Deutsches Institut für Bautechnik DIBt

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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-19/0802 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-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP
Product family to which the construction product belongs	Post-installed fasteners in concrete , under fatigue cyclic loading
Manufacturer	Hilti Aktiengesellschaft Feldkircherstrasse 100 9494 SCHAAN FÜRSTENTUM LIECHTENSTEIN
Manufacturing plant	Hilti Plants
This European Technical Assessment contains	22 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 06/2021
This version replaces	ETA-19/0802 issued on 15 April 2020

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Specific Part

1 Technical description of the product

The injection systems Hilti HIT-HY 200-A, HIT-HY 200-A V3 or HIT-HY 200-R V3 with HIT-Z-D TP or HIT-Z-R-D TP are bonded expansion fasteners consisting of a cartridge with injection mortar Hilti HIT-HY 200-A or Hilti HIT 200-A V3 or Hilti HIT 200-R V3, a steel element HIT-Z-D TP with a lock nut, a calotte nut and a Hilti sealing washer or a steel element HIT-Z-R-D TP with a lock nut, a hexagon nut, a spherical washer and a Hilti sealing washer.

The load transfer is realised by mechanical interlock of several cones in the bonding mortar and then via a combination of bonding and friction forces in the base material (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 (static and quasi-static loading and seismic loading)	**Performance**
Characteristic resistance to tension load (static and quasi-static loading)	see Annex B2, B3, C1
Characteristic resistance to shear load (static and quasi-static loading)	see Annex C2
Displacements under short-term and long-term loading (static and quasi-static loading)	No performance assessed on basis of EAD 330250-00-0601
Characteristic resistance and displacements for seismic performance categories C1 and C2	

Essential characteristic (fatigue loading, Assessment method A: Continuous function of fatigue resistance)	**Performance**
Characteristic fatigue resistance under cyclic tension loading	
Characteristic steel fatigue resistance $\Delta N_{Rk,s,0,n}$ (n = 1 to n = ∞)	See Annex C3 and C5
Characteristic concrete cone, pull-out and splitting fatigue resistance $\Delta N_{Rk,c,0,n}$ $\Delta N_{Rk,p,0,n}$ $\Delta N_{Rk,sp,0,n}$ (n = 1 to n = ∞)	

Essential characteristic (fatigue loading, Assessment method A: Continuous function of fatigue resistance)	**Performance**
Characteristic fatigue resistance under cyclic shear loading	
Characteristic steel fatigue resistance $\Delta V_{Rk,s,0,n}$ (n = 1 to n = ∞)	See Annex C4 and C5
Characteristic concrete edge fatigue resistance $V_{Rk,c,0,n}$ (n = 1 to n = ∞)	
Characteristic concrete pry out fatigue resistance $\Delta V_{Rk,cp,0,n}$ (n = 1 to n = ∞)	
Characteristic fatigue resistance under cyclic combined tension and shear loading	
Characteristic steel fatigue resistance a_{sn} (n = 1 to n = ∞)	See Annex C6
Load transfer factor for cyclic tension and shear loading	
Load transfer factor ψ_{FN}, ψ_{FV}	See Annex C3 to C5

3.2 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 European Assessment Document No. 330250-00-0601, 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 with Deutsches Institut für Bautechnik.

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

-	EN 10088-1:2014	Stainless steels - Part 1: List of stainless steels
-	EN 206:2013 + A1:2016	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

