Company:		Page:	1
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jun 27, 2024 (1)	Date:	6/29/2024
Fastening point:			

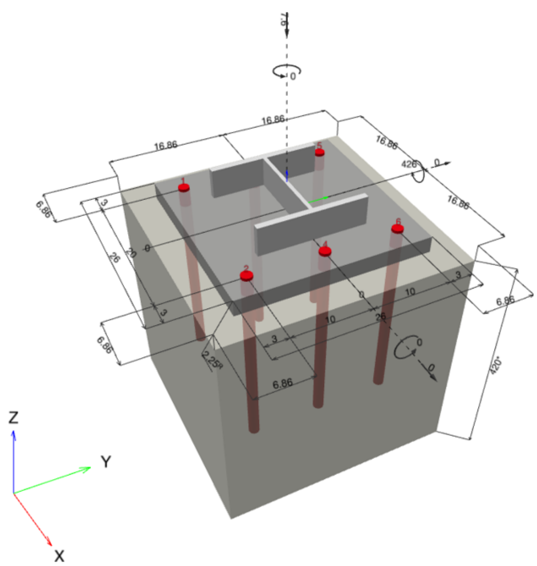
Specifier's comments:

1 Input data

Anchor type and diameter:	**Heavy Hex Head ASTM F 1554 GR. 105 1 1/2**
Item number:	not available
Specification text:	Hilti Heavy Hex Head headed stud anchor with 25 in embedment, 1 1/2, Steel galvanized, installation per instruction for use
Effective embedment depth:	h_{ef} = 25.000 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ACI 318-19 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 2.250 in.
Anchor plate[R] :	l_x x l_y x t = 26.000 in. x 26.000 in. x 2.250 in.;
Profile:	W shape (AISC), W14X109; (L x W x T x FT) = 14.300 in. x 14.600 in. x 0.525 in. x 0.860 in.
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 420.000 in.
Reinforcement:	tension: not present, shear: not present;
	edge reinforcement: none or < No. 4 bar

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

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



1.1 Design results

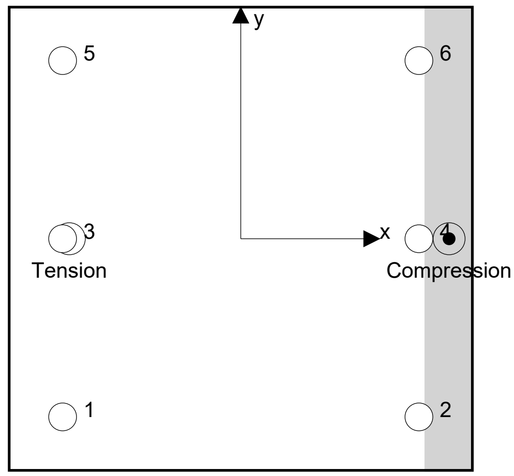
Case	Description	Forces [kip] / Moments [ft.kip]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = -7.600; V_x = 0.000; V_y = 0.000; M_x = 0.00000; M_y = 426.00000; M_z = 0.00000;	no	879

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	77.065	0.000	0.000	0.000
2	1.471	0.000	0.000	0.000
3	77.065	0.000	0.000	0.000
4	1.471	0.000	0.000	0.000
5	77.065	0.000	0.000	0.000
6	1.471	0.000	0.000	0.000



max. concrete compressive strain:	0.24 [‰]
max. concrete compressive stress:	3.583 [ksi]
resulting tension force in (x/y)=(-9.625/0.000):	235.606 [kip]
resulting compression force in (x/y)=(11.695/0.000):	243.206 [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*	77.065	132.187	59	OK
Pullout Strength*	77.065	87.304	89	OK
Concrete Breakout Failure**	235.606	26.828	879	not recommended
Concrete Side-Face Blowout, direction x-**	231.194	142.547	163	not recommended

