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-17/0200 of 5 October 2020

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 | Hilti bonded anchor HVZ dynamic |
| Product family to which the construction product belongs | Post-installed fasteners in concrete under fatigue cyclic loading |
| Manufacturer | HILTI Corporation<br>Feldkircherstraße 100<br>9494 SCHAAN<br>FÜRSTENTUM LIECHTENSTEIN |
| Manufacturing plant | Hilti Werke |
| This European Technical Assessment contains | 18 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 330250-00-0601, Edition 09/2019 |



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## Specific Part

### 1 Technical description of the product

The Hilti bonded anchor HVZ dynamic is a torque controlled bonded anchor which is anchored into a drilled hole in the concrete. The anchor consists of an anchor rod HAS-(HCR)-TZ, a dynamic-set (nut, sealing washer, spherical washer and nut lock), a foil capsule with mortar Hilti HVU-TZ and the Hilti injection mortar HIT-HY 200-A or HIT-HY 200-R.

The special formed anchor rod is driven into the foil capsule by machine with simultaneous hammering and turning. The load transfer is realized by mechanical interlock of several cones in the bonding mortar and then via a combination of bonding and friction forces in the concrete. The annular gap between anchor rod and fixture must be filled up with injection mortar HIT-HY 200-A or HIT-HY 200-R.

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 fastener 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 fastener 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 fatigue resistance under cyclic tension loading (Assessment method B) | |
| Characteristic steel fatigue resistance | See Annex C1 |
| Characteristic concrete cone, pull-out, splitting and blow out fatigue resistance | |
| Characteristic fatigue resistance under cyclic shear loading (Assessment method B) | |
| Characteristic steel fatigue resistance | See Annex C2 |
| Characteristic concrete edge fatigue resistance | |
| Characteristic concrete pry out fatigue resistance | |
| Characteristic fatigue resistance under cyclic combined tension and shear loading (Assessment method B) | |
| Characteristic steel fatigue resistance | See Annex C2 |
| Load transfer factor for cyclic tension and shear loading | |
| Load transfer factor | See Annex C1 and C2 |

## 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 330250-00-0601 the applicable European legal act is: 1996/582/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 with Deutsches Institut für Bautechnik.

Issued in Berlin 5 October 2020 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

*beglaubigt:*
Baderschneider

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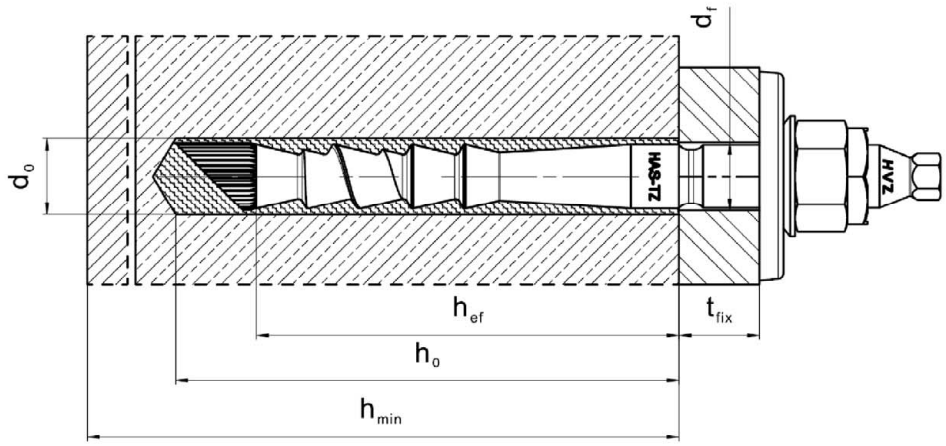
## Installed condition




| Hilti bonded anchor HVZ dynamic | Annex A1 |
|---|---|
| **Product description**<br>Installed condition | |

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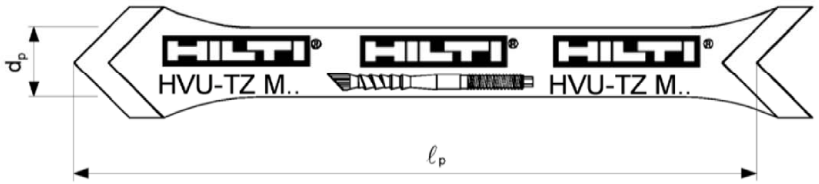
## Product description: Mortar capsule, fastener, filling set and injection mortar