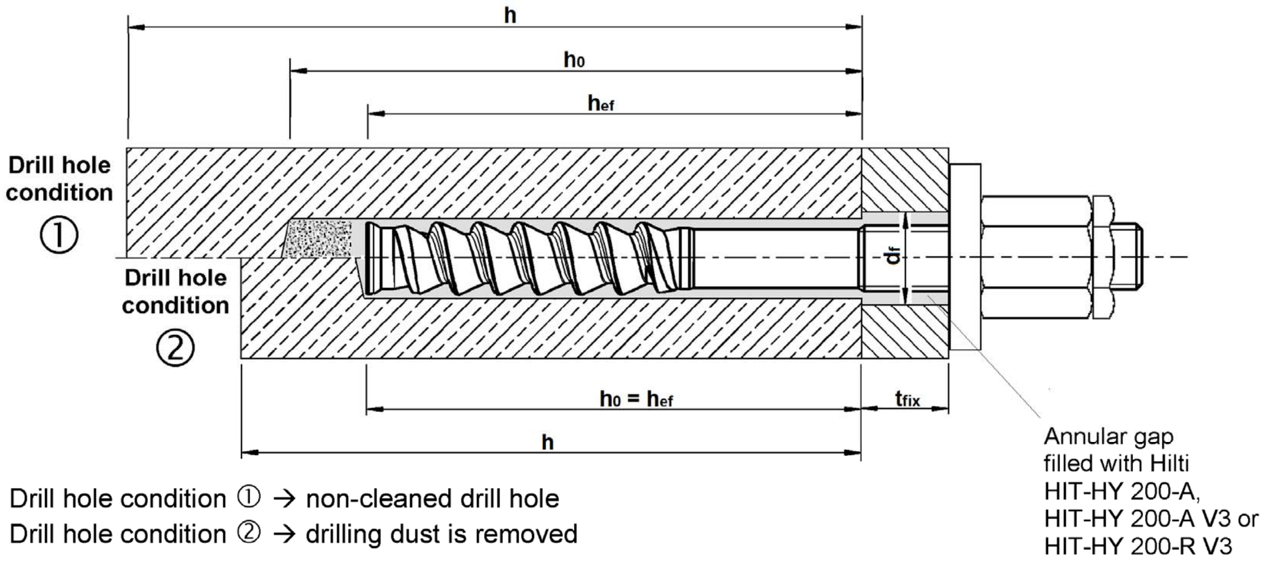
Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Stiller

Installed condition

Figure A1:

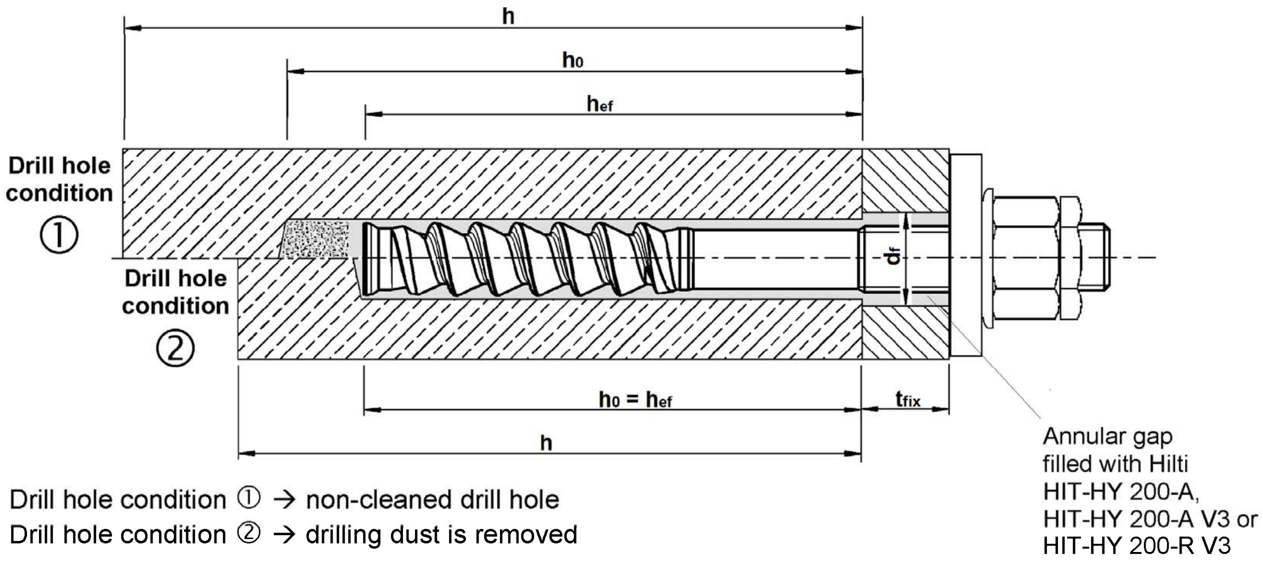
HIT-Z-D TP



Drill hole condition ① → non-cleaned drill hole
Drill hole condition ② → drilling dust is removed

Figure A2:

HIT-Z-R-D TP



Drill hole condition ① → non-cleaned drill hole
Drill hole condition ② → drilling dust is removed

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	**Annex A1**
Product description Installed condition	

Product description: Injection mortar

Injection mortar Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3:
Hybrid system with aggregate, 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-A V3
Production time and production line
Expiry date mm/yyyy

