Structural Calculations

Wade Tolman Building

425 S 8300 E

Huntsville, UT

5/19/2022

Prepared For:

North Star Buildings

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Design Parameters

Codes IBC 2018, ASCE 7-16

Inputs

Risk Category:	I - Low Risk	Site Class	D
Location	41.2573°N, 111.7500°W	Seismic Design Category	D
Street Address:	425 S 8300 E	R=	**2.5** Response Modification Factor
City:	Huntsville, UT		
Basic Wind Speed V=	97 mph		
Exposure Category:	C		

S_s=	**0.78** g	S_{DS}=	**0.62** g
S_1=	**0.27** g	S_{D1}=	0.33 g
S_{MS}=	**0.93** g	F_a=	1.20
S_{M1}=	**0.50** g	F_V=	1.84
T_L=	**8** s		

Length Normal to Ridge B=	**50** ft	Roof Slope	4 :12		Lean		Lean (double)
Length Parallel to Ridge L=	**60** ft	Angle Q=	18.4 °	Lean Width=	**14** ft	Lean Width=	**14** ft
Roof Overhang=	**1.5** ft			Lean Length=	**60** ft	Lean Length=	**60** ft
Post Sidewall Spacing s=	**12** ft	Diagonal:	98.41 ft	Roof Slope=	2 :12	Roof Slope=	2 :12
Max Endwall Post Spacing=	**10** ft			Angle Q=	9.5 °	Angle Q=	9.5 °
Inside Clear Height=	**16.5** ft			Post height=	10.33 ft	Post height=	10.33 ft
Roof Eve Height=	**17.98** ft	Peak Ht=	26.32 ft	Wall Height h_w=	1 ft	Wall Height h_w=	1 ft
Wall Height h_w=	**17.98** ft			Lean Floor Area:	840 sf	Lean Floor Area:	840 sf
Main Floor Area:	3000 sf						
Total Square Footage:	4680 sf						

Roof Purlin Spacing= 24 in   Wall Girt Spacing= 24 in

Roof Live Load	20 psf		Roof Dead Loads		Wall Dead Loads
Roof Dead Load	4 psf	Metal Sheathing	1 psf	Metal Sheathing	1 psf
Wall Dead Load	4 psf	Purlins	1 psf	Girts	1 psf
		Ceiling	2 psf	Interior Wall	1 psf
		Total	4 psf	Insulation	1 psf
Frost Depth	40 in			Total	4 psf
Site Elevation	4970 ft				

p_g=	53	Utah Ground Snow Load (From table 7-2.9 or "The Utah Snow Load Study" http://utahsnowload.usu.edu)
I_s=	0.8	Importance Factor
C_e=	1	Snow Exposure Factor (Partially Exposed) ASCE Table 7.3-1
C_t=	1.2	Thermal Factor ASCE Table 7.3-2

	Main Roof	Lean Roof		
Roof Slope	4	2	:12	
C_s=	0.94	1		Roof Slope Factor
p_f=	36	36	psf	Flat Roof Snow Load $p_f=0.7C_eC_tI_sp_g$
p_s=	33	36	psf	Sloped Roof Snow Load $p_s=C_sp_f$
W		25	ft	Width eave to ridge of main roof
Sliding Snow load=		23.7	psf	$0.4p_fW$
Sliding + Balanced Roof Snow Load=		59	psf	
Local Minimum=	30	30	psf	From Local Design Criteria
Roof Snow Load S=	**33**	**59**	psf	Design Snow Load

Wind Loading

per ASCE 7 Directional Procedure

Risk Category:	I - Low Risk				
Basic Wind Speed V=	97	mph	Ultimate Design Wind Speed		
Roof Slope	4	:12			
Length Normal to Ridge B=	**50**	ft			
Length Parallel to Ridge L=	**60**	ft		L/B=	1.2
Roof Overhang=	**1.5**	ft			
Post Sidewall Spacing s=	**12**	ft			
Roof Eve Height=	**17.984**	ft			
Roof Peak Height=	26.3	ft			
Mean Roof Height=	22.2	ft			
h_{mean}=	22.2	ft		h/L=	0.3692
Exposure Category:	C				
Wind Directionality Factor K_d=	0.85				
Topographic Factor K_{zt}=	1.0				
Gust Effect Factor G:	0.85				
Enclosure Classification:	Enclosed				
Velocity Pressure Coeff. K_z=	$2.01(z/z_g)$^(2/a)				
z_g=	900				
a=	9.5				
Velocity Pressure Coeff. K_z=	0.88	at eave height			
K_h=	0.92	at mean roof height			
Ground Elevation=	4970	ft			
K_e=	0.84	Ground Elevation Factor e^-0.0000362zg			
Velocity Pressure q_z=	$0.00256K_zK_ztK_dK_eV^2$ ASCE eq 27.3-1				
q_z=	15.1	lb/ft	z: 15 ft minimum		
q_h=	15.8	lb/ft			
Internal Press Coeff GC_{pi}=	0.18	(enclosed building)			

Design Wind Pressure

Note: Ultimate pressures converted to ASD by multiplying by 0.6. Pressures shown are ASD

Design Wind Pressure p= qG_p-q_i*GC_{pi} (lb/ft^2) ASCE eq 27.4-1

External Pressure Coeff. Cp, Cn

		GC_{pi}+	G_{cpi}-	G_{cpi} 0		
Building Side	C_p	0.18	-0.18	0	Max	Min
Windward Wall	0.8	4.5	7.9	6.2	7.9	4.5
Windward Roof 1	-0.4	-5.0	-1.6	-3.3	-1.6	-5.0
Windward Roof 2	0.0	-1.4	2.0	0.3	2.0	-1.4
Leeward Roof	-0.6	-6.1	-2.7	-4.4	-2.7	-6.1
Leeward Wall	-0.5	-5.5	-2.1	-3.8	-2.1	-5.5
Side Walls	-0.7	-7.1	-3.7	-5.4	-3.7	-7.1

Components and Cladding

Design Wind Pressure p= q_h[($GC_{p)}$-(Gcpi)] (lb/ft^2) ASCE eq 30.4-1

Effective Area= 20 sf

		GC_{pi}+	G_{cpi}-	G_{cpi} 0		GC_{pi}+	G_{cpi}-	G_{cpi} 0		
Zone	GC_{p+}	0.18	-0.18	0	GC_{p-}	0.18	-0.18	0	Max	Min
4: Wall Interior	0.95	7.3	10.7	9.0	-1.1	-12.1	-8.7	-10.4	10.7	-12.1
5: Wall Edge	0.95	7.3	10.7	9.0	-1.3	-14.0	-10.6	-12.3	10.7	-14.0
1: Roof Interior	0.3	1.1	4.5	2.8	-0.9	-10.2	-6.8	-8.5	4.5	-10.2
2: Roof Edge	0.3	1.1	4.5	2.8	-1.5	-15.9	-12.5	-14.2	4.5	-15.9
3: Roof Corners	0.3	1.1	4.5	2.8	-2.4	-24.4	-21.0	-22.7	4.5	-24.4

Earthquake Load

Location 41.2573°N, 111.7500°W
Site Class D
S. Design Category D
Risk Category I - Low Risk

I_e=	1		ASCE 7 table 11.5-1					
R=	**2.5**		Response Modification Factor					
S_s=	**0.778**				F_a=	1.20		
S_1=	**0.269**				F_V=	1.84		
S_{MS}=	**0.933**	g	S_sF_a		S_{DS}=	**0.62**	g	$2/3S_{MS}$
S_{M1}=	**0.495**	g	S_1F_v		S_{D1}=	0.33	g	$2/3S_{M1}$
C_t=	0.02							
C_u=	1.4		ASCE 7 Table 12.8-1					
T_a=	0.20	s	Approximate Fund. Period		x=	0.75	ASCE Table 12.8-2	
T=	0.29	s	Fundamental Period					
T_0=	0.11	s	$0.2(S_{D1}/S_{DS})$					
T_S=	0.53	s	S_{D1}/S_{DS}					
$1.5T_S$=	0.80	s						
T_L=	8.00	s						
C_S=	0.249	g	S_{DS}*I/R Eq. (12.8-2)	**T<1.5Ts: Eq 12.8-2 ok**				

Roof Dead Load=	4	psf	Bld Width B=	50	ft	Overhang=	1.5	ft	
Wall Dead Load=	4	psf	Bld Length L=	60	ft	Lean Width=	14	ft	Single
Flat Roof Snow Load=	36	psf	Eave Height=	18	ft	Lean Width=	14	ft	Double
A=	4.97		Elevation (ft/1000)			Lean Wall Ht=	1	ft	
S=	7.12	psf	Snow Seismic Load: max of 0.2S, $(0.20+0.025(A-5))P_f$						

