B160 Anchorage Calculations

T-Mobile
856199
1 CASA GRANDE ROAD PETALUMA, CA 94954

Anchorage Calculations

October 21, 2021

AMMTEC CONSULTANTS, PLLC
CONSULTING ENGINEERING SERVICES

AMMTEC PLLC CONSULTANTS

Calculation of Design Wind Loads

CBC 2019/ASCE 7-16

Height of Structure = 1.0 ft
Height of Crest above Surrounding Terraine = 1.0 ft
Height Attenuation factor (f) = 1.25 (Table 2 - 5) [40]
Height Above the Ground at the Base (z) = 1.0 ft

Exposure: C
Risk Category: II
3s Wind Gust (mph): 91
Tower Type: Other

Velocity Pressure (q_z)

Where: $q_z = 0.00256*k_z*k_{zt}*k_D*V^2*I$ (S 2.6.11.6) [2-24]

$k_z = 2.01(z/z_g)^{(2/\alpha)}$ (S2.6.5.2)[2-9]

z_g = 900 (T 2 - 4) [2-41]

α = 9.5 (T 2 - 4) [2-41]

$k_z = 2.01(z/z_g)^{(2/\alpha)}$ = 0.85 $k_{z(min)}$ = 0.85 (T 2 - 4) [2-41]

$k_{zt} = (1+ (k_e*k_t)/k_h)^2$ (S 2.6.6.2.2) [2-10]

k_e = 1.0 (T 2 - 6) [2-42]

k_t = 0.43 Topo Factor - (T 2 - 5) [2-42]

Note: As k_h increases k_{zt} goes to 1 k_h = 3.49 2.718^(1.25*1/1) (S 2.6.6.4) [14]

k_{zt} = 1

k_D = 0.95 (Table 2 - 2) [2-41]

V = 70.5 mph $V_{ASD} - 0.775_{VULT}$

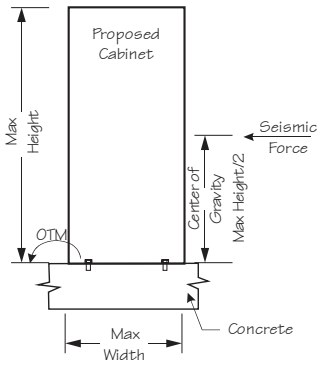
I = 1.0

q_z = 0.00256*0.85*1.3*0.95*70.525^2*1= 12.97 psf

G_h = 1.00 (S 2.6.9.1) [2-12]

Load Combination Factor for Wind = 1.20 (S 2.3.1) [8]

Use q = 15.57 psf for Design Purposes



Weight of Equipment = 295.00 lbs

Total Max Weight = 1615.00 lbs
Max height = 63.00 in
Maximum Width = 26.00 in
Maximum Depth = 26.00 in
Projected Wind Area = 63" x 26"/144 = 11.38 ft²
Wind Force on Equipment = 177.06 lbs
Seismic Force on Equipment (See Seismic) = 930.24 lbs

930lbs > 177lbs Seismic Controls

OTM = 930 x Ωo (63/2) = 73256 in-lbs
RM = 0.9(1615)(26/2) = 18896 in-lbs
Excess OTM = 4530 ft-lbs

Required Anchorage/Side = M/d = 174.2 lbs

Use Min 5/8" diameter Simpson Strong Bolt SS with a min 3-1/4"Effective embedment depth at each bolt location

Equipment Min Required Bolts = 4
Minimum Slab thickness = 8"
By Observation 1615/4 = 404lbs Uplift Ok

Overstrength Factor Ωo 2.5

Loads for Anchorage

Resisting Force (0.9 - 0.2SI 1066 lbs
Seismic Force x Ωo 2328 lbs
OTM including Overstrength Factor 6105 ft-lbs

ATC Hazards–Provided Output					
Petaluma, CA					
S_S =	1.5	S_{MS} =	1.8	S_{DS} =	1.2
S_1 =	0.6	S_{M1} =	N/A	S_{D1} =	N/A

856199 Seismic Design Requirements - Equivalent Lateral Force Procedure

IBC/CBC Section 1613 Earthquake Loads

Risk Category	II		ASCE 7-16 Table 1.5-1 [4]
Importance Factor =	1.0		ASCE 7-16 Table 1.5-2 [4]

Site Classification

Soil Site Class =	D		ASCE 7-16 Table 20.3-1 [204]

