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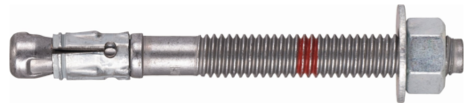
Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Horizontal- Concrete - Mar 2, 2023	Date:	3/3/2023
Fastening point:			

Specifier's comments:

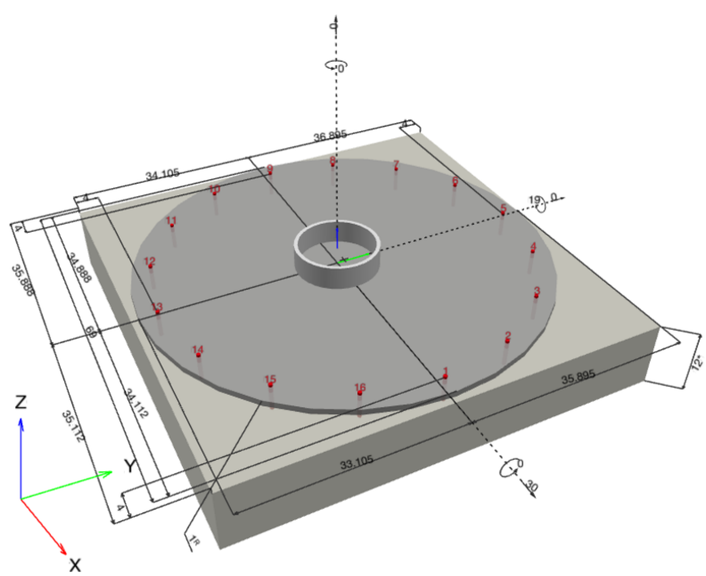
1 Input data



Anchor type and diameter:	**Kwik Bolt TZ2 - SS 304 5/8 (3 1/4) hnom2**
Item number:	2210279 KB-TZ2 5/8x6 SS304
Effective embedment depth:	$h_{ef,act}$ = 3.250 in., h_{nom} = 3.750 in.
Material:	AISI 304
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 = 1.000 in.
Anchor plate[R] :	l_x x l_y x t = 69.000 in. x 69.000 in. x 1.000 in.; (Recommended plate thickness: not calculated)
Profile:	Round HSS (AISC), HSS14X.625; (L x W x T) = 14.000 in. x 14.000 in. x 0.625 in.
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 12.000 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 [kip, ft.kip]

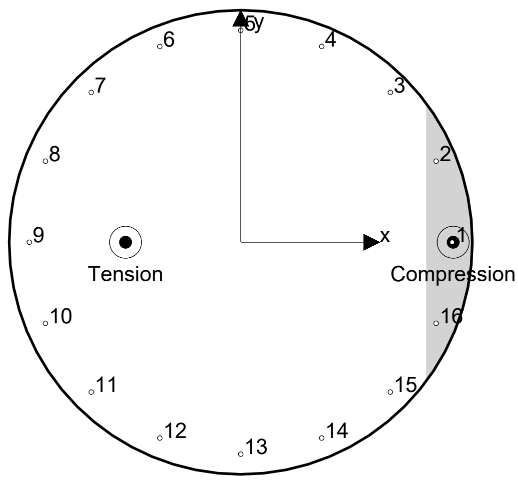


Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Horizontal- Concrete - Mar 2, 2023	Date:	3/3/2023
Fastening point:			

1.1 Design results

Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 0.000; V_x = 30.000; V_y = 0.000; M_x = 0.00000; M_y = 19.00000; M_z = 0.00000;	yes	1,101

2 Load case/Resulting anchor forces



Anchor reactions [kip]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0.000	1.877	1.875	0.083
2	0.000	1.845	1.843	0.077
3	0.057	1.817	1.816	0.059
4	0.163	1.799	1.798	0.032
5	0.288	1.792	1.792	0.000
6	0.413	1.799	1.798	-0.032
7	0.518	1.817	1.816	-0.059
8	0.589	1.845	1.843	-0.077
9	0.614	1.877	1.875	-0.083
10	0.589	1.908	1.907	-0.077
11	0.518	1.935	1.934	-0.059
12	0.413	1.952	1.952	-0.032
13	0.288	1.958	1.958	0.000
14	0.163	1.952	1.952	0.032
15	0.057	1.935	1.934	0.059
16	0.000	1.908	1.907	0.077

max. concrete compressive strain: 0.01 [‰]
max. concrete compressive stress: 63 [psi]
resulting tension force in (x/y)=(-17.163/0.000): 4.672 [kip]
resulting compression force in (x/y)=(31.642/0.000): 4.672 [kip]

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

3 Tension load

	Load N_{ua} [kip]	Capacity ϕ N_n [kip]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	0.614	14.132	5	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	4.672	14.716	32	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]
0.16	114,604

Calculations

N_{sa} [kip]
18.843

Results

N_{sa} [kip]	ϕ_{steel}	$\phi_{nonductile}$	$\phi\ N_{sa}$ [kip]	N_{ua} [kip]
18.843	0.750	1.000	14.132	0.614

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)
$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$	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.]	$\psi_{c,N}$
3.250	10.262	0.000	4.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
7.000	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 [kip]
1,210.22	95.06	0.322	1.000	0.946	1.000	7.782

Results

N_{cbg} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi \, N_{cbg}$ [kip]	N_{ua} [kip]
30.187	0.650	0.750	1.000	14.716	4.672

4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	1.958	8.034	25	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	30.000	125.355	24	OK
Concrete edge failure in direction x+**	30.003	2.726	1,101	not recommended