<u>**Base Shear**</u> (When roof snow load is greater than 30 psf)

W=	73292	lb	Weight of structure
V=	18235	lbs	Seismic Base Shear C_sW
s=	12	ft	Post Sidewall Spacing
W=	12586	lb/frame	Weight of structure per bay
W=	11477	lb/frame	Effective seismic weight of bld (3/8 wall height)
V=	2856	lbs	Seismic Base Shear per frame C_sW
F_R=	2604	lbs	Lateral Seismic Force per frame
ASD	0.7		
F_R=	1823	lbs	Lateral Seismic Force per frame (ASD)

<u>**Wind at Eave**</u>

Tributary Wall Height= 8.9922 ft (1/2 eave height) Roof Height= 8.33 ft

Combined= (windward-leeward)			Wall (upper 1/2) Windward	Wall (upper 1/2) Leeward		Roof Windward	Roof Leeward		
F_W=	1579	lb	1079.1	0	lb	500	0	lb	10 psf min walls, 5 psf min roof
F_W=	1552	lb	848	-231	lb	205	-268	lb	Roof and Walls
F_W=	1189	lb	848	-231	lb	-158	-268		Roof and Walls
F_W=	1079	lb	848	-231	lb	0	0	lb	Walls Only
F_W=	1579	lb	Controlling Wind Load - Max combined						

Seismic Controls

Diaphragm Design

per ASABE EP484.2 Diaphragm Design of Metal-clad, Post Frame Rectangular Buildings

Sheathing Imperial Rib or similar

	Roof	Walls		
Panel Thickness	29	29	Ga	
v_a=	140	116	lb/ft	Allowable Shear Strength
G=	2666	2245	lb/in	Effective Shear Modulus

From Modified MCA; From Development of Strength and Stiffness Design Values for Steel-clad, Wood-framed Diaphragms by David Aguilera August 2014 Building will use 29

Roof Diaphragm Stiffness

$b_{h1\ roof}$=	26.5	ft	Half of bld with + overhang
$b_{h,\ lean}$=	14.0	ft	Lean Width
s=	12.0	ft	Column Spacing
$c_{h,1\ roof}$=$c_{h,2\ roof}$=	5584	lb/in	G(cos(roof angle))($b_{h1\ roof}$/s)
$c_{h,1\ lean\ roof}$=	3067	lb/in	G(cos(roof angle))($b_{h1\ roof}$/s)
C_h=	14236	lb/in	Diaphragm Horizontal Roof Stiffness

Frame Stiffness

	Left Endwall(1)	Int. Frame	Right Endwall(2)		
B=	50		50	ft	Endwall Length
B_{o1}=	21.83333		21.83333	ft	Door and Window Openings, Each Endwall
b_{h1}=	28.16667		28.16667	ft	Effective Endwall Length
Post Height H_p=	198	198	198	in	
# of 6x6 Posts n_1=	6		6		
# of 6x8+2x6 Posts n_1=		2			
E=	1300000	1300000	1300000	psi	Solid Post
Lean Post Height H_p=	124	124	124	in	
# of lean Posts n_4=	2	2	2		
Frame Stiffness k=	542	648	542	lb/in	$n3EI/L^3$
29 Ga Metal k_{e1}=	3832		3832	lb/in	k_e=G(b_{h1})/H_p
Frame +29 Ga Metal k_{e1}=	4374		4374	lb/in	k_e=G(b_{h1})/H_p+$n3EI/L^3$

	I (in^4)	k (lb/in)
	76	38
	334	168

	I (in^4)	k (lb/in)
Lean	76	156

Eave Loads

h_{wr}=	8.333333	ft	roof height - windward
h_{lr}=	10.66667	ft	roof height - leeward
h_{ww}=	17.98438	ft	wall height - windward
h_{lw}=	15.65104	ft	wall height - leeward
q_{wr}=	-3.3	psf	windward roof wind pressure
q_{lr}=	-4.4	psf	leeward roof wind pressure
q_{ww}=	6.2	psf	windward wall wind pressure
q_{lw}=	-3.8	psf	leeward wall wind pressure
f_w=	0.383	fixity factor - windward	
f_l=	0.456	fixity factor - leeward	
s=	12.0	ft	Column Spacing
P_{iw}=	1071	lb	Wind Eave Load =s[$h_{wr}q_{wr}$-$h_{lr}q_{lr}$+$h_{ww}fq_{ww}$-$h_{ww}fq_{lw}$]
P_s=	1823	lb	Seismic Eave Load
P_i=	1823	lb	Design Eave Load

Summary of DAFI Outputs

Shear Load in Endwall 1=	3306	lb
Shear Load in Endwall 2=	3306	lb
Horizontal Diaphragm Shear=	2395	lb

Endwall Shear Strength Check

Frame	Wall Component	Stiffness of Wall Component	Load Ratio	Total Load on Component	Shear Load on Component v_{max}	Allowable Load on Component v_a
1	Metal Sheathing	3832	0.88	2896	103	116
	Bare Frame	542	0.12	410		
					OK	
2	Metal Sheathing	3832	0.88	2896	103	116
	Bare Frame	542	0.12	410		
					OK	

Sidewall Shear Strength Check

Wall:	**A**	**B**	
$L_{sidewall}$=	60	60	ft Length of sidewall
$L_{openings}$=	15	15	ft Length of sidewall openings
$L_{sidewall}$=	45	45	ft Length of sidewall minus openings
q_w=	10.0	10.0	psf
f_{fixed}=	0.38	0.38	Fixity Factor
At=	303	303	sf Tributary Area to one side
V_W=	3027	3027	
V_E=	4997	4997	
V_{max}=	4997	4997	lb Max Shear Load
$v_{sidewall}$=	111	111	lb/ft $V_{max}/L_{sidewall}$
Sheathing:	29 Ga Stee	29 Ga Steel	
	116	116	lb/ft Allowable Shear Strength
	OK	**OK**	

Roof Diaphragm Shear Strength Check

v_a=	140	lb/ft Allowable Shear Strength	
$V_{max, horizontal}$=	2395	lb from DAFI	
C_h=	14236	lb/in Diaphragm Horizontal Roof Stiffness from above	
$L_{s, roof}$=	55.9		
$v_{max, horizontal roof}$=	2395	lb	
Q=	18.4	° Roof Angle	
$v_{max, in-plane roof}$=	2525	lb	**Vmax<Va, Roof Diaphragm Shear OK**
v_{max}=	45	lb/ft Shear Load in Plane of Component	

Story Drift and Wind Deflections

Allowable Story Drift=	0.02	ASCE Table 12.12-1	
h_{s1}=	198	in Story Height	
Allowable Story Drift=	3.96	in	
Deflection Criterion D=	1/120		
Allowable D Eave=	1.65	in	
Calc. Diaphragm D=	1.01	in From DAFI output	**Deflection OK**

Diaphragm and Frame Interaction Program (DAFI) Outputs

Inputs

5	Number of Building Bays
14236	Default Value for Diaphragm Shear Stiffness
4374	Endwall 1 Stiffness
648	Default Value for Interior Frame Stiffness
1823	Default Value for Eave Load on a Interior Frame
4374	Endwall 2 Stiffness

Outputs

6	# of frames
652	Load of Interior frame with largest load resisted by frame
3	Controlling Frame Number
1.01	Deflection of Frame, in
652	Load Resistance by Frame, lb
1171	Resisting Force by Diaphragm, Q, lb
3306	Shear Load in Endwall 1, lb
3306	Shear Load in Endwall 2, lb
2395	Horizontal Diaphragm Shear, lb
0.76	Deflection in End Frame 1, in.
0.76	Deflection in End Frame 2, in.