**Mortar capsule HVU-TZ:** resin and hardener with aggregate

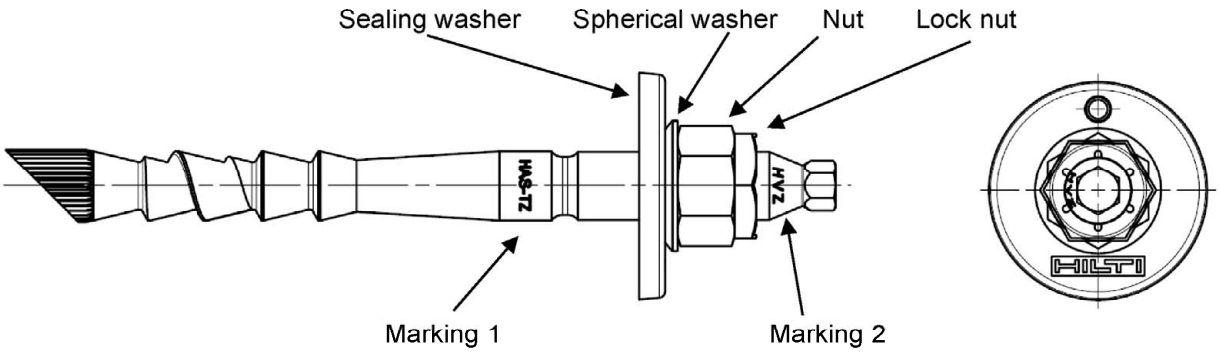
Marking:
HVU-TZ M .. .
Expiry date mm/yyyy




### Table A1: Marking and dimensions – mortar capsule

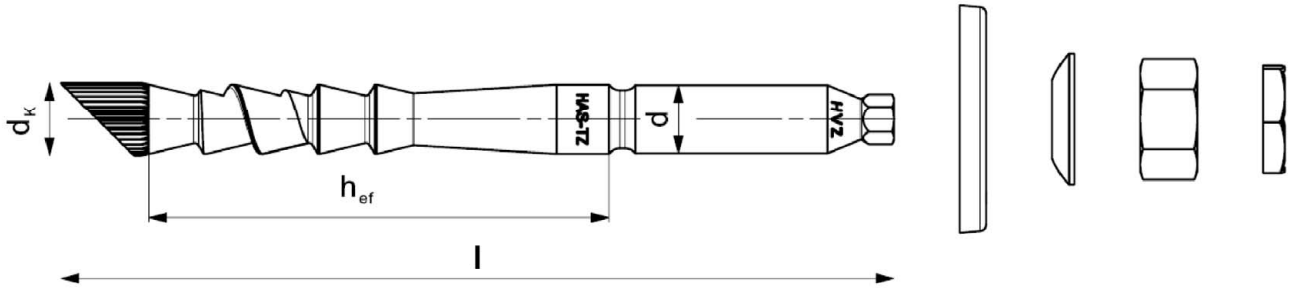
| Size | | | M10 | M12 | M16 |
|---|---|---|---|---|---|
| Diameter of mortar capsule | $d_p$ | [mm] | 11 | 13 | 17 |
| Length of mortar capsule | $l_p$ | [mm] | 110 | 127 | 140 |

**Fastener: Hilti HAS-(HCR)-TZ: M10, M12 and M16 with filling set**




Marking 1:
HAS-(HCR)-TZ M…/$t_{fix}$ Fastener type as well as size and fixture thickness

Marking 2:
HVZ $h_{ef}$ Fastener type as well as embedment depth






| Hilti bonded anchor HVZ dynamic | Annex A2 |
|---|---|
| **Product description**<br>Mortar capsule / steel element | |

