Deutsches Institut für Bautechnik

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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-18/0972 of 18 July 2023

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, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D |
| Product family to which the construction product belongs | Bonded fasteners and bonded expansion fasteners for use in concrete |
| Manufacturer | Hilti Aktiengesellschaft<br>Feldkircherstrasse 100<br>9494 SCHAAN<br>FÜRSTENTUM LIECHTENSTEIN |
| Manufacturing plant | Hilti Plants |
| This European Technical Assessment contains | 21 pages including 3 annexes which form an integral part of this assessment |
| This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of | EAD 330499-02-0601 Edition 04/2023 |
| This version replaces | ETA-18/0972 issued on 13 May 2020 |



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## Specific Part

### 1 Technical description of the product

The Injection systems Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D are bonded fasteners consisting of a cartridge with injection mortar Hilti HIT-HY 200-A or Hilti HIT-HY 200-R or Hilti HIT-HY 200-A V3 or Hilti HIT-HY 200-R V3 and the steel element Hilti HAS-D with Hilti sealing washer, a calotte nut and a lock nut in the range of M12, M16 and M20.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between steel element, 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 to static and quasi-static tension load | See Annex B2, C1 and C2 |
| Characteristic resistance to static and quasi-static shear load | See Annex C3 |
| Displacements for static and quasi-static load | See Annex C4 |
| Characteristic resistance for seismic category C1 and C2 | No performance assessed |

#### 3.2 Safty in Case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Class A1 |
| Resistance to fire | No performance assessed |

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

| Essential characteristic | Performance |
|---|---|
| Content, emission and/or release of dangerous substances | No performance assessed |

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

In accordance with the European Assessment Document EAD 330499-02-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 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.

The following standards and documents are referred to in this European Technical Assessment:

| | |
|---|---|
| - EN ISO 683-4:2018 | Heat-treatable steels, alloy steels and free-cutting steels - Part 4: Free-cutting steels (ISO 683-4:2016) |
| - EN 206:2013 + A2:2021 | Concrete - Specification, performance, production and conformity |
| - EN 1992-4:2018 | Eurocode 2: Design of concrete structures - Part 4: Design of fastenings for use in concrete |
| - EOTA TR 055 | Design of fastenings based on EAD 330232-00-0601, EAD 330499-00-0601 and EAD 330747-00-0601, February 2018 |

Issued in Berlin on 18 July 2023 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

*beglaubigt:*
Stiller

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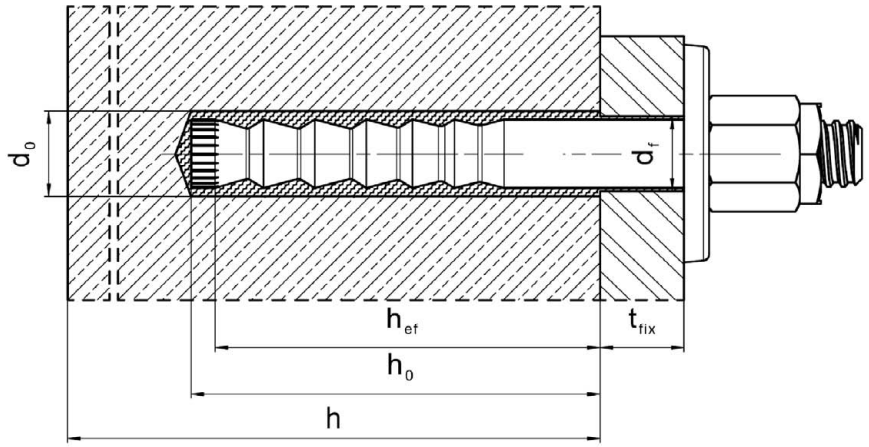
## Installed condition






| | |
|---|---|
| **Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D** | |
| **Product description**<br>Installed condition | **Annex A1** |

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## Product description: Injection mortar