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

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} [ksi]
1.41	125.001

Calculations

N_{sa} [kip]
176.250

Results

N_{sa} [kip]	ϕ_{steel}	$\phi\ N_{sa}$ [kip]	N_{ua} [kip]
176.250	0.750	132.187	77.065

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	3.12	1.000	5,000

Calculations

N_p [kip]
124.720

Results

N_{pn} [kip]	$\phi_{concrete}$	$\phi\ N_{pn}$ [kip]	N_{ua} [kip]
124.720	0.700	87.304	77.065

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)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ 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.]	$\psi_{c,N}$
6.667	9.625	0.000	6.860	1.000

c_{ac} [in.]	k_c	λ_a	f_c' [psi]
-	24	1.000	5,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [kip]
1,137.04	400.00	0.510	1.000	0.906	1.000	29.212

Results

N_{cbg} [kip]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [kip]	N_{ua} [kip]
38.325	0.700	26.828	235.606

Company:		Page:	5
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jun 27, 2024 (1)	Date:	6/29/2024
Fastening point:			

3.4 Concrete Side-Face Blowout, direction x-

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

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

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

$\alpha_{group} = \left(1 + \frac{s}{6\ c_{a1}}\right)$ 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.]
6.860	6.860	3.12	1.000	5,000	20.000

Calculations

α_{group}	N_{sb} [kip]
1.486	137.046

Results

N_{sbg} [kip]	$\phi_{concrete}$	$\phi\ N_{sbg}$ [kip]	$N_{ua,edge}$ [kip]
203.638	0.700	142.547	231.194

4 Shear load

	Load V_{ua} [kip]	Capacity ϕ V_n [kip]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	N/A	N/A	N/A	N/A
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength*	N/A	N/A	N/A	N/A
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

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

5 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.
- For additional information about ACI 318 strength design provisions, please go to https://submittals.us.hilti.com/PROFISAnchorDesignGuide/

Fastening does not meet the design criteria!

6 Anchor plate and concrete bearing stress check

	Load	Capacity	Utilization [%]	Status
Concentric Compression	N/A	N/A	N/A	N/A
Concrete bearing	3.583 [ksi]	3.583 [ksi]	100	OK
Tension Interface	95,686.32 [in.lb/in.]	56,953.15 [in.lb/in.]	169	not recommended
Uniaxial Moment (Strong Axis)	15,851.11 [in.lb/in.]	56,953.15 [in.lb/in.]	28	OK
Uniaxial Moment (Weak Axis)	56,647.11 [in.lb/in.]	56,953.15 [in.lb/in.]	100	OK

6.1 Concrete bearing check (per AISC DG1, section 3.1.1)

$A_1 = B \cdot N$

$A_2 = L \cdot W$

$f_{pu(max)} = \phi \left(0.85 f'_c \sqrt{\frac{A_2}{A_1}}\right), \sqrt{\frac{A_2}{A_1}} \leq 2$

$f_{pu} = f_{pu(max)}$

Variables

B [in.]	N [in.]	L [in.]	W [in.]
26.000	26.000	33.720	33.720

f_c' [ksi]	ϕ	P_u [kip]	M_u [ft.kip]
5.000	0.650	7.600	0.00000

Calculations

A_1 [in.^{2}]	A_2 [in.^{2}]
676.00	1,137.04

Results

f_{pu} [ksi]	$f_{pu(max)}$ [ksi]
3.583	3.583

Company:		Page:	8
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jun 27, 2024 (1)	Date:	6/29/2024
Fastening point:			

6.2 Plate bending (Strong Axis), Compression (per AISC DG1, sections 3.3 and AISC's Engineering Journal, Volume 51, No. 4)

$$A_1 = B \cdot N$$
$$A_2 = L \cdot W$$
$$f_{pu(max)} = \phi \left(0.85f'_c \sqrt{\frac{A_2}{A_1}}\right), \sqrt{\frac{A_2}{A_1}} \leq 2$$
$$m = \frac{N-0.95d}{2}$$
$$n = \frac{B-0.80b_f}{2}$$
$$M_{pl1} = C_r \cdot \frac{x}{b_{eff}}$$
$$\phi M_n = \phi \cdot F_y \cdot \frac{t_p^2}{4}$$
$$M_{pl1} \leq \phi M_n$$

