Supplemental Structural Calculations

PREPARED FOR:

Red Dot Corporation
Puyallup Corporate Center
East Main Avenue at Linden Lane

PROJECT:

Red Dot Corporation
Environmental Chamber Framing Re-Use
2220760.20

PREPARED BY:

Andrew McEachern, P.E., S.E.
Principal

DATE:

October 2023

Civil Engineers ● Structural Engineers ● Landscape Architects ● Community Planners ● Land Surveyors ● Neighbors

Supplemental

Structural Calculations

Red Dot Corporation

Environmental Chamber Framing Re-Use

Project # 2220760.20

Project Principal Andrew D. McEachern, P.E., S.E.

Design Criteria

Design Codes and Standards

Codes and Standards: Structural design and construction shall be in accordance with the applicable sections of the following codes and standards as adopted and amended by the local building authority: International Building Code, 2018 Edition.

Structural Design Criteria:

Live Load Criteria:

Roof (Min Blanket Snow): 25 psf

Slab on Grade: 350 psf

Wind Load Criteria:

Basic Wind Speed: 97 mph

Risk Category: II

Wind Exposure: B

Topographic Factor: 1.0

ANDREW DEAN McEACHERN

38722

10/25/2023

Seismic Criteria:

Risk Category: II

Seismic Importance Factor: 1.0

S_s = 1.258 S_1 = 0.433

S_{ds} = 1.006 S_{d1} = N/A

Site Class: D

Seismic Design Category: D

Soil Criteria:

Based on Geotechnical Engineering Report by: Terra Associates Inc, dated September 2019.

Soil Bearing Capacity: 2,500 psf when sitting on 2 feet of structural fill on the previously preloaded side. Allow 33% increase for loads from wind or seismic origin.

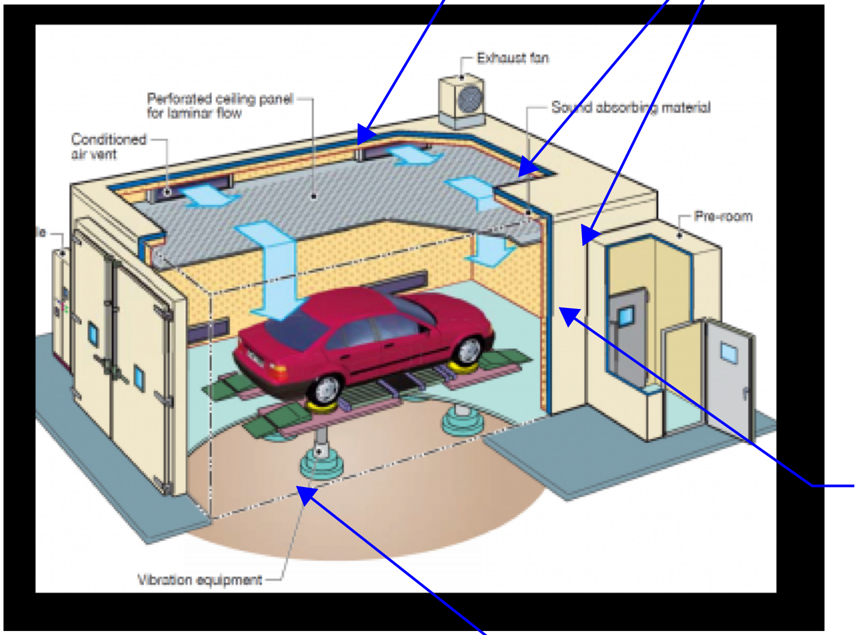
Project Description

This submittal includes supplemental information related to the structural evaluation of an existing Environmental Chamber to be relocated to a new facility. The Environmental Chamber is essentially a large walk-in cooler, which will be located within an existing building. This existing equipment was originally installed roughly 30 years ago.

This resubmittal is in response the plan review comments provided by the City of Puyallup.