**Injection mortar Hilti HIT-HY 200-A, Hilti HIT-HY 200-R, Hilti HIT-HY 200-A V3 and Hilti HIT-HY 200-R V3:** hybrid system with aggregate, foil pack 330 ml and 500 ml

Marking:
HILTI HIT
HY 200-A
Production time and production line
Expiry date mm/yyyy


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

Marking:
HILTI HIT
HY 200-R
Production time and production line
Expiry date mm/yyyy


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

Marking:
HILTI HIT
HY 200-A V3
Production time and production line
Expiry date mm/yyyy


Product name: "Hilti HIT-HY 200-A V3"

Marking:
HILTI HIT
HY 200-R V3
Production time and production line
Expiry date mm/yyyy


Product name: "Hilti HIT-HY 200-R V3"

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

| | |
|---|---|
| **Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D** | **Annex A2** |
| **Product description**<br>Injection mortar / Static mixer | |

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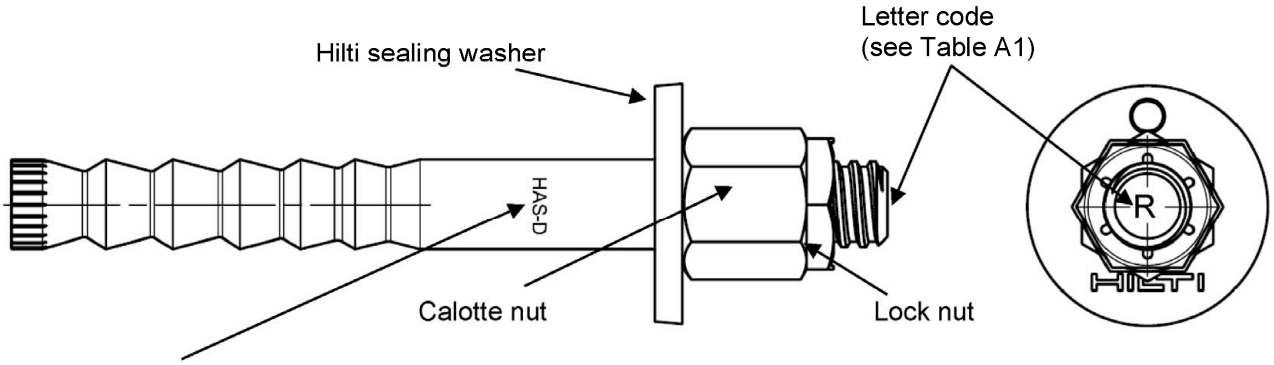
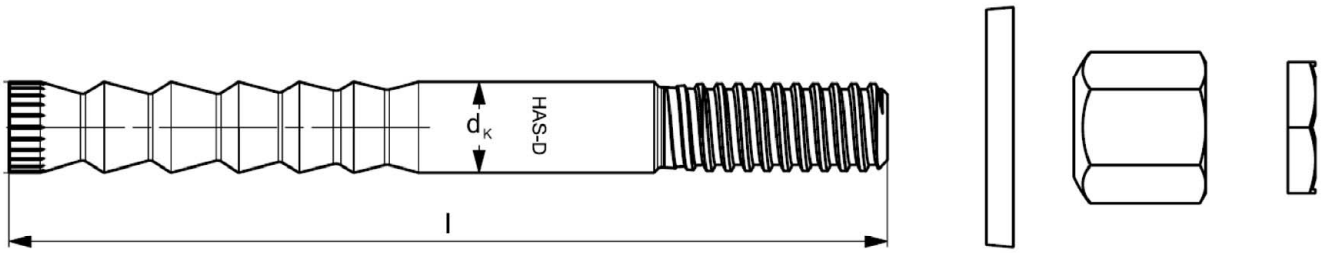
**Fastener: Hilti HAS-D: M12, M16 and M20 with sealing washer**




