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| Phone I Fax: | \| | E-Mail: | |
| Design: | Concrete - Aug 11, 2022 | Date: | 2022-08-12 |
| Fastening point: | | | |

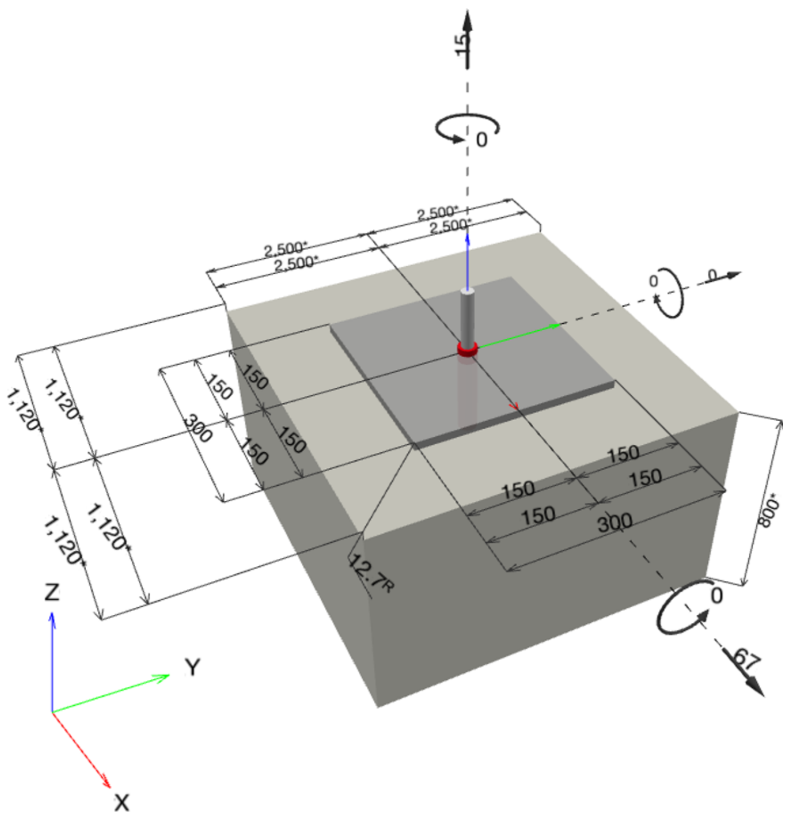
**Specifier's comments:**

# 1 Input data

| | |
|---|---|
| **Anchor type and diameter:** | **Heavy Hex Head ASTM F 1554 GR. 36 1 1/8** |
| Item number: | not available |
| Effective embedment depth: | $h_{ef}$ = 120.0 mm |
| Material: | ASTM F 1554 |
| Evaluation Service Report: | Hilti Technical Data |
| Issued I Valid: | - \| - |
| Proof: | Design Method CSA A23.3-14 / CIP. |
| Stand-off installation: | $e_b$ = 0.0 mm (no stand-off); t = 12.7 mm |
| Anchor plate$^R$ : | $l_x$ x $l_y$ x t = 300.0 mm x 300.0 mm x 12.7 mm; (Recommended plate thickness: not calculated) |
| Profile: | Round bars (AISC), 3/4; (L x W x T) = 19.1 mm x 19.1 mm |
| Base material: | cracked concrete, $f_c'$ = 34.47 N/mm$^2$; h = 800.0 mm |
| Reinforcement: | tension: condition B, shear: condition B; |
| | edge reinforcement: none or < 15M bar |