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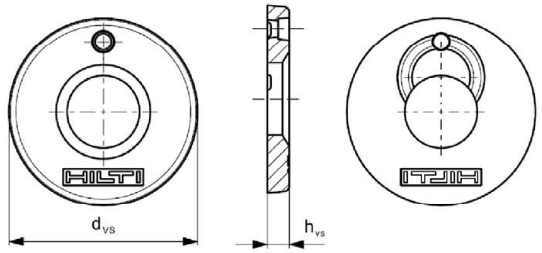
## Table A2: Marking and dimensions – fastener

| **HAS-TZ…** | | | **M10x75** | | **M12x95** | | | **M16x105** | | | **M16x125** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HAS-HCR-TZ…** | | | | | **M12x95** | | | | | | **M16x125** | | |
| Marking 1: | | | M10/$t_{fix}$ | | M12/$t_{fix}$ | | | M16/$t_{fix}$ | | | M16L/$t_{fix}$ | | |
| | $t_{fix}$ [1] | [mm] | 30 | 50 | 40 | 50 | 100 | 30 | 60 | 100 | 30 | 60 | 100 |
| Min. fixture thickness | min. $t_{fix}$ [1] | [mm] | 10 | | 10 | | | 16 | | | | | |
| Max. fixture thickness | max. $t_{fix}$ [1] | [mm] | 21 | 41 | 30 | 40 | 90 | 19 | 49 | 89 | 19 | 49 | 89 |
| Marking 2: HVZ | $h_{ef}$ | [mm] | 75 | | 95 | | | 105 | | | 125 | | |
| Total length of fastener | l [1] | [mm] | 139 | 159 | 173 | 183 | 233 | 181 | 211 | 251 | 201 | 231 | 271 |
| Shaft diameter | d | [mm] | 10 | | 12 | | | 16 | | | | | |
| Diameter at tip | $d_k$ | [mm] | 10,8 | | 12,8 | | | 16,8 | | | | | |

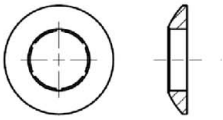
[1] Other fixture thicknesses and fastener lengths are possible; max. l = 450 mm.

**Hilti Filling Set to fill the annular gap between anchor and fixture**

Sealing washer




Spherical washer



## Table A3: Dimensions Filling Set

| **Size** | | | **M10** | **M12** | **M16** |
|---|---|---|---|---|---|
| Diameter of sealing washer | $d_{vs}$ | [mm] | 42 | 44 | 52 |
| Thickness of sealing washer | $h_{vs}$ | [mm] | 5 | | 6 |



**Hilti bonded anchor HVZ dynamic**

**Product description**
Steel element

**Annex A3**

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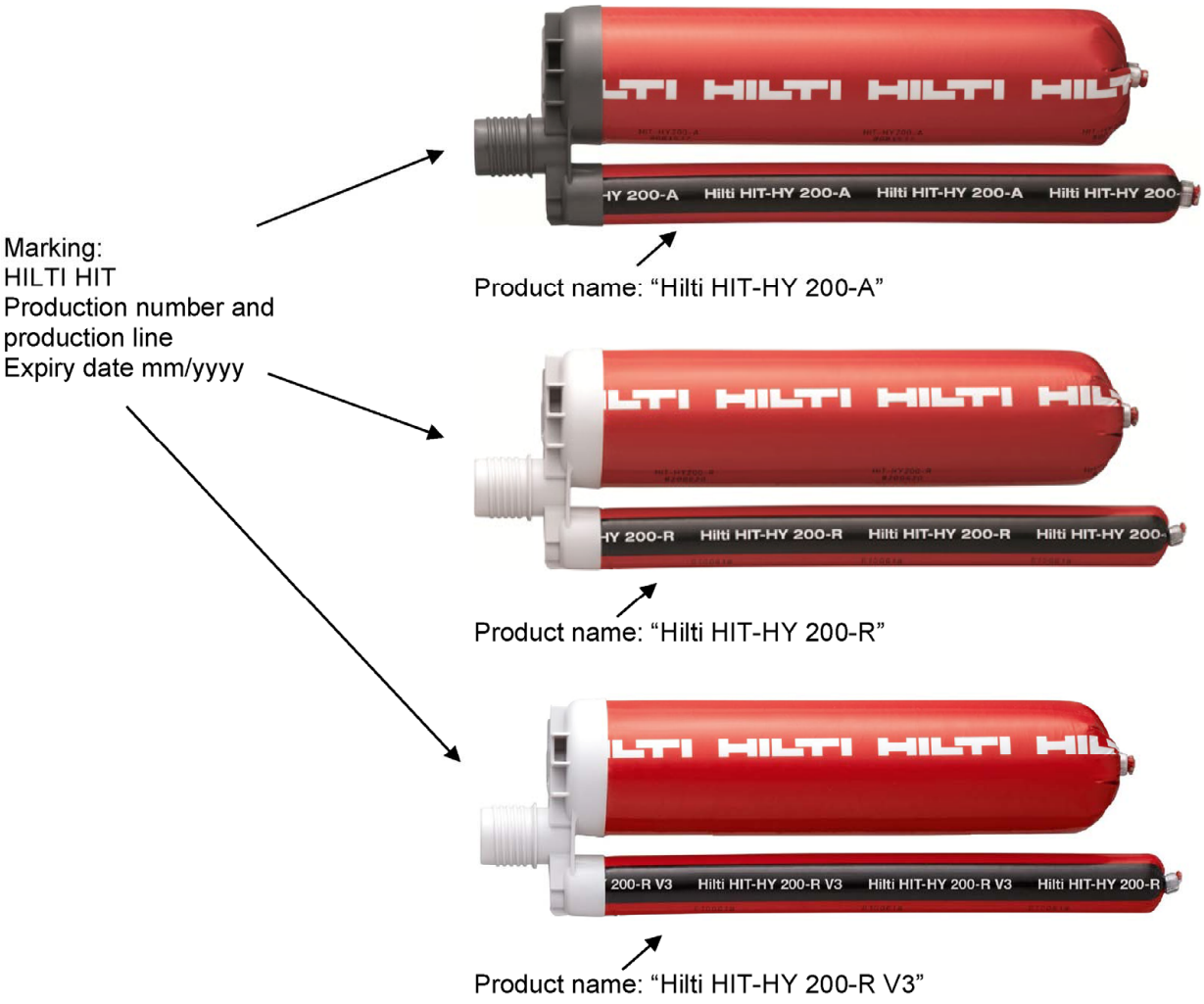
**Injection mortar Hilti HIT-HY 200-A, Hilti HIT-HY 200-R and Hilti HIT-HY 200-R V3:** hybrid system with aggregate