**Marking:**
HAS-D M..x L Fastener type as well as size and length of anchor rod




## Table A1: Letter code for identification of anchor rod length[1)]

| **Letter code** | | | I | **J** | K | **L** | **M** | N | **O** | P | Q | **R** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of anchor rod l | ≥ | [mm] | 139,7 | **152,4** | 165,1 | **177,8** | **190,5** | 203,2 | **215,9** | 228,6 | 241,3 | **254,0** |
| | < | [mm] | 152,4 | **165,1** | 177,8 | **190,5** | **203,2** | 215,9 | **228,6** | 241,3 | 254,0 | **279,4** |

| **Letter code** | | | S | T | U | V | W | X | Y | Z | >Z |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of anchor rod l | ≥ | [mm] | 279,4 | 304,8 | 330,2 | 355,6 | 381,0 | 406,4 | 431,8 | 457,2 | 482,6 |
| | < | [mm] | 304,8 | 330,2 | 355,6 | 381,0 | 406,4 | 431,8 | 457,2 | 482,6 | |

1) Anchor length in bold is standard item. For selection of other anchor lengths, check availability of the items.

## Table A2: Dimensions

| **HAS-D…** | | | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|
| Shaft diameter | $d_k$ | [mm] | 12,5 | 16,5 | 22,0 |
| Length of anchor rod l | ≥ | [mm] | 143 | 180 | 242 |
| | ≤ | [mm] | 531 | 565 | 623 |
| Calotte nut | SW | [mm] | 18/19 | 24 | 30 |
| Lock nut | SW | [mm] | 19 | 24 | 30 |



**Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D**

**Product description**
Steel element

**Annex A3**

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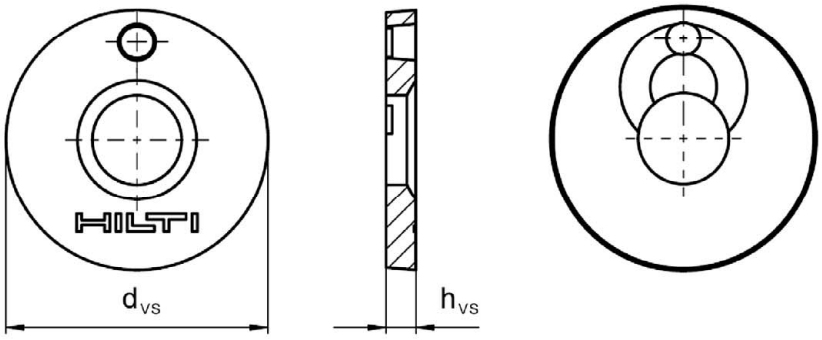
**Hilti sealing washer to fill the annular gap between anchor and fixture**




## Table A3: Geometry of Hilti sealing washer

| Size | | | M12 | M16 | M20 |
|---|---|---|---|---|---|
| Diameter of sealing washer | $d_{vs}$ | [mm] | 44 | 52 | 60 |
| Thickness of sealing washer | $h_{vs}$ | [mm] | 5 | 6 | |

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## Table A4: Materials

| Designation | Material |
|---|---|
| Anchor rod HAS-D | Steel acc. to EN ISO 683-4, galvanized and coated |
| Sealing washer | Steel, electroplated zinc coated ≥ 5 µm |
| Calotte nut | Steel, electroplated zinc coated ≥ 5 µm |
| Lock nut | Steel, electroplated zinc coated ≥ 5 µm |

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## Specifications of intended use

**Anchorages subject to:**

- Static and quasi-static loading.

**Base material:**

- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206.
- Strength classes C20/25 to C50/60 according to EN 206.
- Cracked and uncracked concrete.

**Temperature in the base material:**

- **at installation**
  -10 °C to +40 °C for the standard variation of temperature after installation
- **in-service**
  Temperature range: -40 °C to +80 °C
  (max. long term temperature +50 °C and max. short term temperature +80 °C)

**Use conditions (Environmental conditions):**

- Structures subject to dry internal conditions.

**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 fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Anchorages under static or quasi-static loading are designed in accordance with:
  EN 1992-4 and EOTA Technical Report TR 055.