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

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



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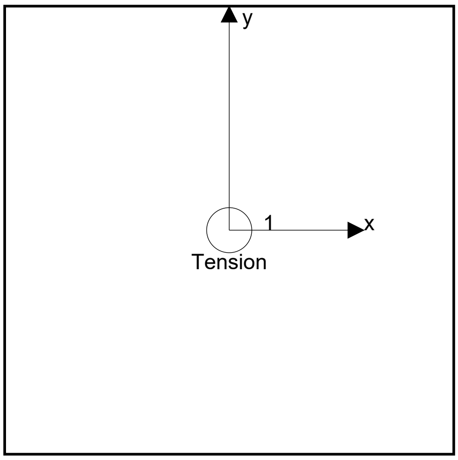
### 1.1 Design results

| Case | Description | Forces [kN] / Moments [kNm] | Seismic | Max. Util. Anchor [%] |
|---|---|---|---|---|
| 1 | Combination 1 | $N = 15.000$; $V_x = 67.000$; $V_y = 0.000$; $M_x = 0.000$; $M_y = 0.000$; $M_z = 0.000$; | no | 96 |

## 2 Load case/Resulting anchor forces




**Anchor reactions [kN]**

Tension force: (+Tension, -Compression)

| Anchor | Tension force | Shear force | Shear force x | Shear force y |
|---|---|---|---|---|
| 1 | 15.000 | 67.000 | 67.000 | 0.000 |

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [N/mm$^2$]
resulting tension force in (x/y)=(0.0/0.0): 15.000 [kN]
resulting compression force in (x/y)=(0.0/0.0): 0.000 [kN]

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

## 3 Tension load

| | Load $N_f$ [kN] | Capacity $N_r$ [kN] | Utilization $\beta_N = N_f/N_r$ | Status |
|---|---|---|---|---|
| Steel Strength* | 15.000 | 133.859 | 12 | OK |
| Pullout Strength* | 15.000 | 214.075 | 8 | OK |
| Concrete Breakout Failure** | 15.000 | 50.168 | 30 | OK |
| Concrete Side-Face Blowout, direction ** | N/A | N/A | N/A | N/A |

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

### 3.1 Steel Strength

$N_{s,uta} = A_{se}\, f_{uta}$

$N_{sar} = A_{se}\, \phi_s\, f_{uta}\, R$ CSA A23.3-14 Eq. D.2

$N_{sar} \geq N_{fa}$ CSA A23.3-14 Table D.1

**Variables**

| n | $A_{se,N}$ [mm$^2$] | $f_{uta}$ [N/mm$^2$] |
|---|---|---|
| 1 | 492 | 399.90 |

**Calculations**

| $N_{s,uta}$ [kN] |
|---|
| 196.852 |

**Results**

| $N_{s,uta}$ [kN] | $\phi_s$ | R | $N_{sar}$ [kN] | $N_{fa}$ [kN] |
|---|---|---|---|---|
| 196.852 | 0.850 | 0.800 | 133.859 | 15.000 |

### 3.2 Pullout Strength

$N_{cpr} = \psi_{c,p} N_{pr}$

$N_{pr} = 8 \cdot A_{brg} \ \phi_c f'_c R$ CSA A23.3-14 Eq. D.16

$N_{cpr} \geq N_{fa}$ CSA A23.3-14 Table D.1

**Variables**

| $f'_c$ [N/mm$^2$] | $\psi_{c,p}$ | $A_{brg}$ [mm$^2$] |
|---|---|---|
| 34.47 | 1.000 | 1,194 |

**Calculations**

| $8 A_{brg} f'_c$ [kN] |
|---|
| 329.346 |

**Results**

| $8 A_{brg} f'_c$ [kN] | $\phi_c$ | R | $N_{pr}$ [kN] | $N_{cpr}$ [kN] | $N_{fa}$ [kN] |
|---|---|---|---|---|---|
| 329.346 | 0.650 | 1.000 | 214.075 | 214.075 | 15.000 |

### 3.3 Concrete Breakout Failure

$N_{cbr} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N} \ \psi_{c,N} \ \psi_{cp,N} \ N_{br}$ CSA A23.3-14 Eq. D.3

