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Design:	Concrete - Nov 14, 2022	Date:	11/15/2022
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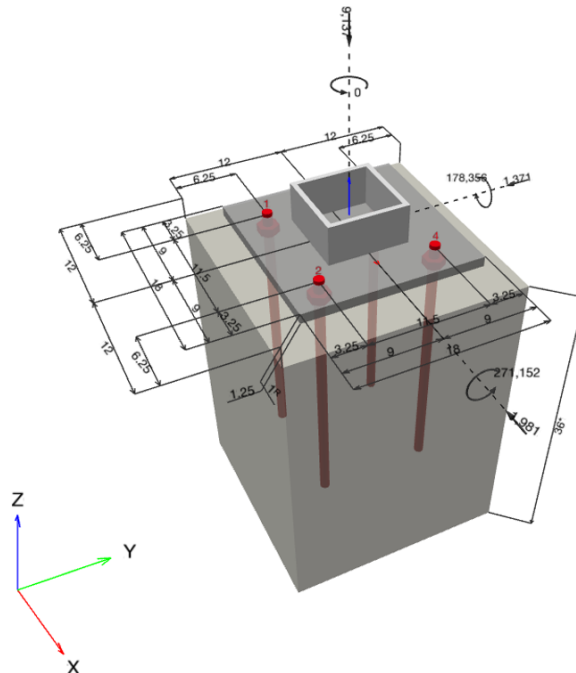
**Specifier's comments:**

**1 Input data**

<b>Anchor type and diameter:</b>	<b>Heavy Hex Head ASTM F 1554 GR. 55 1</b>	
Item number:	not available	
Effective embedment depth:	$h_{ef} = 25.000$ in.	
Material:	ASTM F 1554	
Evaluation Service Report:	Hilti Technical Data	
Issued   Valid:	-   -	
Proof:	Design Method ACI 318-19 / CIP	
Stand-off installation:	without clamping (anchor); restraint level (anchor plate): 1.00; $e_b = 1.250$ in.; $t = 1.000$ in.	
Anchor plate <sup>R</sup> :	$l_x \times l_y \times t = 18.000$ in. x $18.000$ in. x $1.000$ in.; (Recommended plate thickness: not calculated)	
Profile:	Square HSS (AISC), HSS8X8X.500; (L x W x T) = $8.000$ in. x $8.000$ in. x $0.500$ in.	
Base material:	cracked concrete, 4000, $f'_c = 4,000$ psi; $h = 36.000$ in.	
Reinforcement:	tension: not present, shear: not present; edge reinforcement: none or < No. 4 bar	

<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 = -9,137; V <sub>x</sub> = -1,981; V <sub>y</sub> = -1,371; M <sub>x</sub> = 271,152; M <sub>y</sub> = 178,356; M <sub>z</sub> = 0;	no	210

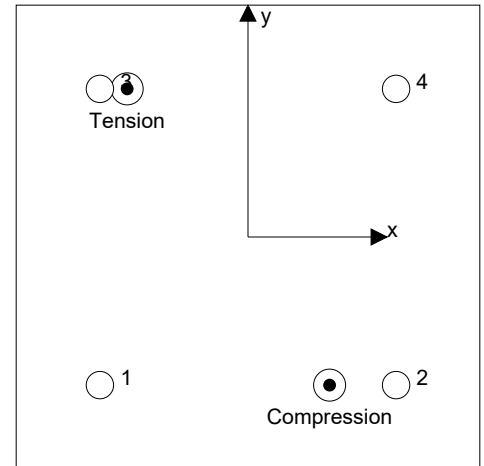
2 Load case/Resulting anchor forces

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	-6,319	602	-495	-343
2	-21,828	602	-495	-343
3	17,260	602	-495	-343
4	1,750	602	-495	-343

max. concrete compressive strain: - [%]  
 max. concrete compressive stress: - [psi]  
 resulting tension force in (x/y)=(-4.691/5.750): 19,010 [lb]  
 resulting compression force in (x/y)=(3.168/-5.750): 28,147 [lb]



