Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

# European Technical Assessment ETA-11/0493 of 15 April 2015

English translation prepared by DIBt - Original version in German language

**General Part**

| | |
|---|---|
| Technical Assessment Body issuing the European Technical Assessment: | Deutsches Institut für Bautechnik |
| Trade name of the construction product | Injection system Hilti HIT-HY 200-A |
| Product family<br>to which the construction product belongs | Bonded anchor with threaded rods, rebar, internal threaded sleeves and Hilti tension anchor HZA for use in concrete |
| Manufacturer | Hilti Aktiengesellschaft<br>9494 SCHAAN<br>FÜRSTENTUM LIECHTENSTEIN |
| Manufacturing plant | Hilti Werke |
| This European Technical Assessment contains | 33 pages including 3 annexes |
| This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of | Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 5: "Bonded anchors", April 2013,<br>used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011. |

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission according to Article 25 Paragraph 3 of Regulation (EU) No 305/2011.

## Specific Part

### 1 Technical description of the product

The Injection system Hilti HIT-HY 200-A is a bonded anchor consisting of a foil pack with injection mortar Hilti HIT-HY 200-A and a steel element. The steel element consist of

- a threaded rod HIT-V or a commercial threaded rod with washer and hexagon nut in the range of M8 to M30 or
- an internal threaded sleeve HIS-(R)N in the range of M8 to M20 or
- Hilti tension anchor HZA M12 to M27
- Hilti tension anchor HZA-R M12 to M24 or
- Reinforcing bar (rebar) of sizes $\phi$ = 8 to 32 mm.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

### 2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

### 3 Performance of the product and references to the methods used for its assessment

### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic | Performance |
|---|---|
| Characteristic resistance under static and quasi-static action for design according to TR 029, displacements | See Annex C1 to C12 |
| Characteristic resistance for seismic performance category C1 for design according to TR 045, displacements | See Annex C13 to C15 |

### 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Anchorages satisfy requirements for Class A1 |
| Resistance to fire | No performance determined (NPD) |

### 3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

### 3.4 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

### 3.5 Protection against noise (BWR 5)

Not applicable.

### 3.6 Energy economy and heat retention (BWR 6)

Not applicable.

### 3.7 Sustainable use of natural resources (BWR 7)

The sustainable use of natural resources was not investigated.

### 3.8 General aspects

The verification of durability is part of testing the essential characteristics. Durability is only ensured if the specifications of intended use according to Annex B are taken into account.

## 4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

According to Decision of the Commission of 24 June 1996 (96/582/EC) (OJ L 254 of 08.10.96 p. 62-65), the system of assessment and verification of constancy of performance (see Annex V and Article 65 Paragraph 2 to Regulation (EU) No 305/2011) given in the following table applies.

| Product | Intended use | Level or class | System |
|---|---|---|---|
| Metal anchors for use in concrete (heavy-duty type) | For fixing and/or supporting concrete structural elements or heavy units such as cladding and suspended ceilings | — | 1 |

## 5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 15 April 2015 by Deutsches Institut für Bautechnik

Uwe Bender
Head of Department

*beglaubigt:*
Lange

## Installed condition

**Figure A1:**
**Threaded rod and HIT-V-…**

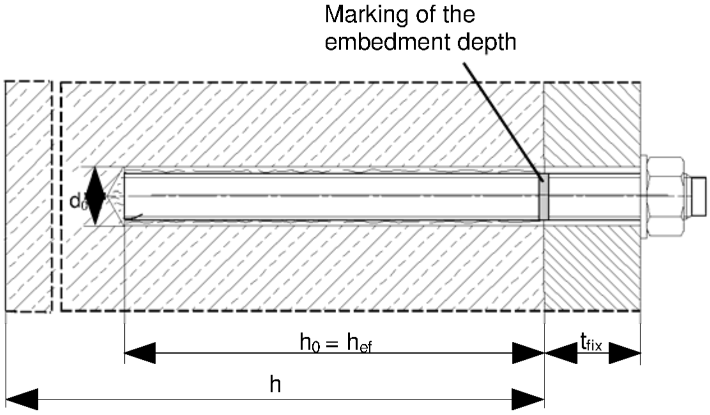



**Figure A2:**
**Internally threaded sleeve HIS-(R)N**

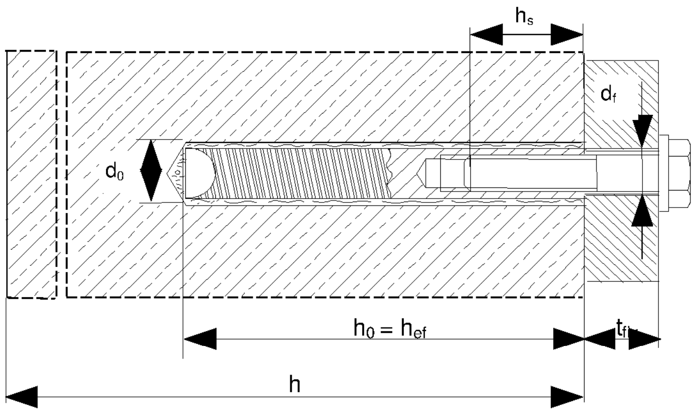
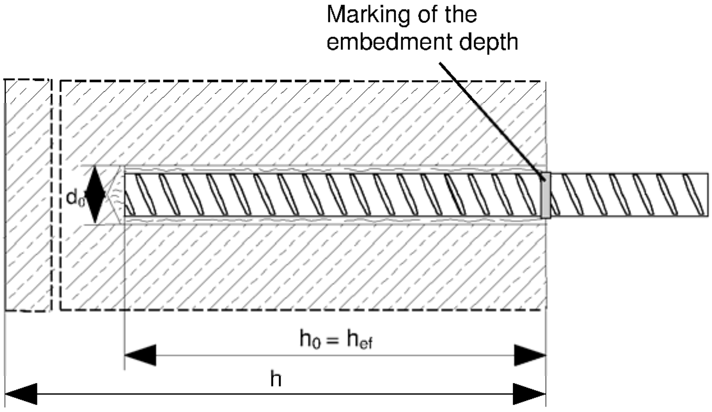



**Figure A3:**
**Reinforcing bar**




| | |
|---|---|
| **Injection System Hilti HIT-HY 200-A** | **Annex A1** |
| **Product description**<br>Installed condition | |

Deutsches Institut für Bautechnik DIBt

## Product description: Injection mortar and steel elements

**Injection mortar Hilti HIT-HY 200-A:** hybrid system with aggregate

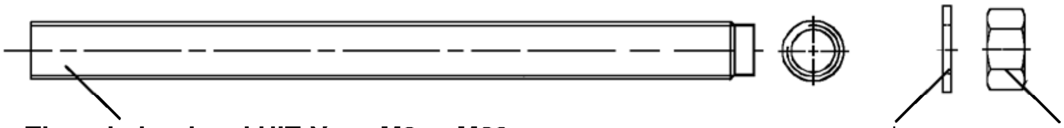
**330 ml and 500 ml**

Marking:
HILTI-HIT
Production number and production line
Expiry date mm/yyyy


Product name: "Hilti HIT-HY 200-A"

**Static mixer Hilti HIT-RE-M**

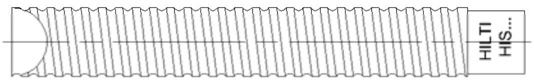
**Steel elements**



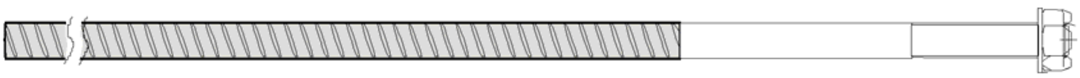
**Threaded rod and HIT-V-...: M8 to M30** washer nut

Commercial standard threaded rod:

- Materials and mechanical properties according to Table A1.
- Inspection certificate 3.1 according to EN 10204:2004. The document shall be stored.
- Marking of embedment depth.




