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5/21/2019

DCSPE Job#				7196
Project Zip Code				98040
City, State				Mercer Islan
Building Design				
Building Code				2018
Building Category				II
Occupancy Type				Assembly A-5
ASCE				ASCE 7-10
Overall Width				20.0 ft
Overall Length				40.0 ft
Post Spacing				10.0 ft
CTB Width				5.0 in
CTB Length				16.0 ft
CTB Span				16.0 ft
CTB Weight				346.0 lbs
Mean Roof Ht				15.0 ft
Roof Slope				6 :12
Footing Depth				4.6 ft
Footing Diameter				3.0 ft Ø
Soil Bearing				2000 psf
Design Loads				
Roof Dead Load				12 psf
Roof Live Load				30 psf
Wind Design Data				
Wind Speed				110 mph
Exposure				C
Imp wind				1.00
Tributary Area				80.0 ft^2
Kh				0.85
Kd				*0.85*
Kzt				*1*
Internal Pressure Coefficient				0.00
Components & Cladding Wind Pressures	Z1	-12.1 psf	Z2	-38.0 psf
	Z3	-58.2 psf		
qh =				22.38
Wind Base Shears	Vxx	1.5 kips	Vyy	2.9 kips

SNOW DESIGN DATA	
Snow (Pg)	20.0 psf
Snow Exposure (Ce)	1.00
Imp Snow (Is)	1.00
Snow Thermal (Ct)	1.2
Flat Roof Snow Load (Pf) (.7 IS USED FOR FNEAR FLAT ROOFS ONLY)	24.0 psf
Roof Slope (Cs)	1.00
Sloped Roof Snow Load (Ps)	24.0 psf
SEISMIC DESIGN DATA	
Seismic Importance Factor (Ie)	1.00
Short Period Spectral Response Accel (Ss from maps)	1.443
1-Sec Period Spectral Response Accel (S1 from maps)	0.488
Seismic Site Class	D
Design Short Period Spectral Response Accel (Sds)	0.96
Design 1-sec Period Spectral Response Accel (Sd1)	0.49
Seismic Design Category	D
Basic Seismic Resisting System	CANTILEVERED COLUMN SYSTEM
Basic Seismic Force Resisting System	TIMBER FRAMES
Response Modification Factor (R)	1.5
Seismic Response Coefficient (Cs)	0.64
Seismic Base Shear (Allowable Stress Design)	0.00
Connection Design Data	
Plate Thickness	0.50 in
Screw diameter	0.25 in
# of Screws per Post	36
Max Allowable Force per Bolt	230
Shear of Tube Steel	36000 psi
Width of Post	5.0 in
Length of Post	5.5 in
Bearing Pressure of CTB	
Roofing Board Data	
Width of Roofing Board	5.5 in
Height of Roofing Board	1.5 in
Maximum Span of Board	10.0 ft
Modulus of Elasticity	1600000
Cd	1.15
Fb (allowable bending stress)	1350.0 psi

DANIEL C. SMITH, PE
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05/22/19

Project: DCSPE #: 7196 Mercer Island,WA
Subject: Shelter Calculations

1. Scope

Daniel C. Smith PE Consulting Engineers (DCSPE) was contacted by SWS , regarding load calculations.

2. Design Codes

2018 International Building Code

Occupancy Type:	Assembly A-5	Wind Speed:	110 mph
Construction Type:	II	Wind Importance:	1.00
Building Height:	15.0 ft	Exposure:	C
Soil Bearing Capacity:	2000 psf	Snow Load:	20 psf
Seismic Category:	C	ASCE 7-10	

3. Design Loads

Dead Load

CTB Load =	346 lbs each/ (10 x 8 ft) =				4.3 psf
DLr = 12 + CTB 4.3 psf =					16.3 psf
Live Load roof (LLr) =					30.0 psf

Wind Load

V (Allowable) =					110 mph
Open Structure	= 1	= 1	= 0.85	= 0.85	= 15 ft
qh = 0.00256 * Kzt * Kd * Kh * 110^2 =					22.4 psf
			EnWood uses WL (up) 20 psf.		20.0 psf
WL (down) 10 psf				Conservative	10.0 psf

Snow Load			
Pg =			20.0 psf
Exp C - fully Exposed	Imp = 1	Ct = 1.2	
Flat Roof Snow Load (Pf) = .7 * 20 * 1 * 1.2 * 1			24.0 psf
Cs = 1 (Roof Slope: 6:12)			
Sloped Roof Snow Load (Ps) = 1 x 24			24.0 psf

4. Load Combinations

DL - 0.6WL = 16.3 - .6*22.38 =		4.3 psf down
.75 (DLr + Wldown) = .75 (16.3 + 110) =		19.7 psf
DLr +.75(.6WLdown+LLr) = DLr + .75(.6*10 + 30) =		43.3 psf
DLr +.75(.6WLdown+SL) = DLr + .75(.6*10 + 24) =		38.8 psf
DLr + LLr = 16.3 + 30 =		46.3 psf
DL + SL = 16.3 + 24 =		40.3 psf
Worst Case Scenarios		
Use downward pressure of		46.3 psf
Use wind uplift pressure of	(There is no uplift loads)	4.3 psf

