

Company:  
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Design: Concrete - 9 Nov 2020  
Fastening Point:

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 Specifier:  
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**Specifier's comments:**

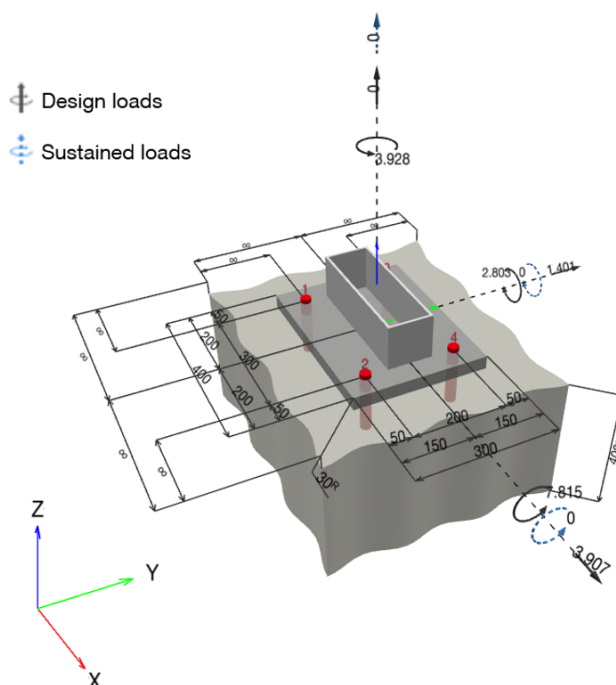
## 1 Input data

|                                        |                                                                                                                                                                                      |                                                                                     |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Anchor type and size:</b>           | <b>HIT-HY 200-A + HAS-U 5.8 HDG M24</b>                                                                                                                                              |  |
| Return period (service life in years): | 50                                                                                                                                                                                   |                                                                                     |
| Item number:                           | 2223908 HAS-U 5.8 HDG M24x300 (insert) /<br>2022696 HIT-HY 200-A (mortar)                                                                                                            |                                                                                     |
| Effective embedment depth:             | $h_{ef,act} = 100.0 \text{ mm}$ ( $h_{ef,limit} = - \text{ mm}$ )                                                                                                                    |                                                                                     |
| Material:                              | 5.8                                                                                                                                                                                  |                                                                                     |
| Approval No.:                          | ETA 11/0493                                                                                                                                                                          |                                                                                     |
| Issued I Valid:                        | 30/08/2019   -                                                                                                                                                                       |                                                                                     |
| Proof:                                 | Design Method EN 1992-4, Chemical                                                                                                                                                    |                                                                                     |
| Stand-off installation:                | $e_b = 0.0 \text{ mm}$ (no stand-off); $t = 30.0 \text{ mm}$                                                                                                                         |                                                                                     |
| Baseplate <sup>R</sup> :               | $l_x \times l_y \times t = 400.0 \text{ mm} \times 300.0 \text{ mm} \times 30.0 \text{ mm}$ ; (Recommended plate thickness: not calculated)                                          |                                                                                     |
| Profile:                               | Rectangular hollow, 300 x 100 x6; ( $L \times W \times T$ ) = 300.0 mm x 100.0 mm x 6.0 mm                                                                                           |                                                                                     |
| Base material:                         | cracked concrete, C35/45, $f_{c,cyl} = 35.00 \text{ N/mm}^2$ ; $h = 400.0 \text{ mm}$ , Temp. short/long: 0/0 °C, partial material safety factor $\gamma_c = 1.500$                  |                                                                                     |
| <b>Installation:</b>                   | <b>hammer drilled hole, Installation condition: Dry</b>                                                                                                                              |                                                                                     |
| Reinforcement:                         | No reinforcement or Reinforcement spacing $\geq 150 \text{ mm}$ (any $\emptyset$ ) or $\geq 100 \text{ mm}$ ( $\emptyset \leq 10 \text{ mm}$ )<br>no longitudinal edge reinforcement |                                                                                     |



<sup>R</sup> - The anchor calculation is based on a rigid baseplate assumption.

