LRFD Chapter F. Beams and other flexural members

For the checks in this chapter to apply, shapes must be classified compact or non-compact per LRFD

2.2a and b M_n for Doubly symmetric shapes and channels

We consolidate the LTB check for these shape of beams in one formulation,
discriminating if the LTB buckling is elastic or inelastic

2c. LTB Mn Tees and Double Angles

Tee $F_y := 260 \cdot MPa$ $E := 200000 \cdot MPa$ $\nu := 0.3$

$b_f := 15 \cdot cm$ total width of base $t_f := 1 \cdot cm$ $h := 15 \cdot cm$ $t_w := 1 \cdot cm$

$C_b := 1$ $Tip := 1$ **1** for somewhere in segment compressed
2 for only tensioned in the segment $L_b := 3 \cdot m$ $\phi_b := 0.9$

$$b := \frac{b_f}{2} \qquad G := \frac{E}{2 \cdot (1 + \nu)}$$

$$w(y) := \begin{cases} b_f & \text{if } y \le t_f \\ t_w & \text{otherwise} \end{cases}$$

$$A := \int_{0 \cdot cm}^{h} w(y)\, dy \qquad A = 29\,cm^2$$

$$y_g := \frac{\int_{0\cdot cm}^{h} y\cdot w(y)\, dy}{A} \qquad y_g = 4.12\,cm$$

$$I_x := \int_{-y_g}^{h-y_g} y^2\cdot w\left(y + y_g\right) dy \qquad I_x = 637.24\,cm^4$$

$$S_{xc} := \begin{cases} \dfrac{I_x}{h - y_g} & \text{if } Tip = 1 \\ \dfrac{I_x}{y_g} & \text{otherwise} \end{cases} \qquad S_{xt} := \begin{cases} \dfrac{I_x}{y_g} & \text{if } Tip = 1 \\ \dfrac{I_x}{h - y_g} & \text{otherwise} \end{cases}$$

$Tip = 1$

$S_{xc} = 58.57\,cm^3$ $\qquad$ $S_{xt} = 154.65\,cm^3$

$M_{yc} := F_y\cdot S_{xc}$ $\qquad$ $M_{yt} := F_y\cdot S_{xt}$

$$I_y := \frac{1}{12}\cdot\left(b_f^{\,3}\cdot t_f + h\cdot t_w^{\,3}\right) \qquad I_y = 6.79\,in^4$$

$$J := 1.1\cdot\left(\frac{b_f\cdot t_f^{\,3}}{3} + \frac{h\cdot t_w^{\,3}}{3}\right)$$

Torsion Constant

$$J = 0.26\,in^4$$

$$C_w := \frac{\left(b_f\cdot t_f\right)^3}{144} + \frac{\left[\left(h - \frac{t_f}{2}\right)\cdot t_w\right]^3}{36}$$

Warping Constant

$$C_w = 0.4\,in^6$$

$$B := \begin{cases} -2.3 \cdot \dfrac{h}{L_b} \cdot \sqrt{\dfrac{I_y}{J}} & \text{if } Tip = 1 \\ 2.3 \cdot \dfrac{h}{L_b} \cdot \sqrt{\dfrac{I_y}{J}} & \text{otherwise} \end{cases}$$

$$M_{n1} := \frac{\pi \cdot \sqrt{E \cdot I_y \cdot G \cdot J}}{L_b} \cdot \left(B + \sqrt{1 + B^2}\right)$$

$$y_p := \frac{h}{4}$$ unwarranted guess for level dividing area of T in 2 equal parts

Given

$$\int_{-y_p}^{0 \cdot cm} w\left(y + y_p\right) dy = \int_{0 \cdot cm}^{h - y_p} w\left(y + y_p\right) dy$$

$$y_p := \mathrm{Find}\left(y_p\right)$$

$$y_p = 0.97\,cm$$

$$Z_x := \int_{-y_p}^{h - y_p} |y| \cdot w\left(y + y_p\right) dy \qquad M_p := Z_x \cdot F_y$$

$$M_n := \min\left[\left[\begin{matrix} M_{n1} \\ \left| \begin{matrix} M_{yc} \ \text{if } Tip = 1 \\ \min\left(\left(\begin{matrix} 1.5 \cdot M_{yc} \\ 1.5 \cdot M_{yt} \\ Z_x \cdot F_y \end{matrix}\right)\right) \ \text{otherwise} \end{matrix}\right. \end{matrix}\right]\right]$$

$M_n = 1.55\,m \cdot ton$ $\phi_b \cdot M_n = 1.4\,m \cdot ton$ $\frac{M_n}{M_p} = 0.56$ $\frac{M_n}{M_{yc}} = 1$ $\frac{M_n}{M_{yt}} = 0.38$