Site Coefficients

S_S = =	1.5	Mapped Spectral Accelerations: Short Period	ATC Hazards Report
S_1 = =	0.6	Mapped Sectral Accelerations: 1 sec Period	ATC Hazards Report
F_a = =	1.2	Site Coefficient	ATC Hazards Report
F_v = =	N/A	Site Coefficient	ATC Hazards Report
S_{MS} =	1.8	Max Spectral Accelerations: Short Periods	ATC Hazards Report
S_{M1} =	N/A	Max Spectral Accelerations: 1sec Period	ATC Hazards Report

Design Spectral Response Acceleration Parameters

S_{DS} =	1.200	5% Damped Spectral Acceleration: Short Period	ATC Hazards Report
S_{D1} =	N/A	5% Damped Spectral Acceleration: 1 sec Period	ATC Hazards Report
SDC =	N/A	Seismic Design Category	ATC Hazards Report

Equivalent Lateral Force Procedure

a_p =	1.000	Component Amplifaction Factor (Table 13.5-1)	ASCE 7-16 Eqn. 13.3-1 [123]
I_p =	1.000	Component Importance Factor (Section 13.1.3)	ASCE 7-16 Eqn. 13.3-1 [123]
W_p =	1615.000 lbs	Component Operating Weight	ASCE 7-16 Eqn. 13.3-1 [123]
R_p =	2.5	Component Response Mod Factor (Table 13.5-1)	ASCE 7-16 Eqn. 13.3-1 [123]
z =	1.000	Height in Structure	ASCE 7-16 Eqn. 13.3-1 [123]
h =	1.000	Height of Roof	ASCE 7-16 Eqn. 13.3-1 [123]
$F_p = (0.4a_pS_{DS}W_p)(1+2z/h)/(R_p/I_p)$		Seismic Design Force	ASCE 7-16 Eqn. 13.3-1 [123]
	$1.6S_{DS}I_pW_p$	Maximum Seismic Design Force	ASCE 7-16 Eqn. 13.3-2 [123]
	$0.3_{DS}I_pW_p$	Minimum Seismic Design Force	ASCE 7-16 Eqn. 13.3-3 [123]
$(0.4a_pS_{DS}W_p)$ =	775.200		
(1+2z/h) =	3.000		
(R_p/I_p) =	2.500		
F_p =	930.2 lbs		

Hazards by Location

Search Information

Address: Petaluma, CA, USA

Coordinates: 38.232417, -122.6366524

Elevation: 15 ft

Timestamp: 2021-10-21T22:56:26.105Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: II

Site Class: D-default

Basic Parameters

Name	Value	Description
S_S	1.5	MCE_R ground motion (period=0.2s)
S_1	0.6	MCE_R ground motion (period=1.0s)
S_{MS}	1.8	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	1.2	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.2	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.915	Coefficient of risk (0.2s)
CR_1	0.905	Coefficient of risk (1.0s)
PGA	0.6	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.72	Site modified peak ground acceleration

T_L	12	Long-period transition period (s)
SsRT	1.767	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.931	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.682	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.753	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.6	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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Company:	Ammtec Consultants	Date:	10/21/2021
Engineer:	Alan E. Money P.E.	Page:	1/5
Project:	856199		
Address:	2447 W 12th St ste #1		
Phone:	(480) 927-9696		
E-mail:			

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description: B160 Cabinet
Location: 1 CASA GRANDE ROAD PETALUMA, CA 949
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Torque controlled expansion anchor
Material: Stainless Steel
Diameter (inch): 0.625
Nominal Embedment depth (inch): 3.875
Effective Embedment depth, h_{ef} (inch): 3.250
Code report: ICC-ES ESR-3037
Anchor category: 1
Anchor ductility: Yes
h_{min} (inch): 6.18
c_{ac} (inch): 7.93
C_{min} (inch): 5.50
S_{min} (inch): 6.25

Base Material
Concrete: All-lightweight
Concrete thickness, h (inch): 8.00
State: Cracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: Yes
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 25.59 x 27.56 x 0.25

