HSS10 x 6 x 3/16 x 10ft Steel Column With Slender Web Verification Calculations:

$R_{Dead} := 1.075\ kip + 30\ kip$ $R_{Snow} := 2.50\ kip + 50\ kip$ $R_{Wind} := -1.5\ kip$

Column Dimensions: Length: $L := 10\ ft$ Unbraced Length: $L_x := L = 10\ ft$ $L_y := L = 10\ ft$

Shape: HSS10x6x3/16 $F_y := 50\ ksi$ $E := 29000\ ksi$ $A := 5.37\ in^2$ $t_{des} := 0.174\ in$ $t := \frac{3}{16}\ in$

$r_x := 3.73\ in$ $r_y := 2.52\ in$ $hTw := 54.5$ $bTf := 31.5$ $I_x := 74.6\ in^4$ $I_y := 34.1\ in^4$

$G := 11200\ ksi$ $J := 73.8\ in^4$ $C_w := 19.9\ in^6$ $W := 19.63\ plf$

Check for compact flange and web per AISC B4.1a:

$$\text{if}\left(bTf \le 1.40 \cdot \sqrt{\frac{E}{F_y}}, \text{“Compact”}, \text{“Slender”}\right) = \text{“Compact”}$$

$$\text{if}\left(hTw \le 1.40 \cdot \sqrt{\frac{E}{F_y}}, \text{“Compact”}, \text{“Slender”}\right) = \text{“Slender”}$$

Total column loads including self weight:

$Dead := R_{Dead} + W \cdot L = 31.271\ kip$ $Snow := R_{Snow} = 52.5\ kip$ $Wind := R_{Wind} = -1.5\ kip$

$$P_{asd} := \begin{bmatrix} Dead \\ Dead + Snow \\ Dead + 0.75 \cdot Wind + 0.75 \cdot Snow \\ 0.6 \cdot Dead + 0.6 \cdot Wind \end{bmatrix} = \begin{bmatrix} 31.271 \\ 83.771 \\ 69.521 \\ 17.863 \end{bmatrix} kip$$

$$P_u := \begin{bmatrix} 1.4 \cdot Dead \\ 1.2 \cdot Dead + 1.6 \cdot Snow \\ 1.2 \cdot Dead + 1.0 \cdot Wind + 0.5 \cdot Snow \\ 1.2 \cdot Dead + 0.5 \cdot Wind + 1.6 \cdot Snow \\ 0.9 \cdot Dead + 1.0 \cdot Wind \end{bmatrix} = \begin{bmatrix} 43.78 \\ 121.526 \\ 62.276 \\ 120.776 \\ 26.644 \end{bmatrix} kip$$

Axial Capacity - Section E7: $K := 1.0$ Calculate min Fe per AISC E3-4

$$F_{e\_x} := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L_x}{r_x}\right)^2} = 276.537\ ksi \qquad F_{e\_y} := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L_y}{r_y}\right)^2} = 126.222\ ksi$$

$F_{e\_E3} := min\left(F_{e\_x}, F_{e\_y}\right) = 126.222\ ksi$

Torsional Buckling Length: $L_z := L = 10\ ft$

$$F_{e\_E4} := \left(\frac{\pi^2 \cdot E \cdot C_w}{(L_z)^2} + G \cdot J\right) \cdot \frac{1}{I_x + I_y} = 7607.687\ ksi$$ AISC E4-2

$F_e := min\left(F_{e\_E3}, F_{e\_E4}\right) = 126.222\ ksi$

Use minimum Fe between chapter E3, E4

$$F_{cr} := \left\| \begin{array}{l} \text{if } \frac{F_y}{F_e} < 2.25 \\ \quad \left\| F_{cr\_1} \leftarrow 0.658^{\frac{F_y}{F_e}} \cdot F_y \right. \\ \text{else} \\ \quad \left\| F_{cr\_1} \leftarrow 0.877 \cdot F_e \right. \end{array} \right. = 42.361\ ksi$$

AISC E3-2 and E3-3

$b := bTf \cdot t = 5.906\ in$ Get the official "b" since it's not in the AISC Manual