**Internally threaded sleeve: HIS-(R)N M8 to M20**



**Hilti Tension Anchor: HZA M12 to M27 and HZA-R M12 to M24**

**Reinforcing bar (rebar): ϕ 8 to ϕ 32**

- Materials and mechanical properties according to Table A1
- Dimensions according to Annex B6

| Injection System Hilti HIT-HY 200-A | Annex A2 |
|---|---|
| **Product description**<br>Injection mortar / Static mixer / Steel elements | |

## Table A1: Materials

| Designation | Material |
|---|---|
| **Reinforcing bars** | |
| Rebar: EN 1992-1-1: 2004 and AC:2010, Annex C | Bars and de-coiled rods class B or C<br>with $f_{yk}$ and k according to NDP or NCL of EN 1992-1-1/NA:2013<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ |
| **Metal parts made of zinc coated steel** | |
| Threaded rod, HIT-V-5.8(F) | Strength class 5.8, $f_{uk}$ = 500 N/mm², $f_{yk}$ = 400 N/mm²,<br>Elongation at fracture ($l_0$=5d) > 8% ductile<br>Electroplated zinc coated ≥ 5 µm, (F) hot dip galvanized ≥ 45 µm |
| Threaded rod, HIT-V-8.8(F) | Strength class 8.8, $f_{uk}$ = 800 N/mm², $f_{yk}$ = 640 N/mm²,<br>Elongation at fracture ($l_0$=5d) > 8% ductile<br>Electroplated zinc coated ≥ 5 µm, (F) hot dip galvanized ≥ 45 µm |
| Hilti tension anchor HZA | Round steel with threaded part: electroplated zinc coated ≥ 5 µm<br>Rebar: Bars class B according to NDP or NCL of EN 1992-1-1/NA:2013 |
| Internally threaded sleeve HIS-N | Electroplated zinc coated ≥ 5 µm |
| Washer | Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 45 µm |
| Nut | Strength class of nut adapted to strength class of threaded rod<br>Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 45 µm |
| **Metal parts made of stainless steel** | |
| Threaded rod, HIT-V-R | For ≤ M24: strength class 70, $f_{uk}$ = 700 N/mm², $f_{yk}$ = 450 N/mm²;<br>For > M24: strength class 50, $f_{uk}$ = 500 N/mm², $f_{yk}$ = 210 N/mm²;<br>Elongation at fracture ($l_0$=5d) > 8% ductile<br>Stainless steel 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362 EN 10088-1:2014 |
| Hilti tension anchor HZA-R | Round steel with threaded part:<br>Stainless steel 1.4404, 1.4362, 1.4571 EN 10088-1:2014<br>Rebar: Bars class B according to NDP or NCL of EN 1992-1-1/NA:2013 |
| Internally threaded sleeve HIS-RN | Stainless steel 1.4401, 1.4571 EN 10088-1:2014 |
| Washer | Stainless steel 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362 EN 10088-1:2014 |
| Nut | Strength class of nut adapted to strength class of threaded rod<br>Stainless steel 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362 EN 10088-1:2014 |
| **Metal parts made of high corrosion resistant steel** | |
| Threaded rod HIT-V-HCR | For ≤ M20: $f_{uk}$ = 800 N/mm², $f_{yk}$ = 640 N/mm²,<br>For > M20: $f_{uk}$ = 700 N/mm², $f_{yk}$ = 400 N/mm²,<br>Elongation at fracture ($l_0$=5d) > 8% ductile<br>High corrosion resistant steel 1.4529, 1.4565 EN 10088-1:2014 |
| Washer | High corrosion resistant steel 1.4529, 1.4565 EN 10088-1:2014 |
| Nut | Strength class of nut adapted to strength class of threaded rod<br>High corrosion resistant steel 1.4529, 1.4565 EN 10088-1:2014 |

## Specifications of intended use

**Anchorages subject to:**
- Static and quasi static loading
- Seismic performance category C1: HIT-V, rebar, HZA-R, (not HIS-N)

**Base material:**
- Reinforced or unreinforced normal weight concrete according to EN 206:2013.
- Strength classes C20/25 to C50/60 according to EN 206:2013.
- Cracked and non-cracked concrete.

**Temperature in the base material:**
- **at installation**
  -10 °C to +40 °C
- **in-service**
  Temperature range I: -40 °C to +40 °C
  (max. long term temperature +24 °C and max. short time temperature +40 °C)
  Temperature range II: -40 °C to +80 °C
  (max. long term temperature +50 °C and max. short time temperature +80 °C)
  Temperature range III: -40 °C to +120 °C
  (max. long term temperature +72 °C and max. short time temperature +120 °C)

### Table B1: Specifications of intended use

| | HIT-HY 200-A with ... | | | |
|---|---|---|---|---|
| Elements | HIT-V ... | Rebar | HZA(-R) | HIS-(R)N |
| Hammer drilling with hollow drill bit TE-CD or TE-YD | ✓ | ✓ | ✓ | ✓ |
| Hammer drilling | ✓ | ✓ | ✓ | ✓ |
| Static and quasi static loading in cracked and non-cracked concrete | M8 to M30 | $\phi$ 8 to $\phi$ 32 | M12 to M27 | M8 to M20 |
| Seismic performance category C1 | M10 to M30 | $\phi$ 10 to $\phi$ 32 | M12 to M27 | - |

**Injection System Hilti HIT-HY 200-A**

**Intended Use**
Specifications

**Annex B1**

**Use conditions (Environmental conditions):**

- Structures subject to dry internal conditions
  (zinc coated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal conditions, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal conditions, if other particular aggressive conditions exist
  (high corrosion resistant steel).
  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing products are used).

**Design:**

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages under static or quasi-static loading are designed in accordance with:
  "EOTA Technical Report TR 029, Edition September 2010"
- Anchorages under seismic actions (cracked concrete) are designed in accordance with:
  "EOTA Technical Report TR 045, Edition February 2013"
  Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure. Fastenings in stand-off installation or with a grout layer under seismic action are not covered in this European technical assessment (ETA).

**Installation:**

- Use category: dry or wet concrete (not in flooded holes)
- Overhead installation is admissible
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

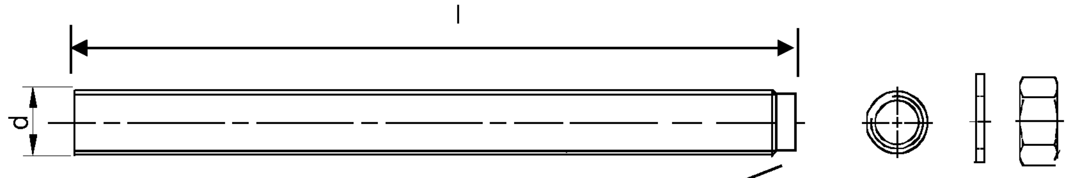
| **Injection System Hilti HIT-HY 200-A** | **Annex B2** |
|---|---|
| **Intended Use**<br>Specifications | |

## Table B2: Installation parameters of threaded rod and HIT-V-…

| **Threaded rod and HIT-V-…** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of element | d | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 27 | 30 |
| Nominal diameter of drill bit | $d_0$ | [mm] | 10 | 12 | 14 | 18 | 22 | 28 | 30 | 35 |
| Effective embedment depth and drill hole depth | $h_{ef} = h_0$ | [mm] | 60 to 160 | 60 to 200 | 70 to 240 | 80 to 320 | 90 to 400 | 96 to 480 | 108 to 540 | 120 to 600 |
| Maximum diameter of clearance hole in the fixture [1)] | $d_f$ | [mm] | 9 | 12 | 14 | 18 | 22 | 26 | 30 | 33 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $h_{ef} + 30$ $\geq 100$ mm | | | $h_{ef} + 2 \cdot d_0$ | | | | |
| Maximum torque moment | $T_{max}$ | [Nm] | 10 | 20 | 40 | 80 | 150 | 200 | 270 | 300 |
| Minimum spacing | $s_{min}$ | [mm] | 40 | 50 | 60 | 75 | 90 | 115 | 120 | 140 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 45 | 45 | 50 | 55 | 60 | 75 | 80 |

[1)] for larger clearance hole see "TR 029 section 1.1"

