FACILITIES DIVISION LAWRENCE BERKELEY LABORATORY	**CALCULATION COVER SHEET** Discipline: **Civ/Struct** Calc. No.: 033.018 No. of Sheets: 9+ Appendix	Job No.: W0275601 Revision No.: 0 Date: 07/15/2022 Page 1 of 9

TITLE: B33-220 Freezer

SUBJECT: Seismic Anchorage

STATEMENT OF PROBLEMS:

Steel angles were fabricated with hole locations per typical details, one of the hole location conflicts with rebar, anchors need to be spaced closer than 3xhef therefore new calcs are provided to shift the conflicting anchor.

SOURCES OF DATA:

SOURCES OF FORMULAS AND REFERENCES: 2019 CBC, ASCE 7-16

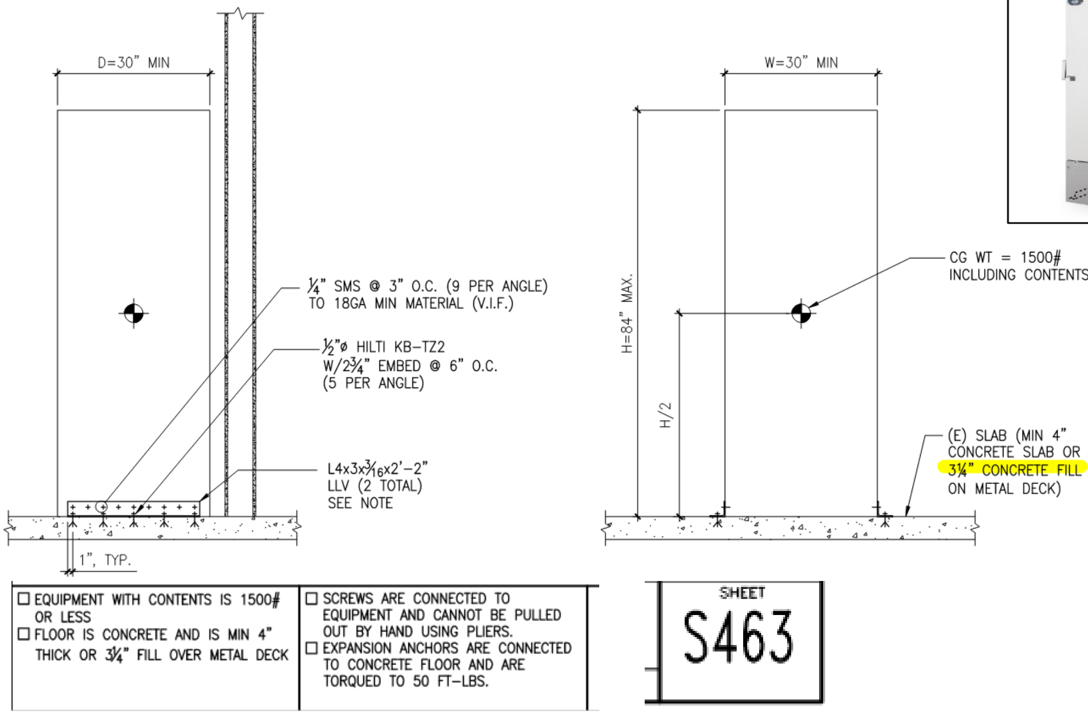
INTENDED USE: Construction

PRELIMINARY CALC [ ] FINAL CALC [X] SUPERCEDES CALC NO

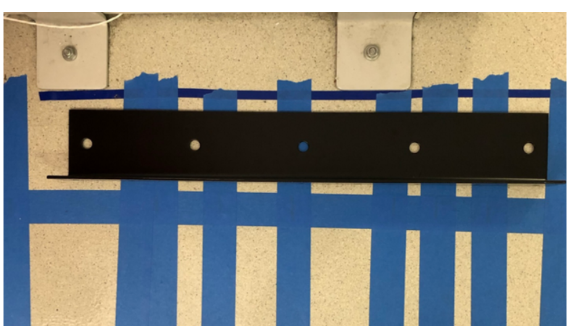
0	N/A	S. De Leon	06/29/22	Y. Yin	07/11/22	T. Hart	07/15/22
Rev	Revision	Calculation by	Date	Checked by	Date	Approved by	Date

Freezer Anchorage S463

This calculation covers the freezer anchorage typical detail S463. If the anchors need to be shifted, or the conditions do not match up exactly, this calculation can be used to utilize the same detail with modifications as required.



B33-220: The typical detail was specified, but the bracket anchorage as shown in the detail was not suitable to miss all rebar. One anchor must be shifted in each bracket. See image below



DECK AND FILL MARK (SEE PLAN)	DECK GAGE AND PROFILE TYPE SEE 10/–	DECK WELDS, SEE DETAIL(s) 3/–, 4/–						FILL THICKNESS ABOVE DECK – FILL TYPE	FILL REINFORCEMENT SEE 17/–	REMARKS FOR TYPICAL NOTES SEE 2/–
		WELD (A)		WELD (B)		WELD (C)				
		SIZE AND TYPE	# PER SHEET	SIZE AND TYPE	SPACING	SIZE AND TYPE	SPACING			
1	18GA A	3/4" PW	4	3/4" PW	2'-0"	1.5" TSW	3'-0"	3.5" N. WT.	#4@12" E.W.	TRIPLE SPAN, NORMAL WEIGHT

CONCRETE

1. ALL CONCRETE SHALL DEVELOP THE FOLLOWING COMPRESSIVE STRENGTHS AT 28 DAYS:

NORMAL WEIGHT CONCRETE	28 DAYS OR 56 DAYS
DRILLED PIERS	4000 PSI
FOOTINGS, GRADE BEAMS	4000 PSI
WALLS, PILASTERS	5000 PSI
BEAMS, JOISTS, SUSPENDED SLABS	4000 PSI
SLABS-ON-GRADE, CURBS	4000 PSI
FILL ON METAL DECK	3500 PSI

Detailed description: Need floor scan at B33 R0220 for securing -80. The area that needs to be scanned is right by Fridge #11

-80 Freezer measurements are: 60.7(H) X 27.8(D) X 29.1(W)
Weight: 625lbs

Freezer B33-220_W0275601 Inbox ×

Dave Smith Wed, Apr 6, 7:57 AM
to me

Seij

I spoke with Garret Bolar who is the building coordinator for that area who told me that this freezer was going to be a back up unit. He estimated that the content weight wouldn't be more than 150lbs when they used it.
I hope this information helps with a workable solution.