**Installation:**

- Concrete condition I1: dry or wet concrete (not in flooded holes) for all drilling techniques.
- Drilling techniques:
  - hammer drilling,
  - hammer drilling with hollow drill bit TE-CD, TE-YD,
  - diamond coring.
- Installation direction D3: downward, horizontal and upward (e.g. overhead) installation.
- Fastener 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, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D | Annex B1 |
|---|---|
| **Intended Use**<br>Specifications | |

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## Table B1: Installation parameters

| HAS-D… | | | | M12 | M16 | M20 |
|---|---|---|---|---|---|---|
| Diameter of fastener | | $d$ | [mm] | 12 | 16 | 20 |
| Nominal diameter of drill bit | | $d_0$ | [mm] | 14 | 18 | 24 |
| Effective embedment depth | | $h_{ef}$ | [mm] | 100 | 125 | 170 |
| Minimum drill hole depth | | $h_0$ | [mm] | 105 | 133 | 180 |
| Minimum thickness of concrete member | | $h_{min}$ | [mm] | 130 | 160[1] / 170 | 220[1] / 230 |
| Pre-setting:<br>Maximum diameter of clearance hole in the fixture | | $d_f$ | [mm] | 14 | 18 | 24 |
| Through-setting:<br>Maximum diameter of clearance hole in the fixture | | $d_f$ | [mm] | 16 | 20 | 26 |
| Installation torque moment | | $T_{inst}$ | [Nm] | 30 | 50 | 80 |
| Uncracked concrete | Minimum spacing | $s_{min,ucr}$ | [mm] | 80[2] | 60 | 80 |
| | Minimum edge distance | $c_{min,ucr}$ | [mm] | 55[2] | 60 | 80 |
| Cracked concrete | Minimum spacing | $s_{min,cr}$ | [mm] | 50 | 60 | 80 |
| | Minimum edge distance | $c_{min,cr}$ | [mm] | 50 | 60 | 80 |

1) The reverse side of the concrete member shall have no break-through after drilling.

2) For min. edge distance $c_{min} \geq 80$ mm, min. spacing $s_{min} = 55$ mm

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## Table B2: Maximum working time and minimum curing time HIT-HY 200-A and HIT-HY 200-R

| Temperature in the base material T [1] | HIT-HY 200-A | | HIT-HY 200-R | |
|---|---|---|---|---|
| | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
| -10 °C to -5 °C | 1,5 hours | 7 hours | 3 hours | 20 hours |
| > -5 °C to 0 °C | 50 min | 4 hours | 2 hours | 8 hours |
| > 0 °C to 5 °C | 25 min | 2 hours | 1 hour | 4 hours |
| >5 °C to 10 °C | 15 min | 75 min | 40 min | 2,5 hours |
| >10 °C to 20 °C | 7 min | 45 min | 15 min | 1,5 hours |
| >20 °C to 30 °C | 4 min | 30 min | 9 min | 1 hour |
| >30 °C to 40 °C | 3 min | 30 min | 6 min | 1 hour |

[1] The minimum temperature of the foil pack is 0°C.

## Table B3: Maximum working time and minimum curing time HIT-HY 200-A V3 and HIT-HY 200-R V3

| Temperature in the base material T [1] | HIT-HY 200-A V3 | | HIT-HY 200-R V3 | |
|---|---|---|---|---|
| | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
| -10 °C to -5 °C | 1,5 hours | 7 hours | 3 hours | 20 hours |
| > -5 °C to 0 °C | 50 min | 4 hours | 1,5 hours | 8 hours |
| > 0 °C to 5 °C | 25 min | 2 hours | 45 min | 4 hours |
| >5 °C to 10 °C | 15 min | 75 min | 30 min | 2,5 hours |
| >10 °C to 20 °C | 7 min | 45 min | 15 min | 1,5 hours |
| >20 °C to 30 °C | 4 min | 30 min | 9 min | 1 hour |
| >30 °C to 40 °C | 3 min | 30 min | 6 min | 1 hour |

[1] The minimum temperature of the foil pack is 0°C.