Frame Analysis					
Inputs			Outputs		
Frame #	Frame Stiffness	Applied Load	Horizontal Displacement	Load Resisted by Frame	Fraction of Applied Load
1	4374	911	0.76	3306	3.63
2	648	1823	0.92	599	0.33
3	648	1823	1.01	652	0.36
4	648	1823	1.01	652	0.36
5	648	1823	0.92	599	0.33
6	4374	911	0.76	3306	3.63

Diaphragm Analysis			
Inputs		Outputs	
Diaphragm Number	Diaphragm Stiffness	Shear Displacement	Shear Load
1	14236	0.17	2395
2	14236	0.08	1171
3	14236		
4	14236	0.08	1171
5	14236	0.17	2395

Post and Frame Forces

D=	4	psf
S=	33	psf
L_r=	20	psf

Wind load combinations (psf)

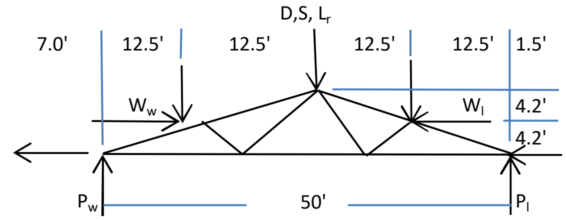
Case	1	2	3	4	5	6	7	
q_{ww}=	4.5	4.5	7.9	7.9	6.2	6.2	10	Windward wall
q_{wr}=	-5.0	-1.4	-1.6	2.0	-3.3	0.3	5	Windward roof
q_{lr}=	-6.1	-6.1	-2.7	-2.7	-4.4	-4.4	5	Leeward roof
q_{lw}=	-5.5	-5.5	-2.1	-2.1	-3.8	-3.8	10	Leeward wall

End Frames

Wall Width s=	6	ft
Roof Width s_r=	8	ft
Roof Height h_r=	8.333333	ft
Inside Clear Height=	16.5	ft
Eave Height=	17.98438	ft
Wall Height h_w=	17.98438	ft

Interior Frames

s=	12	ft
s_r=	12	ft
h_r=	8.333333	ft
h_w=	17.98438	ft



Vertical Loads

End Frames

	P_{w}	P_{l}	
Dead Load	$P_{w, dead}$	$P_{l, dead}$	
D=	960	795	lb
Snow Load	$P_{w, snow}$	$P_{l, snow}$	
S=	8035	6654	lb
Roof Live	$P_{w, R live}$	$P_{l, R live}$	
L_r=	4800	3975	lb
Wind Combinations	$P_{w, wind}$	$P_{l, wind}$	
Wind Max=	1200	-533	lb
Wind Min=	-1196	-1210	lb

Interior Frames

	P_{w}	P_{l}	
Dead Load	$P_{w, dead}$	$P_{l, dead}$	
D=	1536	1272	lb
Snow Load	$P_{w, snow}$	$P_{l, snow}$	
S=	12856	10646	lb
Roof Live	$P_{w, R live}$	$P_{l, R live}$	
L_r=	7680	6360	lb
Wind Combinations	$P_{w, wind}$	$P_{l, wind}$	
Wind Max=	1920	-853	lb
Wind Min=	-1914	-1936	lb

Factored Vert. Loads	P_w	P_l
D	960	795
D+L	960	795
D+S	8995	7449
D+Lr	5760	4770
D+0.75L+.075Lr	4560	3776
D+0.75L+.075S	6986	5785
D+(0.6W or 0.7E)	2160	262
D+0.75L+0.75(0.6W)+0.75Lr	5460	3376
D+0.75L+0.75(0.6W)+0.75S	7526	5386
0.6D+0.6W	-620	-733
0.6D+0.7E	576	477

Factored Vert. Loads	P_w	P_l
D	1536	1272
D+L	1536	1272
D+S	14392	11918
D+Lr	9216	7632
D+0.75L+.075Lr	7296	6042
D+0.75L+.075S	11178	9257
D+(0.6W or 0.7E)	3456	419
D+0.75L+0.75(0.6W)+0.75Lr	8736	5402
D+0.75L+0.75(0.6W)+0.75S	12618	8617
0.6D+0.6W	-993	-1172
0.6D+0.7E	922	763

	P_w	P_l	
Max=	8995	7449	D+S
Min=	-620	-733	0.6D+0.6W

	P_w	P_l	
Max=	14392	11918	D+S
Min=	-993	-1172	0.6D+0.6W

End Frame Post

Solid Post Dimensions=	5.5	5.5	b x d, in DFL No. 2
D=	0.76	in	
H_p=	17	ft	
E'=	1300000	psi	
I=	76.26	in^4	
d=	40.00	in	
A_E=	880	$lb/in^2/ft$	
C=	64		
k_p=	35	lb/in	Fixed
k_p=	34.6	lb/in	Constrained
k_p=	29.8	lb/in	Non-Constrained
f=	3/8		Fixed
f=	0.377		Constrained
f=	0.403		Non-Constrained

Interior Frame Post

	5.5	9	b x d, in DFL No. 2
D=	1.01	in	Deflection at Top of Post From DAF
H_p=	17	ft	Post Height (eave height - 1')
E'=	1300000	psi	
I=	334.13	in^4	
d=	40.00	in	Footing Depth
A_E=	880	$lb/in^2/ft$	
C=	15		$d^4A_EH_P/(6EI)$
k_p=	154	lb/in	$3EI/H_p^3$
k_p=	144.1	lb/in	$3EI/H_p^3*(C/(1+C))$
k_p=	86.2	lb/in	$3EI/H_p^3*[C/(C+4.5(d/H_P)^2+12d/H_p+9)]$
f=	3/8		3/8
f=	0.383		(4+3C)/(8+8C)
f=	0.456		$[C/12+(d/H_p)^2+2d/H_p+1]/[2C/9+(d/H_p)^2+8d/(3H_p)+2]$

Post Lateral Loads Wind cases: GC_{pi}+, GC_{pi}0. GC_{pi}0 for Windward Roof 1 and Windward Roof 2 and 10 and 5 psf minimum loads

Fixity Case 5 (Embedded, Non-Constrained)

Rotation at Grade Θ_b=

Windward End	0.0013	0.0013	0.0021	0.0021	0.0017	0.0017	0.0026
Leeward End	0.0016	0.0016	0.0008	0.0008	0.0012	0.0012	-0.0020
Windward Int.	0.0016	0.0016	0.0022	0.0022	0.0019	0.0019	0.0026
Leeward Int.	0.0018	0.0018	0.0012	0.0012	0.0015	0.0015	-0.0011

From Case 5, Table 8.1, Post-Frame Building Design Manual, Brohnhoff (1992)

Displacement of Post at grade Δ_b=

Windward End	0.038193	0.038193	0.060633	0.060633	0.049413	0.04941	0.074765
Leeward End	0.045421	0.045421	0.02298	0.02298	0.0342	0.0342	-0.057074
Windward Int.	0.046221	0.046221	0.065761	0.065761	0.055991	0.05599	0.078067
Leeward Int.	0.052514	0.052514	0.032974	0.032974	0.042744	0.04274	-0.036736

Calculate shear at bottom of post; Fixity Case 5 (embedded, Non-constrained) (lb)

Windward End	299	299	510	510	404	404	642
Leeward End	367	367	156	156	262	262	-594
Windward Int.	665	665	1076	1076	871	871	1335
Leeward Int.	798	798	387	387	592	592	-1080

Calculate Moment at bottom of post ; Fixity Case 5 (embedded, Non-constrained (lb-in)

Windward End	-14729	-14729	-22266	-22266	-18497	-18497	-27013
Leeward End	-17156	-17156	-9619	-9619	-13387	-13387	17271
Windward Int.	-43120	-43120	-56183	-56183	-49651	-49651	-64409
Leeward Int.	-47327	-47327	-34264	-34264	-40796	-40796	12336

Fixity Case 7 (Embedded, Surface-Constrained)

Rotation at Grade Θ_b=

Windward End	0.000178	0.000178	0.000271	0.000271	0.000224	0.00022	0.000329
Leeward End	0.000208	0.000208	0.000115	0.000115	0.000162	0.00016	-0.000216
Windward Int.	0.000545	0.000545	0.000722	0.000722	0.000634	0.00063	0.000833
Leeward Int.	0.0006	0.0006	0.0004	0.0004	0.0005	0.0005	-0.0002

From Case 7, Table 8.1, Post-Frame Building Design Manual, Brohnhoff (1992)

Calculate shear at bottom of post; Fixity Case 7 (Embedded, Surface-Constrained) (lb):

Windward End	309	309	525	525	417	417	661
Leeward End	378	378	162	162	270	270	-609
Windward Int.	705	705	1133	1133	919	919	1403
Leeward Int.	843	843	415	415	629	629	-1113

Calculate Moment at bottom of post ; Fixity Case Fixity Case 7 (Embedded, Surface-Constrained) (lb-in)

Windward End	-16710	-16710	-25413	-25413	-21061	-21061	-30893
Leeward End	-19513	-19513	-10810	-10810	-15162	-15162	20236
Windward Int.	-51198	-51198	-67747	-67747	-59473	-59473	-78169
Leeward Int.	-56528	-56528	-39979	-39979	-48254	-48254	19058

Slab max V,M

	End	Int
V Windward	661	1403
V Leeward	367	798
M Windward	30893	78169
M Leeward	17156	47327

