www.hilti.com

| | | | |
|---|---|---|---|
| Company: | | Page: | 1 |
| Address: | | Specifier: | |
| Phone I Fax: | \| | E-Mail: | |
| Design: | Concrete - Apr 19, 2022 | Date: | 4/19/2022 |
| Fastening point: | | | |

**Specifier's comments:**

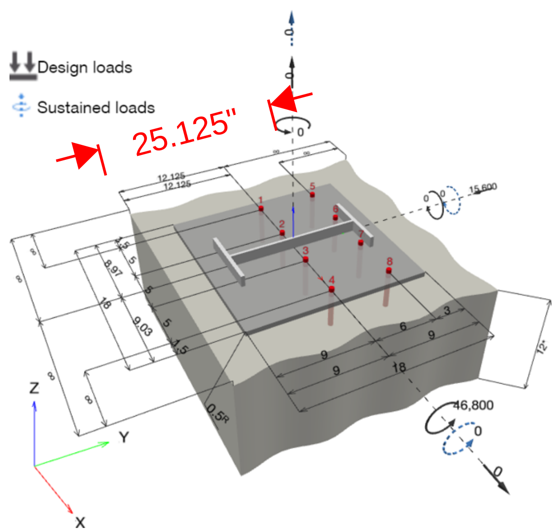
## 1 Input data


| | |
|---|---|
| **Anchor type and diameter:** | **HIT-HY 200 + Rebar A 615 Gr.40 #4** |
| Item number: | not available (element) / 2022791 HIT-HY 200-A (adhesive) |
| Effective embedment depth: | $h_{ef,opti}$ = 3.459 in. ($h_{ef,limit}$ = 10.000 in.) |
| Material: | ASTM A 615 GR.40 |
| Evaluation Service Report: | ESR-3187 |
| Issued I Valid: | 5/1/2021 \| 3/1/2022 |
| Proof: | Design Method ACI 318-14 / Chem |
| Stand-off installation: | $e_b$ = 0.000 in. (no stand-off); t = 0.500 in. |
| Anchor plate$^R$ : | $l_x$ x $l_y$ x t = 18.000 in. x 18.000 in. x 0.500 in.; (Recommended plate thickness: not calculated) |
| Profile: | W shape (AISC), W14X30; (L x W x T x FT) = 13.800 in. x 6.730 in. x 0.270 in. x 0.385 in. |
| Base material: | cracked concrete, 5000, $f_c'$ = 5,000 psi; h = 12.000 in., Temp. short/long: 32/32 °F |
| **Installation:** | **hammer drilled hole, Installation condition: Dry** |
| Reinforcement: | tension: condition B, shear: condition B; no supplemental splitting reinforcement present |
| | edge reinforcement: none or < No. 4 bar |

Note: the HIT-HY 200 + Rebar A 615 Gr.40 anchor is in the process of phase-out. As a result, there is limited/no inventory available.
Application also possible with HIT-HY 200 V3 + Rebar A 615 Gr.40 under the selected boundary conditions.

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

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



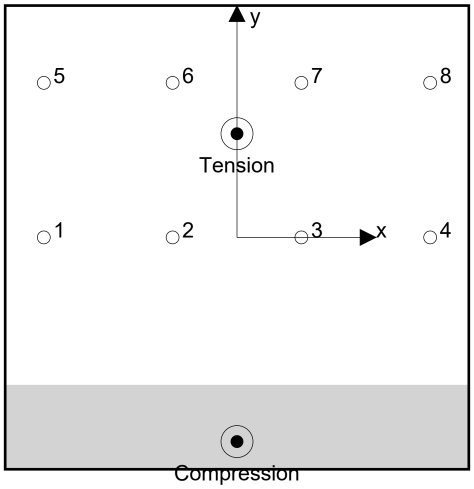
www.hilti.com

| | | | |
|---|---|---|---|
| Company: | | Page: | 2 |
| Address: | | Specifier: | |
| Phone I Fax: | \| | E-Mail: | |
| Design: | Concrete - Apr 19, 2022 | Date: | 4/19/2022 |
| Fastening point: | | | |


### 1.1 Design results

| Case | Description | Forces [lb] / Moments [in.lb] | Seismic | Max. Util. Anchor [%] |
|---|---|---|---|---|
| 1 | Combination 1 | $N = 0$; $V_x = 0$; $V_y = -15{,}600$; $M_x = 46{,}800$; $M_y = 0$; $M_z = 0$; $N_{sus} = 0$; $M_{x,sus} = 0$; $M_{y,sus} = 0$; | no | 100 |

