Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Connection between guard post base and slab	Date:	9/20/2022
Fastening point:			

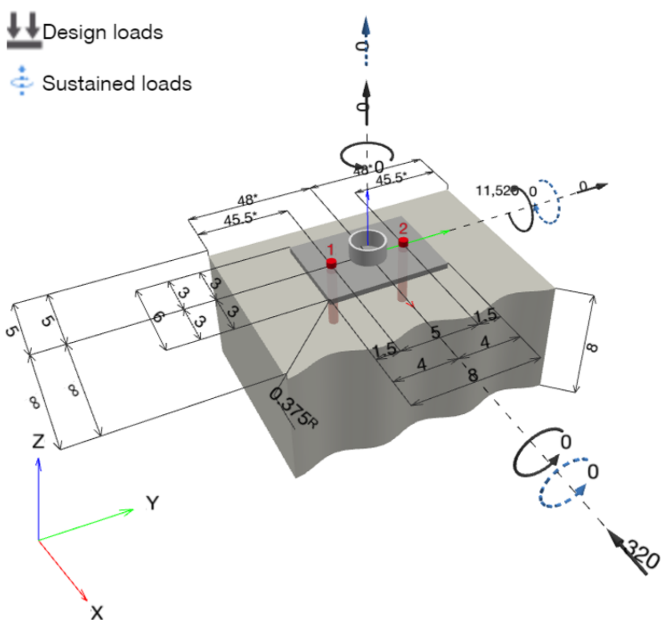
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 V3 + HIT-Z 5/8**
Item number:	2018446 HIT-Z 5/8" x 6" (element) / 2334276 HIT-HY 200-R V3 (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 4.000 in. ($h_{ef,limit}$ = - in.)
Material:	DIN EN ISO 4042
Evaluation Service Report:	ESR-4868
Issued I Valid:	11/1/2021 | 11/1/2022
Proof:	Design Method ACI 318-19 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.375 in.
Anchor plate^R :	l_x x l_y x t = 6.000 in. x 8.000 in. x 0.375 in.; (Recommended plate thickness: not calculated)
Profile:	Steel pipe, PIPE2STD; (L x W x T) = 2.380 in. x 2.380 in. x 0.154 in.
Base material:	cracked concrete, 3000, f_c' = 3,000 psi; h = 8.000 in., Temp. short/long: 75/75 °F
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

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

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



Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:		Page:	2
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Connection between guard post base and slab	Date:	9/20/2022
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	1.2DL + 1.6L + 1.0W	N = 0; V_x = -320; V_y = 0; M_x = 0; M_y = -11,520; M_z = 0;	no	74

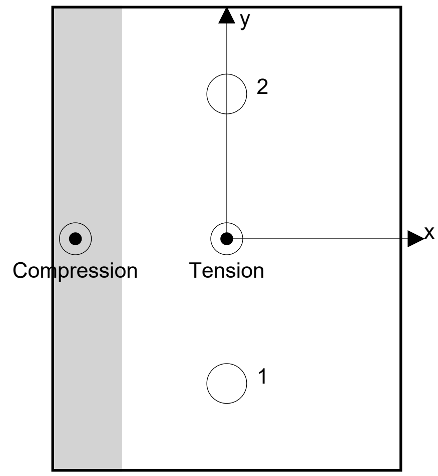
2 Load case/Resulting anchor forces

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

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	2,208	160	-160	0
2	2,208	160	-160	0

max. concrete compressive strain: 0.22 [‰]
max. concrete compressive stress: 941 [psi]
resulting tension force in (x/y)=(0.000/-0.000): 4,416 [lb]
resulting compression force in (x/y)=(-2.609/-0.000): 4,416 [lb]

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



3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	2,208	13,849	16	OK
Pullout Strength*	2,208	13,904	16	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Failure**	4,416	5,973	74	OK

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

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

3.1 Steel Strength

N_{sa} = ESR value — refer to ICC-ES ESR-4868

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

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.23	94,200

Calculations

N_{sa} [lb]
21,306

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
21,306	0.650	13,849	2,208

3.2 Pullout Strength

$N_{pn} = N_p\ \lambda_a$ — refer to ICC-ES ESR-4868

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

Variables

λ_a	N_p [lb]
1.000	21,391

Calculations

N_{pn} [lb]
21,391

Results

N_{pn} [lb]	$\phi_{concrete}$	$\phi\ N_{pn}$ [lb]	N_{ua} [lb]
21,391	0.650	13,904	2,208

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

3.3 Concrete Breakout Failure

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

$\phi\ N_{cbg} \geq N_{ua}$ — 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)