UNIT DEFINITIONS:

$k \equiv 1000 \cdot lb$ $ftk \equiv ft \cdot k$ $plf \equiv \frac{lb}{ft}$ $klf \equiv \frac{k}{ft}$ $psi \equiv \frac{lb}{in^2}$ $psf \equiv \frac{lb}{ft^2}$ $ksi \equiv \frac{k}{in^2}$ $ksf \equiv \frac{k}{ft^2}$

$''k \equiv in \cdot k$ $leg \equiv 1$ $bolt \equiv 1$ $isolator \equiv 1$ $pcf \equiv \frac{lb}{ft^3}$ $kcf \equiv \frac{k}{ft^3}$

The freezer can be considered as 'lab equipment' per ASCE 7-16 Table 13.5-1

$I_p := 1.0$ $a_p := 1.0$ $R_p := 2.5$ $\Omega_0 := 2.0$

for the LBNL site: $S_{DS} := 1.84$

distance from grade elevation to the floor
in where the equipment is located: $z := 16 \cdot ft$

Assumed distance from grade to the roof: $h_r := 48 \cdot ft$

$W_p := 625\ lb + 475\ lb = 1100.00\ lb$ self weight and max allowed content weight

Seismic force:

$$F_p := \frac{(.4 \cdot a_p \cdot S_{DS})}{\left(\frac{R_p}{I_p}\right)} \cdot \left(1 + 2 \cdot \left(\frac{z}{h_r}\right)\right) \cdot W_p = 539.73\ lb$$

$$F_{pv} := 0.2 \cdot S_{DS} \cdot W_p = 404.80\ lb$$

$F_{pmin} := .3 \cdot S_{DS} \cdot I_p \cdot W_p = 607.20\ lb$ $F_{p\_upper\_bound} := 1.6 \cdot S_{DS} \cdot I_p \cdot W_p = 3238.40\ lb$

$$F_p := \text{if}\left(F_{pmin} > F_p, F_{pmin}, \text{if}\left(F_p < F_{p\_upper\_bound}, F_p, F_{p\_upper\_bound}\right)\right) = 607.20\ lb$$

% of "g": $\frac{F_p}{W_p} = 0.55$ $S_g := \frac{F_p}{W_p}$

Free standing unit:

Unit Dimensions:

$a := 60.7\ in$ $b := 29.1\ in$ $c := 27.8\ in$

$e_x := 1\ in$ $e_y := 1\ in$ $z' := 0.5\ a = 30.35\ in$ Estimated

Anchor Locations:

$n := 10$ Number of anchors

$b_1 := \frac{b}{2} = 14.55\ in$ x10

x2 for all

$c_1 := -12\ in$ $c_2 := -6\ in$ $c_3 := 2\ in$

$c_4 := 6\ in$ $c_5 := 12\ in$

$b_{leg} := 0.5\ b = 14.55\ in$ $c_{leg} := 0.5 \cdot c = 13.90\ in$

$b_{max} := \max\left(b_1, b_{leg}\right) = 14.55\ in$ $c_{max} := \max\left(c_4, c_5, c_{leg}\right) = 13.90\ in$

$$S_y := \frac{\left(5 \cdot bolt \cdot b_1^{\,2}\right) + \left(5 \cdot bolt \cdot b_{leg}^{\,2}\right)}{b_{max}} = 145.50\ \boldsymbol{in}$$

$$S_x := \frac{\left(2 \cdot bolt \cdot c_1^{\,2}\right) + \left(4 \cdot bolt \cdot c_2^{\,2}\right) + \left(2 \cdot bolt \cdot c_3^{\,2}\right) + \left(2 \cdot bolt \cdot c_{leg}^{\,2}\right)}{c_{max}} = 59.45\ \boldsymbol{in}$$

Seismic Forces: Overturning about each axis for strength design load case 0.9D +/- Ω_0 E will be added in for the design of the anchors to the concrete but is not to be included in the check of the brackets:

Seismic Force front to back of unit (Fp in Y Direction):

$$M_{ot} := F_p \cdot z' = 1535.71\ \boldsymbol{lb \cdot ft}$$

$$T_1 := \frac{\left(M_{ot} + \left(F_{pv} \cdot e_y\right)\right)}{S_x} + \frac{F_{pv}}{n} - \frac{0.9 \cdot W_p}{n} = 258.25\ \boldsymbol{lb}$$

$$V_1 := \frac{F_p}{n} = 60.72\ \boldsymbol{lb}$$

Seismic Force Across Unit (Fp in X Direction):

$$T_2 := \frac{\left(M_{ot} + \left(F_{pv} \cdot e_x\right)\right)}{S_y} + \frac{F_{pv}}{n} - \frac{0.9 \cdot W_p}{n} = 70.92\ \boldsymbol{lb}$$

$$V_2 := \frac{F_p}{n} = 60.72\ \boldsymbol{lb}$$

Seismic Force At an Angle to the Unit:

