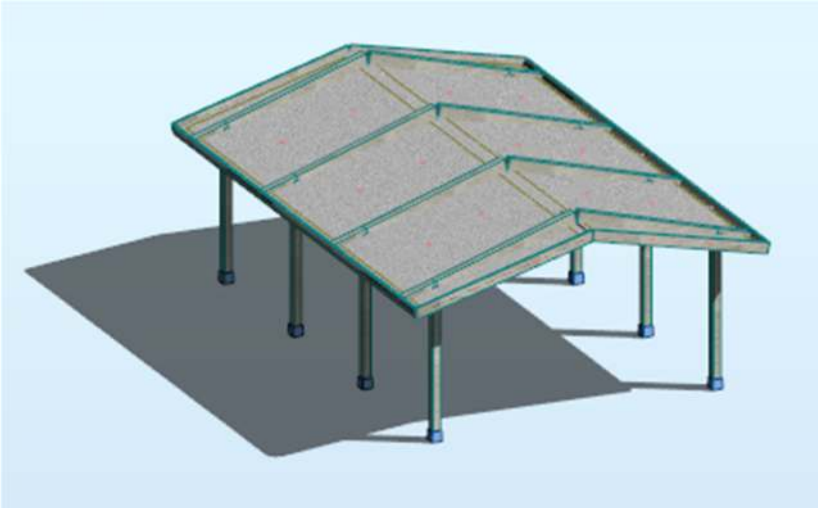
CEDAR FOREST PRODUCTS

Structural Calculations



Job Number: *4208*

Standards: *2015 International Building Code*

Structure Name: *LB2028-M*

Client: *NW Harnett Elementary*

Date: *7/18/2023*

Author: *Troy Garland, P.E., S.E.*

Site Location: *736 Rollins Road, Fuquay-Varina, NC 27526*

NORTH CAROLINA PROFESSIONAL SEAL 041635 ENGINEER TROY L. GARLAND

Troy Garland

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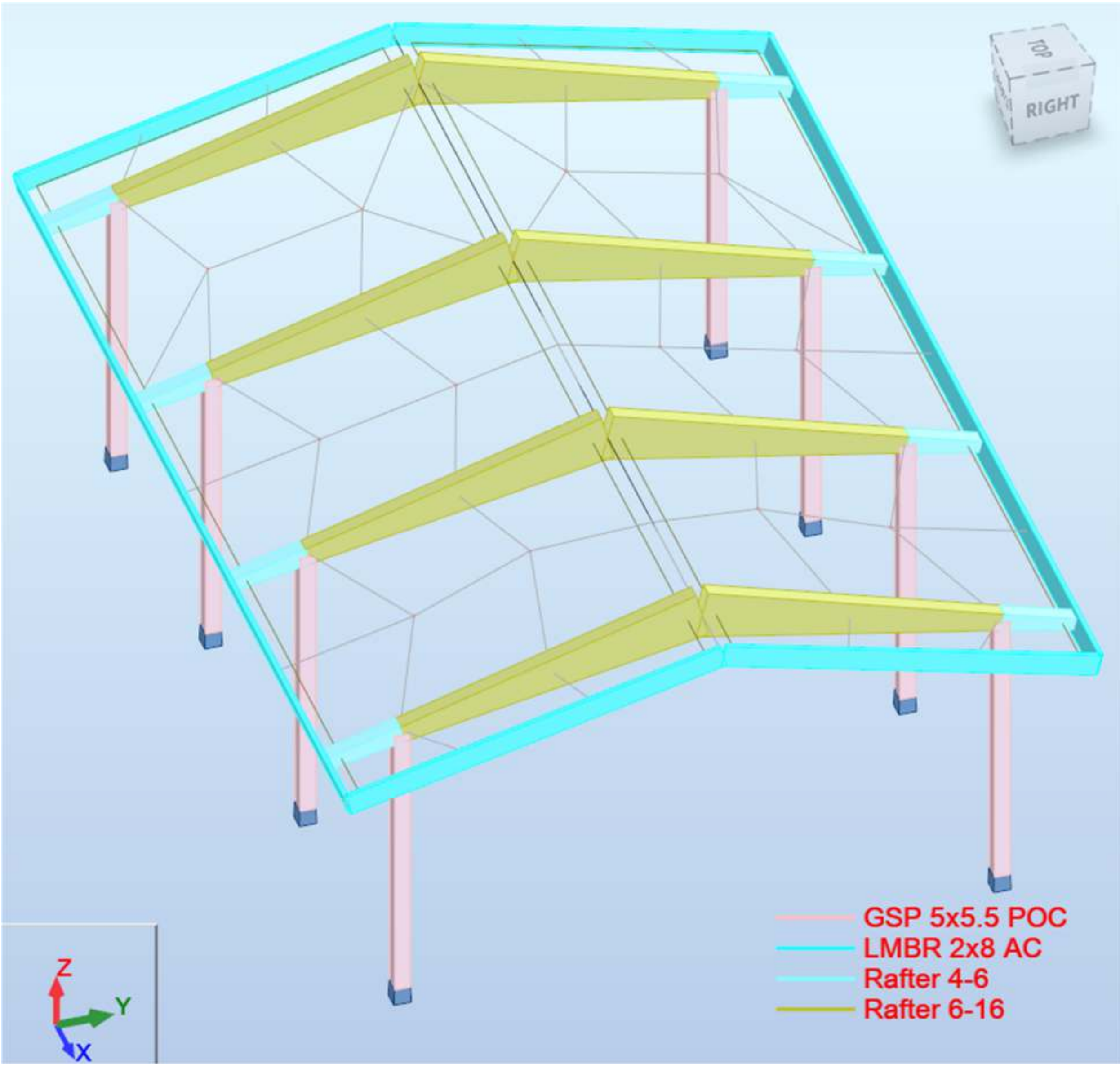
Reason: Engineering Seal
Location: Hamilton, MI
Date: 2023-07-19 10:14-04:00

Structure View



Design Criteria

Codes

2015 International Building Code
ASCE 7-10 Minimum Design Loads for Buildings and Other Structures
2012 AWC National Design Standard for Wood Construction
ACI 318-11 Building Code Requirements for Structural Concrete
AISC 360-16 Specification for Structural Steel Buildings

Dead Loads

Total Dead Load (psf) = 10.7
Frame Weight (psf) = 2.7
Roofing Load (psf) = 8.0

Live Loads

Live Load (psf) = NA
Roof Live Load (psf) = 20

Snow Loads

See snow load calculation sheets

Wind Loads

See wind load calculation sheets

Seismic Loads

See seismic load calculation sheets

Load Combinations

Strength Design Load Combinations — ASCE 7, Section 2.3.2

$1.4D$
$1.2D + 1.6L_R + 0.5W$
$1.2D + 1.0W + 0.5L_R$
$(1.2+0.2S_{DS})D + 1.0E$
$0.9D + 1.0W$
$(0.9-0.2S_{DS})D + 1.0E$

Allowable Stress Design Combinations — ASCE 7, Section 2.4.1

D
$D + L_R$
$D + 0.6W$
$(1+0.14S_{DS})D + 0.7E$
$D + 0.75(0.6W) + 0.75L_R$
$(1+0.14S_{DS})D + 0.75(0.7E)$
$0.6D + 0.6W$
$(0.6-0.14S_{DS})D + 0.7E$

Snow Loads

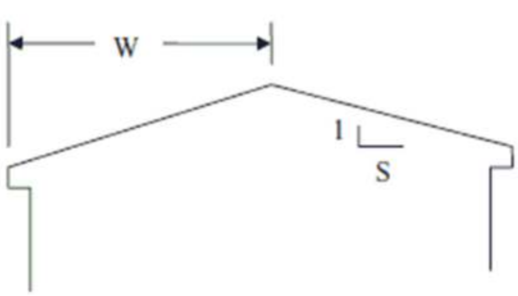
Roof surface = *Main Roof*		
Description = *Snow Loads*		
Ground Snow Load (p_g - psf) = *15.00*		ASCE 7-10, Figure 7-1
Thermal Factor (C_t) = *1.20*		ASCE 7-10, Table 7-3
Exposure Factor (C_e) = *1.00*		ASCE 7-10, Table 7-2
Risk Category = *II*		ASCE 7-10, Table 1.2-1
Snow Importance Factor (I_s) = *1.00*		ASCE 7-10, Table 1.5-2
Surface Condition = *Unslippery*		*ASCE 7-10, Section 7.4*
Ventilated = *False*		*ASCE 7-10, Section 7.4*
R value = *0*		*ASCE 7-10, Section 7.4*
Roof angle (θ - deg) = *14.04*		
Roof slope run for a rise of one (S) = 4.00		*ASCE 7-10, Section 7.6.1*
Flat Roof Snow Load (p_f - psf) = *12.60*	$\mathrm{p_f = 0.7C_eC_tI_sp_g}$	ASCE 7-10, Equation 7.3-1
Snow Density (γ - pcf) = *15.95*	$\gamma = 0.13\mathrm{p_g} + 14 < 30$ pcf	ASCE 7-10, Equation 7.7-1

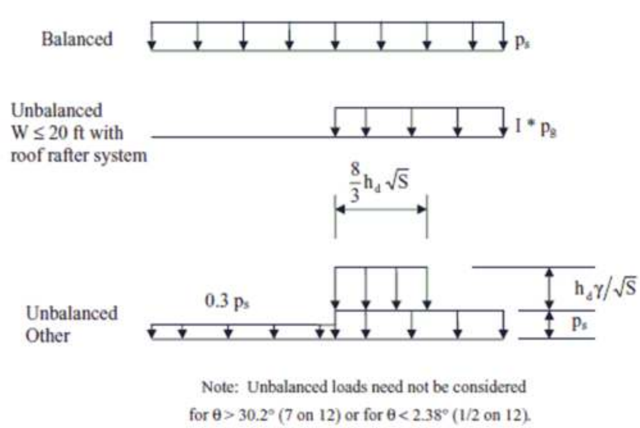
Balanced Snow Loads

Roof Slope Factor (C_s) = *1.00*		ASCE 7-10, Figure 7-2
Sloped Roof Snow Load (p_s - psf) = *12.60*	$p_s = C_s p_f$	ASCE 7-10, Equation 7.4-1
Sloped Snow Depth (h_b - ft.) = *0.79*	$h_b = {p_s}/{\gamma}$	ASCE 7-10, Section 7.7.1
Rain on Snow Surcharge Load (p_{ros} - psf) = *0.00*		*ASCE 7-10, Section 7.10*

Unbalanced Snow Loads

Unbalanced Required = *True*		ASCE 7-10, Section 7.6.1
Rafter System = *True*		ASCE 7-10, Section 7.6.1
Windward Load (p_{ubw} - psf) = *0.00*	$\mathrm{p_{ubw}} = 0.3\mathrm{p_s}$ or 0	ASCE 7-10, Figure 7-5
Leeward Load (p_{ubl} - psf) = *15.00*	$\mathrm{p_{ubl}} = \mathrm{Ip_g}$ or $\mathrm{p_s}$	ASCE 7-10, Figure 7-5
Drift Depth (h_d - ft.) = *0.00*	$\mathrm{h_d} = 0.43\sqrt[3]{\mathrm{l_u}}\sqrt[4]{\mathrm{p_g}+10} - 1.5$	ASCE 7-10, Figure 7-5
Drift Load (p_{ubd} - psf) = *0.00*	$\mathrm{p_{ubd}} = \mathrm{h_d}\gamma/\sqrt{\mathrm{S}}$	ASCE 7-10, Figure 7-5
Drift Width (w_{ubd} - ft.) = *0.00*	$\mathrm{w_{ubd}} = \frac{8}{3}\mathrm{h_d}\sqrt{\mathrm{S}}$	ASCE 7-10, Figure 7-5





Wind Loads

Wind Design Criteria Type = *OpenGableMWFR*
Eave Height (h_e - ft) = *8.00*
Mean Roof Height (h - ft) = *9.50*
Ridge Direction (Deg from X) = *0.00*
Width in the X direction (W_x - ft) = *28.00*
Width in the Y direction (W_y - ft) = *20.00*
Roof angle (θ - deg) = *18.43*
Structure Shape = Gable
Multi Roof Structure = False
Enclosure Classification = Open — *ASCE 7-10, Section 26.10*
Wind Procedure = *Directional* — ASCE 7-10, Equation 26.1
Basic Wind Speed (V - mph) = *115.00* — ASCE 7-10, Figure 26.5-1
Structure Type = *BuildingMWFRS* — *ASCE 7-10, Table 26.6-1*
Exposure Category = C — *ASCE 7-10, Section 26.7*
Low Rise = True
Rigid Structure = True
CNC Edge and Corner Zone Width = 3.00

Global Wind Parameters

Directionality Factor (K_d) = *0.85* — *ASCE 7-10, Table 26.6-1*
Topographic Factor (K_{zt}) = *1.00* — *ASCE 7-10, Table 26.8*
Gust-effect Factor (G) = *0.85* — *ASCE 7-10, Section 26.9*
Velocity pressure exposure coefficient for MWFRS at mean roof height (K_h) = *0.85* — *ASCE 7-10, Table 27.3-1*
Velocity pressure exposure coefficient for CNC at mean roof height (K_h) = *0.85* — *ASCE 7-10, Table 30.3-1*

Velocity pressure $$q_z = 0.00256 K_z K_{zt} K_d V^2$$ ASCE 7-10, Section 27.3

Velocity pressure at mean roof height for MWFRS (q_h - psf) = *24.43*
Velocity pressure at mean roof height for CNC (q_h - psf) = *24.43*