$N_{cbr} \geq N_{fa}$ CSA A23.3-14 Table D.1

$A_{Nc}$ see CSA A23.3-14, Part D.6.2.1, Fig. D.7

$A_{Nc0} = 9 \ h_{ef}^2$ CSA A23.3-14 Eq. D.5

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ CSA A23.3-14 Eq. D.11

$\psi_{cp,N} = 1.0$ CSA A23.3-14 D.6.2.7

$N_{br} = k_c \ \phi_c \ \lambda_a \ \sqrt{f'_c} \ h_{ef}^{1.5} \ R$ CSA A23.3-14 Eq. D.6

**Variables**

| $h_{ef}$ [mm] | $c_{a,min}$ [mm] | $\psi_{c,N}$ | $c_{ac}$ [mm] | $k_c$ | $\lambda_a$ | $f'_c$ [N/mm$^2$] |
|---|---|---|---|---|---|---|
| 120.0 | 1,120.0 | 1.000 | - | 10.0 | 1.000 | 34.47 |

**Calculations**

| $A_{Nc}$ [mm$^2$] | $A_{Nc0}$ [mm$^2$] | $\psi_{ed,N}$ | $\psi_{c,N}$ | $\psi_{cp,N}$ |
|---|---|---|---|---|
| 129,600 | 129,600 | 1.000 | 1.000 | 1.000 |

**Results**

| $\phi_c$ | R | $N_{br}$ [kN] | $N_{cbr}$ [kN] | $N_{fa}$ [kN] |
|---|---|---|---|---|
| 0.650 | 1.000 | 50.168 | 50.168 | 15.000 |

## 4 Shear load

| | Load $V_f$ [kN] | Capacity $V_r$ [kN] | Utilization $\beta_V = V_f/V_r$ | Status |
|---|---|---|---|---|
| Steel Strength* | 67.000 | 75.296 | 89 | OK |
| Steel failure (with lever arm)* | N/A | N/A | N/A | N/A |
| Pryout Strength** | 67.000 | 100.337 | 67 | OK |
| Concrete edge failure in direction x+** | 67.000 | 370.175 | 19 | OK |

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

### 4.1 Steel Strength

$V_{sar} = 0.6\ A_{se,V}\ \phi_s\ f_{uta}\ R$ CSA A23.3-14 Eq. D.31
$V_{sar} \geq V_{fa}$ CSA A23.3-14 Table D.1

**Variables**

| n | $A_{se,V}$ [mm$^2$] | $f_{uta}$ [N/mm$^2$] |
|---|---|---|
| 1 | 492 | 399.90 |

**Calculations**

**Results**

| $\phi_s$ | R | $V_{sar}$ [kN] | $V_{fa}$ [kN] |
|---|---|---|---|
| 0.850 | 0.750 | 75.296 | 67.000 |

### 4.2 Pryout Strength

| | |
|---|---|
| $V_{cpr} = k_{cp} \left[ \left( \frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ed,N} \, \psi_{c,N} \, \psi_{cp,N} \, N_{br} \right] R$ | CSA A23.3-14 Eq. D.44 |
| $V_{cpr} \geq V_{fa}$ | CSA A23.3-14 Table D.1 |
| $A_{Nc}$ see CSA A23.3-14, Part D.6.2.1, Fig. D.7 | |
| $A_{Nc0} = 9\, h_{ef}^2$ | CSA A23.3-14 Eq. D.5 |
| $\psi_{ed,N} = 0.7 + 0.3 \left( \frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ | CSA A23.3-14 Eq. D.11 |
| $\psi_{cp,N} = 1.0$ | CSA A23.3-14 D.6.2.7 |
| $N_{br} = k_c \, \phi_c \, \lambda_a \, \sqrt{f'_c} \, h_{ef}^{1.5} \, R$ | CSA A23.3-14 Eq. D.6 |

#### Variables

| $k_{cp}$ | $h_{ef}$ [mm] | $c_{a,min}$ [mm] | $\psi_{c,N}$ |
|---|---|---|---|
| 2 | 120.0 | 1,120.0 | 1.000 |

| $c_{ac}$ [mm] | $k_c$ | $\lambda_a$ | $f'_c$ [N/mm²] |
|---|---|---|---|
| - | 10.0 | 1.000 | 34.47 |