Variables

B [in.]	N [in.]	L [in.]	W [in.]	d [in.]	b_f [in.]
26.000	26.000	33.720	33.720	14.300	14.600

F_y [ksi]	ϕ	t_p [in.]	P_u [kip]	M_u [ft.kip]
50.000	0.900	2.250	7.600	426.00000

Calculations

A_1 [in.^{2}]	A_2 [in.^{2}]	$f_{pu(max)}$ [ksi]	m [in.]	n [in.]
676.00	1,137.04	3.583	6.207	7.160

f_{pu} [ksi]	C_r [kip]	x [in.]	b_{eff} [in.]	M_{pl1} [in.lb/in.]
3.583	243.206	1.695	26.000	15,851.11

Results

M_n [in.lb/in.]	ϕ	ϕM_n [in.lb/in.]	M_{pl1} [in.lb/in.]
63,281.27	0.900	56,953.15	15,851.11

6.3 Plate bending (Weak Axis), Compression (per AISC DG1, sections 3.3 and AISC's Engineering Journal, Volume 51, No. 4)

$A_1 = B \cdot N$

$A_2 = L \cdot W$

$f_{pu(max)} = \phi \left(0.85f'_c \sqrt{\frac{A_2}{A_1}}\right), \sqrt{\frac{A_2}{A_1}} \leq 2$

$m = \frac{N-0.95d}{2}$

$n = \frac{B-0.80b_f}{2}$

$M_{pl2} = C_r \cdot \frac{x}{b_{eff}}$

$\phi M_n = \phi \cdot F_y \cdot \frac{t_p^2}{4}$

$M_{pl2} \leq \phi M_n$

Variables

B [in.]	N [in.]	L [in.]	W [in.]	d [in.]	b_f [in.]
26.000	26.000	33.720	33.720	14.300	14.600

F_y [ksi]	ϕ	t_p [in.]	P_u [kip]	M_u [ft.kip]
50.000	0.900	2.250	7.600	426.00000

Calculations

A_1 [in.^{2}]	A_2 [in.^{2}]	$f_{pu(max)}$ [ksi]	m [in.]	n [in.]
676.00	1,137.04	3.583	6.207	7.160

f_{pu} [ksi]	C_r [kip]	x [in.]	b_{eff} [in.]	M_{pl2} [in.lb/in.]
3.583	66.975	7.160	8.465	56,647.11

Results

M_n [in.lb/in.]	ϕ	ϕ M_n [in.lb/in.]	M_{pl2} [in.lb/in.]
63,281.27	0.900	56,953.15	56,647.11

6.4 Plate bending, tension (per AISC DG1, sections 3.2, 3.3)

$$m = \frac{N-0.95d}{2}$$

$$n = \frac{B-0.80b_f}{2}$$

$$M_{pl} = \frac{T_{u1} \cdot x_1}{b_{eff1}} + \frac{T_{u2} \cdot x_2}{b_{eff2}}$$

