STRUCTURAL CALCULATIONS

May 12, 2014
PROJECT NO. 14-15

PROJECT:

Daren Edwards Shop Addition

104 West madison
Waterloo, WI

ENGINEER:

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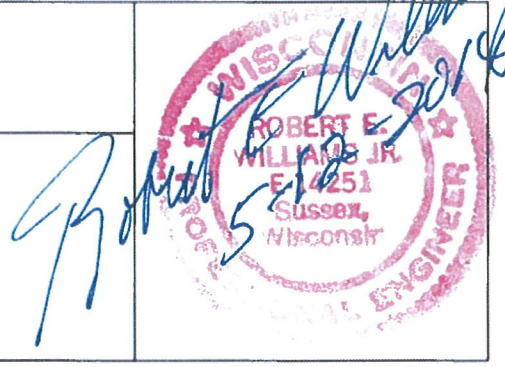


I. LOADS

A. Commercial Code- Environmental Loads

1. Ground Snow Load: 35 #/S.F. (See calcs for roof snow load)
2. Maximum Wind Speed: 100 M.P.H.
   7 (See calcs for Wind Force, with height and site location adjustment)

B. Dead Loads

1. Roofing

- Roofing & ballast	14.0 #/S.F.
- Sheathing	1.5 #/S.F.
- Wood joist @ 16" o.c.	2.0 #/S.F.
- Insulation	3.0 #/S.F.
- Drywall	1.5 #/S.F.
- Collateral	3.0 #/S.F.
TOTAL DEAD ROOF LOAD	25.0 #/S.F.

3. Exterior Wall with Siding : 15 #/S.F.
4. Exterior Wall with Stone Veneer: 60 #/S.F.

C. Live Loads

1. First floor 125 #/S.F.
2. Hallways, Common Areas: 125 #/S.F.
3. Office: 100 #/S.F.

I. LOADS CONTINUED

D. Load Combinations

1. ASD, Allowable Stress Design (for Wood)

   Dead

   7 Dead + Live

   Dead + Live + Snow

   Dead + Wind + Live + Snow (code allows 1.33 Stress Increase)

   0.6 Dead + Wind

2. LRFD, Load Factor Resistance Design (for Concrete and Steel)

   1.4 Dead

   1.2 Dead + 1.6 Live + 0.5 Snow

   1.2 Dead + 1.6 Snow + 0.8 Wind

   1.2 Dead + 1.0 Live + 1.6 Wind + 0.5 Snow

   0.9 Dead + 1.6 Wind

E. Earth Pressure

1. Active Soil Pressure, Lateral (assume dense clay): 60 #/S.F.
2. Hydrostatic Pressure, Lateral (fill voids of clay with water) 15 #/S.F.
3. Allowable Soil Bearing Pressure, Vertical: 2000 #/S.F. (Assumed-field verify)

F. Material Properties- Structural

1. Structural Steel
   a. Wide-Flange Members: 50,000 psi
   b. Tubular Sections: 46,000 psi
   c. Channels, Angles, Pipe Columns, Misc.: 36,000 psi

2. Concrete
   a. For walls and exterior slab on grade: 4,000 psi
   b. For footings and interior slab on grade: 3,000 psi
   c. Exterior concrete to be air entrained
3. Concrete Reinforcement
   a. Steel rebar: 60,000 psi
   b. Steel Welded Wire Mesh: 80,000 psi

I. LOADS CONTINUED

G. Adjustment Factors for Environmental Loads

1. Building Data

P flat roof snow load from ASCE 7-05 Sec 7.3

b. Ground Snow Load	35.0	psf
c. Co-efficent of temp heated	1.0	
d. Co-efficent of exposure urban exposed	1.0	
e. Importance Factor	1.0	
f. Flat Roof for Main Structural Roof	0.00	

Balanced Snow Load:

pf = 0.7 * Ce * Ct * I * pg

pf (psf) 25

Windward Drift (psf) 0

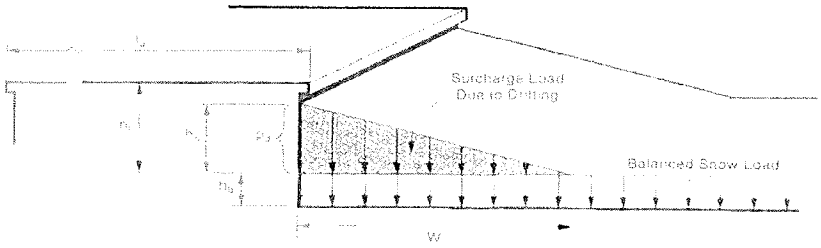
Leeward Drift (psf) 0

I. LOADS CONTINUED

G. Adjustment Factors for Environmental Loads

3A. Drifted Snow onto Main Roof from parapet at front

a. Length of Higher Roof	l_u (ft)	12.0
b. Length of Lower Roof	l_l (ft)	25.5
c. Height in between Higher and Lower Roof	h_r (ft)	7.8
d. Ground Snow Load	pg (psf)	35.0
e. Balanced Snow Load	pf (psf)	25.0
f, importance factor	pf (psf)	1.0



f. Snow Density- from Unbalanced Calculation	γ (psf)	18.55
g. Height of Balanced Snow Load: pf / γ	h_b (ft)	1.35

