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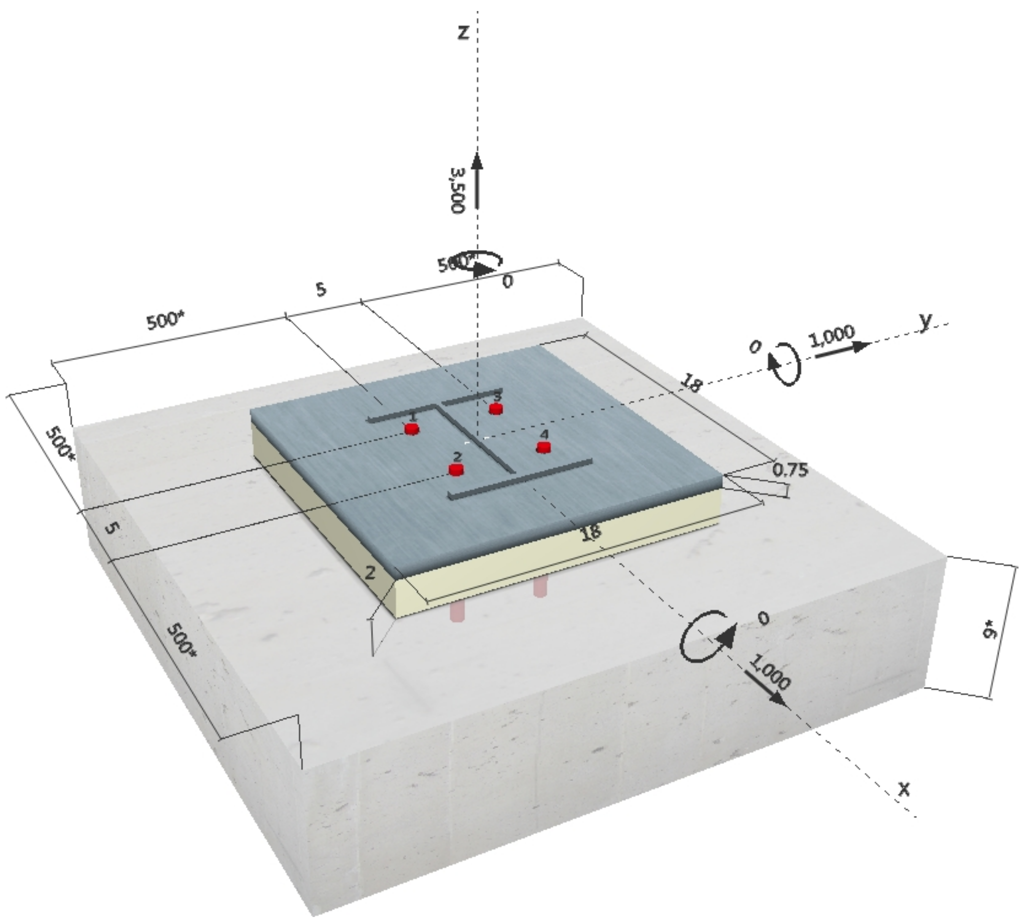
**Specifier's comments:** Anchor design for HILTI HIT-HY 200 system. To be post installed on existing 9" slab.

## 1 Input data


| | |
|---|---|
| **Anchor type and diameter:** | **HIT-HY 200 + HIT-Z-R 3/4** |
| Effective embedment depth: | $h_{ef,act}$ = 6.000 in. ($h_{ef,limit}$ = - in.) |
| Material: | A4 |
| Evaluation Service Report: | ESR-3187 |
| Issued I Valid: | 11/1/2016 \| 3/1/2018 |
| Proof: | Design method ACI 318-14 / Chem |
| Stand-off installation: | without clamping (anchor); restraint level (anchor plate): 2.00; $e_b$ = 2.000 in.; t = 0.750 in. |
| | Hilti Grout: CB-G EG, epoxy, $f_{c,Grout}$ = 14,939 psi |
| Anchor plate: | $l_x$ x $l_y$ x t = 18.000 in. x 18.000 in. x 0.750 in.; (Recommended plate thickness: not calculated |
| Profile: | W shape (AISC); (L x W x T x FT) = 9.730 in. x 7.960 in. x 0.290 in. x 0.435 in. |
| Base material: | uncracked concrete, , $f_c'$ = 3,500 psi; h = 9.000 in., Temp. short/long: 32/32 °F |
| **Installation:** | **automatic cleaned drilled hole, Installation condition: Dry** |
| Reinforcement: | tension: condition B, shear: condition B; no supplemental splitting reinforcement present |
| | edge reinforcement: none or < No. 4 bar |

