

STRUCTURAL DESIGN DATA:

WIND

- 1. ULTIMATE WIND SPEED: V = 130MPH
- 2. RISK CATEGORY: II
- 3. WIND EXPOSURE: C

SEISMIC

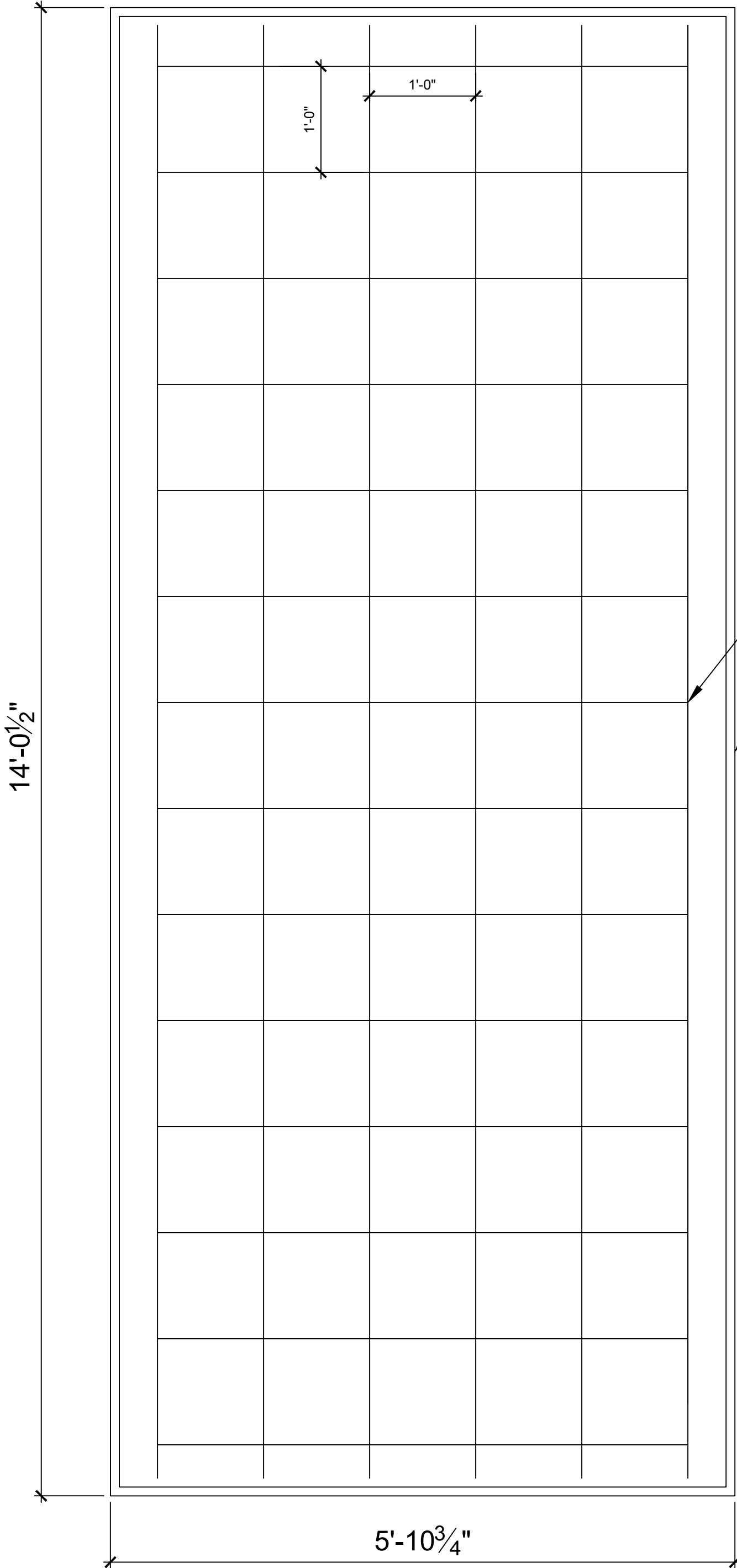
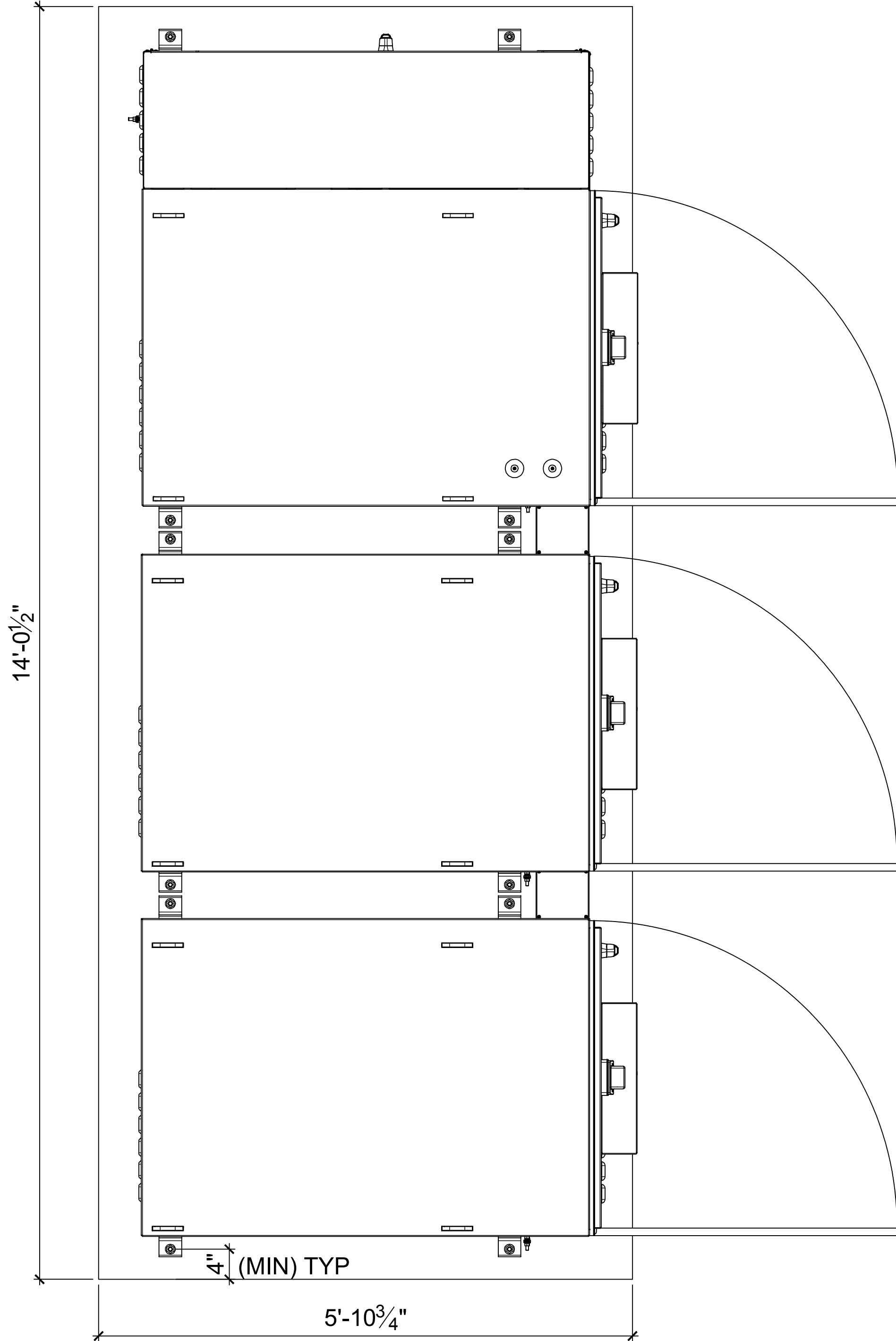
- 1. SEISMIC DESIGN CATEGORY: D
- 2. MAPPED SPECTRAL RESPONSE ACCELERATIONS: S_s = 1.398 S₁ = 0.528
- 3. SEISMIC IMPORTANCE FACTOR I = 1.00
- 4. SITE CLASS: D

APPROVED ANCHORS:

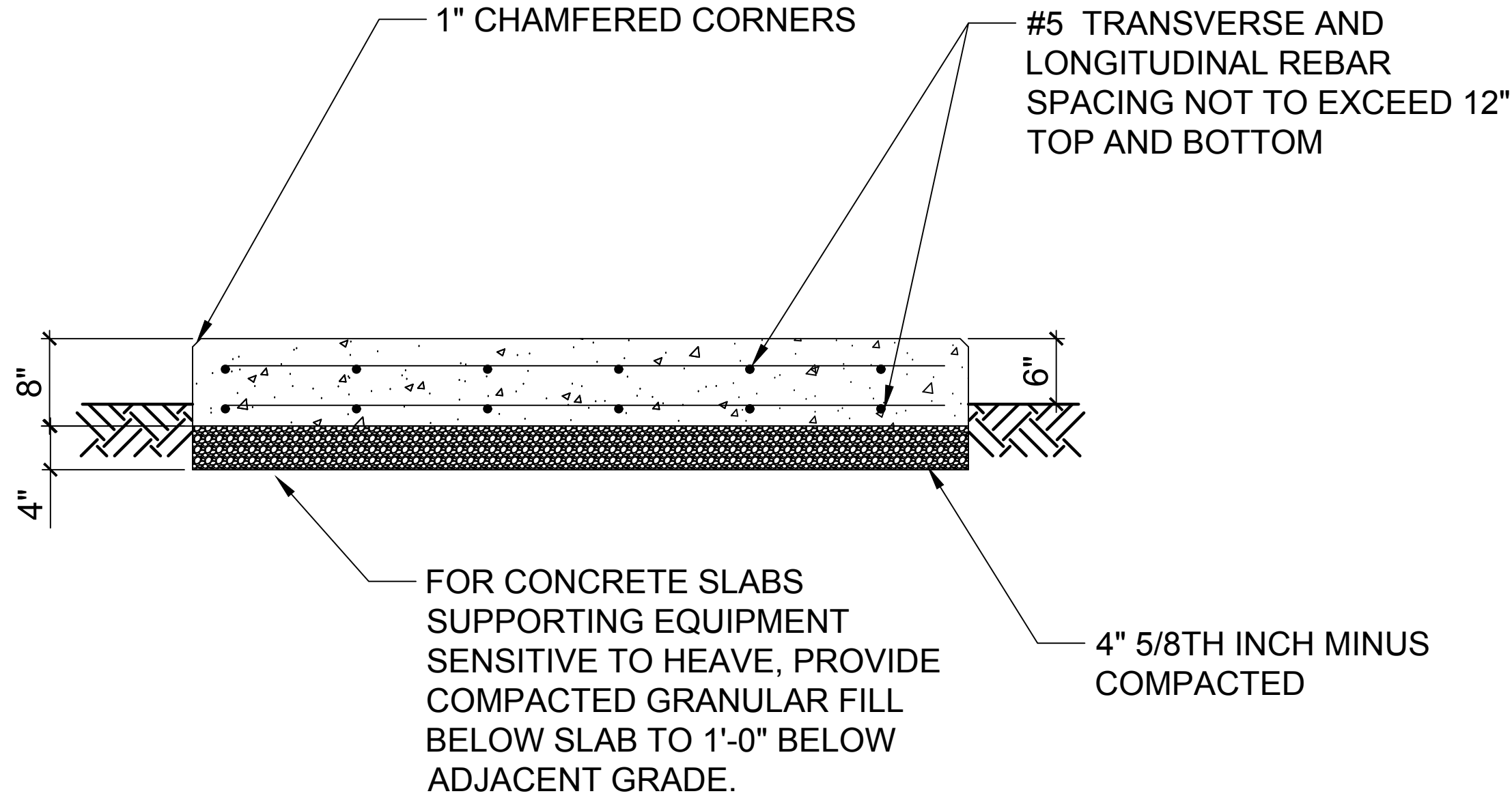
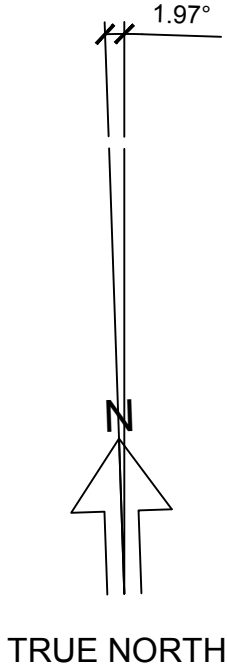
- 1. INSTALL 5/8" DIA HILTI KWIK BOLT TZ-SS 304 OR TZ-SS 316 ANCHOR WITH 3.5" EMBEDMENT (MIN). FOLLOW MANUFACTURER'S INSTALLATION INSTRUCTIONS.
- 2. FIELD DRILLED ADHESIVE ANCHORS: HILTI HIT-RE 500 V3 EPOXY ADHESIVE ANCHOR SYSTEM WITH 5/8" DIA TYPE 316 STAINLESS STEEL OR GALVANIZED ROD. FOLLOW MANUFACTURE'S INSTALLATION INSTRUCTIONS. EMBED 3.5" (MIN.)

NOTES:

- 1. ALL WORK SHOULD BE IN ACCORDANCE WITH THE CODES AND STANDARDS OF THE AMERICAN CONCRETE INSTITUTE (ACI), THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC), THE AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE), ASTM INTERNATIONAL AND CONCRETE REINFORCING STEEL INSTITUTE (CRSI).
- 2. DESIGN ASSUMES SOIL BEARING AT 1500LBS/SQFT.
- 3. CONCRETE SPECIFICATION:
 - 3.1. DESIGN STRENGTH OF 4500PSI IN 28 DAY CURE
 - 3.2. CEMENT TYPE I/II AND ASTM C33 AGGREGATE GRADATION OF 57
 - 3.3. 0.45 MAX WATER/CEMENT RATIO
 - 3.4. AIR ENTRAINMENT OF 6%
 - 3.5. NO CALCIUM CHLORIDE ADMIXTURES
- 4. REINFORCING STEEL USE GRADE 60 UNLESS NOTED.
- 5. ALL REBAR TO BE 2" MINIMUM FROM EDGE, TOP, OR SIDES AND 3" FROM BOTTOM.
- 6. CONTRACTOR TO ENSURE REBAR IS SPACED AND PROPERLY LOCATED TO AVOID INTERFERING WITH CONDUIT AND/OR ANCHORS.
- 7. THE PAD OR BASE SHALL SLOPE A MINIMUM OF 1% AND A MAXIMUM OF 2% TO ALLOW POSITIVE DRAINAGE FROM THE PAD/ BASE OR TOWARDS A DRAIN.
- 8. WELDING OF REINFORCING BARS NOT PERMITTED, USE ONLY FULL LENGTHS.
- 9. CONTRACTOR SHALL REINFORCE AROUND CONDUITS, AS REQUIRED.
- 10. PROVIDE 1" CHAMFERED CORNERS FOR ALL EXPOSED TO VIEW CORNERS.
- 11. TOP SURFACE OF FOUNDATION: LIGHT BROOM FINISH. CONCRETE FINISHING IS REQUIRED TO PRODUCE SMOOTH, EVEN SURFACES OF UNIFORM TEXTURE AND APPEARANCE, FREE FROM BULGES, DEPRESSIONS, AND OTHER IMPERFECTIONS THAT WOULD IMPACT EQUIPMENT ANCHORAGE OR FOUNDATION/BASE DRAINAGE.
- 12. USE RECOMMENDED CURING METHODS PER ACI 301 AS NEEDED RELATIVE TO TEMPERATURE, HUMIDITY AND DISCONTINUITIES IN CONCRETE.
- 13. COLD JOINTS NOT PERMITTED.
- 14. DO NOT LOCATE THE SYSTEM WHERE EXCESSIVE WATER MAY ACCUMULATE OR IN LOCATIONS SUBJECT TO FLOODING. ENSURE THAT GUTTER DOWNSPOUTS, ROOF RUNOFF, LANDSCAPE IRRIGATION, WATER SPRINKLERS, OR SUMP PUMP DISCHARGE WILL NOT CAUSE WATER TO ACCUMULATE NEAR THE SYSTEM.



