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 Design: Concrete - Oct 12, 2023 (1)  
 Fastening point:

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 Specifier:  
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 Date: 10/12/2023

**Specifier's comments:**

**1 Input data**

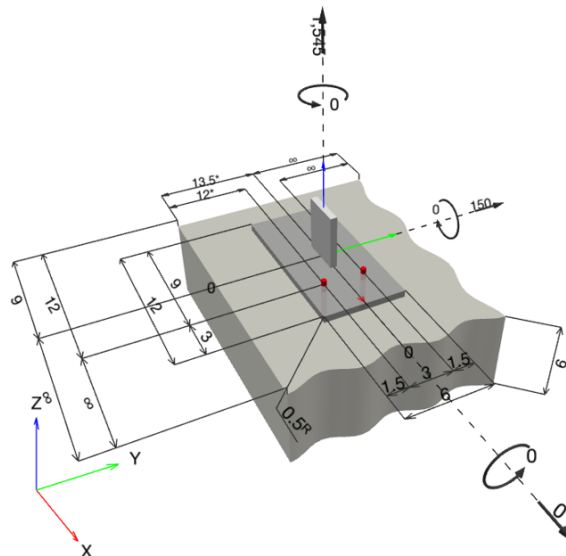


<b>Anchor type and diameter:</b>	<b>KWIK HUS-EZ (KH-EZ) 3/8 (3 1/4)</b>
Item number:	418059 KH-EZ 3/8"x4"
Effective embedment depth:	$h_{ef,act} = 2.500$ in., $h_{nom} = 3.250$ in.
Material:	Carbon Steel
Evaluation Service Report:	ESR-3027
Issued   Valid:	4/1/2022   12/1/2023
Proof:	Design Method ACI 318-19 / Mech
Stand-off installation:	$e_b = 0.000$ in. (no stand-off); $t = 0.500$ in.
Anchor plate <sup>R</sup> :	$l_x \times l_y \times t = 12.000$ in. x $6.000$ in. x $0.500$ in.; (Recommended plate thickness: not calculated)
Profile:	Rectangular plates and bars (AISC), 3 - 1/2; (L x W x T) = $3.000$ in. x $0.500$ in.
Base material:	cracked concrete, 3000, $f'_c = 3,000$ psi; $h = 6.000$ in.
<b>Installation:</b>	<b>hammer drilled hole, Installation condition: Dry</b>
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

**Application also possible with KWIK-X 3/8 (3) hnom2 under the selected boundary conditions.  
 More information in section Alternative fastening data of this report.**

<sup>R</sup> - The anchor calculation is based on a rigid anchor plate assumption.

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



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**1.1 Design results**

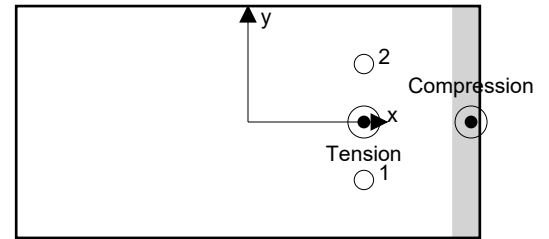
Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 1,545; V <sub>x</sub> = 0; V <sub>y</sub> = 150; M <sub>x</sub> = 0; M <sub>y</sub> = 0; M <sub>z</sub> = 0;	no	97

**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	1,608	168	-150	75
2	1,608	168	150	75



max. concrete compressive strain: 0.19 [‰]  
 max. concrete compressive stress: 820 [psi]  
 resulting tension force in (x/y)=(3.000/0.000): 3,216 [lb]  
 resulting compression force in (x/y)=(5.774/0.000): 1,671 [lb]

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

**3 Tension load**

	Load N <sub>ua</sub> [lb]	Capacity $\phi$ N <sub>n</sub> [lb]	Utilization $\beta_N = N_{ua} / \phi N_n$	Status
Steel Strength*	1,608	6,718	24	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	3,216	3,349	97	OK

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



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**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. <sup>2</sup> ]	$f_{uta}$ [psi]
0.09	120,300

**Calculations**

$N_{sa}$ [lb]
10,335

**Results**

$N_{sa}$ [lb]	$\phi_{steel}$	$\phi N_{sa}$ [lb]	$N_{ua}$ [lb]
10,335	0.650	6,718	1,608



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**3.2 Concrete Breakout Failure**

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

$$\phi N_{cbg} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

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

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

$$\psi_{ec,N} = \left( \frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

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

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

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

**Variables**

$h_{ef}$ [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.500	0.000	0.000	12.000	1.000
$c_{ac}$ [in.]	$k_c$	$\lambda_a$	$f'_c$ [psij]	
3.750	17	1.000	3,000	