Foil pack 330 ml and 500 ml




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



| **Hilti bonded anchor HVZ dynamic** | **Annex A4** |
|---|---|
| **Product description**<br>Injection mortar / Static mixer | |

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## Table A4: Materials

| Designation | Material |
|---|---|
| **Metal parts made of zinc coated steel** | |
| Anchor rod HAS-TZ | Coated, elongation at fracture ($l_0$=5d) > 8% ductile |
| Filling washer | Electroplated zinc coated ≥ 5 µm |
| Spherical washer | Electroplated zinc coated ≥ 5 µm |
| Nut | Electroplated zinc coated ≥ 5 µm |
| Lock nut | Electroplated zinc coated ≥ 5 µm |
| **Metal parts made of stainless steel and high corrosion resistant steel**<br>Corrosion resistance class III acc. to EN 1993-1-4:2006+A1:2015 | |
| Anchor rod HAS-HCR-TZ | Stainless steel 1.4529, elongation at fracture ($l_0$=5d) > 8% ductile |
| Filling washer | Stainless steel |
| Spherical washer | Stainless steel |
| Nut | Stainless steel 1.4529 |
| Lock nut | Stainless steel |

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## Specifications of intended use

**Anchorages subject to:**

- Fatigue cycling load.
  Note: static and quasi-static load according to EN 1992-4:2018 and ETA-03/0032.

**Base material:**

- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A1:2016.
- Strength classes C20/25 to C50/60 according to EN 206:2013+A1:2016.
- Cracked and uncracked concrete.

**Temperature in the base material:**

- **at installation**
  0 °C to +40 °C
- **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 (all materials).
- 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).

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 fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Anchorages under fatigue cycling load are designed in accordance with:
  EN 1992-4:2018 and EOTA Technical Report TR 061.

**Installation:**

- Concrete condition I1: dry or wet concrete (not in flooded holes).
- Drilling techniques:
  - hammer drilling,
  - hammer drilling with hollow drill bit TE-CD, TE-YD.
- Installation direction D3: downward, horizontal and upwards (e.g. overhead) installation.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.



| Hilti bonded anchor HVZ dynamic | Annex B1 |
|---|---|
| **Intended use**<br>Specifications | |