Solid-Sawn Post Column Capacity Calc

End Frame Post

Lamination dimensions=	**5.5**	X	**5.5**	b x d
A=	30.25	in^2		
	x-x	y-y		
S=	27.7	27.7	in^3	
I=	76.3	76.3	in^4	
Eave Height=	17.98438	ft		
Column Length l_u=	16.5	ft		
Wall Girt Spacing L_u=	24	in		
# of wall girts=	8	8		
	x-x	y-y		
l_1=	2	2	ft	
K_e=	0.8	0.8	(NDS Appendix G)	
l_e=	1.6	1.6	ft	
l_e/d=	3.49	3.49		
l_e/d<50	OK	OK		
L_u/d=	4.36	4.36		
L_e=	1.84	1.84	l_u	
L_e=	44.16	44.16	in	
R_B=	2.83	2.83		
l_e/d<50	OK	OK		
Wood Species/Grade=	DF-L #2			
E=	1300000	psi		
E_{min}=	470,000	psi		
F_b=	750	psi		
C_D=	1.6			
C_M=	1			
C_i=	1			
F^*_b=	1200	psi		
F_{bE}=	70245	psi		
F_{bE}/F^*_b=	58.54			
C_L=	1.00			
F'_b=	1199	psi		
f_b=	1114	psi		
Check Bending fb<F'b:	**OK**			
F_c=	700	psi		
C_D=	1.6			
C_M=	0.8			
C_F=	1.1			
C_i=	1			
F^*_c=	986	psi		
F_{cE1}=	31702	psi		
F_{cE2}=	31702	psi		
K_f=	1			
c=	0.8			
C_p=	0.99	NDS 15.3-1		
F'_c=	979	psi		
f_c=	249	psi		
Check Axial $f_c<F'_c$:	**OK**			
0.75*f_b=	836	psi		
0.75*f_c=	187	psi		
	0.74	NDS 3.9-3		
Check NDS 3.9-3<1:	**OK**			
	0.01	NDS 3.9-4		
Check NDS 3.9-4<1:	**OK**			

Interior Frame Post

dim's=	**5.5**	X	**9**	b x d	
A=	49.5	in^2			
	x-x	y-y			
S=	74.3	45.4	in^3		
I=	334.1	124.8	in^4		
Eave Height=	17.98438	ft			
Column Length l_u=	16.5	ft		Unsupported Length	
L_u=	24	in			
# of wall girts=	0	8			
	x-x	y-y			
l_1=	17	2			
K_{e1}=	0.8	0.8	(NDS Appendix G, Fixed base, Pinned Top)		
l_{e1}=	13.2	1.6	ft effective buckling length		
l_{e1}/d_1=	17.60	3.49	Slenderness ratio		
l_e/d<50	OK	OK			
L_u/d=	22.00	4.36			
L_e=	1	1.84	l_u	Eff. Length L_e for Bending Membe	
L_e=	198.00	44.16	in		
R_B=	7.68	1.73	Slenderness Ratio $(L_e d/b^2)^{0.5}$		
l_e/d<50	OK	OK			
Wood Species/Grade=	DF-L #2				
E=	1300000	psi			
E_{min}=	470,000	psi			
F_b=	750	psi			
C_D=	1.6		Wind and Earthquake Duration		
C_M=	1				
C_i=	1				
F^*_b=	1200	psi			
F_{bE}=	9574	psi			
F_{bE}/F^*_b=	7.98				
C_L=	0.99				
F'_b=	1192	psi			
f_b=	1053	psi bending at bottom of post			
fb<F'b:	**OK**				
F_c=	700	psi			
C_D=	1.6		Wind and Earthquake Duration		
C_M=	0.8				
C_F=	1.05				
C_i=	1				
F^*_c=	941	psi			
F_{cE1}=	1247	psi			
F_{cE2}=	31702	psi			
K_f=	1				
c=	0.8				
C_p=	0.78	NDS 15.3-1			
F'_c=	732	psi			
f_c=	255	psi			
$f_c<F'_c$:	**OK**				
0.75*f_b=	790	psi D+0.75L+0.75(0.6W)+0.75S			
0.75*f_c=	191	psi D+0.75L+0.75(0.6W)+0.75S			
	0.90	Check Axial and Bending NDS 3.9-3<1:			
NDS 3.9-3<1:	**OK**				
	0.16	Check Axial and Bending NDS 3.9-4<1:			
NDS 3.9-4<1:	**OK**				

Post Design

Gable End Post

Post dimensions= 5.5 X 5.5 inch Wood Post - DF-L Post and Timbers No. 2

	Transverse	Longitudinal		
Horiz. Building Trib. Width=	0.00	10.00	ft	
Wall Width=	0.00	10.00	ft	
Roof Overhang=	1.5	1.5	ft	
Roof Tributary Width=	1.50	12	ft	
Horiz. Roof Area=	17	sq ft		
Roof Slope=	4	:12		
Roof Height=	3.3	ft		
Eave Height H_p=	17.98	17.98	ft	
Wall Height h_w=	17.98	17.98	ft	(top of beam/bottom chord of truss)
Post Height H_p=	16.50	16.50	ft	(bottom of truss)
Max Unsuported Length=	2.00	16.5	ft	
Vert Roof Area=	5.75	0.00	sq ft	
Vert Wall Area=	8	180	sq ft	
Horiz. Floor Area=	0	sq ft	(loft)	

D=	4	psf	Roof
D=	4	psf	Wall
D=	10	psf	Floor
S=	33	psf	
L=	40	psf	
L_r=	20	psf	

Vertical Loads

Dead Load=	821	lb
Snow Load=	578	lb
Floor Live Load=	0	lb
Roof Live Load=	345	lb

Wind Max=	35	lb
Wind Min=	-105	lb

Wind Combinations

	windward	leeward		
q+=	-5.0	-6.1	psf	roof wind loads (vertical)
q-=	2.0	-2.7	psf	
q0=	-3.3	-4.4	psf	
W+=	-86	-105	lb	
W-=	35	-46	lb	
W0=	-57	-76	lb	

Earthquake: Vert +=	102	lb $+0.2S_{DS}D$
Earthquake: Vert -=	-102	lb $-0.2S_{DS}D$

S_{DS}= 0.62 g

Factored Vertical Load to Post

Max=	1399	lb	D+(0.6W or 0.7E)
Min=	391	lb	0+6D+0.7E
Max Lateral=	1331	lb	D+(0.6W or 0.7E)

Lateral Loads

q_{ww}=	7.9	psf	Windward Wall
q_{lw}=	-2.1	psf	Leeward Wall
q_{lw}=	-3.7	psf	Side Wall

	Transverse	Longitudinal		
Wind w=	4	86	lb/ft	06.W
Wall D=	33	719	lb	
Roof and Floor D=	69	69		
Earthquake w=	2	12	lb/ft	0.7E C_S= 0.249
Design w=	4	86	lb/ft	0.6W
V=	24	530	lb	Propped Cantilever post - Shear at Top
V=	40	883	lb	Propped Cantilever post - Shear at Base
M=	75	1639	lb-ft	Propped Cantilever post - Moment at Zero Shear
M=	134	2914	lb-ft	Propped Cantilever post - Moment at Base
V=	883		lb	Max Shear at post ground level
M=	34,969		lb-in	Max Moment at post ground level

Post Capacity

Gable End Post

	Transverse	Longitudinal		
Post dimensions=	**5.5** X	**5.5**	inch Wood Post - DF-L Post and Timbers No. 2	
Post Length l_u=	16.50	16.50	ft	Unsupported Length
A=	30.25	30.25	in^2	
S=	27.73	27.73	in^3	Section Modulus bd^2/6
I=	76.26	76.26	in^4	Moment of Inertia bd^3/12
Wall Girt Spacing L_u=	24	198	in	
# of wall girts=	8	0		
l_1=	2.00	16.50	ft	
K_e=	0.8	0.8	(NDS Appendix G)	
l_e=	1.60	13.20	ft	
l_e/d=	3.49	28.80		
l_e/d<50	OK	OK		
L_u/d=	4.36	36.00		
L_u=	1.84	1	l_u	
L_e=	44	198	in	
R_B=	2.8	6.00		Slenderness ratio (l_ed/b^2)^.5
l_e/d<50	OK	OK		
Wood Species/Grade=	DF-L #2	DF-L #2		
E=	1300000	1300000	psi	
E_{min}=	470,000	470,000	psi	
F'_b=	750	750	psi	
C_D=	1.6	1.6		
C_M=	1	1		
C_i=	1	1		
F^*_b=	1200	1200	psi	
F_{bE}=	70245	15667	psi	
F_{bE}/F^*_b=	58.54	13.06		
C_L=	1.00	1.00		
F'_b=	1199	1195	psi	
f_b=	58	1261	psi	0.6W
fb<F'b:	**OK**	**OK**		