Wind Loads Transverse

Dimensional Parameters

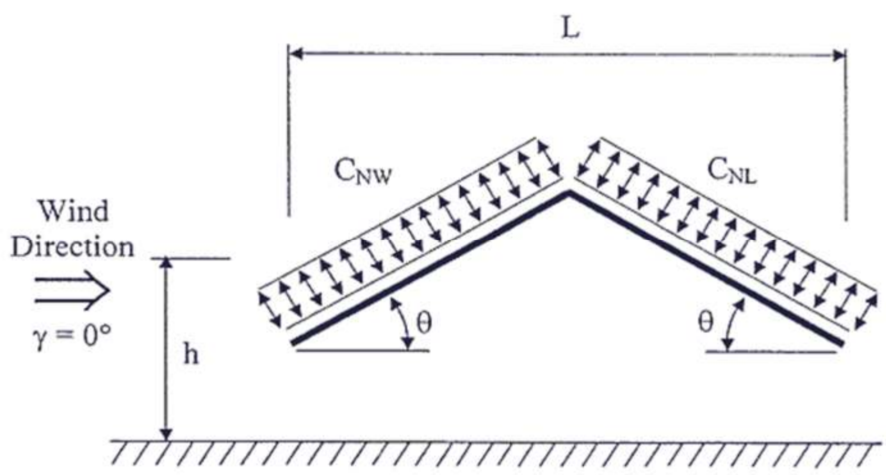
Dimension of Structure in the Wind Direction (L - ft) = *20.00*
Dimension of Structure Perpendicular to the Wind Direction (B - ft) = *28.00*
Height to Length (h/L) = *0.48*
Length to Width (L/B) = *0.71*

Design Wind Pressures (Transverse Wind)

Wind Direction (γ - deg) = *0.00*
Ridge Direction (Deg from X) = *0.00*
Roof Angle (θ - deg) = *18.43*
Mean Roof Height (h - ft) = *9.50*
Roof Length (L - ft) = *20.00*
Clear Wind Flow = *True*
Roofing Solidity Factor (ε) = *1.00*

Design pressures (p - psf) $p = q_h G C_N \varepsilon$ ASCE 7-10, Section 27.4.2

Wind Zone	Pressure Coefficient (C_n)	Design Pressure (p - psf)
Windward Roof Case A	*1.10*	*22.84*
Leeward Roof Case A	*-0.17*	*-3.55*
Windward Roof Case B	*0.01*	*0.17*
Leeward Roof Case B	*-0.96*	*-19.99*



**Plus and minus signs signify pressures acting towards and away from the top roof surface, respectively.*
**Pressure Coefficients are from ASCE 7-10, Figure 27.4-5*

Wind Loads Parallel

Dimensional Parameters

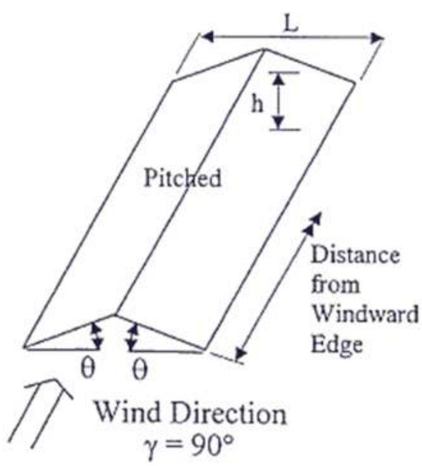
Dimension of Structure in the Wind Direction (L - ft) = *28.00*
Dimension of Structure Perpendicular to the Wind Direction (B - ft) = *20.00*
Height to Length (h/L) = *0.34*
Length to Width (L/B) = *1.40*

Design Wind Pressures (Longitudinal Wind)

Wind Direction (γ - deg) = *90.00*
Ridge Direction (Deg from X) = *0.00*
Roof Angle (θ - deg) = *18.43*
Mean Roof Height (h - ft) = *9.50*
Roof Length (L - ft) = *20.00*
Clear Wind Flow = *True*
Roofing Solidity Factor (ε) = *1.00*

Design pressures (p - psf) $p = q_h G C_N \varepsilon$ ASCE 7-10, Section 27.4.3

Wind Zone	Pressure Coefficient (C_n)	Design Pressure (p - psf)	Zone Ends at (X from Windward Edge - ft)
Roof Area 1 Case A	*-0.80*	*-16.61*	*9.50*
Roof Area 2 Case A	*-0.60*	*-12.46*	*19.00*
Roof Area 3 Case A	*-0.30*	*-6.23*	*28.00*
Roof Area 1 Case B	*0.80*	*16.61*	*9.50*
Roof Area 2 Case B	*0.50*	*10.38*	*19.00*
Roof Area 3 Case B	*0.30*	*6.23*	*28.00*



**Plus and minus signs signify pressures acting towards and away from the top roof surface, respectively.*
**Pressure Coefficients are from ASCE 7-10, Figure 27.4-7*

Seismic Loads

Seismic Ground Motion Values

Short Period spectral response acceleration parameter (S_s) = *0.172* — ASCE 7-10, Chapter 22
One Second Period spectral response acceleration parameter (S_1) = *0.083* — ASCE 7-10, Chapter 22
Site Class = *D*
Site Coefficient (F_a) = *1.600* — ASCE 7-10, Table 11.4-1
Site Coefficient (F_v) = *2.400* — ASCE 7-10, Table 11.4-2

MCER spectral response acceleration parameters

Short Period (S_{MS}) = *0.275* — $S_{MS} = F_a S_s$ — ASCE 7-10, Equation 11.4-1
1sec period (S_{M1}) = *0.199* — $S_{M1} = F_v S_1$ — ASCE 7-10, Equation 11.4-2

Design spectral Acceleration Parameters

Short Period (S_{DS}) =*0.183* — $S_{DS} = (2/3)S_{MS}$ — ASCE 7-10, Equation 11.4-3
1sec Period (S_{D1}) = *0.133* — $S_{D1} = (2/3)S_{M1}$ — ASCE 7-10, Equation 11.4-4
Short-period transition period (T_s - sec) = *0.724* — $T_S = S_{D1}/S_{DS}$ — ASCE 7-10, Section 11.4.5
Long-period transition period (T_L - sec) = *8.000* — ASCE 7-10, Figure 22-12

Seismic Design Category

Importance Factor (I_e) = *1.000* — ASCE 7-10, Table 1.5-2
Risk Category = *II* — ASCE 7-10, Table 1.2-1
Based on Short Period (SDC_s) =*B* — ASCE 7-10, Table 11.6-1
Based on 1sec Period (SDC_1) = *B* — ASCE 7-10, Table 11.6-2
Seismic Design Category (SDC) = *B*

Seismic Coefficients

Structure Type = *Seismic Structure*
Seismic System Name =*Timber frames* — ASCE 7-10, Table 12.2-1
Detailing Requirements = *14.5*
(R) = *1.5*
(Ω_o) = *1.5*
(Cd) = *1.5*

Analysis Procedure Selection

Structural Analysis Procedure = *Equivalent Lateral Force Procedure* — ASCE 7-10, Table 12.6-1

Equivalent lateral Force Procedure

Fundamental period of the structure (T - sec) = *0.5* — From dynamic analysis
Seismic response coefficient (Cs 8-2) = *0.122* — $C_s = S_{DS}/(^R/_{I_e})$ — ASCE 7-10, Equation 12.8-2
Cs need not exceed for T≤T_L (Cs 8-3) = *0.177* — $C_s = S_{D1}/(T(\frac{R}{I_e}))$ — ASCE 7-10, Equation 12.8-3
Cs need not exceed for T>TL (Cs 8-4) = *2.833* — $C_s = S_{D1}/(T^2(\frac{R}{I_e}))$ — ASCE 7-10, Equation 12.8-4
Cs shall not be less than (Cs 8-5) = *0.010* — $C_s = 0.044 S_{DS} I_e \geq 0.01$ — ASCE 7-10, Equation 12.8-5
Where S1 ≥ 0.6g Cs shall not be less than (Cs 8-6) = *0.028* — $C_s = 0.5 S_1/(^R/_{I_e})$ — ASCE 7-10, Equation 12.8-6

Cs to use in the Calculation of base shear (Cs) = *0.122*
**Additional loads due to connection plates and fasteners have been accounted for by multiplying Cs by 1.2.*
Effective seismic weight (W - kip) = 5.994 — *ASCE 7-10, Section 12.7.2*
Seismic Base Shear (V - kip) = 0.733 — $V = C_s W$ — *ASCE 7-10, Equation 12.8-1*

Vertical Distribution

Structure period factor (k) = *1.000* ASCE 7-10, Section 12.8.3

Seismic Weight factor sum (Sum C_{vx}) = *59.945* $\sum_{i=1}^{n} w_i h_i^k$ ASCE 7-10, Equation 12.8-12

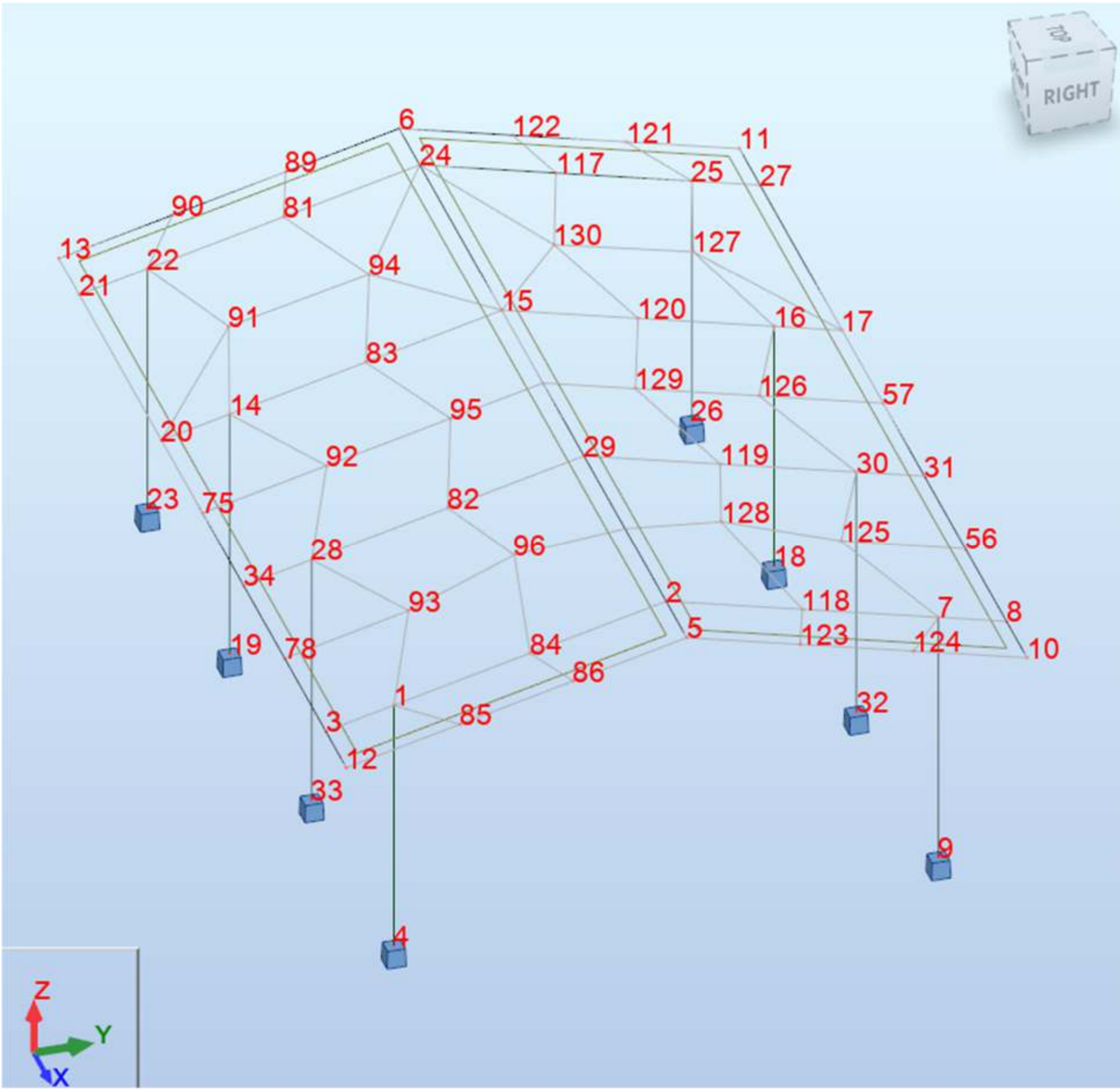
Level	h_x (ft)	W_x Ratio [(a)]	C_{vx} [(b)]	F_x (Kip)[(c)]
1	*10*	*1.00*	*1.00*	*0.73*

(a) Portion of the seismic weight that is assigned to the level.