**HIT-V-…**




**Marking:**

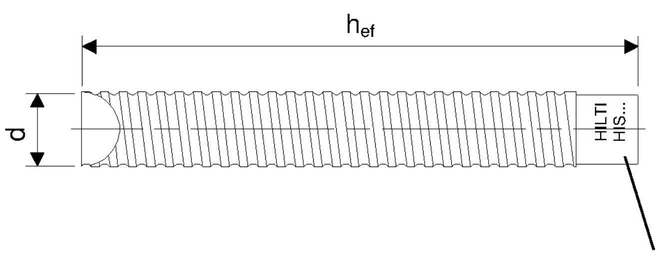
5.8 - l = HIT-V-5.8 M…x l
5.8F - l = HIT-V-5.8F M…x l
8.8 - l = HIT-V-8.8 M…x l
8.8F - l = HIT-V-8.8F M…x l
R - l = HIT-V-R M …x l
HCR - l = HIT-V-HCR M …x l

## Table B3: Installation parameters of internally threaded sleeve HIS-(R)N

| **Internally threaded sleeve HIS-(R)N…** | | | **M8** | **M10** | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|---|---|
| Outer diameter of sleeve | $d$ | [mm] | 12,5 | 16,5 | 20,5 | 25,4 | 27,6 |
| Nominal diameter of drill bit | $d_0$ | [mm] | 14 | 18 | 22 | 28 | 32 |
| Effective embedment depth and drill hole depth | $h_{ef} = h_0$ | [mm] | 90 | 110 | 125 | 170 | 205 |
| Maximum diameter of clearance hole in the fixture [1)] | $d_f$ | [mm] | 9 | 12 | 14 | 18 | 22 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | 120 | 150 | 170 | 230 | 270 |
| Maximum torque moment | $T_{max}$ | [Nm] | 10 | 20 | 40 | 80 | 150 |
| Thread engagement length min-max | $h_s$ | [mm] | 8-20 | 10-25 | 12-30 | 16-40 | 20-50 |
| Minimum spacing | $s_{min}$ | [mm] | 60 | 75 | 90 | 115 | 130 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 45 | 55 | 65 | 90 |

[1)] for larger clearance hole see “TR 029 section 1.1”

**Internally threaded sleeve HIS-(R)N…**




**Marking:**
Identifying mark - HILTI and
embossing "HIS-N" (for C-steel)
embossing "HIS-RN" (for stainless steel)

## Table B4: Installation parameters of Hilti tension anchor HZA-R

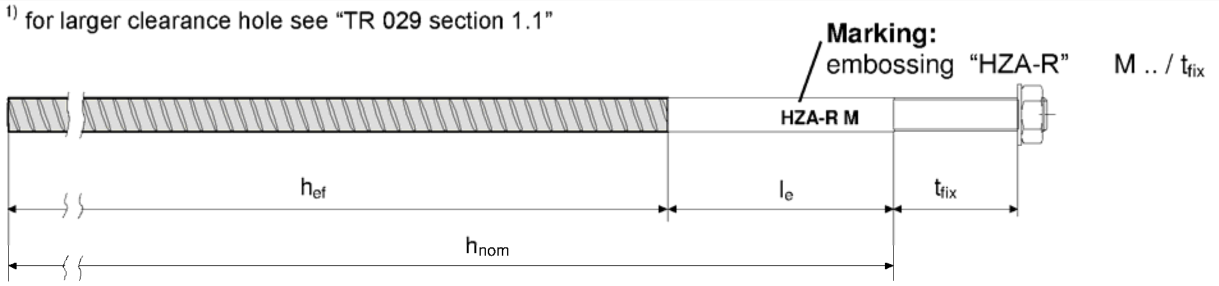
| Hilti tension anchor HZA-R … | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| Rebar diameter | $\phi$ | [mm] | 12 | 16 | 20 | 25 |
| Nominal embedment depth and drill hole depth | $h_{nom} = h_0$ | [mm] | 170 to 240 | 180 to 320 | 190 to 400 | 200 to 500 |
| Effective embedment depth ($h_{ef} = h_{nom} - l_e$) | $h_{ef}$ | [mm] | $h_{nom} - 100$ | | | |
| Length of smooth shaft | $l_e$ | [mm] | 100 | | | |
| Nominal diameter of drill bit | $d_0$ | [mm] | 16 | 20 | 25 | 32 |
| Maximum diameter of clearance hole in the fixture [1)] | $d_f$ | [mm] | 14 | 18 | 22 | 26 |
| Maximum torque moment | $T_{max}$ | [Nm] | 40 | 80 | 150 | 200 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $h_{nom} + 2 \cdot d_0$ | | | |
| Minimum spacing | $s_{min}$ | [mm] | 65 | 80 | 100 | 130 |
| Minimum edge distance | $c_{min}$ | [mm] | 45 | 50 | 55 | 60 |

[1)] for larger clearance hole see "TR 029 section 1.1"

## Table B5: Installation parameters of Hilti tension anchor HZA

| Hilti tension anchor HZA… | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| Rebar diameter | $\phi$ | [mm] | 12 | 16 | 20 | 25 | 28 |
| Nominal embedment depth and drill hole depth | $h_{nom} = h_0$ | [mm] | 90 to 240 | 100 to 320 | 110 to 400 | 120 to 500 | 140 to 560 |
| Effective embedment depth ($h_{ef} = h_{nom} - l_e$) | $h_{ef}$ | [mm] | $h_{nom} - 20$ | | | | |
| Length of smooth shaft | $l_e$ | [mm] | 20 | | | | |
| Nominal diameter of drill bit | $d_0$ | [mm] | 16 | 20 | 25 | 32 | 35 |
| Maximum diameter of clearance hole in the fixture [1)] | $d_f$ | [mm] | 14 | 18 | 22 | 26 | 30 |
| Maximum torque moment | $T_{max}$ | [Nm] | 40 | 80 | 150 | 200 | 270 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $h_{nom} + 2 \cdot d_0$ | | | | |
| Minimum spacing | $s_{min}$ | [mm] | 65 | 80 | 100 | 130 | 140 |
| Minimum edge distance | $c_{min}$ | [mm] | 45 | 50 | 55 | 60 | 75 |

[1)] for larger clearance hole see "TR 029 section 1.1"




**Injection System Hilti HIT-HY 200-A**

**Intended Use**
Installation parameters of Hilti tension anchor HZA-(R)

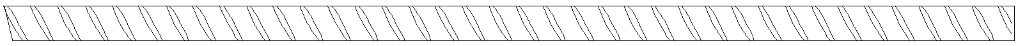
**Annex B5**

## Table B6: Installation parameters of reinforcing bar

| **Reinforcing bar (rebar)** | | | **ϕ 8** | **ϕ 10** | **ϕ 12** | | **ϕ 14** | **ϕ 16** | **ϕ 20** | **ϕ 25** | **ϕ 26** | **ϕ 28** | **ϕ 30** | **ϕ 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter | $\phi$ | [mm] | 8 | 10 | 12 | | 14 | 16 | 20 | 25 | 26 | 28 | 30 | 32 |
| Effective embedment depth and drill hole depth | $h_{ef} = h_0$ | [mm] | 60 to 160 | 60 to 200 | 70 to 240 | | 75 to 280 | 80 to 320 | 90 to 400 | 100 to 500 | 104 to 520 | 112 to 560 | 120 to 600 | 128 to 640 |
| Nominal diameter of drill bit | $d_0$ | [mm] | 10 / 12[1] | 12 / 14[1] | 14[1] | 16[1] | 18 | 20 | 25 | 32 | 32 | 35 | 37 | 40 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $h_{ef}$ + 30 ≥ 100 mm | | | $h_{ef} + 2 \cdot d_0$ | | | | | | | | |
| Minimum spacing | $s_{min}$ | [mm] | 40 | 50 | 60 | | 70 | 80 | 100 | 125 | 130 | 140 | 150 | 160 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 45 | 45 | | 50 | 50 | 65 | 70 | 75 | 75 | 80 | 80 |

[1] Each of the two given values can be used.