RELOCATED ENVIRO CHAMBER IS
18ft WIDE x 47ft LONG x 19'-2" TALL

ENVIRO CHAMBER WALL
AND CEILING PANELS
CONSIST OF 7" THICK
INSULATED METAL PANELS



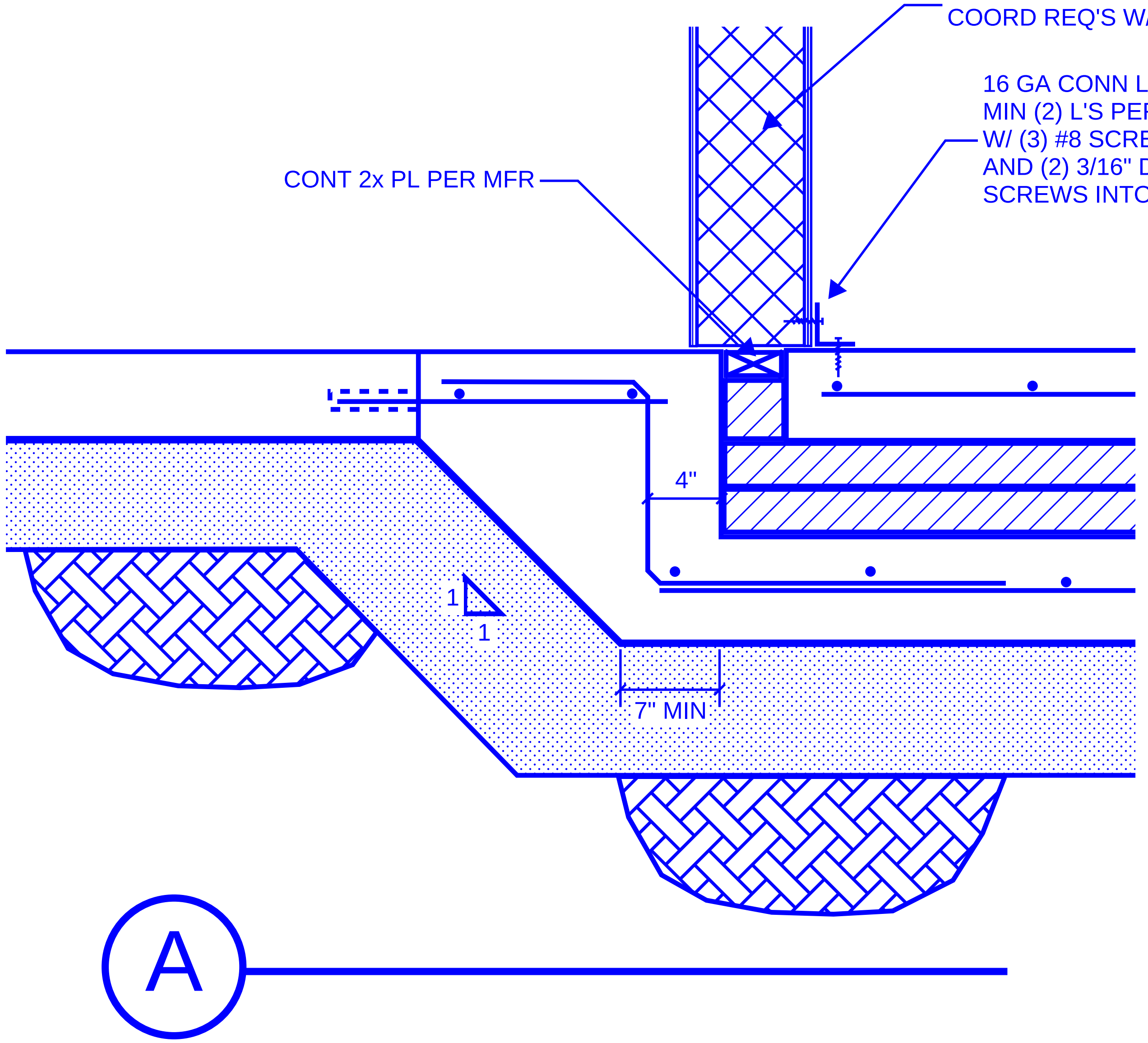
INSULATED PANELS ARE
CONNECTED WITH CAM
LOCKS AT EACH PANEL
JOINT

PANEL BASES CONNECT TO
CONCRETE SLAB ON GRADE
WITH L 2x2 MEMBERS

FOR CALLOUTS
IN COMMON
SEE SSK 01

GENERAL NOTES:

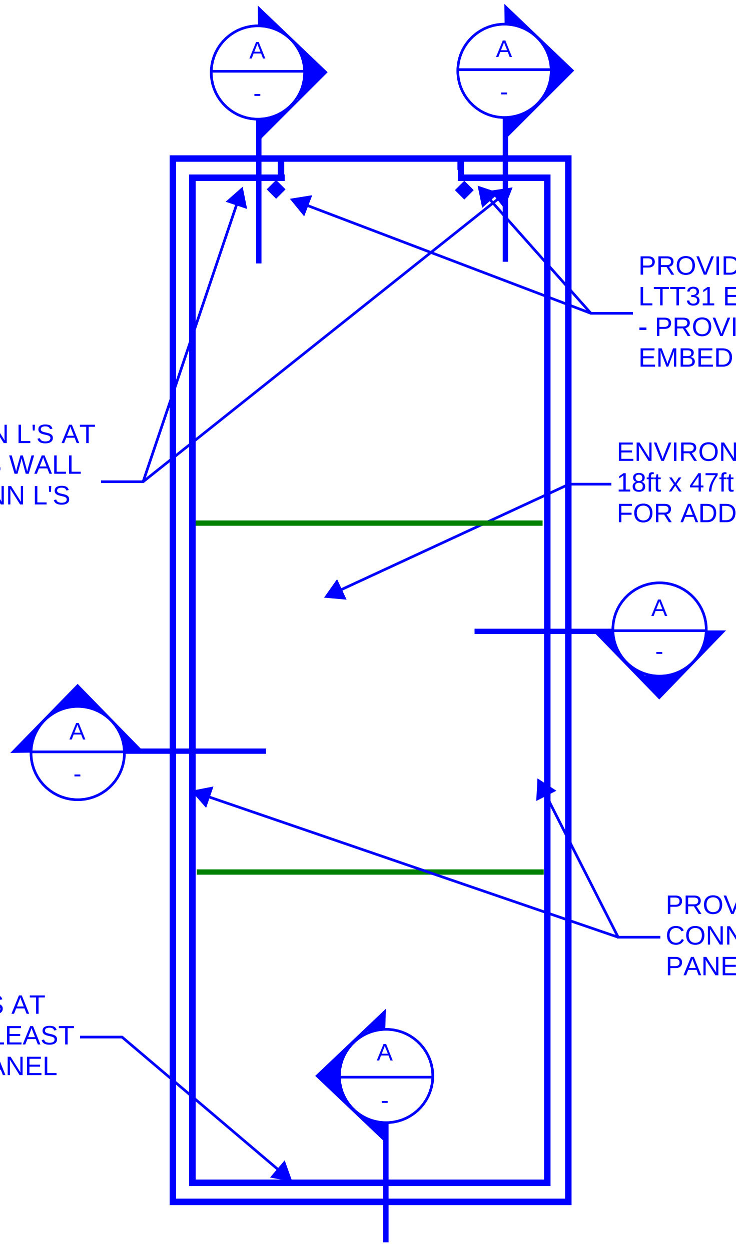
- FIELD VERIFY ALL DIMENSIONS SHOWN W/ EQUIPMENT MFR



ENVIRO CHAMBER PER PLAN -
COORD REQ'S W/ INSTALLER

16 GA CONN L 2" x 2" x 0'-6" - PROVIDE
MIN (2) L'S PER WALL PANEL AND CONN
W/ (3) #8 SCREWS INTO WALL PANEL
AND (2) 3/16" DIA x 1-3/4" CONCRETE
SCREWS INTO SLAB ON GRADE

CONT 2x PL PER MFR



PROVIDE VERT SIMSPON
LTT31 EA SIDE OF DOOR OPNG
- PROVIDE 5/8" ANCHOR ROD
EMBED 3" MIN W/ EPOXY

PROVIDE MIN (3) CONN L'S AT
EA WALL PIER AT THIS WALL
- PROVIDE MIN (2) CONN L'S
PER WALL PANEL

ENVIRONMENTAL CHAMBER -
18ft x 47ft - SEE MFR DRAWINGS
FOR ADDITIONAL INFORMATION

PROVIDE MIN (2)
CONN L'S PER WALL
PANEL AT THIS WALL

PROVIDE MIN (8) CONN L'S AT
THIS WALL - PROVIDE AT LEAST
(2) CONN L'S PER WALL PANEL

ENVIRONMENTAL CHAMBER PLAN

AHBL

2215 North 30th Street
Suite 300
Tacoma, WA 98403
253.383.2422 TEL
253.383.2572 FAX

RED DOT CORPORATION EQUIPMENT FOUNDATIONS

ENVIRONMENTAL CHAMBER ANCHORAGE REQUIREMENTS

DRAWN BY: ADM
DATE: 10/25/2023
JOB NO.: 2220760.20

SSK-04

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ENVIRO CHAMBER LATERAL ANALYSIS