$h := hTw \cdot t = 10.219\ in$ Get the official "h" since it's not in the AISC Manual

From table E7.1 assign the Effective Width Imperfection Adjustment Factors:

$c_1 := 0.20 \quad c_2 := \frac{1-\sqrt{1-4\cdot c_1}}{2\cdot c_1} = 1.382$

$\lambda := bTf = 31.5 \qquad \lambda_r := 1.40\cdot\sqrt{\frac{E}{F_y}} = 33.716$

$b_e := \text{if } \lambda \le \lambda_r \cdot \sqrt{\frac{F_y}{F_{cr}}}$ $= 5.906\ in$ AISC E7-2 and E7-3

$\quad\quad b$

else

$\quad\quad F_{el} \leftarrow \left(c_2 \cdot \frac{\lambda_r}{\lambda}\right)^2 \cdot F_y$

$\quad\quad min\left(b\cdot\left(1-c_1\cdot\sqrt{\frac{F_{el}}{F_{cr}}}\right)\cdot\sqrt{\frac{F_{el}}{F_{cr}}}, b\right)$

From table E7.1 assign the Effective Width Imperfection Adjustment Factors:

$c_1 := 0.20 \quad c_2 := \frac{1-\sqrt{1-4\cdot c_1}}{2\cdot c_1} = 1.382$

$\lambda := hTw = 54.5 \qquad \lambda_r := 1.40\cdot\sqrt{\frac{E}{F_y}} = 33.716$

$h_e := \text{if } \lambda \le \lambda_r \cdot \sqrt{\frac{F_y}{F_{cr}}}$ $= 7.728\ in$ AISC E7-2 and E7-3

$\quad\quad h$

else

$\quad\quad F_{el} \leftarrow \left(c_2 \cdot \frac{\lambda_r}{\lambda}\right)^2 \cdot F_y$

$\quad\quad h_e \leftarrow min\left(h\cdot\left(1-c_1\cdot\sqrt{\frac{F_{el}}{F_{cr}}}\right)\cdot\sqrt{\frac{F_{el}}{F_{cr}}}, h\right)$

$A_e := A - 2\cdot(b-b_e)\cdot t_{des} - 2\cdot(h-h_e)\cdot t_{des} = 4.503\ in^2 \quad A = 5.37\ in^2$ Note there was an adjustment in the effective area

$F_{cr} = 42.361\ ksi$

$P_n := F_{cr}\cdot A_e = 190.766\ kip$ AISC E7-1

ASD Axial Capacity: $\Omega := 1.67$ $\frac{P_n}{\Omega} = 114.231$ ***kip*** $P_{asd} = \begin{bmatrix} 31.271 \\ 83.771 \\ 69.521 \\ 17.863 \end{bmatrix}$ ***kip***

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Steel Member Size: HSS10X6X3/16
Steel Member Grade: A500 Grade C 50ksi
Axial Code Check = 0.73 at 10.00 ft
    A = -83.77 K vs 114.23 K
    for Dead + Snow
    Horizontal Axis OK, KL/r = 47.62
No Moment Forces
No Shear Forces
No Deflection
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$\frac{P_{asd}}{\frac{P_n}{\Omega}} = \begin{bmatrix} 0.274 \\ 0.733 \\ 0.609 \\ 0.156 \end{bmatrix}$

LRFD Axial Capacity: $\phi := 0.9$ $\phi P_n := \phi \cdot P_n = 171.69$ ***kip*** $P_u = \begin{bmatrix} 43.78 \\ 121.526 \\ 62.276 \\ 120.776 \\ 26.644 \end{bmatrix}$ ***kip***

```
Steel Member Size: HSS10X6X3/16
Steel Member Grade: A500 Grade C 50ksi
Axial Code Check = 0.71 at 10.00 ft
    A = -121.53 K vs 171.69 K
    for 1.2 Dead + 1.6 Snow
    Horizontal Axis OK, KL/r = 47.62
No Moment Forces
No Shear Forces
No Deflection
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$\frac{P_u}{\phi P_n} = \begin{bmatrix} 0.255 \\ 0.708 \\ 0.363 \\ 0.703 \\ 0.155 \end{bmatrix}$