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## Table B4: Parameters of drilling, cleaning and setting tools

| Fastener | Drill and clean | | | | Installation |
|---|---|---|---|---|---|
| HAS-D | Hammer drilling | | Diamond coring | Brush | Piston plug |
| | | Hollow drill bit TE-CD, TE-YD[1)] | | | |
| |  |  |  |  |  |
| Size | $d_0$ [mm] | $d_0$ [mm] | $d_0$ [mm] | HIT-RB | HIT-SZ |
| M12 | 14 | 14 | 14 | 14 | 14 |
| M16 | 18 | 18 | 18 | 18 | 18 |
| M20 | 24 | 24 | 24 | 24 | 24 |

1) With vacuum cleaner Hilti VC 10/20/40 (automatic filter cleaning activated, eco mode off) or a vacuum cleaner providing equivalent cleaning performance in combination with the specified Hilti hollow drill bit TE-CD or TE-YD.

## Table B5: Cleaning alternatives

| | |
|---|---|
| **Compressed Air Cleaning (CAC):**<br>Air nozzle with an orifice opening of minimum 3,5 mm in diameter. |  |
| **Automatic Cleaning (AC):**<br>Cleaning is performed during drilling with Hilti TE-CD and TE-YD drilling system including vacuum cleaner. |  |

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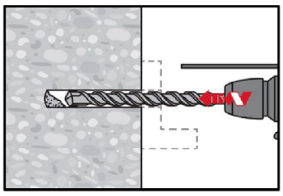
## Installation instruction

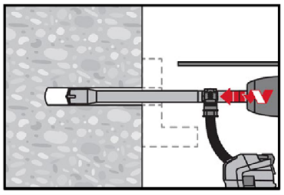
### Hole drilling

#### a) Hammer drilling



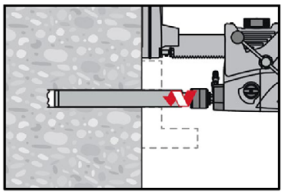
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Pre-setting: Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.

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



Pre- / Through-setting: Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with vacuum attachment following the requirements given in Table B4. This drilling system removes the dust and cleans the drill 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.

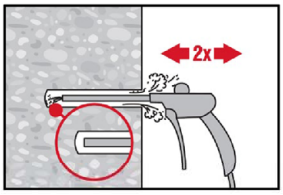
#### c) Diamond coring



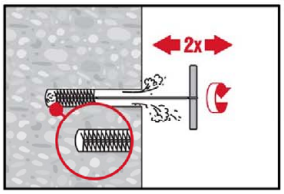
Diamond coring is permissible when suitable diamond core drilling machines and corresponding core bits are used.
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth.
Pre-setting: Drill hole to the required embedment depth.

**Drill hole cleaning:** just before setting the fastener, the drill hole must be free of dust and debris.

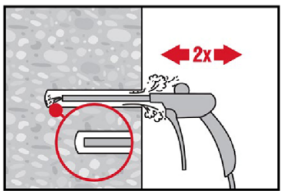
**a) Compressed Air Cleaning (CAC):** for all drill hole diameters $d_0$ and all drill hole depths $h_0$.




Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust.




Brush 2 times with the specified brush (see Table B4) 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 system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D | Annex B5 |
|---|---|
| **Intended use**<br>Installation instructions | |

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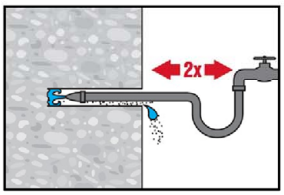
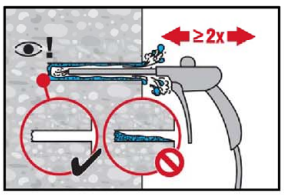
**b) Cleaning of diamond cored holes:** for all drill hole diameters $d_0$ and all drill hole depths $h_0$.

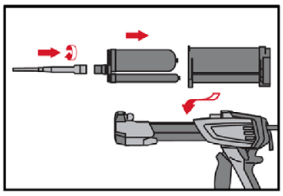



Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.