If $l_u < 25$ ft, use $l_u = 25$ ft

$$h_d = 0.43 \sqrt[3]{l_u} \sqrt[4]{p_g + 10} - 1.5$$

I=	1	h. Maximum Height of Drifted Snow	h_d (ft)	1.33	
ce=	1	i. Weight of Drifted Snow: hd * g	p_d (psf)	24.74	
		j. Weight of sliding snow .4Wbal snowxslope factor/15		0.00	
		Slope of roof	0		
		j. Total Weight of Drifted Snow $p_d + p_{f+ps}$	Σ p (psf)	49.74	
		k. Distance to end of Drift "W" min (4*hd, 4*hc)		5.3	
		l. Distance to lower roof		0	feet
		m. Total Weight of Drifted & sliding Snow at start of lower roof	Σ p (psf)	49.74	psf
		n. Total load of snow at start of lower roof	psf	74.74	psf
		Compute equalivent uniform live load Unbalanced snow load		41.58	psf

M for unbal load =wl^2/8 + M drift=R1^2/2w w= 8xMtotal/l^2=	3617.23 ft. pounds
Compute equalivent uniform live load =	44.50 psf
design load for roof truss minimum	43.00 psf

I. LOADS CONTINUED

G. Adjustment Factors for Environmental Loads (Continued)

4. Seismic Design for Earthquakes

1. Data from ASCE 7, NEHRB

Daren Edwards Shop Addition Waterloo, WI

MCE Ground Motion - Conterminous 48 States
Zip Code - 53594

Period, (sec)	MCE Sa (%g)	
0.2	10	MCE Value of Ss, Site Class D
1.0	4.2	MCE Value of S1, Site Class D

Spectral Parameters for Site Class D

0.2	16	Sa = FaSs Fa =	1.60
1.0	10.08	Sa = FvS1 Fv =	2.40

For Seismic Use Group I Seismic Factor 1.0

S_{DS} = 2/3 S_{MS}	0.107	< 0.167	Seismic Design Category A
S_{D1} = 2/3 S_{M1}	0.067	< 0.067	Seismic Design Category A

Use Seismic Design Category A per 1613.5.6.1

By IBC 1613.6, use the procedure in ASCE 7

For (4) Stories of Light-Frame Construction with a SDC of A
Shear force at base of structure=V

Importance Factor= 1.00

V = Csxw
V = 0.0164 * W
V= 1.64% of Building Mass per Floor

R = 6.5 For Light Wood stud bearing walls with wood panel shear walls

Cs=Sds/(R/I)= 0.0164
Cs need not exceed
Sdi/T(R/I)= for T<Tl 1.8968
SdiTl/((T^2)(R/I))= for t>Tl 30.3489
but not less than 0.01

Ta=CtHn^x 0.0009 **equals T conseratively**

Tl= 16 From Figure 22-16 ASCE

Cu = 1.2 for Spectural Response Acceleration at 1-second Period ≥ 4.0
Our SD1 amount is 6.72% which is more

I. LOADS CONTINUED

G. Adjustment Factors for Environmental Loads

5. Wind Analysis

Tabular Results from Wind Speed of 90 MPH and Roof Slope (degrees): 39.00
Exposure Class B (No reduction or magification factor)
Mean Roof Height (ft): 18.0

- Main Force Resisting System: Low Rise Building Provisions

	Horizontal Loads	
	End Zone	Interior Zone
Wall	14.4	11.5
Roof	9.9	7.9

	Vertical Loads	
	End Zone	Interior Zone
Leeward	-8.8	-7.5
Windward	-5.6	4.8
Overhang	-5.1	-5.8

Height and Exposure Adjustment Coffici 1.00

	Horizontal Loads * Coeff.	
	End Zone	Interior Zone
Wall	14.4	11.5
Roof	9.9	7.9

	Vertical Loads * Coeff.	
	End Zone	Interior Zone
Leeward	-8.8	-7.5
Windward	-5.6	4.8
Overhang	-5.1	-5.8

- Components and Cladding: Low Rise Building Provisions

	Wall	
Area	Dir. Pres.	Uplift
10	14.6	-15.8
20	13.9	-15.2
50	13.0	-14.3
100	12.4	-13.5

