WILCO – HAY STORAGE BUILDING (FOUNDATION CALCULATIONS)

W11TH & WILLOW CREEK
EUGENE, OR 97402

FEBRUARY 17, 2023
JOB# 22-0690

STRUCTURAL CALCULATIONS
BY

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02/17/2023

2/16/2023 Project: 22-0690 Wilco Hay Storage

STABILITY ENGINEERING INC.

By: Paul Schroeder

STEEL COLUMN: LINE A COLUMNS 1 & 4

LOADS (lbs) DIRECTION:	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DEAD:	200	0	2600	---
LIVE:	0	0	0	---
LIVE ROOF:	400	0	4600	---
SNOW:	500	0	5700	---
RAIN:	0	0	0	---
WIND:	4600	2000	7400	-7400
SEISMIC:	1200	1700	2000	-2000

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	200	0	2600	---
LOAD COMB 2	200	0	2600	---
LOAD COMB 3	700	0	8300	---
LOAD COMB 4	575	0	6875	---
LOAD COMB 5	2960	1200	7040	1200
LOAD COMB 6a	2645	900	10205	3545
LOAD COMB 6b	1205	892.5	7925	5825
LOAD COMB 7	2880	1200	6000	-2880
LOAD COMB 8	960	1190	2960	160

DESIGN LOADS	TRANS.	LONG.	VERT.
MINUMUM:	200	0	-2880
MAXIMUM:	2960	1200	10205

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	2.6
LENGTH:	2.6

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	2600	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	29 FT^2
UPLIFT (lbs):	-7400	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-2880	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.1	3.25
LENGTH:	3.1	3.25

END WALL SLAB AREA: 29 FT^2

SIDE WALL SLAB AREA: 58 FT^2

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	2960	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	1544	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	1416	REBAR SIZE (#)	4
		Fy:	60 KSI
		Ψt:	1
		Ψe:	1
		Ψs:	1
		λ:	1

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

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STEEL COLUMN: LINE A COLUMNS 2 & 3

LOADS (lbs) DIRECTION:	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DEAD:	300	0	3900	---
LIVE:	0	0	0	---
LIVE ROOF:	600	0	7900	---
SNOW:	900	0	10900	---
RAIN:	0	0	0	---
WIND:	7300	2900	12400	-12400
SEISMIC:	1800	600	2200	-2200

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	300	0	3900	---
LOAD COMB 2	300	0	3900	---
LOAD COMB 3	1200	0	14800	---
LOAD COMB 4	975	0	12075	---
LOAD COMB 5	4680	1740	11340	2360
LOAD COMB 6a	4260	1305	17655	6495
LOAD COMB 6b	1920	315	13230	10920
LOAD COMB 7	4560	1740	9780	-5100
LOAD COMB 8	1440	420	3880	800

DESIGN LOADS	TRANS.	LONG.	VERT.
MINUMUM:	300	0	-5100
MAXIMUM:	4680	1740	17655

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	3.4
LENGTH:	3.4

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	3900	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	64 FT^2
UPLIFT (lbs):	-12400	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-5100	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.7	4.00
LENGTH:	3.7	4.00

END WALL SLAB AREA: 32 FT^2

SIDE WALL SLAB AREA: 64 FT^2

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	4680
FRICTION (lbs):	2331
DESIGN LOAD (lbs):	2349

CONCRETE WEIGHT:	150 PCF
SOIL WEIGHT:	120 PCF
REBAR SIZE (#)	4
Fy:	60 KSI
Ψt:	1
Ψe:	1
Ψs:	1
λ:	1

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

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STABILITY ENGINEERING INC.

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STEEL COLUMN: LINE C COLUMNS 1 & 4

LOADS (lbs) DIRECTION:	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DEAD:	200	0	1600	---
LIVE:	0	0	0	---
LIVE ROOF:	400	0	3200	---
SNOW:	500	0	4000	---
RAIN:	0	0	0	---
WIND:	3300	2100	5800	-5800
SEISMIC:	600	900	2000	-2000

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	200	0	1600	---
LOAD COMB 2	200	0	1600	---
LOAD COMB 3	700	0	5600	---
LOAD COMB 4	575	0	4600	---
LOAD COMB 5	2180	1260	5080	200
LOAD COMB 6a	2060	945	7210	1990
LOAD COMB 6b	890	472.5	5650	3550
LOAD COMB 7	2100	1260	4440	-2520
LOAD COMB 8	540	630	2360	-440

