdot t_f^{\ 3} + \left(h - t_f\right) \cdot t_w^{\ 3}}{3} = \left(4.936 \cdot 10^5\right)\ mm^4$$

$$r_{ts} := \sqrt{\frac{\sqrt{I_y \cdot c_w}}{S_x}} = 50.643\ mm$$

(1) For doubly symmetric I-shapes

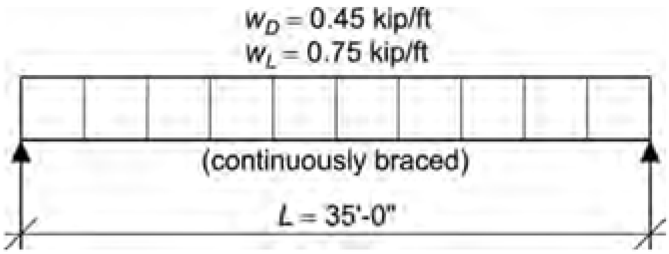
$$c = 1 \qquad \text{(F2-8a)}$$

(2) For channels

$$c = \frac{h_o}{2}\sqrt{\frac{I_y}{C_w}} \qquad \text{(F2-8b)}$$

$h_0 := h - t_f = 442.722\ mm$

$c := 1$



$$l := 35\ ft = \left(1.067 \cdot 10^{4}\right)\ mm$$

$$w := 1.2 \cdot 0.45\ \frac{kip}{ft} + 1.6 \cdot 0.75\ \frac{kip}{ft} = 1.74\ \frac{kip}{ft}$$

$$w := 1.2 \cdot 6.567\ \frac{kN}{m} + 1.6 \cdot 10.945\ \frac{kN}{m} = 25.392\ \frac{kN}{m}$$

$$M := \frac{w \cdot l^2}{8} = 266.427\ kip \cdot ft$$

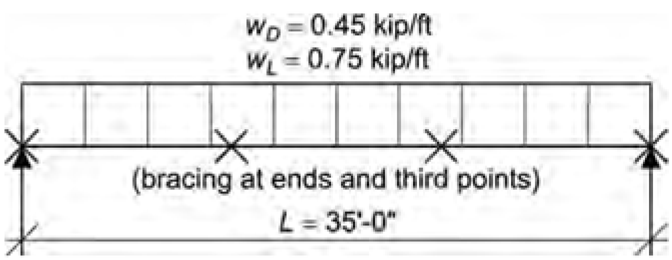
$$M := \frac{w \cdot l^2}{8} = 361.227\ kN \cdot m$$

$$F_y := 50\ ksi = 344.738\ MPa$$

$$E := 29000\ ksi = \left(1.999 \cdot 10^{5}\right)\ MPa$$

$$\phi M_{n1} := 0.9 \cdot F_y \cdot Z_x = 374.03\ kip \cdot ft \quad > \quad M := \frac{w \cdot l^2}{8} = 266.427\ kip \cdot ft$$

$$\phi M_{n1} := 0.9 \cdot F_y \cdot Z_x = 507.116\ kN \cdot m \qquad M := \frac{w \cdot l^2}{8} = 361.227\ kN \cdot m$$



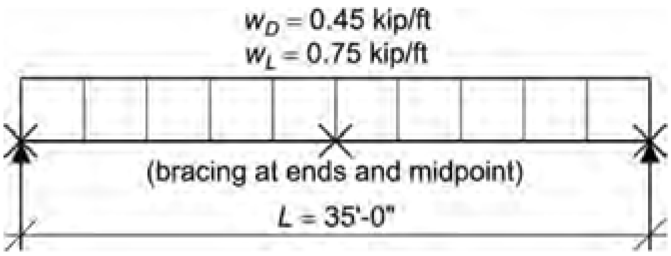
$$L_b := \frac{35\ ft}{3} = 3.556\ m$$

$$L_p := 1.76 \cdot r_y \cdot \sqrt{\frac{E}{F_y}} = 1.789\ m$$

$$L_r := 1.95 \cdot r_{ts} \cdot \frac{E}{0.7 \cdot F_y} \cdot \sqrt{\frac{J \cdot c}{S_x \cdot h_0} + \sqrt{\left(\frac{J \cdot c}{S_x \cdot h_0}\right)^2 + 6.76 \cdot \left(\frac{0.7 \cdot F_y}{E}\right)^2}} = 5.179\ m$$

$$\phi M_{n2} := 0.9 \cdot \left(F_y \cdot Z_x - \left(F_y \cdot Z_x - 0.7 \cdot F_y \cdot S_x \right) \cdot \frac{L_b - L_p}{L_r - L_p} \right) = 405.905 \ kN \cdot m$$

$$\square > \square \qquad M := \frac{w \cdot l^2}{8} = 361.227 \ kN \cdot m$$



$$L_b := \frac{35 \ ft}{2} = 5.334 \ m$$

$$C_b := 1.3$$

$$F_{cr} := C_b \cdot \frac{\pi^2 \cdot E}{\left(\frac{L_b}{r_{ts}} \right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{S_x \cdot h_0} \cdot \left(\frac{L_b}{r_{ts}} \right)^2} = 298.801 \ MPa$$

$$\phi M_{n3} := 0.9 \cdot F_{cr} \cdot S_x = 387.505 \ kN \cdot m \qquad \square > \square \qquad M := \frac{w \cdot l^2}{8} = 361.227 \ kN \cdot m$$

$$F_{cr} := \frac{\pi^2 \cdot E}{\left(\frac{L_b}{r_{ts}} \right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{S_x \cdot h_0} \cdot \left(\frac{L_b}{r_{ts}} \right)^2} = 229.847 \ MPa$$

$$\phi M_{n3} := 0.9 \cdot F_{cr} \cdot S_x = 298.081 \ kN \cdot m \qquad \square < \square \qquad M := \frac{w \cdot l^2}{8} = 361.227 \ kN \cdot m$$