#5 REBAR
12" GRID
8" CONCRETE PAD
1" CHAMFERED CORNERS



BESS PAD PLAN: SCALE: 1" : 1'-0"



DUNGENESS RIVER CENTER

PROJECT ADDRESS:
1943 W HENDRICKSON RD,
SEQUIM, WA 98382

CLIENT NAME:
JAMESTOWN S'KLALLAM TRIBE

DESIGNER:
MICHEL ZUIDWEG
MZ SOLAR CONSULTING
425-260-1425
MICHEL@MZSOLARCONSULTING.COM

ENGINEER OF RECORD:
KEVIN WINNER, PE
PACIFIC ENGINEERING & DESIGN
509-662-1161
KEVIN@PACIFICENGINEERING.NET

CONTRACTOR:
NAME
NAME OF COMPANY
PHONE NUMBER
EMAIL

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ISSUE CHART

PRELIMINARY	6/24/2025
DESIGN SET	

DESIGNER	MICHEL ZUIDWEG
CHECKED	MICHEL ZUIDWEG
DATE	JUNE 24 2025

SHEET NAME

BESS PAD PLAN

SHEET NUMBER

S-010

STRUCTURAL DESIGN DATA:

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SEISMIC

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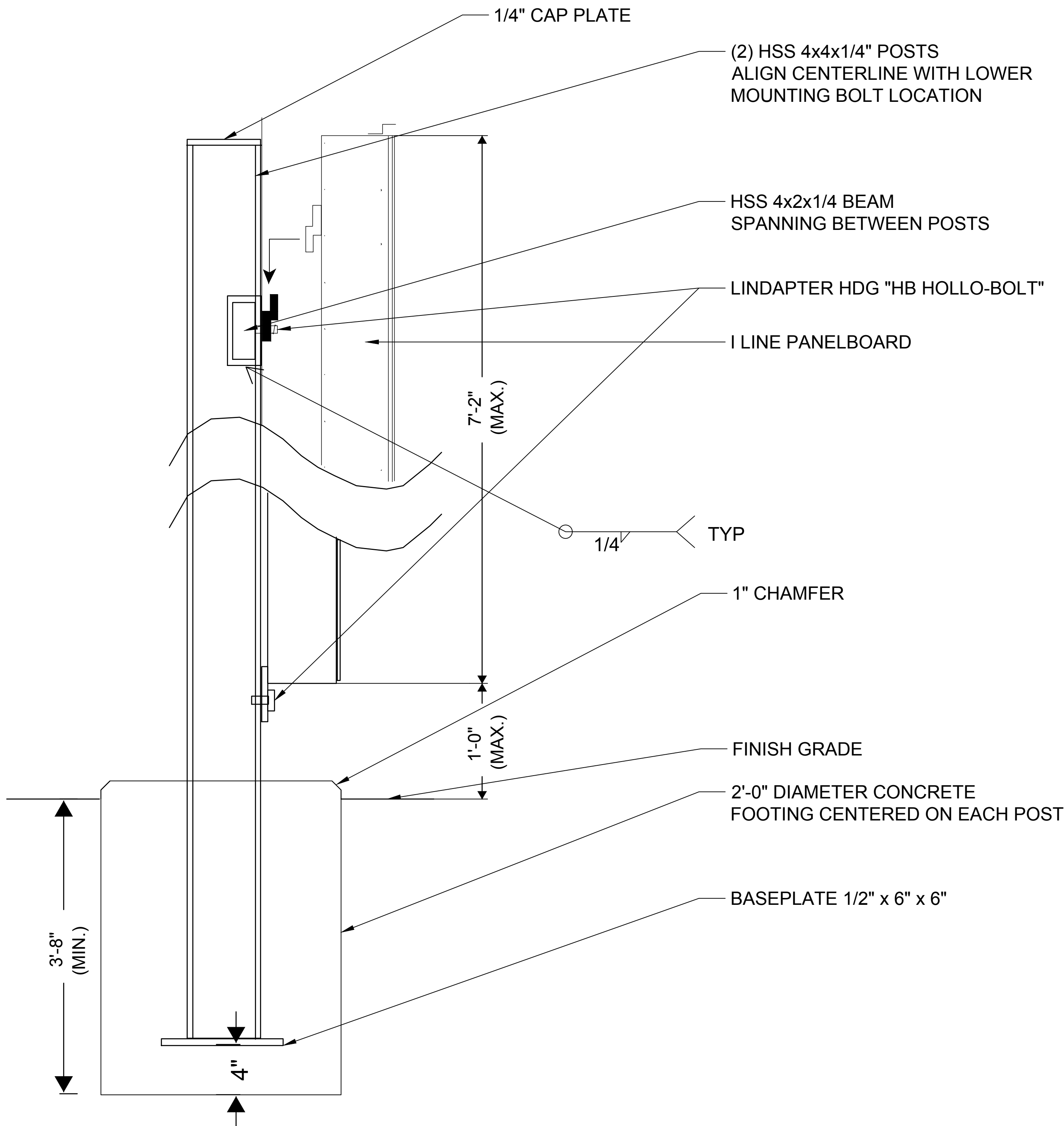
APPROVED ANCHORS FOR XFMR MOUNTING:

- 1. 3/8" KWIK BOLT TZ2-SS ANCHORS WITH 2" (MIN.) EMBED

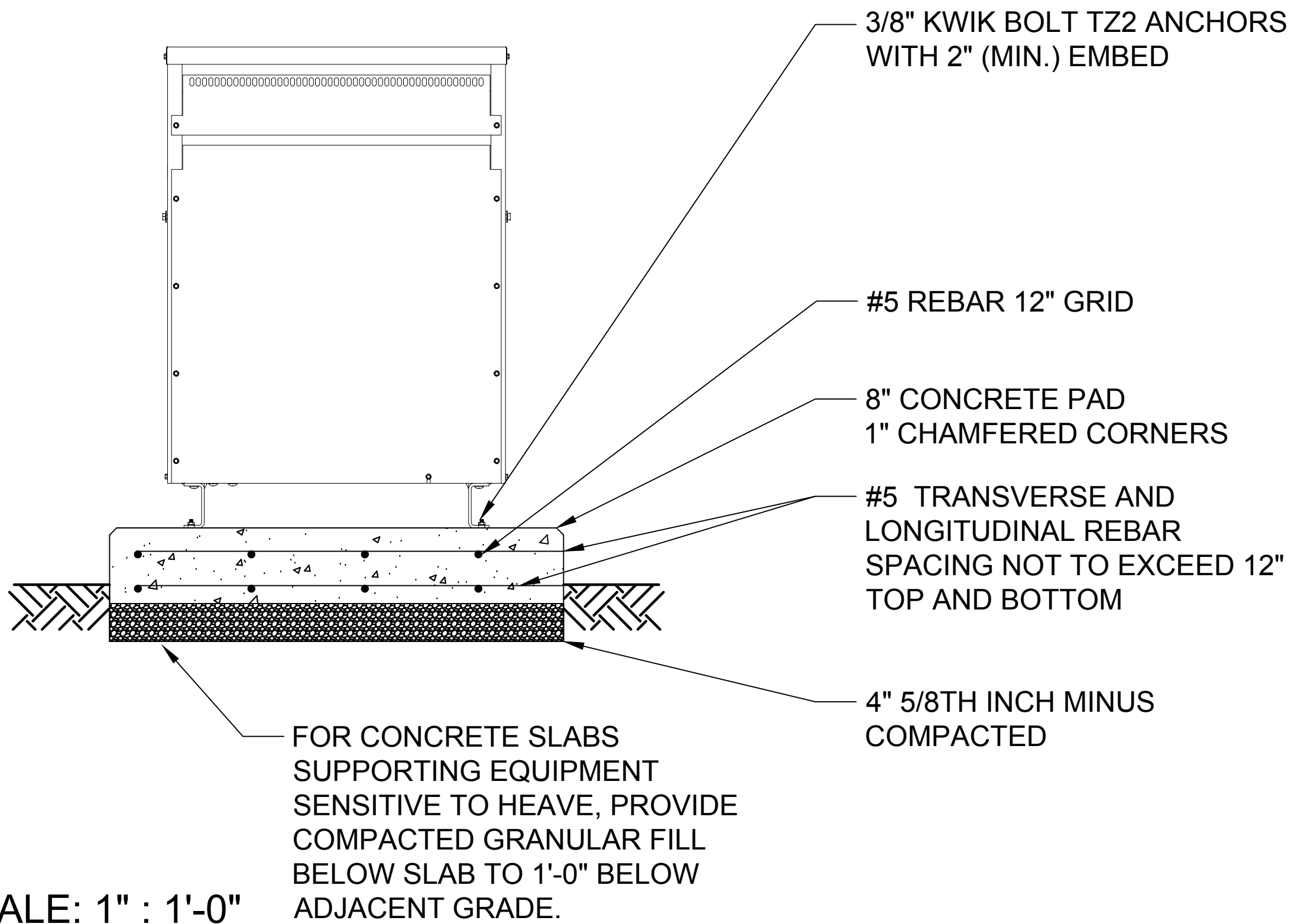
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- 15. STRUCTURAL STEEL SHALL BE ASTM A36, FY = 36,000 PSI. SQUARE AND RECTANGULAR HSS COLUMNS AND BEAMS SHALL BE ASTM A500, GRADE C, FY = 50,000 PSI. DESIGN, FABRICATION, AND ERECTION SHALL BE IN ACCORDANCE WITH THE AISC FIFTEENTH EDITION "STEEL CONSTRUCTION MANUAL" AND "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS", LATEST EDITION. ALL STEEL SHALL BE GIVEN ONE SHOP COAT OF APPROVED PRIMER PAINT AND ONE SHOP COAT OF APPROVED FINISH PAINT. CONTRACTOR SHALL TOUCH UP PAINT ALL AREAS EITHER NOT SHOP PAINTED OR DAMAGED BY FIELD WELDING OR OTHERWISE DAMAGED.

I LINE PANELBOARD MOUNTING AND ELEVATION



SCALE: 3" : 1'-0"



SCALE: 1" : 1'-0"



DUNGENESS RIVER CENTER

PROJECT ADDRESS:
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JAMESTOWN S'KLALLAM TRIBE

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MZ Solar Consulting

ISSUE CHART

PRELIMINARY 6/24/2025
DESIGN SET

DESIGNER MICHIEL ZUIDWEG
CHECKED MICHIEL ZUIDWEG
DATE JUNE 24 2025

SHEET NAME
XFMR PAD AND
PANELBOARD SUPPORT

SHEET NUMBER
S-011

STRUCTURAL CALCULATIONS

**DUNGENESS RIVER CENTER
1943 W HENDRICKSON RD
SEQUIM, WASHINGTON 98382**

FOR

MZ Solar Consulting



BY



200 South Columbia Street, Suite 300
Wenatchee, Washington 98801
P 509.662.1161 | F 509.663.8227

Kevin Winner, PE
Professional Engineer

Project No. 25102.0SA
June 25, 2025

ASCE Hazards Report

Address:

1943 W Hendrickson Rd
Sequim, Washington
98382

Standard:

ASCE/SEI 7-22

Risk Category: II

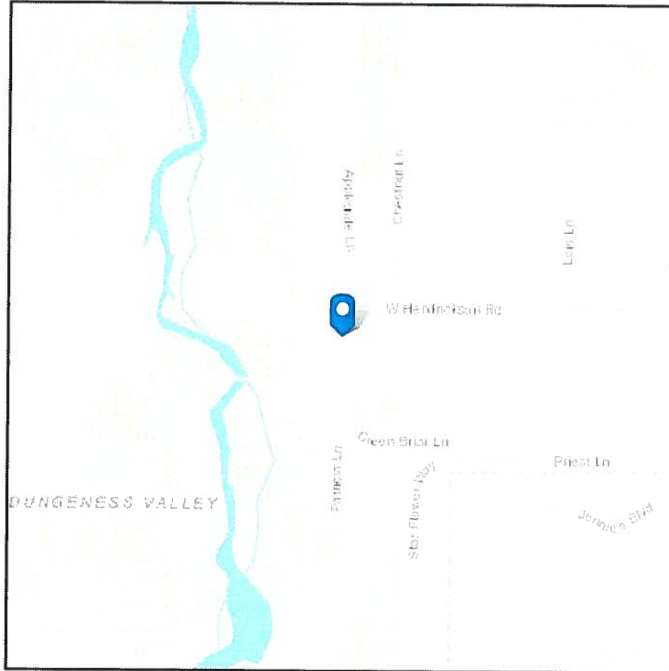
Soil Class:

D - Stiff Soil

Latitude: 48.086338

Longitude: -123.144216

Elevation: 207.13371278969592 ft
(NAVD 88)

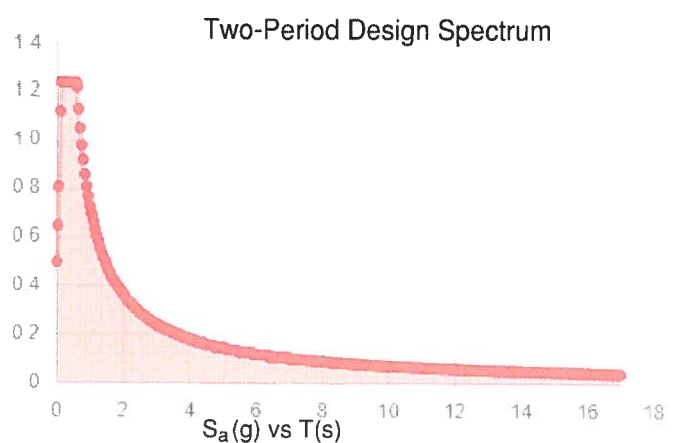
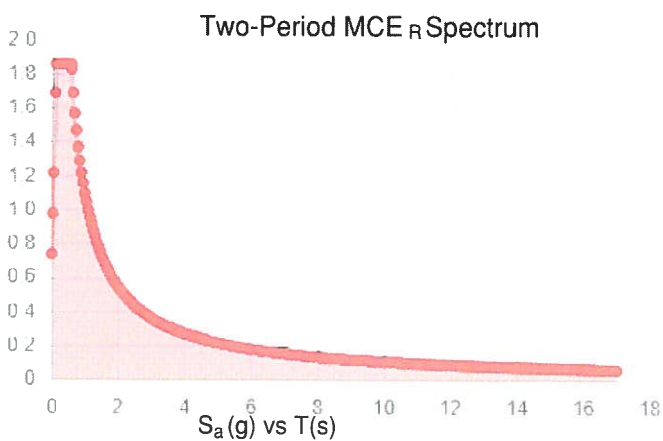
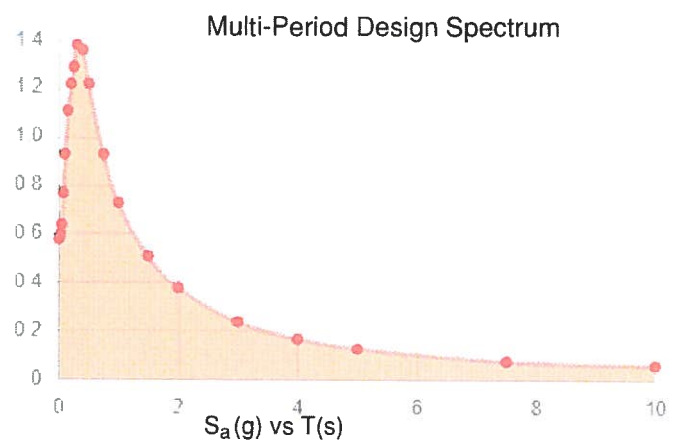
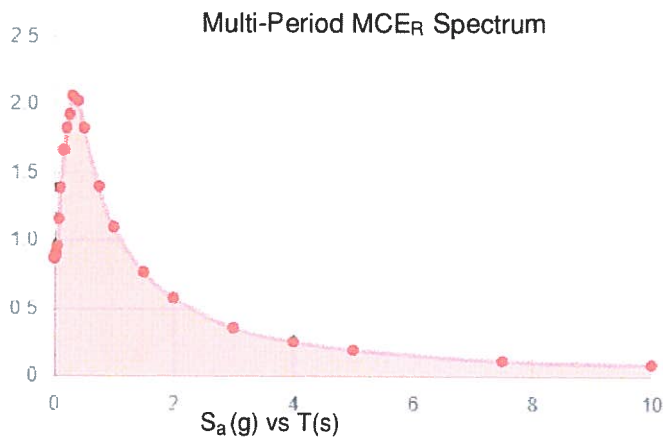


Site Soil Class: D - Stiff Soil

Results:

PGA _M :	0.74	T _L :	16
S _{MS} :	1.86	S _S :	1.5
S _{M1} :	1.1	S ₁ :	0.53
S _{DS} :	1.24	V _{S30} :	260
S _{D1} :	0.73		

Seismic Design Category: D



MCE_R Vertical Response Spectrum
Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum
Vertical ground motion data has not yet been made available by USGS.

Data Accessed: Tue Jun 10 2025

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.

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SEISMIC DESIGN - ASCE 7-16 §13.3

$$F_p = \frac{.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)} \left(1 + 2 \frac{z}{h}\right) \text{ AND } .3 S_{DS} I_p W_p \leq F_p \leq 1.6 S_{DS} I_p W_p$$

- $a_p = 1.0$
- $S_{DS} = 1.24$
- $R_p = 1.5$
- $I_p = 1.0$
- $\frac{z}{h} = 0$

- CMG-2 AC $\rightarrow W_p = 8100 \text{ lb}$

$$L = 60.5''$$

$$W = 60.2''$$

$$H = 99.4''$$

$$F_p = \frac{.4(1.0)(1.24)(8100 \text{ lb})}{\left(\frac{1.5}{1.0}\right)} \left(1 + 2(0)\right) = 2678.4 \text{ lb}$$

$$\text{LOWER LIMIT} = .3(1.24)(1.0)(8100 \text{ lb}) = 3013.2 \text{ lb}$$

$$\text{UPPER LIMIT} = 1.6(1.24)(1.0)(8100 \text{ lb}) = 16070.4 \text{ lb}$$

F_p FALLS BELOW LOWER LIMIT, USE $F_p = \text{LOWER LIMIT} = 3013.2 \text{ lb}$

- CMG-2 DC $\rightarrow W_p = 7300 \text{ lb}$

$$L = 42''$$

$$W = 60.2''$$

$$H = 99.4''$$

$$F_p = \frac{.4(1.0)(1.24)(7300 \text{ lb})}{\left(\frac{1.5}{1.0}\right)} \left(1 + 2(0)\right) = 2413.9 \text{ lb}$$

$$\text{LOWER LIMIT} = .3(1.24)(1.0)(7300 \text{ lb}) = 2715.6 \text{ lb}$$

$$\text{UPPER LIMIT} = 1.6(1.24)(1.0)(7300 \text{ lb}) = 14483.2 \text{ lb}$$

F_p FALLS BELOW LOWER LIMIT, USE $F_p = \text{LOWER LIMIT} = 2715.6 \text{ lb}$

WIND DESIGN - §29.4

$$F = q_z G C_F A_F$$

$$G = .85$$

$$q_z = .00256 K_z K_{zt} K_d K_e V^2$$

$$K_z = .85$$

$$K_{zt} = 1.0$$

$$K_d = .9$$

$$K_e = 1.0$$

$$V = 130 \text{ mph}$$

$$q_z = .00256(.85)(1.0)(.9)(1.0)(130 \text{ mph})^2 = 33.1 \text{ psf}$$

CMG 2 AC $\rightarrow w = 8100 \text{ lb}$

$$A_F = H \cdot L = (99.4 \text{ in})(60.2 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right)^2 = 41.76 \text{ ft}^2$$

$$\frac{h}{D} = \frac{H}{D} = \frac{99.4 \text{ in}}{60.2 \text{ in}} = 1.65$$

$$C_F = 1.4$$

$$F = (33.1 \text{ psf})(.85)(1.4)(41.76 \text{ ft}^2) = 1644.9 \text{ lb}$$

$F_p > F \rightarrow$ SEISMIC CONTROLS OVER WIND

CMG 2 DC $\rightarrow w = 7300 \text{ lb}$

$$A_F = H \cdot L = (99.4 \text{ in})(42 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right)^2 = 41.55 \text{ ft}^2$$

$$\frac{h}{D} = \frac{H}{D} = \frac{99.4 \text{ in}}{42 \text{ in}} = 2.37$$

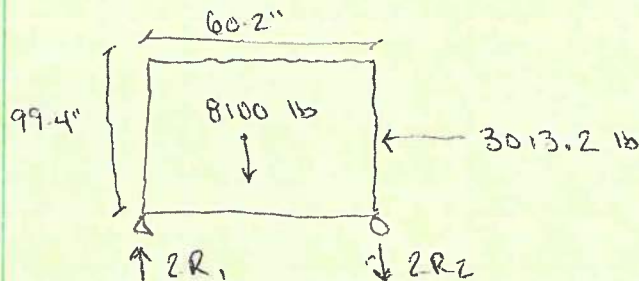
$$C_F = 1.4$$

$$F = (33.1 \text{ psf})(.85)(1.4)(41.55 \text{ ft}^2) = 1636.6 \text{ lb}$$

$F_p > F \rightarrow$ SEISMIC CONTROLS OVER WIND

DIAGRAMS -

CMG 2 AC



$$R_1 = \frac{(3013.2 \text{ lb})(99.4 \text{ in}) + (8100 \text{ lb})(\frac{60.2 \text{ in}}{2})}{2} = 3269 \text{ lb}$$