(b) $C_{vx} = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k}$ - (ASCE 7-10, Equation 12.8-12)

(c) $F_x = C_{vx} V$ - (ASCE 7-10, Equation 12.8-11)

Structure Nodes

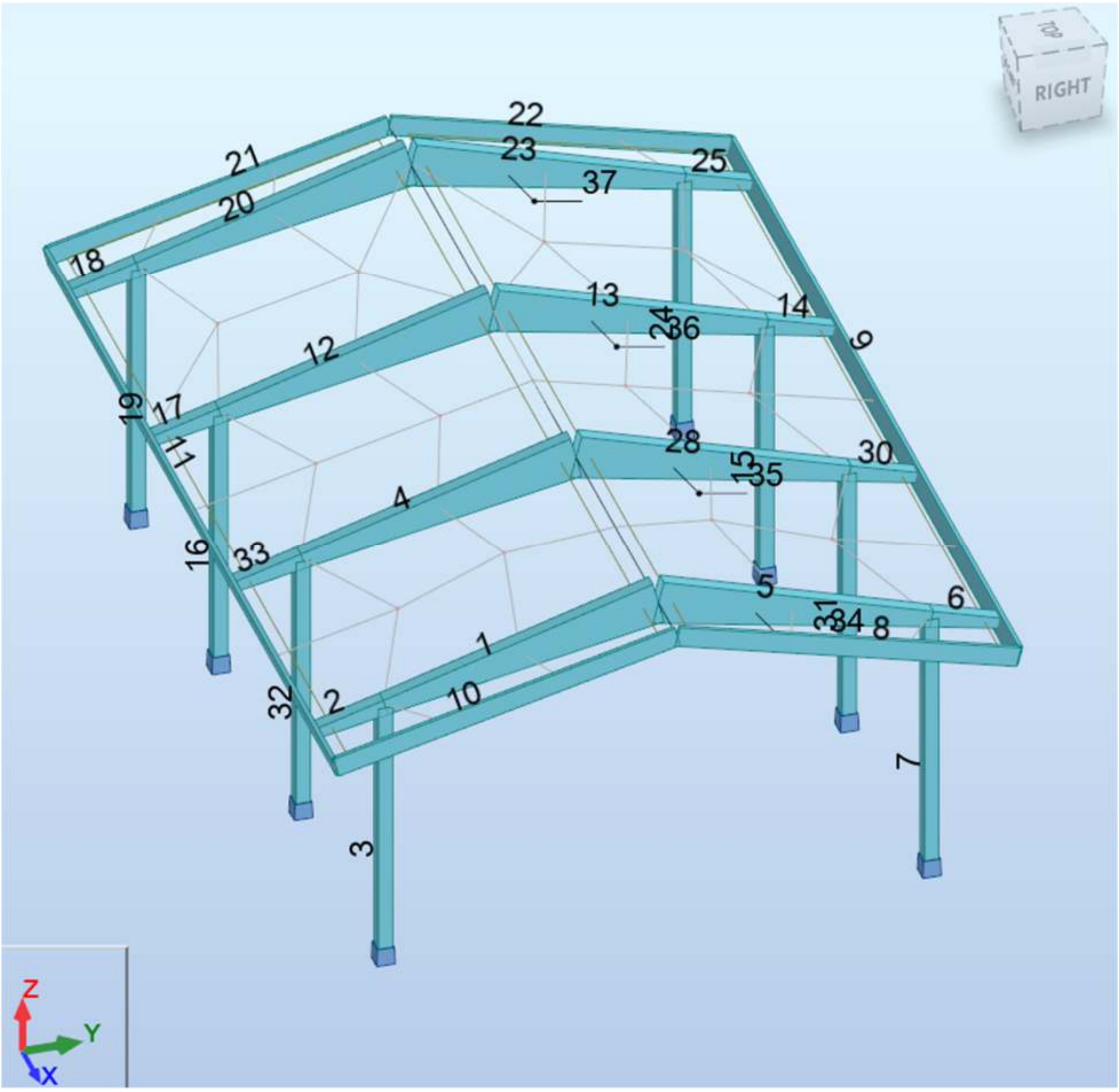


NODE	X (FT)	Y (FT)	Z (FT)	SUPPORT
1	*8.00*	*-96.00*	*0.00*	
2	*8.00*	*-88.00*	*2.00*	
3	*8.00*	*-98.00*	*-0.50*	
4	*8.00*	*-96.00*	*-8.00*	*Fixed*
5	*10.00*	*-88.00*	*2.00*	
6	*-18.00*	*-88.00*	*2.00*	
7	*8.00*	*-80.00*	*0.00*	
8	*8.00*	*-78.00*	*-0.50*	
9	*8.00*	*-80.00*	*-8.00*	*Fixed*

10	*10.00*	*-78.00*	*-0.50*	
11	*-18.00*	*-78.00*	*-0.50*	
12	*10.00*	*-98.00*	*-0.50*	
13	*-18.00*	*-98.00*	*-0.50*	
14	*-8.00*	*-96.00*	*0.00*	
15	*-8.00*	*-88.00*	*2.00*	
16	*-8.00*	*-80.00*	*0.00*	
17	*-8.00*	*-78.00*	*-0.50*	
18	*-8.00*	*-80.00*	*-8.00*	*Fixed*
19	*-8.00*	*-96.00*	*-8.00*	*Fixed*
20	*-8.00*	*-98.00*	*-0.50*	
21	*-16.00*	*-98.00*	*-0.50*	
22	*-16.00*	*-96.00*	*0.00*	
23	*-16.00*	*-96.00*	*-8.00*	*Fixed*
24	*-16.00*	*-88.00*	*2.00*	
25	*-16.00*	*-80.00*	*0.00*	
26	*-16.00*	*-80.00*	*-8.00*	*Fixed*
27	*-16.00*	*-78.00*	*-0.50*	
28	*0.00*	*-96.00*	*0.00*	
29	*0.00*	*-88.00*	*2.00*	
30	*0.00*	*-80.00*	*0.00*	
31	*0.00*	*-78.00*	*-0.50*	
32	*0.00*	*-80.00*	*-8.00*	*Fixed*
33	*0.00*	*-96.00*	*-8.00*	*Fixed*
34	*0.00*	*-98.00*	*-0.50*	
56	*4.00*	*-78.00*	*-0.50*	
57	*-4.00*	*-78.00*	*-0.50*	
75	*-4.00*	*-98.00*	*-0.50*	
78	*4.00*	*-98.00*	*-0.50*	
81	*-16.00*	*-92.00*	*1.00*	
82	*0.00*	*-92.00*	*1.00*	
83	*-8.00*	*-92.00*	*1.00*	
84	*8.00*	*-92.00*	*1.00*	
85	*10.00*	*-94.67*	*0.33*	
86	*10.00*	*-91.33*	*1.17*	
89	*-18.00*	*-91.33*	*1.17*	
90	*-18.00*	*-94.67*	*0.33*	
91	*-11.98*	*-94.82*	*0.29*	
92	*-4.00*	*-94.35*	*0.41*	
93	*3.98*	*-94.35*	*0.41*	
94	*-11.92*	*-90.72*	*1.32*	
95	*-4.00*	*-90.72*	*1.32*	
96	*3.28*	*-91.04*	*1.24*	
117	*-16.00*	*-84.00*	*1.00*	
118	*8.00*	*-84.00*	*1.00*	

119	*0.00*	*-84.00*	*1.00*
120	*-8.00*	*-84.00*	*1.00*
121	*-18.00*	*-81.33*	*0.33*
122	*-18.00*	*-84.67*	*1.17*
123	*10.00*	*-84.67*	*1.17*
124	*10.00*	*-81.33*	*0.33*
125	*3.98*	*-81.65*	*0.41*
126	*-4.00*	*-81.65*	*0.41*
127	*-11.98*	*-81.18*	*0.29*
128	*3.28*	*-84.96*	*1.24*
129	*-4.00*	*-85.28*	*1.32*
130	*-11.92*	*-85.28*	*1.32*

Structure Bars



BAR	NODE 1	NODE 2	LENGTH (FT)	SECTION	MATERIAL	GAMMA	TYPE
1	*1*	*2*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
2	*3*	*1*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
3	*4*	*1*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
4	*28*	*29*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*

5	*2*	*7*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
6	*7*	*8*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
7	*9*	*7*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
8	*10*	*5*	*10.31*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*0.00*	*Timber Member Fascia*
9	*11*	*10*	*28.00*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*-14.00*	*Timber Member Fascia*
10	*12*	*5*	*10.31*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*0.00*	*Timber Member Fascia*
11	*13*	*12*	*28.00*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*14.00*	*Timber Member Fascia*
12	*14*	*15*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
13	*15*	*16*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
14	*16*	*17*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
15	*18*	*16*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
16	*19*	*14*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
17	*20*	*14*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
18	*21*	*22*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
19	*23*	*22*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
20	*22*	*24*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
21	*6*	*13*	*10.31*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*0.00*	*Timber Member Fascia*
22	*6*	*11*	*10.31*	*LMBR 2x8 AC*	*ALASKA CEDAR No.1*	*0.00*	*Timber Member Fascia*
23	*24*	*25*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
24	*26*	*25*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
25	*25*	*27*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
28	*29*	*30*	*8.25*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
30	*30*	*31*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*
31	*32*	*30*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
32	*33*	*28*	*8.00*	*GSP 5x5.5 POC*	*GL VG SOFTWOOD 20F-V15 POC/POC*	*0.00*	*Timber Member Column*
33	*34*	*28*	*2.06*	*Rafter 4-6*	*GL VG SOFTWOOD 24F-V3 SP/SP*	*0.00*	*Timber Member*

34	*1*	*7*	*16.49*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
35	*28*	*30*	*16.49*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
36	*14*	*16*	*16.49*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*
37	*22*	*25*	*16.49*	*Rafter 6-16*	*GL VG SOFTWOOD 24F-1.8E*	*0.00*	*Timber Member Rafter*

Loads

CASE	CASE NAME	LOAD TYPE	LIST	LOAD VALUES
1	*DL1*	*self-weight*	*1to28 30to33*	*PZ Negative Factor=1.0000*
1	*DL1*	*(FE) uniform*	*26 27*	*PZ=-0.0030(kip/ft2)*
2	*SN1*	*(FE) uniform*	*26 27*	*PZ=-0.0200(kip/ft2) projected*
3	*SN2*	*(FE) uniform*	*26*	*PZ=-0.0200(kip/ft2) projected*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*1*	*PY=-0.0054(kip/ft) PZ=-0.0002(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*2*	*PY=-0.0010(kip/ft) PZ=0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*3*	*PY=0.0001(kip/ft) PZ=-0.0020(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*5*	*PY=-0.0043(kip/ft) PZ=-0.0007(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*6*	*PY=-0.0014(kip/ft) PZ=0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*7*	*PY=-0.0003(kip/ft) PZ=-0.0026(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*8*	*PY=0.0044(kip/ft) PZ=-0.0002(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*9*	*PY=0.0014(kip/ft) PZ=-0.0000(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*10*	*PY=-0.0037(kip/ft) PZ=-0.0003(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*11*	*PY=-0.0015(kip/ft) PZ=-0.0000(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*12*	*PY=-0.0053(kip/ft) PZ=-0.0008(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*13*	*PY=-0.0052(kip/ft) PZ=-0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*14*	*PY=-0.0009(kip/ft) PZ=0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*15*	*PY=-0.0009(kip/ft) PZ=-0.0008(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*16*	*PY=-0.0014(kip/ft) PZ=-0.0019(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*17*	*PY=-0.0012(kip/ft) PZ=-0.0000(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*18*	*PY=-0.0007(kip/ft) PZ=0.0013(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*19*	*PY=-0.0008(kip/ft) PZ=-0.0053(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*20*	*PY=-0.0014(kip/ft) PZ=0.0007(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*21*	*PY=0.0123(kip/ft) PZ=0.0010(kip/ft) local*

4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*22*	*PY=-0.0120(kip/ft) PZ=0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*23*	*PY=-0.0014(kip/ft) PZ=0.0005(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*24*	*PY=-0.0003(kip/ft) PZ=-0.0044(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*25*	*PY=-0.0003(kip/ft) PZ=0.0017(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*26*	*PZ=0.0003(kip/ft2) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*27*	*PZ=-0.0003(kip/ft2) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*4*	*PY=-0.0055(kip/ft) PZ=-0.0004(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*28*	*PY=-0.0052(kip/ft) PZ=-0.0006(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*30*	*PY=-0.0012(kip/ft) PZ=0.0002(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*31*	*PY=-0.0004(kip/ft) PZ=-0.0017(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*32*	*PY=-0.0001(kip/ft) PZ=-0.0020(kip/ft) local*
4	*Wind X+ 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*33*	*PY=-0.0011(kip/ft) PZ=0.0002(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*1*	*PY=0.0063(kip/ft) PZ=0.0095(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*2*	*PY=0.0011(kip/ft) PZ=0.0059(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*3*	*PY=-0.0084(kip/ft) PZ=0.0013(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*5*	*PY=0.0077(kip/ft) PZ=0.0010(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*6*	*PY=0.0052(kip/ft) PZ=-0.0001(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*7*	*PY=-0.0050(kip/ft) PZ=0.0064(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*8*	*PY=-0.0060(kip/ft) PZ=0.0003(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*9*	*PY=-0.0065(kip/ft) PZ=0.0000(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*10*	*PY=0.0041(kip/ft) PZ=0.0027(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*11*	*PY=-0.0042(kip/ft) PZ=0.0001(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*12*	*PY=0.0026(kip/ft) PZ=0.0056(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*13*	*PY=0.0026(kip/ft) PZ=0.0008(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*14*	*PY=0.0018(kip/ft) PZ=-0.0004(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*15*	*PY=-0.0059(kip/ft) PZ=0.0046(kip/ft) local*