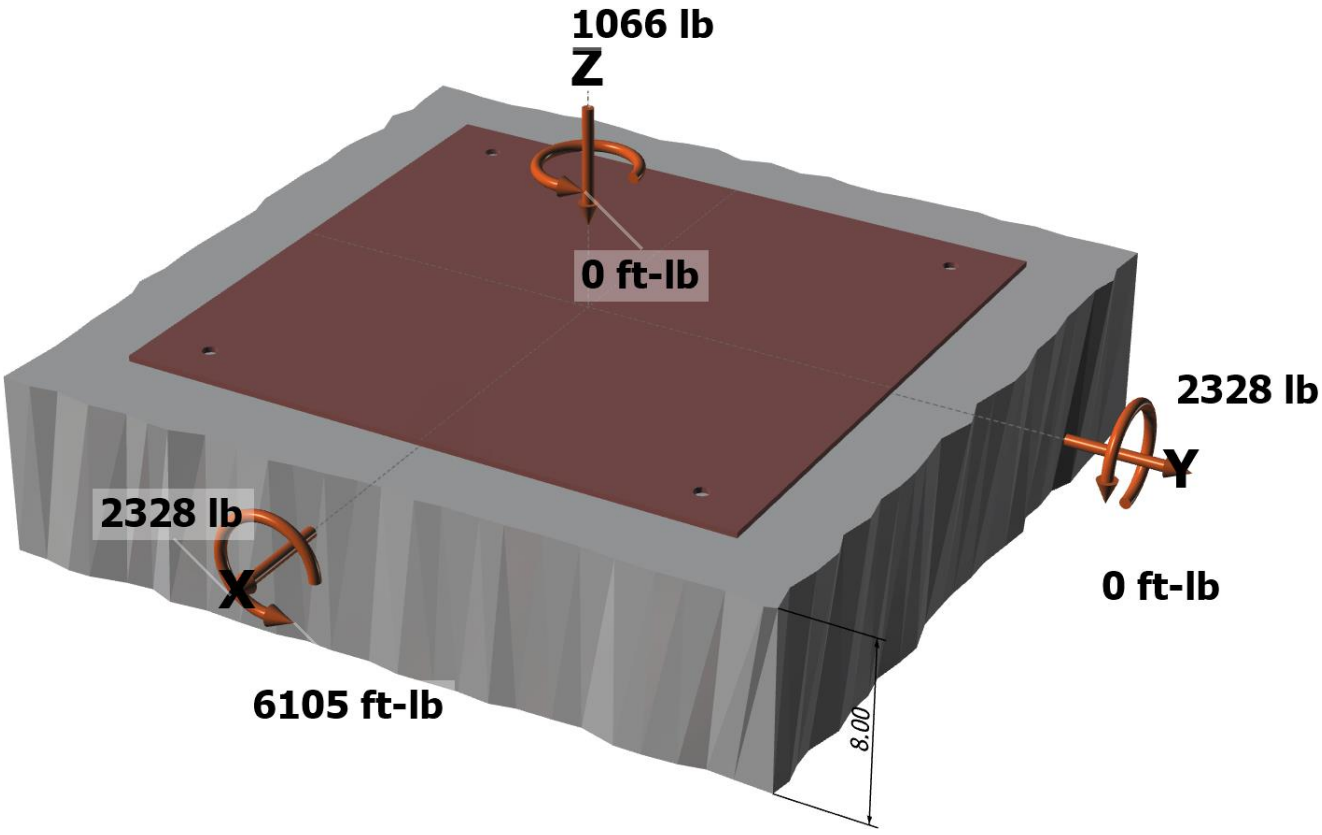
Recommended Anchor
Anchor Name: Strong-Bolt® 2 Stainless Steel - 5/8"Ø SS Strong-Bolt 2, hnom:3.875" (98mm)
Code Report: ICC-ES ESR-3037

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.2.3.4.3 (d) is satisfied
Ductility section for shear: 17.2.3.5.2 not applicable
Ω_0 factor: not set
Apply entire shear load at front row: Yes
Anchors only resisting wind and/or seismic loads: Yes