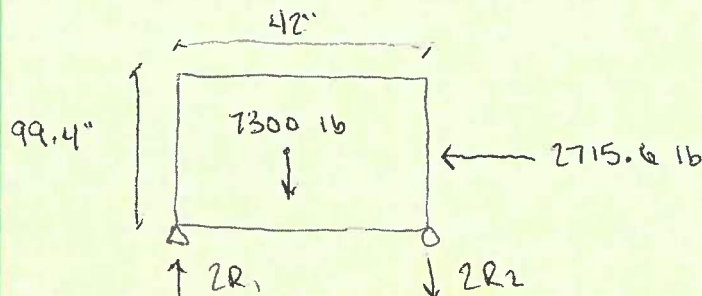
$$R_2 = \frac{(3013.2 \text{ lb})(\frac{2(60.2 \text{ in})}{2}) - (8100 \text{ lb})(\frac{60.2 \text{ in}}{2})}{2(60.2 \text{ in})} = -781 \text{ lb}$$

MAX COMPRESSION = 3269 lb

MAX TENSION = -781 lb

*NEGATIVE SO IN COMPRESSION

CMG 2 DC



$$R_1 = \frac{(2715.6 \text{ lb})(99.4 \text{ in})}{2} + \frac{(7300 \text{ lb})(42 \text{ in})}{2} = 3432 \text{ lb} \bullet$$

$$R_2 = \frac{(2715.6 \text{ lb})(99.4 \text{ in})}{2} - \frac{(7300 \text{ lb})(42 \text{ in})}{2} = -218 \text{ lb} \bullet$$

MAX COMPRESSION = 3432 lb

MAX TENSION = -218 lb

* NEGATIVE SO IN COMPRESSION

Seismic Information	
ap	1
SDS	1.6
Rp	1.5
lp	1
Ω	2
z (ft)	0
h (ft)	0
z/h	0

Wind Information	
Exposure Category	C
V (mph)	130
Kz	0.85
Kzt	1
Kd	0.9
Ke	1
G	0.85
qz (psf)	33.09696

Max Topographic Factor (Kzt)	
CMG2 AC	4.202322669
CMG2 DC	3.806151936
Maximum Possible	2.9584

CMG2 AC Unit	
Weight, Wp (lb)	8100
Length, L (in)	60.5
Width, W (in)	60.2
Height, H (in)	99.4
Max Area, As (ft^2)	41.76
Net Force Coefficient, Cf	1.4
Seismic Force, $\Omega \cdot F_s$ (lb)	6912
Max Seismic Force (lb)	20736
Min Seismic Force (lb)	3888
Controlling Seismin Force (lb)	6912
Wind Force, Fw (lb)	1382

Per Anchor Bolt	
Seismic Controls, Force (lb)	6912
Max Compression Reaction (lb)	4878
Max Tension Reaction (lb)	828
Max Shear Reaction (lb)	1728

* If (-), no tension force and only compression

Per Unit	
Vertical Force (lb)	8100
Horizontal Force (lb)	6912
0.7 * Vertical Force (lb)	5670
0.7 * Horizontal Force (lb)	4838

* Input
* Calculation

$$T_{max} = 1861 \# \quad @ S_{as} = 1.24, T_{max} = 1038 \#$$

$$V_{max} = 1728 \# \quad \Rightarrow 55\%$$

@ CENTER

$$T = 1861 \# \times 2 = 3722 \#$$

$$V = 1728 \# \times 2 = 3456 \#$$

$\Rightarrow$ SEE OUTPUT

CMG2 DC Unit	
Weight, Wp (lb)	7300
Length, L (in)	42
Width, W (in)	60.2
Height, H (in)	99.4
Max Area, As (ft^2)	41.55
Net Force Coefficient, Cf	1.4
Seismic Force, $\Omega \cdot F_s$ (lb)	6229
Max Seismic Force (lb)	18688
Min Seismic Force (lb)	3504
Controlling Seismin Force (lb)	6229
Wind Force, Fw (lb)	1375

Per Anchor Bolt	
Seismic Controls, Force (lb)	6229
Max Compression Reaction (lb)	5511
Max Tension Reaction (lb)	1861
Max Shear Reaction (lb)	1557

* If (-), no tension force and only compression

Per Unit	
Vertical Force (lb)	7300
Horizontal Force (lb)	6229
0.7 * Vertical Force (lb)	5110
0.7 * Horizontal Force (lb)	4361

	1.2	1.25	1.3
100	SC	SC	SC
110	2.48	2.58	2.68
120	2.08	2.17	2.25
130	1.77	1.85	1.92
140	1.53	1.59	1.66
150	1.33	1.39	1.44
160	1.17	1.22	1.27
170	1.04	1.08	1.12
V (mph)	* SC = Seismic will always contro		

	1.2	1.25	1.3
100	2.71	2.83	2.94
110	2.24	2.34	2.43
120	1.88	1.96	2.04
130	1.61	1.67	1.74
140	1.38	1.44	1.50
150	1.21	1.26	1.31
160	1.06	1.10	1.15
170	0.94	0.98	1.02
V (mph)	* SC = Seismic will always contro		

CMG2 AC Unit						SDS
1.35	1.4	1.45	1.5	1.55	1.6	
SC	SC	SC	SC	SC	SC	
2.79	2.89	SC	SC	SC	SC	
2.34	2.43	2.51	2.60	2.69	2.77	
1.99	2.07	2.14	2.22	2.29	2.36	
1.72	1.78	1.85	1.91	1.97	2.04	
1.50	1.55	1.61	1.66	1.72	1.78	
1.32	1.37	1.41	1.46	1.51	1.56	
1.17	1.21	1.25	1.30	1.34	1.38	

l design

CMG2 DC Unit						SDS
1.35	1.4	1.45	1.5	1.55	1.6	
SC	SC	SC	SC	SC	SC	
2.52	2.62	2.71	2.80	2.90	SC	
2.12	2.20	2.28	2.36	2.43	2.51	
1.81	1.87	1.94	2.01	2.07	2.14	
1.56	1.62	1.67	1.73	1.79	1.85	
1.36	1.41	1.46	1.51	1.56	1.61	
1.19	1.24	1.28	1.33	1.37	1.41	
1.06	1.10	1.13	1.17	1.21	1.25	

l design

CMG2 DC Unit	
Weight, Wp (lb)	7300
Length, L (in)	42
Width, W (in)	60.2
Height, H (in)	99.4
Max Area, As (ft^2)	41.55
Ta	0.098
a1	2.5
a2	0
Hf	1
Seismic Force, Fp (lb)	2414
Max Seismic Force (lb)	14483.2
Min Seismic Force (lb)	2715.6
Controlling Seismic Force (lb)	2716
Wind Force, Fw (lb)	2132

Per Anchor Bolt	
Seismic Controls, Force (lb)	2716
Max Compression Reaction (lb)	3432
Max Tension Reaction (lb)	-218
Max Shear Reaction (lb)	679

* If tension (-), only compression

Per Unit	
Vertical Force (lb)	7300
Horizontal Force (lb)	2716
0.7 * Vertical Force (lb)	5110
0.7 * Horizontal Force (lb)	1901

Transformer	
Weight, Wp (lb)	935
Length, L (in)	31.5
Width, W (in)	29.5
Height, H (in)	44.5
Max Area, As (ft^2)	9.73
Ta	0.053
a1	2.5
a2	0
Hf	1
Seismic Force, Fp (lb)	309
Max Seismic Force (lb)	1855.04
Min Seismic Force (lb)	347.82
Controlling Seismic Force (lb)	348
Wind Force, Fw (lb)	499

Per Anchor Bolt	
Wind Controls, Force (lb)	499
Max Compression Reaction (lb)	422
Max Tension Reaction (lb)	-45
Max Shear Reaction (lb)	125

* If tension (-), only compression

Per Unit	
Vertical Force (lb)	935
Horizontal Force (lb)	499
0.7 * Vertical Force (lb)	655
0.7 * Horizontal Force (lb)	350

RECTANGULAR SPREAD FOOTING ANALYSIS

For Assumed Rigid Footing with from 1 To 8 Piers
Subjected to Uniaxial or Biaxial Eccentricity

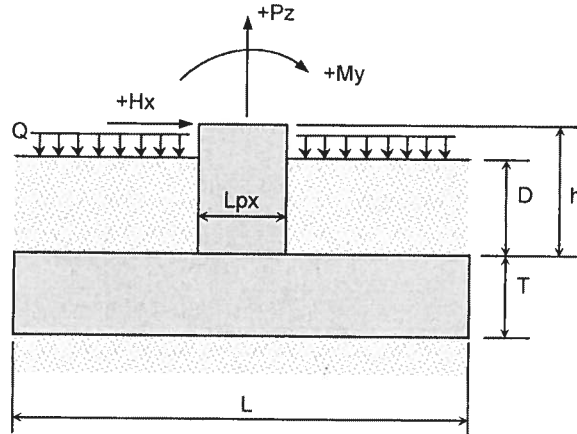
Job Name:	MZ Solar	Subject:	Battery Footing
Job Number:	25102.0SA	Originator:	LP
		Checker:	KWW

Input Data:

$$\gamma_{ps} = 1.6$$

Footing Data:

Footing Length, L =	14.000	ft.
Footing Width, B =	5.833	ft.
Footing Thickness, T =	0.667	ft.
Concrete Unit Wt., γ_c =	0.150	kcf
Soil Depth, D =	0.000	ft.
Soil Unit Wt., γ_s =	0.120	kcf
Pass. Press. Coef., K_p =	3.000	
Coef. of Base Friction, μ =	0.400	
Uniform Surcharge, Q =	0.000	ksf

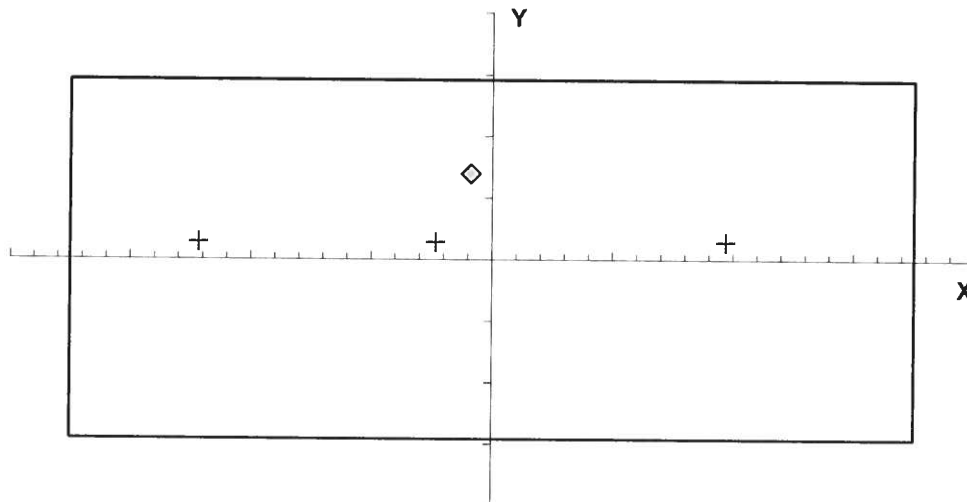


Pier/Loading Data:

Number of Piers = 3

Nomenclature

	Pier #1	Pier #2	Pier #3					
Xp (ft.) =	-4.880	-0.938	3.859					
Yp (ft.) =	0.292	0.292	0.292					
Lpx (ft.) =								
Lpy (ft.) =								
h (ft.) =	4.142	4.142	4.142					
Pz (k) =	-7.30	-7.30	-8.10					
Hx (k) =								
Hy (k) =	2.45	2.45	2.72					
Mx (ft-k) =								
My (ft-k) =								



FOOTING PLAN

Results:

Total Resultant Load and Eccentricities:

$\Sigma P_z =$	-30.87	kips
$e_x =$	-0.36	ft. ($\leq L/6$)
$e_y =$	1.40	ft. ($> B/6$)

Overturning Check:

$\Sigma M_{rx} =$	83.40	ft-kips
$\Sigma M_{oy} =$	-36.68	ft-kips
$FS(ot)x =$	2.274	(≥ 1.5)
$\Sigma M_{ry} =$	57.17	ft-kips
$\Sigma M_{ox} =$	0.00	ft-kips
$FS(ot)y =$	N.A.	

Sliding Check:

$Pass(x) =$	0.47	kips
$Frict(x) =$	12.35	kips
$FS(slid)x =$	N.A.	
$Passive(y) =$	1.12	kips
$Frict(y) =$	12.35	kips
$FS(slid)y =$	1.765	(≥ 1.5)

Uplift Check:

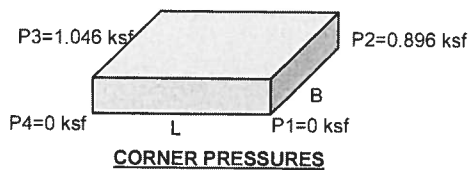
$\Sigma P_z(down) =$	-30.87	kips
$\Sigma P_z(uplift) =$	0.00	kips
$FS(uplift) =$	N.A.	

Bearing Length and % Bearing Area:

Dist. x =	97.560	ft.
Dist. y =	4.882	ft.
Brg. Ly1 =	4.182	ft.
Brg. Ly2 =	4.882	ft.
%Brg. Area =	77.69	%
Biaxial Case =	Case 2	$6 \cdot e_x/L + 6 \cdot e_y/B = 1.594$

Gross Soil Bearing Corner Pressures:

P1 =	0.000	ksf
P2 =	0.896	ksf
P3 =	1.046	ksf
P4 =	0.000	ksf



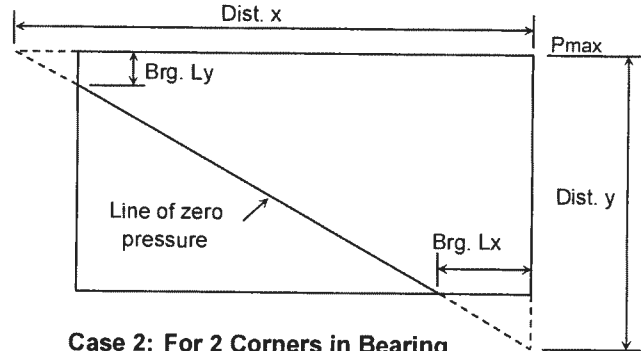
Maximum Net Soil Pressure:

$$P_{max(net)} = P_{max(gross)} - (D+T) \cdot \gamma_s$$

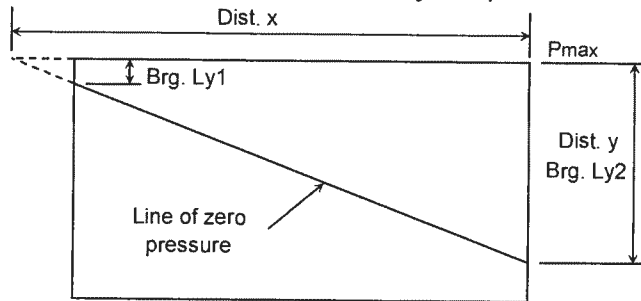
$$P_{max(net)} = 0.966 \text{ ksf}$$

Nomenclature for Biaxial Eccentricity:

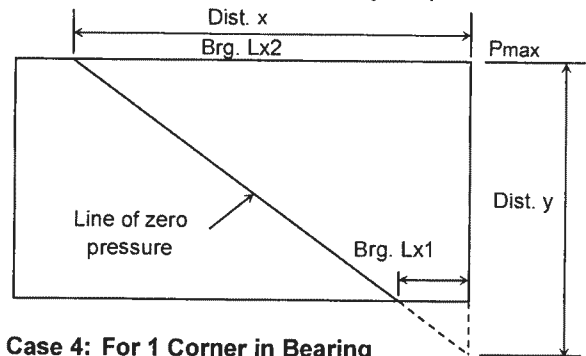
Case 1: For 3 Corners in Bearing
(Dist. x > L and Dist. y > B)



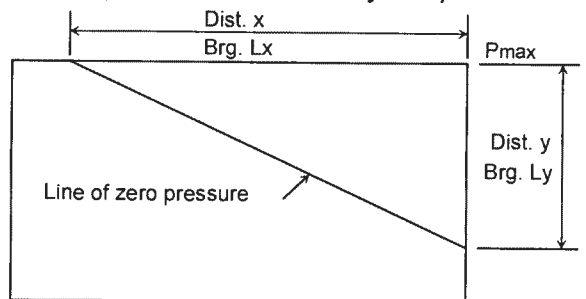
Case 2: For 2 Corners in Bearing
(Dist. x > L and Dist. y $\leq$ B)



Case 3: For 2 Corners in Bearing
(Dist. x $\leq$ L and Dist. y > B)

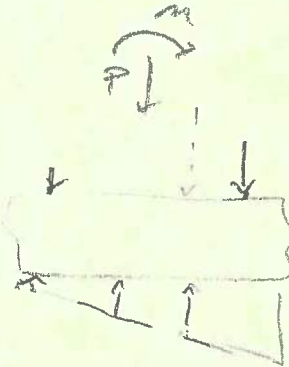


Case 4: For 1 Corner in Bearing
(Dist. x $\leq$ L and Dist. y $\leq$ B)



$P_{max(net)} < 150 \text{ psf}$ OK

FOOTING DESIGN:



$$M_u = \frac{7.62 \text{ k}}{0.7} (4.142') = 45 \text{ k-ft}$$

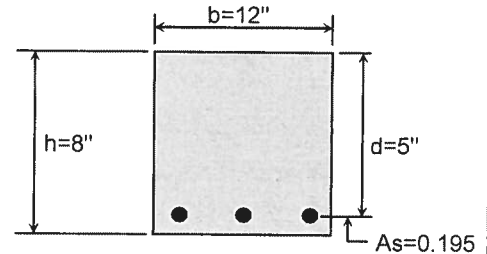
$$\begin{aligned} M_u/ft &= 45 \text{ k-ft} / 14' \\ &= 3.22 \text{ k-ft} \end{aligned}$$

RECTANGULAR CONCRETE BEAM/SECTION DESIGN Flexural Reinforcing for Singly or Doubly Reinforced Sections Per ACI 318-05 Code

Job Name:	MZ Solar - Dungeness River Center	Subject:	Footing
Job Number:	25102.0SA	Originator:	KWW
		Checker:	

Input Data:

Beam or Slab Section?	Beam	
Reinforcing Yield Strength, f_y =	60	ksi
Concrete Comp. Strength, f'_c =	4	ksi
Beam Width, b =	12.000	in.
Depth to Tension Reinforcing, d =	5.000	in.
Total Beam Depth, h =	8.000	in.
Ultimate Design Moment, M_u =	3.22	ft-kips
Depth to Compression Reinf., d' =	0.000	in.