5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*16*	*PY=-0.0033(kip/ft) PZ=0.0038(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*17*	*PY=0.0010(kip/ft) PZ=0.0019(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*18*	*PY=0.0023(kip/ft) PZ=0.0011(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*19*	*PY=-0.0037(kip/ft) PZ=0.0040(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*20*	*PY=0.0051(kip/ft) PZ=0.0034(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*21*	*PY=-0.0030(kip/ft) PZ=0.0002(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*22*	*PY=0.0052(kip/ft) PZ=0.0000(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*23*	*PY=0.0063(kip/ft) PZ=0.0003(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*24*	*PY=-0.0031(kip/ft) PZ=0.0048(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*25*	*PY=0.0049(kip/ft) PZ=-0.0011(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) linear on edges*	*26_EDGE(2)*	*PY=-0.0000(kip/ft) PZ=0.0177(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*26*	*PZ=0.0126(kip/ft2) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*27*	*PZ=0.0012(kip/ft2) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*4*	*PY=0.0029(kip/ft) PZ=0.0069(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*28*	*PY=0.0021(kip/ft) PZ=0.0018(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*30*	*PY=0.0013(kip/ft) PZ=0.0004(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*31*	*PY=-0.0071(kip/ft) PZ=0.0033(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*32*	*PY=-0.0081(kip/ft) PZ=0.0045(kip/ft) local*
5	*Wind X-Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*33*	*PY=0.0007(kip/ft) PZ=0.0020(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*1*	*PY=-0.0033(kip/ft) PZ=0.0063(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*2*	*PY=-0.0024(kip/ft) PZ=0.0029(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*3*	*PY=-0.0052(kip/ft) PZ=-0.0021(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*5*	*PY=-0.0018(kip/ft) PZ=0.0013(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*6*	*PY=-0.0021(kip/ft) PZ=-0.0010(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*7*	*PY=-0.0057(kip/ft) PZ=-0.0031(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*8*	*PY=0.0028(kip/ft) PZ=-0.0001(kip/ft) local*

6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*9*	*PY=-0.0070(kip/ft) PZ=0.0002(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*10*	*PY=-0.0020(kip/ft) PZ=0.0012(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*11*	*PY=-0.0036(kip/ft) PZ=0.0005(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*12*	*PY=0.0002(kip/ft) PZ=0.0079(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*13*	*PY=0.0004(kip/ft) PZ=0.0024(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*14*	*PY=-0.0002(kip/ft) PZ=0.0000(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*15*	*PY=-0.0075(kip/ft) PZ=0.0006(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*16*	*PY=-0.0040(kip/ft) PZ=0.0003(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*17*	*PY=0.0001(kip/ft) PZ=0.0032(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*18*	*PY=0.0022(kip/ft) PZ=0.0030(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*19*	*PY=-0.0053(kip/ft) PZ=0.0018(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*20*	*PY=0.0029(kip/ft) PZ=0.0067(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*21*	*PY=-0.0024(kip/ft) PZ=0.0013(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*22*	*PY=0.0030(kip/ft) PZ=-0.0001(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*23*	*PY=0.0028(kip/ft) PZ=0.0014(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*24*	*PY=-0.0058(kip/ft) PZ=0.0034(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*25*	*PY=0.0019(kip/ft) PZ=-0.0011(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*26*	*PZ=0.0175(kip/ft2) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) linear on edges*	*27_EDGE(3)*	*PY=0.0058(kip/ft) PZ=0.0231(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*27*	*PZ=0.0002(kip/ft2) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*4*	*PY=-0.0004(kip/ft) PZ=0.0078(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*28*	*PY=0.0003(kip/ft) PZ=0.0022(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*30*	*PY=0.0000(kip/ft) PZ=0.0002(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*31*	*PY=-0.0075(kip/ft) PZ=-0.0007(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*32*	*PY=-0.0041(kip/ft) PZ=-0.0005(kip/ft) local*
6	*Wind Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*33*	*PY=-0.0003(kip/ft) PZ=0.0030(kip/ft) local*

7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*1*	*PY=-0.0044(kip/ft) PZ=0.0028(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*2*	*PY=-0.0018(kip/ft) PZ=0.0015(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*3*	*PY=-0.0039(kip/ft) PZ=-0.0042(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*5*	*PY=-0.0059(kip/ft) PZ=0.0010(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*6*	*PY=-0.0047(kip/ft) PZ=-0.0013(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*7*	*PY=-0.0032(kip/ft) PZ=-0.0051(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*8*	*PY=0.0054(kip/ft) PZ=0.0002(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*9*	*PY=-0.0068(kip/ft) PZ=0.0001(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*10*	*PY=-0.0031(kip/ft) PZ=0.0001(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*11*	*PY=-0.0040(kip/ft) PZ=0.0000(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*12*	*PY=-0.0032(kip/ft) PZ=0.0065(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*13*	*PY=-0.0017(kip/ft) PZ=0.0016(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*14*	*PY=-0.0017(kip/ft) PZ=0.0007(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*15*	*PY=-0.0075(kip/ft) PZ=-0.0038(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*16*	*PY=-0.0086(kip/ft) PZ=-0.0052(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*17*	*PY=-0.0008(kip/ft) PZ=0.0018(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*18*	*PY=0.0001(kip/ft) PZ=0.0057(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*19*	*PY=-0.0077(kip/ft) PZ=-0.0007(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*20*	*PY=-0.0055(kip/ft) PZ=0.0096(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*21*	*PY=0.0043(kip/ft) PZ=0.0027(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*22*	*PY=-0.0061(kip/ft) PZ=0.0004(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*23*	*PY=-0.0071(kip/ft) PZ=0.0014(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*24*	*PY=-0.0054(kip/ft) PZ=-0.0068(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*25*	*PY=-0.0047(kip/ft) PZ=0.0008(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) linear on edges*	*26_EDGE(4)*	*PY=-0.0000(kip/ft) PZ=0.0180(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*26*	*PZ=0.0126(kip/ft2) local*

7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*(FE) uniform*	*27*	*PZ=0.0011(kip/ft2) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*4*	*PY=-0.0016(kip/ft) PZ=0.0049(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*28*	*PY=-0.0020(kip/ft) PZ=0.0012(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*30*	*PY=-0.0020(kip/ft) PZ=0.0004(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*31*	*PY=-0.0059(kip/ft) PZ=-0.0049(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*32*	*PY=-0.0034(kip/ft) PZ=-0.0038(kip/ft) local*
7	*Wind X+Y- 169 ft/s (f = 0.90-1.80) Simulation*	*uniform load*	*33*	*PY=-0.0006(kip/ft) PZ=0.0019(kip/ft) local*
8	*EX*	*(FE) uniform*	*26 27*	
9	*EY*	*(FE) uniform*	*26 27*	

Load Combinations

COMBINATION	NAME	ANALYSIS TYPE	COMBINATION NATURE (A)	CASE NATURE	DEFINITION
10 (C)	*LRFD1*	*Linear Combination*	*ULS*	*dead*	*1*1.4000*
11 (C)	*LRFD3.0*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+2*1.6000+4*0.5000*
12 (C)	*LRFD3.1*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+2*1.6000+5*0.5000*
13 (C)	*LRFD3.2*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+2*1.6000+6*0.5000*
14 (C)	*LRFD3.3*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+2*1.6000+7*0.5000*
15 (C)	*LRFD3.4*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+3*1.6000+4*0.5000*
16 (C)	*LRFD3.5*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+3*1.6000+5*0.5000*
17 (C)	*LRFD3.6*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+3*1.6000+6*0.5000*
18 (C)	*LRFD3.7*	*Linear Combination*	*ULS*	*snow*	*1*1.2000+3*1.6000+7*0.5000*
19 (C)	*LRFD4.0*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+4*1.0000+2*0.5000*
20 (C)	*LRFD4.1*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+5*1.0000+2*0.5000*
21 (C)	*LRFD4.2*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+6*1.0000+2*0.5000*
22 (C)	*LRFD4.3*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+7*1.0000+2*0.5000*
23 (C)	*LRFD4.4*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+4*1.0000+3*0.5000*
24 (C)	*LRFD4.5*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+5*1.0000+3*0.5000*
25 (C)	*LRFD4.6*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+6*1.0000+3*0.5000*
26 (C)	*LRFD4.7*	*Linear Combination*	*ULS*	*wind*	*1*1.2000+7*1.0000+3*0.5000*
27 (C)	*LRFD5.0*	*Linear Combination*	*ULS*	*seismic*	*1*1.2400+8*1.0000+2*0.2000*
28 (C)	*LRFD5.1*	*Linear Combination*	*ULS*	*seismic*	*1*1.2400+8*-1.0000+2*0.2000*
29 (C)	*LRFD5.2*	*Linear Combination*	*ULS*	*seismic*	*1*1.2400+9*1.0000+3*0.2000*
30 (C)	*LRFD5.3*	*Linear Combination*	*ULS*	*seismic*	*1*1.2400+9*-1.0000+3*0.2000*
31 (C)	*LRFD6.0*	*Linear Combination*	*ULS*	*wind*	*1*0.9000+4*1.0000*
32 (C)	*LRFD6.1*	*Linear Combination*	*ULS*	*wind*	*1*0.9000+5*1.0000*

33 (C)	*LRFD6.2*	*Linear Combination*	*ULS*	*wind*	*1*0.9000+6*1.0000*
34 (C)	*LRFD6.3*	*Linear Combination*	*ULS*	*wind*	*1*0.9000+7*1.0000*
35 (C)	*LRFD7.0*	*Linear Combination*	*ULS*	*seismic*	*1*0.8600+8*1.0000*
36 (C)	*LRFD7.1*	*Linear Combination*	*ULS*	*seismic*	*1*0.8600+8*-1.0000*
37 (C)	*LRFD7.2*	*Linear Combination*	*ULS*	*seismic*	*1*0.8600+9*1.0000*
38 (C)	*LRFD7.3*	*Linear Combination*	*ULS*	*seismic*	*1*0.8600+9*-1.0000*
39 (C)	*ASD1.0*	*Linear Combination*	*SLS*	*dead*	*1*1.0000*
40 (C)	*ASD3.0*	*Linear Combination*	*SLS*	*snow*	*(1+2)*1.0000*
41 (C)	*ASD3.1*	*Linear Combination*	*SLS*	*snow*	*(1+3)*1.0000*
42 (C)	*ASD5.0*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+4*0.6000*
43 (C)	*ASD5.1*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+5*0.6000*
44 (C)	*ASD5.2*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+6*0.6000*
45 (C)	*ASD5.3*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+7*0.6000*
46 (C)	*ASD6.0*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+4*0.4500+2*0.7500*
47 (C)	*ASD6.1*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+5*0.4500+2*0.7500*
48 (C)	*ASD6.2*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+6*0.4500+2*0.7500*
49 (C)	*ASD6.3*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+7*0.4500+2*0.7500*
50 (C)	*ASD6.4*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+4*0.4500+3*0.7500*
51 (C)	*ASD6.5*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+5*0.4500+3*0.7500*
52 (C)	*ASD6.6*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+6*0.4500+3*0.7500*
53 (C)	*ASD6.7*	*Linear Combination*	*SLS*	*wind*	*1*1.0000+7*0.4500+3*0.7500*
54 (C)	*ASD6.8*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+8*0.5250+2*0.7500*
55 (C)	*ASD6.9*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+8*-0.5250+2*0.7500*
56 (C)	*ASD6.10*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+9*0.5250+2*0.7500*
57 (C)	*ASD6.11*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+9*-0.5250+2*0.7500*
58 (C)	*ASD6.12*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+8*0.5250+3*0.7500*

59 (C)	*ASD6.13*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+8*-0.5250+3*0.7500*
60 (C)	*ASD6.14*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+9*0.5250+3*0.7500*
61 (C)	*ASD6.15*	*Linear Combination*	*SLS*	*seismic*	*1*1.0300+9*-0.5250+3*0.7500*
62 (C)	*ASD7.0*	*Linear Combination*	*SLS*	*wind*	*(1+4)*0.6000*
63 (C)	*ASD7.1*	*Linear Combination*	*SLS*	*wind*	*(1+5)*0.6000*
64 (C)	*ASD7.2*	*Linear Combination*	*SLS*	*wind*	*(1+6)*0.6000*
65 (C)	*ASD7.3*	*Linear Combination*	*SLS*	*wind*	*(1+7)*0.6000*
66 (C)	*ASD8.0*	*Linear Combination*	*SLS*	*seismic*	*1*0.5700+8*0.7000*
67 (C)	*ASD8.1*	*Linear Combination*	*SLS*	*seismic*	*1*0.5700+8*-0.7000*
68 (C)	*ASD8.2*	*Linear Combination*	*SLS*	*seismic*	*1*0.5700+9*0.7000*
69 (C)	*ASD8.3*	*Linear Combination*	*SLS*	*seismic*	*1*0.5700+9*-0.7000*

