STRUCTURAL CALCULATIONS

42'x90' Metal Building

MVE #170669

DESERET INDUSTRIES COVER
American Fork, Utah

OCT 25 2017

Design by:

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4 pages of Calculations

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DESIGN CRITERIA

Code: 2012 International Building Code (ASCE 7-10)

A. Floor Live Load		=	NA	
B. Roof Live Load		=	20	psf
C. Roof Snow Load Data				
Ground Snow Load	P_G	=	43	psf
Flat-roof Snow Load	P_F	=	36	psf
Exposure Factor	C_E	=	1.0	
Importance Factor	I_S	=	1.0	
Thermal Factor	C_T	=	1.2	
D. Wind Design Data				
Ultimate Design Wind Speed	V_{ULT}	=	115	mph
Nominal Design Wind Speed	V_{ASD}	=	90	mph
Risk Category		=	II	
Exposure		=	C	
Internal Pressure Coefficient		=	±0.18	
Component & Cladding		=	See ASCE 7-10 Chapter 30	
E. Earthquake Design Data				
Risk Category		=	II	
Importance Factor	I_E	=	1.0	
Mapped Spectral Parameters				
S_S		=	1.581	
S_1		=	0.560	
Site Class		=	D	
Design Spectral Parameters				
S_{DS}		=	1.054	
S_{D1}		=	0.560	
Seismic Design Category		=	D	
Seismic Force Resisting System		=	OSMF, OSCBF	
Seismic Response Coefficient		=	0.301, 0.324	
Response Modification Factor		=	3.5,3.25 as per ASCE 7 Table 12.2-1	
Analysis Procedeure		=	Equivalent Lateral Force Procedure	
F. Frost Depth		=	30	inches
G. Allowable Soil Bearing Pressure		=	1500	psf

MATERIAL DESIGN STANDARDS AND STRENGTHS

Concrete

3000 P.S.I. for Foundations
3500 P.S.I. for Slabs
2500 P.S.I. used for design
Anchor Rods - ASTM F1554-36 or equal
Rebar - ASTM A615 Grade 60

Steel Shapes

Wide Flange - ASTM A992 (Fy = 50 ksi)
Tubes (HSS) - ASTM A500 Grade B (Fy = 46 ksi)
Pipes - ASTM A53 Grade B (Fy = 35 ksi)
Angles, Plates, and Channels - ASTM A36 (Fy = 36 ksi)
Cold Formed Steel Shapes (Fy = 50 ksi)

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Description: 42'x90' Metal Building
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Sidewall Footings
(Lines 2 - 5 / Grids A & B)

P_{D+L} = 15.7 kips
F_H = 3.6 kips
Uplift = 4.5 kips

Use 5.0 ft. x 5.0 ft. x 30 inch deep footing

*Note: Use a rectangle of equivalent width and area to a 16" diameter pier.

Check Soil Bearing

Moment Arm =	4.5	ft	Allowable Bearing Pressure =	1500	psf
P (total) =	15.70	kips	Top of Wall to Grade =	24	in
Overturning Moment =	16.2	kip*ft	OS Conc. to CL A.R. =	4	in
OTM Eccentricity =	12.4	inches	Pier Width =	16	in
Footing Offset =	0	inches	Pier Depth (wall included) =	12.6	in
Offset Resisting Moment =	- 0.00	kip*ft	Pier Height =	24	in
Passive Resisting Moment =	- 2.60	kip*ft	Wall Thickness =	0	in
Net Eccentricity =	10.4	inches	Wall Height =	0	in
B/6 = 10 inches	**PARTIAL BEARING**		Footing Width =	0	in
X = 3(B/2 - e) =	4.90	ft	Footing Depth =	0	in
Recheck Bearing Pressure, q (max.) =	**1281**	**psf OK**			

Offset footing 0 inches.

Sliding Resistance

Coefficient of Friction =	0.25		Wall Length for Sliding =	1.3	ft
Weight of Pier =	0.40	kips	Wall Length for Passive Res. =	1.3	ft
Weight of Soil Above Footing =	0.00	kips	Ftg. Width for Sliding/Passive =	5	ft
Weight of Spot Footing =	9.06	kips	Passive Earth Pressure =	200	psf/ft
Weight of Continuous Wall =	0.00	kips	Passive Res. (Spot Footing) =	3.13	kips
Weight of Continuous Ftg. =	0.00	kips	Passive Res. (Wall & Pier) =	0.00	kips
Sliding Resistance from Footing & Pier =	2.37	kips	Passive Res. (Cont. Ftg.) =	0.00	kips
Sliding Resistance from Soil above Ftg. =	0.00	kips	**Total Passive Resistance =**	**3.13**	**kips**
Sliding Resistance from Vertical Load =	3.93	kips	**Total Sliding Resistance =**	**6.29**	**kips**
Sliding Resistance from Wall & Ftg. =	0.00	kips	**Factor of Safety =**	**2.62**	**> 1.0 OK**