$\theta := 0 \cdot \boldsymbol{deg}, 1 \cdot \boldsymbol{deg} .. 90 \cdot \boldsymbol{deg}$ $\quad F_y(\theta) := F_p \cdot \sin(\theta)$ $\quad F_x(\theta) := F_p \cdot \cos(\theta)$

$$f_t(\theta) := \frac{\left(F_y(\theta) \cdot z'\right) + \left(F_{pv} \cdot e_y\right)}{S_x} + \frac{\left(F_x(\theta) \cdot z'\right) + \left(F_{pv} \cdot e_x\right)}{S_y} + \frac{F_{pv}}{n} - \frac{.9 \cdot W_p}{n}$$

$f_{t\theta_{\frac{\theta}{deg}}} := f_t(\theta)$ $\quad \max\left(f_{t\theta}\right) = 285.91\ lb$ $\quad T_{max} := \max\left(f_{t\theta}\right) = 285.91\ \boldsymbol{lb}$

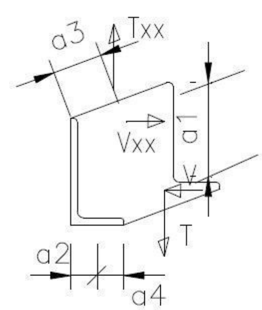
$\theta f_{t_{\frac{\theta}{deg}}} := \mathbf{if}\left(\max\left(f_{t\theta}\right) = f_t(\theta), \theta, 0\right)$ $\quad \max\left(\theta f_t\right) = 68.00\ deg$ $\quad \theta := \max\left(\theta f_t\right)$

$T_3 := T_{max} = 285.91\ \boldsymbol{lb}$ $\quad V_{3x} := \frac{F_x(\theta)}{n} = 22.75\ \boldsymbol{lb}$ $\quad V_{3y} := \frac{F_y(\theta)}{n} = 56.30\ \boldsymbol{lb}$

Check of Angle Bracket:

Angle Size: 26" W x 3" D x 4" H x 3/16" thick A36 angle

Analyze a 4" long section for the purpose of angle analysis with loads per anchor



$b_a := 3\ \boldsymbol{in}$ $\quad a3 := 0.5 \cdot b_a = 1.50\ \boldsymbol{in}$

$a1 := 3\ \boldsymbol{in}$ $\quad a2 := 1.5\ \boldsymbol{in}$

$a4 := 3\ \boldsymbol{in} - a2 = 1.50\ \boldsymbol{in}$ $\quad t_a := \frac{3}{16}\ \boldsymbol{in} = 0.19\ \boldsymbol{in}$

$F_{ya} := 36\ ksi$ $F_{ua} := 58\ ksi$ $\phi_b := 0.9$

Vertical Angle Leg Bending:

$V_{angle} := \max\left(V_2, V_{3x}\right) = 60.72\ \mathbf{lb}$

$M_{val} := V_{angle} \cdot a1 = 182.16\ \mathbf{lb \cdot in}$ $t_{a\_reqd1} := \sqrt{\dfrac{4 \cdot M_{val}}{\phi_b \cdot F_{ya} \cdot b_a}} = 0.09\ \mathbf{in}$

Horizontal Angle Leg Bending:

$T_{angle} := \max\left(T_1, T_2, T_3\right) = 285.91\ \mathbf{lb}$

$M_{hal} := T_{angle} \cdot a2 = 428.86\ \mathbf{lb \cdot in}$ $t_{a\_reqd2} := \sqrt{\dfrac{4 \cdot M_{hal}}{\phi_b \cdot F_{ya} \cdot b_a}} = 0.13\ \mathbf{in}$

Prying:

$b_p := a2 - 0.5 \cdot t_a - 0.5 \cdot 0.625\ \mathbf{in} = 1.09\ \mathbf{in}$

To avoid prying:

$$t_{a\_reqd3} := \sqrt{\frac{4 \cdot T_{angle} \cdot b_p}{\phi_b \cdot F_{ua} \cdot b_a}} = 0.09\ \mathbf{in}$$

DCR

$$DCR := \frac{\max\left(t_{a\_reqd1}, t_{a\_reqd2}, t_{a\_reqd3}\right)}{t_a} = 0.71$$ < 1 OK

Angle is OK

Check fasteners from bracket to leg of unit:

Use #12 screws into assumed 18 ga metal

Screw Shear Capacity: Assume Fy to be 33 ksi for all materials

$t_s := t_a = 0.19\ \mathbf{in}$ $t_{unit} := \dfrac{1}{20}\ \mathbf{in}$ $d_s := \dfrac{7}{32}\ \mathbf{in} = 0.22\ \mathbf{in}$

$F_{u\_s} := F_{ua}$ $F_{u\_unit} := 45\ ksi$ $\phi_s := 0.5$

Shear Capacity based on bearing (per AISI E4.3.1):

$P_{ns1} := 4.2 \cdot \sqrt{t_{unit}^{\ 3} \cdot d_s} \cdot F_{u\_unit} = 988.30\ \mathbf{lb}$

$P_{ns2} := 2.7 \cdot t_{unit} \cdot d_s \cdot F_{u\_unit} = 1328.91\ \mathbf{lb}$

$P_{ns3} := 2.7 \cdot t_s \cdot d_s \cdot F_{u\_s} = 6423.05\ \mathbf{lb}$

Shear Capacity based on end distance (per AISI Appendix A E4.3.2):

$e_{ed\_angle} := 0.25\ \mathbf{in}$

$P_{ns4} := t_{unit} \cdot e_{ed\_angle} \cdot F_{u\_unit} = 562.50\ \mathbf{lb}$

Shear strength of screw (from Hilti catalog):

$P_{ns5} := 1880\ \mathbf{lb}$

Shear Capacity:

$P_{ns} := min\left(P_{ns1}, P_{ns2}, P_{ns3}, P_{ns4}, P_{ns5}\right) = 562.50\ \boldsymbol{lb}$