#### Calculations

| $A_{Nc}$ [mm²] | $A_{Nc0}$ [mm²] | $\psi_{ed,N}$ | $\psi_{c,N}$ | $\psi_{cp,N}$ |
|---|---|---|---|---|
| 129,600 | 129,600 | 1.000 | 1.000 | 1.000 |

#### Results

| $\phi_c$ | $N_{br}$ [kN] | $V_{cp}$ [kN] | R | $V_{cpr}$ [kN] | $V_{fa}$ [kN] |
|---|---|---|---|---|---|
| 0.650 | 50.168 | 100.337 | 1.000 | 100.337 | 67.000 |

### 4.3 Concrete edge failure in direction x+

| | |
|---|---|
| $V_{cbr} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{\alpha,V(D.7.2.1(c))}\ V_{br}$ | CSA A23.3-14 Eq. D.32 |
| $V_{cbr} \geq V_{fa}$ | CSA A23.3-14 Table D.1 |
| $A_{Vc}$ see CSA A23.3-14, Part D.7.2.1, Fig. D.13 | |
| $A_{Vc0} = 4.5\ c_{a1}^2$ | CSA A23.3-14 Eq. D.34 |
| $\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ | CSA A23.3-14 Eq. D.41 |
| $\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ | CSA A23.3-14 Eq. D.42 |
| $V_{br} = 3.75\ \lambda_a\ \phi_c\ \sqrt{f'_c}\ c_{a1}^{1.5}\ R$ | CSA A23.3-14 Eq. D.36 |

**Variables**

| $c_{a1}$ [mm] | $c_{a2}$ [mm] | $\psi_{c,V}$ | $h_a$ [mm] | $l_e$ [mm] |
|---|---|---|---|---|
| 1,120.0 | 2,500.0 | 1.000 | 800.0 | 120.0 |

| $\lambda_a$ | $d_a$ [mm] | $f'_c$ [N/mm$^2$] | $\psi_{\alpha,V(D.7.2.1(c))}$ |
|---|---|---|---|
| 1.000 | 28.6 | 34.47 | 1.000 |

**Calculations**

| $A_{Vc}$ [mm$^2$] | $A_{Vc0}$ [mm$^2$] | $\psi_{ed,V}$ | $\psi_{h,V}$ |
|---|---|---|---|
| 2,688,000 | 5,644,800 | 1.000 | 1.449 |

**Results**

| $\phi_c$ | R | $V_{br}$ [kN] | $V_{cbr}$ [kN] | $V_{fa}$ [kN] |
|---|---|---|---|---|
| 0.650 | 1.000 | 536.434 | 370.175 | 67.000 |

## 5 Combined tension and shear loads

| $\beta_N = N_f/N_r$ | $\beta_V = V_f/V_r$ | $\zeta$ | Utilization $\beta_{N,V}$ [%] | Status |
|---|---|---|---|---|
| 0.299 | 0.890 | 5/3 | 96 | OK |

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

## 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 when supplementary reinforcement is used. The R 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.
- Checking the transfer of loads into the base material is required in accordance with CSA A23.3!