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

3 Tension load

	Load N <sub>ua</sub> [lb]	Capacity $\phi N_n$ [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	-21,828	34,087	65	OK
Pullout Strength*	17,260	33,622	52	OK
Concrete Breakout Failure**	19,010	12,677	150	not recommended
Concrete Side-Face Blowout, direction x-**	17,260	54,240	32	OK

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



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3.1 Steel Strength

$$N_{sa} = A_{se,N} f_{uta} \quad \text{ACI 318-19 Eq. (17.6.1.2)}$$

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

Variables

$A_{se,N} [\text{in.}^2]$	$f_{uta} [\text{psi}]$
0.61	75,000

Calculations

$N_{sa} [\text{lb}]$
45,450

Results

$N_{sa} [\text{lb}]$	$\phi_{\text{steel}}$	$\phi N_{sa} [\text{lb}]$	$N_{ua} [\text{lb}]$
45,450	0.750	34,087	-21,828

The steel proof was done for the highest absolute force per anchor - in this case compression loading. Please be aware that buckling should be verified separately

3.2 Pullout Strength

$$N_{pn} = \psi_{c,p} N_p \quad \text{ACI 318-19 Eq. (17.6.3.1)}$$

$$N_p = 8 A_{brg} f'_c \quad \text{ACI 318-19 Eq. (17.6.3.2.2a)}$$

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

Variables

$\psi_{c,p}$	$A_{brg} [\text{in.}^2]$	$\lambda_a$	$f'_c [\text{psi}]$
1.000	1.50	1.000	4,000

Calculations

$N_p [\text{lb}]$
48,032

Results

$N_{pn} [\text{lb}]$	$\phi_{\text{concrete}}$	$\phi N_{pn} [\text{lb}]$	$N_{ua} [\text{lb}]$
48,032	0.700	33,622	17,260

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**3.3 Concrete Breakout Failure**

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

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

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

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

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

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

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

$$N_b = 16 \lambda_a \sqrt{f_c} h_{ef}^{5/3} \quad \text{ACI 318-19 Eq. (17.6.2.2.3)}$$

**Variables**

$h_{ef}$ [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\Psi_{c,N}$
11.833	4.691	0.000	6.250	1.000
$c_{ac}$ [in.]	$k_c$	$\lambda_a$	$f_c$ [psij]	
-	16	1.000	4,000	

**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]
576.00	1,260.25	0.791	1.000	0.806	1.000	62,182

**Results**

$N_{cbg}$ [lb]	$\phi_{concrete}$	$\phi N_{cbg}$ [lb]	$N_{ua}$ [lb]
18,110	0.700	12,677	19,010



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3.4 Concrete Side-Face Blowout, direction x-

$$N_{sb} = 160 c_{a1} \sqrt{A_{brg}} \lambda_a \sqrt{f'_c} \quad \text{ACI 318-19 Eq. (17.6.4.1)}$$

$$N_{sbg} = \alpha_{group} N_{sb} \quad \text{ACI 318-19 Eq. (17.6.4.2)}$$

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

$$\alpha_{group} = \left( 1 + \frac{s}{6 c_{a1}} \right) \quad \text{see ACI 318-19, Section 17.6.4.2, Eq. (17.6.4.2)}$$

Variables

$c_{a1}$ [in.]	$c_{a2}$ [in.]	$A_{brg}$ [in. <sup>2</sup> ]	$\lambda_a$	$f'_c$ [psi]	$s$ [in.]
6.250	6.250	1.50	1.000	4,000	-

Calculations

$\alpha_{group}$	$N_{sb}$ [lb]
1.000	77,485

Results

$N_{sbg}$ [lb]	$\phi_{concrete}$	$\phi N_{sbg}$ [lb]	$N_{ua,edge}$ [lb]
77,485	0.700	54,240	17,260



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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*	602	17,725	4	OK
Steel failure (with lever arm)*	602	594	102	not recommended
Pryout Strength**	2,409	66,628	4	OK
Concrete edge failure in direction y-**	2,409	7,172	34	OK