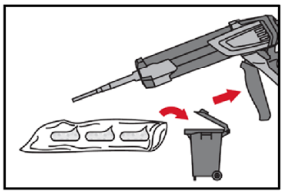



Blow 2 times from the back of the hole (if needed with nozzle extension) with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust and water.

**Injection preparation**



Tightly attach Hilti mixing nozzle HIT-RE-M to foil pack manifold. Do not modify the mixing nozzle.
Observe the instruction for use of the dispenser.
Check foil pack holder for proper function. Insert foil pack into foil pack holder and put holder into dispenser.

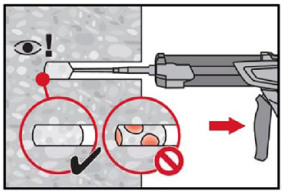


The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive must be discarded. Discarded quantities are:

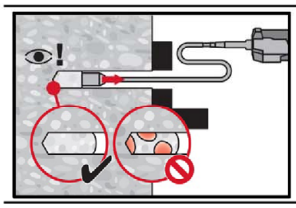
| | |
|---|---|
| 2 strokes | for 330 ml foil pack, |
| 3 strokes | for 500 ml foil pack |
| 4 strokes | for 500 ml foil pack ≤ 5°C. |

The minimum temperature of the foil pack is 0°C.

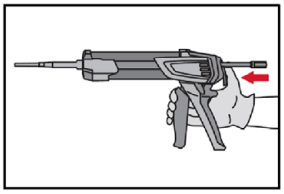
**Inject adhesive** from the back of the drill hole without forming air voids (through- and pre-setting)



Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull. The quantity of mortar should be selected so that the annular gap in the borehole is filled.



Injection is possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B4). 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. The quantity of mortar should be selected so that the annular gap in the borehole is filled.



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



| | |
|---|---|
| **Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D** | **Annex B6** |
| **Intended use**<br>Installation instructions | |

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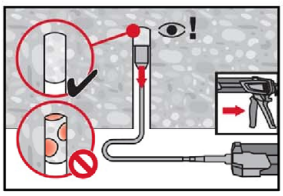
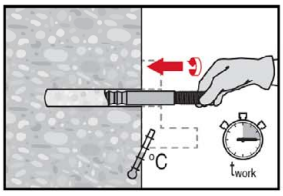
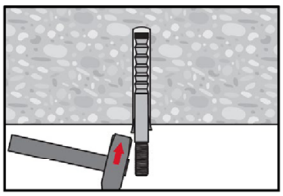


For overhead installation, the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B4). Insert piston plug to back of the hole and inject adhesive. During injection, the piston plug will be naturally extruded out of the drill hole by the adhesive pressure.

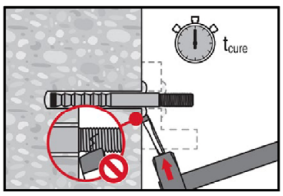
**Setting the fastener**




Before use, verify that the fastener is dry and free of oil and other contaminants. Set the fastener to the required embedment depth before working time $t_{work}$ (see Table B2 and B3) has elapsed.

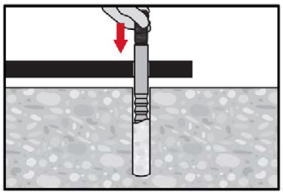


For overhead installation fix embedded parts with e.g. wedges.

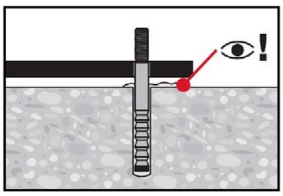



After required curing time $t_{cure}$ (see Table B2 and B3) remove excess mortar.

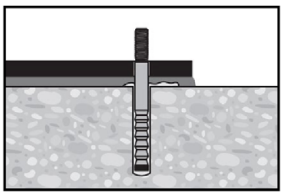
**Setting the fastener with clearance between concrete and anchor plate (only if the fastener is loaded in axial direction)**



Set the fastener to the required embedment depth before working time $t_{work}$ (see Table B2 and B3) has elapsed.