### Geometry [mm] & Loading [kN, kNm]



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### 1.1 Load combination

| Case     | Description          | Forces [kN] / Moments [kNm]                                                                                                                                                              | Seismic   | Fire      | Max. Util. Anchor [%] |
|----------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------------------|
| <b>1</b> | <b>Combination 1</b> | <b><math>N = 0.000; V_x = 3.907; V_y = 1.401;</math><br/><math>M_x = 7.815; M_y = 2.803; M_z = 3.928;</math><br/><math>N_{sus} = 0.000; M_{x,sus} = 0.000; M_{y,sus} = 0.000;</math></b> | <b>no</b> | <b>no</b> | <b>74</b>             |
| 2        | Combination 2        | $N = 0.000; V_x = 1.401; V_y = 0.000;$<br>$M_x = 0.000; M_y = 0.000; M_z = 0.000;$<br>$N_{sus} = 0.000; M_{x,sus} = 0.000; M_{y,sus} = 0.000;$                                           | no        | no        | 1                     |

## 2 Load case/Resulting anchor forces

Controlling load case: 1 Combination 1

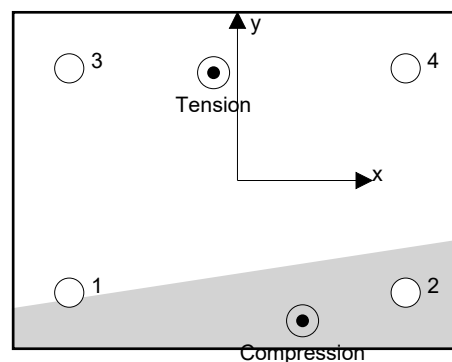
### Anchor reactions [kN]

Tension force: (+Tension, -Compression)

| Anchor | Tension force | Shear force | Shear force x | Shear force y |
|--------|---------------|-------------|---------------|---------------|
| 1      | 0.683         | 5.786       | 3.998         | -4.182        |
| 2      | 0.000         | 6.311       | 3.998         | 4.883         |
| 3      | 19.487        | 4.655       | -2.045        | -4.182        |
| 4      | 15.155        | 5.293       | -2.045        | 4.883         |

max. concrete compressive strain: 0.12 [‰]  
max. concrete compressive stress: 3.67 [N/mm<sup>2</sup>]  
resulting tension force in (x/y)=(-21.3/96.1): 35.324 [kN]  
resulting compression force in (x/y)=(58.1/-125.1): 35.324 [kN]

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



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### 3 Tension load (EN 1992-4, Section 7.2.1)

|                                          | Load [kN] | Capacity [kN] | Utilization $\beta_N$ [%] | Status |
|------------------------------------------|-----------|---------------|---------------------------|--------|
| Steel failure*                           | 19.487    | 117.667       | 17                        | OK     |
| Combined pullout-concrete cone failure** | 35.324    | 75.908        | 47                        | OK     |
| Concrete Breakout failure**              | 35.324    | 47.915        | 74                        | OK     |
| Splitting failure**                      | N/A       | N/A           | N/A                       | N/A    |

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

#### 3.1 Steel failure

$$N_{Ed} \leq N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{M,s}} \quad \text{EN 1992-4, Table 7.1}$$

| $N_{Rk,s}$ [kN] | $\gamma_{M,s}$ | $N_{Rd,s}$ [kN] | $N_{Ed}$ [kN] |
|-----------------|----------------|-----------------|---------------|
| 176.500         | 1.500          | 117.667         | 19.487        |

**3.2 Combined pullout-concrete cone failure**

$$N_{Ed} \leq N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{M,p}} \quad \text{EN 1992-4, Table 7.1}$$

$$N_{Rk,p} = N_{Rk,p}^0 \cdot \frac{A_{p,N}}{A_{p,N}^0} \cdot \psi_{g,Np} \cdot \psi_{s,Np} \cdot \psi_{re,N} \cdot \psi_{ec1,Np} \cdot \psi_{ec2,Np} \quad \text{EN 1992-4, Eq. (7.13)}$$

$$N_{Rk,p}^0 = \psi_{sus} \cdot \tau_{Rk} \cdot \pi \cdot d \cdot h_{ef} \quad \text{EN 1992-4, Eq. (7.14)}$$