$V_{ns} := \phi_s \cdot P_{ns} = 281.25\ \boldsymbol{lb}$

Tensile Capacity based on pullout (per AISI E4.4.1):

$P_{nt1} := 0.85 \cdot d_s \cdot t_{unit} \cdot F_{u\_unit} = 418.36\ \boldsymbol{lb}$

Tensile Capacity based on pullover (per AISI E4.4.2), assuming no washer:

$d'_w := 0.415\ \boldsymbol{in}$

$P_{nt2} := 1.5 \cdot t_s \cdot F_{u\_s} \cdot d'_w = 6769.69\ \boldsymbol{lb}$

Tensile strength of screw (from Hilti catalog):

$P_{nt3} := 2325\ \boldsymbol{lb}$

Tensile Capacity:

$P_{nt} := min\left(P_{nt1}, P_{nt2}, P_{nt3}\right) = 418.36\ \boldsymbol{lb}$

$T_{ns} := \phi_s \cdot P_{nt} = 209.18\ \boldsymbol{lb}$

Combined Load Capacity:

$n_s := \dfrac{9}{5}$ Screws per anchor. Loads are for a single anchor, therefore determine the equivalent # screws per each anchor

X Direction (Across Unit):

$V_{screws\_x} := T_2 = 70.92\ \boldsymbol{lb}$ $T_{screws\_x} := V_2 = 60.72\ \boldsymbol{lb}$

$DCR_{screws\_x} := \dfrac{V_{screws\_x}}{n_s \cdot V_{ns}} + 0.71 \cdot \dfrac{T_{screws\_x}}{n_s \cdot V_{ns}} = 0.23$ < 1.1 OK

Y Direction (Front Back):

$V_{screws\_y} := \sqrt{T_1^{\ 2} + V_1^{\ 2}} = 265.29\ \boldsymbol{lb}$ $T_{screws\_y} := 0\ \boldsymbol{lb}$

$DCR_{screws\_y} := \dfrac{V_{screws\_y}}{n_s \cdot V_{ns}} + 0.71 \cdot \dfrac{T_{screws\_y}}{n_s \cdot V_{ns}} = 0.52$ < 1.1 OK

Theta Direction:

$V_{screws\_\theta} := \sqrt{T_3^{\ 2} + V_{3y}^{\ 2}} = 291.40\ \boldsymbol{lb}$ $T_{screws\_\theta} := V_{3x} = 22.75\ \boldsymbol{lb}$

$DCR_{screws\_y} := \dfrac{V_{screws\_\theta}}{n_s \cdot V_{ns}} + 0.71 \cdot \dfrac{T_{screws\_\theta}}{n_s \cdot V_{ns}} = 0.61$ < 1.1 OK

OK to use #12 screws from angle to equipment. OK to upsize to 1/4" SMS

Attachment to Concrete Slab: Check using strength design load case 0.9D +/- Ω_0 E

Loads to a single anchor:

Seismic Force front to back of unit (Fp in Y Direction):

$$M_{ot\Omega} := F_p \cdot z' \cdot \Omega_0 = 3071.42 \; \boldsymbol{lb \cdot ft}$$

$$V_{1\Omega} := \frac{F_p \cdot \Omega_0}{n} = 121.44 \; \boldsymbol{lb}$$

$$T_{1\Omega} := \frac{\left(M_{ot\Omega} + \left(F_{pv} \cdot e_y\right)\right)}{S_x} + \frac{F_{pv}}{n} - \frac{0.9 \cdot W_p}{n} = 568.21 \; \boldsymbol{lb}$$

Seismic Force Across Unit (Fp in X Direction):

$$V_{2\Omega} := \frac{F_p \cdot \Omega_0}{n} = 121.44 \; \boldsymbol{lb}$$

$$T_{2\Omega} := \frac{\left(M_{ot\Omega} + \left(F_{pv} \cdot e_x\right)\right)}{S_y} + \frac{F_{pv}}{n} - \frac{0.9 \cdot W_p}{n} + V_{2\Omega} \cdot \frac{a1}{a2} = 440.46 \; \boldsymbol{lb}$$

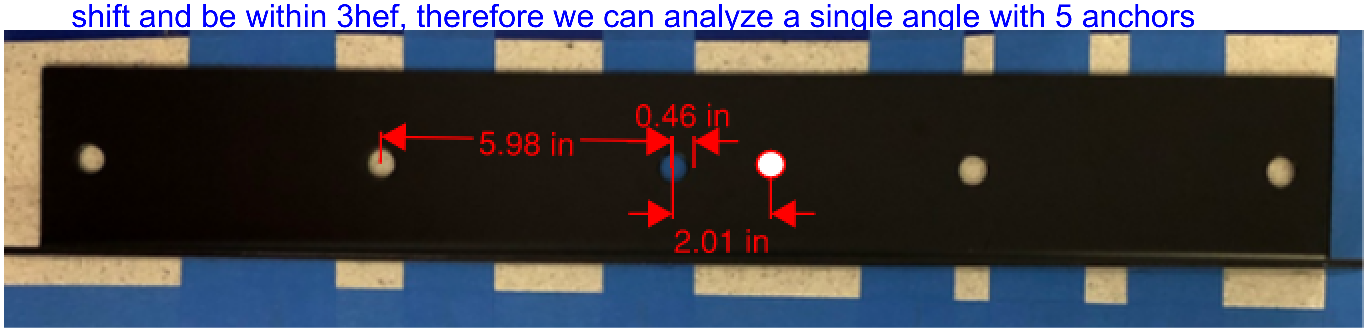
Seismic Force At an Angle to the Unit:

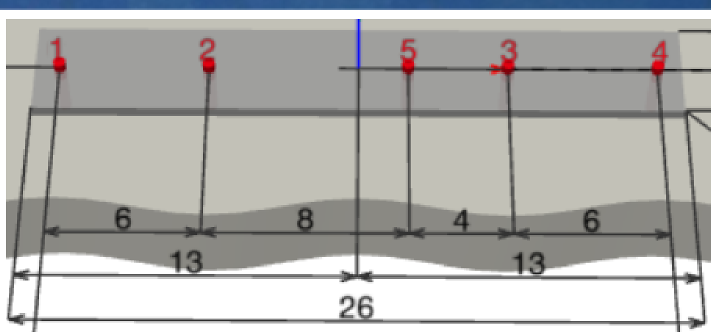
$$V_{3x\Omega} := \frac{F_x(\theta) \cdot \Omega_0}{n} = 45.49 \; \boldsymbol{lb}$$

$$V_{3y\Omega} := \frac{F_y(\theta) \cdot \Omega_0}{n} = 112.60 \; \boldsymbol{lb}$$

$$T_{3\Omega} := \frac{\left(F_y(\theta) \cdot z' \cdot \Omega_0\right) + \left(F_{pv} \cdot e_y\right)}{S_x} + \frac{\left(F_x(\theta) \cdot z' \cdot \Omega_0\right) + \left(F_{pv} \cdot e_x\right)}{S_y} + \frac{F_{pv}}{n} - \frac{.9 \cdot W_p}{n} + V_{3x\Omega} \cdot \frac{a1}{a2} = 711.73 \; \boldsymbol{lb}$$

The above analysis is acceptable if the anchors are all minimum 3xhef from each other so they can be analyzed separately, however for B33-220 the anchors need to shift and be within 3hef, therefore we can analyze a single angle with 5 anchors





Seismic loads for each angle:

$n_{angle} := 2$

100%X

$$T_1 := \frac{\Omega_0 \cdot F_p \cdot z'}{b} - \frac{\left(0.9 \cdot W_p - F_{pv}\right)}{n_{angle}} + \frac{\Omega_0 \cdot F_p \cdot \frac{a1}{a2}}{n_{angle}} = 2188.36\ \boldsymbol{lb}$$

$$V_{1\_x} := \frac{\Omega_0 \cdot F_p}{n_{angle}} = 607.20\ \boldsymbol{lb}$$

100%Y

$$M_2 := \frac{\Omega_0 \cdot F_p \cdot z'}{n_{angle}} = 18428.52\ \boldsymbol{lb \cdot in} \qquad N := \frac{-0.9\ W_p + F_{pv}}{n_{angle}} = -292.60\ \boldsymbol{lb}$$

$$V_{2\_y} := \frac{\Omega_0 \cdot F_p}{n_{angle}} = 607.20\ \boldsymbol{lb}$$

Theta Direction

$$T_3 := \frac{\Omega_0 \cdot F_x(\theta) \cdot z'}{b} - \frac{\left(0.9 \cdot W_p - F_{pv}\right)}{n_{angle}} + \frac{\Omega_0 \cdot F_x(\theta) \cdot \frac{a1}{a2}}{n_{angle}} = 636.79\ \boldsymbol{lb}$$

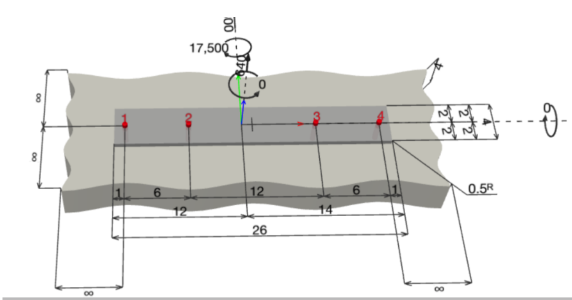
$$V_{3\_x} := \frac{\Omega_0 \cdot F_x(\theta)}{n_{angle}} = 227.46\ \boldsymbol{lb}$$

$$M_3 := \frac{\Omega_0 \cdot F_y(\theta) \cdot z'}{n_{angle}} = 17086.63\ \boldsymbol{lb \cdot in}$$

$$V_{3\_y} := \frac{\Omega_0 \cdot F_y(\theta)}{n_{angle}} = 562.99\ \boldsymbol{lb}$$

OK to use 1/2" diameter KB-TZ2 anchors, see attached Profis Report.

-After the analysis, it is found that we can just eliminate the center-most anchors and still use the same depth/diameter KB-TZ2 anchors



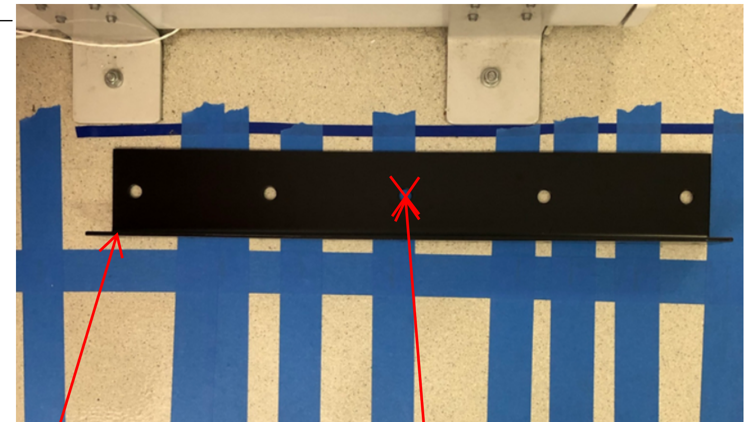
Type		Forces [lb]			Moments [in-lb]			Utilization			
		Vx	Vy	N	Mx	My	Mz	T	S	C	Max
		0	608	2,200	0	0	0	43%	9%	26%	43%
		608	0	-290	0	18,500	0	36%	7%	19%	36%
		600	300	640	0	17,500	0	58%	8%	42%	58%
		-600	**300**	**1,100**	**0**	**-17,500**	**0**	**66%**	**8%**	**51%**	**66%**