## 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 | 322 | 1,961 | 4 | -1,961 |
| 2 | 322 | 1,954 | 4 | -1,954 |
| 3 | 322 | 1,946 | 4 | -1,946 |
| 4 | 322 | 1,939 | 4 | -1,939 |
| 5 | 657 | 1,961 | -4 | -1,961 |
| 6 | 657 | 1,954 | -4 | -1,954 |
| 7 | 657 | 1,946 | -4 | -1,946 |
| 8 | 657 | 1,939 | -4 | -1,939 |

max. concrete compressive strain: 0.03 [‰]
max. concrete compressive stress: 135 [psi]
resulting tension force in (x/y)=(0.000/4.026): 3,916 [lb]
resulting compression force in (x/y)=(0.000/-7.925): 3,916 [lb]

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

## 3 Tension load

| | Load $N_{ua}$ [lb] | Capacity $\phi$ $N_n$ [lb] | Utilization $\beta_N = N_{ua}/\phi$ $N_n$ | Status |
|---|---|---|---|---|
| Steel Strength* | 657 | 7,800 | 9 | OK |
| Bond Strength** | 3,916 | 11,586 | 34 | OK |
| Sustained Tension Load Bond Strength* | N/A | N/A | N/A | N/A |
| Concrete Breakout Failure** | 3,916 | 16,197 | 25 | OK |

* highest loaded anchor **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] |
|---|---|
| 0.20 | 60,000 |

**Calculations**

| $N_{sa}$ [lb] |
|---|
| 12,000 |

**Results**

| $N_{sa}$ [lb] | $\phi_{steel}$ | $\phi\ N_{sa}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 12,000 | 0.650 | 7,800 | 657 |

### 3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ec1,Na} \psi_{ec2,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba}$ ACI 318-14 Eq. (17.4.5.1b)

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

$A_{Na}$ see ACI 318-14, Section 17.4.5.1, Fig. R 17.4.5.1(b)

$A_{Na0} = (2 c_{Na})^2$ ACI 318-14 Eq. (17.4.5.1c)

$c_{Na} = 10 d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ ACI 318-14 Eq. (17.4.5.1d)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e_N'}{c_{Na}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.5.3)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.5.4b)

$\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.5.5b)

$N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ ACI 318-14 Eq. (17.4.5.2)

**Variables**

| $\tau_{k,c,uncr}$ [psi] | $d_a$ [in.] | $h_{ef}$ [in.] | $c_{a,min}$ [in.] | $\alpha_{overhead}$ | $\tau_{k,c}$ [psi] |
|---|---|---|---|---|---|
| 1,673 | 0.500 | 3.459 | 12.125 | 1.000 | 1,158 |

| $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{ac}$ [in.] | $\lambda_a$ |
|---|---|---|---|
| 0.000 | 1.026 | 5.605 | 1.000 |

**Calculations**

| $c_{Na}$ [in.] | $A_{Na}$ [in.$^2$] | $A_{Na0}$ [in.$^2$] | $\psi_{ed,Na}$ |
|---|---|---|---|
| 6.138 | 498.45 | 150.68 | 1.000 |

| $\psi_{ec1,Na}$ | $\psi_{ec2,Na}$ | $\psi_{cp,Na}$ | $N_{ba}$ [lb] |
|---|---|---|---|
| 1.000 | 0.857 | 1.000 | 6,289 |

**Results**

| $N_{ag}$ [lb] | $\phi_{bond}$ | $\phi N_{ag}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 17,825 | 0.650 | 11,586 | 3,916 |

### 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 318-14 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)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ — 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.] | $\psi_{c,N}$ |
|---|---|---|---|---|
| 3.459 | 0.000 | 1.026 | 12.125 | 1.000 |

| $c_{ac}$ [in.] | $k_c$ | $\lambda_a$ | $f'_c$ [psi] |
|---|---|---|---|
| 5.605 | 17 | 1.000 | 5,000 |

**Calculations**

| $A_{Nc}$ [in.$^2$] | $A_{Nc0}$ [in.$^2$] | $\psi_{ec1,N}$ | $\psi_{ec2,N}$ | $\psi_{ed,N}$ | $\psi_{cp,N}$ | $N_b$ [lb] |
|---|---|---|---|---|---|---|
| 415.56 | 107.66 | 1.000 | 0.835 | 1.000 | 1.000 | 7,732 |

**Results**

| $N_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi\ N_{cbg}$ [lb] | $N_{ua}$ [lb] |
|---|---|---|---|
| 24,918 | 0.650 | 16,197 | 3,916 |

