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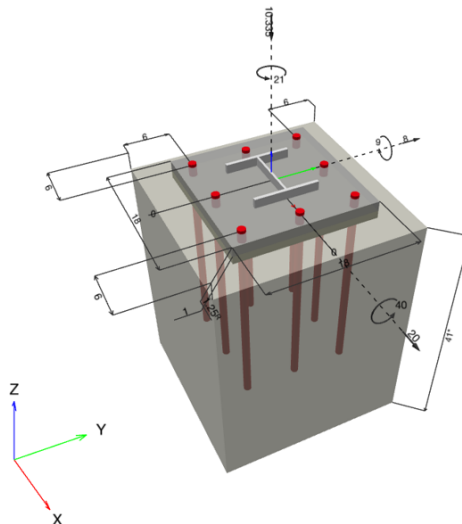
Specifier's comments:

1 Input data

Anchor type and diameter:	Heavy Hex Head ASTM F 1554 GR. 55 1	
Item number:	not available	
Additional plate or washer (17.6.2.1.3):	$d_{plate} = 2.250$ in., $t_{plate} = 0.625$ in.	
Effective embedment depth:	$h_{ef} = 24.000$ in., $h_{ef,17.6.2.1.3} = 0.000$ 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): 2.00; $e_b = 1.000$ in.; $t = 1.250$ in. Hilti Grout: CB-G EG, epoxy, $f_{c,Grout} = 14,939$ psi	
Anchor plate ^R :	$l_x \times l_y \times t = 18.000$ in. x 18.000 in. x 1.250 in.; (Recommended plate thickness: not calculated)	
Profile:	W shape (AISC), W8X31; (L x W x T x FT) = 8.000 in. x 8.000 in. x 0.285 in. x 0.435 in.	
Base material:	cracked concrete, 4000, $f_c' = 4,000$ psi; $h = 41.000$ in.	
Reinforcement:	tension: present, shear: present; anchor reinforcement: tension, shear edge reinforcement: > No. 4 bar with stirrups	
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.10.5.3 (d)) Shear load: yes (17.10.6.3 (a))	

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

Geometry [in.] & Loading [kip, ft.kip]



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1.1 Design results

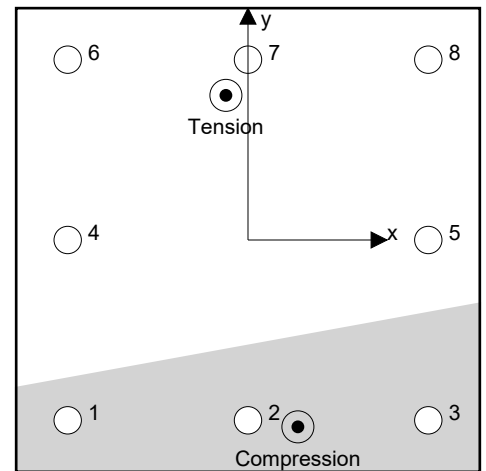
Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = -10.335; V _x = 20.000; V _y = 8.000; M _x = 40.00000; M _y = 9.00000; M _z = 21.00000;	yes	199

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	5.852	5.500	-2.000
2	0.000	5.590	5.500	1.000
3	0.000	6.801	5.500	4.000
4	4.079	3.202	2.500	-2.000
5	2.150	4.717	2.500	4.000
6	9.380	2.062	-0.500	-2.000
7	8.416	1.118	-0.500	1.000
8	7.451	4.031	-0.500	4.000



max. concrete compressive strain: 0.28 [‰]
 max. concrete compressive stress: 1,223 [psi]
 resulting tension force in (x/y)=(-0.858/5.615): 31.476 [kip]
 resulting compression force in (x/y)=(1.937/-7.253): 41.811 [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*	9.380	34.087	28	OK
Pullout Strength*	9.380	25.217	38	OK
Concrete Breakout Failure** ¹	N/A	N/A	N/A	N/A
Concrete Side-Face Blowout, direction y+**	25.247	58.114	44	OK

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

¹ Tension Anchor Reinforcement has been selected!



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3.1 Steel Strength

$N_{sa} = A_{se,N} f_{uta}$ ACI 318-19 Eq. (17.6.1.2)
 $\phi N_{sa} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

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

Calculations

N_{sa} [kip]
45.450

Results

N_{sa} [kip]	ϕ_{steel}	ϕN_{sa} [kip]	N_{ua} [kip]
45.450	0.750	34.087	9.380

3.2 Pullout Strength

$N_{pN} = \psi_{c,p} N_p$ ACI 318-19 Eq. (17.6.3.1)
 $N_p = 8 A_{brg} f'_c$ ACI 318-19 Eq. (17.6.3.2.2a)
 $\phi N_{pN} \geq N_{ua}$ ACI 318-19 Table 17.5.2

Variables

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

Calculations

N_p [kip]
48.032

Results

N_{pn} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{pn} [kip]	N_{ua} [kip]
48.032	0.700	0.750	1.000	25.217	9.380



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3.3 Concrete Side-Face Blowout, direction y+

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

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

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

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

Variables

c_{a1} [in.]	c_{a2} [in.]	A_{brg} [in. ²]	λ_a	f'_c [psi]	s [in.]
6.000	6.000	1.50	1.000	4,000	14.000

Calculations

α_{group}	N_{sb} [kip]
1.389	74.386

Results

N_{sbg} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{sbg} [kip]	$N_{ua,edge}$ [kip]
103.314	0.750	0.750	1.000	58.114	25.247



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4 Shear load

	Load V_{ua} [kip]	Capacity ϕV_n [kip]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	6.801	14.180	48	OK
Steel failure (with lever arm)*	6.801	3.495	195	not recommended
Pryout Strength*	5.590	8.933	63	OK
Concrete edge failure in direction ** ¹	N/A	N/A	N/A	N/A

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

¹ Shear Anchor Reinforcement has been selected!