5. Calculations

CTB Gravity Loads to Column (Shear)

46.3 psf x 10 ft x 16 ft/2 =		3704 lbs
Wood bears on 0.5" thick steel plate 5 x 5.5 x 650 =		17875 lbs
36 - 0.25" bolts - 3.16" thick steel	<= 1.0 = OKAY	0.207
Shear of metal tube steel psi x .4 x .187: x 36 faces x 36 bolts =		10771 lbs
	<= 1.0 = OKAY	0.344

Check Screws (Uplift)

Uplift Pressure	Uplift check with 25 psf	25
Uplift Force Total		2000
Quantity of Screws		36
Force per Screw		55.56
Maximum Allowable Force per Screw		230
	<= 1.0 = OKAY	0.242

Check Bolts (Uplift)

Uplift Pressure	Uplift check with 25 psf	25
Uplift Force Total		2000
Quantity of Bolts (5/5" diameter)		2
Force per Bolt		1000.00
Max Allowable Force perBolt (NDS Parallel to Grain)		1900
	<= 1.0 = OKAY	0.526

Check footings

Calculated load

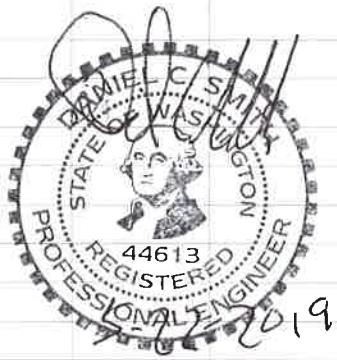
Tributary area supported by each post is 10 ft * 16 ft/2 =		80.0 ft^2
Volume of Footing =		32.52 ft^3
Weight of Footing =		4877 lbs
46.3 psf x 80 ft^2 = 3704 lbs + Weight of Footing =		8581 lbs

Calculated soil resistance

2000 psf soil bearing x (3 ft Ø)^2 x Pi/4 =		14138 lbs
	<= 1.0 = OKAY	0.607
Required Area of Footing = Calculated Load / Soil Bearing =		4.29
Provided Area of Footing = (Footing Diameter^2 * Pi) / 4		7.07
	<= 1.0 = OKAY	0.61

Wind Uplift is negligible.

7. Check Roof Deck Boards



2x6 Tongue and groove boards - SYP #1		
Modulus of Inertia (I) = 5.5 x 1.5^3/12 =		1.55 in^4
Section Modulus (S) = 5.5 x 1.5^2/6=		2.06 in^3
Worst case load combination is =		46.3 psf
Uniform load per board (w)= 46.3 x 5.5 in/(12 in/ft)		21.2 plf
Cd =		1.15
Bending Stress 10' Span		
Moment (M) = w*L^2/8ftx12in/ft		3180.0 lbs-in
fb (bending stress) = M/(S*Cd)		1340.7 psi
Fb (allowable bending stress) =		1350.0 psi
	<= 1.0 = OKAY	0.993

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Project Name: Mercer Island Wa DCSPE 7196
Location: Mercer Island Wa

Curved Taper Beam Calculation

Material Properties

Fb	2400	psi	F'b	2275.62	psi	
Fv	200	psi	F'v	223	psi	
Frt	66.67	psi	F'rt	67.08	psi	
Cm	0.97		Cfbend	0.84		
Cd	1.15		Cftan	0.88		
Cf	1		Cr	0.85		
Ey	1800000		E'	1620000	psi	

Structural Dimensions

Length/Span (L)		16	ft	(l)	192	in
Trib Width/Spacing		10	ft		120	in
Top Pitch/Slope (P)		6	:12		26.57	degrees
A=	0.135	D=	2.76			
B=	0.060	E=	-2.7554426			
C=	0.120	F=	3.19			

Estimated Beam Size

width/b	5	in	vert end depth/de	7	in	
Radius (R)	16	ft	vert CL depth/dc	30	in	
	192	in				

Structural Loads

DL=	20	psf	w=	500	plf
SL=	15	psf			
LL=	30	psf			

Stress Factors

Radial Stress Factor	Kr	0.1462944	A+B(dc/Rm*12)+C(dc/Rm*12)^2
Bending Stress Factor	Ktheta	2.43	D+E(dc/Rm*12)+F(dc/Rm*12)^2
Radial Stress Red Factor	Cr	0.9371981	

Design of CTB

1. Determine minimum end depth OK

SHEAR AT END OF BEAM	Rv=	4000	lbs	wL/2	
UNADJUSTED END DEPTH?	d=	5.4	in	3Rv/2bF'v	
EFFECTIVE LENGTH FOR SHEAR	Le=	15.1	ft	L-2d	
SHEAR BASED ON EFFECTIVE LENGTH	V=	3776	lbs	wLe/2	
MINIMUM END DEPTH	**de=**	5.1	**in**	3V/2bF'v	