## 4 Shear load

| | Load $V_{ua}$ [lb] | Capacity $\phi V_n$ [lb] | Utilization $\beta_V = V_{ua}/\phi V_n$ | Status |
|---|---|---|---|---|
| Steel Strength* | 1,961 | 4,320 | 46 | OK |
| Steel failure (with lever arm)* | N/A | N/A | N/A | N/A |
| Pryout Strength (Bond Strength controls)** | 15,600 | 28,983 | 54 | OK |
| Concrete edge failure in direction y-** | 15,600 | 17,449 | 90 | OK |

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

### 4.1 Steel Strength

$V_{sa}$ = ESR value 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] |
|---|---|
| 0.20 | 60,000 |

**Calculations**

| $V_{sa}$ [lb] |
|---|
| 7,200 |

**Results**

| $V_{sa}$ [lb] | $\phi_{steel}$ | $\phi V_{sa}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 7,200 | 0.600 | 4,320 | 1,961 |

### 4.2 Pryout Strength (Bond Strength controls)

| | |
|---|---|
| $V_{cpg} = k_{cp}\left[\left(\frac{A_{Na}}{A_{Na0}}\right)\psi_{ec1,Na}\ \psi_{ec2,Na}\ \psi_{ed,Na}\ \psi_{cp,Na}\ N_{ba}\right]$ | ACI 318-14 Eq. (17.5.3.1b) |
| $\phi\ V_{cpg} \geq V_{ua}$ | ACI 318-14 Table 17.3.1.1 |
| $A_{Na}$ see ACI 318-14, Section 17.4.5.1, Fig. R 17.4.5.1(b) | |
| $A_{Na0} = (2\ c_{Na})^2$ | ACI 318-14 Eq. (17.4.5.1c) |
| $c_{Na} = 10\ d_a \sqrt{\frac{\tau_{uncr}}{1100}}$ | ACI 318-14 Eq. (17.4.5.1d) |
| $\psi_{ec,Na} = \left(\frac{1}{1 + \frac{e'_N}{c_{Na}}}\right) \leq 1.0$ | ACI 318-14 Eq. (17.4.5.3) |
| $\psi_{ed,Na} = 0.7 + 0.3\left(\frac{c_{a,min}}{c_{Na}}\right) \leq 1.0$ | ACI 318-14 Eq. (17.4.5.4b) |
| $\psi_{cp,Na} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{Na}}{c_{ac}}\right) \leq 1.0$ | ACI 318-14 Eq. (17.4.5.5b) |
| $N_{ba} = \lambda_a \cdot \tau_{k,c} \cdot \pi \cdot d_a \cdot h_{ef}$ | ACI 318-14 Eq. (17.4.5.2) |

**Variables**

| $k_{cp}$ | $\alpha_{overhead}$ | $\tau_{k,c,uncr}$ [psi] | $d_a$ [in.] | $h_{ef}$ [in.] | $c_{a,min}$ [in.] | $\tau_{k,c}$ [psi] |
|---|---|---|---|---|---|---|
| 2 | 1.000 | 1,673 | 0.500 | 3.459 | 12.125 | 1,158 |

| $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{ac}$ [in.] | $\lambda_a$ |
|---|---|---|---|
| 0.030 | 0.000 | 5.605 | 1.000 |

**Calculations**

| $c_{Na}$ [in.] | $A_{Na}$ [in.$^2$] | $A_{Na0}$ [in.$^2$] | $\psi_{ed,Na}$ |
|---|---|---|---|
| 6.138 | 498.45 | 150.68 | 1.000 |

| $\psi_{ec1,Na}$ | $\psi_{ec2,Na}$ | $\psi_{cp,Na}$ | $N_{ba}$ [lb] |
|---|---|---|---|
| 0.995 | 1.000 | 1.000 | 6,289 |

**Results**

| $V_{cpg}$ [lb] | $\phi_{concrete}$ | $\phi\ V_{cpg}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 41,404 | 0.700 | 28,983 | 15,600 |

### 4.3 Concrete edge failure in direction y-

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

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a\ \sqrt{f_c'}\ c_{a1}^{1.5}$ ACI 318-14 Eq. (17.5.2.2a)

**Variables**

| $c_{a1}$ [in.] | $c_{a2}$ [in.] | $e_{cV}$ [in.] | $\psi_{c,V}$ | $h_a$ [in.] |
|---|---|---|---|---|
| 12.125 | - | 0.023 | 1.000 | 12.000 |

| $l_e$ [in.] | $\lambda_a$ | $d_a$ [in.] | $f_c'$ [psi] | $\psi_{parallel,V}$ |
|---|---|---|---|---|
| 3.459 | 1.000 | 0.500 | 5,000 | 1.000 |