**Reinforcing bar**



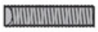
For rebar bolt

- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar $h_{rib}$ shall be in the range $0{,}05 \cdot \phi \le h_{rib} \le 0{,}07 \cdot \phi$
  ($\phi$: Nominal diameter of the bar; $h_{rib}$: Rip height of the bar)

## Table B7: Maximum working time and minimum curing time

| Temperature in the base material T | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
|---|---|---|
| -10 °C to -5 °C | 1,5 hours | 7 hours |
| > -5 °C to 0 °C | 50 min | 4 hours |
| > 0 °C to 5 °C | 25 min | 2 hours |
| > 5 °C to 10 °C | 15 min | 75 min |
| > 10 °C to 20 °C | 7 min | 45 min |
| > 20 °C to 30 °C | 4 min | 30 min |
| > 30 °C to 40 °C | 3 min | 30 min |

## Table B8: Parameters of cleaning and setting tools

| Elements | | | | Drill and clean | | | Installation |
|---|---|---|---|---|---|---|---|
| HIT-V-... | HIS-(R)N | Rebar | HZA(-R) | Hammer drilling | hollow drill bit | Brush | Piston plug |
|  |  |  |  |  |  |  |  |
| size | size | size | size | $d_0$ [mm] | $d_0$ [mm] | HIT-RB | HIT-SZ |
| M8 | - | ϕ8 | - | 10 | - | 10 | - |
| M10 | - | ϕ8 / ϕ10 | - | 12 | 12 | 12 | 12 |
| M12 | M8 | ϕ10 / ϕ12 | - | 14 | 14 | 14 | 14 |
| - | - | ϕ12 | M12 | 16 | 16 | 16 | 16 |
| M16 | M10 | ϕ14 | - | 18 | 18 | 18 | 18 |
| - | - | ϕ16 | M16 | 20 | 20 | 20 | 20 |
| M20 | M12 | - | - | 22 | 22 | 22 | 22 |
| - | - | ϕ20 | M20 | 25 | 25 | 25 | 25 |
| M24 | M16 | - | - | 28 | 28 | 28 | 28 |
| M27 | - | - | - | 30 | - | 30 | 30 |
| - | M20 | ϕ25 / ϕ26 | M24 | 32 | 32 | 32 | 32 |
| M30 | - | ϕ28 | M27 | 35 | 35 | 35 | 35 |
| - | - | ϕ30 | - | 37 | - | 37 | 37 |
| - | - | ϕ32 | - | 40 | - | 40 | 40 |

## Cleaning alternatives

**Manual Cleaning (MC):**
Hilti hand pump for blowing out drill holes with diameters $d_0 \leq 20$ mm and drill hole depths $h_0 \leq 10 \cdot d$

**Compressed air cleaning (CAC):**
Air nozzle with an orifice opening of minimum 3,5 mm in diameter.

**Automatic Cleaning (AC):**
Cleaning is performed during drilling with Hilti TE-CD and TE-YD drilling system including vacuum cleaner.

**Injection System Hilti HIT-HY 200-A**

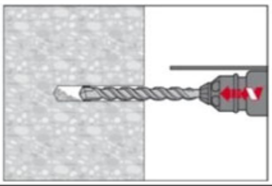
**Intended Use**
Cleaning and setting tools

**Annex B8**

## Installation instruction

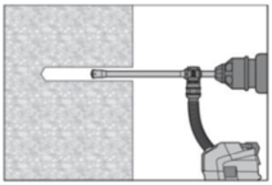
### Hole drilling

### a) Hammer drilling



Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.

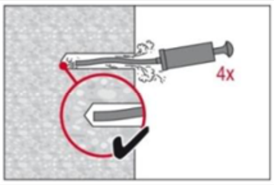
### b) Hammer drilling with Hilti hollow drill bit



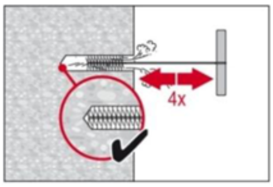
Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with Hilti vacuum attachment. This drilling system removes the dust and cleans the bore hole during drilling when used in accordance with the user's manual. After drilling is completed, proceed to the "injection preparation" step in the installation instruction.

**Drill hole cleaning** Just before setting an anchor, the drill hole must be free of dust and debris. Inadequate hole cleaning = poor load values.

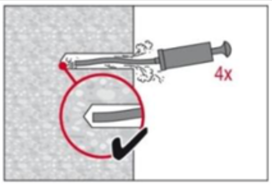
**Manual Cleaning (MC)** **non-cracked concrete only**
for drill hole diameters $d_0 \leq 20$ mm and drill hole depths $h_0 \leq 10 \cdot d$




The Hilti hand pump may be used for blowing out drill holes up to diameters $d_0 \leq 20$ mm and embedment depths up to $h_{ef} \leq 10 \cdot d$.
Blow out at least 4 times from the back of the drill hole until return air stream is free of noticeable dust

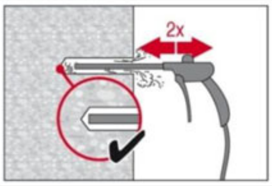



Brush 4 times with the specified brush (see Table B8) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - if not the brush is too small and must be replaced with the proper brush diameter.

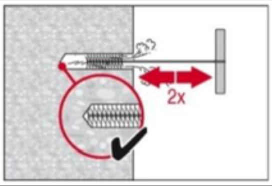



Blow out again with Hilti hand pump at least 4 times until return air stream is free of noticeable dust.

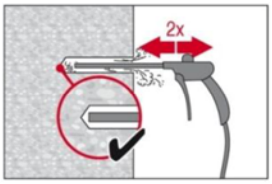
**Compressed air cleaning (CAC)** for all drill hole diameters $d_0$ and all drill hole depths $h_0$




Blow 2 times from the back of the hole (if needed with nozzle extension) over the hole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust.
For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m³/h.

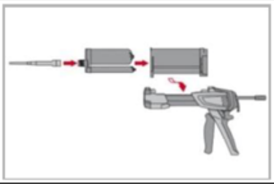



Brush 2 times with the specified brush (see Table B8) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - if not the brush is too small and must be replaced with the proper brush diameter.

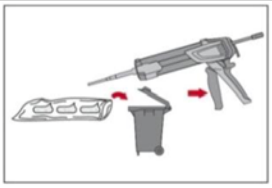



Blow again with compressed air 2 times until return air stream is free of noticeable dust.

**Injection preparation**



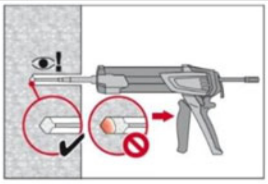
Tightly attach new Hilti mixing nozzle HIT-RE-M to foil pack manifold (snug fit). Do not modify the mixing nozzle.
Observe the instruction for use of the dispenser.
Check foil pack holder for proper function. Do not use damaged foil packs / holders.
Insert foil pack into foil pack holder and put holder into the dispenser.



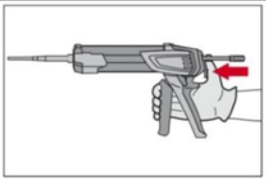
Discard initial adhesive. The foil pack opens automatically as dispensing is initiated.
Depending on the size of the foil pack an initial amount of adhesive has to be discarded.
Discarded quantities are

| | |
|---|---|
| 2 strokes | for 330 ml foil pack, |
| 3 strokes | for 500 ml foil pack, |
| 4 strokes | for 500 ml foil pack ≤ 5 °C. |

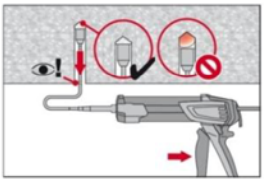
**Inject adhesive** from the back of the drill hole without forming air voids.



Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull.
Fill holes approximately 2/3 full, to ensure that the annular gap between the anchor and the concrete is completely filled with adhesive along the embedment length.

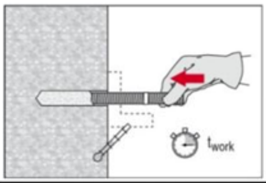


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

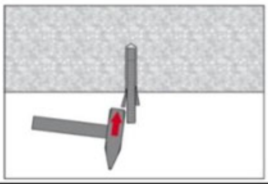


Overhead installation and/or installation with embedment depth $h_{ef}$ > 250mm.
For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B8). Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the adhesive pressure

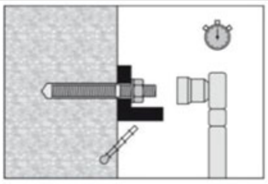
**Setting the element**




Before use, verify that the element is dry and free of oil and other contaminants.
Mark and set element to the required embedment depth until working time $t_{work}$ has elapsed. The working time $t_{work}$ is given in Table B7.