DESIGN LOADS	TRANS.	LONG.	VERT.
MINUMUM:	200	0	-2520
MAXIMUM:	2180	1260	7210

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	2.2
LENGTH:	2.2

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	1600	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	29 FT^2
UPLIFT (lbs):	-5800	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-2520	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	2.7	3.25
LENGTH:	2.7	3.25

END WALL SLAB AREA: 29 FT^2

SIDE WALL SLAB AREA: 58 FT^2

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	2180	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	1334	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	846	REBAR SIZE (#)	4
		Fy:	60 KSI
		Ψt:	1
		Ψe:	1
		Ψs:	1
		λ:	1

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

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STABILITY ENGINEERING INC.

By: Paul Schroeder

STEEL COLUMN: LINE C COLUMNS 2 & 3 W/ X-BRACE

LOADS (lbs) DIRECTION:	HORIZ TRANS.	HORIZ LONG.	VERT. (+)	VERT. (-)
DEAD:	300	0	2600	---
LIVE:	0	0	0	---
LIVE ROOF:	600	0	5400	---
SNOW:	900	0	7600	---
RAIN:	0	0	0	---
WIND:	6600	8600	11100	-11000
SEISMIC:	1100	8500	6500	-6500

ASD LOAD COMB	TRANS.	LONG.	VERT. (+)	VERT. (-)
LOAD COMB 1	300	0	2600	---
LOAD COMB 2	300	0	2600	---
LOAD COMB 3	1200	0	10200	---
LOAD COMB 4	975	0	8300	---
LOAD COMB 5	4260	5950	9260	-1950
LOAD COMB 6a	3945	3870	13295	3350
LOAD COMB 6b	1552.5	4462.5	11712.5	4887.5
LOAD COMB 7	4140	5160	8220	-5040
LOAD COMB 8	950	5950	6110	-2990

DESIGN LOADS	TRANS.	LONG.	VERT.
MINUMUM:	300	0	-5040
MAXIMUM:	4260	5950	13295

DESIGN SQUARE FOOTING FOR GRAVITY LOADS

MINIMUM (Ft)	
WIDTH:	3.0
LENGTH:	3.0

*ASSUMED BEARING CAPACITY: 1500 PSF

DESIGN SQUARE FOOTING FOR UPLIFT LOADS

DEAD LOAD (lbs):	2600	CONCRETE WEIGHT:	150 PCF	SLAB AREA USED:	64 FT^2
UPLIFT (lbs):	-11000	SLAB THICKNESS:	6 "	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	-5040	FTG DEPTH:	12 "	LOAD FACTOR:	0.6

MINIMUM (Ft)		USE
WIDTH:	3.7	4.00
LENGTH:	3.7	4.00

END WALL SLAB AREA: 32 FT^2

SIDE WALL SLAB AREA: 64 FT^2

DESIGN SQUARE FOOTING FOR SLIDING

LAT LOAD (lbs):	5950	CONCRETE WEIGHT:	150 PCF
FRICTION (lbs):	2058	SOIL WEIGHT:	120 PCF
DESIGN LOAD (lbs):	3892	REBAR SIZE (#)	4
		Fy:	60 KSI
		Ψt:	1
		Ψe:	1
		Ψs:	1
		λ:	1

MINIMUM REBAR REQ'TS	
180° HOOK (in):	12.0
DEVELOP. (in):	18.0
LAP SPLICE (in)	23.40
CAPACITY (K):	5.89

SIMPSON Strong-Tie

Anchor Designer™ Software
Version 3.0.7947.0

Company:		Date:	2/17/2023
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Address:			
Phone:			
E-mail:			

1.Project information

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

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

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

Anchor Information:
Anchor type: Cast-in-place
Material: AB
Diameter (inch): 0.750
Effective Embedment depth, h_{ef} (inch): 21.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 23.25
C_{min} (inch): 1.63
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 24.00
State: Uncracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Yes
Reinforcement provided at corners: Yes
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: Yes
Ignore 6do requirement: Yes
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 9.50 x 8.00 x 0.50