Singly Reinforced Section

Results:

Stress Block Data:

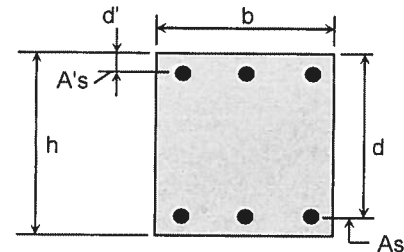
$\beta_1 =$	0.85	
$c =$	0.253	in.
$a =$	0.215	in.

Reinforcing Criteria:

ρb =	0.02851	
ρ(min) =	0.00333	
As(min) =	0.200	in.^2
ρ(temp) =	N.A.	(total)
As(temp) =	N.A.	in.^2/face
ρ(max) =	0.02138	
As(max) =	1.283	in.^2

Computed Reinforcing:

ρ =	0.00244	
A_s =	0.146	in. ²
$(4/3) \cdot A_s$ =	0.195	in. ²
f'_s =	N.A.	ksi
A'_s =	N.A.	in. ²
$A_s(\text{use})$ =	0.195	in. ²

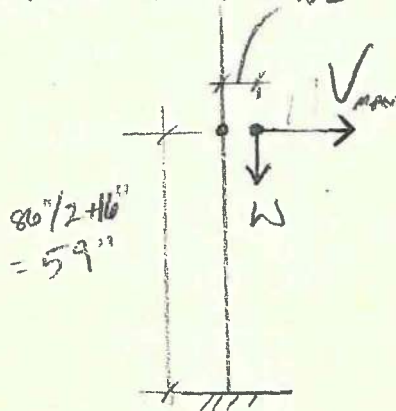


Doubly Reinforced Section

=> #5 @ 12" o.c.
TOP & BOT

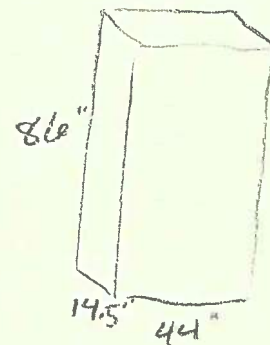
Comments:

PANEL SUPPORT ~ 8"



$$W = 500 \#$$

$$V_{max}$$



$$P = 500 \#$$

$$M = (500 \# \times 8") + (400 \# \times 59")$$

$$= 26800 \text{ in}\cdot\#$$

$$= 26.8 \text{ k-in}$$

USE (2) VERTICAL POSTS:

$$P = 250 \#$$

$$M = 13.4 \text{ k-in}$$

TRY HAS 4x4x1/4

$$M_n / \phi = F_y Z / 1.67$$

$$= (50)(4.69 \text{ in}^3) / 1.67$$

$$= 140 \text{ k-in} >> 13.4 \text{ k-in} \quad \underline{\underline{OK}}$$

$$\Delta = 0.103" = l / 571 \quad \underline{\underline{OK}}$$

$$W / P = 404 \# \Rightarrow 61\% T$$

$$M = 21.6 \text{ k-in} \quad \underline{\underline{OK}}$$

$$\Delta = 0.166" = l / 355 \quad \underline{\underline{OK}}$$

Steel Panel Support

Seismic Information	
ap	1
SOS	1.6
Rp	1.5
Ip	1
Q	2

Unit Information	
Weight, Wp (lb)	500
Length, L (in)	44
Width, W (in)	15
Height, H (in)	86
Wind Force, Fw (lb)	1348.1
Max seismic Force (lb)	1280.0
Min seismic Force (lb)	240.0

Wind Information	
Exposure Category	C
V (mph)	130
Kz	0.85
Kzt	1
Kd	0.9
Ke	1
Cf	1.55
qr (psf)	51.30

z = height in structure of point of attachment
h = average roof height

z/h Ratio	Mounting Height Variation		Bottom Bolt Reactions				Top Bolt Reactions			
	Seismic Force, Fp (lb)	Seismic Force, qFp (lb)	Controlling Force (lb)	Control	Max Compression (lb)	Max Tension (lb)	Max Shear (lb)	Max Compression (lb)	Max Tension (lb)	Max Shear (lb)
0	213.3	480.0	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.1	256.0	512.0	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.2	298.7	597.3	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.3	341.3	682.7	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.4	384.0	768.0	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.5	428.7	853.3	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.6	469.3	938.7	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.7	512.0	1024.0	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.8	554.7	1109.3	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
0.9	597.3	1194.7	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7
1	640.0	1280.0	1348.1	Wind	358.8	315.2	224.7	157.6	179.4	224.7

0.6 Fw = 808 #

0.6 Fw / 2 posts = 404 # / post

IBC 2021 61807.3

b= 2 ft
d (assumed)= 3.67 ft
h= 4.583 ft
P= 404 pounds
Lateral Bearing= 300 psf/f
S₁= 488.11 psf
A= 0.96838827

nonconstrained
d (required)= 2.74 ft

constrained
d (required)= 1.6392 ft

Allowable Foundation Pressure	Lateral Bearing
12000	1200
4000	400
3000	200
2000	150
1500	100

Increase for depth: 61806.3.3

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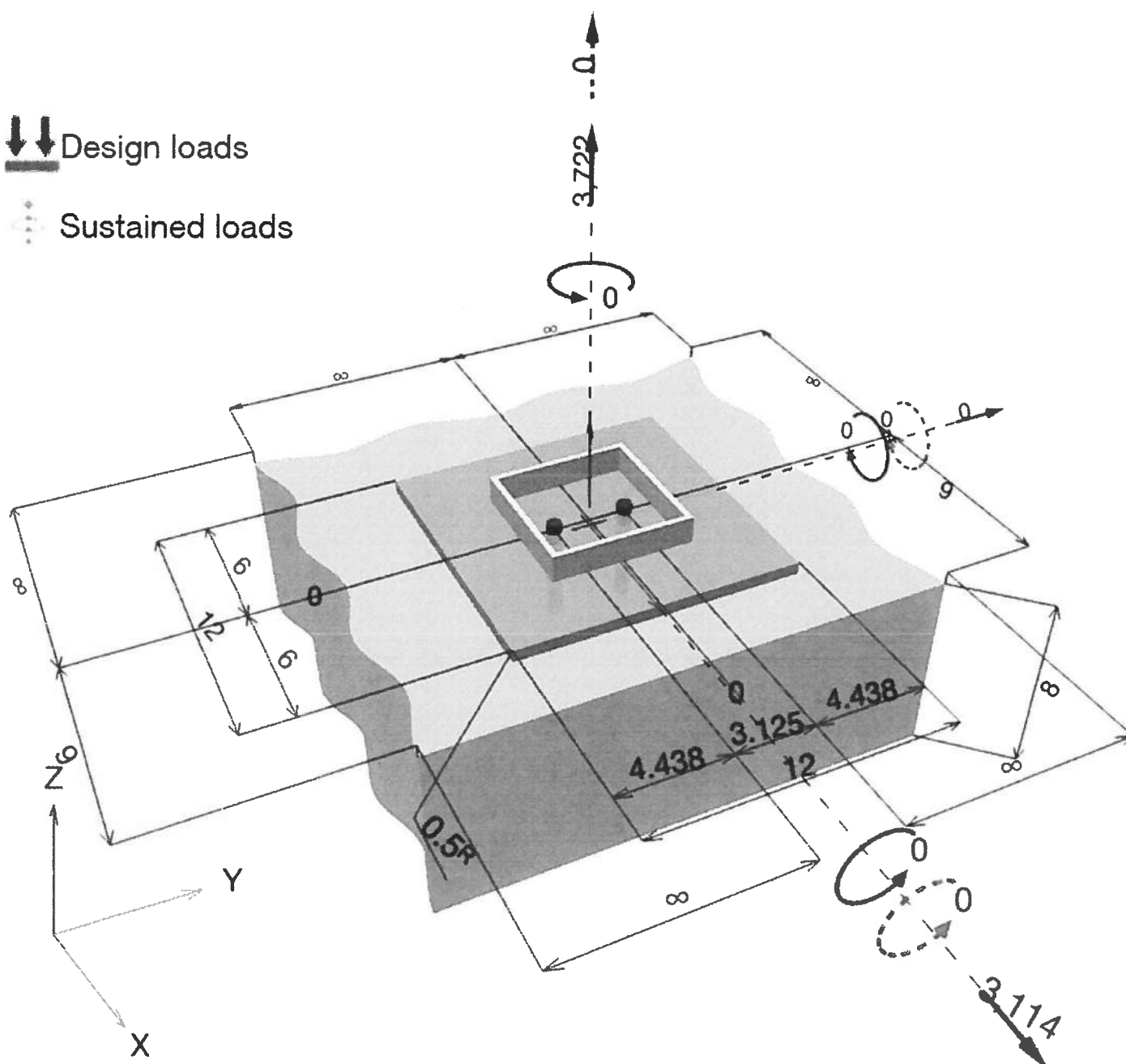
Specifier's comments:

CENTER

1 Input data

Anchor type and diameter:	HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) 5/8		
Item number:	2198024 HAS-V-36 5/8"x6" (element) / 2123401 HIT-RE 500 V3 (adhesive)		
Specification text:	Hilti 5/8 in HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) with 3.5 in nominal embedment depth per ICC-ES ESR-3814 , Hammer drill bit installation per MPII,		
Effective embedment depth:	$h_{ef,act} = 3.500$ in. ($h_{ef,limit} = -$ in.)		
Material:	ASTM F1554 Grade 36		
Evaluation Service Report:	ESR-3814		
Issued Valid:	1/1/2025 1/1/2027		
Proof:	Design Method ACI 318-19 / Chem		
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)		
Stand-off installation:	$e_b = 0.000$ in. (no stand-off); $t = 0.500$ in.		
Anchor plate ^R :	$l_x \times l_y \times t = 12.000$ in. x 12.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)		
Profile:	Square HSS (AISC), HSS6X6X.250; ($L \times W \times T$) = 6.000 in. x 6.000 in. x 0.250 in.		
Base material:	cracked concrete, 4000, $f'_c = 4,000$ psi; $h = 8.000$ in., Temp. short/long: 32/32 °F		
Installation:	Hammer drilled hole, Installation condition: Dry		
Reinforcement:	tension: not present, shear: present; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar		
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (d)) Shear load: yes (17.10.6.3 (c))		

^R - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]

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1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 3,722; V _x = 3,114; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	107

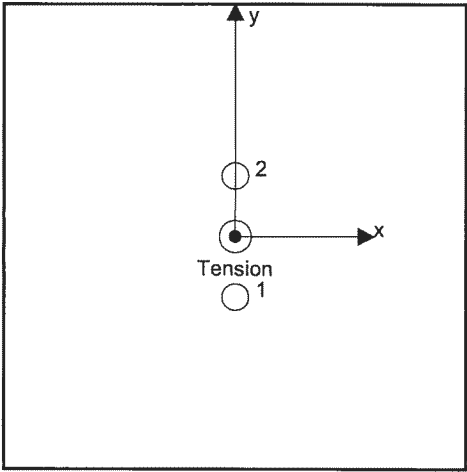
2 Load case/Resulting anchor forces

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,557	1,557	0
2	1,861	1,557	1,557	0

Max. concrete compressive strain: - [%]
 Max. concrete compressive stress: - [psi]
 Resulting tension force in (x/y)=(0.000/0.000): 3,722 [lb]
 Resulting compression force in (x/y)=(-/-): 0 [lb]



Anchor forces are calculated based on the assumption of a rigid anchor plate.

3 Tension load

	Load N _{ua} [lb]	Capacity ϕ N _n [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	1,861	9,832	19	OK
Bond Strength**	3,722	4,872	77	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	3,722	4,454	84	OK

* highest loaded anchor **anchor group (anchors in tension)



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3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-3814
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.23	58,000

Calculations

N_{sa} [lb]
13,110

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
13,110	0.750	9,832	1,861

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3.2 Bond Strength

$$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}} \right) \psi_{ec1,Na} \psi_{ec2,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba} \quad \text{ACI 318-19 Eq. (17.6.5.1b)}$$

$$\phi N_{ag} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Na} \text{ see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)}$$

$$A_{Na0} = (2 c_{Na})^2 \quad \text{ACI 318-19 Eq. (17.6.5.1.2a)}$$

$$c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}} \quad \text{ACI 318-19 Eq. (17.6.5.1.2b)}$$

$$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e_N}{c_{Na}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.3.1)}$$

$$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.4.1b)}$$

$$\psi_{cp,Na} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.5.1b)}$$

$$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef} \quad \text{ACI 318-19 Eq. (17.6.5.2.1)}$$

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,486	0.625	3.500	9.000	1.000	1,352
$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	λ_a	$\alpha_{N,seis}$	
0.000	0.000	5.734	1.000	0.950	

Calculations

c_{Na} [in.]	A_{Na} [in. ²]	A_{Na0} [in. ²]	$\psi_{ed,Na}$
9.353	400.64	349.88	0.989
$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{cp,Na}$	N_{ba} [lb]
1.000	1.000	1.000	8,827

Results

N_{ag} [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{ag} [lb]	N_{ua} [lb]
9,993	0.650	0.750	1.000	4,872	3,722

Input data and results must be checked for conformity with the existing conditions and for plausibility!

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3.3 Concrete Breakout Failure

$$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1b)}$$

$$\phi N_{cbg} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
3.500	0.000	0.000	9.000	1.000
c_{ac} [in.]	k_c	λ_a	f'_c [psi]	
5.734	17	1.000	4,000	

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
143.06	110.25	1.000	1.000	1.000	1.000	7,040

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cbg} [lb]	N_{ua} [lb]
9,135	0.650	0.750	1.000	4,454	3,722



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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_v = V_{ua} / \phi V_n$	Status
Steel Strength*	1,557	3,067	51	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	3,114	12,790	25	OK
Concrete edge failure in direction x+**	3,114	10,310	31	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

 $V_{sa,eq}$ = ESR value refer to ICC-ES ESR-3814 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{v,seis}$
0.23	58,000	0.600

Calculations

$V_{sa,eq}$ [lb]
4,719

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
4,719	0.650	3,067	1,557

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4.2 Pryout Strength (Concrete Breakout Strength controls)

$$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1b)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

 A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	3.500	0.000	0.000	9.000
$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	5.734	17	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
143.06	110.25	1.000	1.000	1.000	1.000	7,040

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
18,271	0.700	1.000	1.000	12,790	3,114

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4.3 Concrete edge failure in direction x+

$$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1b)}$$

$$\phi V_{cbg} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.3.1)}$$

$$\psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
9.000	-	0.000	1.200	8.000
l_e [in.]	λ_a	d_a [in.]	f_c [psi]	$\psi_{parallel,V}$
3.500	1.000	0.625	4,000	1.000

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
241.00	364.50	1.000	1.000	1.299	13,337

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cbg} [lb]	V_{ua} [lb]
13,746	0.750	1.000	1.000	10,310	3,114

*Anchor row defined by: Anchor 1, 2; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.836	0.508	5/3	107	not recommended

$$\beta_{NV} = \beta_N^c + \beta_V^c \leq 1$$

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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0 .
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening does not meet the design criteria!

OK @ $\lambda_{ss} = 1.24$

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7 Installation data

Profile: Square HSS (AISC), HSS6X6X.250; (L x W x T) = 6.000 in. x 6.000 in. x 0.250 in.

Hole diameter in the fixture: $d_f = 0.687$ in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) 5/8

Item number: 2198024 HAS-V-36 5/8"x6" (element) / 2123401 HIT-RE 500 V3 (adhesive)

Maximum installation torque: 720 in.lb

Hole diameter in the base material: 0.750 in.

Hole depth in the base material: 3.500 in.

Minimum thickness of the base material: 5.000 in.