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



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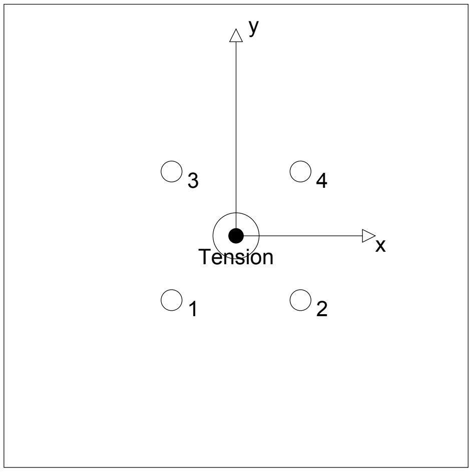
## 2 Load case/Resulting anchor forces

Load case: Design loads

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

| Anchor | Tension force | Shear force | Shear force x | Shear force y |
|---|---|---|---|---|
| 1 | 875 | 354 | 250 | 250 |
| 2 | 875 | 354 | 250 | 250 |
| 3 | 875 | 354 | 250 | 250 |
| 4 | 875 | 354 | 250 | 250 |

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 3,500 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]




## 3 Tension load

| | Load $N_{ua}$ [lb] | Capacity $\phi N_n$ [lb] | Utilization $\beta_N = N_{ua}/\phi N_n$ | Status |
|---|---|---|---|---|
| Steel Strength* | 875 | 20,457 | 5 | OK |
| Pullout Strength* | 875 | 18,499 | 5 | OK |
| Sustained Tension Load Bond Strength* | N/A | N/A | N/A | N/A |
| Concrete Breakout Strength** | 3,500 | 22,146 | 16 | OK |

* anchor having the highest loading **anchor group (anchors in tension)

### 3.1 Steel Strength

$N_{sa}$ = ESR value refer to ICC-ES ESR-3187
$\phi N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

**Variables**

| $A_{se,N}$ [in.$^2$] | $f_{uta}$ [psi] |
|---|---|
| 0.33 | 94,200 |

**Calculations**

| $N_{sa}$ [lb] |
|---|
| 31,472 |

**Results**

| $N_{sa}$ [lb] | $\phi_{steel}$ | $\phi N_{sa}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 31,472 | 0.650 | 20,457 | 875 |

| | | | |
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### 3.2 Pullout Strength

$N_{pn} = N_p \lambda_a$ refer to ICC-ES ESR-3187

$\phi N_{pn} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

**Variables**

| $\lambda_a$ | $N_p$ [lb] |
|---|---|
| 1.000 | 28,460 |

**Calculations**

| - |
|---|
| - |

**Results**

| $N_{pn}$ [lb] | $\phi_{concrete}$ | $\phi N_{pn}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 28,460 | 0.650 | 18,499 | 875 |

### 3.3 Concrete Breakout Strength

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ ACI 318-14 Eq. (17.4.2.1b)

$\phi N_{cbg} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

$A_{Nc}$ see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e_N'}{3 h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c \lambda_a \sqrt{f_c'} h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

**Variables**

| $h_{ef}$ [in.] | $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{a,min}$ [in.] | $\psi_{c,N}$ |
|---|---|---|---|---|
| 6.000 | 0.000 | 0.000 | 500.000 | 1.000 |

| $c_{ac}$ [in.] | $k_c$ | $\lambda_a$ | $f_c'$ [psi] |
|---|---|---|---|
| 19.200 | 24 | 1.000 | 3,500 |

**Calculations**

| $A_{Nc}$ [in.$^2$] | $A_{Nc0}$ [in.$^2$] | $\psi_{ec1,N}$ | $\psi_{ec2,N}$ | $\psi_{ed,N}$ | $\psi_{cp,N}$ | $N_b$ [lb] |
|---|---|---|---|---|---|---|
| 529.00 | 324.00 | 1.000 | 1.000 | 1.000 | 1.000 | 20,868 |

**Results**

| $N_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi N_{cbg}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 34,071 | 0.650 | 22,146 | 3,500 |

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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* | 354 | 9,064 | 4 | OK |
| Steel failure (with lever arm)* | 354 | 1,288 | 28 | OK |
| Pryout Strength (Concrete Breakout Strength controls)** | 1,414 | 47,699 | 3 | OK |
| Concrete edge failure in direction x+** | 1,414 | 428,177 | 1 | OK |

* anchor having the highest loading    **anchor group (relevant anchors)

### 4.1 Steel Strength

$V_{sa} = (0.6\, A_{se,V}\, f_{uta})$    refer to ICC-ES ESR-3187
$\phi\ V_{steel} \geq V_{ua}$    ACI 318-14 Table 17.3.1.1