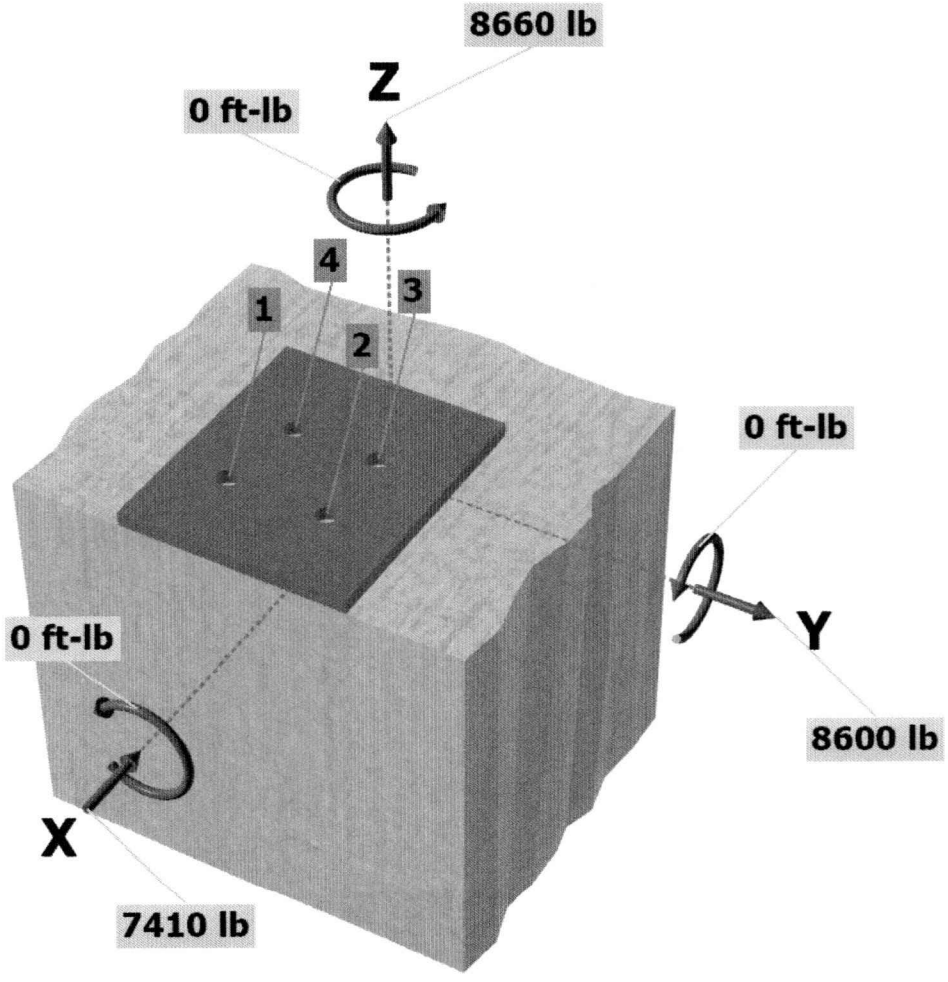
Recommended Anchor
Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB6 (3/4"Ø)

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 8660
V_{uax} [lb]: -7410
V_{uay} [lb]: 8600
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



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Anchor Designer™ Software
Version 3.0.7947.0

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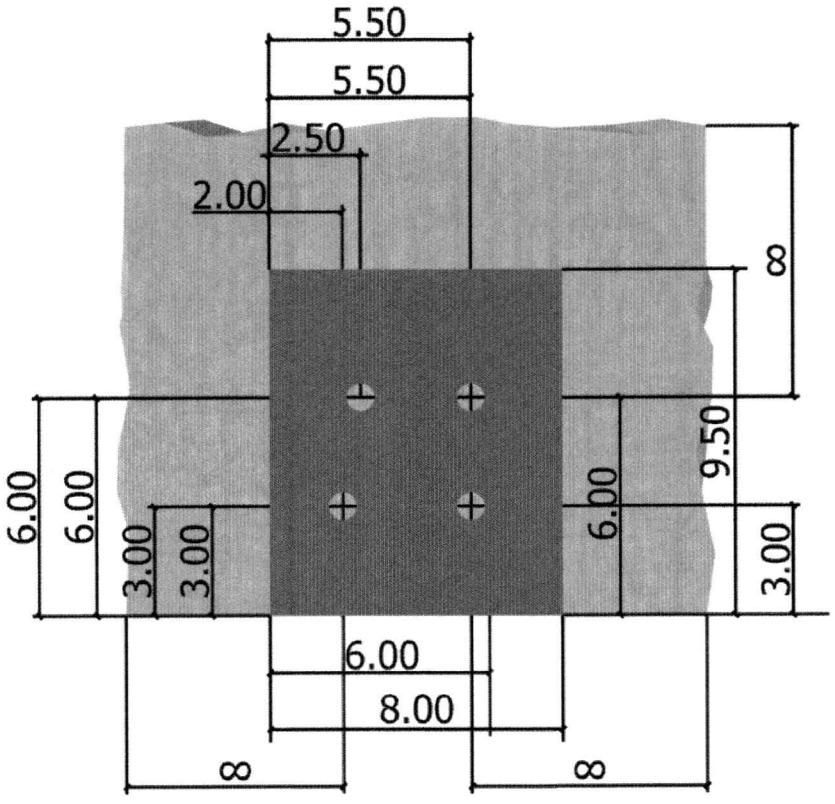
<Figure 2>