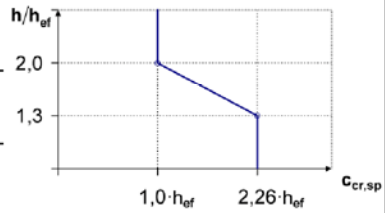


For overhead installation use piston plugs and fix embedded parts with e.g. wedges.



Loading the anchor: After required curing time $t_{cure}$ (see Table B7) the anchor can be loaded.
The applied installation torque shall not exceed the values $T_{max}$ given in Table B2 to Table B5.

## Table C1: Characteristic values of resistance for threaded rod, HIT-V-... under tension loads in concrete

| **HIT-HY 200-A with threaded rod, HIT-V-...** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| Installation safety factor | $\gamma_2$ | [-] | 1,0 | | | | | | | |
| **Steel failure** | | | | | | | | | | |
| Characteristic steel resistance | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ | | | | | | | |
| **Combined pullout and concrete cone failure** | | | | | | | | | | |
| Characteristic bond resistance in non-cracked concrete C20/25 | | | | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 18 | | | | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 15 | | | | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13 | | | | | | | |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | | 8,5 | | | 9,0 | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | | 7,0 | | | 7,5 | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | | 6,0 | | | 6,5 | | |
| Increasing factors for $\tau_{Rk}$ in concrete | $\psi_c$ | C30/37 | 1,04 | | | | | | | |
| | | C40/45 | 1,07 | | | | | | | |
| | | C50/60 | 1,1 | | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Edge distance $c_{cr,sp}$ [mm] for | | $h / h_{ef} \geq 2,0$ | $1,0 \cdot h_{ef}$ | |  | | | | | |
| | | $2,0 > h / h_{ef} > 1,3$ | $4,6\ h_{ef} - 1,8\ h$ | | | | | | | |
| | | $h / h_{ef} \leq 1,3$ | $2,26\ h_{ef}$ | | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2 \cdot c_{cr,sp}$ | | | | | | | |



**Injection System Hilti HIT-HY 200-A**

**Performances**
Characteristic values of resistance under tension loads in concrete
Design according to „EOTA Technical Report TR 029, Edition September 2010“

**Annex C1**

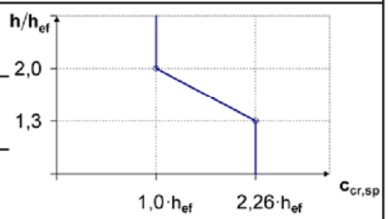
## Table C2: Characteristic values of resistance for threaded rod, HIT-V-… under shear loads

| **HIT-HY 200-A with threaded rod, HIT-V-…** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | |
| Characteristic steel resistance | $V_{Rk,s}$ | [kN] | $0{,}5 \cdot A_s \cdot f_{uk}$ | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | |
| Characteristic bending moment | $M^0_{Rk,s}$ | [Nm] | $1{,}2 \cdot W_{el} \cdot f_{uk}$ | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | |
| Factor in equation (5.7) of Technical Report TR 029 for the design of bonded anchors | k | [-] | 2,0 | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: | | | min ($h_{ef}$; $12 \cdot d_{nom}$) | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 27 | 30 |

| | |
|---|---|
| **Injection System Hilti HIT-HY 200-A** | **Annex C2** |
| **Performances**<br>Characteristic values of resistance under shear loads in concrete<br>Design according to „EOTA Technical Report TR 029, Edition September 2010“ | |

Deutsches Institut für Bautechnik DIBt

## Table C3: Characteristic values of resistance for internally threaded sleeve HIS-(R)N under tension loads in concrete

| **Hilti HIT-HY 200-A with HIS-(R)N** | | | **M8** | **M10** | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|---|---|
| Installation safety factor | $\gamma_2$ | [-] | 1,0 | | | | |
| **Steel failure threaded rods** | | | | | | | |
| Characteristic resistance HIS-N with screw grade 8.8 | $N_{Rk,s}$ | [kN] | 25 | 46 | 67 | 125 | 116 |
| Partial safety factor | $\gamma_{Ms,N}$ [1)] | [-] | 1,50 | | | | |
| Characteristic resistance HIS-RN with screw grade 70 | $N_{Rk,s}$ | [kN] | 26 | 41 | 59 | 110 | 166 |
| Partial safety factor | $\gamma_{Ms,N}$ [1)] | [-] | 1,87 | | | | 2,4 |
| **Combined pull-out and Concrete cone failure** | | | | | | | |
| Effective anchorage depth | $h_{ef}$ | [mm] | 90 | 110 | 125 | 170 | 205 |
| Effective anchor diameter | $d_1$ | [mm] | 12,5 | 16,5 | 20,5 | 25,4 | 27,6 |
| Characteristic bond resistance in non-cracked concrete C20/25 | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 13 | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 11 | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 9,5 | | | | |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7 | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5 | | | | |
| Increasing factor for $\tau_{Rk}$ in concrete | $\psi_c$ | C30/37 | 1,04 | | | | |
| | | C40/45 | 1,07 | | | | |
| | | C50/60 | 1,1 | | | | |
| **Splitting failure relevant for non-cracked concrete** | | | | | | | |
| Edge distance $c_{cr,sp}$ [mm] for | $h / h_{ef} \geq 2,0$ | | $1,0 \cdot h_{ef}$ |  | | | |
| | $2,0 > h / h_{ef} > 1,3$ | | $4,6 \cdot h_{ef} - 1,8 \cdot h$ | | | | |
| | $h / h_{ef} \leq 1,3$ | | $2,26 \cdot h_{ef}$ | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2 \cdot c_{cr,sp}$ | | | | |



1) In absence of national regulations.

**Injection System Hilti HIT-HY 200-A**

**Performances**
Characteristic values of resistance under tension loads in concrete
Design according to „EOTA Technical Report TR 029, Edition September 2010“

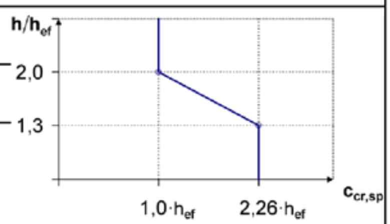
**Annex C3**

## Table C4: Characteristic values of resistance for internally threaded sleeve HIS-(R)N under shear loads in concrete

| **Hilti HIT-HY 200-A with HIS-(R)N** | | | **M8** | **M10** | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | |
| Characteristic resistance HIS-N with screw grade 8.8 | $V_{Rk,s}$ | [kN] | 13 | 23 | 34 | 63 | 58 |
| Partial safety factor | $\gamma_{Ms,V}$ [1)] | [-] | 1,25 | | | | |
| Characteristic resistance HIS-RN with screw grade 70 | $V_{Rk,s}$ | [kN] | 13 | 20 | 30 | 55 | 83 |
| Partial safety factor | $\gamma_{Ms,V}$ [1)] | [-] | 1,56 | | | | 2,0 |
| **Steel failure with lever arm** | | | | | | | |
| Characteristic resistance HIS-N with screw grade 8.8 | $M^{o}_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 |
| Partial safety factor | $\gamma_{Ms,V}$ [1)] | [-] | 1,25 | | | | |
| Characteristic resistance HIS-RN with screw grade 70 | $M^{o}_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 233 | 454 |
| Partial safety factor | $\gamma_{Ms,V}$ [1)] | [-] | 1,56 | | | | |
| **Concrete pry-out failure** | | | | | | | |
| Factor in equation (5.7) of Technical Report TR 029 for the design of bonded anchors | k | [-] | 2,0 | | | | |
| **Concrete edge failure** | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 12,5 | 16,5 | 20,5 | 25,4 | 27,6 |

1) In absence of national regulations.