Hilti $\varnothing$ 5/8 in HIT-RE 500 V3 + HAS-V-36 (ASTM F1554 Gr.36) with 3.5 in nominal embedment depth per ICC-ES ESR-3814 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling

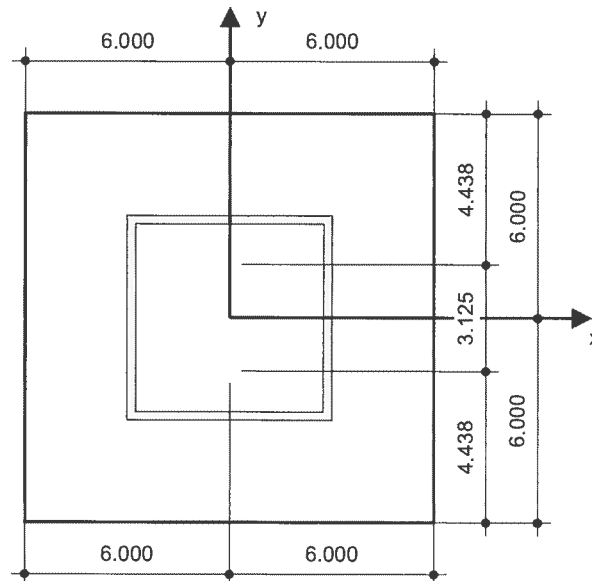
- Suitable Rotary Hammer
- Properly sized drill bit

Cleaning

- Compressed air with required accessories to blow from the bottom of the hole
- Proper diameter wire brush

Setting

- Dispenser including cassette and mixer
- Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	0.000	-1.562	-	9.000	-	-
2	0.000	1.562	-	9.000	-	-



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8 Remarks; Your Cooperation Duties

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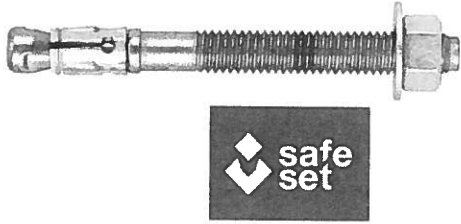
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Specifier's comments: CENTER

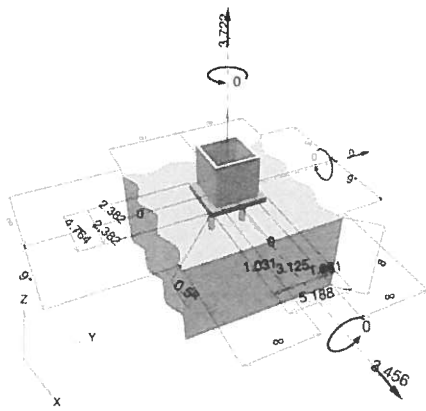
1 Input data

Anchor type and diameter:	Kwik Bolt TZ2 - SS 316 5/8 (3 1/4) hnom2
Item number:	2210306 KB-TZ2 5/8x6 SS316
Specification text:	Hilti Ø 5/8 in Kwik Bolt TZ2 - SS 316 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII,
Effective embedment depth:	$h_{ef,act} = 3.250$ in., $h_{nom} = 3.750$ in.
Material:	AISI 316
Evaluation Service Report:	ESR-4266
Issued Valid:	10/1/2024 12/1/2025
Proof:	Design Method ACI 318-19 / Mech
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)
Stand-off installation:	$e_b = 0.000$ in. (no stand-off); $t = 0.500$ in.
Anchor plate ^R :	$l_x \times l_y \times t = 4.764$ in. x 5.188 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.
Base material:	cracked concrete, 4000 , $f'_c = 4,000$ psi; $h = 8.000$ in.
Installation:	Hammer drilled hole, Installation condition: Dry
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present
Seismic loads (cat. C, D, E, or F)	edge reinforcement: > No. 4 bar Tension load: yes (17.10.5.3 (d)) Shear load: yes (17.10.6.3 (a))



^R - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Max Compression and Wind X-X (+)	$N = -11,022; V_x = 3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	37
2	Max Compression and Wind X-X (-)	$N = -11,022; V_x = -3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
3	Max Compression and Wind Y-Y (+)	$N = -11,022; V_x = 0; V_y = 3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
4	Max Compression and Wind Y-Y (-)	$N = -11,022; V_x = 0; V_y = -3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
5	Max Tension and Wind X-X (+)	$N = 3,722; V_x = 3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	80
6	Max Tension and Wind X-X (-)	$N = 3,722; V_x = -3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75
7	Max Tension and Wind Y-Y (+)	$N = 3,722; V_x = 0; V_y = 3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75
8	Max Tension and Wind Y-Y (-)	$N = 3,722; V_x = 0; V_y = -3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75

2 Load case/Resulting anchor forces

Controlling load case: 5 Max Tension and Wind X-X (+)

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

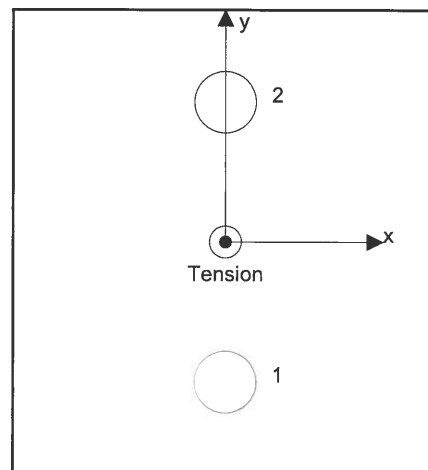
Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,728	1,728	0
2	1,861	1,728	1,728	0

Max. concrete compressive strain: - [%]

Max. concrete compressive stress: - [psi]

Resulting tension force in (x/y)=(0.000/0.000): 3,722 [lb]

Resulting compression force in (x/y)=(-/-): 0 [lb]



Anchor forces are calculated based on the assumption of a rigid anchor plate.



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3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	1,861	14,132	14	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	3,722	5,009	75	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4266
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.16	114,604

Calculations

N_{sa} [lb]
18,843

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
18,843	0.750	14,132	1,861

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3.2 Concrete Breakout Failure

$$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1b)}$$

$$\phi N_{cbg} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
3.250	0.000	0.000	9.000	1.000
c_{ac} [in.]	k_c	λ_a	f_c [psi]	
6.500	21	1.000	4,000	

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
125.53	95.06	1.000	1.000	1.000	1.000	7,782

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cbg} [lb]	N_{ua} [lb]
10,276	0.650	0.750	1.000	5,009	3,722

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua} / \phi V_n$	Status
Steel Strength*	1,728	8,034	22	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	3,456	14,386	25	OK
Concrete edge failure in direction x+**	3,456	9,481	37	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4266

$\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{V,seis}$
0.16	114,604	1.000

Calculations

$V_{sa,eq}$ [lb]
12,360

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
12,360	0.650	8,034	1,728

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4.2 Pryout Strength

$$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1b)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

 A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_{N1}}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{ac}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	3.250	0.000	0.000	9.000
$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
125.53	95.06	1.000	1.000	1.000	1.000	7,782

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
20,552	0.700	1.000	1.000	14,386	3,456

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4.3 Concrete edge failure in direction x+

$$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b$$

ACI 318-19 Eq. (17.7.2.1b)

$$\phi V_{cbg} \geq V_{ua}$$

ACI 318-19 Table 17.5.2

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2$$

ACI 318-19 Eq. (17.7.2.1.3)

$$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0$$

ACI 318-19 Eq. (17.7.2.3.1)

$$\psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0$$

ACI 318-19 Eq. (17.7.2.4.1b)

$$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$$

ACI 318-19 Eq. (17.7.2.6.1)

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f_c} c_{a1}^{1.5}$$

ACI 318-19 Eq. (17.7.2.2.1a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
9.000	-	0.000	1.200	8.000
l_e [in.]	λ_a	d_a [in.]	f_c [psi]	$\psi_{parallel,V}$
3.250	1.000	0.625	4,000	1.000

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
241.00	364.50	1.000	1.000	1.299	13,141

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cbg} [lb]	V_{ua} [lb]
13,544	0.700	1.000	1.000	9,481	3,456

*Anchor row defined by: Anchor 1, 2; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.743	0.365	5/3	80	OK

$$\beta_{NV} = \beta_N^\zeta + \beta_V^\zeta \leq 1$$

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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_p .
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.

Hole diameter in the fixture: $d_r = 0.687$ in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: Kwik Bolt TZ2 - SS 316 5/8 (3 1/4) hnom2

Item number: 2210306 KB-TZ2 5/8x6 SS316

Maximum installation torque: 722 in.lb

Hole diameter in the base material: 0.625 in.

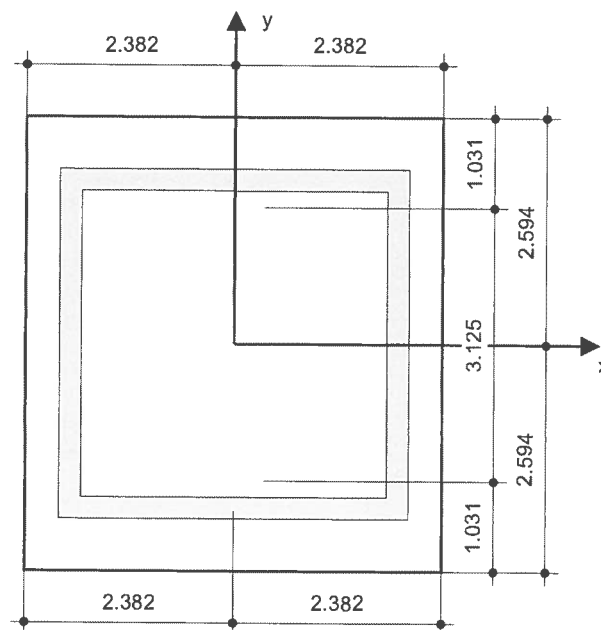
Hole depth in the base material: 4.250 in.

Minimum thickness of the base material: 5.500 in.

Hilti $\varnothing$ 5/8 in Kwik Bolt TZ2 - SS 316 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling	Cleaning	Setting
- Suitable Rotary Hammer - Properly sized drill bit	Manual blow-out pump	- Torque controlled cordless impact tool - Torque wrench - Hammer



Coordinates Anchor [in.]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	0.000	-1.563	-	9.000	-	-
2	0.000	1.562	-	9.000	-	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
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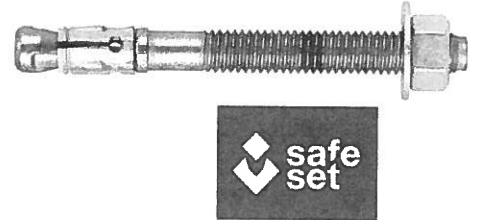
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Specifier's comments:

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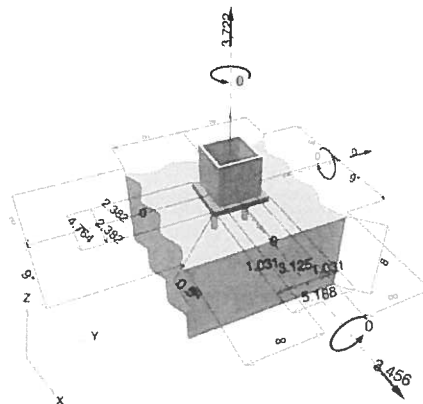
1 Input data

Anchor type and diameter:	Kwik Bolt TZ2 - SS 304 5/8 (3 1/4) hnom2	
Item number:	2210279 KB-TZ2 5/8x6 SS304	
Specification text:	Hilti Ø 5/8 in Kwik Bolt TZ2 - SS 304 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII,	
Effective embedment depth:	$h_{ef,act} = 3.250$ in., $h_{nom} = 3.750$ in.	
Material:	AISI 304	
Evaluation Service Report:	ESR-4266	
Issued / Valid:	10/1/2024 12/1/2025	
Proof:	Design Method ACI 318-19 / Mech	
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)	
Stand-off installation:	$e_b = 0.000$ in. (no stand-off); $t = 0.500$ in.	
Anchor plate ^R :	$l_x \times l_y \times t = 4.764$ in. x 5.188 in. x 0.500 in.; (Recommended plate thickness: not calculated)	
Profile:	Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.	
Base material:	cracked concrete, 4000, $f'_c = 4,000$ psi; $h = 8.000$ in.	
Installation:	Hammer drilled hole, Installation condition: Dry	
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present	
	edge reinforcement: > No. 4 bar	
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (d))	
	Shear load: yes (17.10.6.3 (a))	



^R - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Max Compression and Wind X-X (+)	$N = -11,022; V_x = 3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	37
2	Max Compression and Wind X-X (-)	$N = -11,022; V_x = -3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
3	Max Compression and Wind Y-Y (+)	$N = -11,022; V_x = 0; V_y = 3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
4	Max Compression and Wind Y-Y (-)	$N = -11,022; V_x = 0; V_y = -3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	25
5	Max Tension and Wind X-X (+)	$N = 3,722; V_x = 3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	80
6	Max Tension and Wind X-X (-)	$N = 3,722; V_x = -3,456; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75
7	Max Tension and Wind Y-Y (+)	$N = 3,722; V_x = 0; V_y = 3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75
8	Max Tension and Wind Y-Y (-)	$N = 3,722; V_x = 0; V_y = -3,456;$ $M_x = 0; M_y = 0; M_z = 0;$	yes	75

2 Load case/Resulting anchor forces

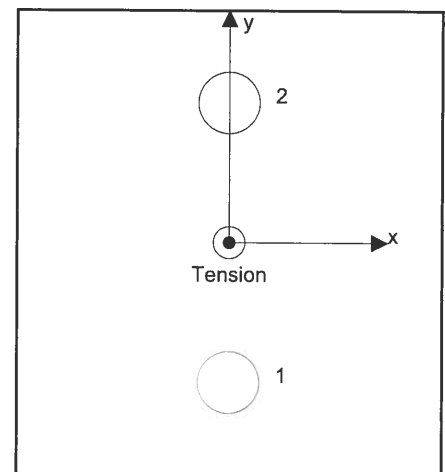
Controlling load case: 5 Max Tension and Wind X-X (+)

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,728	1,728	0
2	1,861	1,728	1,728	0

Max. concrete compressive strain: - [%]
Max. concrete compressive stress: - [psi]
Resulting tension force in (x/y)=(0.000/0.000): 3,722 [lb]
Resulting compression force in (x/y)=(-/-): 0 [lb]



Anchor forces are calculated based on the assumption of a rigid anchor plate.



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3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	1,861	14,132	14	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	3,722	5,009	75	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4266
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.16	114,604

Calculations

N_{sa} [lb]
18,843

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
18,843	0.750	14,132	1,861

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3.2 Concrete Breakout Failure

$$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1b)}$$

$$\phi N_{cbg} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
3.250	0.000	0.000	9.000	1.000
c_{ac} [in.]	k_c	λ_a	f'_c [psi]	
6.500	21	1.000	4,000	

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
125.53	95.06	1.000	1.000	1.000	1.000	7,782

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cbg} [lb]	N_{ua} [lb]
10,276	0.650	0.750	1.000	5,009	3,722

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	1,728	8,034	22	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	3,456	14,386	25	OK
Concrete edge failure in direction x+**	3,456	9,481	37	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4266
 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{V,seis}$
0.16	114,604	1.000

Calculations

$V_{sa,eq}$ [lb]
12,360

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
12,360	0.650	8,034	1,728

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4.2 Pryout Strength

$$V_{cpq} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1b)}$$

$$\phi V_{cpq} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

 A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_{c1,N}}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	3.250	0.000	0.000	9.000
$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
125.53	95.06	1.000	1.000	1.000	1.000	7,782

Results

V_{cpq} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cpq} [lb]	V_{ua} [lb]
20,552	0.700	1.000	1.000	14,386	3,456

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4.3 Concrete edge failure in direction x+

$$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1b)}$$

$$\phi V_{cbg} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\psi_{ec,V} = \left(\frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.3.1)}$$

$$\psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
9.000	-	0.000	1.200	8.000
l_e [in.]	λ_a	d_a [in.]	f_c [psi]	$\psi_{parallel,V}$
3.250	1.000	0.625	4,000	1.000

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
241.00	364.50	1.000	1.000	1.299	13,141

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cbg} [lb]	V_{ua} [lb]
13,544	0.700	1.000	1.000	9,481	3,456

*Anchor row defined by: Anchor 1, 2; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.743	0.365	5/3	80	OK

$$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} \leq 1$$

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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0 .
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

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7 Installation data

Profile: Square HSS (AISC), HSS4X4X.25; (L x W x T) = 4.000 in. x 4.000 in. x 0.250 in.

Hole diameter in the fixture: $d_f = 0.687$ in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: Kwik Bolt TZ2 - SS 304 5/8 (3 1/4) hnom2

Item number: 2210279 KB-TZ2 5/8x6 SS304

Maximum installation torque: 722 in.lb

Hole diameter in the base material: 0.625 in.

Hole depth in the base material: 4.250 in.

Minimum thickness of the base material: 5.500 in.

Hilti $\varnothing$ 5/8 in Kwik Bolt TZ2 - SS 304 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling

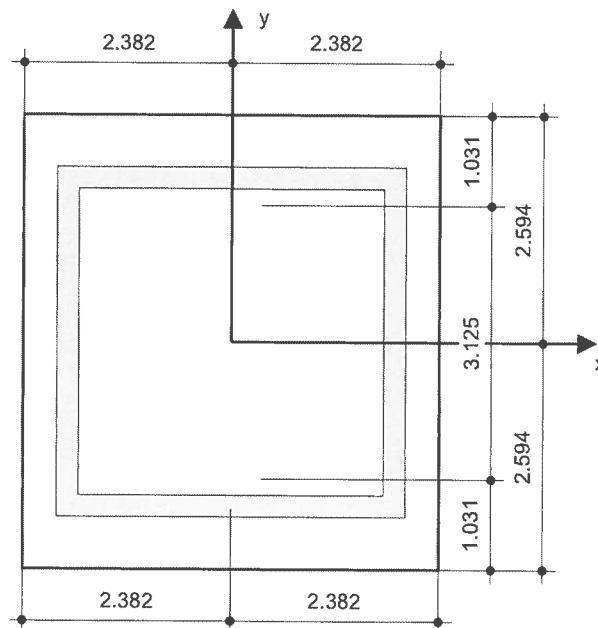
- Suitable Rotary Hammer
- Properly sized drill bit

Cleaning

- Manual blow-out pump

Setting

- Torque controlled cordless impact tool
- Torque wrench
- Hammer



Coordinates Anchor [in.]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	0.000	-1.563	-	9.000	-	-
2	0.000	1.562	-	9.000	-	-

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.



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Specifier's comments:

CORNER

1 Input data

Anchor type and diameter:

HIT-RE 500 V3 + HAS-R 304/316 SS 5/8

Item number:

2045007 HAS-R 316 SS 5/8"x7 5/8" (element) / 2123401
HIT-RE 500 V3 (adhesive)

Specification text:

Hilti $\varnothing$ 5/8 in HIT-RE 500 V3 + HAS-R 304/316
SS with 3.25 in nominal embedment depth per
ICC-ES ESR-3814 , Hammer drill bit
installation per MPII,

Effective embedment depth:

$h_{ef,act} = 3.250$ in. ($h_{ef,limit} = -$ in.)