(a) SLS = Service Limit State, ULS = Ultimate Limit State

Member Design

ANSI/AWC NDS-2012 LRFD - Code Group Verification (ULS) 1to3 5

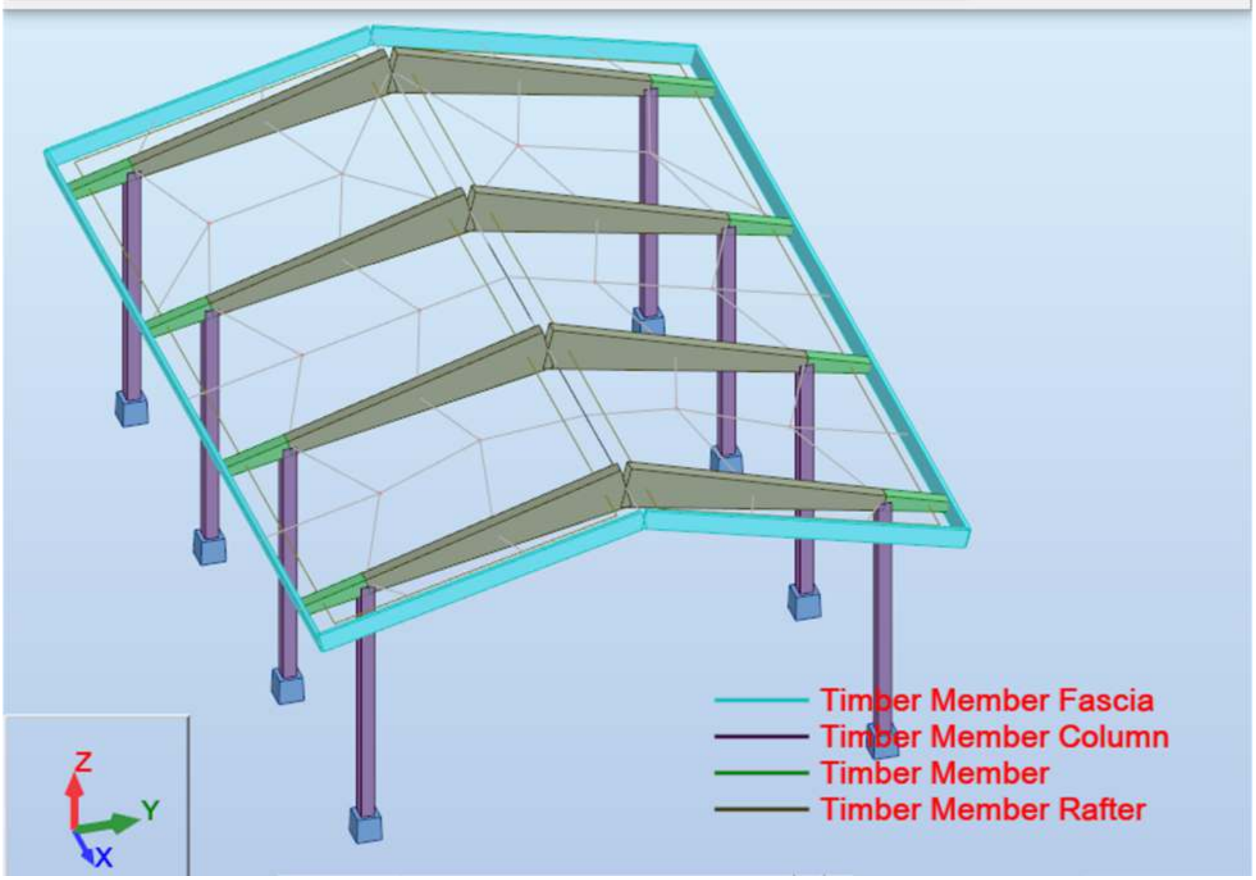
Results | Messages

Member	Section	Material	Lay	Laz	Ratio	Case
Code group : 1 TAILS						
30	OK Rafter 4-6	GL VG SOFTWOOD 24F-V3 SP/SP	5.0487	4.9477	0.1028	11 LRFD3.0
Code group : 2 FASCIA						
8	OK LMBR 2x8 AC	ALASKA CEDAR No.1 2+	17.0611	82.4621	0.1604	12 LRFD3.1
Code group : 3 RAFTERS						
35 35	OK Rafter 6-16	GL VG SOFTWOOD 24F-V3 SP/SP	19.6680	39.5818	0.3076	11 LRFD3.0
Code group : 5 COLUMNS						
32	OK GSP 5x5.5 POC	GL VG SOFTWOOD 20F-V15 POC/POC	34.9091	38.4000	0.3450	20 LRFD4.1

Calc. Note | Close | Help

Ratio: Analysis | Map

Calculation points
Division: n = 3
Extremes: Fx,Fy,Fz,My,Mz
Additional: none



TIMBER STRUCTURE CALCULATIONS

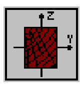
CODE: *ANSI/AWC NDS-2012 LRFD*
ANALYSIS TYPE: Code Group Verification

CODE GROUP: 1 TAILS
MEMBER: 30 **POINT:** 3 **COORDINATE:** x = 1.00 L = 2.0616 ft

LOADS:
Governing Load Case: 11 LRFD3.0 1*1.2000+2*1.6000+4*0.5000

MATERIAL: GL VG SOFTWOOD 24F-V3 SP/SP
Structural Glued Laminated Softwood Timber - Tab.5A
Ft=1.1500 ksi Fc=1.6500 ksi

Fby=2.0000 ksi Fvy=0.3000 ksi Fcpy=0.7400 ksi Ey=1800.0006 ksi
Eminy=950.0003 ksi
Fbz=2.4000 ksi Fvz=0.3000 ksi Fcpz=0.7400 ksi Ez=1800.0006 ksi
Eminz=950.0003 ksi



SECTION PARAMETERS: Rafter 4-6
d=4.00 in
b=5.00 in Ay=13.333 in2 Az=13.333 in2 A=20.000 in2
drep=4.90 in Iy=26.667 in4 Iz=41.667 in4 Ix=54.956 in4
brep=5.00 in Sy=13.333 in3 Sz=16.667 in3

MEMBER PARAMETERS:
BUCKLING Y **BUCKLING Z** **LT BUCKLING**

INTERNAL FORCES AND ACTUAL STRESSES:
N = -0.0445 kip My = -0.0124 kip*in Vy = 0.5117 kip Vz = 0.0049 kip
ft = -0.0022 ksi fby = -0.0009 ksi fvy = 0.0384 ksi fvz = 0.0004 ksi

DESIGN WOOD STRENGHTS:
Ft' = Ft(1.1500)*CM(1.0000)*Ct(1.0000)*KF(2.7000)*Fi(0.8000)*Lam(0.8000) = 1.9872 ksi
Fby' = Fby(2.0000)*CM(1.0000)*Ct(1.0000)*CV(1.0000)*CI(4.6451)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 16.0461 ksi
Fvy' = Fvy(0.3000)*CM(1.0000)*Ct(1.0000)*Cvr(0.7200)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.3732 ksi
Fvz' = Fvz(0.3000)*CM(1.0000)*Ct(1.0000)*Cvr(0.7200)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.3732 ksi
Fby* = Fby(2.0000)*CM(1.0000)*Ct(1.0000)*CV(1.0000)*CI(4.6451)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 16.0461 ksi
Fby** = Fby(2.0000)*CM(1.0000)*Ct(1.0000)*CI(4.6451)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 16.0461 ksi

RESULTS:
ft/Ft' + fby/Fby* = 0.0012 < 1.0000 [3.9-1] OK!
(fby-ft)/Fby** = -0.0001 < 1.0000 [3.9-2] OK!
fvy/Fvy' = 0.1028 < 1.0000 [3.4.1] OK!, fvz/Fvz' = 0.0010 < 1.0000 [3.4.1] OK!

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *ANSI/AWC NDS-2012 LRFD*
ANALYSIS TYPE: Code Group Verification

CODE GROUP: 2 FASCIA
MEMBER: 8 **POINT:** 1 **COORDINATE:** x = 0.67 L = 6.8718 ft

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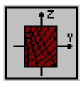
LOADS:
Governing Load Case: 12 LRFD3.1 1*1.2000+2*1.6000+5*0.5000

MATERIAL: ALASKA CEDAR No.1 2+
Visually Graded Dimension Lumber - Tab.4A

Fb=0.9750 ksi	Ft=0.5250 ksi	Fv=0.1650 ksi	Fcp=0.5250 ksi
Fc=0.9000 ksi	E=1300.0004 ksi	Emin=470.0001 ksi	



SECTION PARAMETERS: LMBR 2x8 AC

d=7.25 in			
b=1.50 in	Ay=7.253 in2	Az=7.253 in2	A=10.880 in2
	Iy=47.630 in4	Iz=2.039 in4	Ix=7.093 in4
	Sy=13.139 in3	Sz=2.719 in3	

MEMBER PARAMETERS:

BUCKLING Y	**BUCKLING Z**	**LT BUCKLING**
FcEy = INF ksi	FcEz = INF ksi	FbE = INF ksi

INTERNAL FORCES AND ACTUAL STRESSES:

N = 0.1701 kip	My = 3.9087 kip*in	Mz = 0.0825 kip*in	Vy = -0.0670 kip	Vz = 0.0078 kip
fc = 0.0156 ksi	fby = 0.2975 ksi	fbz = 0.0304 ksi	fvy = -0.0092 ksi	fvz = 0.0011 ksi
Mx = -0.0211 kip*in				fvty = 0.0045 ksi
	fvtz = 0.0033 ksi			

DESIGN WOOD STRENGHTS:
Fc' = Fc(0.9000)*CM(1.0000)*Ct(1.0000)*CF(1.0500)*KF(2.4000)*Fi(0.9000)*Lam(0.8000) = 1.6330 ksi
Fb' = Fb(0.9750)*CM(1.0000)*Ct(1.0000)*CF(1.2000)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 2.0208 ksi
Fv' = Fv(0.1650)*CM(1.0000)*Ct(1.0000)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.2851 ksi

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RESULTS:
(fc/Fc')^2 + fby/(Fb'*(1-fc/FcEy) + fbz/(Fb'*(1-fc/FcEz-(fby/FbE)^2) = 0.1604 < 1.0000 [3.9-3] OK!
(fvy + 3/2*fvty)/Fv' = 0.0558 < 1.0000 [3.4.1] OK!, (fvz + 3/2*fvtz)/Fv' = 0.0211 < 1.0000 [3.4.1] OK!

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *ANSI/AWC NDS-2012 LRFD*
ANALYSIS TYPE: Code Group Verification

CODE GROUP: 3 RAFTERS
MEMBER: 35 35 **POINT:** 3 **COORDINATE:** x = 0.75 L = 12.3693 ft

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LOADS:
Governing Load Case: 11 LRFD3.0 1*1.2000+2*1.6000+4*0.5000

MATERIAL: GL VG SOFTWOOD 24F-V3 SP/SP
Structural Glued Laminated Softwood Timber - Tab.5A
Ft=1.1500 ksi Fc=1.6500 ksi

Fby=2.4000 ksi Fvy=0.3000 ksi Fcpy=0.7400 ksi Ey=1800.0006 ksi
Eminy=950.0003 ksi
Fbz=1.4500 ksi Fvz=0.2300 ksi Fcpz=0.5600 ksi Ez=1600.0005 ksi
Eminz=850.0003 ksi

SECTION PARAMETERS: Rafter 6-16
d=11.00 in
b=5.00 in Ay=36.667 in2 Az=36.667 in2 A=55.000 in2
drep=10.06 in Iy=554.583 in4 Iz=114.583 in4 Ix=327.295 in4
brep=5.00 in Sy=100.833 in3 Sz=45.833 in3

MEMBER PARAMETERS:

BUCKLING Y **BUCKLING Z** **LT BUCKLING**
Key = 1.0000
ley = 16.4924 ft
ley/d = 19.6680
CPy = 0.7809
FcEy = 3.0200 ksi FcEz = INF ksi FbE = INF ksi

INTERNAL FORCES AND ACTUAL STRESSES:
N = 0.6991 kip My = 92.6863 kip*in Mz = -1.3985 kip*in Vy = -0.5317 kip Vz = 0.0764 kip
fc = 0.0127 ksi fby = 0.9192 ksi fbz = -0.0305 ksi fvy = -0.0145 ksi fvz = 0.0021 ksi
Mx = -4.6099 kip*in fvty = 0.0669 ksi
fvtz = 0.0526 ksi
fr = 0.0103 ksi

DESIGN WOOD STRENGHTS:
Fc' = Fc(1.6500)*CM(1.0000)*Ct(1.0000)*CP(0.7809)*KF(2.4000)*Fi(0.9000)*Lam(0.8000) = 2.2265 ksi
Fby' =
Fby(2.4000)*CM(1.0000)*Ct(1.0000)*CV(1.0000)*Cc(0.9344)*CI(3.5265)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 13.6586 ksi
Fbz' = Fbz(1.4500)*CM(1.0000)*Ct(1.0000)*Cfu(1.1022)*CI(3.5265)*KF(2.5400)*Fi(0.8500)*Lam(0.8000) = 2.7603 ksi
Fvy' = Fvy(0.3000)*CM(1.0000)*Ct(1.0000)*Cvr(0.7200)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.3732 ksi
Fvz' = Fvz(0.2300)*CM(1.0000)*Ct(1.0000)*Cvr(0.7200)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.2862 ksi
Eminy' = Eminy(950.0003)*CM(1.0000)*Ct(1.0000)*KF(1.7600)*Fi(0.8500) = 1421.2004 ksi
Eminz' = Eminz(850.0003)*CM(1.0000)*Ct(1.0000)*KF(1.7600)*Fi(0.8500) = 1271.6004 ksi

Frt' = (1/3)*Fvy(0.3000)*Cvr(0.7200)*CM(1.0000)*Ct(1.0000)*KF(2.8800)*Fi(0.7500)*Lam(0.8000) = 0.1244 ksi

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RESULTS:

(fc/Fc')^2 + fby/(Fby'*(1-fc/FcEy) + fbz/(Fbz'*(1-fc/FcEz-(fby/FbE)^2) = 0.0787 < 1.0000 [3.9-3]   OK!
(fvy + 3/2*fvty)/Fvy' = 0.3076 < 1.0000 [3.4.1]   OK!,   (fvz + 3/2*fvtz)/Fvz' = 0.2832 < 1.0000 [3.4.1]   OK!
fr/Frt' = 0.0828 < 1.0000 [5.4.1]   OK!
ley/d = 19.6680 < 50.0000 STABLE,

Section OK !!!