## Table C5: Characteristic values of resistance for Hilti tension anchor HZA / HZA-R under tension loads in concrete

| **Hilti HIT-HY 200-A with HZA, HZA-R** | | | **M12** | **M16** | **M20** | **M24** | **M27** |
|---|---|---|---|---|---|---|---|
| Installation safety factor | $\gamma_2$ | [-] | 1,0 | | | | |
| **Steel failure** | | | | | | | |
| Characteristic resistance HZA | $N_{Rk,s}$ | [kN] | 46 | 86 | 135 | 194 | 253 |
| Characteristic resistance HZA-R | $N_{Rk,s}$ | [kN] | 62 | 111 | 173 | 248 | - |
| Partial safety factor | $\gamma_{Ms}$ [1)] | [-] | 1,4 | | | | |
| **Combined pull-out and concrete cone failure** | | | | | | | |
| Diameter of rebar | d | [mm] | 12 | 16 | 20 | 25 | 28 |
| Characteristic bond resistance in non-cracked concrete C20/25 | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 12 | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 10 | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,ucr}$ | [N/mm²] | 8,5 | | | | |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,cr}$ | [N/mm²] | 7 | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,cr}$ | [N/mm²] | 5 | | | | |
| Increasing factor for $\tau_{Rk}$ in concrete | $\psi_c$ | C30/37 | 1,04 | | | | |
| | | C40/45 | 1,07 | | | | |
| | | C50/60 | 1,1 | | | | |
| Effective anchorage depth for calculation of $N^0_{Rk,p}$ acc. Eq. 5.2a (TR 029, 5.2.2.3 Combined pull -out and concrete cone failure) HZA | $h_{ef}$ | [mm] | $h_{nom} - 20$ | | | | |
| HZA-R | $h_{ef}$ | [mm] | $h_{nom} - 100$ | | | | |
| **Concrete cone failure** | | | | | | | |
| Effective anchorage depth for calculation of $N^0_{Rk,c}$ acc. Eq. 5.3a (TR 029, 5.2.2.4 Concrete cone failure) HZA HZA-R | $h_{ef}$ | [mm] | $h_{nom}$ | | | | |
| **Splitting failure relevant for non-cracked concrete** | | | | | | | |
| Edge distance $c_{cr,sp}$ [mm] for | $h / h_{ef} \geq 2{,}0$ | | $1{,}0 \cdot h_{ef}$ |  | | | |
| | $2{,}0 > h / h_{ef} > 1{,}3$ | | $4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$ | | | | |
| | $h / h_{ef} \leq 1{,}3$ | | $2{,}26 \cdot h_{ef}$ | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2 \cdot c_{cr,sp}$ | | | | |



1) In absence of national regulations.

**Injection System Hilti HIT-HY 200-A**

**Performances**
Characteristic values of resistance under tension loads in concrete
Design according to „EOTA Technical Report TR 029, Edition September 2010“

**Annex C5**

## Table C6: Characteristic values of resistance for Hilti tension anchor HZA, HZA-R under shear loads in concrete

| **Hilti HIT-HY 200-A with HZA, HZA-R** | | | | **M12** | **M16** | **M20** | **M24** | **M27** |
|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | |
| Characteristic resistance | HZA | $V_{Rk,s}$ | [kN] | 23 | 43 | 67 | 97 | 126 |
| Characteristic resistance | HZA-R | $V_{Rk,s}$ | [kN] | 31 | 55 | 86 | 124 | - |
| Partial safety factor | | $\gamma_{Ms}$ [1)] | [-] | 1,5 | | | | |
| **Steel failure with lever arm** | | | | | | | | |
| Characteristic resistance | HZA | $M^0_{Rk,s}$ | [Nm] | 72 | 183 | 357 | 617 | 915 |
| Characteristic resistance | HZA-R | $M^0_{Rk,s}$ | [Nm] | 97 | 234 | 457 | 790 | - |
| Partial safety factor | | $\gamma_{Ms}$ [1)] | [-] | 1,5 | | | | |
| **Concrete pry-out failure** | | | | | | | | |
| Factor in equation (5.7) of Technical Report TR 029 for the design of bonded anchors | | k | [-] | 2,0 | | | | |
| **Concrete edge failure** | | | | | | | | |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: | | | | min ($h_{nom}$; 12 · $d_{nom}$) | | | | |
| Outside diameter of anchor | | $d_{nom}$ | [mm] | 12 | 16 | 20 | 24 | 27 |

1) In absence of national regulations.

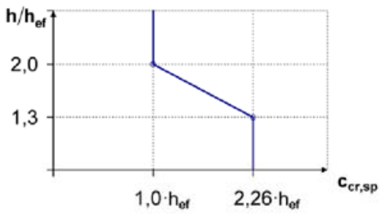
**Injection System Hilti HIT-HY 200-A**

**Performances**
Characteristic values of resistance under shear loads in concrete
Design according to „EOTA Technical Report TR 029, Edition September 2010"

**Annex C6**

## Table C7: Characteristic values of resistance for rebar under tension loads in concrete

| **HIT-HY 200-A with rebar** | | | **ϕ 8** | **ϕ 10** | **ϕ 12** | **ϕ 14** | **ϕ 16** | **ϕ 20** | **ϕ 25** | **ϕ 26** | **ϕ 28** | **ϕ 30** | **ϕ 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation safety factor | $\gamma_2$ | [-] | 1,0 | | | | | | | | | | |
| **Steel failure** | | | | | | | | | | | | | |
| Characteristic resistance for rebar B500B acc. to DIN 488:2009-08 [1)] | $N_{Rk,s}$ | [kN] | 28 | 43 | 62 | 85 | 111 | 173 | 270 | 292 | 339 | 388 | 442 |
| **Combined pull-out and Concrete cone failure** | | | | | | | | | | | | | |
| Diameter of rebar | d | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 25 | 26 | 28 | 30 | 32 |
| Characteristic bond resistance in non-cracked concrete C20/25 | | | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr}$ | [N/mm²] | 12 | | | | | | | | | | |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr}$ | [N/mm²] | 10 | | | | | | | | | | |
| Temperature range III: 120°C/72°C | $\tau_{Rk,ucr}$ | [N/mm²] | 8,5 | | | | | | | | | | |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 5 | 7 | | | | | | | | |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 4 | 5,5 | | | | | | | | |
| Temperature range III: 120°C/72°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 3,5 | 5 | | | | | | | | |
| Increasing factor for $\tau_{Rk}$ in concrete | $\psi_c$ | C30/37 | 1,04 | | | | | | | | | | |
| | | C40/45 | 1,07 | | | | | | | | | | |
| | | C50/60 | 1,1 | | | | | | | | | | |
| **Splitting failure relevant for non-cracked concrete** | | | | | | | | | | | | | |
| Edge distance $c_{cr,sp}$ [mm] for | $h / h_{ef} \geq 2,0$ | | $1,0 \cdot h_{ef}$ | | | | | | | | | | |
| | $2,0 > h / h_{ef} > 1,3$ | | $4,6 \cdot h_{ef} - 1,8 \cdot h$ | | | | | | | | | | |
| | $h / h_{ef} \leq 1,3$ | | $2,26 \cdot h_{ef}$ | | | | | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2\ c_{cr,sp}$ | | | | | | | | | | |




[1)] The characteristic tension resistance $N_{Rk,s}$ for rebars that do not fulfil the requirements acc. DIN 488 shall be calculated acc. Technical Report TR 029, Equation (5.1).