Uplift

Weight of Footing and Pier =	9.47	kips	Wall Length used for Uplift =	1.3	ft
Weight of Soil Above Footing =	0.00	kips	Cont. Ftg. Length for Uplift =	5.5	ft
Weight of Cont. Wall & Footing =	0.00	kips			
Total =	9.47	kips	**Factor of Safety =**	**2.10**	**> 1.0 OK**

Check Footing Flexure (Reinforcing in Direction of Horizontal Force)

q (min.) =	0	psf	Rebar d' =	3.5	in
OS Footing Edge from Wall =	2.167	ft	Rebar d =	26.5	in
q (at face of wall) =	726	psf	Rebar fy =	60000	psi
Moment in Footing (Mu, ULT) =	12.04	k*ft	Concrete f'c =	2500	psi
As (req'd by calc.) =	0.101	in^2	ACI 7.12 As (min) =	3.240	in^2

Opposite Direction Reinforcing

Min. Steel Ratio = 0.0018
As per ACI 7.12

Use (6) #5 bars each way top and bottom of footing.

Check Footing Shear

Shear in Footing (Vu, ULT) =	11.11	kips	
Required Thickness =	5.97	in	**OK**

For Pier Design

Nu =	**25**	**kips**	****See pier calculation**
Mu =	**12**	**kip*ft**	**on page 3.**
Vu =	**6**	**kips**	

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Description: 42'x90' Metal Building
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Concrete Column Analysis (ACI 318)

For X-Axis Flexure with Axial Compression or Tension Load
Assuming "Short", Non-Slender Member with Symmetric Reinforcing

Input

f_c' =	2500	psi
f_y =	60	ksi
d' =	2.375	in
b =	14	in
h =	14	in
ϕ =	0.65	

USE 16" Ø SOLID TUBE PIER

Loading

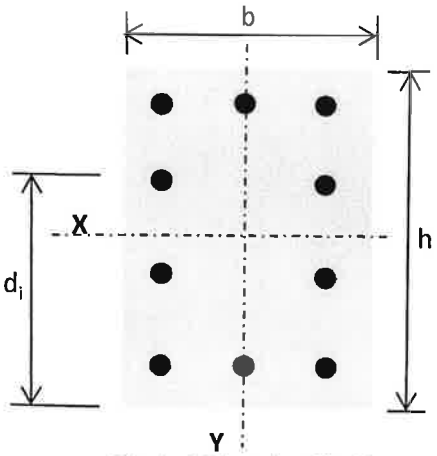
P_{ux} =	25.1	kips
M_{ux} =	11.5	kip-ft
V_{ux} =	5.8	kips

Column Geometry

Bar Size =	5	Total # of Bars	8
# of Bars b Face	3	Tie Size =	3
# of Bars h Face	3		

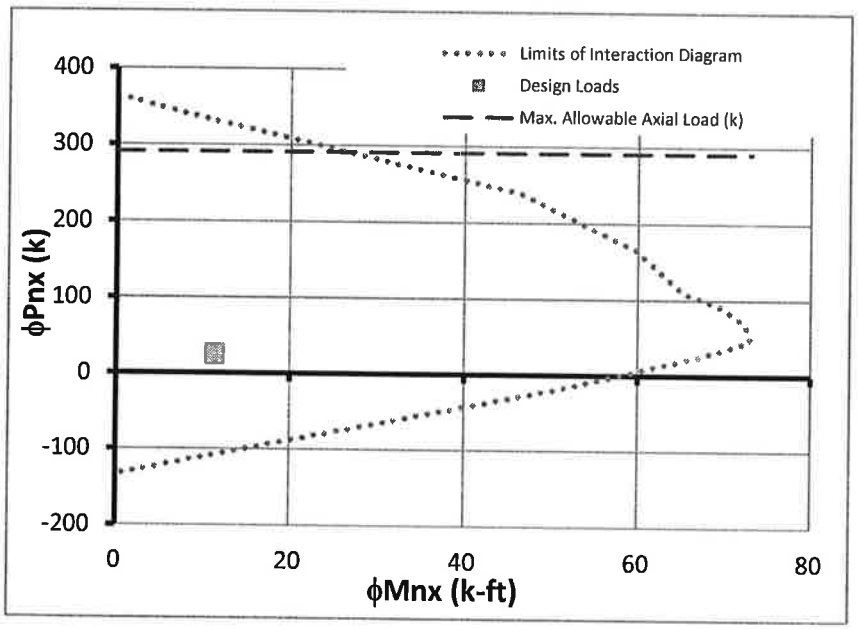
Placement of Reinforcement Steel

	d_i	A_{st}
Edge Layer (d_1)	11.63	0.93
Interor Layer (d_2)	7.00	0.62
Interor Layer (d_3)	0.00	0.00
Edge Layer (d_4)	2.38	0.93



Typical Member Section

X-AXIS INTERACTION DIAGRAM



DESIGN LOADS FALL WITHIN THE LIMITS OF THE INTERACTION DIAGRAM, THEREFORE, USE (8) # 5 VERTICAL BARS IN COLUMN.