**Calculations**

$A_{Nc}$ [in. <sup>2</sup> ]	$A_{Nc0}$ [in. <sup>2</sup> ]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	$N_b$ [lb]
78.75	56.25	1.000	1.000	1.000	1.000	3,681

**Results**

$N_{cbg}$ [lb]	$\phi_{concrete}$	$\phi N_{cbg}$ [lb]	$N_{ua}$ [lb]
5,153	0.650	3,349	3,216



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### 4 Shear load

	Load $V_{ua}$ [lb]	Capacity $\phi V_n$ [lb]	Utilization $\beta_v = V_{ua} / \phi V_n$	Status
Steel Strength*	168	3,111	6	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength*	168	3,607	5	OK
Concrete edge failure in direction x-**	212	4,491	5	OK

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

#### 4.1 Steel Strength

$V_{sa}$  = 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. <sup>2</sup> ]	$f_{uta}$ [psi]
0.09	120,300

#### Calculations

$V_{sa}$ [lb]
5,185

#### Results

$V_{sa}$ [lb]	$\phi_{steel}$	$\phi V_{sa}$ [lb]	$V_{ua}$ [lb]
5,185	0.600	3,111	168



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**4.2 Pryout Strength**

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

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

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

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

$$\Psi_{ec,N} = \left( \frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

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

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

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

**Variables**

$k_{cp}$	$h_{ef}$ [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	2.500	0.000	0.000	12.000
$\Psi_{c,N}$	$c_{ac}$ [in.]	$k_c$	$\lambda_a$	$f_c$ [psi]
1.000	3.750	17	1.000	3,000

**Calculations**

$A_{Nc}$ [in. <sup>2</sup> ]	$A_{Nc0}$ [in. <sup>2</sup> ]	$\Psi_{ec1,N}$	$\Psi_{ec2,N}$	$\Psi_{ed,N}$	$\Psi_{cp,N}$	$N_b$ [lb]
39.38	56.25	1.000	1.000	1.000	1.000	3,681

**Results**

$V_{cp}$ [lb]	$\phi_{concrete}$	$\phi V_{cp}$ [lb]	$V_{ua}$ [lb]
5,153	0.700	3,607	168

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**4.3 Concrete edge failure in direction x-**

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

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

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

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

$$\Psi_{ec,V} = \left( \frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.3.1)}$$

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

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

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

**Variables**

$c_{a1}$ [in.]	$c_{a2}$ [in.]	$e_{cV}$ [in.]	$\Psi_{c,V}$	$h_a$ [in.]
12.000	12.000	1.061	1.000	6.000
$l_e$ [in.]	$\lambda_a$	$d_a$ [in.]	$f'_c$ [psi]	$\Psi_{parallel,V}$
2.500	1.000	0.375	3,000	1.000

**Calculations**

$A_{Vc}$ [in. <sup>2</sup> ]	$A_{Vc0}$ [in. <sup>2</sup> ]	$\Psi_{ec,V}$	$\Psi_{ed,V}$	$\Psi_{h,V}$	$V_b$ [lb]
198.00	648.00	0.944	0.900	1.732	14,264

**Results**

$V_{cbg}$ [lb]	$\phi_{concrete}$	$\phi V_{cbg}$ [lb]	$V_{ua}$ [lb]
6,416	0.700	4,491	212

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

$\beta_N$	$\beta_V$	$\zeta$	Utilization $\beta_{N,V}$ [%]	Status
0.960	0.054	1.000	85	OK

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



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## 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/>
- 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!**

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## 7 Installation data

Profile: Rectangular plates and bars (AISC), 3 - 1/2; (L x W x T) = 3.000 in. x 0.500 in.

Hole diameter in the fixture:  $d_f = 0.500$  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 HUS-EZ (KH-EZ) 3/8 (3 1/4)

Item number: 418059 KH-EZ 3/8"x4"

Maximum installation torque: 480 in.lb

Hole diameter in the base material: 0.375 in.