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## Table B1: Installation parameters

| **HAS-TZ…** | | | | **M10x75** | **M12x95** | **M16x105** | **M16x125** |
|---|---|---|---|---|---|---|---|
| **HAS-HCR-TZ…** | | | | | **M12x95** | | **M16x125** |
| Nominal diameter of fastener | | $d$ | [mm] | 10 | 12 | 16 | |
| Nominal diameter of drill bit | | $d_0$ | [mm] | 12 | 14 | 18 | |
| Max. cutting diameter of drill bit | | $d_{cut}$ | [mm] | 12,5 | 14,5 | 18,5 | |
| Nominal drill hole depth | | $h_0$ | [mm] | 90 | 110 | 125 | 145 |
| Effective embedment depth | | $h_{ef}$ | [mm] | 75 | 95 | 105 | 125 |
| Minimum thickness of concrete member | | $h_{min}$ | [mm] | 150 | 190 | 160 | 190 |
| Max. diameter of clearance hole in the fixture | | $d_f$ | [mm] | 14 | 16 | 20 | |
| Fixture thickness | | $t_{fix}$[1)] | [mm] | 10 / 21 / 41 | 10 / 30<br>40 / 90 | 16 / 19 / 49 / 89 | |
| Installation torque | HAS-TZ | $T_{inst}$ | [Nm] | 40 | 50 | 90 | |
| | HAS-HCR-TZ | $T_{inst}$ | [Nm] | 50 | 70 | 100 | |
| Uncracked concrete | Minimum spacing | $s_{min,ucr}$ | [mm] | 50 | 60 | 70 | |
| | Minimum edge distance | $c_{min,ucr}$ | [mm] | 50 | 70 | 85 | |
| Cracked concrete | Minimum spacing | $s_{min,cr}$ | [mm] | 50 | 60 | 70 | |
| | Minimum edge distance | $c_{min,cr}$ | [mm] | 50 | 60 | 70 | |

[1)] Other fixture thickness' are possible.



**Hilti bonded anchor HVZ dynamic**

**Intended use**
Installation parameters

**Annex B2**

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## Table B2: Curing time of mortar capsule HVU-TZ[1)]

| Temperature in the base material T | Curing time: release screwed on setting tool $t_{rel}$ | Curing time: full load $t_{cure}$ |
|---|---|---|
| 0 °C to 9 °C | 30 min | 1 h |
| 10 °C to 19 °C | 20 min | 30 min |
| 20 °C to 40 °C | 8 min | 20 min |

[1)] The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.

## Table B3: Working and curing time of injection mortar HIT-HY 200-A[1)]

| Temperature in the base material T | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
|---|---|---|
| 0 °C to 5 °C | 25 min | 2 h |
| > 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 |

[1)] The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.

## Table B4: Working and curing time of injection mortar HIT-HY 200-R[1)]

| Temperature in the base material T | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
|---|---|---|
| 0 °C to 5 °C | 1 h | 4 h |
| > 5 °C to 10 °C | 40 min | 2,5 h |
| > 10 °C to 20 °C | 15 min | 1,5 h |
| > 20 °C to 30 °C | 9 min | 1 h |
| > 30 °C to 40 °C | 6 min | 1 h |

[1)] The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.

## Table B5: Working and curing time of injection mortar HIT-HY 200-R V3[1)]

| Temperature in the base material T | Maximum working time $t_{work}$ | Minimum curing time $t_{cure}$ |
|---|---|---|
| 0 °C to 5 °C | 45 h | 4 h |
| > 5 °C to 10 °C | 30 min | 2,5 h |
| > 10 °C to 20 °C | 15 min | 1,5 h |
| > 20 °C to 30 °C | 9 min | 1 h |
| > 30 °C to 40 °C | 6 min | 1 h |

[1)] The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.

**Hilti bonded anchor HVZ dynamic**

**Intended use**
Working and curing time

**Annex B3**

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## Table B6: Parameters of drilling and setting tool

| Fastener | Drill | | Setting tool |
|---|---|---|---|
| HAS-(HCR)-TZ | Hammer drilling | | |
| | | Hollow drill bit TE-CD, TE-YD | |
| |  |  |  |
| Size | $d_0$ [mm] | $d_0$ [mm] | |
| M10 | 12 | - | TE-C HEX M10 |
| M12 | 14 | 14 | TE-C HEX M12 |
| M16 | 18 | 18 | TE-C HEX M16 |