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

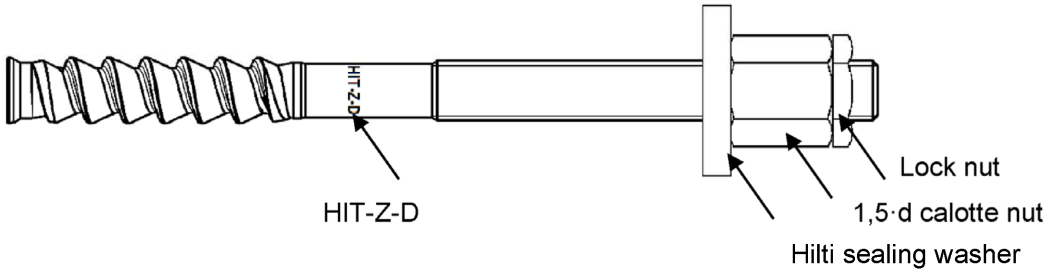
Marking:
HILTI HIT
HY 200-R V3
Production time and production line
Expiry date mm/yyyy

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

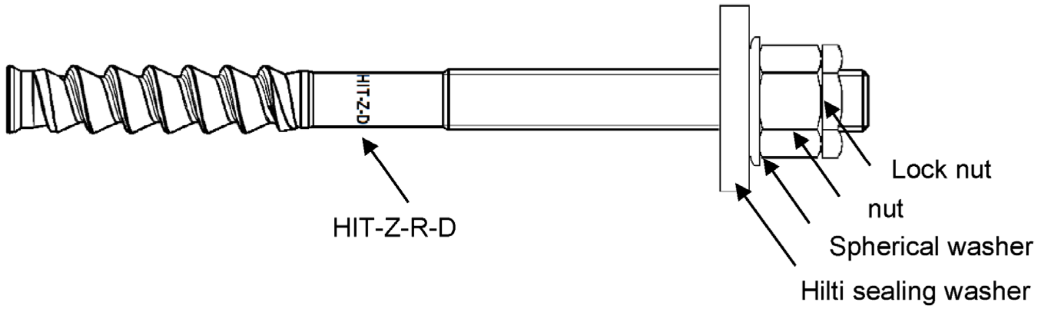
Static mixer Hilti HIT-RE-M

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	Annex A2
Product description Injection mortar / Static mixer	

Fastener HIT-Z-D TP M16



Fastener HIT-Z-R-D TP M16



Hilti Filling Set to fill the annular gap between fastener and fixture

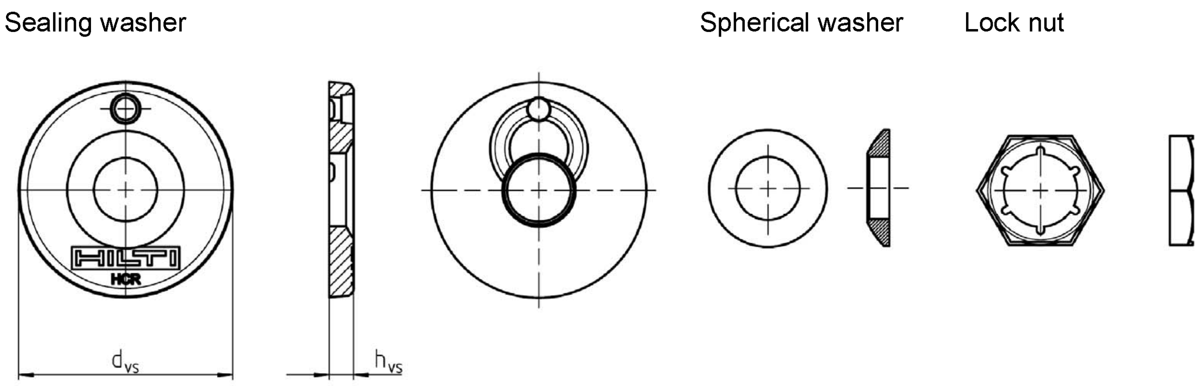


Table A1: Geometry of Hilti filling set

Size	**M16**
Diameter of sealing washer d_{vs} [mm]	52
Thickness of sealing washer h_{vs} [mm]	6

