4X6 DF#2 x 10ft Column Verification Calculations:

Surface Area Loading:

$Roof_{Dead} := 20\ psf$ $Roof_{Snow} := 50\ psf$ $Roof_{Wind} := -30\ psf$

Beam Transferring Load To This Column: Span: $L_{beam} := 10\ ft$

Shape: 4x10 Width: $b := 3.5\ in$ Depth: $d := 9.25\ in$ $Density := 35\ pcf$

$A := b \cdot d = 32.375\ in^2$ $S_{xx} := \frac{1}{6} \cdot b \cdot d^2 = 49.911\ in^3$ $I_{xx} := \frac{1}{12} \cdot b \cdot d^3 = 230.84\ in^4$

Roof Load Tributary Width: $T := 4\ ft$

$Dead := Roof_{Dead} \cdot T + A \cdot Density = 87.869\ plf$ $Snow := Roof_{Snow} \cdot T = 200\ plf$

$Wind := Roof_{Wind} \cdot T = -120\ plf$

$$W_{asd} := \begin{bmatrix} Dead \\ Dead + Snow \\ Dead + 0.75 \cdot Wind + 0.75 \cdot Snow \\ 0.6 \cdot Dead + 0.6 \cdot Wind \end{bmatrix} = \begin{bmatrix} 87.869 \\ 287.869 \\ 147.869 \\ -19.279 \end{bmatrix} plf$$

$$W_{LRFD} := \begin{bmatrix} 1.4 \cdot Dead \\ 1.2 \cdot Dead + 1.6 \cdot Snow \\ 1.2 \cdot Dead + 1.0 \cdot Wind + 0.5 \cdot Snow \\ 1.2 \cdot Dead + 0.5 \cdot Wind + 1.6 \cdot Snow \\ 0.9 \cdot Dead + 1.0 \cdot Wind \end{bmatrix} = \begin{bmatrix} 123.016 \\ 425.443 \\ 85.443 \\ 365.443 \\ -40.918 \end{bmatrix} plf$$

Reactions:

$$R_a := (W_{asd}) \cdot \frac{L_{beam}}{2} = \begin{bmatrix} 0.439 \\ 1.439 \\ 0.739 \\ -0.096 \end{bmatrix} kip \qquad R_b := (W_{asd}) \cdot \frac{L_{beam}}{2} = \begin{bmatrix} 0.439 \\ 1.439 \\ 0.739 \\ -0.096 \end{bmatrix} kip$$

Column Dimensions:

Length: $L := 10\ ft$ Unbraced Length Horizontal: $L_{u\_x} := 10\ ft$

Unbraced Length Vertical: $L_{u\_y} := 10\ ft$

Shape: Use 4x6 Width: $b := 3.5\ in$ Depth: $d := 5.5\ in$ $Density := 35\ pcf$

Material: DF #2 $A := b \cdot d = 19.25\ in^2$ $f_c := 1350\ psi$ $E := 1600\ ksi$ $E_{min} := 580\ ksi$
Dimensional Lumber

Loading (ASD):

Factors for the load cases:

Add in the self weight of the column:

$$R_{asd} := (W_{asd}) \cdot \frac{L_{beam}}{2} = \begin{bmatrix} 0.439 \\ 1.439 \\ 0.739 \\ -0.096 \end{bmatrix} \ kip \qquad f := \begin{bmatrix} 1.0 \\ 1.0 \\ 1.0 \\ 0.6 \end{bmatrix} \qquad P_{asd} := R_{asd} + f \cdot A \cdot Density \cdot L = \begin{bmatrix} 0.486 \\ 1.486 \\ 0.786 \\ -0.068 \end{bmatrix} \ kip$$

Loading (LRFD):

$$R_{LRFD} := (W_{LRFD}) \cdot \frac{L_{beam}}{2} = \begin{bmatrix} 0.615 \\ 2.127 \\ 0.427 \\ 1.827 \\ -0.205 \end{bmatrix} \ kip \qquad f := \begin{bmatrix} 1.6 \\ 1.2 \\ 1.2 \\ 1.2 \\ 0.9 \end{bmatrix} \qquad P_u := R_{LRFD} + f \cdot A \cdot Density \cdot L = \begin{bmatrix} 0.69 \\ 2.183 \\ 0.483 \\ 1.883 \\ -0.162 \end{bmatrix} \ kip$$

Design Factors: NDS 4.3.3 NDS 4.3.4 NDS 4.3.8 NDS Table 4A

$C_m := 1.0$ $C_t := 1.0$ $C_i := 1.0$ $C_F := 1.1$

NDS Table 4.3.1 ASD Only: $C_d := \begin{bmatrix} 0.9 \\ 1.15 \\ 1.15 \\ 1.6 \end{bmatrix}$

NDS Table 4.3.1 LRFD Only: $K_f := 2.40$ $\phi := 0.9$ $\lambda := \begin{bmatrix} 0.6 \\ 0.8 \\ 0.8 \\ 0.8 \\ 1.0 \end{bmatrix}$

Check Slenderness: $K := 1.0$ Check Column Slenderness per NDS 3.7.1.4

$$\text{if}\left(\frac{L_{u\_x}}{d} > 50, \text{“Slender”}, \text{“OK”}\right) = \text{“OK”} \qquad \text{if}\left(\frac{L_{u\_y}}{d} > 50, \text{“Slender”}, \text{“OK”}\right) = \text{“OK”}$$