## Table B7: Cleaning alternatives

| | |
|---|---|
| **Manual cleaning (MC):**<br>Hilti hand pump for blowing out drill holes. |  |
| **Automatic Cleaning (AC):**<br>Cleaning is performed during drilling with Hilti TE-CD and TE-YD drilling system including vacuum cleaner. |  |



| Hilti bonded anchor HVZ dynamic | Annex B4 |
|---|---|
| **Intended use**<br>Drilling, cleaning and setting tools | |

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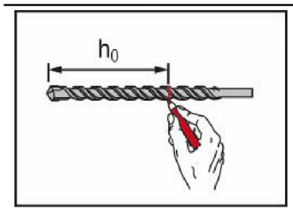
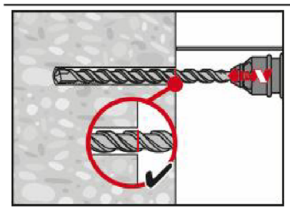
## Installation instruction

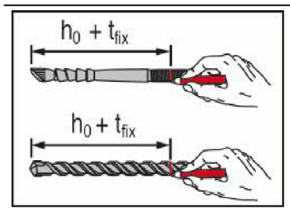
### Hole drilling



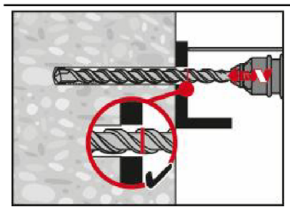

Pre-setting:
Mark drill hole depth $h_0$ on drill bit TE-C, TE-Y, TE-CD or TE-YD or set the depth gauge of the drilling machine to drill hole depth $h_0$.



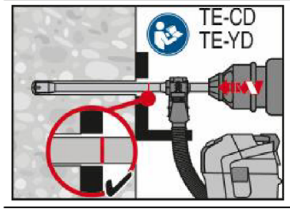
Pre-setting:
Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Do not drill deeper.




Through-setting:
Mark setting depth $h_0 + t_{fix}$ on element.
Mark drill hole depth $h_0 + t_{fix}$ on drill bit TE-C, TE-Y, TE-CD or TE-YD or set the depth gauge of the drilling machine to drill hole depth $h_0 + t_{fix}$.

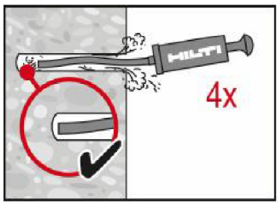


Through-setting:
Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Do not drill deeper.




Pre- / Through-setting:
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 removes dust while drilling. After drilling is complete, proceed to the “check setting depth” step in the instructions for use.

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




The Hilti hand pump may be used for blowing out drill holes.
Blow out at least 4 times from the back of the drill hole until return air stream is free of noticeable dust.

| **Hilti bonded anchor HVZ dynamic** | **Annex B5** |
|---|---|
| **Intended use**<br>Installation instructions | |

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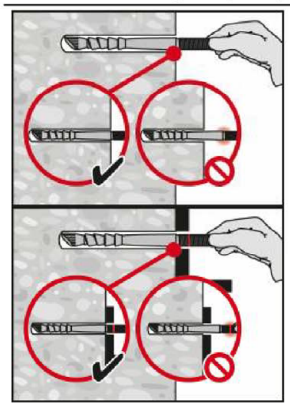
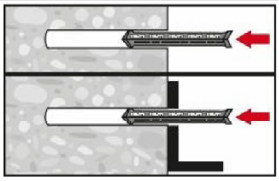
**Check setting depth** (Pre- and through-setting)

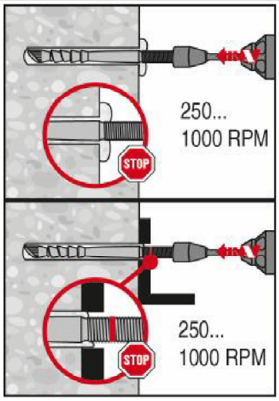


Check the setting depth with the marked element.
The element has to fit in the hole until the required embedment depth (pre-setting) or until the fixture surface.
If it is not possible to insert the element to the required embedment depth, drill deeper.

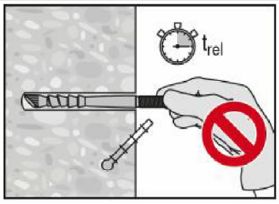
**Setting the element** (Pre- and through-setting)



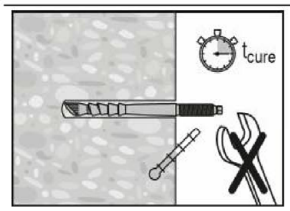
Push the anchor foil capsule with the peak ahead to the back of the hole.