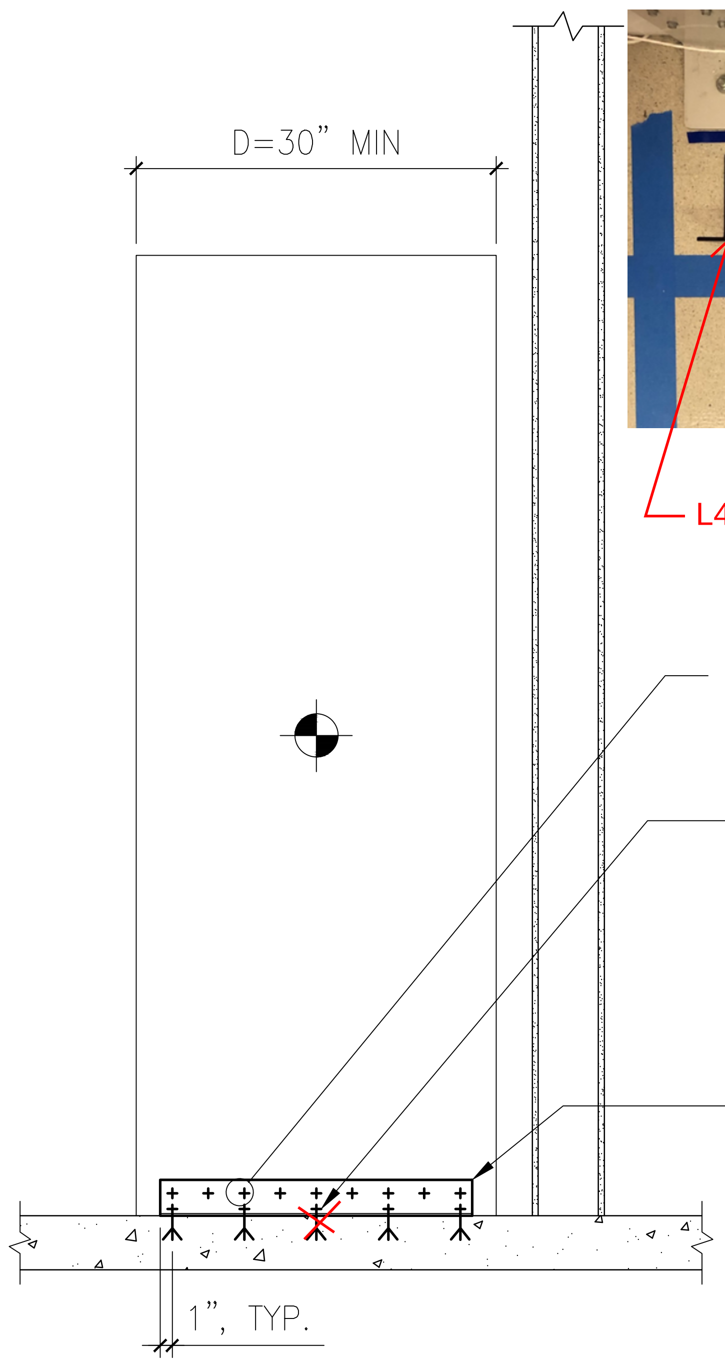
Conclusions:

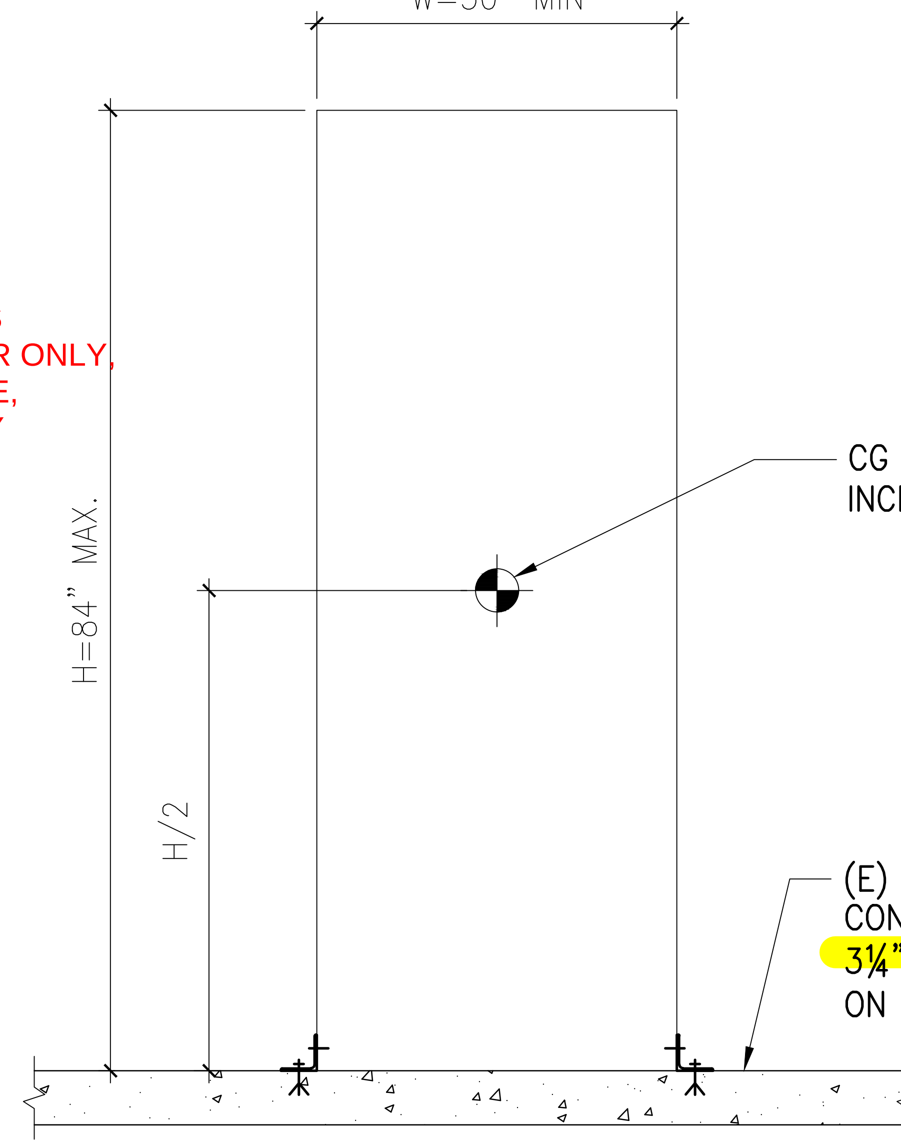
Brace the freezer with the attached detail S463. The center anchor may be left un-anchored, therefore only (4) anchors are required per angle.