**Variables**

| $A_{se,V}$ [in.$^2$] | $f_{uta}$ [psi] | $(0.6\, A_{se,V}\, f_{uta})$ [lb] |
|---|---|---|
| 0.33 | 94,200 | 18,883 |

**Calculations**

| $V_{sa}$ [lb] |
|---|
| 18,883 |

**Results**

| $V_{sa}$ [lb] | $\phi_{steel}$ | $\phi_{eb}$ | $\phi\ V_{sa}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|---|
| 18,883 | 0.600 | 0.800 | 9,064 | 354 |

### 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 318-14 Table 17.3.1.1

**Variables**

| $\alpha_M$ | $f_{u,min}$ [psi] | $N_{ua}$ [lb] | $\phi\, N_{sa}$ [lb] | z [in.] | n | $d_0$ [in.] |
|---|---|---|---|---|---|---|
| 2.00 | 94,200 | 875 | 20,457 | 2.375 | 0.500 | 0.750 |

**Calculations**

| $M_s^0$ [in.lb] | $\left(1 - \frac{N_{ua}}{\phi\, N_{sa}}\right)$ | $M_s$ [in.lb] | $L_b$ [in.] |
|---|---|---|---|
| 3,084.534 | 0.957 | 2,952.599 | 2.750 |

**Results**

| $V_s^M$ [lb] | $\phi_{steel}$ | $\phi\, V_s^M$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 2,147 | 0.600 | 1,288 | 354 |

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### 4.3 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 318-14 Eq. (17.5.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

$A_{Nc}$ see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e'_N}{3\, h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\, \lambda_a \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

**Variables**

| $k_{cp}$ | $h_{ef}$ [in.] | $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{a,min}$ [in.] |
|---|---|---|---|---|
| 2 | 6.000 | 0.000 | 0.000 | 500.000 |

| $\psi_{c,N}$ | $c_{ac}$ [in.] | $k_c$ | $\lambda_a$ | $f'_c$ [psi] |
|---|---|---|---|---|
| 1.000 | 19.200 | 24 | 1.000 | 3,500 |

**Calculations**

| $A_{Nc}$ [in.$^2$] | $A_{Nc0}$ [in.$^2$] | $\psi_{ec1,N}$ | $\psi_{ec2,N}$ | $\psi_{ed,N}$ | $\psi_{cp,N}$ | $N_b$ [lb] |
|---|---|---|---|---|---|---|
| 529.00 | 324.00 | 1.000 | 1.000 | 1.000 | 1.000 | 20,868 |

**Results**

| $V_{cpg}$ [lb] | $\phi_{concrete}$ | $\phi\ V_{cpg}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 68,142 | 0.700 | 47,699 | 1,414 |

| | | | |
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**4.4 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 318-14 Eq. (17.5.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ — ACI 318-14 Table 17.3.1.1

$A_{Vc}$ see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ — ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e_V'}{3c_{a1}}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.5.2.5)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-14 Eq. (17.5.2.8)

$V_b = 9\ \lambda_a \sqrt{f_c'}\ c_{a1}^{1.5}$ — ACI 318-14 Eq. (17.5.2.2b)

**Variables**

| $c_{a1}$ [in.] | $c_{a2}$ [in.] | $e_{cV}$ [in.] | $\psi_{c,V}$ | $h_a$ [in.] |
|---|---|---|---|---|
| 333.333 | 500.000 | 0.000 | 1.400 | 9.000 |

| $l_e$ [in.] | $\lambda_a$ | $d_a$ [in.] | $f_c'$ [psi] | $\psi_{parallel,V}$ |
|---|---|---|---|---|
| 6.000 | 1.000 | 0.750 | 3,500 | 1.000 |

**Calculations**

| $A_{Vc}$ [in.$^2$] | $A_{Vc0}$ [in.$^2$] | $\psi_{ec,V}$ | $\psi_{ed,V}$ | $\psi_{h,V}$ | $V_b$ [lb] |
|---|---|---|---|---|---|
| 9,045.00 | 500,000.00 | 1.000 | 1.000 | 7.454 | 3,240,369 |

**Results**

| $V_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi\ V_{cbg}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 611,681 | 0.700 | 428,177 | 1,414 |

## 5 Combined tension and shear loads

| $\beta_N$ | $\beta_V$ | $\zeta$ | Utilization $\beta_{N,V}$ [%] | Status |
|---|---|---|---|---|
| 0.158 | 0.274 | 5/3 | 17 | OK |

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

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## 6 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (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 Anchor calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The fixture thickness may not be feasible for the anchor selected. Check the fixture thickness against the anchor length and effective embedment depth.
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- ACI 318 does not specifically address anchor bending when a stand-off condition exists. PROFIS Anchor calculates a shear load corresponding to anchor bending when stand-off exists and includes the results as a shear Design Strength!
- 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
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-14, Section 17.8.1.