TIMBER STRUCTURE CALCULATIONS

CODE: *ANSI/AWC NDS-2012 LRFD*
ANALYSIS TYPE: Code Group Verification

CODE GROUP: 5 COLUMNS
MEMBER: 32 **POINT:** **COORDINATE:** x = 0.00 L = 0.0000 ft

LOADS:
Governing Load Case: 20 LRFD4.1 1*1.2000+5*1.0000+2*0.5000

MATERIAL: GL VG SOFTWOOD 20F-V15 POC/POC
Structural Glued Laminated Softwood Timber - Tab.5A
Ft=0.9000 ksi Fc=1.6000 ksi

Fby=2.0000 ksi Fvy=0.2650 ksi Fcpy=0.5600 ksi Ey=1500.0000 ksi
Eminy=790.0000 ksi
Fbz=1.3000 ksi Fvz=0.2300 ksi Fcpz=0.4700 ksi Ez=1400.0000 ksi
Eminz=740.0000 ksi

SECTION PARAMETERS: GSP 5x5.5 POC
d=5.50 in

b=5.00 in	Ay=18.333 in2	Az=18.333 in2	A=27.500 in2
	Iy=69.323 in4	Iz=57.292 in4	Ix=105.868 in4
	Sy=25.208 in3	Sz=22.917 in3	

MEMBER PARAMETERS:

BUCKLING Y	**BUCKLING Z**	**LT BUCKLING**
Key = 2.0000	Kez = 2.0000	
ley = 16.0000 ft	lez = 16.0000 ft	
ley/d = 34.9091	lez/b = 38.4000	
CPy = 0.2242	CPz = 0.1749	
FcEy = 0.7972 ksi	FcEz = 0.6171 ksi	FbE = INF ksi

INTERNAL FORCES AND ACTUAL STRESSES:

N = 0.9404 kip	My = 8.2853 kip*in	Mz = 17.5616 kip*in	Vy = -0.1044 kip	Vz = 0.2154 kip
fc = 0.0342 ksi	fby = 0.3287 ksi	fbz = 0.7663 ksi	fvy = -0.0057 ksi	fvz = 0.0117 ksi

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DESIGN WOOD STRENGHTS:
Fc' = Fc(1.6000)*CM(1.0000)*Ct(1.0000)*CP(0.1749)*KF(2.4000)*Fi(0.9000)*Lam(1.0000) = 0.6043 ksi
Fby' = Fby(2.0000)*CM(1.0000)*Ct(1.0000)*CV(1.0000)*KF(2.5400)*Fi(0.8500)*Lam(1.0000) = 4.3180 ksi
Fbz' = Fbz(1.3000)*CM(1.0000)*Ct(1.0000)*Cfu(1.1022)*KF(2.5400)*Fi(0.8500)*Lam(1.0000) = 3.0934 ksi
Fvy' = Fvy(0.2650)*CM(1.0000)*Ct(1.0000)*Cvr(1.0000)*KF(2.8800)*Fi(0.7500)*Lam(1.0000) = 0.5724 ksi
Fvz' = Fvz(0.2300)*CM(1.0000)*Ct(1.0000)*Cvr(1.0000)*KF(2.8800)*Fi(0.7500)*Lam(1.0000) = 0.4968 ksi
Eminy' = Eminy(790.0000)*CM(1.0000)*Ct(1.0000)*KF(1.7600)*Fi(0.8500) = 1181.8400 ksi
Eminz' = Eminz(740.0000)*CM(1.0000)*Ct(1.0000)*KF(1.7600)*Fi(0.8500) = 1107.0400 ksi

---

RESULTS:
(fc/Fc')^2 + fby/(Fby'*(1-fc/FcEy) + fbz/(Fbz'*(1-fc/FcEz-(fby/FbE)^2) = 0.3450 < 1.0000 [3.9-3] OK!
fc/FcEz + (fby/FbE)^2 = 0.0554 < 1.0000 [3.9-4] OK!, fc/FcEy = 0.0429 < 1.0000 [3.9.2] OK!,
fvy/Fvy' = 0.0100 < 1.0000 [3.4.1] OK!, fvz/Fvz' = 0.0236 < 1.0000 [3.4.1] OK!

ley/d = 34.9091 < 50.0000 STABLE,   lez/b = 38.4000 < 50.0000 STABLE,

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Section OK !!!

Foundation Design

Cantilever Column Foundation Design

Reaction Forces Local to Column (ASD)

$D := \text{READEXCEL}\left(\text{“.\textbackslash 4208-Forces.xlsx”}, \text{“Sheet1!A2:I14”}\right)$

“Bar”	“Point”	“Case”	“Fx (Kip)”	“Fy (Kip)”	“Fz (Kip)”	“Mx (Kip-in)”	“My (Kip-in)”	“Mz (Kip-in)”
31	1	11	2.445	−0.012	0.031	0.001	−2.787	−1.168
32	1	33	−0.398	0.14	0.001	0.001	0.015	12.422
15	1	33	0.215	0.154	−0.003	0.001	0.179	12.838
31	1	11	2.445	−0.012	0.031	0.001	−2.787	−1.168
19	1	19	0.932	0.014	0.076	0.001	−5.926	1.175
7	1	20	0.731	0.127	−0.07	0.001	5.059	10.933
3	1	10	0.629	0.004	0.001	0.001	−0.001	0.376
3	1	10	0.629	0.004	0.001	0.001	−0.001	0.376
32	1	32	−0.093	0.139	−0.07	0.001	5.524	11.294
19	1	31	0.389	0.011	0.076	0.001	−5.928	0.837
19	1	21	0.308	0.149	−0.006	0.001	0.166	12.927
31	1	11	2.445	−0.012	0.031	0.001	−2.787	−1.168

$F_x := \text{submatrix}(D, 1, 12, 3, 3) \cdot \mathbf{kip}$ $M_x := \text{submatrix}(D, 1, 12, 6, 6) \cdot \mathbf{kip} \cdot \mathbf{in}$

$F_y := \text{submatrix}(D, 1, 12, 4, 4) \cdot \mathbf{kip}$ $M_y := \text{submatrix}(D, 1, 12, 7, 7) \cdot \mathbf{kip} \cdot \mathbf{in}$

$F_z := \text{submatrix}(D, 1, 12, 5, 5) \cdot \mathbf{kip}$ $M_z := \text{submatrix}(D, 1, 12, 8, 8) \cdot \mathbf{kip} \cdot \mathbf{in}$

Loads are given in coordinates local to member. X is axial, Y is horizontal axis and Z is vertical axis. Tension is given as a negative value.

Pier Properties

$B := 2.0\ \mathbf{ft}$	Diameter of the pier footing
$\gamma_c := 150\ \mathbf{pcf}$	Unit weight of concrete
$c_f := 0.25$	Coefficient of friction at base of footing
$q_l := 200\ \dfrac{\mathbf{psf}}{\mathbf{ft}}$	Allowable Lateral Bearing Pressure at depth below natural grade with increase per 1806.3.4
$q_v := 1500\ \mathbf{psf}$	Allowable net vertical bearing pressure
$G := 120\ \mathbf{pcf}$	Unit weight of soil
$K := 0.5$	Coefficient of lateral earth pressure
$P_r := B \cdot \pi = 6.283\ \mathbf{ft}$	Perimeter of the footing
$A_b := \pi \cdot B^2 \cdot 0.25 = 3.142\ \mathbf{ft}^2$	Bearing area at base of footing
$\phi_f := 30\ \mathbf{deg}$	Friction angle
$d_{frost} := 48\ \mathbf{in}$	Minimum depth
$\rho_{min} := 0.005$	Minimum reinforcement ratio
$d_{bar} := 0.75\ \mathbf{in}$	Diameter of vertical bars
$d_{agg} := 0.75\ \mathbf{in}$	Max aggregate diameter
$d_{tie} := 0.5\ \mathbf{in}$	Diameter of the tie

Lateral Force Resistance

$UnconstrainedDepthCheck := CapacityCheck\left(D_u, D_{requ}\right) = \text{“OK”}$ $D_u = 48\ \mathbf{in}$

$ConstrainedDepthCheck := CapacityCheck\left(D_c, D_{reqc}\right) = \text{“OK”}$ $D_c = 48\ \mathbf{in}$

Uplift Resistance

$UnconstrainedUpliftCheck := CapacityCheck\left(UL_{nUncon}, UL_{max}\right) = \text{“OK”}$
$ConstrainedUpliftCheck := CapacityCheck\left(UL_{nCon}, UL_{max}\right) = \text{“OK”}$

Soil Bearing Resistance

$UnconstrainedBearingCheck := CapacityCheck\left(q_v, Q_{netUncon}\right) = \text{“OK”}$
$ConstrainedBearingCheck := CapacityCheck\left(q_v, Q_{netCon}\right) = \text{“OK”}$

Rebar

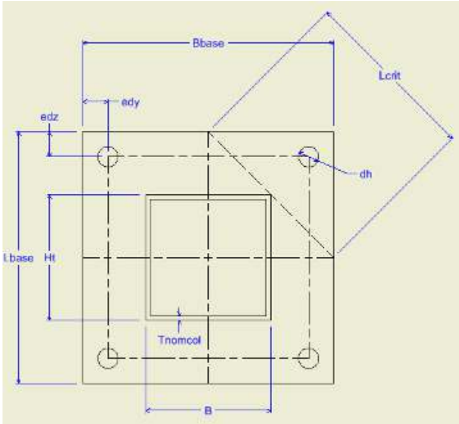
Summary

$B = 24\ in$	Footing Diameter
$D_u = 48\ in$	Unconstrained Depth
$D_c = 48\ in$	Constrained Depth
$d_{bar} = 0.75\ in$	Diameter of the vertical bars
$n_{bar} = 6$	Vertical bar count
$d_{tie} = 0.5\ in$	Tie Diameter
$s_{max} = 12\ in$	Tie Spacing max

Base Plate Design

Unstiffened Base Plate Calculations

Connection Properties



$Ht := 6\ in$ Height of the Column

$B := 5\ in$ Width of the Column

$Tnom_{col} := 0.25\ in$ Nominal Thickness of the Column

$d_b := 0.625\ in$ Diameter of the anchor bolt

$d_h := d_b + 0.25\ in$ Diameter of the bolt hole

$ed_y := d_b \cdot 2 + 0.25\ in = 1.5\ in$ Hole edge distance in the x direction

$ed_z := ed_y$ Hole edge distance in the y direction

$B_{base} := 10\ in$ Width of the base plate

$L_{base} := 13\ in$ Length of the base plate

$t_{base} := 0.5\ in$ Thickness of the base plate

$d_{ped} := 24\ in$ Diameter of the pedestal

$h_{ped} := 48\ in$ Depth of the pedestal

$T_{Areinforced} := 0$ Anchor tension reinforcement present

$d_{tr} := 0.75\ in$ Diameter of tension rebar

$V_{Areinforced} := 0$ Anchor shear reinforcement present

$d_{vr} := 0.5\ in$ Diameter of shear rebar

$F_{ybp} := 36\ ksi$ Yield stress of the plate material

$F_{ubp} := 58\ ksi$ Ultimate stress of the plate material

$F_{ucol} := 62\ ksi$ Ultimate stress of the column pipe material

$F_{ycol} := 50\ ksi$ Yield stress of the column pipe material

$s_w := Tnom_{col} = 0.25\ in$ Leg size of the fillet weld

$F_{EXX} := 70\ ksi$ Strength classification of the filler metal

$n_{blt} := 4$ Number of bolts in the pattern

$h_{ef1} := 12\ in$ Effective embedment depth

$s_{yblt} := B_{base} - 2 \cdot ed_y = 7\ in$ Spacing in the y direction

$s_{zblt} := L_{base} - 2 \cdot ed_z = 10\ in$ Spacing in the z direction

$f_{ya} := 36\ ksi$ yield stress of the bolts

$f_{uab} := min\left(58\ ksi, 1.9 \cdot f_{ya}\right) = 58\ ksi$ ultimate tensile strength of the anchor steel

$f'_c := 3\ ksi$ Compressive strength of the concrete

$\lambda := 1$ Lightweight concrete modification factor

$\gamma_c := 150\ pcf$ Unit weight of concrete

$f_y := 60\ ksi$ Yield stress of the rebar

Loads

$D := \text{READEXCEL}\left(\text{".\textbackslash 4208-Forces.xlsx"}, \text{"Sheet1!A17:I29"}\right)$

$D =$

"Bar"	"Point"	"Case"	"Fx (Kip)"	"Fy (Kip)"	"Fz (Kip)"	"Mx (Kip-in)"	"My (Kip-in)"	"Mz (Kip-in)"
31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752
32	1	33	−0.598	0.21	0.002	0.001	0.023	18.633
15	1	33	0.323	0.231	−0.005	0.001	0.269	19.257
31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752
19	1	19	1.399	0.022	0.114	0.001	−8.889	1.762
7	1	20	1.097	0.191	−0.105	0.001	7.588	16.399
3	1	10	0.943	0.006	0.001	0.001	−0.001	0.564
3	1	10	0.943	0.006	0.001	0.001	−0.001	0.564
32	1	32	−0.139	0.209	−0.104	0.001	8.286	16.94
19	1	31	0.584	0.016	0.114	0.001	−8.892	1.255
19	1	21	0.461	0.223	−0.01	0.001	0.248	19.391
31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752

Loads are given in coordinates local to column. X is axial, Y is horizontal axis and Z is vertical axis. Tension is given as a negative value.