MINIMUM OUT-OF-PLANE LOAD

5 PSF FOR INTERIOR PARTITIONS

SEISMIC ANALYSIS

7" FOAM SANDWICH PANELS

$w = 4$ PSF (APPROX)

SEISMIC LOAD - WALL DESIGN FORCES

$$F_p = 0.4\,(S_{DS})(I_e)\,W_p$$

$$= 0.4\,(1.006)(1.0)(4\,\text{psf})$$

$$= 1.61\ \text{psf (ULT)}$$

∴ 5 PSF GOVERNS BY INSPECTION

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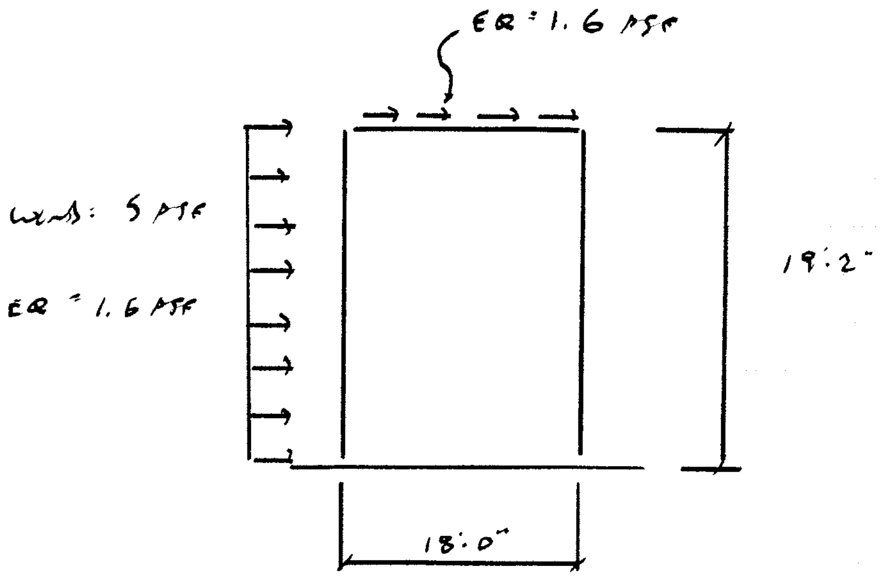
ENVIRO CHAMBER LATERAL ANALYSIS



LOAD TO ROOF LEVEL

WIND = 5 PSF (1/2) (19'-2") (2 WALLS)

= 96 PLF ASD

SEISMIC = 1.6 PSF (1/2) (19'-2") (2 WALLS) +
1.6 PSF (18')

= 59.5 PLF (ULT)
= 42 PLF (ASD) ∴ 5 PSF LOAD GOVERNS

If this does not meet with your understanding, please contact us in writing within seven days. THANK YOU.

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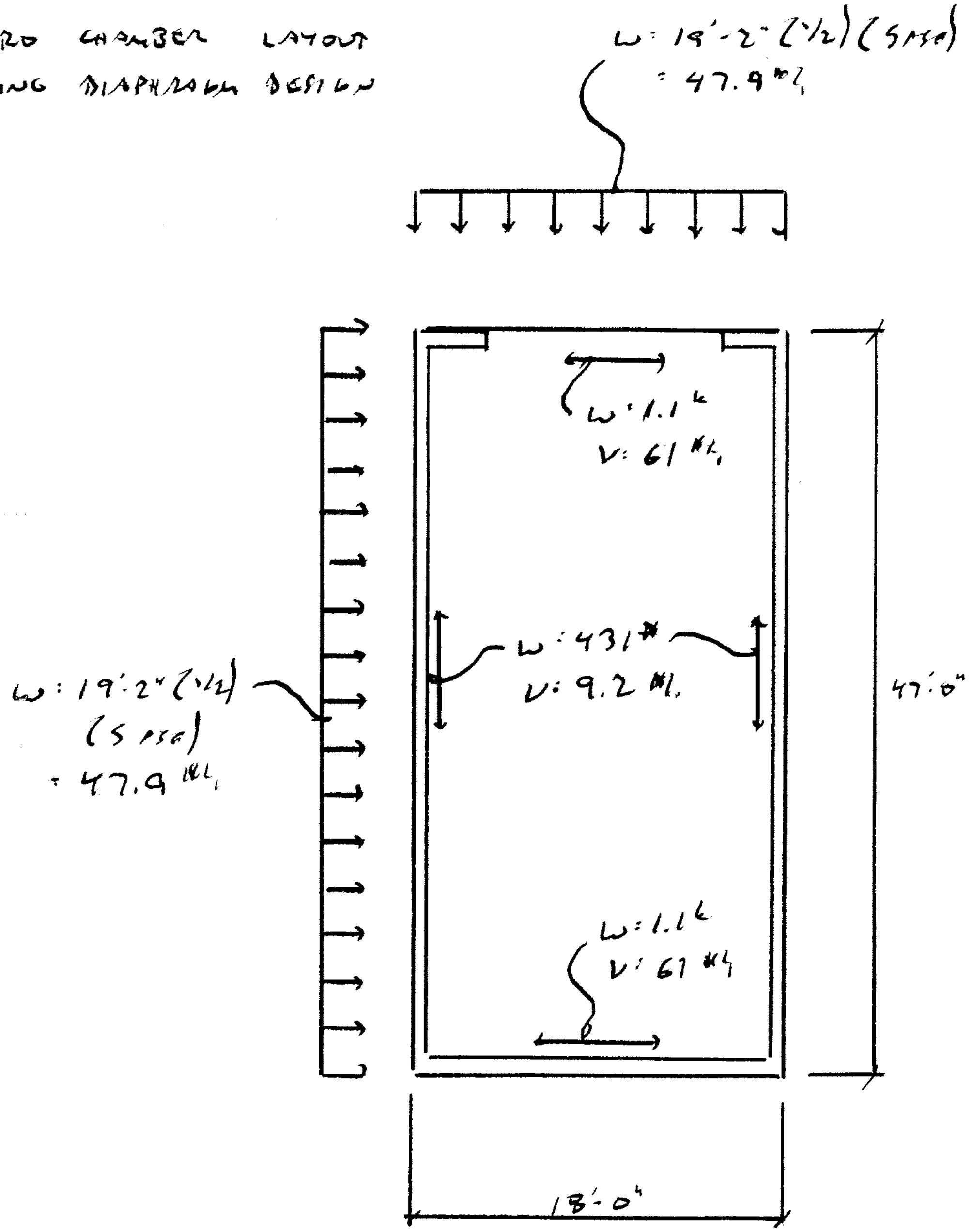
ENVIRO CHAMBER LAYOUT
CEILING DIAPHRAGM DESIGN