Drive the anchor rod with the plugged on or screwed on setting tool (see Table B6) into the hole, applying moderate pressure and with the hammering action switched on (250 RPM to maximum 1000 RPM).
After reaching the embedment depth switch off setting machine.




After required curing time $t_{rel}$ (see Table B2) the screwed-on setting tool can be removed.




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



| **Hilti bonded anchor HVZ dynamic** | **Annex B6** |
|---|---|
| **Intended use**<br>Installation instructions | |

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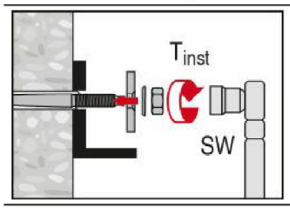
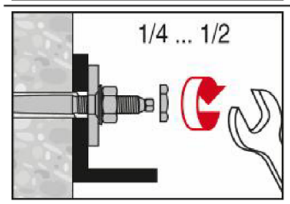
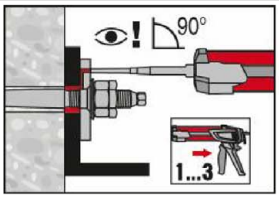
**Final assembly with filling set** (Pre- and through-setting)




The required installation torque is given in Table B1.




Apply the lock nut and tighten with a ¼ to ½ turn.




Fill annular gap between anchor rod and fixture with injection mortar Hilti HIT-HY 200 with approximately 1 to 3 trigger pull.

The static mixer nozzle must be put orthogonally on the filling hole.
Follow the installation instructions supplied with the HIT-HY 200 foil pack.
After required curing time $t_{cure}$ (see Table B3, B4 and B5), the fastener can be loaded.



| **Hilti bonded anchor HVZ dynamic** | **Annex B7** |
|---|---|
| **Intended use**<br>Installation instructions | |

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

| HAS-… | | | TZ | | | | HCR-TZ | |
|---|---|---|---|---|---|---|---|---|
| **Size** | | | **M10x75** | **M12x95** | **M16x105** | **M16x125** | **M12x95** | **M16x125** |
| **Steel failure** | | | | | | | | |
| Characteristic resistance | $\Delta N_{Rk,s,0,\infty}$ | [kN] | 10,0 | 18,0 | 20,0 | 26,0 | 15,0 | 20,8 |
| Partial factor | $\gamma_{Ms,N,fat}$ | [-] | 1,35 | | | | | |
| Load transfer factor for fastener group | $\psi_{FN}$ | [-] | 0,69 | | | | | |
| **Concrete failure** | | | | | | | | |
| Partial factor | $\gamma_{Mc,fat}$ | [-] | 1,5 | | | | | |
| Characteristic concrete cone resistance | | | $\Delta N_{Rk,c,0,\infty} = \eta_{k,c,N,fat,\infty} \cdot N_{Rk,c}$ [1)] | | | | | |
| Effective embedment depth | $h_{ef}$ | [mm] | 75 | 95 | 105 | 125 | 95 | 125 |
| Reduction factor | $\eta_{k,c,N,fat,\infty}$ | [-] | 0,6 | | | | | |
| Characteristic splitting resistance | | | $\Delta N_{Rk,sp,0,\infty} = \eta_{k,sp,N,fat,\infty} \cdot N_{Rk,sp}$ [2)] | | | | | |
| Reduction factor | $\eta_{k,sp,N,fat,\infty}$ | [-] | 0,6 | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2 \cdot c_{cr,sp}$ | | | | | |
| For member thickness $h \geq 2\ h_{ef}$ | | | | | | | | |
| Edge distance | $c_{cr,sp}$ | [mm] | $1{,}5 \cdot h_{ef}$ | | | | | |
| Minimum member thickness | $h_{min}$ [3)] | [mm] | 150 | 190 | 210 | 250 | 190 | 250 |
| For member thickness $h < 2\ h_{ef}$ | | | | | | | | |
| Edge distance | $c_{cr,sp}$ | [mm] | 4) | 4) | $2 \cdot h_{ef}$ | $3 \cdot h_{ef}$ | 4) | 4) |
| Minimum member thickness | $h_{min}$ [3)] | [mm] | 4) | 4) | 160 | 190 | 4) | 4) |
| **Pull-out failure** | | | $\Delta N_{Rk,p,0,\infty} = \eta_{k,p,N,fat,\infty} \cdot N_{Rk,p}$ [5)] | | | | | |
| Partial factor | $\gamma_{Mp,N,fat}$ | [-] | 1,5 | | | | | |
| Reduction factor | $\eta_{k,p,N,fat,\infty}$ | [-] | 0,6 | | | | | |
| Characteristic resistance in uncracked concrete C20/25 | $N_{Rk,p}$ | [kN] | 5) | 40 | 5) | 5) | 40 | 5) |
| Characteristic resistance in cracked concrete C20/25 | $N_{Rk,p}$ | [kN] | 5) | 5) | 5) | 5) | 5) | 5) |