$$\phi M_n = \phi \cdot F_y \cdot \frac{t_p^2}{4}$$

$$M_{pl} \leq \phi M_n$$

Variables

B [in.]	N [in.]	d [in.]	b_f [in.]	F_y [ksi]
26.000	26.000	14.300	14.600	50.000

ϕ	t_p [in.]	P_u [kip]	M_u [ft.kip]
0.900	2.250	7.600	426.00000

Calculations

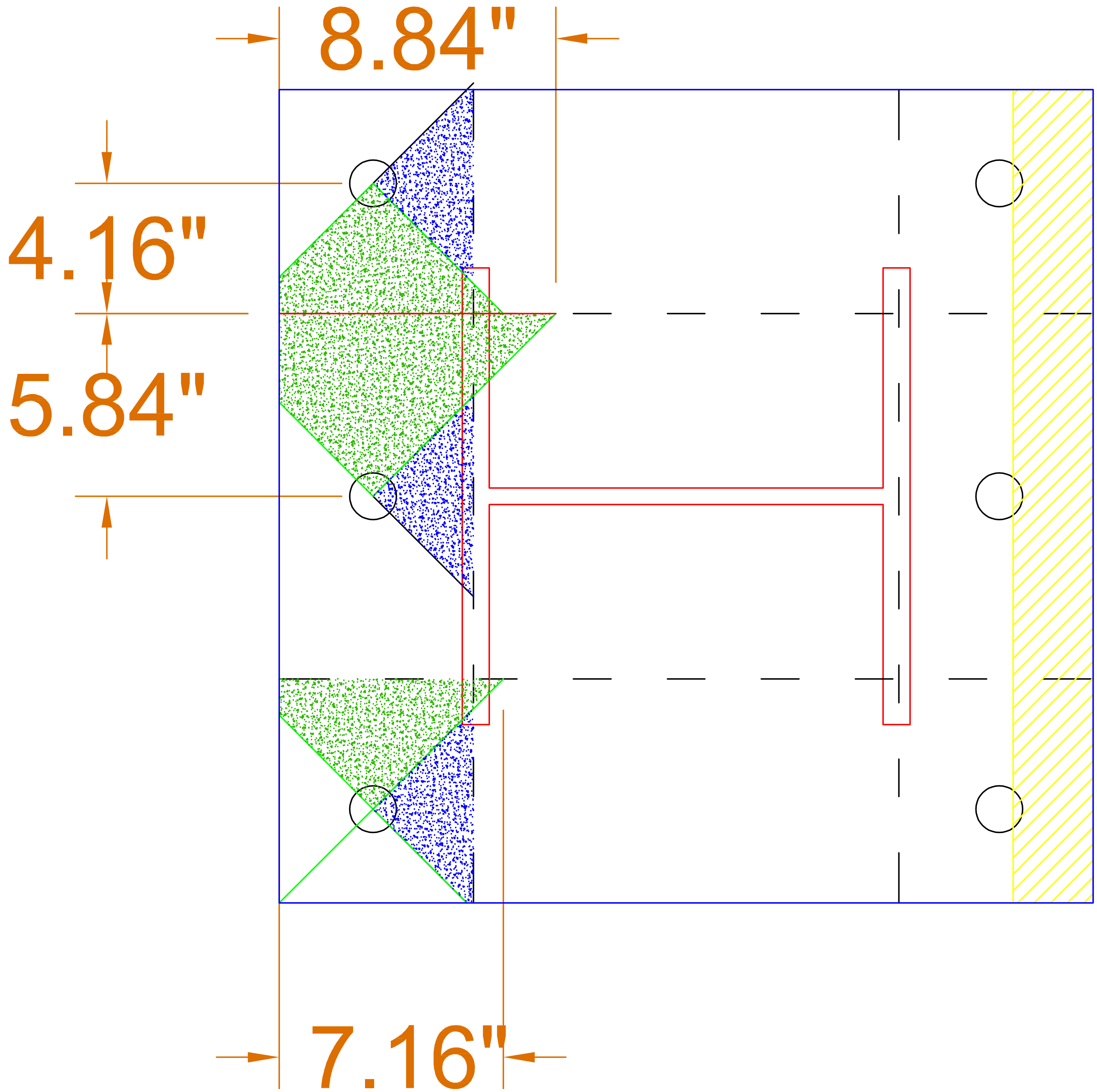
m [in.]	n [in.]
6.207	7.160

T_{u1} [kip]	x_1 [in.]	b_{eff1} [in.]
77.065	5.840	8.840

T_{u2} [kip]	x_2 [in.]	b_{eff2} [in.]
77.065	4.160	7.160

Results

M_n [in.lb/in.]	ϕ	ϕ M_n [in.lb/in.]	M_{pl} [in.lb/in.]
63,281.27	0.900	56,953.15	95,686.32


8.84"
4.16"
5.84"
7.16"

7 Installation data

Profile: W shape (AISC), W14X109; (L x W x T x FT) = 14.300 in. x 14.600 in. x 0.525 in. x 0.860 in.