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

#### 4.1 Steel Strength

$V_{sa} = 0.6 A_{se,V} f_{uta}$       ACI 318-19 Eq. (17.7.1.2b)  
 $\phi V_{steel} \geq V_{ua}$               ACI 318-19 Table 17.5.2

#### Variables

$A_{se,V}$ [in. <sup>2</sup> ]	$f_{uta}$ [psi]
0.61	75,000

#### Calculations

$V_{sa}$ [lb]
27,270

#### Results

$V_{sa}$ [lb]	$\phi_{steel}$	$\phi V_{sa}$ [lb]	$V_{ua}$ [lb]
27,270	0.650	17,725	602



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4.2 Steel failure (with lever arm)

$V_s^M$	$= \frac{\alpha_M \cdot M_s}{L_b}$	bending equation for stand-off
$M_s$	$= M_s^0 \left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	resultant flexural resistance of anchor
$M_s^0$	$= (1.2) (S) (f_{u,min})$	characteristic flexural resistance of anchor
$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$		reduction for tensile force acting simultaneously with a shear force on the anchor
$S$	$= \frac{\pi(d)^3}{32}$	elastic section modulus of anchor bolt at concrete surface
$L_b$	$= z + (n)(d_0)$	internal lever arm adjusted for spalling of the surface concrete
$\phi V_s^M$	$\geq V_{ua}$	ACI 318-19 Table 17.5.2

Variables

$\alpha_M$	$f_{u,min}$ [psi]	$N_{ua}$ [lb]	$\phi N_{sa}$ [lb]	$z$ [in.]	$n$	$d_0$ [in.]
1.00	75,000	-21,828	34,087	1.750	0.500	1.000

Calculations

$M_s^0$ [in.lb]	$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	$M_s$ [in.lb]	$L_b$ [in.]
5,713	0.360	2,055	2.250

Results

$V_s^M$ [lb]	$\phi_{steel}$	$\phi V_s^M$ [lb]	$V_{ua}$ [lb]
913	0.650	594	602

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**4.3 Pryout Strength**

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

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

$A_{Nc}$  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	4.167	0.000	0.000	6.250
$\psi_{c,N}$	$c_{ac}$ [in.]	$k_c$	$\lambda_a$	$f'_c$ [psi]
1.000	$\infty$	24	1.000	4,000

**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]
576.00	156.25	1.000	1.000	1.000	1.000	12,910

**Results**

$V_{cp,g}$ [lb]	$\phi_{concrete}$	$\phi V_{cp,g}$ [lb]	$V_{ua}$ [lb]
95,182	0.700	66,628	2,409

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**4.4 Concrete edge failure in direction y-**

$V_{cbg} = \left( \frac{A_{Vc}}{A_{Vc0}} \right) \Psi_{ec,V} \Psi_{ed,V} \Psi_{c,V} \Psi_{h,V} \Psi_{parallel,V} V_b$	ACI 318-19 Eq. (17.7.2.1b)
$\phi V_{cbg} \geq V_{ua}$	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)	
$A_{Vc0} = 4.5 c_{a1}^2$	ACI 318-19 Eq. (17.7.2.1.3)
$\Psi_{ec,V} = \left( \frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0$	ACI 318-19 Eq. (17.7.2.3.1)
$\Psi_{ed,V} = 0.7 + 0.3 \left( \frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0$	ACI 318-19 Eq. (17.7.2.4.1b)
$\Psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$	ACI 318-19 Eq. (17.7.2.6.1)
$V_b = 9 \lambda_a \sqrt{f_c} c_{a1}^{1.5}$	ACI 318-19 Eq. (17.7.2.2.1b)

**Variables**

$c_{a1}$ [in.]	$c_{a2}$ [in.]	$e_{cV}$ [in.]	$\Psi_{c,V}$	$h_a$ [in.]
6.250	6.250	0.000	1.000	36.000
$l_e$ [in.]	$\lambda_a$	$d_a$ [in.]	$f_c$ [psi]	$\Psi_{parallel,V}$
8.000	1.000	1.000	4,000	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]
225.00	175.78	1.000	0.900	1.000	8,894