## Table C8: Characteristic values of resistance for rebar under shear loads in concrete

| HIT-HY 200-A with rebar | | | ϕ 8 | ϕ 10 | ϕ 12 | ϕ 14 | ϕ 16 | ϕ 20 | ϕ 25 | ϕ 26 | ϕ 28 | ϕ 30 | ϕ 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | | | |
| Characteristic resistance for rebar B500B acc. to DIN 488:2009-08 [1] | $V_{Rk,s}$ | [kN] | 14 | 22 | 31 | 42 | 55 | 86 | 135 | 146 | 169 | 194 | 221 |
| **Steel failure with lever arm** | | | | | | | | | | | | | |
| Characteristic resistance for rebar B500B acc. to DIN 488:2009-08 [2] | $M^o_{Rk,s}$ | [Nm] | 33 | 65 | 112 | 178 | 265 | 518 | 1012 | 1139 | 1422 | 1749 | 2123 |
| **Concrete pry-out failure** | | | | | | | | | | | | | |
| Factor in equation (5.7) of Technical Report TR 029 for the design of bonded anchors | k | [-] | 2,0 | | | | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | | | | |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: | | | min ($h_{ef}$; 12 · $d_{nom}$) | | | | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 25 | 26 | 28 | 30 | 32 |

[1] The characteristic shear resistance $V_{Rk,s}$ for rebars that do not fulfil the requirements acc. DIN 488 shall be calculated acc. Technical Report TR 029, Equation (5.5).

[2] The characteristic bending resistance $M^0_{Rk,s}$ for rebars that do not fulfil the requirements acc. DIN 488 shall be calculated acc. Technical Report TR 029, Equation (5.6b).

**Injection System Hilti HIT-HY 200-A**

**Performances**
Characteristic values of resistance under shear loads in concrete
Design according to „EOTA Technical Report TR 029, Edition September 2010“

**Annex C8**

## Table C9: Displacements under tension load

| **Hilti HIT-HY 200-A with threaded rod, HIT-V-…** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| Non-cracked concrete temperature range I : 40°C / 24°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,02 | 0,03 | 0,03 | 0,04 | 0,06 | 0,07 | 0,07 | 0,08 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,08 | 0,10 | 0,13 | 0,14 | 0,16 |
| Non-cracked concrete temperature range II : 80°C / 50°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,03 | 0,04 | 0,05 | 0,06 | 0,08 | 0,09 | 0,10 | 0,12 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,09 | 0,11 | 0,13 | 0,15 | 0,16 |
| Non-cracked concrete temperature range III : 120°C / 72°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,08 | 0,10 | 0,12 | 0,13 | 0,16 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,07 | 0,09 | 0,11 | 0,13 | 0,15 | 0,17 |
| Cracked concrete temperature range I : 40°C / 24°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,07 | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,16 | | | | | | | |
| Cracked concrete temperature range II : 80°C / 50°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,10 | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,22 | | | | | | | |
| Cracked concrete temperature range III : 120°C / 72°C | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,13 | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,29 | | | | | | | |

## Table C10: Displacements under shear load

| **Hilti HIT-HY 200-A with threaded rod, HIT-V-…** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V0}$ | [mm/kN] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$ | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |

## Table C11: Displacements under tension load

| Hilti HIT-HY 200-A with HIS-(R)N | | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|---|
| Non-cracked concrete temperature range I : 40°C / 24°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,03 | 0,05 | 0,06 | 0,07 | 0,08 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,06 | 0,09 | 0,11 | 0,13 | 0,14 |
| Non-cracked concrete temperature range II : 80°C / 50°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,05 | 0,06 | 0,08 | 0,10 | 0,11 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,07 | 0,09 | 0,11 | 0,13 | 0,15 |
| Non-cracked concrete temperature range III : 120°C / 72°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,06 | 0,08 | 0,10 | 0,13 | 0,14 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,07 | 0,09 | 0,11 | 0,14 | 0,15 |
| Cracked concrete temperature range I : 40°C / 24°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,11 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,16 | | | | |
| Cracked concrete temperature range II : 80°C / 50°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,15 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,22 | | | | |
| Cracked concrete temperature range III : 120°C / 72°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,20 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,29 | | | | |

## Table C12: Displacements under shear load

| Hilti HIT-HY 200-A with HIS-(R)N | | | M8 | M10 | M12 | M16 | M20 |
|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V0}$ | [mm/kN] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 |
| | $\delta_{V\infty}$ | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 |

**Injection System Hilti HIT-HY 200-A**

**Performances**
Displacements with HIS-(R)N

**Annex C10**

## Table C13: Displacements under tension load

| Hilti HIT-HY 200-A with HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| Non-cracked concrete temperature range I : 40°C / 24°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,03 | 0,04 | 0,06 | 0,07 | 0,08 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,06 | 0,08 | 0,13 | 0,13 | 0,15 |
| Non-cracked concrete temperature range II : 80°C / 50°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,05 | 0,06 | 0,08 | 0,10 | 0,11 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,06 | 0,09 | 0,14 | 0,14 | 0,15 |
| Non-cracked concrete temperature range III : 120°C / 72°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,06 | 0,08 | 0,10 | 0,12 | 0,14 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,07 | 0,09 | 0,14 | 0,14 | 0,16 |
| Cracked concrete temperature range I : 40°C / 24°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,11 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,16 | | | | |
| Cracked concrete temperature range II : 80°C / 50°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,15 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,22 | | | | |
| Cracked concrete temperature range III : 120°C / 72°C | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,20 | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,29 | | | | |

## Table C14: Displacements under shear load

| Hilti HIT-HY 200-A with HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V0}$ | [mm/kN] | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 |
| | $\delta_{V\infty}$ | [mm/kN] | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 |

## Table C15: Displacements under tension load

| **Hilti HIT-HY 200-A with rebar** | | | **ϕ 8** | **ϕ 10** | **ϕ 12** | **ϕ 14** | **ϕ 16** | **ϕ 20** | **ϕ 25** | **ϕ 26** | **ϕ 28** | **ϕ 30** | **ϕ 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-cracked concrete temperature range I : 40°C / 24°C | | | | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,02 | 0,03 | 0,03 | 0,04 | 0,04 | 0,06 | 0,07 | 0,08 | 0,08 | 0,09 | 0,09 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,07 | 0,08 | 0,10 | 0,13 | 0,14 | 0,15 | 0,16 | 0,17 |
| Non-cracked concrete temperature range II : 80°C / 50°C | | | | | | | | | | | | | |
| | $\delta_{N0}$ | [mm/(N/mm²)] | 0,03 | 0,04 | 0,05 | 0,05 | 0,06 | 0,08 | 0,10 | 0,11 | 0,11 | 0,12 | 0,12 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,07 | 0,09 | 0,11 | 0,14 | 0,15 | 0,15 | 0,16 | 0,17 |
| Non-cracked concrete temperature range III : 120°C / 72°C | | | | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,06 | 0,07 | 0,08 | 0,10 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,04 | 0,05 | 0,07 | 0,08 | 0,09 | 0,11 | 0,14 | 0,15 | 0,16 | 0,17 | 0,18 |
| Cracked concrete temperature range I : 40°C / 24°C | | | | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,11 | | | | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,16 | | | | | | | | | | |
| Cracked concrete temperature range II : 80°C / 50°C | | | | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,15 | | | | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,22 | | | | | | | | | | |
| Cracked concrete temperature range III : 120°C / 72°C | | | | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm/(N/mm²)] | 0,20 | | | | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | 0,29 | | | | | | | | | | |

## Table C16: Displacements under shear load

| **Hilti HIT-HY 200-A with rebar** | | | **ϕ 8** | **ϕ 10** | **ϕ 12** | **ϕ 14** | **ϕ 16** | **ϕ 20** | **ϕ 25** | **ϕ 26** | **ϕ 28** | **ϕ 30** | **ϕ 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V0}$ | [mm/kN] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$ | [mm/kN] | 0,09 | 0,08 | 0,07 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 |

## Seismic design shall be carried out according to the TR 045 „Design of Metal Anchors Under Seismic Action“

### Table C17: Characteristic values of resistance for threaded rod, HIT-V-… under tension loads for seismic performance category C1

| HIT-HY 200-A with threaded rod, HIT-V-… | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | |
| HIT-V-5.8(F), threaded rod 5.8 | $N_{Rk,s,seis}$ | [kN] | - | 29 | 42 | 79 | 123 | 177 | 230 | 281 |
| HIT-V-8.8(F), threaded rod 8.8 | $N_{Rk,s,seis}$ | [kN] | - | 46 | 67 | 126 | 196 | 282 | 367 | 449 |
| HIT-V-R, threaded rod A4-70 | $N_{Rk,s,seis}$ | [kN] | - | 41 | 59 | 110 | 172 | 247 | 230 | 281 |
| HIT-V-HCR, threaded rod HCR-80 | $N_{Rk,s,seis}$ | [kN] | - | 46 | 67 | 126 | 196 | 247 | 321 | 393 |
| **Combined pullout and concrete cone failure** | | | | | | | | | | |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | | | | |
| Temperature range I: 40 °C/24 °C | $\tau_{Rk,seis}$ | [N/mm²] | - | 5,2 | 7,0 | | | | | |
| Temperature range II: 80 °C/50 °C | $\tau_{Rk,seis}$ | [N/mm²] | - | 3,9 | 5,7 | | | | | |
| Temperature range III: 120 °C/72 °C | $\tau_{Rk,seis}$ | [N/mm²] | - | 3,5 | 4,8 | | | | | |