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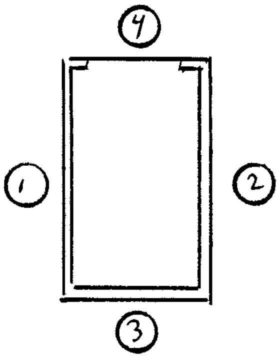
ENVIRO CHAMBER
SHEARWALL DESIGN



SHEARWALL ① + ②

$v = 0.43^{k} / 47'$

$= 9.2^{\#/L}$

OVERTURNING

$= [0.43^{k} (19'\text{-}2") - \tfrac{2}{3} DL] / 47'$

$= [8.3^{k\cdot ft} - 103.1^{k\cdot ft}] / 47'$

$= 0^{k}$

SHEARWALL ③

$V = 1.1^{k} / 18'$

$= 61^{\#/L}$

$OT = [1.1^{k} (19'\text{-}2") - \tfrac{2}{3} DL] / 18'$

$= [21.1^{k\cdot ft} - 12.4^{k\cdot ft}] / 18'$

$= 483\#$ ∴ USE CONNECTIONS AT CORNER TO RESIST UPLIFT

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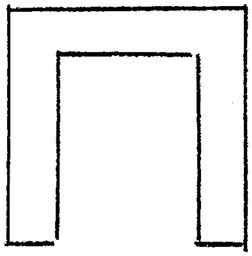
SHEARWALL ④



$V = 1.1^{k} / (2)(3')$

$= 183^{PLF}$

$OT = [(550^{\#})(12'\text{-}0") - 2/3 DL]/3'$

$= (6.6^{k\text{-}ft} - 0.3^{k\text{-}ft})/3'$

$= 2.1^{k}$

∴ USE CONNECTION AT CORNER TO
RESIST UPLIFT
USE SPANDREL FRAME ABOVE DOOR
TO RESIST RACKING

· PROVIDE SIMPSON LTT131 HD EA SIDE OF
OPNG (MAX CAPACITY = 2.3^{k})

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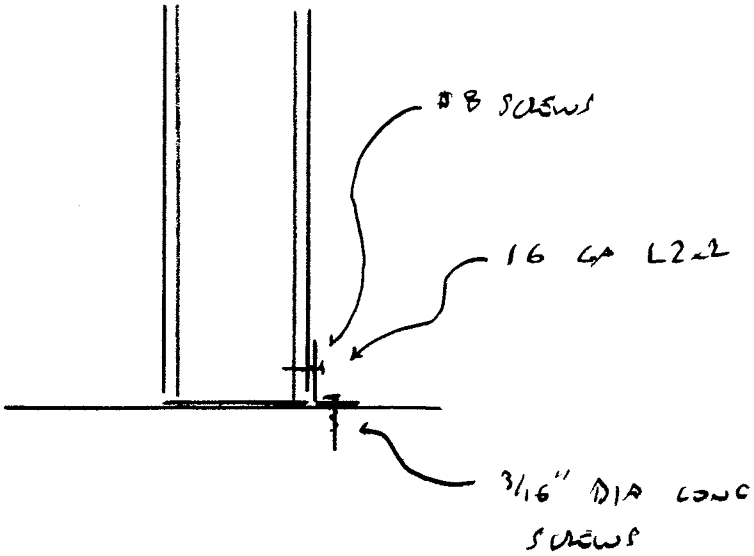
ENVIRO CHAMBER ANCHORAGE

TYPICAL SILL L

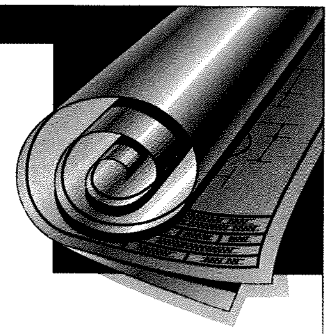
16 GA x 2" x 2" STEEL L

PROVIDE MIN (2) L'S AT EA PANEL

3/16" x 1 3/4" TAP CON ANCHORS INTO SLAB



TECHNICAL NOTE



Fastener Loads for Plywood – Screws

Number E830E • June 2011

INTRODUCTION

The integrity of a structure is frequently dependent upon the connections between its component elements. For maximum strength and stability, each joint requires a design adapted to the fastener type and to the strength properties of the individual structural members. Included in the following tables are ultimate withdrawal and lateral loads for plywood joints fastened with wood and sheet metal screws. These values are based upon tests conducted on plywood by *APA – The Engineered Wood Association.*

To calculate design withdrawal and lateral capacities for various sizes of wood screws, see Table 11.3.1A of AF&PA NDS-2005, and APA Technical Topic TT-051 and Section 4.4.7 of *Panel Design Specification,* APA Form D510. See also www.awc.org/calculators/index.html for online fastener calculators.

TEST RESULTS

Panel-and-Metal Connections

Self-drilling, self-tapping screws are commonly used to attach panels up to 1-1/8 inches thick to steel flanges up to 3/16 inch thick. However, since threads are usually provided on only a portion of the fastener shank, it is important to specify the appropriate fastener length for a given panel thickness. This precaution ensures that the threaded portion of the shank will engage in the steel framing. Several lengths and styles are available. Additional details for these types of screws may be obtained from specific fastener manufacturers. The following test data apply to wood screws and sheet metal screws. Little design data is available on sheet metal screws, but the primary difference between wood and sheet metal screws is that sheet metal screws are generally threaded their full length and wood screws are only threaded about two-thirds of their length.