2. Determine approximate trial centerline depth dcb from the bending stress limitation

M=	192000	in-lb	wL^2/8
F'b=	2275.62	psi	Fb*Cf
dcb=	16.7	**in**	sqrt(6MD/bF'b)

3. Determine trial minimum centerline depth dcdelta from the deflection limitation

deltamax	1.07	in	l/180
deff=	4.56	in	((Wl^3)/(6.4*E'*b*deltamax*cosT^3))^(1/3)
dcdelta=	4.0	**in**	2deff-de

4. Determine trial minimum centerline depth dcrt from radial stress limitation.

dcrt=	22.4	in	sqrt(6MKr/bF'rt)

To reduce depth design for radial reinforcement, using maximum radial tension stress Fv/3

dcrt=	21.0	**in**	sqrt(6MKr/(b(Fv/3)*1.15))

5. Determine height of apex ha, trial bottom slope thetaB, and soffit radius R

HEIGHT OF APEX POINT	ha=	4.58	ft
LARGEST DEPTH	**dc=**	30.0	**in**
HEIGHT OF SOFFIT MIDSPAN	hs=	2.08	ft
MAXIMUM BOTTOM SLOPE	max bot sl	29.19	º
MAX EFFECTIVE BOTTOM SLOPE	thetaB ma	26.6	º
MINIMUM BOTTOM SLOPE	thetaB mir	25.3	º
TRIAL BOTTOM SLOPE	trial bot sl	25.3	º
EFFECTIVE SOFFIT RADIUS	R=	17.25	ft

6. Find the following values based on the values of thetaB and R determined in step 5

a) length of tapered leg

lt=	14.04	in	l/2 - RsinB	Lt	1.1 ft

b) Ratio of Span Length to distance between tangent points

lc=	163.9	in	l - 2lt	Lc	13.66 ft
l/lc=	1.17				

c) Depth of beam at tangent points

dt=	7.4	in	de + lt(tanT - tanB)

d)

Rm=	17.3	in	R+DC/24
dc/Rm=	1.74		

e)

ftheta=	256	psi	6M/bdc^2

7. Check maximum deflection

deb=	12.1		(de+dc)(0.5+0.735*tanT)-(1.41dctanB)
deltaC=	0.55	in	5Wl^3/32E'bdeb^3

1.06 > 0.55 = OK

8. Check stresses			
a) Bending stress at centerline			
fb=	622	psi	ktheta*ftheta
F'b=	1911.52		FbCdCf
	622 < 1911.52 = OK		
b) Bending stress at tangent point			
Mt=	49170		wl(lt)/2 - wlt^2/2
fbt=	1080		6Mt/bdt^2
F'b=	2002.55		F'b * Cd
	1080 < 2002.54 = OK		
c) Radial stress at centerline			
frt=	31.8	psi	KrCrf0
F'rt=	67.08	psi	
	31.83 < 67.08 = OK		

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DCSPE# 7196

5/20/2019

LOCATION Mercer Island,WA				98040	
BLDG CODE				2018	
BLDG CATEGORY				II	
Shelter Length				40.0 ft	
Shelter Width				20.0 ft	
Shelter Mean Roof Height				15.0 ft	
ASCE 7-10					
Roof Dead Load				12.0 psf	
Roof Live Load				30.0 psf	
SNOW DESIGN DATA					
Ground Snow Load (Pg)				20.0 psf	
Snow Exposure Factor (Ce)				1.0	
Snow Importance Factor (Is)				1.00	
Snow Thermal Factor (Ct)				1.2	
Flat Roof Snow Load (Pf)				24.0 psf	
Roof Slope (Cs)				1.0	
Sloped Roof Snow Load (Ps)				24.0 psf	
					shingles
WIND DESIGN DATA					
Basic Wind Speed (3-sec gust)				110 mph	
Wind Importance Factor (Iw)				1.00	
Wind Exposure Category				C	
Internal Pressure Coefficient				0.0	
Components & Cladding Wind Pressures	Z1	-12.1 psf	Z2	-22.8 psf	
	Z3	-34.9 psf			
qh =				22.38	
Wind Base Shears	Vxx	2.9 kips	Vyy	1.5 kips	

SEISMIC DESIGN DATA				
Seismic Importance Factor (Ie)		1.00		
Short Period Spectral Response Accel (Ss from maps)		1.443		
1-Sec Period Spectral Response Accel (S1 from maps)		0.488		
Seismic Site Class		D		
Design Short Period Spectral Response Accel (Sds)		0.96		0.66667
Design 1-sec Period Spectral Response Accel (Sd1)		0.49		
Seismic Design Category		D		
Basic Seismic Resisting System	CANTILEVERED COLUMN SYSTEM			
Basic Seismic Force Resisting System	TIMBER FRAMES			
Response Modification Factor (R)		1.5		
Seismic Response Coefficient (Cs)		0.64		
Seismic Base Shear (Allowable Stress Design)		7.20	kips