Hole diameter in the fixture: d_f = 1.562 in.

Plate thickness (input): 2.250 in.

Anchor type and diameter: Heavy Hex Head ASTM F 1554 GR. 105 1 1/2

Item number: not available

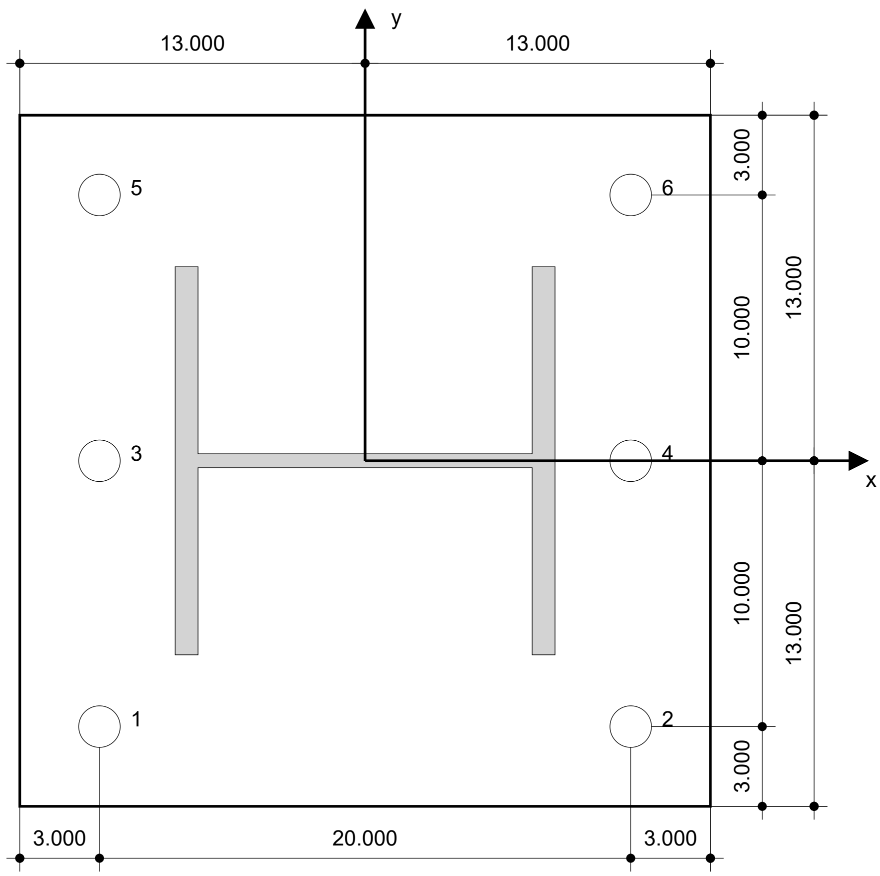
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 25.000 in.

Minimum thickness of the base material: 26.500 in.

Hilti Heavy Hex Head headed stud anchor with 25 in embedment, 1 1/2, Steel galvanized, installation per instruction for use



Coordinates Anchor in.

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-10.000	-10.000	6.860	26.860	6.860	26.860
2	10.000	-10.000	26.860	6.860	6.860	26.860
3	-10.000	0.000	6.860	26.860	16.860	16.860

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
4	10.000	0.000	26.860	6.860	16.860	16.860
5	-10.000	10.000	6.860	26.860	26.860	6.860
6	10.000	10.000	26.860	6.860	26.860	6.860

Company:		Page:	12
Address:		Specifier:	
Phone I Fax:	|	E-Mail:	
Design:	Concrete - Jun 27, 2024 (1)	Date:	6/29/2024
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.