F_c=	700	700	psi	
C_D=	1.6	1.6		
C_M=	1	1		
C_F=	1.1	1.1		
C_i=	1	1		
F^*_c=	1232	1232	psi	
F_{cE}=	31702	466	psi	
c=	0.8	0.8		
C_p=	0.99	0.34	NDS 15.3-1	
F'_c=	1222	422	psi	
f_c=	46	46	psi	D+(0.6W or 0.7E)
Check Axial $f_c<F'_c$:	**OK**	**OK**		
0.75*f_b=	43	946	psi	D+(0.6W or 0.7E)
f_c=	44	44	psi	D+(0.6W or 0.7E)
	0.91	0.92	Check Axial and Bending NDS 3.9-3<1:	
Check NDS 3.9-3<1:	**OK**	**OK**		
	0.10	0.01	Check Axial and Bending NDS 3.9-4<1:	
Check NDS 3.9-4<1:	**OK**	**OK**		

Post Design

Lean Post

Post dimensions= **5.5** **X** **5.5** inch Wood Post - DF-L Post and Timbers No. 2

	Transverse	Longitudinal		
Horiz. Building Trib. Width=	12.00	7.00	ft	
Wall Width=	12.00	7.00	ft	
Roof Overhang=	0	1.5	ft	
Roof Tributary Width=	12.00	9	ft	
Horiz. Roof Area=	102	sq ft		
Roof Slope=	2	:12		
Roof Height=	1.2	ft		
Eave Height H_p=	11.33	11.33	ft	
Wall Height h_w=	1.00	1.00	ft	(top of beam/bottom chord of truss)
Post Height H_p=	10.33	10.33	ft	(bottom of beam)
Max Unsuported Length=	2.00	2	ft	
Vert Roof Area=	17.00	0.00	sq ft	
Vert Wall Area=	12	7	sq ft	
Horiz. Floor Area=	0	sq ft	(loft)	

D=	4	psf	Roof
D=	4	psf	Wall
D=	10	psf	Floor
S=	59	psf	
L=	40	psf	
L_r=	20	psf	

Vertical Loads

Dead Load=	484	lb
Snow Load=	6055	lb
Floor Live Load=	0	lb
Roof Live Load=	2040	lb

Wind Max=	209	lb
Wind Min=	-621	lb

Wind Combinations

	windward	leeward		
q+=	-5.0	-6.1	psf	roof wind loads (vertical)
q-=	2.0	-2.7	psf	
q0=	-3.3	-4.4	psf	
W+=	-508	-621	lb	
W-=	209	-274	lb	
W0=	-335	-447	lb	

Earthquake: Vert +=	60	lb +0.2S_{DS}D
Earthquake: Vert -=	-60	lb -0.2S_{DS}D

S_{DS}= 0.62 g

Factored Vertical Load to Post

Max=	6539	lb	D+(0.6W or 0.7E)
Min=	230	lb	0+6D+0.7E
Max Lateral=	5182	lb	D+(0.6W or 0.7E)

Lateral Loads

q_{ww}=	7.9	psf	Windward Wall
q_{lw}=	-2.1	psf	Leeward Wall
q_{lw}=	-3.7	psf	Side Wall

	Transverse	Longitudinal		
Wind w=	9	5	lb/ft	06.W
Wall D=	48	28	lb	
Roof and Floor D=	408	408		
Earthquake w=	8	7	lb/ft	0.7E
Design w=	9	7	lb/ft	0.6W
V=	35	28	lb	Propped Cantilever post - Shear at Top
V=	59	47	lb	Propped Cantilever post - Shear at Base
M=	68	55	lb-ft	Propped Cantilever post - Moment at Zero Shear
M=	122	98	lb-ft	Propped Cantilever post - Moment at Base
V=	59		lb	Max Shear at post ground level
M=	1,461		lb-in	Max Moment at post ground level

C_S= 0.249

Post Capacity

Lean Post

	Transverse	Longitudinal		
Post dimensions=	**5.5**	**X**	**5.5**	inch Wood Post - DF-L Post and Timbers No. 2
Post Length l_u=	10.33	10.33	ft	Unsupported Length
A=	30.25	30.25	in^2	
S=	27.73	27.73	in^3	Section Modulus bd^2/6
I=	76.26	76.26	in^4	Moment of Inertia bd^3/12
Wall Girt Spacing L_u=	24	24	in	
# of wall girts=	5	5		
l_1=	2.00	2.00	ft	
K_e=	0.8	0.8	(NDS Appendix G)	
l_e=	1.60	1.60	ft	
l_e/d=	3.49	3.49		
l_e/d<50	OK	OK		
L_u/d=	4.36	4.36		
L_u=	1.73	1.73	l_u	
L_e=	42	42	in	
R_B=	2.7	2.75		Slenderness ratio (l_ed/b^2)^.5
l_e/d<50	OK	OK		
Wood Species/Grade=	DF-L #2	DF-L #2		
E=	1300000	1300000	psi	
E_{min}=	470,000	470,000	psi	
F'_b=	750	750	psi	
C_D=	1.6	1.6		
C_M=	1	1		
C_i=	1	1		
F^*_b=	1200	1200	psi	
F_{bE}=	74711	74711	psi	
F_{bE}/F^*_b=	62.26	62.26		
C_L=	1.00	1.00		
F'_b=	1199	1199	psi	
f_b=	53	42	psi	0.6W
fb<F'b:	**OK**	**OK**		

F_c=	700	700	psi	
C_D=	1.6	1.6		
C_M=	1	1		
C_F=	1.1	1.1		
C_i=	1	1		
F^*_c=	1232	1232	psi	
F_{cE}=	31702	31702	psi	
c=	0.8	0.8		
C_p=	0.99	0.99	NDS 15.3-1	
F'_c=	1222	1222	psi	
f_c=	216	216	psi	D+(0.6W or 0.7E)
Check Axial $f_c<F'_c$:	**OK**	**OK**		
0.75*f_b=	40	32	psi	D+(0.6W or 0.7E)
f_c=	171	171	psi	D+(0.6W or 0.7E)
	0.08	0.08	Check Axial and Bending NDS 3.9-3<1:	
Check NDS 3.9-3<1:	**OK**	**OK**		
	0.01	0.01	Check Axial and Bending NDS 3.9-4<1:	
Check NDS 3.9-4<1:	**OK**	**OK**		

Bolt Capacity Check - Truss to Post

Truss Supports at Post	Truss	Lean		Double Shear
Bolts N=	**5**	**3**		Number of bolts in support (one row only)
Rows=	**1**	**1**		
bolts per row=	**5**	**3**		
Bolt Diameter D=	0.75	0.75	in	Up to 1" diameter
F_{yb}=	45000	45000	psi	Bending Yield Strength of Fastener
l_m=	5.5	5.5	in	Post bearing width
l_s=	1.5	1.75	in	Truss support width, bearing length of bolt in side member
Q_{truss}=	0	9.467122	°	Angle of load to grain - truss to post
F_{em}=	5600	5600	psi	dowel bearing strength on main holding member NDS Table 12.3.3
Perpendicular F_{es}=	2600	2600	psi	dowel bearing strength on side member Perpendicular to grain
Parallel F_{es}=	5600	5600	psi	dowel bearing strength on side member Parallel to grain
F_{eQ}=	5600	5430	psi	Dowel bearing strength at angle of load to grain per Hankinson Formula
R_e	1.00	1.03		F_{em}/F_{es}
R_t=	3.67	3.14		l_m/l_s
$K_{D=}$	3	3		reduction coefficient for fasteners with D < 0.25 in
$K_{Q=}$	1	1.026298		
k_1=	1.23	1.08		
k_2=	1.07	1.09		
k_3=	1.83	1.63		
Yield Limit Equations - Single Shear				
Mode I_m Z=	5775	5627	lb	Dl_mF_{em}/K_D NDS equation 12.3-1
Mode I_s Z=	1575	1736	lb	Dl_sF_{es}/K_D NDS equation 12.3-2
Mode II Z=	2145	2074	lb	$k_1Dl_sF_{es}/K_D$ NDS equation 12.3-3
Mode III_m Z=	2583	2503	lb	$k_2Dl_sF_{em}/(1+2R_e)K_D$ NDS equation 12.3-4
Mode III_s Z=	1202	1204	lb	$k_3Dl_sF_{em}/(2+2R_e)K_D$ NDS equation 12.3-5
Mode IV Z=	1611	1558	lb	$D^2/KD\ (2F_{em}F_{yb}/(3(1+2R_e))^{0.5}$ NDS equation 12.3-6
Yield Limit Equations - Double Shear				
Mode I_m Z=	5775	5627	lb	Dl_mF_{em}/K_D NDS equation 12.3-7
Mode I_s Z=	3150	3581	lb	$2Dl_sF_{es}/K_D$ NDS equation 12.3-8
Mode III_s Z=	2404	2408	lb	$2k_3Dl_sF_{em}/(2+2R_e)K_D$ NDS equation 12.3-9
Mode IV Z=	3222	3115	lb	$2D^2/KD\ (2F_{em}F_{yb}/(3(1+2R_e))^{0.5}$ NDS equation 12.3-6
Smallest Z=	**2404**	**2408**	lb	Double Shear
Z'= $Z(C_D)(C_M)(C_t)(C_g)(C_D)$ allowable capacity				
C_D=	1.15	1.15		Load Duration= Snow Load
C_M=C_t=C_D=	1	1		
Group Action Factor Calculation NDS 11.3-1				
D=	0.75	0.75	in	fastener diameter
g=	116913	116913	lb/in	load/slip modulus for connection (dowel type, wood to wood)
s=	3.00	3.00	in	center to center bolt spacing
E_m=	1300000	1300000	psi	modulus of elasticity, main member
A_m=	50	30	in^2	gross cross sectional area, main member
E_s=	1600000	1600000	psi	modulus of elasticity, side member
A_s=	17	26	in^2	gross cross sectional area, side member
R_{EA}=	0.41	0.94		
u=	1.01	1.01		
m=	0.87	0.88		
C_g=	**0.95**	**1.00**		$\dfrac{m(1-m^{2n}) \ * [1+R_{EA}]}{n[(1+R_{EA}m_n)(1+m)-1+3^{2n}] \ * [1-m]}$
Z'=	**2618**	**2759**	lb	
Check Capacity				
Load=	11918	6539	lb	Load from Truss, two trusses per post - Double Shear
Load Capacity=	13091	8278	lb	Z' * Number of bolts
	OK	**OK**		