4.1 Steel Strength

$$V_{sa} = 0.6 A_{se,V} f_{uta} \quad \text{ACI 318-19 Eq. (17.7.1.2b)}$$

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

Variables

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

Calculations

V_{sa} [kip]
27.270

Results

V_{sa} [kip]	ϕ_{steel}	ϕ_{eb}	$\phi V_{sa,eq}$ [kip]	V_{ua} [kip]
27.270	0.650	0.800	14.180	6.801



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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

α_M	$f_{u,min}$ [psi]	N_{ua} [kip]	ϕN_{sa} [kip]	z [in.]	n	d_0 [in.]
2.00	75,000	0.000	34.087	1.625	0.500	1.000

Calculations

M_s^0 [ft.kip]	$\left(1 - \frac{N_{ua}}{\phi N_{sa}}\right)$	M_s [ft.kip]	L_b [in.]
0.47606	1.000	0.47606	2.125

Results

V_s^M [kip]	ϕ_{steel}	ϕV_s^M [kip]	V_{ua} [kip]
5.377	0.650	3.495	6.801



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4.3 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)

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

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

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

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

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

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	4.000	0.000	0.000	6.000
$\Psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c [psi]
1.000	∞	24	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]
75.67	144.00	1.000	1.000	1.000	1.000	12.143

Results

V_{cp} [kip]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕV_{cp} [kip]	V_{ua} [kip]
12.762	0.700	1.000	1.000	8.933	5.590

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

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.434	1.946	1.000	199	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/>
- "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 .
- The design of Anchor Reinforcement is beyond the scope of PROFIS Engineering. Refer to ACI 318-19, Section 17.5.2.1 (a) for information about Anchor Reinforcement.
- The design of Anchor Reinforcement is beyond the scope of PROFIS Engineering. Refer to ACI 318-19, Section 17.5.2.1 (b) for information about Anchor Reinforcement.
- Anchor Reinforcement has been selected as a design option, calculations should be compared with PROFIS Engineering calculations.

Fastening does not meet the design criteria!

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7 Installation data

Profile: W shape (AISC), W8X31; (L x W x T x FT) = 8.000 in. x 8.000 in. x 0.285 in. x 0.435 in.

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

Plate thickness (input): 1.250 in.

Recommended plate thickness: not calculated

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

Item number: not available

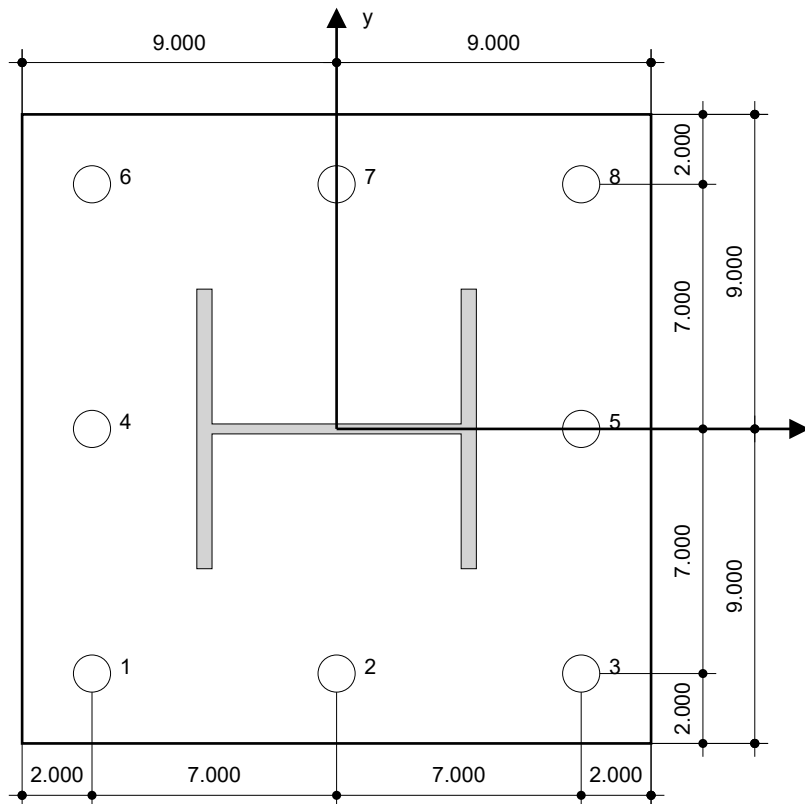
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 24.000 in.

Minimum thickness of the base material: 25.172 in.

Hilti Heavy Hex Head headed stud anchor with 24 in embedment, 1, Steel galvanized, installation per instruction for use



Coordinates Anchor [in.]

Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}	Anchor	x	y	c _{-x}	c _{+x}	c _{-y}	c _{+y}
1	-7.000	-7.000	6.000	20.000	6.000	20.000	5	7.000	0.000	20.000	6.000	13.000	13.000
2	0.000	-7.000	13.000	13.000	6.000	20.000	6	-7.000	7.000	6.000	20.000	20.000	6.000
3	7.000	-7.000	20.000	6.000	6.000	20.000	7	0.000	7.000	13.000	13.000	20.000	6.000
4	-7.000	0.000	6.000	20.000	13.000	13.000	8	7.000	7.000	20.000	6.000	20.000	6.000

Input data and results must be checked for conformity with the existing conditions and for plausibility!
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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.