Shear Design ϕV_c = 12.988 $\phi V_c/2$ = 6.4942 $V_u < \phi V_c/2$

If $V_u < \phi V_c/2$ then Vertical Spacing of ties shall not exceed the least of:

16 x (longitudal bar diameters)	=	10	in
48 x (tie bar diameter)	=	18	in
Least dimension of column	=	14	in

If $V_u > \phi V_c/2$ then vertical spacing of ties shall not exceed the least of:

s max =	$A_v f_y/(0.75\sqrt{(f_c')}b)$	=	25.143 in
s max =	$A_v f_y/(50b)$	=	18.857 in
s max =	$d/2 \le 24$ in	=	5.8125 in

USE # 3 TIES AT 8.00 INCHES ON CENTER WITH (3) IN THE TOP FIVE INCHES OF PIER.

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Sidewall Footings
(Lines 1 & 6 / Grids A & B)

P_{D+L} = 8.2 kips
F_H = 2.2 kips
Uplift = 2.0 kips

Use 4.5 ft. x 4.5 ft. x 30 inch deep footing

*Note: Use a rectangle of equivalent width and area to a 16" diameter pier.

Check Soil Bearing

Moment Arm =	4.5	ft	Allowable Bearing Pressure =	1500	psf
P (total) =	15.9	kips	Top of Wall to Grade =	24	in
Overturning Moment =	9.9	kip*ft	OS Conc. to CL A.R. =	4	in
OTM Eccentricity =	7.5	inches	Pier Width =	16	in
Footing Offset =	0	inches	Pier Depth (wall included) =	12.6	in
Offset Resisting Moment =	- 0.00	kip*ft	Pier Height =	24	in
Passive Resisting Moment =	- 2.34	kip*ft	Wall Thickness =	0	in
Net Eccentricity =	5.7	inches	Wall Height =	0	in
B/6 = 9 inches **OK**			Footing Width =	0	in
			Footing Depth =	0	in

Recheck Bearing Pressure, q (max.) = 1285 psf OK

Offset footing 0 inches.

Sliding Resistance

Coefficient of Friction =	0.25		Wall Length for Sliding =	1.3	ft
Weight of Pier =	0.40	kips	Wall Length for Passive Res. =	1.3	ft
Weight of Soil Above Footing =	0.00	kips	Ftg. Width for Sliding/Passive =	4.5	ft
Weight of Spot Footing =	7.34	kips	Passive Earth Pressure =	200	psf/ft
Weight of Continuous Wall =	0.00	kips	Passive Res. (Spot Footing) =	2.81	kips
Weight of Continuous Ftg. =	0.00	kips	Passive Res. (Wall & Pier) =	0.00	kips
Sliding Resistance from Footing & Pier =	1.94	kips	Passive Res. (Cont. Ftg.) =	0.00	kips
Sliding Resistance from Soil above Ftg. =	0.00	kips	**Total Passive Resistance =**	**2.81**	**kips**
Sliding Resistance from Vertical Load =	2.05	kips	**Total Sliding Resistance =**	**3.99**	**kips**
Sliding Resistance from Wall & Ftg. =	0.00	kips	**Factor of Safety =**	**3.09**	**> 1.0 OK**

Uplift

Weight of Footing and Pier =	7.75	kips	Wall Length used for Uplift =	1.3	ft
Weight of Soil Above Footing =	0.00	kips	Cont. Ftg. Length for Uplift =	4.5	ft
Weight of Cont. Wall & Footing =	0.00	kips			
Total =	7.75	kips	**Factor of Safety =**	**3.87**	**> 1.0 OK**

Check Footing Flexure (Reinforcing in Direction of Horizontal Force)

q (min.) =	290	psf	Rebar d' =	3.5	in
OS Footing Edge from Wall =	1.917	ft	Rebar d =	26.5	in
q (at face of wall) =	861	psf	Rebar fy =	60000	psi
Moment in Footing (Mu, ULT) =	9.40	k*ft	Concrete f'c =	2500	psi
As (req'd by calc.) =	0.079	in^2	ACI 7.12 As (min) =	2.916	in^2

Opposite Direction Reinforcing

Min. Steel Ratio = 0.0018
As per ACI 7.12

Use (5) #5 bars each way top and bottom of footing.

Check Footing Shear

Shear in Footing (Vu, ULT) = 9.81 kips
Required Thickness = 5.92 in **OK**

For Pier Design

Nu =	**13**	**kips**	****Use the same pier**
Mu =	**7**	**kip*ft**	**calculation on page 3.**
Vu =	**4**	**kips**	