Single Shear Nail Capacity - Truss Support to Post Connection

Nails N=	**57**		Number of nails in support
Nail Size=	**10**	d	Screw Shank Steel Nail
Nail Diameter D=	0.148	in	Nail diameter
l=	3.00		Length of nail
G=	0.50		Wood Specific Gravity, main and side
Fyb=	90000	psi	Bending Yield Strength of Fastener
Fem=	4650	psi	dowel bearing strength, main member NDS Table 12.3.3
Fes=	4650	psi	dowel bearing strength on side member
ls=	1.5	in	dowel bearing length of nail in side member
tm=	5.5	in	thickness of main member
ts=	1.5	in	thickness of side member
lm=	1.8	in	dowel bearing length of nail in main member (Member holding point)
p	1.5	in	l-ts<tm Penetration of Nail
Re	1.00		Fem/Fes
Rt=	1.20		lm/ls
$K_{D=}$	2.2		reduction coefficient for fasteners with D < 0.25" Table 12.3.1B
k1=	0.46		Table 12.3.1A
k2=	1.06		Table 12.3.1A
k3=	1.09		Table 12.3.1A

Yield Limit Equations

Mode I_m Z=	563	lb	Dl_mF_{em}/K_D NDS equation 12.3-1
Mode I_m Z=	469	lb	Dl_sF_{es}/K_D NDS equation 12.3-2
Mode II Z=	215	lb	$k_1Dl_sF_{es}/K_D$ NDS equation 12.3-3
Mode III_m Z=	200	lb	$k_2Dl_sF_{em}/(1+2R_e)K_D$ NDS equation 12.3-4
Mode III_s Z=	171	lb	$k_3Dl_sF_{em}/(2+2R_e)K_D$ NDS equation 12.3-5
Mode IV Z=	118	lb	$D^2/KD\ (2F_{em}F_{yb}/(3(1+2R_e))$^0.5 NDS equation 12.3-6
Smallest Z=	**118**	lb	
C_D=	1.15		Load Duration= Snow Load
C_M=C_t=C_D=	1		
C_g=	1		Cg=1 for dowel diameters < 0.25
Z'=	**135**	lb	

Check Capacity

Load=	7449	lb	Load from Truss, one truss to post - Single Shear
Load Capacity=	7708	lb	Z' * Number of fasteners **Capacity > Load - OK**

Withdrawal Capacity

W=	54	lb/nail	Smooth Shank 1380 $G^{5/2}$ D NDS 12.2-3
W=	100	lb/nail	Ring Shank 1800 G^2 D NDS 12.2-5

Roof Purlins

Full lateral support

Span Length=	12.00	ft		
Support Width=	8.5	in		
Beam Length=	11.29	ft	L	
Tributary Width=	24	in		Roof Purlin Spacing
Roof Slope=	4	:12		
Dead Load=	4	lb/ft^2	D	
Snow Load=	33	lb/ft^2	S	
Snow Load to Roof=	31.8	lb/ft^2	S	Snow Load Normal to Roof
Total Load=	36	lb/ft^2	D+S	
Uniform Load w=	71.5	lb/ft		

Propped Cantilever Beam

M+=	641	lb*ft	$9/128*w*L^2$ Max Positive Moment
V+=	303	lb	w*L*3/8 Max Positive Shear
M-=	1140	lb*ft	$w*L^2/8$ Max Negative Moment
V-=	505	lb	w*L*5/8 Max Negative Shear

$F'_{bx}= F_{bx}(C_D)(C_M)(C_t)(C_L)(C_V)(C_{fu})(C_c)(C_f)$ allowable bending stress

F_{bx}=	900	psi	DF-L #2
C_D=	1.15		Load Duration= Snow Load
$C_M=C_t=C_{fu}=C_i=C_f$=	1		
C_F=	1.30		Size factor
C_r=	1.15		Repetitive Member Factor (used as a joist = 1.15)
F'_{bx}=	1547	psi	

Positive Moment - at roof ends

Beam dimensions= **1.5** **x** **5.5** (bxd) inches

A=	8.3	in^2	Area	bd
S=	7.6	in^3	Section Modulus	$bd^2/6$
I=	21	in^4	Moment of Inertia	$bd^3/12$

Check Stresses

S= M/F'_{bx} Required Section Modulus

M/F'_{bx}= 5.0 in^3

f_b= M/S calculated bending stress, compare to F'_{bx}

f_b= 1017 psi **fb<F'bx - OK**

Negative Moment - at mid span support

Beam dimensions= **3** **x** **5.5** bxd Purlins overlap and nailed together

A=	16.5	in^2	Area	bd
S=	15.1	in^3	Section Modulus	$bd^2/6$
I=	42	in^4	Moment of Inertia	$bd^3/12$

Check Stresses

M/F'_{bx}=	8.8	in^3	M/F'_{bx} Required Section Modulus
f_b=	904	psi	M/S calculated bending stress, compare to F'_{bx}

fb<F'bx - OK

2x6 DF-L #2 @ 24" O.C. for 12'-0" spans OK. Overlap purlins 20" (min, 10" either side of truss centerline) nailed with six 10d nails within 4" of purlin ends.

Wall Girts
full lateral support, normal temp
Check 2x6 dimensional lumber

Check bending caused by wind

Wind Load=	-12.1	lb/ft^2	W
Span Length=	12.0	ft	
Support Width=	5.5	in	
Beam Length=	11.54	ft	L
Tributary Width=	24	in	

Total Wind Load=	24.2	lb/ft	W per unit length
Max Shear=	140	lb	wL/2
Max Moment=	269	lb*ft	Beam Fixed at Both Ends $wL^2/12$
=	3225	lb*in	

Beam dimensions=	**5.5**	**x**	**1.5**	(dxb) inches
A=	8.3	in^2	Area	bd
S=	7.56	in^3	Section Modulus	$bd^2/6$
I=	20.80	in^4	Moment of Inertia	$bd^3/12$

Check Moment

f_b= M/S calculated bending stress

f_b=	426	psi	calculated bending stress

F'_{bx}= $F_{bx}(C_D)(C_M)(C_t)(C_L)(C_V)(C_{fu})(C_c)(C_f)$ allowable bending stress

F_{bx}=	900	psi	DF-L #2
C_D=	1.6		Load Duration= Wind Load
C_M=	1		Wet Service Factor = >19%
C_t=	1		Temperature Factor
C_L=	1		Beam Stability Factor
C_F=	1.30		Size factor
C_{fu}=	1.15		Flat Use Factor
C_i=	1		Incising Factor
C_r=	1.15		Repetitive Member Factor (used as a joist = 1.15)
C_f=	1		Form Factor
F'_{bx}=	2476	psi	**fb<F'bx - OK**

Check Shear

f_v= 1.5 V/A calculated shear

f_v=	25	psi

F'_{vx}= $F_v (C_D)(C_M)(C_t)$ allowable shear

F_{vx}=	180	psi	DF-L #2
C_D=	1.15		
C_M=	0.97		
C_t=	1		
F'_{vx}=	201	psi	**fv<F'vx - OK**