$$\psi_{sus} = 1 \quad \text{EN 1992-4, Eq. (7.14a)}$$

$$s_{cr,Np} = 7.3 \cdot d \cdot \sqrt{\psi_{sus} \cdot \tau_{Rk}} \leq 3 \cdot h_{ef} \quad \text{EN 1992-4, Eq. (7.15)}$$

$$\psi_{g,Np} = \psi_{g,Np}^0 \cdot \left( \frac{s}{s_{cr,Np}} \right)^{0.5} \cdot (\psi_{g,Np}^0 - 1) \geq 1.00 \quad \text{EN 1992-4, Eq. (7.17)}$$

$$\psi_{g,Np}^0 = \sqrt{n} - (\sqrt{n} - 1) \cdot \left( \frac{\tau_{Rk}}{\tau_{Rk,c}} \right)^{1.5} \geq 1.00 \quad \text{EN 1992-4, Eq. (7.18)}$$

$$\tau_{Rk,c} = \frac{k_3}{\pi \cdot d} \cdot \sqrt{h_{ef} \cdot f_{ck}} \quad \text{EN 1992-4, Eq. (7.19)}$$

$$\psi_{s,Np} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,Np}} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.20)}$$

$$\psi_{ec1,Np} = \frac{1}{1 + \left( \frac{2 \cdot e_{c1,N}}{s_{cr,Np}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.21)}$$

$$\psi_{ec2,Np} = \frac{1}{1 + \left( \frac{2 \cdot e_{c2,N}}{s_{cr,Np}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.21)}$$

| $A_{p,N}$ [mm <sup>2</sup> ] | $A_{p,N}^0$ [mm <sup>2</sup> ]      | $\tau_{Rk,ucr,20}$ [N/mm <sup>2</sup> ] | $s_{cr,Np}$ [mm]                   | $c_{cr,Np}$ [mm] | $c_{min}$ [mm] | $f_{c,cyl}$ [N/mm <sup>2</sup> ] |
|------------------------------|-------------------------------------|-----------------------------------------|------------------------------------|------------------|----------------|----------------------------------|
| 240,000                      | 90,000                              | 18.00                                   | 300.0                              | 150.0            | ∞              | 35.00                            |
| $\psi_c$                     | $\tau_{Rk,cr}$ [N/mm <sup>2</sup> ] | $k_3$                                   | $\tau_{Rk,c}$ [N/mm <sup>2</sup> ] | $\psi_{g,Np}^0$  | $\psi_{g,Np}$  |                                  |
| 1.063                        | 9.57                                | 7.700                                   | 6.04                               | 1.000            | 1.000          |                                  |
| $e_{c1,N}$ [mm]              | $\psi_{ec1,Np}$                     | $e_{c2,N}$ [mm]                         | $\psi_{ec2,Np}$                    | $\psi_{s,Np}$    | $\psi_{re,Np}$ |                                  |
| 28.7                         | 0.839                               | 62.8                                    | 0.705                              | 1.000            | 1.000          |                                  |
| $\psi_{sus}^0$               | $\alpha_{sus}$                      | $\psi_{sus}$                            |                                    |                  |                |                                  |
| 0.740                        | 0.000                               | 1.000                                   |                                    |                  |                |                                  |
| $N_{Rk,p}^0$ [kN]            | $N_{Rk,p}$ [kN]                     | $\gamma_{M,p}$                          | $N_{Rd,p}$ [kN]                    | $N_{Ed}$ [kN]    |                |                                  |
| 72.167                       | 113.861                             | 1.500                                   | 75.908                             | 35.324           |                |                                  |

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### 3.3 Concrete Breakout failure

$$N_{Ed} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{M,c}} \quad \text{EN 1992-4, Table 7.1}$$

$$N_{Rk,c} = N_{Rk,c}^0 \cdot \frac{A_{c,N}}{A_{c,N}^0} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N} \quad \text{EN 1992-4, Eq. (7.1)}$$

$$N_{Rk,c}^0 = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} \quad \text{EN 1992-4, Eq. (7.2)}$$

$$A_{c,N}^0 = s_{cr,N} \cdot s_{cr,N} \quad \text{EN 1992-4, Eq. (7.3)}$$

$$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.4)}$$

$$\psi_{ec1,N} = \frac{1}{1 + \left( \frac{2 \cdot e_{N,1}}{s_{cr,N}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.6)}$$