**Calculations**

| $A_{Vc}$ [in.$^2$] | $A_{Vc0}$ [in.$^2$] | $\psi_{ec,V}$ | $\psi_{ed,V}$ | $\psi_{h,V}$ | $V_b$ [lb] |
|---|---|---|---|---|---|
| 616.50 | 661.57 | 0.999 | 1.000 | 1.231 | 21,756 |

**Results**

| $V_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi\ V_{cbg}$ [lb] | $V_{ua}$ [lb] |
|---|---|---|---|
| 24,927 | 0.700 | 17,449 | 15,600 |

REMOVING 4 OF THE ANCHORS BUT LEAVING THE REST IN EXACTLY THE SAME POSITION HELPED THE CAPACITY IMMENSLY

## 5 Combined tension and shear loads

| $\beta_N$ | $\beta_V$ | $\zeta$ | Utilization $\beta_{N,V}$ [%] | Status |
|---|---|---|---|---|
| 0.338 | 0.894 | 5/3 | 100 | 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 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 318-14, Section 17.8.1.

## Fastening meets the design criteria!

# 7 Installation data

Anchor type and diameter: HIT-HY 200 + Rebar A 615 Gr.40 #4

Item number: not available (element) / 2022791 HIT-HY 200-A (adhesive)

Maximum installation torque: -

Hole diameter in the base material: 0.625 in.

Hole depth in the base material: 3.459 in.

Minimum thickness of the base material: 4.709 in.

Profile: W shape (AISC), W14X30; (L x W x T x FT) = 13.800 in. x 6.730 in. x 0.270 in. x 0.385 in.

Hole diameter in the fixture: $d_f$ = 0.500 in.

Plate thickness (input): 0.500 in.

Recommended plate thickness: not calculated

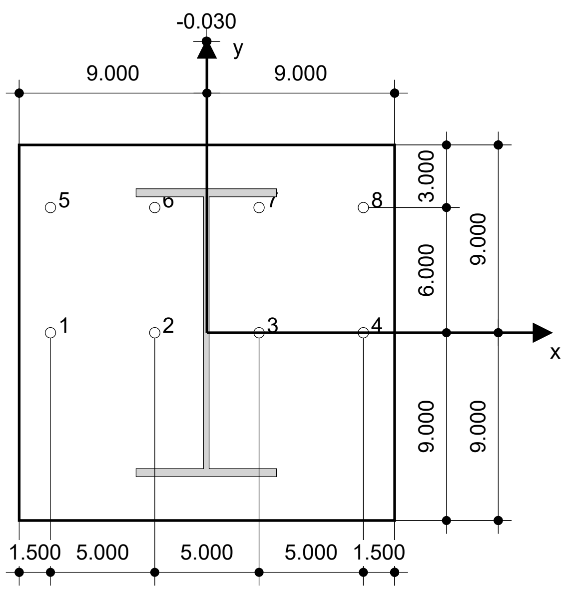
Drilling method: Hammer drilled

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

#4 Rebar with Hilti HIT-HY 200 Safe Set System

### 7.1 Recommended accessories

| Drilling | Cleaning | Setting |
|---|---|---|
| • Suitable Rotary Hammer<br>• Properly sized drill bit | • Compressed air with required accessories to blow from the bottom of the hole<br>• Proper diameter wire brush | • Dispenser including cassette and mixer<br>• For deep installations, a piston plug is necessary<br>• Torque wrench |




**Coordinates Anchor [in.]**

| Anchor | x | y | $c_{-x}$ | $c_{+x}$ | $c_{-y}$ | $c_{+y}$ |
|---|---|---|---|---|---|---|
| 1 | -7.500 | 0.000 | - | - | 12.125 | - |
| 2 | -2.500 | 0.000 | - | - | 12.125 | - |
| 3 | 2.500 | 0.000 | - | - | 12.125 | - |
| 4 | 7.500 | 0.000 | - | - | 12.125 | - |

| Anchor | x | y | $c_{-x}$ | $c_{+x}$ | $c_{-y}$ | $c_{+y}$ |
|---|---|---|---|---|---|---|
| 5 | -7.500 | 6.000 | - | - | 18.125 | - |
| 6 | -2.500 | 6.000 | - | - | 18.125 | - |
| 7 | 2.500 | 6.000 | - | - | 18.125 | - |
| 8 | 7.500 | 6.000 | - | - | 18.125 | - |

## 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.