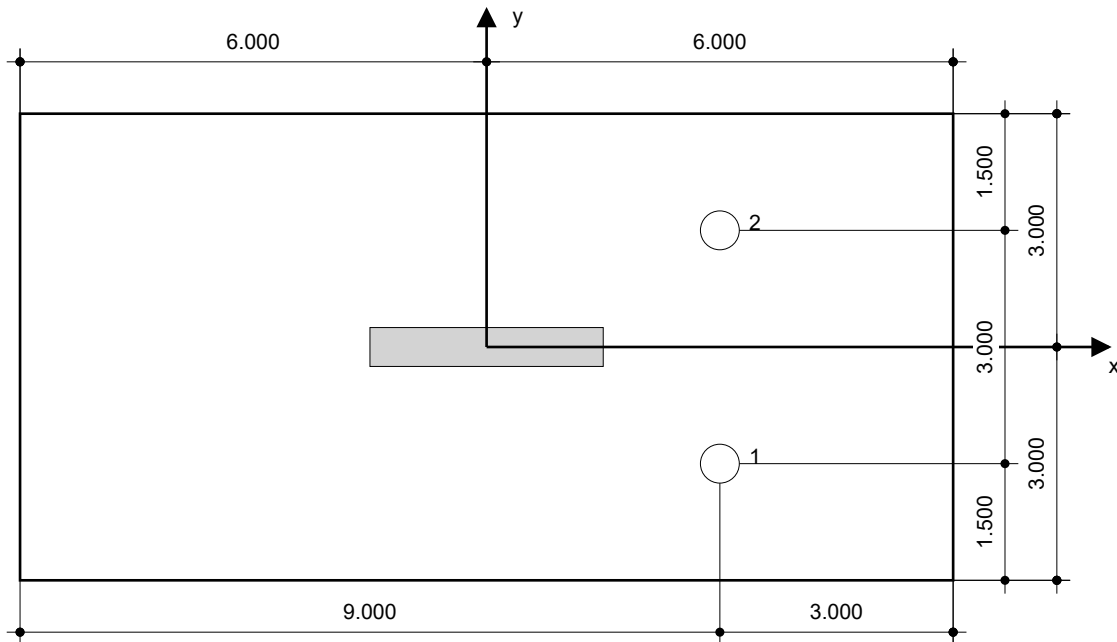
Hole depth in the base material: 3.500 in.

Minimum thickness of the base material: 4.750 in.

Hilti KH-EZ screw anchor with 3.25 in embedment, 3/8 (3 1/4), Carbon steel, installation per ESR-3027

### 7.1 Recommended accessories

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



Coordinates Anchor [in.]

Anchor	x	y	c <sub>-x</sub>	c <sub>+x</sub>	c <sub>-y</sub>	c <sub>+y</sub>
1	3.000	-1.500	12.000	-	12.000	-
2	3.000	1.500	12.000	-	15.000	-

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## 8 Alternative fastening

### 8.1 Alternative fastening data

<b>Anchor type and diameter:</b>	<b>KWIK-X 3/8 (3) hnom2</b>	
Item number:	418059 KH-EZ 3/8"x4" (element) / 2346659 KHC 3/8" LARGE (capsule)	
Effective embedment depth:	$h_{ef,opti} = 3.000$ in. ( $h_{ef,limit} = 3.500$ in.), $h_{nom} = 3.000$ in.	
Material:	Carbon Steel	
Evaluation Service Report:	ESR-5065	
Issued   Valid:	1/1/2023   12/1/2023	
Proof:	Design Method ACI 318-19 / Chem	
Stand-off installation:	$e_b = 0.000$ in. (no stand-off); $t = 0.500$ in.	
Anchor plate <sup>R</sup> :	$l_x \times l_y \times t = 12.000$ in. x $6.000$ in. x $0.500$ in.; (Recommended plate thickness: not calculated)	
Profile:	Rectangular plates and bars (AISC), 3 - 1/2; (L x W x T) = $3.000$ in. x $0.500$ in.	
Base material:	cracked concrete, 3000, $f'_c = 3,000$ psi; $h = 6.000$ in., Temp. short/long: 32/32 °F	
<b>Installation:</b>	<b>hammer drilled hole, Installation condition: Dry</b>	
Reinforcement:	tension: not present, shear: not present; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar	

**Max. Utilization with KWIK-X 3/8 (3) hnom2: 77 %  
Fastening meets the design criteria!**

### 8.2 Installation data

Profile: Rectangular plates and bars (AISC), 3 - 1/2; (L x W x T) = $3.000$ in. x $0.500$ in.	Anchor type and diameter: KWIK-X 3/8 (3) hnom2
Hole diameter in the fixture: $d_f = 0.500$ in.	Item number: 418059 KH-EZ 3/8"x4" (element) / 2346659 KHC 3/8" LARGE (capsule)
Plate thickness (input): $0.500$ in.	Maximum installation torque: -
Recommended plate thickness: not calculated	Hole diameter in the base material: $0.375$ in.
Drilling method: Hammer drilled	Hole depth in the base material: $4.250$ in.
Cleaning: No cleaning of the drilled hole is required	Minimum thickness of the base material: $5.500$ in.

3/8 (3) hnom2 Hilti KH-EZ Carbon steel screw anchor with Hilti KHC

#### 8.2.1 Recommended accessories

Drilling	Cleaning	Setting
<ul style="list-style-type: none"> <li>• Suitable Rotary Hammer</li> <li>• Properly sized drill bit</li> </ul>	<ul style="list-style-type: none"> <li>• No accessory required</li> </ul>	<ul style="list-style-type: none"> <li>• SIW 6-A22 Impact Screw Driver</li> </ul>



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## 9 Remarks; Your Cooperation Duties

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