	Roof	
Area	Dir. Pres.	Uplift
10	13.3	-14.6
20	13.0	-13.8
50	12.5	-12.8
100	12.1	-12.1

Height and Exposure Adjustment Coffici 1.00

	Wall * Coeff.	
Area	Dir. Pres.	Uplift
10	14.6	-15.8
20	13.9	-15.2
50	13.0	-14.3
100	12.4	-13.5

	Roof * Coeff.	
Area	Dir. Pres.	Uplift
10	13.3	-14.6
20	13.0	-13.8
50	12.5	-12.8
100	12.1	-12.1

TDI Associates, Inc.
Architects • Engineers • Planners

Job: Daren Edward Shop Addition
Project No.: 14-153
Date: May 12, 2014 Sheet ___ of ___

Nominal Wood Stud Wall, First Floor- Worst Case Interior

Designed with 2005 NDS and International Building Code

Size of Member- Nominal	in x in	2x6
Spacing of Members (O.C.)	inches	16
Three members or <?	Yes or No	Y
Snow Increase factor (1.15)?	Yes or No	Y
Are Studs 16" O.C., does it have wood sheath. & gyp.**	Yes or No	Y

Under the current lateral load and height:

P_{max} (lbs)	4262.3
w_{max} (lbs/ft)	3196.7

** By IBC 2306.2.1, If the exterior wall has studs spaced a min. 16" o.c., min. 3/8" wood structural panels (6/12), and 1/2" gyp board; the wall is allowed a composite action increase factor for bending, see Table 2306.2.1 (in place of C_r)

C_F: Form Factor
C_r: Repetitive Use Factor (see above)
C_p : Euler Reduction Factor
C_D : Load Duration Factor (1.15 Snow, 1.6 Wind)

Properties of Wood- SPF #2		
Allow. Bending Stress	F_b (psi)	1310
Allow. Tension Stress	F_t (psi)	675
Allow. Shear Stress	F_v (psi)	135
Allow. Comp. Perp. Stress	$F_{c\perp}$ (psi)	425
Allow. Compressive Stress	F_c (psi)	1320
Modulus of Elasticty	E (psi)	1400000

Properties of Wood * Adjustment Factors		C_D	C_F	C_r	Adjusted Properties
Allow. Bending Stress	F_b' (psi)	1.15 / 1.6	1.3	1.4	2741.9 / 3814.72
Allow. Tension Stress	F_t' (psi)	1.15 / 1.6	1.3	1	1009.2 / 1404
Allow. Shear Stress	F_v' (psi)	1.15 / 1.6	1	1	155.3 / 216
Allow. Comp. Perp. Stress	$F_{c\perp}'$ (psi)	1	1	1	489
Allow. Compressive Stress	F_c' *(psi)	1.15 / 1.6	1.1	1	1669.8 / 2323.2
Modulus of Elasticty	E (psi)	1	1	1	1400000

Forces applied on Stud		
Distributed Load (per lf)	w (plf)	1160
Lateral force (per sq.ft)	$w_{lateral}$ (psf)	20
Height of Wall	h (ft)	11.5
Interior	Yes or No	Y

Column - Euler Reduction Factor (for Grav. Only)		
$k_{ce} = 0.510 - 0.839*(COV_E)$	k_{ce}	0.3
Sawn Lumber Factor, c	c	0.8
$F_{ce} = K_{ce}*E' / (l_e/d)^2$	F_{ce} (psi)	667.14
$x_1 = [1 + (F_{ce}/F_c'*)]/ 2*c$	x_1 (unitless)	0.875
$x_2 = (F_{ce}/F_c'*) / c$	x_2 (unitless)	0.499
$C_p = X_1 - (X_1^2 - X_2)^{1/2}$	C_p (unitless)	0.359
F_c' (After Euler Reduction)	F_c' (psi)	599.87

Column Stress Check, f_c

P/A (psi)	187.47
> F'_C	**O.K.**

Beam- Continuously Braced		
$M_{wind} = (w_{wind}*l_e^2) / 8$	M (#*ft)	330.63
Allow. Bending Stress	F_b' (psi)	3814.7

Beam Stress Check, f_b

M/S (psi)	699.50
> F'_b	**O.K.**

Beam Column- Interaction Equation, EXTERIOR ONLY			
Column: $(f_c / (1.33 * F'_c))^2$	(unitless)	0.051	
Beam: $f_b / (1.33*F_b'*(1-f_c / F_{CE}))$	(unitless)	0.191	
Interaction Equation: < 1.0	(unitless)	0.243	**O.K.**

*Two transient Loads: Code allows a stress increase of 1.33 in each