Lateral Resistance:

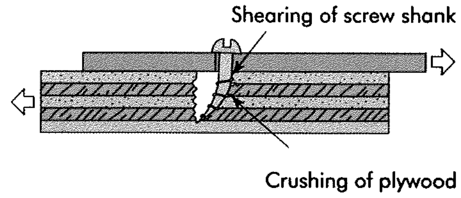
Performance of panel-and-metal connections is dependent upon the strength properties of all three elements.

a) Panel-critical joints are characterized by a shearing of the wood fibers oriented parallel to the direction of the applied force.

b) Fastener-critical joints are characterized by a shear failure of the screw shank. As shown in Figure 1, once localized crushing of the wood has occurred, resistance of the metal to fastener-head embedment causes the screw to become

FIGURE 1

FAILURE OF LATERALLY LOADED, SINGLE-SHEAR METAL-TO-PLYWOOD CONNECTION



USE 465LBS ULTIMATE LOAD AS BASIS
OF DESIGN W/ FACTOR OF SAFETY OF 6
THEREFORE USE ALLOWABLE SHEAR
LOAD OF 78LBS PER SCREW

a shear specimen and joint behavior is dependent upon the shear strength of the fastener. Shear failure of the screw shank occurs at the wood-metal interface.

c) The metal-critical joint may fail in one of two ways. Failure occurs when the resistance of the screw head to embedment is greater than the resistance of the metal to lateral and/or withdrawal load, and the screw tears through or away from the metal. Failure also occurs when thin metal in a metal-to-panel joint crushes or tears away from the screw.

The following test data are presented for **plywood** only.

Tables 1 and 2 present average ultimate lateral loads for wood- and sheet-metal-screw connections in plywood-and-metal joints. The end distance of the loaded-edge in these tests was one inch. Plywood face grain was parallel to the load since this direction yields the lowest lateral loads when the joint is plywood-critical. All wood-screw specimens were tested with a 3/16-inch-thick steel side plate, and values should be modified if thinner steel is used.

TABLE 1

SCREWS: METAL-TO-PLYWOOD CONNECTIONS(a)

Depth of Threaded Penetration (inch)	Average Ultimate Lateral Load (lbf)(b)					
	Wood Screws			Sheet Metal Screws		
	#8	#10	#12	#8	#10	#12
1/2	415	(500)	590	465	(565)	670
5/8	–	–	–	500	(600)	705
3/4	–	–	–	590	(655)	715

(a) Plywood was C-D grade with exterior glue (all plies Group 1), face grain parallel to load. Side plate was 3/16"-thick steel.

(b) Values are **not** design values. Values in parentheses are estimates based on other tests.

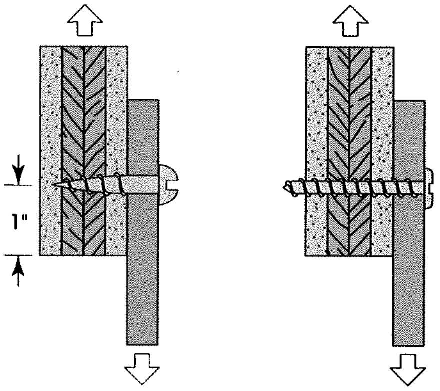


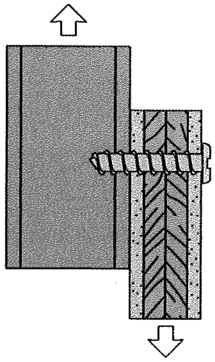
TABLE 2

SHEET METAL SCREWS: PLYWOOD-TO-METAL CONNECTIONS(a)

Framing	Plywood Performance Category	Average Ultimate Lateral Load (lbf)(b)				
		Screw Size				1/4"-20 Self Tapping Screw
		#8	#10	#12	#14	
0.080-inch Aluminum	1/4	330	360	390	410	590
	1/2	630	850*	860	920	970
	3/4	910*	930*	1250	1330	1440
0.078-inch Galvanized Steel (14 gage)	1/4	360	380	400	410	650
	1/2	700*	890*	900	920	970
	3/4	700*	950*	1300*	1390*	1500

(a) Plywood was A-C EXT (all plies Group 1), face grain parallel to load.

(b) Values are **not** design values. Loads denoted by an asterisk(*) were limited by screw-to-framing strength; others were limited by plywood strength.



Withdrawal:

Tables 3 and 4 present average ultimate withdrawal loads for wood and sheet metal screws in plywood-and-metal joints, based on analysis of test results. Wood screws are threaded for only 2/3 of their length. Sheet metal screws typically have higher ultimate load than wood screws in the smaller gages because of their full-length thread.

Values shown in Table 3 for wood screws are based on 1/4-inch protrusion of the wood screw from the back of the panel. This was to assure measurable length of thread embedment in the wood, since the tip of the tapered wood screw may be smaller than the pilot hole. This was not a factor for sheet metal screws due to their uniform shank diameters.

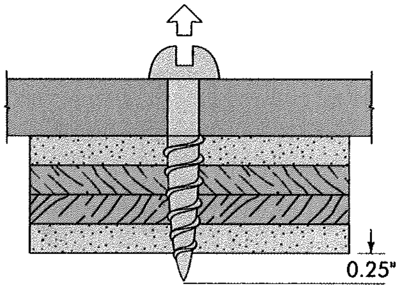
TABLE 3

WOOD AND SHEET METAL SCREWS: METAL-TO-PLYWOOD CONNECTIONS[(a,b)]

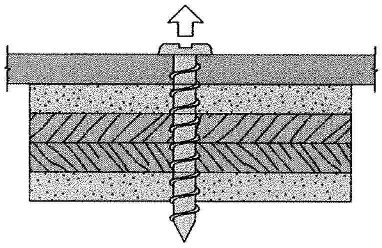
Depth of Threaded Penetration (inch)	Average Ultimate Withdrawal Load (lbf)					
	Screw Size					
	#6	#8	#10	#12	#14	#16
3/8	150	180	205	–	–	–
1/2	200	240	275	315	350	–
5/8	250	295	345	390	440	–
3/4	300	355	415	470	525	–
1	–	–	–	625	700	775
1-1/8	–	–	–	705	790	875
2-1/4	–	–	–	–	1580	–

(a) Plywood was C-D grade with exterior glue (all plies Group 1).

(b) Values are **not** design values.