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

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

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — 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.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
4.000	0.000	0.000	5.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
8.800	17	1.000	3,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
187.00	144.00	1.000	1.000	0.950	1.000	7,449

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
9,190	0.650	5,973	4,416

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	160	5,625	3	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	320	12,865	3	OK
Concrete edge failure in direction x-**	320	4,585	7	OK

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

4.1 Steel Strength

V_{sa} = ESR value refer to ICC-ES ESR-4868
ϕ $V_{steel} \geq V_{ua}$ ACI 318-19 Table 17.5.2

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.23	94,200

Calculations

V_{sa} [lb]
9,375

Results

V_{sa} [lb]	ϕ $_{steel}$	ϕ V_{sa} [lb]	V_{ua} [lb]
9,375	0.600	5,625	160

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4.2 Pryout Strength (Concrete Breakout Strength controls)

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

$\phi \; V_{cpg} \geq V_{ua}$ 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)

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

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ 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

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	4.000	0.000	0.000	5.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c' [psi]
1.000	8.800	17	1.000	3,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
187.00	144.00	1.000	1.000	0.950	1.000	7,449

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi \; V_{cpg}$ [lb]	V_{ua} [lb]
18,379	0.700	12,865	320

Input data and results must be checked for conformity with the existing conditions and for plausibility!
PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

4.3 Concrete edge failure in direction x-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ 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)

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

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
5.000	45.500	0.000	1.000	8.000

l_e [in.]	λ_a	d_a [in.]	f_c' [psi]	$\psi_{parallel,V}$
4.000	1.000	0.625	3,000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
150.00	112.50	1.000	1.000	1.000	4,912

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
6,550	0.700	4,585	320

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

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.739	0.070	5/3	62	OK

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

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

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.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-19, Section 26.7.

Fastening meets the design criteria!

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

7 Installation data

Profile: Steel pipe, PIPE2STD; (L x W x T) = 2.380 in. x 2.380 in. x 0.154 in.

Hole diameter in the fixture (pre-setting) : d_f = 0.687 in.

Hole diameter in the fixture (through fastening) : d_f = 0.812 in.

Plate thickness (input): 0.375 in.

Recommended plate thickness: not calculated

Drilling method: Hammer drilled

Cleaning: Compressed air cleaning of the drilled hole according to instructions for use is required

Anchor type and diameter: HIT-HY 200 V3 + HIT-Z 5/8

Item number: 2018446 HIT-Z 5/8" x 6" (element) / 2334276 HIT-HY 200-R V3 (adhesive)

Maximum installation torque: 708 in.lb

Hole diameter in the base material: 0.750 in.

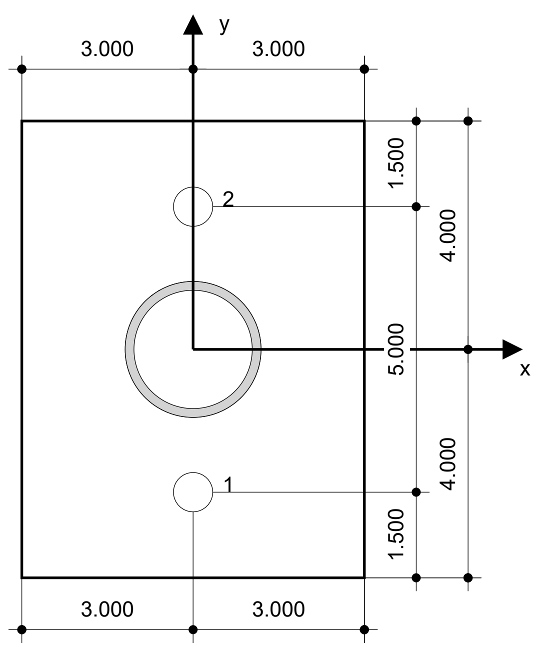
Hole depth in the base material: 4.000 in.

Minimum thickness of the base material: 8.000 in.

5/8 Hilti HIT-Z Carbon steel non-cleaning bonded expansion anchor with Hilti HIT-HY 200 V3 Safe Set System

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer • Properly sized drill bit	• -	• Dispenser including cassette and mixer • Torque wrench



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	-2.500	5.000	-	45.500	50.500
2	0.000	2.500	5.000	-	50.500	45.500

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan

Company:		Page:	10
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Connection between guard post base and slab	Date:	9/20/2022
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.

PROFIS Engineering (c) 2003-2022 Hilti AG, FL-9494 Schaan Hilti is a registered Trademark of Hilti AG, Schaan