Material:

ASTM F 593

Evaluation Service Report:

ESR-3814

Issued | Valid:

1/1/2025 | 1/1/2027

Proof:

Design Method ACI 318-19 / Chem

Shear edge breakout verification:

Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)

Stand-off installation:

Profile:

Base material:

cracked concrete, 4000, $f_c' = 4,000$ psi; $h = 8.000$ in., Temp. short/long: 32/32 °F

Installation:

Hammer drilled hole, Installation condition: Dry

Reinforcement:

tension: not present, shear: not present; no supplemental splitting reinforcement present
edge reinforcement: > No. 4 bar

Seismic loads (cat. C, D, E, or F)

Tension load: yes (17.10.5.3 (d))
Shear load: yes (17.10.6.3 (a))

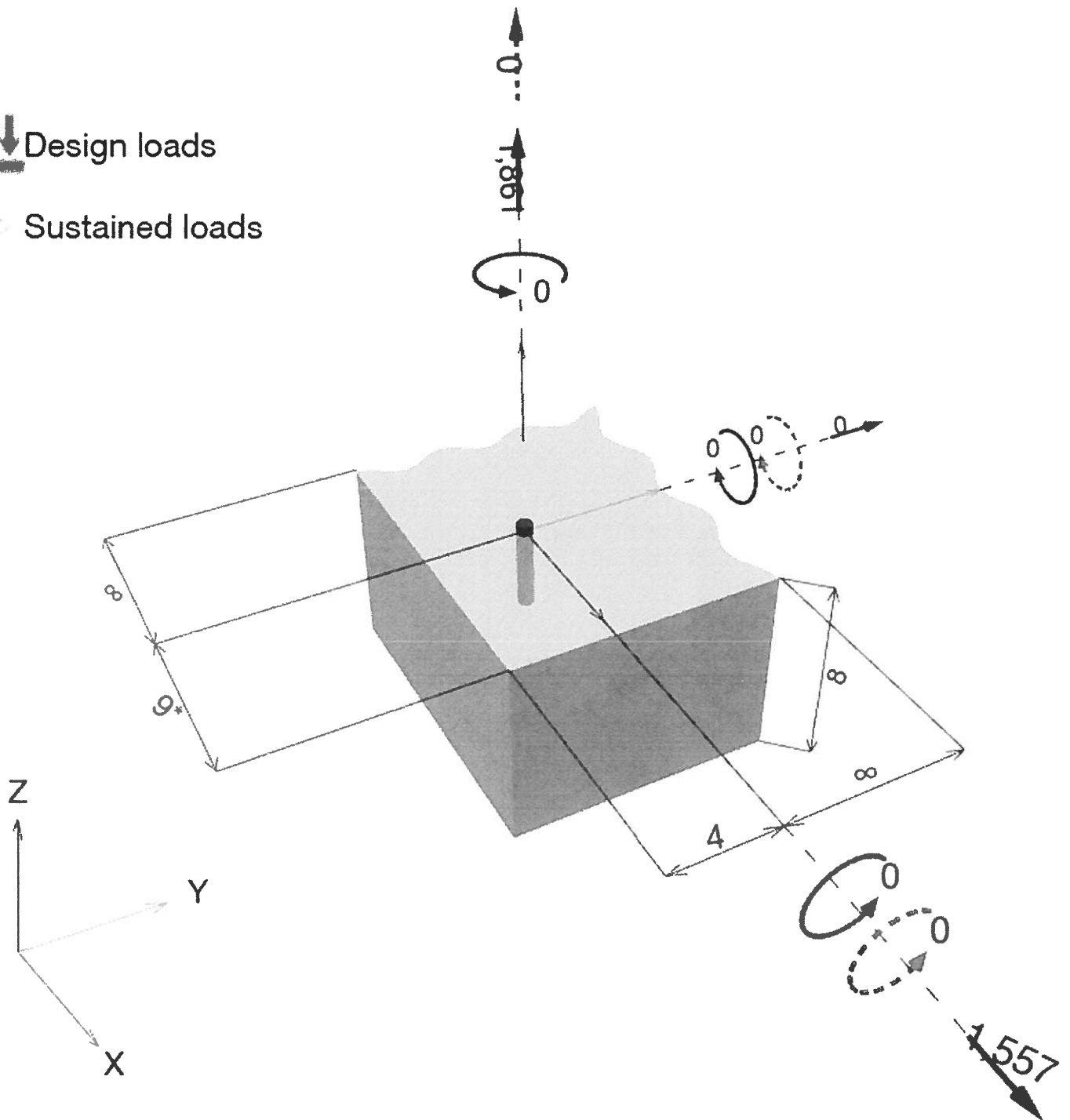


Application also possible with HVU2 + HAS-R 304/316 SS 5/8 under the selected boundary conditions.
More information in section Alternative fastening data of this report.

Geometry [in.] & Loading [lb, in.lb]

 Design loads

 Sustained loads





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1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	CMG2 AC - Max Compression and Wind Y-Y	$N = -4,878; V_x = 0; V_y = 1,728;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	34
2	CMG2 AC - Max Compression and Wind X-X	$N = -4,878; V_x = 1,728; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	40
3	CMG2 AC - Max Tension and Wind Y-Y	$N = 828; V_x = 0; V_y = 1,728;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	36
4	CMG2 AC - Max Tension and Wind X-X	$N = 828; V_x = 1,728; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	40
5	CMG2 DC - Max Compression and Wind Y-Y	$N = -5,511; V_x = 0; V_y = 1,557;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	38
6	CMG2 DC - Max Compression and Wind X-X	$N = -5,511; V_x = 1,557; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	38
7	CMG2 DC - Max Tension and Wind Y-Y	$N = 1,861; V_x = 0; V_y = 1,557;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	81
8	CMG2 DC - Max Tension and Wind X-X	$N = 1,861; V_x = 1,557; V_y = 0;$ $M_x = 0; M_y = 0; M_z = 0;$ $N_{sus} = 0; M_{x,sus} = 0; M_{y,sus} = 0;$	yes	88

2 Load case/Resulting anchor forces

Controlling load case: 8 CMG2 DC - Max Tension and Wind X-X

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,557	1,557	0



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3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	1,861	14,690	13	OK
Bond Strength**	1,861	2,318	81	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	1,861	2,645	71	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-3814
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.23	100,000

Calculations

N_{sa} [lb]
22,600

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	ϕN_{sa} [lb]	N_{ua} [lb]
22,600	0.650	1.000	14,690	1,861



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3.2 Bond Strength

$$N_a = \left(\frac{A_{Na}}{A_{Na0}} \right) \psi_{ed,Na} \psi_{cp,Na} N_{ba} \quad \text{ACI 318-19 Eq. (17.6.5.1a)}$$

$$\phi N_a \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Na} \text{ see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)}$$

$$A_{Na0} = (2 c_{Na})^2 \quad \text{ACI 318-19 Eq. (17.6.5.1.2a)}$$

$$c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}} \quad \text{ACI 318-19 Eq. (17.6.5.1.2b)}$$

$$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.4.1b)}$$

$$\psi_{cp,Na} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.5.1b)}$$

$$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef} \quad \text{ACI 318-19 Eq. (17.6.5.2.1)}$$

Variables

$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\alpha_{overhead}$	$\tau_{k,c}$ [psi]
2,486	0.625	3.250	4.000	1.000	1,352
c_{ac} [in.]	λ_a	$\alpha_{N,seis}$			
4.897	1.000	0.950			

Calculations

c_{Na} [in.]	A_{Na} [in. ²]	A_{Na0} [in. ²]	$\psi_{ed,Na}$
9.353	245.05	349.88	0.828
$\psi_{cp,Na}$	N_{ba} [lb]		
1.000	8,196		

Results

N_a [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_a [lb]	N_{ua} [lb]
4,755	0.650	0.750	1.000	2,318	1,861



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3.3 Concrete Breakout Failure

$$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1a)}$$

$$\phi N_{cb} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
3.250	4.000	1.000	4.897	17	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
86.53	95.06	0.946	1.000	6,299

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
5,425	0.650	0.750	1.000	2,645	1,861



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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_v = V_{ua}/\phi V_n$	Status
Steel Strength*	1,557	6,509	24	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Bond Strength controls)**	1,557	6,657	24	OK
Concrete edge failure in direction x+**	1,557	4,345	36	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-3814
 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{V,seis}$
0.23	100,000	0.800

Calculations

$V_{sa,eq}$ [lb]
10,848

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
10,848	0.600	1.000	6,509	1,557



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4.2 Pryout Strength (Bond Strength controls)

$$V_{cp} = k_{cp} \left[\left(\frac{A_{Na}}{A_{Na0}} \right) \psi_{ed,Na} \psi_{cp,Na} N_{ba} \right] \quad \text{ACI 318-19 Eq. (17.7.3.1a)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Na} \text{ see ACI 318-19, Section 17.6.5.1, Fig. R 17.6.5.1(b)}$$

$$A_{Na0} = (2 c_{Na})^2 \quad \text{ACI 318-19 Eq. (17.6.5.1.2a)}$$

$$c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}} \quad \text{ACI 318-19 Eq. (17.6.5.1.2b)}$$

$$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.4.1b)}$$

$$\psi_{cp,Na} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.5.5.1b)}$$

$$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \alpha_{N,seis} \cdot \pi \cdot d_a \cdot h_{ef} \quad \text{ACI 318-19 Eq. (17.6.5.2.1)}$$

Variables

k_{cp}	$\alpha_{overhead}$	$\tau_{k,c,uncr}$ [psi]	d_a [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	$\tau_{k,c}$ [psi]
2	1.000	2,486	0.625	3.250	4.000	1,352
c_{ac} [in.]	λ_a	$\alpha_{N,seis}$				
4.897	1.000	0.950				

Calculations

c_{Na} [in.]	A_{Na} [in. ²]	A_{Na0} [in. ²]	$\psi_{ed,Na}$
9.353	245.05	349.88	0.828
$\psi_{cp,Na}$	N_{ba} [lb]		
1.000	8,196		

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
9,510	0.700	1.000	1.000	6,657	1,557

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4.3 Concrete edge failure in direction x+

$$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} \Psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1a)}$$

$$\phi V_{cb} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\Psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5 c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\Psi_{h,V} = \sqrt{\frac{1.5 c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f'_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

Variables

c_{a1} [in.]	c_{a2} [in.]	$\Psi_{c,V}$	h_a [in.]	l_e [in.]
9.000	4.000	1.200	8.000	3.250
λ_a	d_a [in.]	f'_c [psi]	$\Psi_{parallel,V}$	
1.000	0.625	4,000	1.000	

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\Psi_{ed,V}$	$\Psi_{h,V}$	V_b [lb]
140.00	364.50	0.789	1.299	13,141

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
6,207	0.700	1.000	1.000	4,345	1,557

*Anchor row defined by: Anchor 1; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.803	0.358	5/3	88	OK

$$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} \leq 1$$



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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_p .
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!



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7 Installation data

Profile: -

Hole diameter in the fixture: -

Plate thickness (input): -

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions
for use is required

Anchor type and diameter: HIT-RE 500 V3 + HAS-R
304/316 SS 5/8

Item number: 2045007 HAS-R 316 SS 5/8"x7 5/8"
(element) / 2123401 HIT-RE 500 V3 (adhesive)

Maximum installation torque: 720 in.lb

Hole diameter in the base material: 0.750 in.

Hole depth in the base material: 3.250 in.

Minimum thickness of the base material: 4.750 in.

Hilti Ø 5/8 in HIT-RE 500 V3 + HAS-R 304/316 SS with 3.25 in nominal embedment depth per ICC-ES ESR-3814 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling

- Suitable Rotary Hammer
- Properly sized drill bit

Cleaning

- Compressed air with required accessories
to blow from the bottom of the hole
- Proper diameter wire brush

Setting

- Dispenser including cassette and mixer
- Torque wrench

Coordinates Anchor in.

Anchor	x	y	C _{-x}	C _{+x}	C _{-y}	C _{+y}
1	0.000	0.000	-	9.000	4.000	-



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8 Alternative fastening

8.1 Alternative fastening data

Anchor type and diameter:	HVU2 + HAS-R 304/316 SS 5/8	
Item number:	2045007 HAS-R 316 SS 5/8"x7 5/8" (element) / 2234722 HVU2 5/8" x 5" (capsule)	
Specification text:	Hilti Ø 5/8 in HIT-RE 500 V3 + HAS-R 304/316 SS with 3.25 in nominal embedment depth per ICC-ES ESR-3814 , Hammer drill bit installation per MPII,	
Effective embedment depth:	$h_{ef,act} = 5.000$ in., $h_{nom} = 5.000$ in.	
Material:	ASTM F 593	
Evaluation Service Report:	ESR-4372	
Issued Valid:	6/1/2024 6/1/2026	
Proof:	Design Method ACI 318-19 / Chem	
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)	
Stand-off installation:		
Profile:		
Base material:	cracked concrete, 4000, $f_c' = 4,000$ psi; $h = 8.000$ in., Temp. short/long: 32/32 °F	
Installation:	Hammer drilled hole, Installation condition: Dry, Installation direction: vertical downward	
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar	
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (d)) Shear load: yes (17.10.6.3 (a))	

Max. Utilization with HVU2 + HAS-R 304/316 SS 5/8: 57 %
Fastening meets the design criteria!



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8.2 Installation data

Profile: -

Hole diameter in the fixture: -

Plate thickness (input): -

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HVU2 + HAS-R 304/316 SS 5/8
Item number: 2045007 HAS-R 316 SS 5/8"x7 5/8" (element) / 2234722 HVU2 5/8" x 5" (capsule)
Maximum installation torque: 720 in.lb
Hole diameter in the base material: 0.687 in.
Hole depth in the base material: 5.000 in.
Minimum thickness of the base material: 6.375 in.

Hilti Ø 5/8 in HVU2 + HAS-R 304/316 SS with 5 in nominal embedment depth per ICC-ES ESR-4372 , Hammer drill bit installation per MPII

8.2.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• Compressed air with required accessories to blow from the bottom of the hole • Proper diameter wire brush	• HVA square drive shafts • Torque wrench



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Specifier's comments:

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1 Input data

Anchor type and diameter:

Kwik Bolt TZ2 - SS 316 5/8 (3 1/4) hnom2

Item number:

2210284 KB-TZ2 5/8x4 3/4 SS316

Specification text:

Hilti $\varnothing$ 5/8 in Kwik Bolt TZ2 - SS 316 with 3.75 in nominal embedment depth per ICC-ES ESR-4266, Hammer drill bit installation per MPII,

Effective embedment depth:

$h_{ef,act} = 3.250$ in., $h_{nom} = 3.750$ in.

Material:

AISI 316

Evaluation Service Report:

ESR-4266

Issued | Valid:

10/1/2024 | 12/1/2025

Proof:

Design Method ACI 318-19 / Mech

Shear edge breakout verification:

Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)

Stand-off installation:

Profile:

Base material:

cracked concrete, 4000, $f_c' = 4,000$ psi; $h = 8.000$ in.

Installation:

Hammer drilled hole, Installation condition: Dry

Reinforcement:

tension: not present, shear: not present; no supplemental splitting reinforcement present

Seismic loads (cat. C, D, E, or F)

edge reinforcement: > No. 4 bar

Tension load: yes (17.10.5.3 (d))

Shear load: yes (17.10.6.3 (a))



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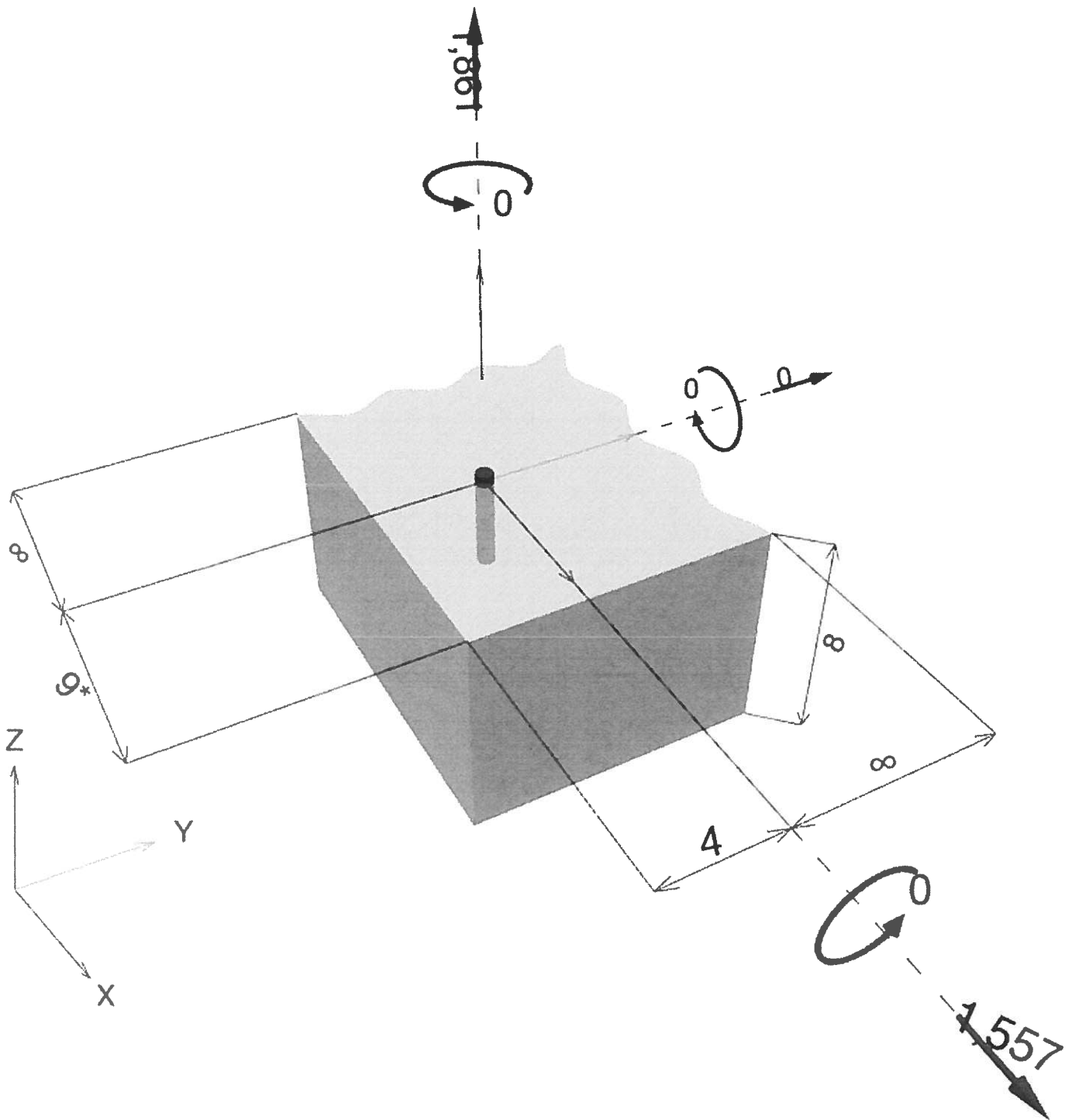
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Geometry [in.] & Loading [lb, in.lb]