Calculation of the Column Stability Factor (Cp):

$c := 0.8$ For Sawn Lumber per NDS 3.7-1

$l_{e\_x} := K \cdot L_{u\_x} = 10 \ ft$ $l_{e\_y} := K \cdot L_{u\_y} = 10 \ ft$ NDS 3.7.1.2

$$l_e := \text{if}\left(\frac{l_{e\_x}}{b} < \frac{l_{e\_y}}{d}, l_{e\_y}, l_{e\_x}\right) = 10 \ ft \qquad d_e := \text{if}\left(\frac{l_{e\_x}}{b} < \frac{l_{e\_y}}{d}, d, b\right) = 3.5 \ in$$

Check ASD Axial Capacity:

$$F_{cE} := \frac{0.822 \cdot E_{min} \cdot C_m \cdot C_t \cdot C_i}{\left(\frac{l_e}{d_e}\right)^2} = 405.577 \ psi$$ NDS 3.7.1

Calculate factored Fc without Column Stability Factor:

$$F_{c`} := C_d \cdot f_c \cdot C_m \cdot C_t \cdot C_F \cdot C_i = \begin{bmatrix} 1336.5 \\ 1707.75 \\ 1707.75 \\ 2376 \end{bmatrix} psi$$

Calculate Column Stability Factor Per NDS 3.7.1

$$C_P := \frac{1 + \frac{F_{cE}}{F_{c`}}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE}}{F_{c`}}}{2 \cdot c}\right)^2 - \frac{\frac{F_{cE}}{F_{c`}}}{c}} = \begin{bmatrix} 0.281 \\ 0.224 \\ 0.224 \\ 0.164 \end{bmatrix}$$ NDS 3.7-1

Calculate Allowable Compression Capacity per NDS Table 4.3.1

$$P_{allowable} := \overrightarrow{A \cdot C_d \cdot f_c \cdot C_m \cdot C_t \cdot C_F \cdot C_P \cdot C_i} = \begin{bmatrix} 7.24 \\ 7.38 \\ 7.38 \\ 7.512 \end{bmatrix} kip$$

ASD Results from Loadpath:

```
Wood Member Size: 4x6
Wood Member Grade: Dim Lumber - DF No. 2
Axial Code Check = 0.20 at 10.00 ft
    A = -1.49 K vs 7.38 K
    for Dead + Snow
    Horizontal Axis OK, Rc = 34.29
No Moment Forces
No Shear Forces
No Deflection
```

$$P_{asd} = \begin{bmatrix} 0.486 \\ 1.486 \\ 0.786 \\ -0.068 \end{bmatrix} kip$$

$$\frac{P_{asd}}{P_{allowable}} = \begin{bmatrix} 0.067 \\ 0.201 \\ 0.107 \\ -0.009 \end{bmatrix}$$

Check LRFD Axial Capacity:

$$F_{cE} := \frac{0.822 \cdot E_{min} \cdot C_m \cdot C_t \cdot C_i \cdot 1.76 \cdot 0.85}{\left(\frac{l_e}{d_e}\right)^2} = 606.743 \ psi$$ NDS 3.7.1

Calculate factored Fc without Column Stability Factor:

$$F_{c`} := f_c \cdot C_m \cdot C_t \cdot C_F \cdot C_i \cdot K_f \cdot \phi \cdot \lambda = \begin{bmatrix} 1924.56 \\ 2566.08 \\ 2566.08 \\ 2566.08 \\ 3207.6 \end{bmatrix} psi$$

Calculate Column Stability Factor Per NDS 3.7.1

$$C_P := \frac{1 + \frac{F_{cE}}{F_{c`}}}{2 \cdot c} - \sqrt{\left(\frac{1 + \frac{F_{cE}}{F_{c`}}}{2 \cdot c}\right)^2 - \frac{\frac{F_{cE}}{F_{c`}}}{c}} = \begin{bmatrix} 0.291 \\ 0.224 \\ 0.224 \\ 0.224 \\ 0.181 \end{bmatrix}$$ NDS 3.7-1

Calculate Allowable Compression Capacity per NDS Table 4.3.1

$$\phi P_n := \overrightarrow{A \cdot f_c \cdot C_m \cdot C_t \cdot C_F \cdot C_P \cdot C_i \cdot K_f \cdot \phi \cdot \lambda} = \begin{bmatrix} 10.793 \\ 11.044 \\ 11.044 \\ 11.044 \\ 11.185 \end{bmatrix} kip$$

LRFD Results from Loadpath:

```
Wood Member Size: 4x6
Wood Member Grade: Dim Lumber - DF No. 2
Axial Code Check = 0.20 at 10.00 ft
    A = -2.18 K vs 11.04 K
    for 1.2 Dead + 1.6 Snow
    Horizontal Axis OK, Rc = 34.29
No Moment Forces
No Shear Forces
No Deflection
```

$$P_u = \begin{bmatrix} 0.69 \\ 2.183 \\ 0.483 \\ 1.883 \\ -0.162 \end{bmatrix} kip$$

$$\frac{P_u}{\phi P_n} = \begin{bmatrix} 0.064 \\ 0.198 \\ 0.044 \\ 0.171 \\ -0.015 \end{bmatrix}$$