## Fastening meets the design criteria!

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## 7 Installation data

Anchor plate, steel: -
Profile: W shape (AISC); 9.730 x 7.960 x 0.290 x 0.435 in.
Hole diameter in the fixture: $d_f$ = 0.813 in.
Plate thickness (input): 0.750 in.
Recommended plate thickness: not calculated
Drilling method: SafeSet - automatic cleaning
Cleaning: Automatically performed while drilling

Anchor type and diameter: HIT-HY 200 + HIT-Z-R 3/4
Installation torque: 1,327.612 in.lb
Hole diameter in the base material: 0.875 in.
Hole depth in the base material: 6.000 in.
Minimum thickness of the base material: 7.750 in.

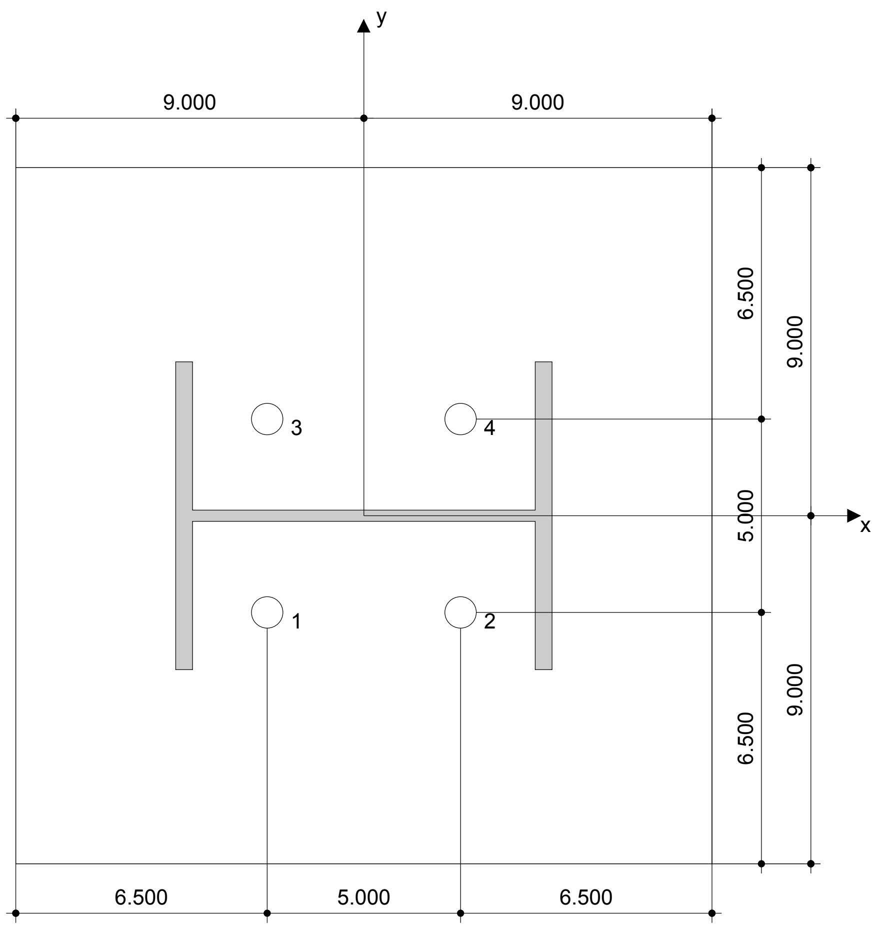
Hilti Safe Set System Hole condition 2 according to ESR 3187: Remove all dust prior to anchor installation!

### 7.1 Recommended accessories

**Drilling**
- Suitable Rotary Hammer
- Properly sized drill bit for SAFEset - automatic cleaning (TE-CD / TE-YD)
- Vacuum cleaner

**Cleaning**
- No accessory required

**Setting**
- Dispenser including cassette and mixer
- Torque wrench




**Coordinates Anchor in.**

| Anchor | x | y | $c_{-x}$ | $c_{+x}$ | $c_{-y}$ | $c_{+y}$ |
|---|---|---|---|---|---|---|
| 1 | -2.500 | -2.500 | 500.000 | 505.000 | 500.000 | 505.000 |
| 2 | 2.500 | -2.500 | 505.000 | 500.000 | 500.000 | 505.000 |
| 3 | -2.500 | 2.500 | 500.000 | 505.000 | 505.000 | 500.000 |
| 4 | 2.500 | 2.500 | 505.000 | 500.000 | 505.000 | 500.000 |

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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.