1) $N_{Rk,c}$ according to EN 1992-4:2018 with $N^0_{Rk,c}$ with $k_{cr,N} = 7{,}7$ and $k_{ucr,N} = 11{,}0$.
2) $N_{Rk,sp}$ according to EN 1992-4:2018 with $N^0_{Rk,sp} = \min(N_{Rk,p}; N^0_{Rk,c})$.
3) Minimum member thickness to be used for splitting failure.
4) No performance assessed.
5) $N_{Rk,p} = N_{Rk,c}$ with $N_{Rk,c}$ according to EN 1992-4:2018 with $N^0_{Rk,c}$ with $k_{cr,N} = 7{,}7$ and $k_{ucr,N} = 11{,}0$.



**Hilti bonded anchor HVZ dynamic**

**Performance**
Essential characteristics under tension fatigue load in concrete

**Annex C1**

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

| HAS-… | | | TZ | | | | HCR-TZ | |
|---|---|---|---|---|---|---|---|---|
| **Size** | | | **M10x75** | **M12x95** | **M16x105** | **M16x125** | **M12x95** | **M16x125** |
| **Steel failure** | | | | | | | | |
| Characteristic resistance | $\Delta V_{Rk,s,0,\infty}$ | [kN] | 4,5 | 8,5 | 15,0 | 15,0 | 8,5 | 7,6 |
| Partial factor | $\gamma_{Ms,V,fat}$ | [-] | 1,35 | | | | | |
| Load transfer factor for fastener group | $\psi_{FV}$ | [-] | 0,77 | | | | | |
| **Concrete failure** | | | | | | | | |
| Partial factor | $\gamma_{Mc,fat}$ | [-] | 1,5 | | | | | |
| Characteristic concrete edge resistance | | | $\Delta V_{Rk,c,0,\infty} = \eta_{k,c,V,fat,\infty} \cdot V_{Rk,c}$ [1)] | | | | | |
| Effective length of fastener | $l_f$ | [mm] | 75 | 95 | 105 | 125 | 95 | 125 |
| Effective outside diameter of fastener | $d_{nom}$ | [mm] | 10 | 12 | 16 | 16 | 12 | 16 |
| Reduction factor | $\eta_{k,c,V,fat,\infty}$ | [-] | 0,6 | | | | | |
| Characteristic pry out resistance | | | $\Delta V_{Rk,cp,0,\infty} = \eta_{k,cp,V,fat,\infty} \cdot V_{Rk,cp}$ [2)] | | | | | |
| Reduction factor | $\eta_{k,cp,V,fat,\infty}$ | [-] | 0,6 | | | | | |

1) $V_{Rk,c}$ according to EN 1992-4:2018.
2) $V_{Rk,cp}$ according to EN 1992-4:2018 with $k_8$ = 2,0.

## Table C3: Essential characteristics under combined fatigue load in concrete

| HAS-… | | | TZ | | | | HCR-TZ | |
|---|---|---|---|---|---|---|---|---|
| **Size** | | | **M10x75** | **M12x95** | **M16x105** | **M16x125** | **M12x95** | **M16x125** |
| **Steel failure** | | | | | | | | |
| Exponent for combined fatigue load | $\alpha_s$ | [-] | 0,75 | 0,85 | 0,7 | 0,7 | 0,5 | 0,7 |
| **Concrete failure** | | | | | | | | |
| Exponent for combined fatigue load | $\alpha_c$ | [-] | 1,5 | | | | | |