Bending in the Base Plate

Out

$$BendCheck := \begin{array}{l} \text{if } \phi_b \cdot M_n > \max\left(M_u\right) \\ \quad \text{"OK"} \\ \text{else} \\ \quad \text{"NG"} \end{array} = \text{"OK"}$$

$\phi_b \cdot M_n = 18.479\ \textbf{kip} \cdot \textbf{in}$

$\max\left(M_u\right) = 4.402\ \textbf{kip} \cdot \textbf{in}$

$t_{base} = 0.5\ \textbf{in}$

Weld Calculations (Elastic Method)

Out

$$WeldToBaseCheck := \begin{array}{l} \text{if } \phi_w \cdot R_{nb} > \max\left(V_{uw}\right) \\ \quad \text{"OK"} \\ \text{else} \\ \quad \text{"NG"} \end{array} = \text{"OK"}$$

$\phi_w \cdot R_{nb} = 5.568\ \dfrac{\textbf{kip}}{\textbf{in}}$

$\max\left(V_{uw}\right) = 0.646\ \dfrac{\textbf{kip}}{\textbf{in}}$

$s_w = 0.25\ \textbf{in}$

$$t_{minr} := \frac{F_{EXX} \cdot \sin\left(45\ \textbf{deg}\right) \cdot s_w}{F_{ucol}} = 0.2\ \textbf{in}$$

Minimum thickness of pipe required to develop the shear rupture strength of the base metal

Out

$$ColThickCheck := \begin{array}{l} \text{if } \left(Tnom_{col} \cdot 0.93\right) > t_{minr} \\ \quad \text{"OK"} \\ \text{else} \\ \quad \text{"NG"} \end{array} = \text{"OK"}$$

$Tnom_{col} \cdot 0.93 = 0.233\ \textbf{in}$

$t_{minr} = 0.2\ \textbf{in}$

Anchor Bolt Calculations

Steel strength of anchor in tension

Concrete breakout strength of anchor in tension

Pullout strength of anchor in tension

Concrete side-face blowout strength in tension

Shear strength of steel

Concrete breakout strength

Concrete pry out strength

Combined Tension and Shear

Max tension strength ratio for each load case

Max shear strength ratio for each load case

$$N_{sr} = \begin{bmatrix} 0 \\ 0.185 \\ 0.168 \\ 0 \\ 0.06 \\ 0.171 \\ 0 \\ 0 \\ 0.213 \\ 0.085 \\ 0.165 \\ 0 \end{bmatrix} \qquad V_{sr} = \begin{bmatrix} 0.007 \\ 0.023 \\ 0.026 \\ 0.007 \\ 0.017 \\ 0.026 \\ 0.001 \\ 0.001 \\ 0.028 \\ 0.017 \\ 0.025 \\ 0.007 \end{bmatrix} \qquad InteractionCheck = \begin{bmatrix} \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \\ \text{“OK”} \end{bmatrix}$$

Base and anchor Summary

$t_{base} = 0.5\ in$	Thickness of the base plate
$L_{base} = 13\ in$	Length of the base plate
$B_{base} = 10\ in$	Width of the base plate
$d_h = 0.875\ in$	Hole diameter
$d_b = 0.625\ in$	Bolt diameter
$n_{blt} = 4$	Number of bolts
$s_{yblt} = 7\ in$	Bolt spread width
$s_{zblt} = 10\ in$	Bolt spread length
$ed_y = 1.5\ in$	Bolt Edge Distance
$s_w = 0.25\ in$	Size of the weld
$L_{Anchor} = 28\ in$	Length of the anchor to eliminate concrete breakout
$h_{ef1} = 12\ in$	Length of anchor if concrete breakout is considered

$$L_{AnchorEmbed} := \begin{array}{l} \text{if } T_{Areinforced} = 1 \\ \quad L_{Anchor} \\ \text{else} \\ \quad h_{ef1} \end{array} = 12\ in$$

Base Shoe Design

Wood Bolted Throughbolt connection

Internal Forces

$D := \text{READEXCEL}\left(\text{“.\textbackslash 4208-Forces.xlsx”}, \text{“Sheet1!A17:I29”}\right)$

$D =$

"Bar"	"Point"	"Case"	"Fx (Kip)"	"Fy (Kip)"	"Fz (Kip)"	"Mx (Kip-in)"	"My (Kip-in)"	"Mz (Kip-in)"
31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752
32	1	33	−0.598	0.21	0.002	0.001	0.023	18.633
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31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752
19	1	19	1.399	0.022	0.114	0.001	−8.889	1.762
7	1	20	1.097	0.191	−0.105	0.001	7.588	16.399
3	1	10	0.943	0.006	0.001	0.001	−0.001	0.564
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32	1	32	−0.139	0.209	−0.104	0.001	8.286	16.94
19	1	31	0.584	0.016	0.114	0.001	−8.892	1.255
19	1	21	0.461	0.223	−0.01	0.001	0.248	19.391
31	1	11	3.668	−0.018	0.047	0.001	−4.181	−1.752

$F_x := \text{submatrix}(D, 1, 12, 3, 3) \cdot \mathbf{kip}$ $\qquad M_x := \text{submatrix}(D, 1, 12, 6, 6) \cdot \mathbf{kip} \cdot \mathbf{in}$

$F_y := \text{submatrix}(D, 1, 12, 4, 4) \cdot \mathbf{kip}$ $\qquad M_z := \text{submatrix}(D, 1, 12, 7, 7) \cdot \mathbf{kip} \cdot \mathbf{in}$

$F_z := \text{submatrix}(D, 1, 12, 5, 5) \cdot \mathbf{kip}$ $\qquad M_y := \text{submatrix}(D, 1, 12, 8, 8) \cdot \mathbf{kip} \cdot \mathbf{in}$

Loads are given in coordinates local to member. X is axial, Y is horizontal axis and Z is vertical axis. Tension is given as a negative value.

Compression will be handled by bearing against the base plate, so all positive axial forces shall not be considered in the bolted connection.

```
Fx := for i ∈ 0,1..last(Fx)
          if Fx_i > 0 kip
              n_i ← 0.001 kip
          else
              n_i ← Fx_i
      n
```

$D := 0.75\ \mathbf{in}$ — dowel diameter (greater than 0.25")

$n := 2$ — Number of fasteners in a row

$r := 1$ — Number of rows

$n_b := n \cdot r = 2$ — total number of bolts

$s_y := 8\ \mathbf{in}$ — Spacing of fasteners in a row

$s_x := 0\ \mathbf{in}$ — Spacing between rows

$$I_x := 2 \cdot \left(\frac{s_y}{2}\right)^2 = 32\ \frac{\mathbf{in}^4}{\mathbf{in}^2}$$ MOI of bolt group about the horizontal axis

$$I_y := 4 \cdot \left(\frac{s_x}{2}\right)^2 = 0\ \frac{\mathbf{in}^4}{\mathbf{in}^2}$$ MOI of bolt group about the vertical axis

$$I_o := I_x + I_y = 32\ \frac{\mathbf{in}^4}{\mathbf{in}^2}$$ polar MOI of the bolt group

$V_p := \dfrac{\overrightarrow{|F_x|}}{n_b}$ vertical force due to the applied load

$V_e := \dfrac{\overrightarrow{|M_y|} \cdot s_x \cdot 0.5}{I_o}$ vertical force due to the applied moment

$V_u := V_p + V_e$ total vertical force

$H_p := \dfrac{\overrightarrow{|F_z|}}{n_b}$ horizontal force due to the applied load

$H_e := \dfrac{\overrightarrow{|M_y|} \cdot s_y \cdot 0.5}{I_o}$ horizontal force due tot he applied moment

$H_u := H_p + H_e$ total horizontal force

$\vartheta_m := \operatorname{atan}\left(\dfrac{H_u}{V_u}\right)$ angle of the force relative to the grain

$Z_u := \sqrt{{H_u}^2 + {V_u}^2}$ max resultant force on an individual bolt

$d_m := 5.5\ \boldsymbol{in}$ Depth of the main member

$b_m := 5\ \boldsymbol{in}$ Width of the main member

$d_s := 3\ \boldsymbol{in}$ Depth of the side member

$b_s := 0.25\ \boldsymbol{in}$ Width of the side member (two plates each this thickness)

$l_m := b_m$ main member dowel bearing length

$l_s := b_s \cdot 2$ side member dowel bearing length

$A_m := d_m \cdot b_m$ Area of the main member

$A_s := d_s \cdot b_s$ Area of the side member

$E_m := 1500\ \boldsymbol{ksi}$ Elastic modulus of the main member

$E_s := 29000\ \boldsymbol{ksi}$ Elastic modulus of the side member

$G := \begin{bmatrix} 0.55 \\ 7.853 \end{bmatrix}$ specific gravity of the member (main and side)

$F_{ePara} := \operatorname{Round}\left(11200\ \boldsymbol{psi} \cdot G , 50\ \boldsymbol{psi}\right) = \begin{bmatrix} 6150 \\ 87950 \end{bmatrix} \boldsymbol{psi}$ dowel bearing strength parallel to grain

$F_{ePerp} := \operatorname{Round}\left(\dfrac{6100\ \boldsymbol{psi} \cdot G^{1.45}}{\sqrt{\dfrac{D}{\boldsymbol{in}}}} , 50\ \boldsymbol{psi}\right) = \begin{bmatrix} 2950 \\ 139850 \end{bmatrix} \boldsymbol{psi}$ dowel bearing strength perpendicular to grain

$F_{e\vartheta}(n , \vartheta) := \dfrac{{F_{ePara}}_n \cdot {F_{ePerp}}_n}{{F_{ePara}}_n \cdot \sin(\vartheta)^2 + {F_{ePerp}}_n \cdot \cos(\vartheta)^2}$ function for dowel bearing strength at an angle to the grain

$F_{eMain} := F_{e\vartheta}(0 , \vartheta_m)$ dowel bearing strength for the main member adjusted for angle to grain

$F_{eSide} := F_{e\vartheta}\left(1, \vartheta_m\right)$ dowel bearing strength for the side member adjusted for angle to grain

$F_{yb} := 45\ \mathbf{ksi}$ dowel bending yield strength

$\vartheta := \max\left(\vartheta_m\right) = 89.988\ \mathbf{deg}$ max angle between the direction of load and the direction of grain for any member in a connection

$K_\vartheta := 1 + 0.25\left(\frac{\vartheta}{90\ \mathbf{deg}}\right) = 1.25$

$R_{dIm} := 4 \cdot K_\vartheta = 5$ Reduction Terms

$R_{dIs} := 4 \cdot K_\vartheta = 5$

$R_{dII} := 3.6 \cdot K_\vartheta = 4.5$

$R_{dIIIm} := 3.2\ K_\vartheta = 4$

$R_{dIIIs} := 3.2\ K_\vartheta = 4$

$R_{dIV} := 3.2\ K_\vartheta = 4$

$R_e := \frac{F_{eMain}}{F_{eSide}}$

$R_t := \frac{l_m}{l_s} = 10$

$$k_1\left(R_e\right) := \overrightarrow{\frac{\sqrt{R_e + 2 \cdot R_e^2 \cdot \left(1 + R_t + R_t^2\right) + R_t^2 \cdot R_e^3} - R_e \cdot \left(1 + R_t\right)}{\left(1 + R_e\right)}}$$

$k_1 := k_1\left(R_e\right)$

$$k_2\left(R_e, F_{em}\right) := \overrightarrow{-1 + \sqrt{2 \cdot \left(1 + R_e\right) + \frac{2 \cdot F_{yb} \cdot \left(1 + 2 \cdot R_e\right) \cdot D^2}{3 \cdot F_{em} \cdot l_m^2}}}$$

$k_2 := k_2\left(R_e, F_{eMain}\right)$

$$k_3\left(R_e, F_{em}\right) := \overrightarrow{-1 + \sqrt{\frac{2 \cdot \left(1 + R_e\right)}{R_e} + \frac{2 \cdot F_{yb} \cdot \left(2 + R_e\right) \cdot D^2}{3 \cdot F_{em} \cdot l_s^2}}}$$

$k_3 := k_3\left(R_e, F_{eMain}\right)$

$F_{em} := F_{eMain}$ $F_{es} := F_{eSide}$

$$Z_{Im} := \overrightarrow{\frac{D \cdot l_m \cdot F_{em}}{R_{dIm}}}$$ Yield Mode I for the main member

$$Z_{Is} := \overrightarrow{\frac{2\ D \cdot l_s \cdot F_{es}}{R_{dIm}}}$$ Yield Mode I for the side member

$$Z_{II} := \overrightarrow{\frac{k_1 \cdot D \cdot l_s \cdot F_{es}}{R_{dII}}}$$ Yield Mode II

$$Z_{IIIm} := \overrightarrow{\frac{k_2 \cdot D \cdot l_m \cdot F_{em}}{\left(1 + 2 \cdot R_e\right) \cdot R_{dIIIm}}}$$ Yield Mode III for the main member

$$Z_{IIIs} := \overrightarrow{\frac{2\ k_3 \cdot D \cdot l_s \cdot F_{em}}{\left(2 + R_e\right) \cdot R_{dIIIs}}}$$ Yield Mode III for the side member

$$Z_{IV} := \overrightarrow{\frac{2\ D^2}{R_{dIV}} \cdot \sqrt{\frac{2 \cdot F_{em} \cdot F_{yb}}{3 \cdot \left(1 + R_e\right)}}}$$ Yield Mode IV