$$\psi_{ec2,N} = \frac{1}{1 + \left( \frac{2 \cdot e_{N,2}}{s_{cr,N}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.6)}$$

$$\psi_{M,N} = 1 \quad \text{EN 1992-4, Eq. (7.7)}$$

| $A_{c,N} [\text{mm}^2]$ | $A_{c,N}^0 [\text{mm}^2]$ | $c_{cr,N} [\text{mm}]$ | $s_{cr,N} [\text{mm}]$   | $f_{c,cyl} [\text{N/mm}^2]$ |                        |                      |
|-------------------------|---------------------------|------------------------|--------------------------|-----------------------------|------------------------|----------------------|
| 240,000                 | 90,000                    | 150.0                  | 300.0                    | 35.00                       |                        |                      |
| $e_{c1,N} [\text{mm}]$  | $\psi_{ec1,N}$            | $e_{c2,N} [\text{mm}]$ | $\psi_{ec2,N}$           | $\psi_{s,N}$                | $\psi_{re,N}$          |                      |
| 28.7                    | 0.839                     | 62.8                   | 0.705                    | 1.000                       | 1.000                  |                      |
| $z [\text{mm}]$         | $\psi_{M,N}$              | $k_1$                  | $N_{Rk,c}^0 [\text{kN}]$ | $\gamma_{M,c}$              | $N_{Rd,c} [\text{kN}]$ | $N_{Ed} [\text{kN}]$ |
| 235.0                   | 1.000                     | 7.700                  | 45.554                   | 1.500                       | 47.915                 | 35.324               |

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## 4 Shear load (EN 1992-4, Section 7.2.2)

|                                       | Load [kN] | Capacity [kN] | Utilization $\beta_v$ [%] | Status |
|---------------------------------------|-----------|---------------|---------------------------|--------|
| Steel failure (without lever arm)*    | 6.311     | 70.640        | 9                         | OK     |
| Steel failure (with lever arm)*       | N/A       | N/A           | N/A                       | N/A    |
| Pryout failure*                       | 6.311     | 50.615        | 13                        | OK     |
| Concrete edge failure in direction ** | N/A       | N/A           | N/A                       | N/A    |

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

### 4.1 Steel failure (without lever arm)

$$V_{Ed} \leq V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{M,s}} \quad \text{EN 1992-4, Table 7.2}$$

$$V_{Rk,s} = k_7 \cdot V_{Rk,s}^0 \quad \text{EN 1992-4, Eq. (7.35)}$$

| $V_{Rk,s}^0$ [kN] | $k_7$ | $V_{Rk,s}$ [kN] | $\gamma_{M,s}$ | $V_{Rd,s}$ [kN] | $V_{Ed}$ [kN] |
|-------------------|-------|-----------------|----------------|-----------------|---------------|
| 88.300            | 1.000 | 88.300          | 1.250          | 70.640          | 6.311         |

### 4.2 Pryout failure (concrete cone relevant)

$$V_{Ed} \leq V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{M,c,p}} \quad \text{EN 1992-4, Table 7.2}$$

$$V_{Rk,cp} = k_8 \cdot \min \{N_{Rk,c}; N_{Rk,p}\} \quad \text{EN 1992-4, Eq. (7.39c)}$$

$$N_{Rk,c} = N_{Rk,c}^0 \cdot \frac{A_{c,N}}{A_{c,N}^0} \cdot \psi_{s,N} \cdot \psi_{re,N} \cdot \psi_{ec1,N} \cdot \psi_{ec2,N} \cdot \psi_{M,N} \quad \text{EN 1992-4, Eq. (7.1)}$$

$$N_{Rk,c}^0 = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5} \quad \text{EN 1992-4, Eq. (7.2)}$$

$$A_{c,N}^0 = s_{cr,N} \cdot s_{cr,N} \quad \text{EN 1992-4, Eq. (7.3)}$$

$$\psi_{s,N} = 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.4)}$$

$$\psi_{ec1,N} = \frac{1}{1 + \left( \frac{2 \cdot e_{v,1}}{s_{cr,N}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.6)}$$