Input data and results must be checked for conformity with the existing conditions and for plausibility!
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1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	CMG2 AC - Max Compression and Wind Y-Y	N = -4,878; V _x = 0; V _y = 1,728; M _x = 0; M _y = 0; M _z = 0;	yes	35
2	CMG2 AC - Max Compression and Wind X-X	N = -4,878; V _x = 1,728; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	40
3	CMG2 AC - Max Tension and Wind Y-Y	N = 828; V _x = 0; V _y = 1,728; M _x = 0; M _y = 0; M _z = 0;	yes	26
4	CMG2 AC - Max Tension and Wind X-X	N = 828; V _x = 1,728; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	40
5	CMG2 DC - Max Compression and Wind Y-Y	N = -5,511; V _x = 0; V _y = 1,557; M _x = 0; M _y = 0; M _z = 0;	yes	39
6	CMG2 DC - Max Compression and Wind X-X	N = -5,511; V _x = 1,557; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	39
7	CMG2 DC - Max Tension and Wind Y-Y	N = 1,861; V _x = 0; V _y = 1,557; M _x = 0; M _y = 0; M _z = 0;	yes	57
8	<u>CMG2 DC - Max Tension and Wind X-X</u>	<u>N = 1,861; V_x = 1,557; V_y = 0;</u> <u>M_x = 0; M_y = 0; M_z = 0;</u>	<u>yes</u>	<u>58</u>

2 Load case/Resulting anchor forces

Controlling load case: 8 CMG2 DC - Max Tension and Wind X-X

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,557	1,557	0



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3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	1,861	14,132	14	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	1,861	3,267	57	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4266
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.16	114,604

Calculations

N_{sa} [lb]
18,843

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
18,843	0.750	14,132	1,861



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3.2 Concrete Breakout Failure

$$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1a)}$$

$$\phi N_{cb} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
3.250	4.000	1.000	6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
86.53	95.06	0.946	1.000	7,782

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
6,702	0.650	0.750	1.000	3,267	1,861



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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_v = V_{ua}/\phi V_n$	Status
Steel Strength*	1,557	8,034	20	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	1,557	9,383	17	OK
Concrete edge failure in direction x+**	1,557	4,345	36	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4266
 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{V,seis}$
0.16	114,604	1.000

Calculations

$V_{sa,eq}$ [lb]
12,360

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
12,360	0.650	8,034	1,557



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4.2 Pryout Strength

$$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1a)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

k_{cp}	h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2	3.250	4.000	1.000
c_{ac} [in.]	k_c	λ_a	f'_c [psi]
6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
86.53	95.06	0.946	1.000	7,782

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
13,404	0.700	1.000	1.000	9,383	1,557



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4.3 Concrete edge failure in direction x+

$$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} \Psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1a)}$$

$$\phi V_{cb} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\Psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\Psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f'_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

Variables

c_{a1} [in.]	c_{a2} [in.]	$\Psi_{c,V}$	h_a [in.]	l_e [in.]
9.000	4.000	1.200	8.000	3.250
λ_a	d_a [in.]	f'_c [psi]	$\Psi_{parallel,V}$	
1.000	0.625	4,000	1.000	

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\Psi_{ed,V}$	$\Psi_{h,V}$	V_b [lb]
140.00	364.50	0.789	1.299	13,141

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
6,207	0.700	1.000	1.000	4,345	1,557

*Anchor row defined by: Anchor 1; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.570	0.358	5/3	58	OK

$$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} \leq 1$$



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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0 .
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!



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7 Installation data

Profile: -

Hole diameter in the fixture: -

Plate thickness (input): -

Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: Kwik Bolt TZ2 - SS 316 5/8 (3 1/4) hnom2

Item number: 2210284 KB-TZ2 5/8x4 3/4 SS316

Maximum installation torque: 722 in.lb

Hole diameter in the base material: 0.625 in.

Hole depth in the base material: 4.250 in.

Minimum thickness of the base material: 5.500 in.

Hilti Ø 5/8 in Kwik Bolt TZ2 - SS 316 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling

- Suitable Rotary Hammer
- Properly sized drill bit

Cleaning

- Manual blow-out pump

Setting

- Torque controlled cordless impact tool
- Torque wrench
- Hammer

Coordinates Anchor in.

Anchor	x	y	C _{-x}	C _{+x}	C _{-y}	C _{+y}
1	0.000	0.000	-	9.000	4.000	-



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Specifier's comments:

CORNER

1 Input data

Anchor type and diameter:

Kwik Bolt TZ2 - SS 304 5/8 (3 1/4) hnom2

Item number:

2210278 KB-TZ2 5/8x4 3/4 SS304

Specification text:

Hilti Ø 5/8 in Kwik Bolt TZ2 - SS 304 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII,

Effective embedment depth:

$h_{ef,act} = 3.250$ in., $h_{nom} = 3.750$ in.

Material:

AISI 304

Evaluation Service Report:

ESR-4266

Issued | Valid:

10/1/2024 | 12/1/2025

Proof:

Design Method ACI 318-19 / Mech

Shear edge breakout verification:

Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)

Stand-off installation:

Profile:

Base material:

cracked concrete, 4000, $f'_c = 4,000$ psi; $h = 8.000$ in.

Installation:

Hammer drilled hole, Installation condition: Dry

Reinforcement:

tension: not present, shear: not present; no supplemental splitting reinforcement present

Seismic loads (cat. C, D, E, or F)

edge reinforcement: > No. 4 bar

Tension load: yes (17.10.5.3 (d))

Shear load: yes (17.10.6.3 (a))



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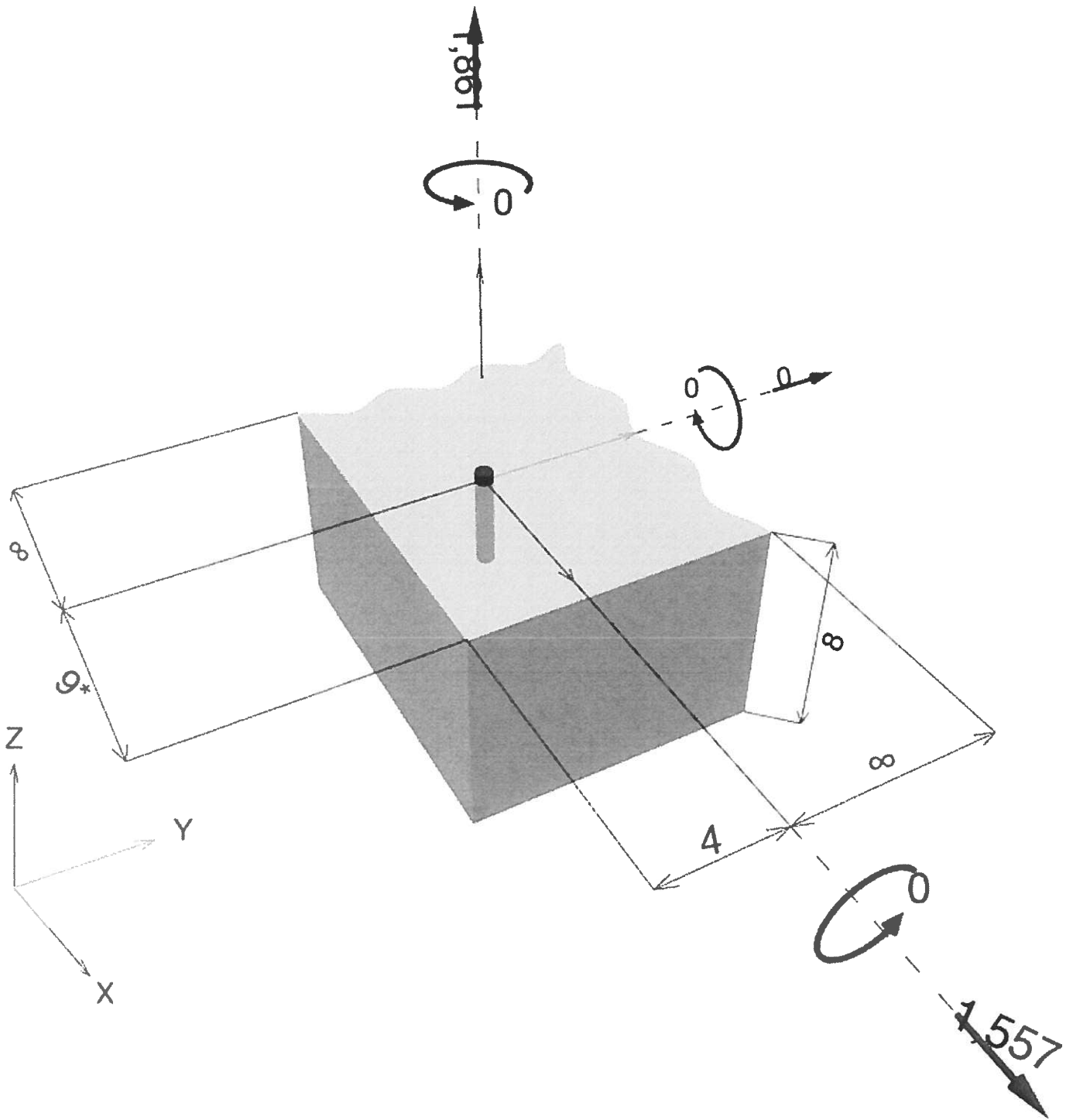
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Geometry [in.] & Loading [lb, in.lb]



Input data and results must be checked for conformity with the existing conditions and for plausibility!
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1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	CMG2 AC - Max Compression and Wind Y-Y	N = -4,878; V _x = 0; V _y = 1,728; M _x = 0; M _y = 0; M _z = 0;	yes	35
2	CMG2 AC - Max Compression and Wind X-X	N = -4,878; V _x = 1,728; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	40
3	CMG2 AC - Max Tension and Wind Y-Y	N = 828; V _x = 0; V _y = 1,728; M _x = 0; M _y = 0; M _z = 0;	yes	26
4	CMG2 AC - Max Tension and Wind X-X	N = 828; V _x = 1,728; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	40
5	CMG2 DC - Max Compression and Wind Y-Y	N = -5,511; V _x = 0; V _y = 1,557; M _x = 0; M _y = 0; M _z = 0;	yes	39
6	CMG2 DC - Max Compression and Wind X-X	N = -5,511; V _x = 1,557; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	39
7	CMG2 DC - Max Tension and Wind Y-Y	N = 1,861; V _x = 0; V _y = 1,557; M _x = 0; M _y = 0; M _z = 0;	yes	57
8	CMG2 DC - Max Tension and Wind X-X	N = 1,861; V _x = 1,557; V _y = 0; M _x = 0; M _y = 0; M _z = 0;	yes	58

2 Load case/Resulting anchor forces

Controlling load case: 8 CMG2 DC - Max Tension and Wind X-X

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1,861	1,557	1,557	0



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3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	1,861	14,132	14	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	1,861	3,267	57	OK

* highest loaded anchor **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-4266
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.16	114,604

Calculations

N_{sa} [lb]
18,843

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
18,843	0.750	14,132	1,861



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3.2 Concrete Breakout Failure

$$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1a)}$$

$$\phi N_{cb} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
3.250	4.000	1.000	6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
86.53	95.06	0.946	1.000	7,782

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
6,702	0.650	0.750	1.000	3,267	1,861



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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_v = V_{ua}/\phi V_n$	Status
Steel Strength*	1,557	8,034	20	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	1,557	9,383	17	OK
Concrete edge failure in direction x+**	1,557	4,345	36	OK

* highest loaded anchor **anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-4266
 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{V,seis}$
0.16	114,604	1.000

Calculations

$V_{sa,eq}$ [lb]
12,360

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
12,360	0.650	8,034	1,557



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4.2 Pryout Strength

$$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1a)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

A_{Nc} see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

Variables

k_{cp}	h_{ef} [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2	3.250	4.000	1.000
c_{ac} [in.]	k_c	λ_a	f'_c [psi]
6.500	21	1.000	4,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
86.53	95.06	0.946	1.000	7,782

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
13,404	0.700	1.000	1.000	9,383	1,557

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4.3 Concrete edge failure in direction x+

$$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}} \right) \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} \Psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1a)}$$

$$\phi V_{cb} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\Psi_{ed,V} = 0.7 + 0.3 \left(\frac{c_{a2}}{1.5 c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\Psi_{h,V} = \sqrt{\frac{1.5 c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left(7 \left(\frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f'_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

Variables

c_{a1} [in.]	c_{a2} [in.]	$\Psi_{c,V}$	h_a [in.]	l_e [in.]
9.000	4.000	1.200	8.000	3.250
λ_a	d_a [in.]	f'_c [psi]	$\Psi_{parallel,V}$	
1.000	0.625	4,000	1.000	

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\Psi_{ed,V}$	$\Psi_{h,V}$	V_b [lb]
140.00	364.50	0.789	1.299	13,141

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
6,207	0.700	1.000	1.000	4,345	1,557

*Anchor row defined by: Anchor 1; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

5 Combined tension and shear loads, per ACI 318-19 section 17.8

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.570	0.358	5/3	58	OK

$$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} \leq 1$$



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6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- "An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-19, Chapter 17, Section 17.10.5.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.10.5.3 (b), Section 17.10.5.3 (c), or Section 17.10.5.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.10.6.3 (a), Section 17.10.6.3 (b), or Section 17.10.6.3 (c)."
- Section 17.10.5.3 (b) / Section 17.10.6.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.10.5.3 (c) / Section 17.10.6.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.10.5.3 (d) / Section 17.10.6.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0 .
- Hilti post-installed anchors shall be installed in accordance with the Hilti Manufacturer's Printed Installation Instructions (MPII). Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!



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7 Installation data

Profile: -

Hole diameter in the fixture: -

Plate thickness (input): -

Drilling method: Hammer drilled

Cleaning: Manual cleaning of the drilled hole according to instructions for use is required.

Anchor type and diameter: Kwik Bolt TZ2 - SS 304 5/8 (3 1/4) hnom2

Item number: 2210278 KB-TZ2 5/8x4 3/4 SS304

Maximum installation torque: 722 in.lb

Hole diameter in the base material: 0.625 in.

Hole depth in the base material: 4.250 in.

Minimum thickness of the base material: 5.500 in.

Hilti Ø 5/8 in Kwik Bolt TZ2 - SS 304 with 3.75 in nominal embedment depth per ICC-ES ESR-4266 , Hammer drill bit installation per MPII

7.1 Recommended accessories

Drilling

- Suitable Rotary Hammer
- Properly sized drill bit

Cleaning

- Manual blow-out pump

Setting

- Torque controlled cordless impact tool
- Torque wrench
- Hammer

Coordinates Anchor in.

Anchor	x	y	C _{-x}	C _{+x}	C _{-y}	C _{+y}
1	0.000	0.000	-	9.000	4.000	-



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8 Remarks; Your Cooperation Duties

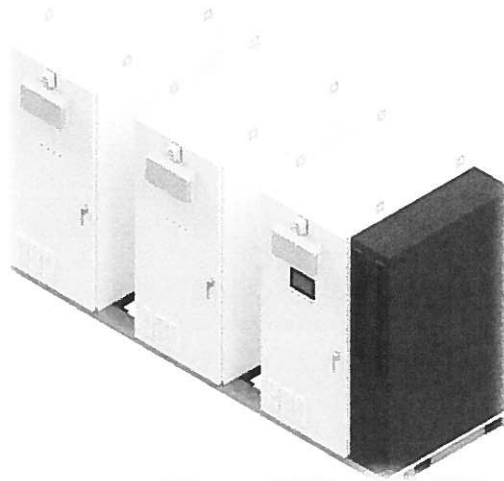
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CMG2 Series

SPECIFICATION SHEET

Document Number: ELM-CMG2-DAS-001

December 10, 2024



OVERVIEW

ELM's CMG2 Series Microgrid System utilizes a combination of AC and DC Energy Storage System (ESS) containers to provide their customers the most configurable and complete system.

Each CMG2 Series product comes with ELM's FieldSight Energy Management System (EMS) technology to manage the charging/discharging of the ESS as well as powerflow of all other site generation assets such as photovoltaic, generators and the grid interconnection. The ELM CMG2 ESS is a liquid cooled battery storage system based on Hithium prismatic LFP ESS Cell 280 Ah with high cyclic lifetime. Each enclosure houses Hithium LFP battery modules. All auxiliary power, DC connections, communications and fire safety systems are installed above ground utilizing prefabricated cabling to interconnect Main ESS and DC blocks containers.