Check if mortar excess from the borehole.
The annular gap in the fixture does not have to be filled.



After required curing time $t_{cure}$ (see Table B2 and B3) backfill the anchor plate.



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| **Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D** | |
| **Intended use**<br>Installation instructions | **Annex B7** |

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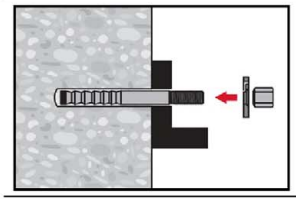
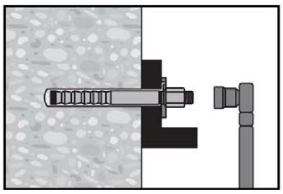
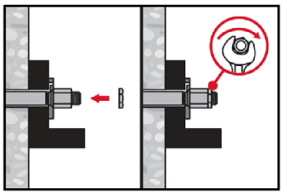
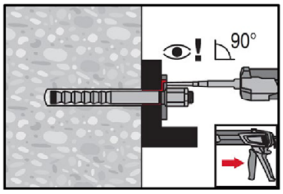
**Final assembly with sealing washer**

| | |
|---|---|
|  | Orient round part of the calotte nut to the sealing washer and install. |
|  | The required installation torque moment is given in Table B1. |
|  | Apply the lock nut and tighten with a ¼ to ½ turn. |
|  | Fill the annular gap between the anchor rod and fixture completely with Hilti injection mortar HIT-HY 200 or HIT-HY 200 V3. The static mixer nozzle must be put orthogonally on the filling hole. After required curing time $t_{cure}$ (see Table B2 and B3), the fastener can be loaded. |



| | |
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| **Injection system Hilti HIT-HY 200-A, HIT-HY 200-R, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HAS-D** | **Annex B8** |
| **Intended use**<br>Installation instructions | |

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## Table C1: Essential characteristics under tension load in concrete

| **HAS-D…** | | | | **M12** | **M16** | **M20** |
|---|---|---|---|---|---|---|
| Effective embedment depth | | $h_{ef}$ | [mm] | 100 | 125 | 170 |
| Installation safety factor | | $\gamma_{inst}$ | [-] | 1,0 | | |
| **Steel failure** | | | | | | |
| Characteristic resistance | | $N_{Rk,s}$ | [kN] | 57 | 111 | 188 |
| Partial factor | | $\gamma_{Ms,N}$ [1)] | [-] | 1,5 | | |
| **Pull-out failure** | | | | | | |
| Characteristic bond resistance in uncracked concrete C20/25 | | | | | | |
| Temperature range: 50 °C / 80 °C | | $N_{Rk,p,ucr}$ | [kN] | 49,2 | 68,8 | 109 |
| Characteristic bond resistance in cracked concrete C20/25 | | | | | | |
| Temperature range: 50 °C / 80 °C | | $N_{Rk,p,cr}$ | [kN] | 34,4 | 48,1 | 76,3 |
| Factor for the influence of concrete strength class<br>$N_{Rk,p} = N_{Rk,p,(C20/25)} \cdot \psi_c$ | | $\psi_c$ | C30/37 | 1,22 | | |
| | | | C40/50 | 1,41 | | |
| | | | C50/60 | 1,58 | | |
| **Concrete cone failure** | | | | | | |
| Factor for uncracked concrete | | $k_{ucr,N}$ | [-] | 11,0 | | |
| Factor for cracked concrete | | $k_{cr,N}$ | [-] | 7,7 | | |
| Edge distance | | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | |
| Spacing | | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | |
| **Splitting failure for standard thickness of concrete member** | | | | | | |
| Standard thickness of concrete member | | h | [mm] | 200 | 250 | 340 |
| Case 1 | Edge distance | $c_{cr,sp}$ | [mm] | $1,5 \cdot h_{ef}$ | | |
| | Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | |
| | Characteristic resistance in uncracked concrete C20/25 | $N^0_{Rk,sp}$ | [kN] | 40 | 50 | 109 |
| Case 2 | Edge distance | $c_{cr,sp}$ | [mm] | $2,0 \cdot h_{ef}$ | | $1,5 \cdot h_{ef}$ |
| | Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | |
| | Characteristic resistance in uncracked concrete C20/25 | $N^0_{Rk,sp}$ | [kN] | 49,2 | 68,8 | 109 |