**Fastening meets the design criteria!**

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## 7 Installation data

Profile: Round bars (AISC), 3/4; (L x W x T) = 19.1 mm x 19.1 mm

Hole diameter in the fixture: $d_f$ = 30.2 mm

Plate thickness (input): 12.7 mm

Recommended plate thickness: not calculated

Anchor type and diameter: Heavy Hex Head ASTM F 1554 GR. 36 1 1/8

Item number: not available

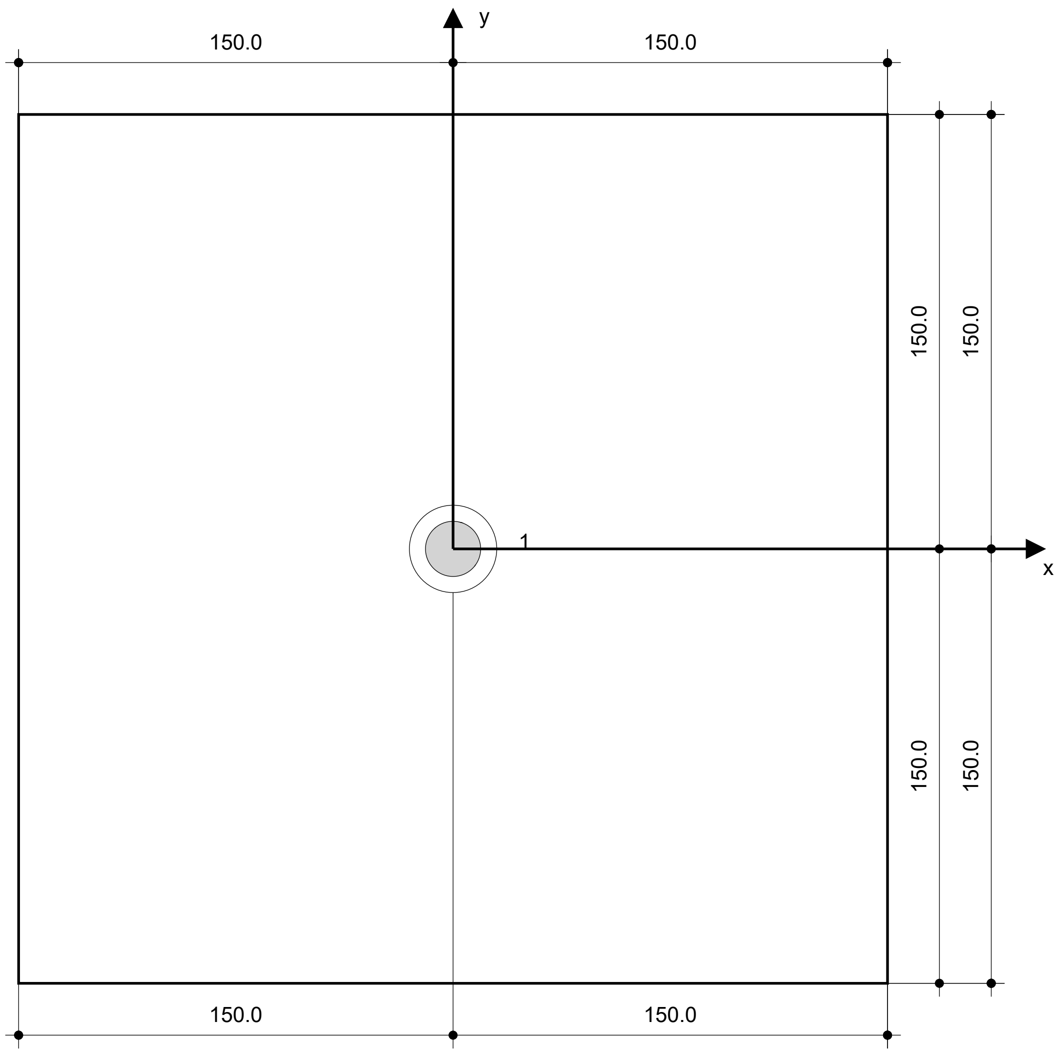
Maximum installation torque: -

Hole diameter in the base material: -

Hole depth in the base material: 120.0 mm

Minimum thickness of the base material: 151.8 mm

Hilti Heavy Hex Head headed stud anchor with 120 mm embedment, 1 1/8, Steel galvanized, installation per instruction for use




**Coordinates Anchor [mm]**

| Anchor | x | y | $c_{-x}$ | $c_{+x}$ | $c_{-y}$ | $c_{+y}$ |
|---|---|---|---|---|---|---|
| 1 | 0.0 | 0.0 | 1,120.0 | 1,120.0 | 2,500.0 | 2,500.0 |

## 8 Remarks; Your Cooperation Duties

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