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

4.1 Steel Strength

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

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

Variables

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

Calculations

$V_{sa,eq}$ [kip]
12.360

Results

$V_{sa,eq}$ [kip]	ϕ steel	$\phi_{nonductile}$	ϕ $V_{sa,eq}$ [kip]	V_{ua} [kip]
12.360	0.650	1.000	8.034	1.958

4.2 Pryout Strength

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

$\phi\ V_{cpg} \geq V_{ua}$ 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.]
2	3.250	0.000	1.395	4.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	7.000	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 [kip]
1,486.87	95.06	1.000	0.778	0.946	1.000	7.782

Results

V_{cpg} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ V_{cpg}$ [kip]	V_{ua} [kip]
179.079	0.700	1.000	1.000	125.355	30.000

4.3 Concrete edge failure in direction x+

$V_{cb} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ ACI 318-14 Eq. (17.5.2.1a)

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

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-14 Eq. (17.5.2.8)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\ c_{a1}^{1.5}$ ACI 318-14 Eq. (17.5.2.2a)

Variables

c_{a1} [in.]	c_{a2} [in.]	$\psi_{c,V}$	h_a [in.]	l_e [in.]
4.000	35.500	1.000	12.000	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 [kip]
72.00	72.00	1.000	1.000	3.894

Results

V_{cb} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ V_{cb}$ [kip]	V_{ua} [kip]
3.894	0.700	1.000	1.000	2.726	30.003

all of the horizontal force, instead of the maximum from the shear forces on an anchor

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.317	11.008	1.000	944	not recommended

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

Company:		Page:	8
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Horizontal- Concrete - Mar 2, 2023	Date:	3/3/2023
Fastening point:			

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 does not meet the design criteria!

7 Installation data

Profile: Round HSS (AISC), HSS14X.625; (L x W x T) = 14.000 in. x 14.000 in. x 0.625 in.

Hole diameter in the fixture: d_f = 0.687 in.

Plate thickness (input): 1.000 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: 0.06019 ft.kip

Hole diameter in the base material: 0.625 in.

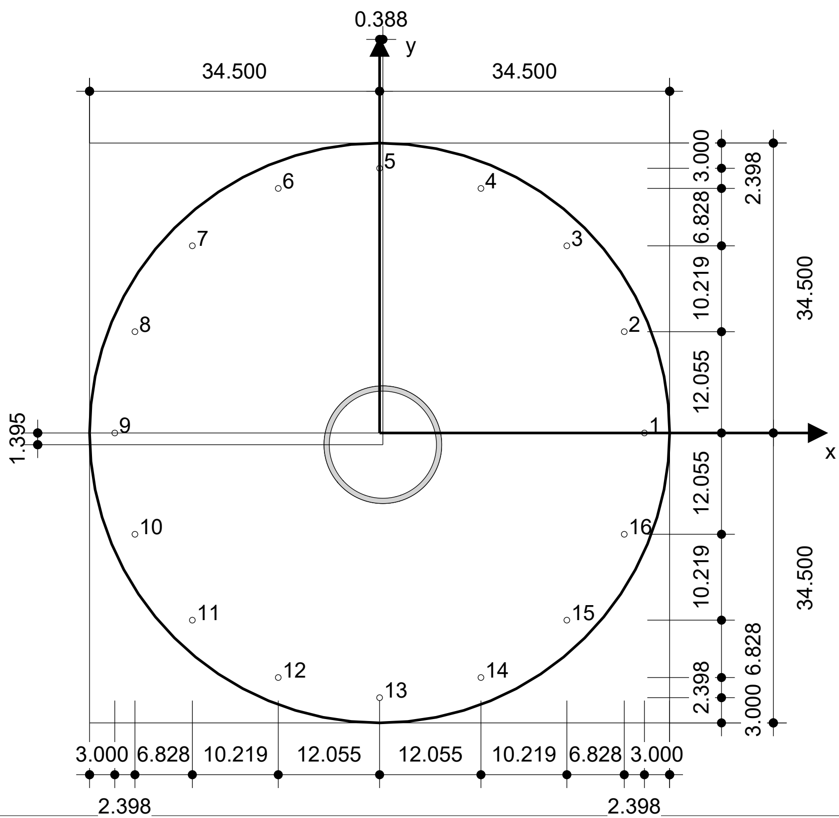
Hole depth in the base material: 4.250 in.

Minimum thickness of the base material: 5.500 in.

Hilti KB-TZ2 stud anchor with 3.75 in embedment, 5/8 (3 1/4) hnom2, Stainless 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



Company:		Page:	10
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Horizontal- Concrete - Mar 2, 2023	Date:	3/3/2023
Fastening point:			

Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	31.500	-0.000	67.000	4.000	35.500	35.500
2	29.102	12.055	64.602	6.398	47.555	23.445
3	22.274	22.274	57.774	13.226	57.774	13.226
4	12.055	29.102	47.555	23.445	64.602	6.398
5	0.000	31.500	35.500	35.500	67.000	4.000
6	-12.055	29.102	23.445	47.555	64.602	6.398
7	-22.274	22.274	13.226	57.774	57.774	13.226
8	-29.102	12.055	6.398	64.602	47.555	23.445

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
9	-31.500	-0.000	4.000	67.000	35.500	35.500
10	-29.102	-12.055	6.398	64.602	23.445	47.555
11	-22.274	-22.274	13.226	57.774	13.226	57.774
12	-12.055	-29.102	23.445	47.555	6.398	64.602
13	0.000	-31.500	35.500	35.500	4.000	67.000
14	12.055	-29.102	47.555	23.445	6.398	64.602
15	22.274	-22.274	57.774	13.226	13.226	57.774
16	29.102	-12.055	64.602	6.398	23.445	47.555

Company:		Page:	11
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Horizontal- Concrete - Mar 2, 2023	Date:	3/3/2023
Fastening point:			

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.