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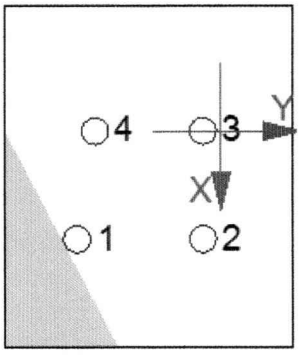
3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	392.4	-1581.4	2366.9	2846.6
2	3602.7	-2087.4	2366.9	3155.8
3	5040.4	-2087.4	1933.1	2845.1
4	2288.7	-1653.7	1933.1	2544.0
Sum	11324.3	-7410.0	8600.0	11391.5

Maximum concrete compression strain (‰): 0.19
Maximum concrete compression stress (psi): 847
Resultant tension force (lb): 11324
Resultant compression force (lb): 2664
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.90
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.44
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.16
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.19

<Figure 3>



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

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
19370	0.75	14528

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

$N_b = 16\lambda_a\sqrt{f'_c}h_{ef}^{5/3}$ (Eq. 17.4.2.2b)

λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
1.00	2500	21.000	127876

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

A_{Nc} (in²)	A_{Nco} (in²)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
2653.97	3969.00	3.00	0.959	0.729	1.25	1.000	127876	0.70	52268

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

$\phi N_{pn} = \phi\Psi_{c,P}N_p = \phi\Psi_{c,P}8A_{brg}f'_c$ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.4)

$\Psi_{c,P}$	A_{brg} (in²)	f'_c (psi)	ϕ	ϕN_{pn} (lb)
1.4	3.53	2500	0.70	69266

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7. Side-Face Blowout Strength of Anchor in Tension (Sec. 17.4.4)

$\phi N_{sbg} = \phi\{(1+c_{a2}/c_{a1})/4\}(1+s/6c_{a1})N_{sb} = \phi\{(1+c_{a2}/c_{a1})/4\}(1+s/6c_{a1})(160c_{a1}\sqrt{A_{brg}})\lambda\sqrt{f'_c}$ (Sec. 17.3.1, Eq. 17.4.4.1 & 17.4.4.2)

s (in)	c_{a1} (in)	c_{a2} (in)	A_{brg} (in²)	λ_a	f'_c (psi)	ϕ	ϕN_{sbg} (lb)
3.50	3.00	99999.00	3.53	1.00	2500	0.70	37723

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

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
11625	1.0	0.65	7556

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

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

k_{cp}	A_{Nc} (in²)	A_{Nco} (in²)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
2.0	2653.97	3969.00	0.989	0.729	1.250	1.000	127876	0.70	107808

11. Results

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

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	**5040**	**14528**	**0.35**	**Pass (Governs)**
Concrete breakout	11324	52268	0.22	Pass
Pullout	5040	69266	0.07	Pass
Side-face blowout	3995	37723	0.11	Pass

Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status
Steel	**3156**	**7556**	**0.42**	**Pass (Governs)**
Pryout	11352	107808	0.11	Pass

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..2	0.00	0.42	41.8%	1.0	Pass

PAB6 (3/4"Ø) with hef = 21.000 inch meets the selected design criteria.

12. Warnings

- For irregular anchor patterns, the designer must consider sizing of base plate holes to ensure shear loads are distributed to anchors as designed.

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

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

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