2x6 Commercial Girts @ 24" O.C. for 12'-0" spans OK

Footing Design

End Frames With Lean

Footing Diameter=	**30**	inch diameter round footing			
Footing Depth=	**40**	in	Flying Gable Area=	0	ft^2
Frost Depth=	40	in	**Frost Depth OK**		
Roof Tributary Width=	**7.5**	ft	Lean Tributary Width=	**7.5**	ft
Roof Tributary Length=	**25**	ft	Lean Tributary Length=	**7**	ft
Main Roof Tributary Area=	187.5	ft^2	Lean Roof Trib. Area=	52.5	ft^2
Total Roof Area=	240	ft^2			

Dead Load=	1500	lb	D	Roof Dead Load=	4	lb/ft^2	D
Snow Load=	9394	lb	S	Wall Dead Load=	4	lb/ft^2	D
Floor Live Load=	0	lb	L	Floor Dead Load=	10	lb/ft^2	D
Roof Live Load=	4800	lb	Lr	Floor Live Load=	40	lb/ft^2	L
Wind Load=	491	lb	W	Roof Live Load=	20	lb/ft^2	Lr
Wind Uplift Load=	-1461	lb	W	Roof Snow Load=	33	lb/ft^2	S
Shear Uplift=	-10	lb	W	Lean Roof Snow Load=	59	lb/ft^2	S
				Roof Wind Load=	2.0	lb/ft^2	W
				Roof Uplift Wind Load=	-6.1	lb/ft^2	W
				Roof Eve Height=	17.98438	ft	

Load Combinations

D+S	10,893	lb			
D+L	1,500	lb			
D+Lr	6,300	lb			
D+0.75W+0.75S	8,913	lb			
D+0.75W+0.75L	1,868	lb			
D+0.75L+0.75Lr	5,100	lb			
D+0.75L+0.75S	8,545	lb			
D+0.75W+0.75Lr	5,468	lb	Min. Combined Load=	-571	lb
0.6D+W	-571	lb	Max. Combined Load=	10893	lb

Footing Capacity

Footing bearing area=	707	in^2
Allowable Soil Pressure=	**1500**	psf
Vert. adj. factor	1.766666667	(ASABE EP486.1)
S'=	2650	psf/ft
Tip capacity=	13008	lb

EP486.1 Table 1 footnote 4) Pressure may be increased 20% for each additional 1 ft of width and /or depth to a max of three times the tabulated value

Concrete Density=	145	lb/ft^3	**Footing Bearing Area OK**
Uplift resistance=	3872	lb Dead Load + concrete weight	
Uplift Factor of Safety=	2.7		**Uplift OK**

ASAE EP486.1 Required Embedment - Constrained Post With Full Depth Collar - Windward Side

M_g=	25,413	lb-in	Moment at Post Base	2,118	lb-ft
S=	150	psf/ft	ASAE EP486.1		
b=	2.5	ft	Post Diameter		
s/b=	4.80		Check for isolated post conditions		
S'=	200	psf/ft	Adjusted Allowable Lateral Soil Pressure		
d=	2.57	ft	ASAE EP486.2 $d=(4.25M_a/(s'b))^{1/3}$	31	in
				OK	

30" Round Footing 40" Deep OK

Footing Design

Interior Frame With Lean

Footing Diameter=	**33**	inch diameter round footing				
Footing Depth=	**48**	in				
Frost Depth=	40	in	**Frost Depth OK**			
Roof Tributary Width=	**12**	ft		Lean Tributary Width=	**12**	ft
Roof Tributary Length=	**25**	ft		Lean Tributary Length=	**7**	ft
Main Roof Tributary Area=	300	ft^2		Lean Roof Trib. Area=	84	ft^2
Total Roof Area=	384	ft^2				

Dead Load=	2399	lb	D	Roof Dead Load=	4	lb/ft^2	D
Snow Load=	15030	lb	S	Wall Dead Load=	4	lb/ft^2	D
Floor Live Load=	0	lb	L	Floor Dead Load=	10	lb/ft^2	D
Roof Live Load=	7680	lb	Lr	Floor Live Load=	40	lb/ft^2	L
Wind Load=	786	lb	W	Roof Live Load=	20	lb/ft^2	Lr
Wind Uplift Load=	-2337	lb	W	Roof Snow Load=	33	lb/ft^2	S
Shear Uplift=	-10	lb	W	Lean Roof Snow Load=	59	lb/ft^2	S

Load Combinations						
			Roof Wind Load=	2.0	lb/ft^2	W
D+S	17,429	lb	Roof Uplift Wind Load=	-6.1	lb/ft^2	W
D+L	2,399	lb	Roof Eve Height=	17.98438	ft	
D+Lr	10,079	lb				
D+0.75W+0.75S	14,261	lb				
D+0.75W+0.75L	2,988	lb				
D+0.75L+0.75Lr	8,159	lb				
D+0.75L+0.75S	13,672	lb				
D+0.75W+0.75Lr	8,748	lb	Min. Combined Load=	-908	lb	
0.6D+W	-908	lb	Max. Combined Load=	17429	lb	

Footing Capacity

Footing bearing area=	855	in^2	
Allowable Soil Pressure=	**1500**	psf	
Vert. adj. factor	1.95	(ASABE EP486.1)	EP486.1 Table 1 footnote 4) Pressure may be increased 20% for each additional 1ft of width and /or depth to a max of three times the tabulated value
S'=	2925	psf/ft	
Tip capacity=	17373	lb	
Concrete Density=	145	lb/ft^3	**Footing Bearing Area OK**
Uplift resistance=	5844	lb Dead Load + concrete weight	
Uplift Factor of Safety=	2.5		**Uplift OK**

ASAE EP486.1 Required Embedment - Constrained Post With Full Depth Collar - Windward Side

M_g=	67,747	lb-in	Moment at Post Base	5,646	lb-ft
S=	150	psf/ft	ASAE EP486.1		
b=	2.75	ft	Post Diameter		
s/b=	4.36		Check for isolated post conditions		
S'=	200	psf/ft	Adjusted Allowable Lateral Soil Pressure		
d=	3.45	ft	ASAE EP486.2 $d=(4.25M_a/(s'b))^{1/3}$	41	in
				OK	

33" Round Footing 48" Deep OK

Footing Design

Gable End Post

Footing Diameter=	**24**	inch diameter round footing		
Footing Depth=	**40**	in	Frost Depth=	40 in
				Frost Depth OK

	Transverse	Longitudinal	
Tributary Width=	0.00	10.00	ft
Roof Overhang=	1.5	1.5	ft
Roof Tributary Length=	1.5	11.5	ft
Flying Gable Area=	0	sq ft	
Horiz. Roof Area=	17.25	sq ft	
Lean Tributary Width=	0	0	ft
Lean Roof Trib. Area=	0	sq ft	
Wall Width=	0.00	10	ft
Wall Height h_w=	17.98	17.98	ft (top of beam/bottom chord of truss)
Wall Area=	0	179.8438	sq ft
Total Wall Area=	179.8438	sq ft	
Floor Tributary Width=	0	0	
Floor Tributary Area=	0	sq ft	

Dead Load=	788	lb	D	Roof Dead Load=	4	lb/ft^2	D
Snow Load=	578	lb	S	Wall Dead Load=	4	lb/ft^2	D
Floor Live Load=	0	lb	L	Floor Dead Load=	10	lb/ft^2	D
Roof Live Load=	345	lb	Lr	Floor Live Load=	40	lb/ft^2	L
Wind Load=	35	lb	W	Roof Live Load=	20	lb/ft^2	Lr
Wind Uplift Load=	-105	lb	W	Roof Snow Load=	33	lb/ft^2	S
Shear T=C=	0	lb	E	Lean Roof Snow Load=	33	lb/ft^2	S
				Roof Wind Load=	2.0	lb/ft^2	W
				Roof Uplift Wind Load=	-6.1	lb/ft^2	W

Load Combinations

D+(L or Lr or S)	1,366	lb		
D+0.75L+.075(Lr or S)	1,222	lb		
D+(0.6W or 0.7E)	824	lb		
D+0.75L+0.75(0.6W)+0.75(Lr or S)	1,248	lb		
D+0.525E+.75L+.75S	1,222	lb		
0.6D+0.6W	368	lb	Min. Combined Load=	368 lb
0.6D+0.7E	473	lb	Max. Combined Load=	1366 lb

Footing Capacity

Footing bearing area=	452	in^2
Allowable Soil Pressure=	**1500**	psf
Vert. adj. factor	1.666667	(ASABE EP486.1)
S'=	2500	psf/ft
Tip capacity=	7854	lb