**Results**

$V_{cbg}$ [lb]	$\phi_{concrete}$	$\phi V_{cbg}$ [lb]	$V_{ua}$ [lb]
10,246	0.700	7,172	2,409

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

$\beta_N$	$\beta_V$	$\zeta$	Utilization $\beta_{NV}$ [%]	Status
1.500	1.015	1.000	210	not recommended

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



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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.
- ACI 318 does not specifically address anchor bending when a stand-off condition exists. PROFIS Engineering calculates a shear load corresponding to anchor bending when stand-off exists and includes the results as a shear Design Strength!
- For additional information about ACI 318 strength design provisions, please go to <https://submittals.us.hilti.com/PROFISAnchorDesignGuide/>
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.

**Fastening does not meet the design criteria!**

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### 7 Installation data

Profile: Square HSS (AISC), HSS8X8X.500; (L x W x T) = 8.000 in. x 8.000 in. x 0.500 in.

Hole diameter in the fixture:  $d_f = 1.062$  in.

Plate thickness (input): 1.000 in.

Recommended plate thickness: not calculated

Anchor type and diameter: Heavy Hex Head ASTM F 1554 GR. 55 1

Item number: not available

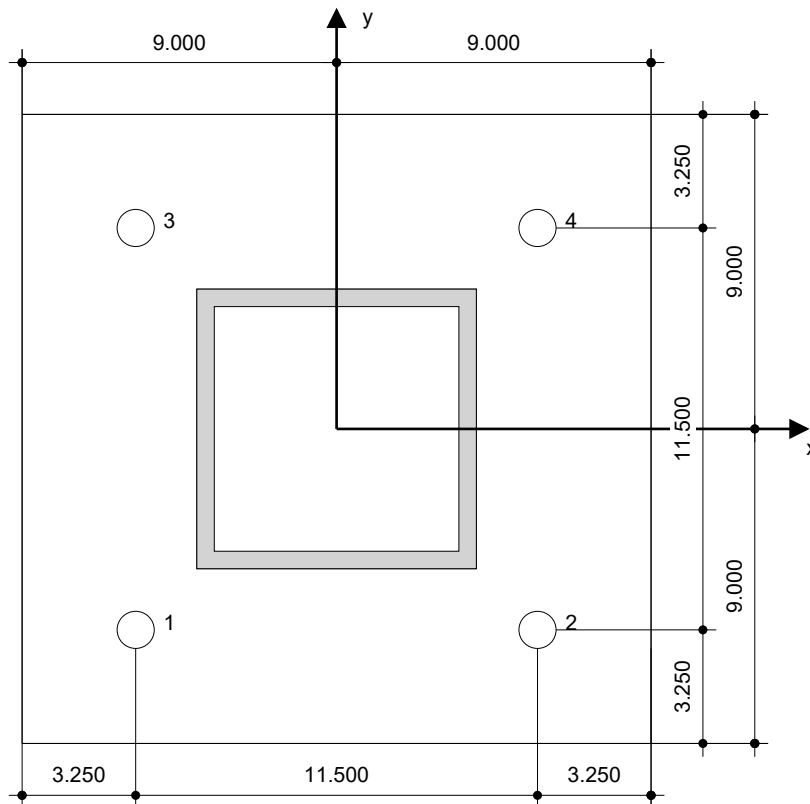
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 25.000 in.

Minimum thickness of the base material: 26.172 in.

Hilti Heavy Hex Head headed stud anchor with 25 in embedment, 1, Steel galvanized, installation per instruction for use



Coordinates Anchor [in.]

Anchor	x	y	c <sub>-x</sub>	c <sub>+x</sub>	c <sub>-y</sub>	c <sub>+y</sub>
1	-5.750	-5.750	6.250	17.750	6.250	17.750
2	5.750	-5.750	17.750	6.250	6.250	17.750
3	-5.750	5.750	6.250	17.750	17.750	6.250
4	5.750	5.750	17.750	6.250	17.750	6.250



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## 8 Remarks; Your Cooperation Duties

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