Anchor Specifications:

Anchor size	1/2 inch diameter
Anchor type	HILTI Kwik Bolt TZ2
ICC Evaluation Report	ESR-4266
Anchor embedment into concrete	2-1/2 inches
Hole depth in concrete	2-3/4 inches
Hole diameter in concrete	1/2 inch
Hole diameter in steel	3/4 inch MAX
Hole drilling	Hammer drill with carbide tip
Special inspection	Required
Installation torque	50 ft-lbs
Torque test	All anchors to 50 ft-lbs
Additional requirements	Locate anchors to avoid (E) slab reinforcing & utilities







NOTE: USE ALTERNATE VERTICAL LEG SIZE AS REQUIRED TO SUIT BASE CONDITION.

☐ EQUIPMENT WITH CONTENTS IS 1500# OR LESS
☐ FLOOR IS CONCRETE AND IS MIN 4" THICK OR 3¼" FILL OVER METAL DECK

REQUIREMENTS CHECKLIST

☐ SCREWS ARE CONNECTED TO EQUIPMENT AND CANNOT BE PULLED OUT BY HAND USING PLIERS.
☐ EXPANSION ANCHORS ARE CONNECTED TO CONCRETE FLOOR AND ARE TORQUED TO 50 FT–LBS.

QUALITY CONTROL CHECKLIST

B33-220 FREEZER
W0275601

LBNL APPROVAL STAMP
(IF REVISION, APPLIES ONLY TO REVISED WORK)

2019 CBC EDITION – 09/30/2020

ISSUE (PROGRESS, ESTIMATE, BID, CONSTRUCTION, CONFORMED, REVISION, RECORD)

HEAVY REFRIGERATOR
FLOOR ATTACHMENT, CONCRETE FLOOR
LBNL TYPICAL DETAILS

UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY NATIONAL LABORATORY
FACILITIES DIVISION

DRAWN BY	DH	DATE 09/30/2020
CHECKED BY	MP	09/30/2020
APPROVED BY	TH	09/30/2020
CAD FILE PATH		
SCALE	NTS	
DRAWING NO.		SHEET S463
PROJECT NO.		

Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	R220 Freezer	Date:	7/19/2022
Fastening point:			

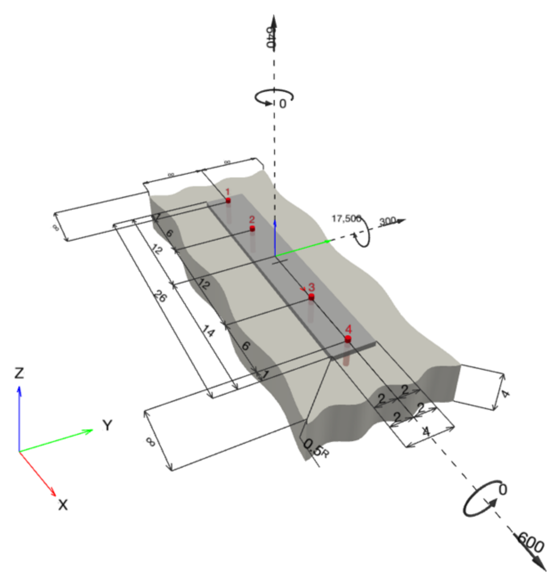
Specifier's comments:

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ2 - CS 1/2 (2) hnom2**
Item number:	2210254 KB-TZ2 1/2x3 3/4
Effective embedment depth:	$h_{ef,act}$ = 2.000 in., h_{nom} = 2.500 in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-4266
Issued I Valid:	12/17/2021 | 12/1/2023
Proof:	Design Method ACI 318-14 / Mech
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate^R :	l_x x l_y x t = 26.000 in. x 4.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, , f_c' = 3,500 psi; h = 4.000 in.
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present
	edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d))
	Shear load: yes (17.2.3.5.3 (c))

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

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



www.hilti.com

Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	R220 Freezer	Date:	7/19/2022
Fastening point:			

1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	100%X	$N = 2{,}200$; $V_x = 0$; $V_y = 608$; $M_x = 0$; $M_y = 0$; $M_z = 0$;	yes	43
2	100%Y	$N = -290$; $V_x = 608$; $V_y = 0$; $M_x = 0$; $M_y = 18{,}500$; $M_z = 0$;	yes	36
3	Theta	$N = 640$; $V_x = 600$; $V_y = 300$; $M_x = 0$; $M_y = 17{,}500$; $M_z = 0$;	yes	58
4	Theta (y reversed)	$N = 640$; $V_x = -600$; $V_y = 300$; $M_x = 0$; $M_y = -17{,}500$; $M_z = 0$;	yes	55