Spacing, end and edge distance requirements for the bolted connection

$d_{edPerp} := 4 \cdot D = 3\ in$ Min end distance for loading perpendicular to grain

$d_{edParaaway} := 4 \cdot D = 3\ in$ Min end distance for loading parallel to grain away from end of member

$d_{edParaToward} := 7 \cdot D = 5.25\ in$ Min end distance for loading parallel to grain toward end of member

$s_{Parallel} := 4 \cdot D = 3\ in$ Min spacing for fasteners in a row

$s_{rowsPara} := 1.5 \cdot D = 1.125\ in$

$$s_{rowsPerp}(l, D) := \left\| \begin{array}{l} r \leftarrow \frac{l}{D} \\ \text{if } r \le 2 \\ \quad \| 2.5 \cdot D \\ \text{else if } 2 < r < 6 \\ \quad \left\| \frac{5 \cdot l + 10 \cdot D}{8} \right. \\ \text{else} \\ \quad \| 5 \cdot D \end{array} \right.$$

$s_{rowsPerpm} := s_{rowsPerp}\left(l_m, D\right) = 3.75\ in$

$s_{rowsPerps} := s_{rowsPerp}\left(l_s, D\right) = 1.875\ in$

$$d_{edgeParallel}(l, D, s) := \left\| \begin{array}{l} \text{if } \frac{l}{D} \le 6 \\ \quad \| 1.5\ D \\ \text{else} \\ \quad \| \max\left(1.5 \cdot D, s \cdot 0.5\right) \end{array} \right.$$

$d_{edgeParaM} := d_{edgeParallel}\left(l_m, D, s_{rowsPara}\right) = 1.125\ in$

$d_{edgeParaS} := d_{edgeParallel}\left(l_s, D, s_{rowsPara}\right) = 1.125\ in$

$C_g := C_g\left(n, s_y, D, E_s, E_m, A_s, A_m\right) = 0.99$ Group effect factor

$\lambda := 1$

$Check\_Im := CapacityCheckVector\left(\phi Z_n\left(Z_{Im}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right), Z_u\right) = \text{“OK”}$

$Check\_Is := CapacityCheckVector\left(\phi Z_n\left(Z_{Is}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right), Z_u\right) = \text{“OK”}$

$Check\_IIIs := CapacityCheckVector\left(\phi Z_n\left(Z_{IIIs}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right), Z_u\right) = \text{“OK”}$

$Check\_IV := CapacityCheckVector\left(\phi Z_n\left(Z_{IV}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right), Z_u\right) = \text{“OK”}$

$$\phi Z_n := \begin{bmatrix} min\left(\phi Z_n\left(Z_{Im}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right)\right) \\ min\left(\phi Z_n\left(Z_{Is}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right)\right) \\ min\left(\phi Z_n\left(Z_{IIIs}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right)\right) \\ min\left(\phi Z_n\left(Z_{IV}, 1, 1, C_g, 1, 1, 1, 1, \lambda\right)\right) \end{bmatrix} = \begin{bmatrix} 4.728 \\ 44.405 \\ 6.41 \\ 5.596 \end{bmatrix} \ \boldsymbol{kip}$$

$Z_u := \max\left(Z_u\right) = 2.429 \ \boldsymbol{kip}$

Connection Designs

Wood Bolted Through-bolt connection

Internal Forces

$D := \text{READEXCEL}\left(\text{".\textbackslash 4208-Forces.xlsx"}, \text{"Sheet1!A32:I44"}\right)$

"Bar"	"Point"	"Case"	"Fx (Kip)"	"Fy (Kip)"	"Fz (Kip)"	"Mx (Kip-in)"	"My (Kip-in)"	"Mz (Kip-in)"
31	5	11	3.611	−0.019	0.04	0.001	0.001	0.001
32	5	33	−0.64	0.178	−0.002	0.001	0.001	0.001
16	5	21	0.425	0.185	0	0.001	0.001	0.001
15	5	11	3.385	−0.019	0.042	0.001	0.001	0.001
15	5	19	1.694	−0.006	0.083	0.001	0.001	0.001
3	5	20	0.483	0.152	−0.078	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001
3	5	10	0.877	0.006	0.001	0.001	0.001	0.001

$F_x := \text{submatrix}(D, 1, 12, 3, 3) \cdot kip$ $\quad M_x := \text{submatrix}(D, 1, 12, 6, 6) \cdot kip \cdot in$

$F_y := \text{submatrix}(D, 1, 12, 4, 4) \cdot kip$ $\quad M_y := \text{submatrix}(D, 1, 12, 7, 7) \cdot kip \cdot in$

$F_z := \text{submatrix}(D, 1, 12, 5, 5) \cdot kip$ $\quad M_z := \text{submatrix}(D, 1, 12, 8, 8) \cdot kip \cdot in$

Loads are given in coordinates local to member. X is axial, Y is horizontal axis and Z is vertical axis. Tension is given as a negative value.

$\vartheta_s := \text{atan}\left(\overrightarrow{\frac{|F_z|}{|F_x|}}\right)$ $\quad min(\vartheta_s) = 0.027\ deg$ $\quad \max(\vartheta_s) = 9.17\ deg$

$\vartheta_m := 90\ deg - \vartheta_s$ $\quad min(\vartheta_m) = 80.83\ deg$ $\quad \max(\vartheta_m) = 89.973\ deg$

$Z_u := \overrightarrow{\sqrt{F_x^{\ 2} + F_z^{\ 2}}}$

$D := 0.75\ in$	dowel diameter (greater than 0.25")
$n := 2$	Number of fasteners in a row
$r := 1$	Number of rows
$s := 2.625\ in$	Spacing of fasteners in a row
$d_m := 5.5\ in$	Depth of the main member
$b_m := 5\ in$	Width of the main member
$d_s := 5\ in$	Depth of the side member
$b_s := 0.25\ in$	Width of the side member
$l_m := d_m$	main member dowel bearing length
$l_s := b_s$	side member dowel bearing length
$A_m := b_m \cdot d_m$	Area of the main member
$A_s := d_s \cdot b_s$	Area of the side member
$E_m := 1500\ ksi$	Elastic modulus of the main member
$E_s := 29000\ ksi$	Elastic modulus of the side member
$G := \begin{bmatrix} 0.55 \\ 7.853 \end{bmatrix}$	specific gravity of the member (main and side)

$F_{ePara} := \text{Round}\left(11200\ \textbf{psi} \cdot G, 50\ \textbf{psi}\right) = \begin{bmatrix} 6150 \\ 87950 \end{bmatrix} \textbf{psi}$ dowel bearing strength parallel to grain

$F_{ePerp} := \text{Round}\left(\dfrac{6100\ \textbf{psi} \cdot G^{1.45}}{\sqrt{\dfrac{D}{\textbf{in}}}}, 50\ \textbf{psi}\right) = \begin{bmatrix} 2950 \\ 139850 \end{bmatrix} \textbf{psi}$ dowel bearing strength perpendicular to grain

$F_{e\vartheta}\left(n, \vartheta\right) := \dfrac{F_{ePara_n} \cdot F_{ePerp_n}}{F_{ePara_n} \cdot \sin\left(\vartheta\right)^2 + F_{ePerp_n} \cdot \cos\left(\vartheta\right)^2}$ function for dowel bearing strength at an angle to the grain

$F_{eMain} := F_{e\vartheta}\left(0, \vartheta_m\right)$ dowel bearing strength for the main member adjusted for angle to grain

$F_{eSide} := F_{e\vartheta}\left(1, \vartheta_s\right)$ dowel bearing strength for the side member adjusted for angle to grain

$F_{yb} := 45\ \textbf{ksi}$ dowel bending yield strength

$\vartheta := \max\left(\vartheta_s\right) = 9.17\ \textbf{deg}$ max angle between the direction of load and the direction of grain for any member in a connection

$K_{\vartheta} := 1 + 0.25\left(\dfrac{\vartheta}{90\ \textbf{deg}}\right) = 1.025$

$R_{dIm} := 4 \cdot K_{\vartheta} = 4.102$ Reduction Terms

$R_{dIs} := 4 \cdot K_{\vartheta} = 4.102$

$R_{dII} := 3.6 \cdot K_{\vartheta} = 3.692$

$R_{dIIIm} := 3.2\ K_{\vartheta} = 3.282$

$R_{dIIIs} := 3.2\ K_{\vartheta} = 3.282$

$R_{dIV} := 3.2\ K_{\vartheta} = 3.282$

$R_e := \dfrac{F_{eMain}}{F_{eSide}}$

$R_t := \dfrac{l_m}{l_s} = 22$

$k_1\left(R_e\right) := \overrightarrow{\dfrac{\sqrt{R_e + 2 \cdot R_e^2 \cdot \left(1 + R_t + R_t^2\right) + R_t^2 \cdot R_e^3} - R_e \cdot \left(1 + R_t\right)}{\left(1 + R_e\right)}}$

$k_1 := k_1\left(R_e\right)$

$k_2\left(R_e, F_{em}\right) := \overrightarrow{-1 + \sqrt{2 \cdot \left(1 + R_e\right) + \dfrac{2 \cdot F_{yb} \cdot \left(1 + 2 \cdot R_e\right) \cdot D^2}{3 \cdot F_{em} \cdot l_m^2}}}$

$k_2 := k_2\left(R_e, F_{eMain}\right)$

$$k_3\left(R_e, F_{em}\right) := \overrightarrow{-1+\sqrt{\frac{2\cdot\left(1+R_e\right)}{R_e}+\frac{2\cdot F_{yb}\cdot\left(2+R_e\right)\cdot D^2}{3\cdot F_{em}\cdot l_s^{\,2}}}}$$

$k_3 := k_3\left(R_e, F_{eMain}\right)$

$F_{em} := F_{eMain}$ $\qquad$ $F_{es} := F_{eSide}$

$Z_{Im} := \overrightarrow{\frac{D\cdot l_m\cdot F_{em}}{R_{dIm}}}$ Yield Mode I for the main member

$Z_{Is} := \overrightarrow{\frac{2\ D\cdot l_s\cdot F_{es}}{R_{dIm}}}$ Yield Mode I for the side member

$Z_{IIIs} := \overrightarrow{\frac{2\ k_3\cdot D\cdot l_s\cdot F_{em}}{\left(2+R_e\right)\cdot R_{dIIIs}}}$ Yield Mode III for the side member

$Z_{IV} := \overrightarrow{\frac{2\ D^2}{R_{dIV}}\cdot\sqrt{\frac{2\cdot F_{em}\cdot F_{yb}}{3\cdot\left(1+R_e\right)}}}$ Yield Mode IV

Spacing, end and edge distance requirements for the bolted connection

$d_{edPerp} := 4\cdot D = 3\ in$ Min end distance for loading perpendicular to grain

$d_{edParaaway} := 4\cdot D = 3\ in$ Min end distance for loading parallel to grain away from end of member

$d_{edParaToward} := 7\cdot D = 5.25\ in$ Min end distance for loading parallel to grain toward end of member

$s_{Parallel} := 4\cdot D = 3\ in$ Min spacing for fasteners in a row

$s_{rowsPara} := 1.5\cdot D = 1.125\ in$

$$s_{rowsPerp}\left(l, D\right) := \begin{array}{l} r \leftarrow \frac{l}{D} \\ \text{if } r \le 2 \\ \quad 2.5\cdot D \\ \text{else if } 2 < r < 6 \\ \quad \frac{5\cdot l + 10\cdot D}{8} \\ \text{else} \\ \quad 5\cdot D \end{array}$$

$s_{rowsPerpm} := s_{rowsPerp}\left(l_m, D\right) = 3.75\ in$

$s_{rowsPerps} := s_{rowsPerp}\left(l_s, D\right) = 1.875\ in$

$$d_{edgeParallel}(l, D, s) := \left\| \begin{array}{l} \text{if } \frac{l}{D} \le 6 \\ \quad \| 1.5\ D \\ \text{else} \\ \quad \| \max(1.5 \cdot D, s \cdot 0.5) \end{array} \right.$$

$d_{edgeParaM} := d_{edgeParallel}(l_m, D, s_{rowsPara}) = 1.125$ ***in***

$d_{edgeParaS} := d_{edgeParallel}(l_s, D, s_{rowsPara}) = 1.125$ ***in***

$C_g := C_g(n, s, D, E_s, E_m, A_s, A_m) = 0.999$ Group effect factor

$\lambda := 0.8$ time effect factor

$Check\_Im := CapacityCheckVector(\phi Z_n(Z_{Im}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r, Z_u) =$ "OK"

$Check\_Is := CapacityCheckVector(\phi Z_n(Z_{Is}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r, Z_u) =$ "OK"

$Check\_IIIs := CapacityCheckVector(\phi Z_n(Z_{IIIs}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r, Z_u) =$ "OK"

$Check\_IV := CapacityCheckVector(\phi Z_n(Z_{IV}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r, Z_u) =$ "OK"

$$\phi Z_n := \begin{bmatrix} min(\phi Z_n(Z_{Im}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r) \\ min(\phi Z_n(Z_{Is}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r) \\ min(\phi Z_n(Z_{IIIs}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r) \\ min(\phi Z_n(Z_{IV}, 1, 1, C_g, 1, 1, 1, 1, \lambda) \cdot n \cdot r) \end{bmatrix} = \begin{bmatrix} 10.238 \\ 27.748 \\ 8.433 \\ 10.948 \end{bmatrix} \textit{kip}$$

$Z_u := \max(Z_u) = 3.611$ ***kip***