$$\psi_{ec2,N} = \frac{1}{1 + \left( \frac{2 \cdot e_{v,2}}{s_{cr,N}} \right)} \leq 1.00 \quad \text{EN 1992-4, Eq. (7.6)}$$

$$\psi_{M,N} = 1 \quad \text{EN 1992-4, Eq. (7.7)}$$

| $A_{c,N}$ [mm <sup>2</sup> ] | $A_{c,N}^0$ [mm <sup>2</sup> ] | $c_{cr,N}$ [mm]  | $s_{cr,N}$ [mm]  | $k_8$         | $f_{c,cyl}$ [N/mm <sup>2</sup> ] |              |
|------------------------------|--------------------------------|------------------|------------------|---------------|----------------------------------|--------------|
| 75,000                       | 90,000                         | 150.0            | 300.0            | 2.000         | 35.00                            |              |
| $e_{c1,V}$ [mm]              | $\psi_{ec1,N}$                 | $e_{c2,V}$ [mm]  | $\psi_{ec2,N}$   | $\psi_{s,N}$  | $\psi_{re,N}$                    | $\psi_{M,N}$ |
| 319.4                        | 0.320                          | 890.8            | 0.144            | 1.000         | 1.000                            | 1.000        |
| $k_1$                        | $N_{Rk,c}^0$ [kN]              | $\gamma_{M,c,p}$ | $V_{Rd,cp}$ [kN] | $V_{Ed}$ [kN] |                                  |              |
| 7.700                        | 45.554                         | 1.500            | 50.615           | 6.311         |                                  |              |

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## 5 Combined tension and shear loads (EN 1992-4, Section 7.2.3)

Steel failure

| $\beta_N$ | $\beta_V$ | $\alpha$ | Utilization $\beta_{N,V}$ [%] | Status |
|-----------|-----------|----------|-------------------------------|--------|
| 0.166     | 0.089     | 2.000    | 4                             | OK     |

$$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$$

Concrete failure

| $\beta_N$ | $\beta_V$ | $\alpha$ | Utilization $\beta_{N,V}$ [%] | Status |
|-----------|-----------|----------|-------------------------------|--------|
| 0.737     | 0.125     | 1.500    | 68                            | OK     |

$$\beta_N^\alpha + \beta_V^\alpha \leq 1.0$$

## 6 Displacements (highest loaded anchor)

Short term loading:

|          |   |             |               |   |             |
|----------|---|-------------|---------------|---|-------------|
| $N_{Sk}$ | = | 11.226 [kN] | $\delta_N$    | = | 0.1042 [mm] |
| $V_{Sk}$ | = | 4.675 [kN]  | $\delta_V$    | = | 0.1402 [mm] |
|          |   |             | $\delta_{NV}$ | = | 0.1747 [mm] |

Long term loading:

|          |   |             |               |   |             |
|----------|---|-------------|---------------|---|-------------|
| $N_{Sk}$ | = | 11.226 [kN] | $\delta_N$    | = | 0.2382 [mm] |
| $V_{Sk}$ | = | 4.675 [kN]  | $\delta_V$    | = | 0.2337 [mm] |
|          |   |             | $\delta_{NV}$ | = | 0.3337 [mm] |

Comments: Tension displacements are valid with half of the required installation torque moment for uncracked concrete! Shear displacements are valid without friction between the concrete and the baseplate! The gap due to the drilled hole and clearance hole tolerances are not included in this calculation!

The acceptable anchor displacements depend on the fastened construction and must be defined by the designer!

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## 7 Warnings

- The anchor design methods in PROFIS Engineering require rigid baseplates per current regulations (AS 5216:2018, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the baseplate are not considered - the baseplate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required baseplate thickness with CBFEM to limit the stress of the baseplate based on the assumptions explained above. The proof if the rigid baseplate 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!
- Checking the transfer of loads into the base material is required in accordance with EN 1992-4, Annex A!
- The design is only valid if the clearance hole in the fixture is not larger than the value given in Table 6.1 of EN 1992-4! For larger diameters of the clearance hole see section 6.2.2 of EN 1992-4!
- The accessory list in this report is for the information of the user only. In any case, the instructions for use provided with the product have to be followed to ensure a proper installation.
- For the determination of the  $\psi_{re,v}$  (concrete edge failure) a concrete cover of the edge reinforcement  $c = 30$  mm is assumed
- Drilled hole cleaning must be performed according to instructions for use (blow twice with oil-free compressed air (min. 6 bar), brush twice, blow twice with oil-free compressed air (min. 6 bar)).
- Characteristic bond resistances depend on short- and long-term temperatures.
- Edge reinforcement is not required to avoid splitting failure
- The characteristic bond resistances depend on the return period (service life in years): 50