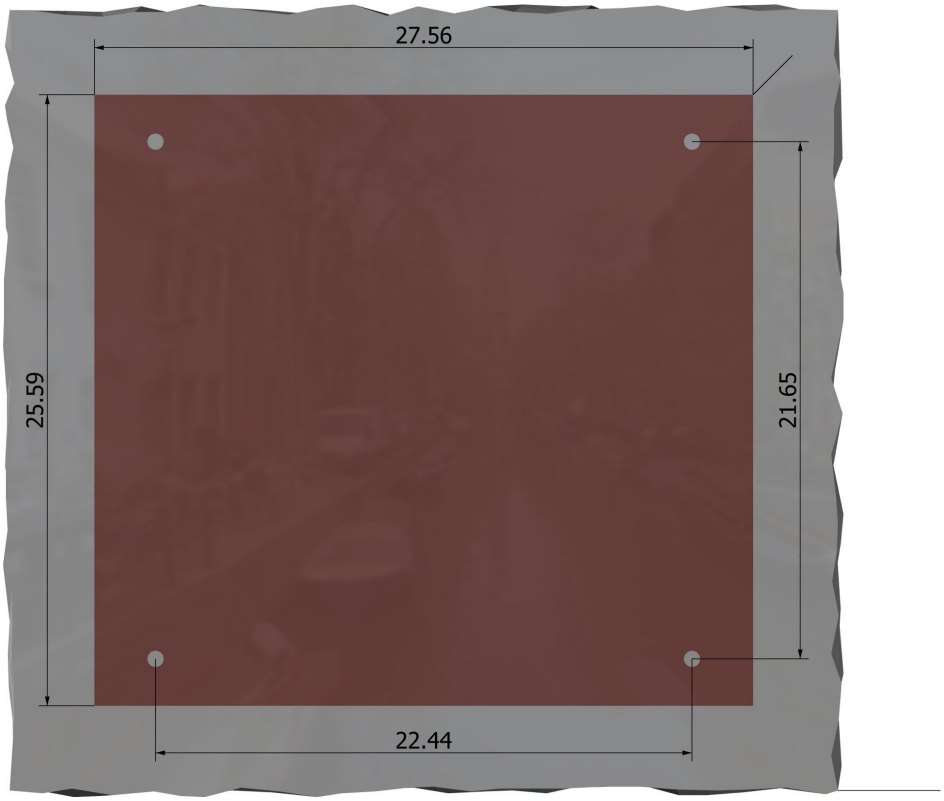
Strength level loads:

N_{ua} [lb]: -1066
V_{uax} [lb]: 2328
V_{uay} [lb]: 2328
M_{ux} [ft-lb]: 6105
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



<Figure 2>

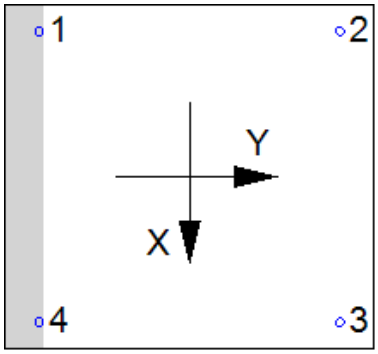


3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	582.0	582.0	823.1
2	1239.6	582.0	582.0	823.1
3	1239.6	582.0	582.0	823.1
4	0.0	582.0	582.0	823.1
Sum	2479.2	2328.0	2328.0	3292.3

Maximum concrete compression strain (‰): 0.02
Maximum concrete compression stress (psi): 96
Resultant tension force (lb): 2479
Resultant compression force (lb): 3545
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
17930	0.75	13448

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	0.60	2500	3.250	2988

$0.75\phi N_{cbg} = 0.75\phi \, (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1b)

A_{Nc} (in²)	A_{Nco} (in²)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	$0.75\phi N_{cbg}$ (lb)
190.13	95.06	-	1.000	1.000	1.00	1.000	2988	0.65	2913

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$0.75\phi N_{pn} = 0.75\phi \Psi_{c,P} \lambda_a N_p (f'_c / 2{,}500)^n$ (Sec. 17.3.1, Eq. 17.4.3.1 & Code Report)

$\Psi_{c,P}$	λ_a	N_p (lb)	f'_c (psi)	n	ϕ	$0.75\phi N_{pn}$ (lb)
1.0	0.60	4639	2500	0.40	0.65	1357

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
7892	1.0	0.65	5130

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cpg} = \phi k_{cp} N_{cbg} = \phi k_{cp} (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1b)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
2.0	380.25	95.06	1.000	1.000	1.000	1.000	2988	0.70	16733

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, øN_n (lb)	Ratio	Status
Steel	1240	13448	0.09	Pass
Concrete breakout	2479	2913	0.85	Pass
Pullout	**1240**	**1357**	**0.91**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	823	5130	0.16	Pass
Pryout	**3292**	**16733**	**0.20**	**Pass (Governs)**

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.91	0.00	91.4%	1.0	Pass

5/8"Ø SS Strong-Bolt 2, hnom:3.875" (98mm) meets the selected design criteria.

12. Warnings

- Minimum spacing and edge distance requirement of 6da per ACI 318 Sections 17.7.1 and 17.7.2 for torqued cast-in-place anchor is waived per designer option.

- Concrete breakout strength in shear has not been evaluated against applied shear load(s) per designer option. Refer to ACI 318 Section 17.3.2.1 for conditions where calculations of the concrete breakout strength may not be required.

- Per designer input, ductility requirements for tension have been determined to be satisfied – designer to verify.

- Per designer input, the shear component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor shear force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.5.2 for shear need not be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.