EP486.1 Table 1 footnote 4) Pressure may be increased 20% for each additional 1 ft of width and /or depth to a max of three times the tabulated value

Concrete Density=	150	lb/ft^3
Uplift resistance=	1571	lb Footing weight
Uplift Factor of Safety=	-4.3	
1/2" Spikes ea side of post=	1	

Footing Bearing Area OK

Uplift OK

ASAE EP486.1 Required Embedment - Constrained Post With Full Depth Collar

M_g=	34,969	lb-in	Moment at Post Base	2,914	lb-ft
S=	150	psf/ft	ASAE EP486.1		
b=	2	ft	Post Diameter		
s/b=	0.00		Check for isolated post conditions		
S'=	200	psf/ft	Adjusted Allowable Lateral Soil Pressure		
d=	3.08	ft	ASAE EP486.2 $d=(4.25M_a/(s'b))^{1/3}$	37	in
				OK	

24" Round Footing 40" Deep OK

Footing Design

Lean Post

Footing Diameter=	**24**	inch diameter round footing		
Footing Depth=	**40**	in	Frost Depth=	40 in
				Frost Depth OK

	Transverse	Longitudinal	
Tributary Width=	12.00	7.00	ft
Roof Overhang=	0	1.5	ft
Roof Tributary Length=	12	0.00	ft
Flying Gable Area=	0	sq ft	
Horiz. Roof Area=	0	sq ft	
Lean Tributary Width=	12	8.50	ft
Lean Roof Trib. Area=	102	sq ft	
Wall Width=	12.00	7	ft
Wall Height h_w=	1.00	1.00	ft (top of beam/bottom chord of truss)
Wall Area=	12	7	sq ft
Total Wall Area=	19	sq ft	
Floor Tributary Width=	0	0	
Floor Tributary Area=	0	sq ft	

Dead Load=	484	lb	D	Roof Dead Load=	4	lb/ft^2	D
Snow Load=	6055	lb	S	Wall Dead Load=	4	lb/ft^2	D
Floor Live Load=	0	lb	L	Floor Dead Load=	10	lb/ft^2	D
Roof Live Load=	2040	lb	Lr	Floor Live Load=	40	lb/ft^2	L
Wind Load=	209	lb	W	Roof Live Load=	20	lb/ft^2	Lr
Wind Uplift Load=	-621	lb	W	Roof Snow Load=	33	lb/ft^2	S
Shear T=C=	0	lb	E	Lean Roof Snow Load=	59	lb/ft^2	S
Load Combinations				Roof Wind Load=	2.0	lb/ft^2	W
D+(L or Lr or S)	6,539	lb		Roof Uplift Wind Load=	-6.1	lb/ft^2	W
D+0.75L+.075(Lr or S)	5,025	lb					
D+(0.6W or 0.7E)	693	lb					
D+0.75L+0.75(0.6W)+0.75(Lr or S)	5,182	lb					
D+0.525E+.75L+.75S	5,025	lb					
0.6D+0.6W	-330	lb		Min. Combined Load=	-330	lb	
0.6D+0.7E	290	lb		Max. Combined Load=	6539	lb	

Footing Capacity

Footing bearing area=	452	in^2	
Allowable Soil Pressure=	**1500**	psf	
Vert. adj. factor	1.666667	(ASABE EP486.1)	EP486.1 Table 1 footnote 4) Pressure may be increased 20%
S'=	2500	psf/ft	for each additional 1 ft of width and /or depth to a max of
Tip capacity=	7854	lb	three times the tabulated value
Concrete Density=	150	lb/ft^3	**Footing Bearing Area OK**
Uplift resistance=	1571	lb Footing weight	
Uplift Factor of Safety=	4.8		**Uplift OK**
1/2" Spikes ea side of post=	1		

ASAE EP486.1 Required Embedment - Constrained Post With Full Depth Collar

M_g=	1,461	lb-in	Moment at Post Base	122	lb-ft
S=	150	psf/ft	ASAE EP486.1		
b=	2	ft	Post Diameter		
s/b=	3.50		Check for isolated post conditions		
S'=	200	psf/ft	Adjusted Allowable Lateral Soil Pressure		
d=	1.07	ft	ASAE EP486.2 $d=(4.25M_a/(s'b))^{1/3}$	13	in
				OK	

24" Round Footing 40" Deep OK

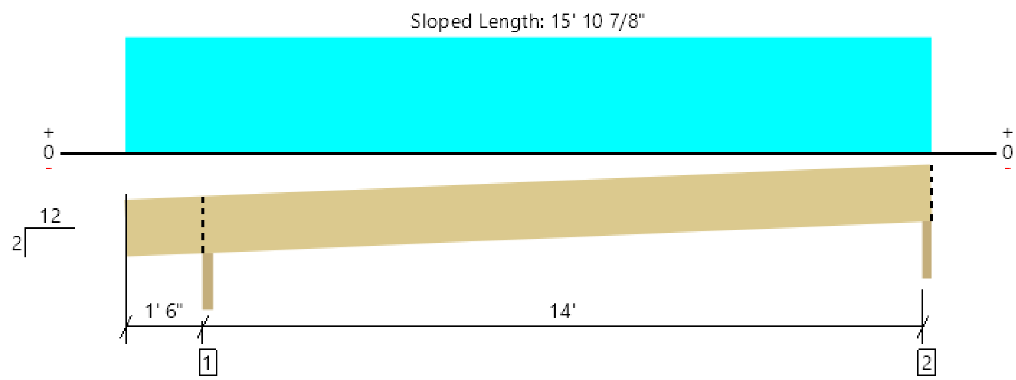
FORTE WEB

MEMBER REPORT

PASSED

Lean, B1 14' Beam

1 piece(s) 1 3/4" x 11 7/8" 2.0E Microllam® LVL



All locations are measured from the outside face of left support (or left cantilever end). All dimensions are horizontal.

Member Length : 16' 13/16"

Design Results	Actual @ Location	Allowed	Result	LDF	Load: Combination (Pattern)
Member Reaction (lbs)	3350 @ 1' 7 1/4"	3327 (2.50")	Passed (101%)	--	1.0 D + 1.0 S (All Spans)
Shear (lbs)	2317 @ 2' 8 3/16"	4541	Passed (51%)	1.15	1.0 D + 1.0 S (All Spans)
Moment (Ft-lbs)	9323 @ 8' 8"	10263	Passed (91%)	1.15	1.0 D + 1.0 S (Alt Spans)
Live Load Defl. (in)	0.686 @ 8' 7 9/16"	0.711	Passed (L/249)	--	1.0 D + 1.0 S (Alt Spans)
Total Load Defl. (in)	0.745 @ 8' 7 9/16"	0.948	Passed (L/229)	--	1.0 D + 1.0 S (Alt Spans)

System : Roof
Member Type : Drop Beam
Building Use : Residential
Building Code : IBC 2015
Design Methodology : ASD
Member Pitch : 2/12

- Deflection criteria: LL (L/240) and TL (L/180).
- Overhang deflection criteria: LL (2L/240) and TL (2L/180). Upward deflection on left cantilever exceeds overhang deflection criteria.
- Allowed moment does not reflect the adjustment for the beam stability factor.

Supports	Bearing Length			Loads to Supports (lbs)					Accessories
	Total	Available	Required	Dead	Roof Live	Snow	Wind	Total	
1 - Column - DF	2.50"	2.50"	2.52"	268	1045	3082	-418	4395/-418	Blocking
2 - Trimmer - DF	2.25"	2.25"	2.06"	215	843	2488	4/-339	3550/-339	Blocking

- Blocking Panels are assumed to carry no loads applied directly above them and the full load is applied to the member being designed.

Lateral Bracing	Bracing Intervals	Comments
Top Edge (Lu)	3' 2" o/c	
Bottom Edge (Lu)	15' 11" o/c	

•Maximum allowable bracing intervals based on applied load.

Vertical Loads	Location (Side)	Tributary Width	Dead (0.90)	Roof Live (non-snow: 1.25)	Snow (1.15)	Wind (1.60)	Comments
0 - Self Weight (PLF)	0 to 15' 8 1/4"	N/A	6.1	--	--	--	
1 - Uniform (PSF)	0 to 15' 8 1/4"	6'	4.1	20.0	59.0	-8.0	

Weyerhaeuser Notes

The product application, input design loads, dimensions and support information have been provided by JDL

ForteWEB Software Operator	Job Notes
Derek Lloyd Mountain Point Engineering (801) 450-5332 derek@mountainpointengineering.com	

Weyerhaeuser

5/20/2022 3:40:00 AM UTC

ForteWEB v3.2, Engine: V8.2.0.17, Data: V8.1.0.16

File Name: NS77 Wade Tolman