Wood Screw



Sheet Metal Screw

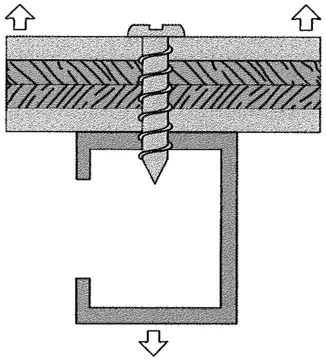
TABLE 4

SHEET METAL SCREWS: PLYWOOD-TO-METAL CONNECTIONS[(a)]

Framing	Plywood Performance Category	Average Ultimate Withdrawal Load (lbf)[(b)]				
		Screw Size				
		#8	#10	#12	#14	1/4"-20 Self Tapping Screw
0.080-inch Aluminum	1/4	130	150	170	180	220
	1/2	350	470	500	520	500
	3/4	660	680	790	850*	790*
0.078-inch Galvanized Steel (14 gage)	1/4	130	150	170	180	220
	1/2	350	470	500	520	500
	3/4	660	680	800	900	850

(a) Plywood was A-C EXT (all plies Group 1).

(b) Values are **not** design values. Loads denoted by an asterisk(*) were limited by screw-to-metal-framing strength; others were limited by plywood strength.



Fastening Into Plywood Panel Edges

Fastening into plywood panel edges is not normally recommended. For some purposes, however, edge fastening may be necessary. Table 5 presents average ultimate lateral and withdrawal loads for various sizes of wood screws in this application.

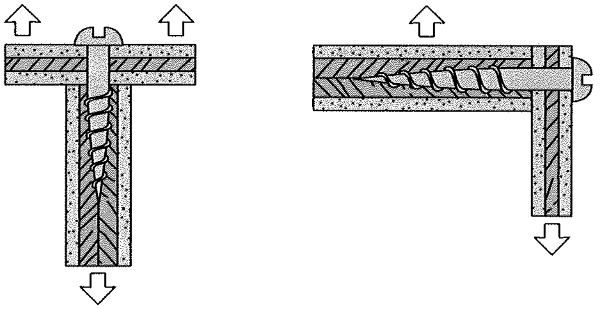
TABLE 5

WOOD SCREWS: PLYWOOD-TO-PLYWOOD EDGE CONNECTIONS(a)

Depth of Threaded Penetration (inch)	Average Ultimate Lateral Load (lbf)(b)			Average Ultimate Withdrawal Load (lbf)(b)		
	#8	#10	#12	#8	#10	#12
1	180	(185)	195	360	(405)	450
1-1/2	180	(185)	195	410	(455)	500

(a) Plywood receiving screw thread was Performance Category 3/4 C-D grade with exterior glue (Group 2 inner plies).

(b) Values are **not** design values. Values in parentheses are estimates based on other tests.



ESTIMATING ALLOWABLE DESIGN LOADS

It is the responsibility of the designer to select a working load suitable for the particular application. A high degree of variability is inherent in individual fastener test results. Therefore, for screws in withdrawal or laterally loaded, a working load of about one-fifth of the ultimate load has traditionally been used for normal duration of load which contemplates fully stressing the connection for approximately ten years, either continuously or cumulatively. For practically all laterally loaded screw connections shown, the normal-duration working load will correspond to a joint slip of less than 0.01 inch.

Adjustments for shorter or longer duration of load apply to design values for mechanical fasteners where the strength of the wood (i.e., not the strength of the metal fastener) determines the load capacity. Calculations and adjustments of design values for varying combinations of materials and durations of load should be in accordance with the current AF&PA *National Design Specification for Wood Construction.*

Fastener Loads For Plywood – Screws

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:

APA HEADQUARTERS
7011 So. 19th St.
Tacoma, Washington 98466
(253) 565-6600 ▪ Fax: (253) 565-7265

PRODUCT SUPPORT HELP DESK
(253) 620-7400 ▪ E-mail Address:
help@apawood.org

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Form No. E830E/Revised June 2011

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APA

REPRESENTING THE ENGINEERED WOOD INDUSTRY

Screw Capacities

Table Notes

1. Capacities based on AISI S100 Section E4.
2. When connecting materials of different steel thicknesses or tensile strengths, use the lowest values. Tabulated values assume two sheets of equal thickness are connected.
3. Capacities are based on Allowable Strength Design (ASD) and include safety factor of 3.0.
4. Where multiple fasteners are used, screws are assumed to have a center-to-center spacing of at least 3 times the nominal diameter (d).
5. Screws are assumed to have a center-of-screw to edge-of-steel dimension of at least 1.5 times the nominal diameter (d) of the screw.
6. Pull-out capacity is based on the lesser of pull-out capacity in sheet closest to screw tip or tension strength of screw.
7. Pull-over capacity is based on the lesser of pull-over capacity for sheet closest to screw header or tension strength of screw.
8. Values are for pure shear or tension loads. See AISI Section E4.5 for combined shear and pull-over.
9. Screw Shear (Pss), tension (Pts), diameter, and head diameter are from CFSEI Tech Note (F701-12).
10. Screw shear strength is the average value, and tension strength is the lowest value listed in CFSEI Tech Note (F701-12).
11. Higher values for screw strength (Pss, Pts), may be obtained by specifying screws from a specific manufacturer.

Allowable Screw Connection Capacity (lbs)

Thickness (Mils)	Design Thickness	Fy Yield (ksi)	Fu Tensile (ksi)	#6 Screw			#8 Screw			#10 Screw			#12 Screw			¼" Screw		
				(Pss = 643 lbs, Pts = 419 lbs)			(Pss= 1278 lbs, Pts = 586 lbs)			(Pss= 1644 lbs, Pts = 1158 lbs)			(Pss= 2330 lbs, Pts = 2325 lbs)			(Pss= 3048 lbs, Pts = 3201 lbs)		
				0.138" dia, 0.272" Head			0.164" dia, 0.272" Head			0.190" dia, 0.340" Head			0.216" dia, 0.340" Head			0.250" dia, 0.409" Head		
				Shear	Pull-Out	Pull-Over	Shear	Pull-Out	Pull-Over	Shear	Pull-Out	Pull-Over	Shear	Pull-Out	Pull-Over	Shear	Pull-Out	Pull-Over
18	0.0188	33	33	44	24	84	48	29	84	52	33	105	55	38	105	60	44	127
27	0.0283	33	33	82	37	127	89	43	127	96	50	159	102	57	159	110	66	191
30	0.0312	33	33	95	40	140	103	48	140	111	55	175	118	63	175	127	73	211
33	0.0346	33	45	151	61	140	164	72	195	177	84	265	188	95	265	203	110	318
43	0.0451	33	45	214	79	140	244	94	195	263	109	345	280	124	345	302	144	415
54	0.0566	33	45	214	100	140	344	118	195	370	137	386	394	156	433	424	180	521
68	0.0713	33	45	214	125	140	426	149	195	523	173	386	557	196	545	600	227	656
97	0.1017	33	45	214	140	140	426	195	195	548	246	386	777	280	775	1,016	324	936
118	0.1242	33	45	214	140	140	426	195	195	548	301	386	777	342	775	1,016	396	1,067
54	0.0566	50	65	214	140	140	426	171	195	534	198	386	569	225	625	613	261	752
68	0.0713	50	65	214	140	140	426	195	195	548	249	386	777	284	775	866	328	948
97	0.1017	50	65	214	140	140	426	195	195	548	356	386	777	405	775	1,016	468	1,067
118	0.1242	50	65	214	140	140	426	195	195	548	386	386	777	494	775	1,016	572	1,067