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## Table C1 continued

| **Splitting failure for minimum thickness of concrete member** | | | | | | |
|---|---|---|---|---|---|---|
| Minimum thickness of concrete member | | $h_{min}$ | [mm] | 130 | 160 | 220 |
| Case 1 | Edge distance | $c_{cr,sp}$ | [mm] | $1,5 \cdot h_{ef}$ | | |
| | Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | |
| | Characteristic resistance in uncracked concrete C20/25 | $N^0_{Rk,sp}$ | [kN] | 30 | 40 | 75 |
| Case 2 | Edge distance | $c_{cr,sp}$ | [mm] | $3,0 \cdot h_{ef}$ | | $2,6 \cdot h_{ef}$ |
| | Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | |
| | Characteristic resistance in uncracked concrete C20/25 | $N^0_{Rk,sp}$ | [kN] | 49,2 | 68,8 | 109 |

1) In absence of national regulations.

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## Table C2: Essential characteristics under shear load in concrete

| HAS-D… | | | M12 | M16 | M20 |
|---|---|---|---|---|---|
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | |
| **Steel failure without lever arm** | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 34 | 63 | 149 |
| Partial factor | $\gamma_{Ms,V}$ 1) | [-] | 1,25 | | |
| Ductility factor | $k_7$ | | 1,0 | | |
| **Steel failure with lever arm** | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 105 | 266 | 519 |
| Partial factor | $\gamma_{Ms,V}$ 1) | [-] | 1,25 | | |
| **Concrete pry-out failure** | | | | | |
| Pry-out factor | $k_8$ | [-] | 2,0 | | |
| **Concrete edge failure** | | | | | |
| Effective length of fastener | $l_f$ | [mm] | 100 | 125 | 170 |
| Outside diameter of fastener | $d_{nom}$ | [mm] | 14 | 18 | 24 |
| Partial factor | $\gamma_{Mc}$ 1) | [-] | 1,5 | | |

1) In absence of national regulations.

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## Table C3: Displacements under tension load in concrete[1)]

| HAS-D… | | | M12 | M16 | M20 |
|---|---|---|---|---|---|
| **Uncracked concrete** | | | | | |
| Displacement | $\delta_{N0}$-Factor | [mm/kN] | 0,017 | 0,018 | 0,011 |
| Displacement | $\delta_{N\infty}$-Factor | [mm/kN] | 0,054 | 0,039 | 0,024 |
| **Cracked concrete** | | | | | |
| Displacement | $\delta_{N0}$-Factor | [mm/kN] | 0,035 | 0,029 | 0,021 |
| Displacement | $\delta_{N\infty}$-Factor | [mm/kN] | 0,076 | 0,054 | 0,034 |

1) Calculation of the displacement:

$\delta_{N0} = \delta_{N0}$-Faktor · N; $\delta_{N\infty} = \delta_{N\infty}$-Faktor · N; (N: applied tension force).

## Table C4: Displacements under shear load in concrete[1)]

| HAS-D… | | | M12 | M16 | M20 |
|---|---|---|---|---|---|
| Displacement | $\delta_{V0}$-Factor | [mm/kN] | 0,17 | 0,11 | 0,057 |
| Displacement | $\delta_{V\infty}$-Factor | [mm/kN] | 0,26 | 0,16 | 0,087 |

1) Calculation of the displacement:

$\delta_{V0} = \delta_{V0}$-factor · V; $\delta_{V\infty} = \delta_{V\infty}$-factor · V; (V: applied shear force).