W18x50

$h := 18\ in$
$b_f := 7.5\ in$
$t_f := 0.57\ in$
$t_w := 0.355\ in$

$A_g := 2 \cdot t_f \cdot b_f + (h - 2 \cdot t_f) \cdot t_w = 14.535\ in^2$

$I_x := \left(2 \cdot \left(b_f \cdot \frac{t_f^3}{12} + b_f \cdot t_f \cdot \left(\frac{(h - 2 \cdot t_f)}{2} + \frac{t_f}{2}\right)^2\right) + t_w \cdot \frac{(h - 2 \cdot t_f)^3}{12}\right) = 791.396\ in^4$

$S_x := \frac{I_x}{\left(\frac{h}{2}\right)} = 87.933\ in^3$

$Z_x := b_f \cdot t_f \cdot (h - t_f) + \frac{1}{4} \cdot (h - 2\ t_f)^2 \cdot t_w = 99.741\ in^3$

$r_x := \sqrt{\frac{I_x}{A_g}} = 7.379\ in$

$I_y := 2 \cdot \left(t_f \cdot \frac{b_f^3}{12}\right) + (h - 2 \cdot t_f) \cdot \frac{t_w^3}{12} = 40.141\ in^4$

$S_y := \frac{I_y}{\frac{b_f}{2}} = 10.704\ in^3$

$Z_y := \frac{1}{2} \cdot b_f^2 \cdot t_f + \frac{1}{4} \cdot (h - 2 \cdot t_f) \cdot t_w^2 = 16.562\ in^3$

$r_y := \sqrt{\frac{I_y}{A_g}} = 1.662\ in$

$c_w := \frac{(h - t_f)^2 \cdot b_f^3 \cdot t_f}{24} = (3.044 \cdot 10^3)\ in^6$

$J := \frac{2 \cdot b_f \cdot t_f^3 + (h - t_f) \cdot t_w^3}{3} = 1.186\ in^4$

$r_{ts} := \sqrt{\frac{\sqrt{I_y \cdot c_w}}{S_x}} = 1.994\ in$

$h_0 := h - t_f = 17.43\ in$

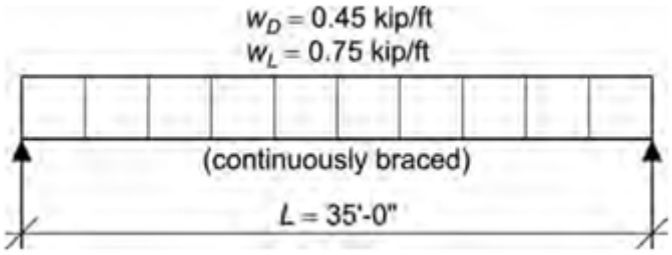
$c := 1$

(1) For doubly symmetric I-shapes

$c = 1$ (F2-8a)

(2) For channels

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



$l := 35\ ft$

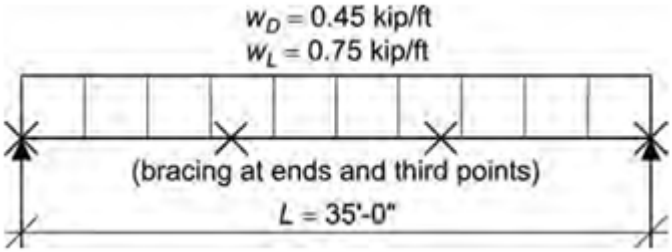
$w := 1.2 \cdot 0.45\ \frac{kip}{ft} + 1.6 \cdot 0.75\ \frac{kip}{ft} = 1.74\ \frac{kip}{ft}$

$M := \frac{w \cdot l^2}{8} = 266.438\ kip \cdot ft$

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

$E := 29000\ ksi$

$\phi M_{n1} := 0.9 \cdot F_y \cdot Z_x = 374.03\ kip \cdot ft$ > $M := \frac{w \cdot l^2}{8} = 266.438\ kip \cdot ft$



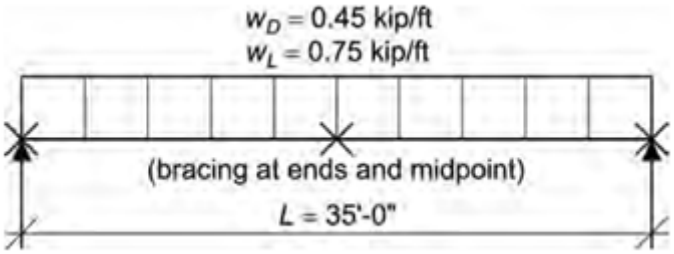
$L_b := \frac{35\ ft}{3} = 11.667\ ft$

$L_p := 1.76 \cdot r_y \cdot \sqrt{\frac{E}{F_y}} = 5.87\ ft$

$L_r := 1.95 \cdot r_{ts} \cdot \frac{E}{0.7 \cdot F_y} \cdot \sqrt{\frac{J \cdot c}{S_x \cdot h_0} + \sqrt{\left(\frac{J \cdot c}{S_x \cdot h_0}\right)^2 + 6.76 \cdot \left(\frac{0.7 \cdot F_y}{E}\right)^2}} = 16.99\ ft$

$\phi M_{n2} := 0.9 \cdot \left(F_y \cdot Z_x - \left(F_y \cdot Z_x - 0.7 \cdot F_y \cdot S_x\right) \cdot \frac{L_b - L_p}{L_r - L_p}\right) = 299.38\ kip \cdot ft$

> $M := \frac{w \cdot l^2}{8} = 266.438\ kip \cdot ft$



$$L_b := \frac{35\ ft}{2} = 17.5\ ft$$

$$C_b := 1.3$$

$$F_{cr} := C_b \cdot \frac{\pi^2 \cdot E}{\left(\frac{L_b}{r_{ts}}\right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{S_x \cdot h_0} \cdot \left(\frac{L_b}{r_{ts}}\right)^2} = 43.337\ ksi$$

$$\phi M_{n3} := 0.9 \cdot F_{cr} \cdot S_x = 285.809\ kip \cdot ft \quad > \quad M := \frac{w \cdot l^2}{8} = 266.438\ kip \cdot ft$$

$$F_{cr} := \frac{\pi^2 \cdot E}{\left(\frac{L_b}{r_{ts}}\right)^2} \cdot \sqrt{1 + 0.078 \cdot \frac{J \cdot c}{S_x \cdot h_0} \cdot \left(\frac{L_b}{r_{ts}}\right)^2} = 33.336\ ksi$$

$$\phi M_{n3} := 0.9 \cdot F_{cr} \cdot S_x = 219.853\ kip \cdot ft \quad < \quad M := \frac{w \cdot l^2}{8} = 266.438\ kip \cdot ft$$