Weld Capacities

Table Notes

1. Capacities based on the AISI S100 Specification Sections E2.4 for fillet welds and E2.5 for flare groove welds.
2. When connecting materials of different steel thicknesses or tensile strengths, use the lowest values.
3. Capacities are based on Allowable Strength Design (ASD).
4. Weld capacities are based on E60 electrodes. For material thinner than 68 mil, 0.030" to 0.035" diameter wire electrodes may provide best results.
5. Longitudinal capacity is considered to be loading in the direction of the length of the weld.
6. Transverse capacity is loading in perpendicular direction of the length of the weld.
7. For flare groove welds, the effective throat of weld is conservatively assumed to be less than 2t.
8. For longitudinal fillet welds, a minimum value of EQ E2.4-1, E2.4-2, and E2.4-4 was used.
9. For transverse fillet welds, a minimum value of EQ E2.4-3 and E2.4-4 was used.
10. For longitudinal flare groove welds, a minimum value of EQ E2.5-2 and E2.5-3 was used.

Allowable Weld Capacity (lbs / in)

Thickness (Mils)	Design Thickness	Fy Yield (ksi)	Fu Tensile (ksi)	Fillet Welds		Flare Groove Welds	
				Longitudinal	Transverse	Longitudinal	Transverse
43	0.0451	33	45	499	864	544	663
54	0.0566	33	45	626	1084	682	832
68	0.0713	33	45	789	1365	859	1048
97	0.1017	33	45	1125	1269	-[1]	-[1]
54	0.0566	50	65	905	1566	985	1202
68	0.0713	50	65	1140	1972	1241	1514
97	0.1017	50	65	1269	1269	-[1]	-[1]

[1] *Weld capacity for material thickness greater than 0.10" requires engineering judgment to determine leg of welds, W1 and W2.*

SIMPSON Strong-Tie®

Anchor Designer™
Software
Version 3.2.2309.2

Company:	AHBL	Date:	10/25/2023
Engineer:	ADM	Page:	1/5
Project:	Red Dot Enviro Chamber Anchorage		
Address:	2215 North 30th, Suite 300		
Phone:	253.383.2422		
E-mail:	dmceachern@ahbl.com		

1.Project information

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

Project description:
Location:
Fastening description: Anchorage Capacity of EnviroChamber Base L

2. Input Data & Anchor Parameters

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

Anchor Information:
Anchor type: Concrete screw
Material: Carbon Steel
Diameter (inch): 0.188
Nominal Embedment depth (inch): 1.750
Effective Embedment depth, h_{ef} (inch): 1.250
Code report: IAPMO UES ER-712
Anchor category: 1
Anchor ductility: No
h_{min} (inch): 3.25
c_{ac} (inch): 3.00
C_{min} (inch): 1.75
S_{min} (inch): 1.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 4.00
State: Uncracked
Compressive strength, f'c (psi): 3000
$\Psi_{c,V}$: 1.4
Reinforcement condition: A tension, A shear
Supplemental edge reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 2.00 x 6.00 x 0.04

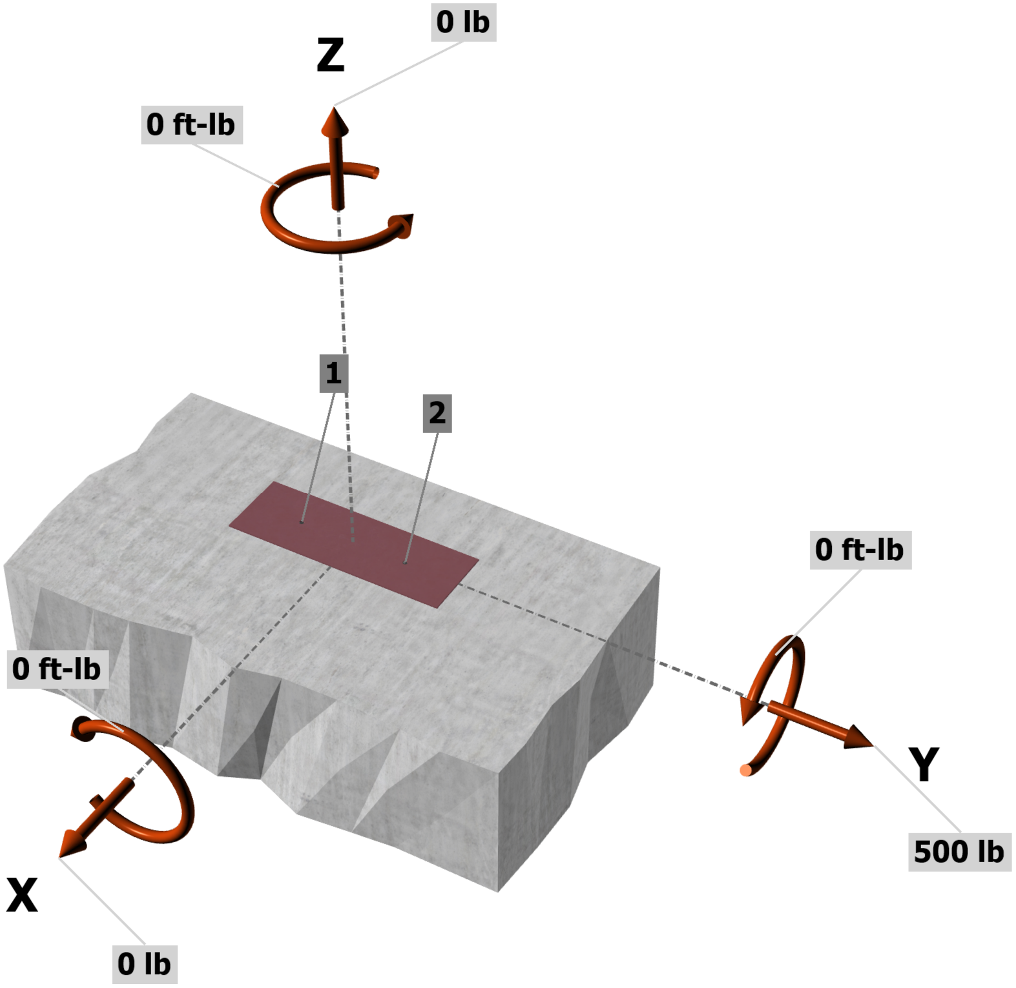
Recommended Anchor
Anchor Name: Titen Turbo™ - 3/16"Ø Titen Turbo, hnom:1.75" (44mm)
Code Report: IAPMO UES ER-712