KEY FEATURES

- ELM Fieldsight Microgrid EMS System included
- Fully integrated system with minimal on-site installation
- Scalable energy in 258kWh or 215kWh DC blocks
- UL Certified
- Multi-stage, active fire protection system, compliant to NFPA855

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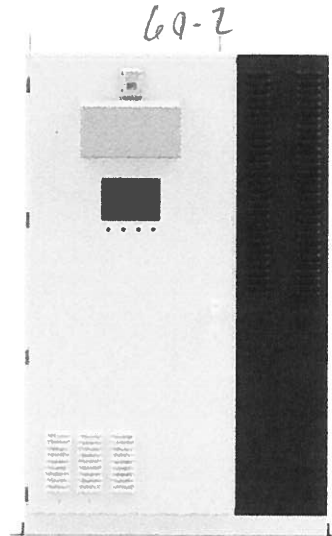
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CMG2 AC Energy Storage System (CMG2-125)



CMG2-125
(includes ELM Fieldsight Microgrid EMS and PCS)

Dimensions	Length 60.5" Width 60.2" Height 99.4"
Weight	8,100 lb. (3,629 kg)
Material	Powder Coated Galvannealed Steel
Protection Level	Type 3R
Paint Tested	1,000 Hour Salt Spray

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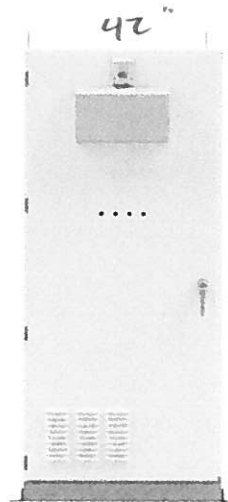
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Reliable, Scalable

ENERGY STORAGE

CMG2 DC Energy Storage System (CMG2-EXP)



CMG2-EXP

Dimensions	Length	42"
	Width	60.2"
	Height	99.4"
Weight	7,300 lb. (3,629 kg)	
Material	Powder Coated Galvannealed Steel	
Protection Level	Type 3R	
Paint Tested	1,000 Salt Hour Spray	

CMG2 BATTERY TECHNICAL SPECIFICATIONS

BATTERY		
Chemistry	Lithium Iron Phosphate (LFP) Lithium Ion	
Cooling Method	Liquid	
Battery Type	Hithium LFP280	
Configuration	6 modules in series rack	5 modules in series rack
Application Altitude	≤3,000m	
ELECTRICAL		
DC Nominal Voltage	921.6V	768V
DC Voltage Range	740V – 1051.2V	740V – 876V
Energy Storage Capacity	258kWh	215kWh
Maximum Power	125kW	107.5kW
Nominal SOC at Delivery	~20%	
Nominal Charge/Discharge Rate	0.5C/0.5C	
Max Charge/Discharge Current	169A	145A

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CMG2 System Model Identification and Capacity

ELM ESS system was evaluated as a multi-part ESS, the system main rating label will include the components included in the system.

CMG2-XX-YYY-ZZZ

Where:

- XX is AC or DC
- YYY is the PCS Maximum Power rating (50-125kW)
- ZZZ is the total energy in kWh (see system configurations on table below)

PCS Max Power (kW)	Quantity of CMG2-EXP	Total Energy (kWh)	Main AC Circuit Breaker Size (A)	AC ESS System Model Number	DC ESS System Model Number
50-125	0	215 ¹	200	CMG2-AC-YYY-215	CMG2-DC-YYY-215
	0	258		CMG2-AC-YYY-258	CMG2-DC-YYY-258
	1	430 ¹		CMG2-AC-YYY-430	CMG2-DC-YYY-430
	1	516		CMG2-AC-YYY-516	CMG2-DC-YYY-516
	2	645 ¹		CMG2-AC-YYY-645	CMG2-DC-YYY-645
	2	774		CMG2-AC-YYY-774	CMG2-DC-YYY-774

* These are not all the configurations available. Please contact ELM sales team for further site configurations.

1. System is limited to a 95% DOD.

Model Variants (Hours of Runtime at Beginning of Life (BOL))									
6 modules	# of Main Containers	1			2				
	# of Exp Containers	0	1	2	0	1	2	3	4
	Energy (kWh)	258	516	774	516	774	1032	1290	1548
PCS Max Power (kW)	125	2.1	4.1	6.2					
	250				2.1	3.1	4.1	5.2	6.2

Model Variants (Hours of Runtime at Beginning of Life (BOL))									
5 modules	# of Main Containers	1			2				
	# of Exp Containers	0	1	2	0	1	2	3	4
	Energy (kWh)	215	430	645	430	645	860	1075	1290
PCS Max Power (kVA)	107.5	2.0							
	125		3.4	5.2					
	215				2.0				
	250					2.6	3.4	4.3	5.2

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CMG2 SYSTEM TECHNICAL SPECIFICATIONS

	CMG2-XX-YYY-ZZZ	
Maximum Power Ratings		
Max. Power Output Ratings	50-125kW	
PCS Ratings*		
DC Input 5CCR Rating	50 kA	
DC Voltage Input Range	740 – 1500 VDC	
DC Maximum Input Continuous Current	171 A	
DC Ratings		
DC Configuration	6 modules in series rack	5 modules in series rack
System DC Voltage Range	740V – 1051.2V	740V – 876V
System DC Nominal Voltage	921.6V	768V
Maximum Discharge Current	169A	145A
Maximum Charge Current	169A	145A
DC Energy (kWh)	See CMG2 System Model Identification and Capacity Table.	
AC Output Ratings		
Nominal Voltage	480V	
Operating Voltage Range	+10%/-12%	
Rated Frequency	60Hz	
Rated AC Import/Export Apparent Power	125kVA	
Rated AC Import/Export Real Power	125kW	
Nominal AC Current	150A	
Overload Capacity	120% (10s)	
Power Factor	-1 to 1, Leading/Lagging	
AC Fault Current Contribution	1.42 kA (0.4 ms)	
Maximum Efficiency	98.7%	
CEC Efficiency	97%	
THD (UL1741 / IEEE 1547)	<5%	
AC Configuration	IT, 3-WIRE (3P3W)	
AC Input SCCR	35kA	
MAIN Auxiliary Consumption**		
PC5 Standby Consumption	200W	
Standby Control Circuits Consumption	100W	
Nominal Control Circuits Consumption	1100W	
Maximum Control Circuits Consumption	2200W	
EXP Auxiliary Consumption**		
Standby Control Circuits Consumption	25W	
Nominal Control Circuits Consumption	1025W	
Maximum Control Circuits Consumption	1840W	

* These are minimum PCS ratings. Different PCS ratings might be available. Consult with ELM for pre-approved PCS.

** Consumption varies per ambient temperature and cooling system.

This document is subject to regular updates, corrections, and improvements. Kindly check you are using latest version.

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4300 Live Oak Dr

The Colony, TX 75056

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Reliable, Scalable

ENERGY STORAGE

General Data	
Internal operating ambient temperature	0 to 49 °C
External operating ambient temperature	-25 ¹ to 50 °C
Storage temperature	-20 to 35 °C (Recommended)
Relative humidity	Up to 95% Non-Condensing
Altitude	3000m
Wind Load	150 MPH (Exposure Cat. C) (ASCE/SEI 7-16)

Notes : 1. Minimum external operating ambient temperature is based on the assumption the system is running at least 25% of the rated power

Certifications	
System	ANSI/CAN/UL 9540:2023 (PENDING) STANDARD FOR SAFETY Energy Storage Systems and Equipment
Batteries	ANSI/CAN/UL 1973 Batteries for Use in Stationary and Motive Auxiliary Power Applications ANSI/CAN/UL 9540A STANDARD for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
Inverter (PCS)	UL 1741 2nd Edition Supplement SB Grid support utility interactive inverters and converters. California RULE 21 Generating Facility Interconnections Hawaii RULE 14 Service Connections and Facilities on Customer's Premises IEEE 1547-2018, IEEE 1547a-2020, IEEE 1547.1-2020 Standard for Interconnecting Distributed Resources with Electric Power Systems
Others	NFPA 855 Compliant UL 3141 (PENDING) Power Control System (PCS) Power Control of Distributed Energy Resources

Communications and Control	
EMS Software	ELM Field5ight EMS Software Built In Data Access and Alerts on Desktop & Mobile 24/7 Asset Monitoring System Level & Individual Individual Microgrid Components pages Local HMI IP 6S Touchscreen
Off-Grid Mode (Islanded)	Black Start Solar Integration Generator Integration
On-Grid Mode	Grid Support Functions Peak Shaving Seamless Back Up Demand Response Time of Use Shift
Communications	4G LTE Cellular Local LAN Modbus TCP Modbus RTU RS-485
Optional	DNP3 to Modbus TCP Additional Serial Ports (Through serial to TCP Converter) Fiber Ports

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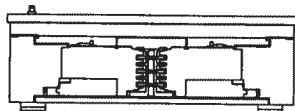
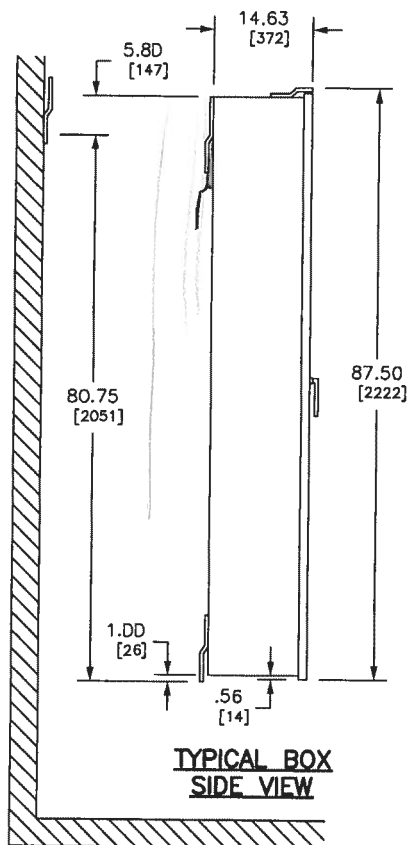
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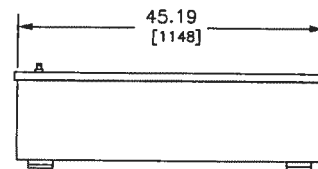
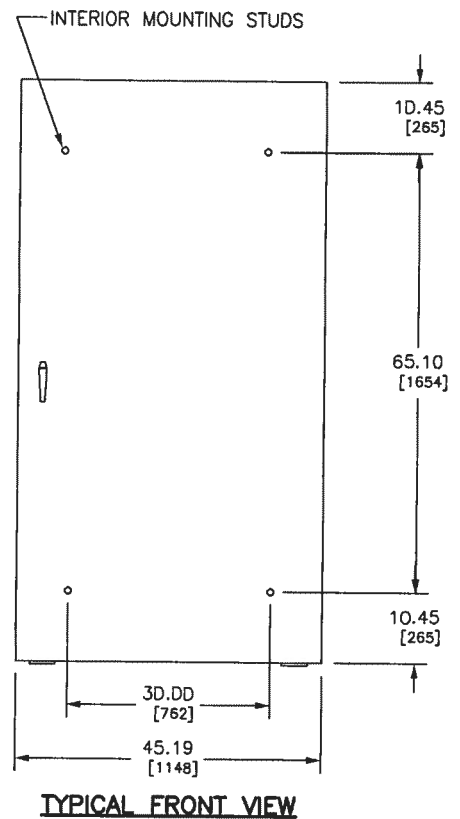
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REV	DESCRIPTION	BY	DATE						
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TYPICAL MOUNTING OF DG, DJ, DL, FA, FC, FD, FG, FH, FI, FJ, FK, FY, HD, HG, HJ, HL, JD, JG, JJ, JL, KA, KC, KH, KI, LA, LC, LE, LH, LI, LX, LXI, MA, ME, MH, MG, MJ, MX, NA, NC, NE, NX, PG, PJ, PK, PL, Q2, Q2H, Q2-H, QB, QD, QG, QJ, QO, RG, RJ, RK OR RL BREAKERS



I-LINE HCR-U PANELBOARDS MEET THE APPLICABLE REQUIREMENTS OF UL AND CSA.

BOX: GRAY BAKED ENAMEL FINISH ELECTRODEPOSITED OVER CLEANED PHOSPHATIZED STEEL. INCLUDES HINGED COVER. MOUNTS TO WALL WITH MOUNTING CHANNEL AND SWINGABLE MOUNTING BRACKET.

LOCK: CHROME-PLATED HANOLE LOCK. NSR-251 KEY CHANGE. NO PROVISIONS FOR PADLOCK.

■ REFER TO DP CATALOG CLASS 211D FOR ADDITIONAL INFORMATION.

FOR NEMA TYPE 3R/12 ENCLOSURE FOR THE I-LINE HCR-U PANELBOARD.

DUAL DIMENSIONS: INCHES
MILLIMETERS

■ ENCLOSURE CATALOG NUMBER
HC4486WP

JOB NAME: ---	EQUIPMENT DESIGNATION: ---
JOB LOCATION: ---	EQUIPMENT TYPE: I-LINE HCR-U TYPE 3R/12 ENCL
DRAWN BY: ---	DRAWING TYPE: ---
ENGR: ---	
DATE: JULY 2020	
DRAWING STATUS: ---	DWG# PRA416

- | | | |
|--|---|---|
| <ol style="list-style-type: none"> 4. Pivot the mounting feet at the bottom of the enclosure to the mounting position at a 90° angle to the bottom of the enclosure. See Figure 4. 5. Position the enclosure on the surface mounting bracket. See Figure 3. 6. Fasten the mounting feet to the mounting surface (hardware not included). See Figure 4. 7. Install the panelboard interior using the instructions provided with the panelboard. 8. Reinstall the interior trim assembly after wiring has been completed. | <ol style="list-style-type: none"> 4. Gire los pies de montaje ubicados en la parte inferior del gabinete para colocarlos en la posición de montaje (en un ángulo de 90° con respecto a la parte inferior del gabinete). Vea la figura 4. 5. Coloque el gabinete en el soporte de montaje para sobreponer, como se muestra en la figura 3. 6. Sujete los pies de montaje a la superficie de montaje (no se incluyen los herrajes). Vea la figura 4. 7. Instale el interior del tablero de alumbrado/distribución siguiendo las instrucciones provistas. 8. Vuelva a instalar el ensamble del marco interior una vez que haya completado el cableado. | <ol style="list-style-type: none"> 4. Faire pivoter les pieds de montage au bas du coffret pour les mettre à la position de montage (à un angle de 90 degrés avec le fond du coffret). Voir la figure 4. 5. Positionner le coffret sur le support de montage en surface comme indiqué à la figure 3. 6. Attacher les pieds de montage à la surface de montage (la quincaillerie n'est pas incluse). Voir la figure 4. 7. Installer l'intérieur du panneau de distribution en suivant les directives fournies. 8. Réinstaller la garniture intérieure après avoir terminé le câblage. |
|--|---|---|

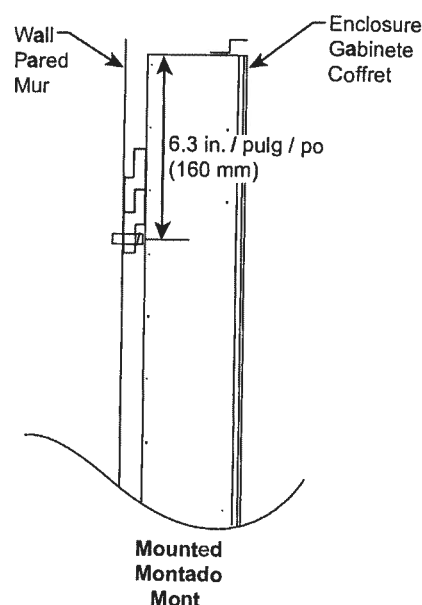
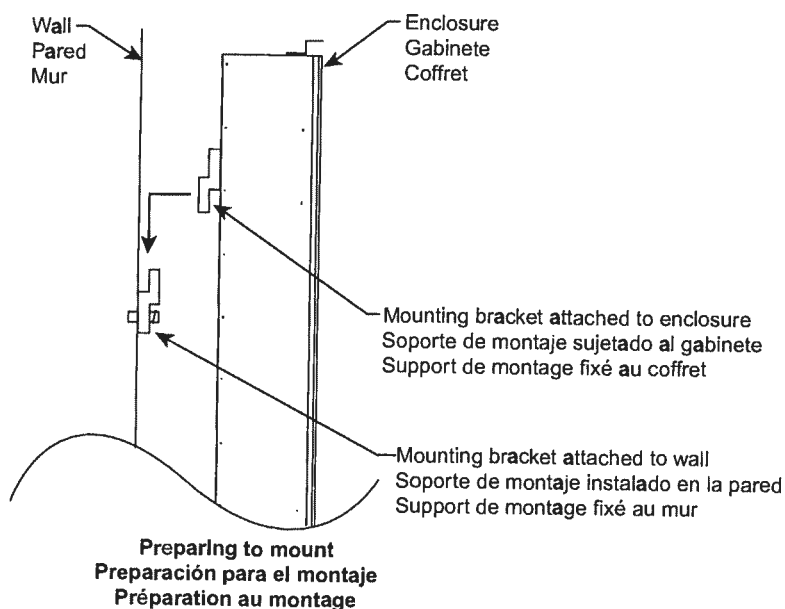


Figure / Figura / Figure 3 : Mounting the Enclosure / Montaje del gabinete / Montage du coffret

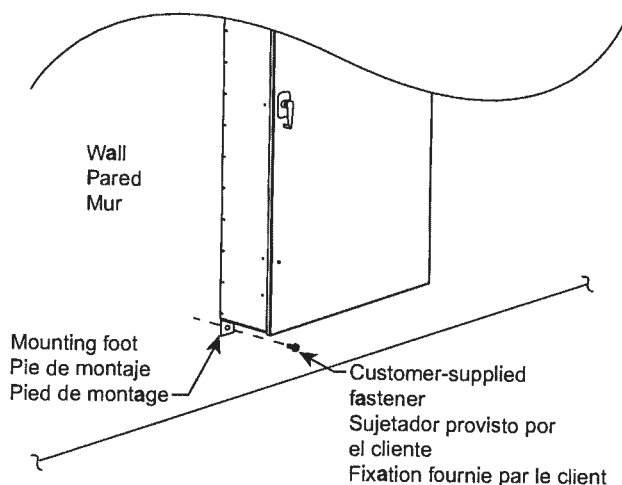


Figure / Figura / Figure 4 : Fastening the Mounting Feet to the Mounting Surface / Sujeción de los pies de montaje a la superficie de montaje / Fixation des pieds de montage à la surface de montage