## Fastening meets the design criteria!



## 8 Installation data

Baseplate, steel: S 235;  $E = 210,000.00 \text{ N/mm}^2$ ;  $f_{yk} = 235.00 \text{ N/mm}^2$

Profile: Rectangular hollow, 300 x 100 x6; (L x W x T) = 300.0 mm x 100.0 mm x 6.0 mm

Hole diameter in the fixture:  $d_f = 26.0 \text{ mm}$

Plate thickness (input): 30.0 mm

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 size: HIT-HY 200-A + HAS-U 5.8 HDG M24

Item number: 2223908 HAS-U 5.8 HDG M24x300 (insert) / 2022696 HIT-HY 200-A (mortar)

Installation torque: 200 Nm

Hole diameter in the base material: 28.0 mm

Hole depth in the base material: 100.0 mm

Minimum thickness of the base material: 156.0 mm

Hilti HAS-U threaded rod with HIT-HY 200 injection mortar with 100 mm embedment  $h_{ef}$ , M24, Hot dip galvanized, SAFEset Auto cleaning Hammer drilling installation per ETA 11/0493

### 8.1 Recommended accessories

#### Drilling

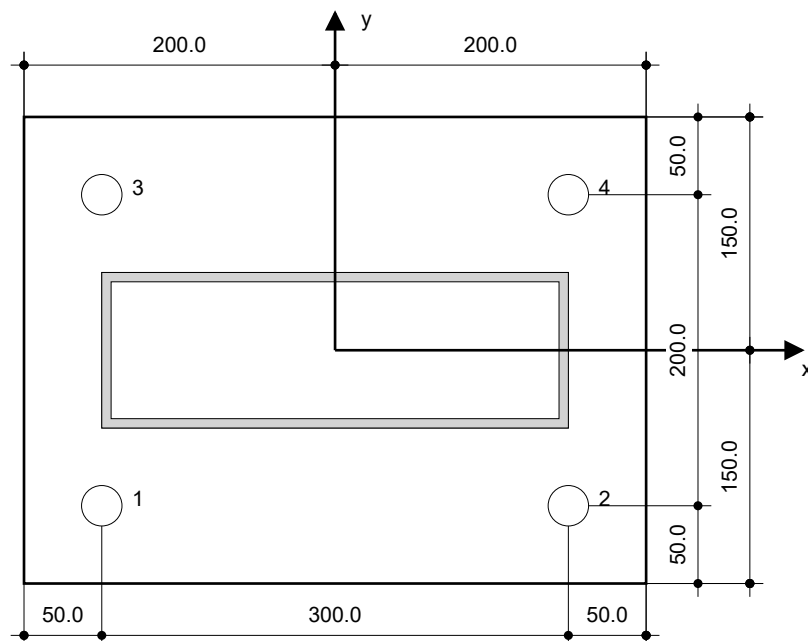
- Suitable Rotary Hammer
- Properly sized drill bit

#### Cleaning

- Compressed air with required accessories to blow from the bottom of the hole
- Proper diameter wire brush

#### Setting

- Dispenser including cassette and mixer
- Torque wrench



#### Coordinates Anchor [mm]

| Anchor | x      | y      | c <sub>-x</sub> | c <sub>+x</sub> | c <sub>-y</sub> | c <sub>+y</sub> |
|--------|--------|--------|-----------------|-----------------|-----------------|-----------------|
| 1      | -150.0 | -100.0 | -               | -               | -               | -               |
| 2      | 150.0  | -100.0 | -               | -               | -               | -               |
| 3      | -150.0 | 100.0  | -               | -               | -               | -               |
| 4      | 150.0  | 100.0  | -               | -               | -               | -               |



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## 9 Remarks; Your Cooperation Duties

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