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

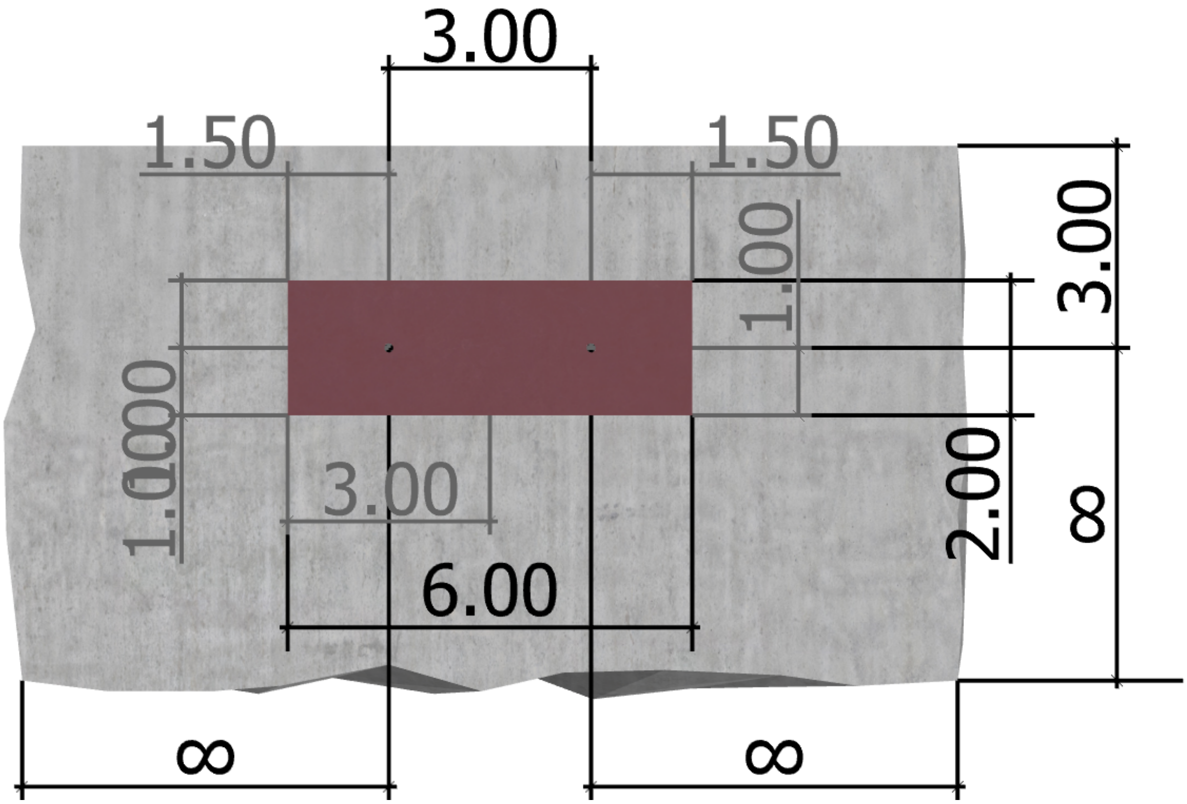
Strength level loads:

N_{ua} [lb]: 0
V_{uax} [lb]: 0
V_{uay} [lb]: 500
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



<Figure 2>

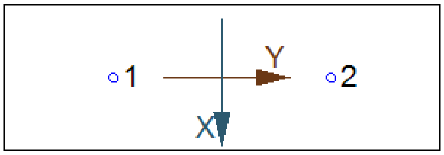

3.00
1.50
1.50
1.00
3.00
1.00
1.00
3.00
2.00
∞
6.00
∞
∞

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	0.0	0.0	250.0	250.0
2	0.0	0.0	250.0	250.0
Sum	0.0	0.0	500.0	500.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 0
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



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

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
475	1.0	0.60	285

9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.5.2)

Shear parallel to edge in x-direction:

$V_{by} = \min|7(l_e/d_a)^{0.2}\sqrt{d_a}\lambda_a\sqrt{f'_c}c_{a1}^{1.5};\ 9\lambda_a\sqrt{f'_c}c_{a1}^{1.5}|$ (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

l_e (in)	d_a (in)	λ_a	f'_c (psi)	c_{a1} (in)	V_{by} (lb)
1.03	0.129	1.00	3000	3.00	1085

$\phi V_{cbgx} = \phi\ (2)(A_{Vc}/A_{Vco})\Psi_{ec,V}\Psi_{ed,V}\Psi_{c,V}\Psi_{h,V}V_{by}$ (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

A_{Vc} (in^2)	A_{Vco} (in^2)	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{c,V}$	$\Psi_{h,V}$	V_{by} (lb)	ϕ	ϕV_{cbgx} (lb)
48.00	40.50	1.000	1.000	1.400	1.061	1085	0.75	2863

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

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

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
1.0	25.31	14.06	1.000	1.000	1.000	1.000	1837	0.70	2315

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6)

Shear	Factored Load, V_{ua} (lb)	Design Strength, $øV_n$ (lb)	Ratio	Status
Steel	**250**	**285**	**0.88**	**Pass (Governs)**
|| Concrete breakout x-	500	2863	0.17	Pass
Pryout	500	2315	0.22	Pass

3/16"Ø Titen Turbo, hnom:1.75" (44mm) meets the selected design criteria.

12. Warnings

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

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