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Company:
 Address:
 Phone | Fax: |
 Design: Concrete - May 31, 2023 (1)
 Fastening point:

Page: 1
 Specifier:
 E-Mail:
 Date: 5/31/2023

Specifier's comments:

1 Input data

Anchor type and diameter: KWIK HUS-EZ (KH-EZ)-CRC 3/8 (2 1/2)

Item number: 2221942 KH-EZ CRC 3/8"x3"

Effective embedment depth: $h_{ef,act} = 1.860$ in., $h_{nom} = 2.500$ in.

Material: Carbon Steel

Evaluation Service Report: ESR-3027

Issued | Valid: 4/1/2022 | 12/1/2023

Proof: Design Method ACI 318-19 / Mech

Stand-off installation:

Profile:

Base material: cracked concrete, 3000, $f'_c = 3,000$ psi; $h = 4.000$ in.

Installation: **hammer drilled hole, Installation condition: Dry**

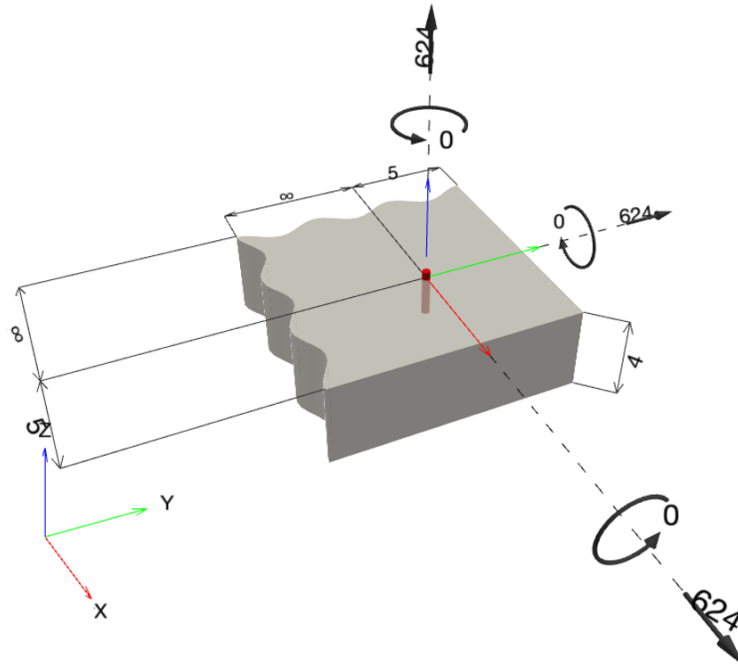
Reinforcement: tension: not present, shear: not present; no supplemental splitting reinforcement present

edge reinforcement: none or < 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))



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





www.hilti.com

Company:		Page:	2
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 624; V _x = 624; V _y = 624; M _x = 0; M _y = 0; M _z = 0;	yes	84

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	624	882	624	624

max. concrete compressive strain: - [%]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 0 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N _{ua} [lb]	Capacity ϕ N _n [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	624	6,718	10	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	624	1,151	55	OK

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



www.hilti.com

Company:		Page:	3
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-3027
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,N}$ [in. ²]	f_{uta} [psi]
0.09	120,300

Calculations

N_{sa} [lb]
10,335

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	ϕN_{sa} [lb]	N_{ua} [lb]
10,335	0.650	1.000	6,718	624

3.2 Concrete Breakout Failure

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

$\phi N_{cb} \geq N_{ua}$ 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)

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

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

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

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ 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]
1.860	5.000	1.000	2.920	17	1.000	3,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
31.14	31.14	1.000	1.000	2,362

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
2,362	0.650	0.750	1.000	1,151	624



www.hilti.com

Company:		Page:	4
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_v = V_{ua} / \phi V_n$	Status
Steel Strength*	882	1,866	48	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	882	1,653	54	OK
Concrete edge failure in direction y+**	882	1,386	64	OK

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

4.1 Steel Strength

$V_{sa,eq}$ = ESR value refer to ICC-ES ESR-3027
 $\phi V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in. ²]	f_{uta} [psi]	$\alpha_{v,seis}$
0.09	120,300	0.600

Calculations

$V_{sa,eq}$ [lb]
3,110

Results

$V_{sa,eq}$ [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi V_{sa,eq}$ [lb]	V_{ua} [lb]
3,110	0.600	1.000	1,866	882



www.hilti.com

Company:		Page:	5
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

4.2 Pryout Strength

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

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

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

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

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

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

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

Variables

k_{cp}	h_{ef} [in.]	$c_{a,min}$ [in.]	$\Psi_{c,N}$
1	1.860	5.000	1.000
c_{ac} [in.]	k_c	λ_a	f_c [psi]
2.920	17	1.000	3,000

Calculations

A_{Nc} [in. ²]	A_{Nc0} [in. ²]	$\Psi_{ed,N}$	$\Psi_{cp,N}$	N_b [lb]
31.14	31.14	1.000	1.000	2,362

Results

V_{cp} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [lb]	V_{ua} [lb]
2,362	0.700	1.000	1.000	1,653	882

www.hilti.com

Company:		Page:	6
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

4.3 Concrete edge failure in direction y+

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

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

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

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

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

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

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

Variables

c_{a1} [in.]	c_{a2} [in.]	$\Psi_{c,V}$	h_a [in.]	l_e [in.]
5.000	5.000	1.000	4.000	1.860
λ_a	d_a [in.]	f_c [psi]	$\Psi_{parallel,V}$	
1.000	0.375	3,000	1.000	

Calculations

A_{Vc} [in. ²]	A_{Vc0} [in. ²]	$\Psi_{ed,V}$	$\Psi_{h,V}$	V_b [lb]
50.00	112.50	0.900	1.369	3,616

Results

V_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cb} [lb]	V_{ua} [lb]
1,981	0.700	1.000	1.000	1,386	882

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

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.542	0.637	5/3	84	OK

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



www.hilti.com

Company:		Page:	7
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
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 318-19, 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!



www.hilti.com

Company:		Page:	8
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
Fastening point:			

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 HUS-EZ (KH-EZ)-CRC
3/8 (2 1/2)
Item number: 2221942 KH-EZ CRC 3/8"x3"
Maximum installation torque: 480 in.lb
Hole diameter in the base material: 0.375 in.
Hole depth in the base material: 2.750 in.
Minimum thickness of the base material: 4.000 in.

Hilti KH-EZ-CRC screw anchor with 2.5 in embedment, 3/8 (2 1/2), Carbon steel, installation per ESR-3027

7.1 Recommended accessories

Drilling	Cleaning	Setting
<ul style="list-style-type: none"> • Suitable Rotary Hammer • Properly sized drill bit 	<ul style="list-style-type: none"> • Manual blow-out pump 	<ul style="list-style-type: none"> • Torque wrench

Coordinates Anchor in.

Anchor	x	y	C _{-x}	C _{+x}	C _{-y}	C _{+y}
1	0.000	0.000	-	5.000	-	5.000



www.hilti.com

Company:		Page:	9
Address:		Specifier:	
Phone Fax:		E-Mail:	
Design:	Concrete - May 31, 2023 (1)	Date:	5/31/2023
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.