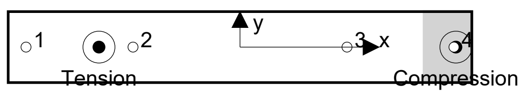
2 Load case/Resulting anchor forces

Controlling load case: 3 Theta

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	672	172	150	85
2	491	170	150	80
3	130	166	150	70
4	0	163	150	65



max. concrete compressive strain: 0.03 [‰]
max. concrete compressive stress: 122 [psi]
resulting tension force in (x/y)=(-7.910/0.000): 1,293 [lb]
resulting compression force in (x/y)=(12.108/0.000): 653 [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*	672	8,433	8	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	1,293	2,231	58	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 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.10	114,004

Calculations

N_{sa} [lb]
11,244

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
11,244	0.750	1.000	8,433	672

Company:		Page:	4
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	R220 Freezer	Date:	7/19/2022
Fastening point:			

3.2 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ — ACI 318-14 Eq. (17.4.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ — ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ — ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ — ACI 318-14 Eq. (17.4.2.2a)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.000	3.910	0.000	∞	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
5.500	21	1.000	3,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
108.00	36.00	0.434	1.000	1.000	1.000	3,514

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
4,577	0.650	0.750	1.000	2,231	1,293

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Company:		Page:	5
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	R220 Freezer	Date:	7/19/2022
Fastening point:			

4 Shear load

	Load V_{ua} [lb]	Capacity $\phi\ V_n$ [lb]	Utilization $\beta_V = V_{ua}/\phi\ V_n$	Status
Steel Strength*	172	3,599	5	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength*	172	2,460	8	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

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

4.1 Steel Strength

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

$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$\alpha_{V,seis}$
0.10	114,004	1.000

Calculations

$V_{sa,eq}$ [lb]
5,537

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi\ V_{sa,eq}$ [lb]	V_{ua} [lb]
5,537	0.650	1.000	3,599	172

4.2 Pryout Strength

$V_{cp} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \ \psi_{c,N} \ \psi_{cp,N} \ N_b \right]$ ACI 318-14 Eq. (17.5.3.1a)

$\phi \ V_{cp} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9 \ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 \ e'_N}{3 \ h_{ef}}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c \ \lambda_a \ \sqrt{f'_c} \ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
1	2.000	0.000	0.000	∞

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	5.500	21	1.000	3,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
36.00	36.00	1.000	1.000	1.000	1.000	3,514

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi \ V_{cp}$ [lb]	V_{ua} [lb]
3,514	0.700	1.000	1.000	2,460	172

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.580	0.070	5/3	42	OK

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

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!
- 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://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-14, Chapter 17, Section 17.2.3.4.3 (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 17.2.3.4.3 (b), Section 17.2.3.4.3 (c), or Section 17.2.3.4.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.2.3.5.3 (a), Section 17.2.3.5.3 (b), or Section 17.2.3.5.3 (c).
- Section 17.2.3.4.3 (b) / Section 17.2.3.5.3 (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 17.2.3.4.3 (c) / Section 17.2.3.5.3 (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 17.2.3.4.3 (d) / Section 17.2.3.5.3 (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 318-14, Section 17.8.1.

Fastening meets the design criteria!

Company:		Page:	8
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	R220 Freezer	Date:	7/19/2022
Fastening point:			

7 Installation data

Profile: no profile

Hole diameter in the fixture: d_f = 0.562 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 - CS 1/2 (2) hnom2

Item number: 2210254 KB-TZ2 1/2x3 3/4

Maximum installation torque: 602 in.lb

Hole diameter in the base material: 0.500 in.

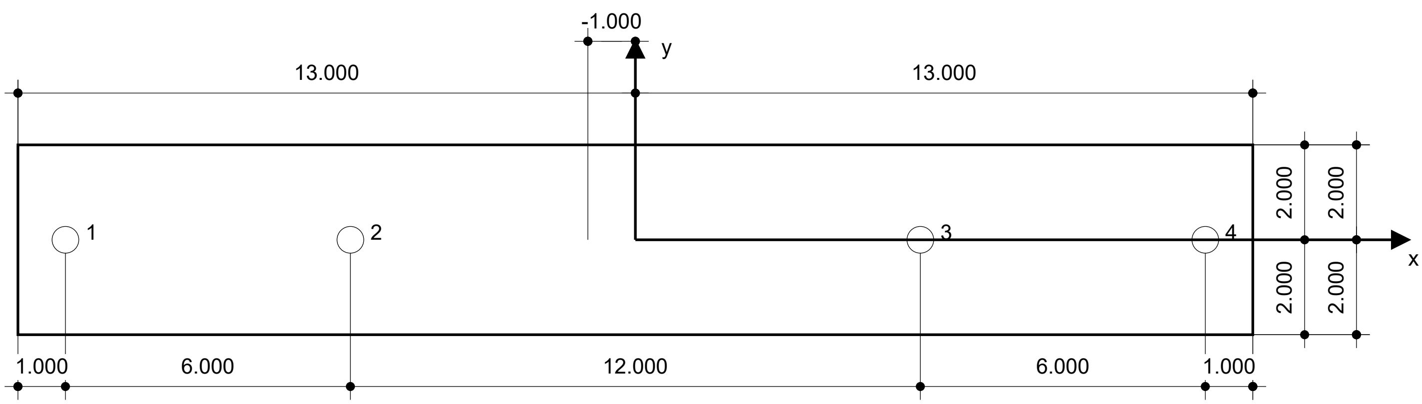
Hole depth in the base material: 2.750 in.

Minimum thickness of the base material: 4.000 in.

Hilti KB-TZ2 stud anchor with 2.5 in embedment, 1/2 (2) hnom2, Carbon steel, installation per ESR-4266

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	-12.000	-0.000	-	-	-	-
2	-6.000	-0.000	-	-	-	-
3	6.000	-0.000	-	-	-	-
4	12.000	-0.000	-	-	-	-

8 Remarks; Your Cooperation Duties

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- 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.