### Table C18: Characteristic values of resistance for threaded rod, HIT-V-… under shear loads for seismic performance category C1

| HIT-HY 200-A with threaded rod, HIT-V-… | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | |
| HIT-V 5.8(F), threaded rod 5.8 | $V_{Rk,s,seis}$ | [kN] | - | 11 | 15 | 27 | 43 | 62 | 81 | 98 |
| HIT-V 8.8(F), threaded rod 8.8 | $V_{Rk,s,seis}$ | [kN] | - | 16 | 24 | 44 | 69 | 99 | 129 | 157 |
| HIT-V R, threaded rod A4-70 | $V_{Rk,s,seis}$ | [kN] | - | 14 | 21 | 39 | 60 | 87 | 81 | 98 |
| HIT-V HCR, threaded rod HCR-80 | $V_{Rk,s,seis}$ | [kN] | - | 16 | 24 | 44 | 69 | 87 | 113 | 137 |

### Table C19: Displacements under tension load for seismic performance category C1

| HIT-HY 200-A with threaded rod, HIT-V-… | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement [1)] | $\delta_{N,seis}$ | [mm] | - | 0,8 | 0,8 | 0,8 | 0,8 | 0,8 | 0,8 | 0,8 |

1) Maximum displacement during cycling (seismic event).

### Table C20: Displacements under shear load for seismic performance category C1

| HIT-HY 200-A with threaded rod, HIT-V-… | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement [1)] | $\delta_{V,seis}$ | [mm] | - | 3,5 | 3,8 | 4,4 | 5,0 | 5,6 | 6,1 | 6,5 |

1) Maximum displacement during cycling (seismic event).

## Table C21: Characteristic values of resistance for Hilti tension anchor HZA, HZA-R under tension loads for seismic performance category C1

| HIT-HY 200-A with Hilti tension anchor HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | |
| Characteristic resistance HZA | $N_{Rk,s,seis}$ | [kN] | 46 | 86 | 135 | 194 | 253 |
| Characteristic resistance HZA-R | $N_{Rk,s,seis}$ | [kN] | 62 | 111 | 173 | 248 | - |
| Partial safety factor | $\gamma_{Ms,N,seis}$ 1) | [-] | 1,4 | | | | |
| **Combined pull-out and concrete cone failure**) | | | | | | | |
| Diameter of rebar | d | [mm] | 12 | 16 | 20 | 25 | 28 |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr}$ | [N/mm²] | 6,1 | | | | |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr}$ | [N/mm²] | 4,8 | | | | |
| Temperature range III: 120°C/72°C | $\tau_{Rk,cr}$ | [N/mm²] | 4,4 | | | | |

1) In absence of national regulations.

## Table C22: Characteristic values of resistance for Hilti tension anchor HZA, HZA-R under shear loads for seismic performance category C1

| HIT-HY 200-A with Hilti tension anchor HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | |
| Characteristic resistance HZA | $V_{Rk,s,seis}$ | [kN] | 16 | 30 | 47 | 68 | 88 |
| Characteristic resistance HZA-R | $V_{Rk,s,seis}$ | [kN] | 22 | 39 | 60 | 124 | - |
| Partial safety factor | $\gamma_{Ms,V,seis}$ 1) | [-] | 1,5 | | | | |

1) In absence of national regulations.

## Table C23: Displacements under tension load for seismic performance category C1

| HIT-HY 200-A with Hilti tension anchor HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| Displacement 1) | $\delta_{N,seis}$ | [mm] | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 |

1) Maximum displacement during cycling (seismic event).

## Table C24: Displacements under shear load for seismic performance category C1

| HIT-HY 200-A with Hilti tension anchor HZA, HZA-R | | | M12 | M16 | M20 | M24 | M27 |
|---|---|---|---|---|---|---|---|
| Displacement 1) | $\delta_{V,seis}$ | [mm] | 3,8 | 4,4 | 5,0 | 5,6 | 6,1 |

1) Maximum displacement during cycling (seismic event).

| | |
|---|---|
| **Injection System Hilti HIT-HY 200-A** | **Annex C14** |
| **Performances**<br>Characteristic values for seismic performance category C1 and displacements<br>Design according to „EOTA Technical Report TR 045, Edition February 2013“ | |

## Table C25: Characteristic values of resistance for rebar under tension loads for seismic performance category C1

| HIT-HY 200-A with rebar | | | ϕ 8 | ϕ 10 | ϕ 12 | ϕ 14 | ϕ 16 | ϕ 20 | ϕ 25 | ϕ 26 | ϕ 28 | ϕ 30 | ϕ 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | | |
| Characteristic resistance for rebar B500B acc. to DIN 488:2009-08 [1)] | $N_{Rk,seis}$ | [kN] | - | 43 | 62 | 85 | 111 | 173 | 270 | 292 | 339 | 388 | 442 |
| **Combined pull-out and Concrete cone failure** | | | | | | | | | | | | | |
| Diameter of rebar | d | [mm] | - | 10 | 12 | 14 | 16 | 20 | 25 | 26 | 28 | 30 | 32 |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 4,4 | 6,1 | | | | | | | | |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 3,5 | 4,8 | | | | | | | | |
| Temperature range III: 120°C/72°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 3 | 4,4 | | | | | | | | |

1) The characteristic tension resistance $N_{Rk,s,seis}$ for rebars that do not fulfil the requirements acc. DIN 488 shall be calculated acc. Technical Report TR 029, Equation (5.1), $N_{Rk,s,seis} = N_{Rk,s}$.

## Table C26: Characteristic values of resistance for rebar under shear loads for seismic performance category C1

| HIT-HY 200-A with rebar | | | ϕ 8 | ϕ 10 | ϕ 12 | ϕ 14 | ϕ 16 | ϕ 20 | ϕ 25 | ϕ 26 | ϕ 28 | ϕ 30 | ϕ 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | | | |
| Characteristic resistance for rebar B500B acc. to DIN 488:2009-08 | $V_{Rk,s,seis}$ | [kN] | - | 15 | 22 | 29 | 39 | 60 | 95 | 102 | 118 | 135 | 165 |

1) The characteristic shear resistance $V_{Rk,s,seis}$ for rebars that do not fulfil the requirements acc. DIN 488 shall be calculated acc. Technical Report TR 029, Equation (5.5), $V_{Rk,s,seis} = 0{,}7 \times V_{Rk,s}$.

## Table C27: Displacements under tension load for seismic performance category C1

| Hilti HIT-HY 200-A with rebar | | | ϕ 8 | ϕ 10 | ϕ 12 | ϕ 14 | ϕ 16 | ϕ 20 | ϕ 25 | ϕ 26 | ϕ 28 | ϕ 30 | ϕ 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement [1)] | $\delta_{N,seis}$ | [mm] | - | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 | 1,3 |

1) Maximum displacement during cycling (seismic event).

## Table C28: Displacements under shear load for seismic performance category C1

| Hilti HIT-HY 200-A with rebar | | | ϕ 8 | ϕ 10 | ϕ 12 | ϕ 14 | ϕ 16 | ϕ 20 | ϕ 25 | ϕ 26 | ϕ 28 | ϕ 30 | ϕ 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Displacement [1)] | $\delta_{V,seis}$ | [mm] | - | 3,5 | 3,8 | 4,1 | 4,4 | 5,0 | 5,8 | 6,2 | 6,2 | 6,8 | 6,8 |

1) Maximum displacement during cycling (seismic event).