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP

Product description
Steel elements / Filling set

Annex A3

Table A2: Materials

Designation	Material
Metal parts made of zinc coated steel	
Anchor rod HIT-Z-D TP M16	f_{uk} = 610 N/mm²; f_{yk} = 490 N/mm² Elongation at fracture (l_0=5d) > 8% ductile Electroplated zinc coated ≥ 5 µm
Filling washer	Electroplated zinc coated ≥ 5 µm
Calotte nut	Hexagon nut with a height of 1,5 d Electroplated zinc coated ≥ 5 µm
Lock nut	Electroplated zinc coated ≥ 5 µm
Metal parts made of stainless steel **Corrosion resistance class III according EN 1993-1-4**	
Anchor rod HIT-Z-R-D TP M16	f_{uk} = 610 N/mm²; f_{yk} = 490 N/mm² Elongation at fracture (l_0=5d) > 8% ductile Stainless steel 1.4401, 1.4404 EN 10088-1
Filling washer	Stainless steel according to EN 10088-1
Spherical washer	Stainless steel according to EN 10088-1
Nut	Strength class of nut adapted to strength class of threaded rod. Stainless steel according to EN 10088-1
Lock nut	Stainless steel according to EN 10088-1

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loading.
- Fatigue cyclic 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**

  +5 °C to +40 °C

- **in-service**

  Temperature range I: -40 °C to +40 °C
  (max. long term temperature +24 °C and max. short term temperature +40 °C)
  Temperature range II: -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).
- For all other conditions according EN 1993-1-4
  corresponding to corrosion resistance classes Annex A4 Table A2 (stainless steels).

Design:

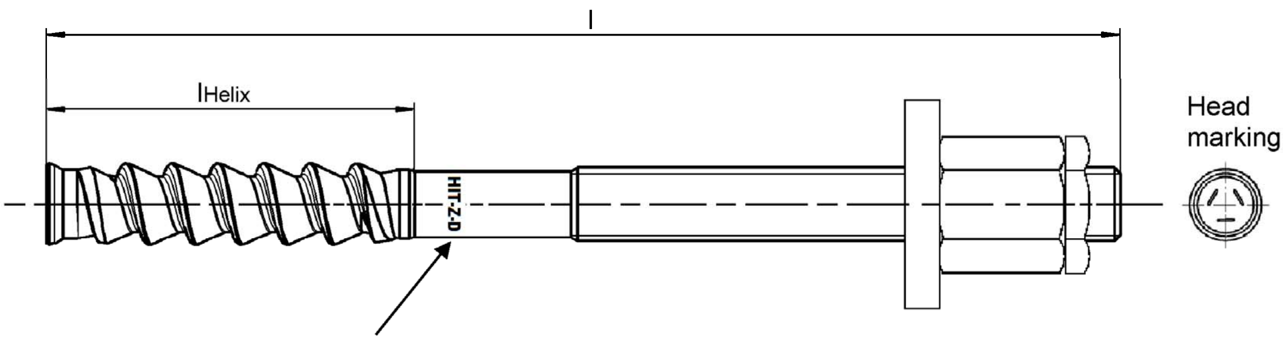
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages under fatigue cycling loading are designed in accordance with:
  EN 1992-4 and EOTA TR 061 (Design method I and II).

Installation:

- Concrete condition I1:
  Installation in dry or wet (water saturated) concrete and use in service in dry or wet concrete.
- Installation direction: D3: downward and horizontal and upward (e.g. overhead).
- Drilling technique: hammer drilling, hammer drilling with hollow drill bit TE-CD, TE-YD, diamond coring.
- Fastener installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

Table B1: Installation parameters HIT-Z(-R)-D TP

HIT-Z-D TP; HIT-Z-R-D TP				**M16**
Nominal diameter		d	[mm]	16
Nominal diameter of drill bit		d_0	[mm]	18
Length of fastener		min l	[mm]	175
		max l	[mm]	240
Length of helix		l_{Helix}	[mm]	96
Nominal anchorage depth		h_{ef}	[mm]	125
Drill hole condition ① Minimum thickness of concrete member		h_{min}	[mm]	225
Drill hole condition ② Minimum thickness of concrete member		h_{min}	[mm]	160
Maximum depth of drill hole		h_0	[mm]	$h - 2\ d_0$
Maximum diameter of clearance hole in the fixture		d_f	[mm]	20
Maximum fixture thickness		t_{fix}	[mm]	80
Installation torque moment	HIT-Z-D TP	T_{inst}	[Nm]	80
	HIT-Z-R-D TP	T_{inst}	[Nm]	155



Marking:
Embossing "HIT-Z-D M16 x l " zinc coated steel
Embossing "HIT-Z-R-D M16 x l" stainless steel
(e.g. HIT-Z-D M16 x 175)

Minimum edge distance and spacing

For the calculation of minimum spacing and minimum edge distance of fasteners in combination with different thickness of concrete member the following equation shall be fulfilled:

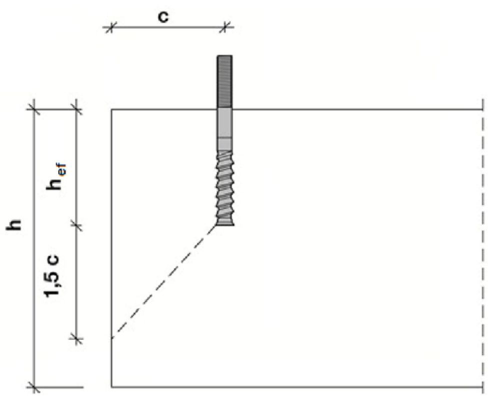
$\mathbf{A_{i,req} < A_{i,ef}}$

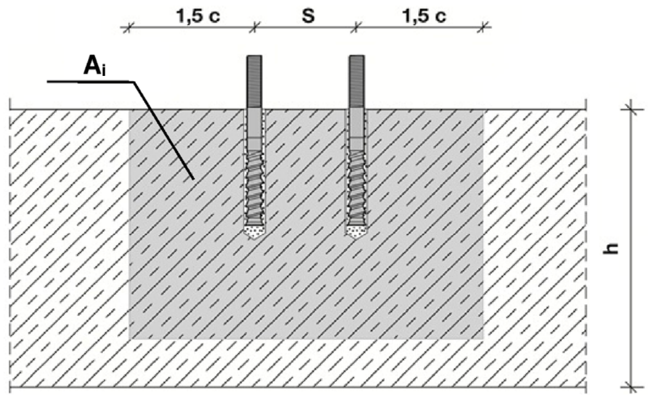
Table B2: Required area $A_{i,req}$

HIT-Z-D TP; HIT-Z-R-D TP			M16
Cracked concrete	$A_{i,req}$	[mm²]	94700
Non-cracked concrete	$A_{i,req}$	[mm²]	128000

Table B3: Effective area $A_{i,ef}$

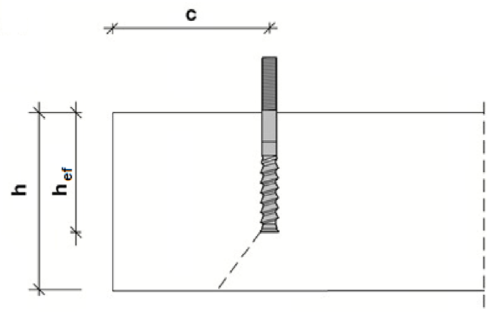
Member thickness $h > h_{ef} + 1{,}5 \cdot c$

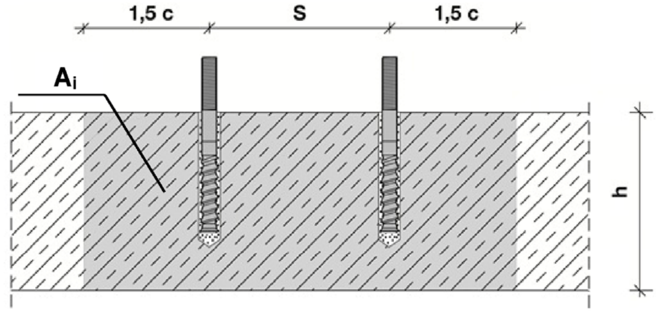




Single fastener and group of fasteners with s > 3·c	[mm²]	$\mathbf{A_{i,ef} = (6 \cdot c) \cdot (h_{ef} + 1{,}5 \cdot c)}$	with $c \geq 5 \cdot d$
Group of fasteners with s ≤ 3·c	[mm²]	$\mathbf{A_{i,ef} = (3 \cdot c + s) \cdot (h_{ef} + 1{,}5 \cdot c)}$	with $c \geq 5 \cdot d$ and $s \geq 5 \cdot d$

Member thickness $h \leq h_{ef} + 1{,}5 \cdot c$





Single fastener and group of fasteners with s > 3·c	[mm²]	$\mathbf{A_{i,ef} = (6 \cdot c) \cdot h}$	with $c \geq 5 \cdot d$
Group of fasteners with s ≤ 3·c	[mm²]	$\mathbf{A_{i,ef} = (3 \cdot c + s) \cdot h}$	with $c \geq 5 \cdot d$ and $s \geq 5 \cdot d$

c_{min} and s_{min} in 5 mm steps

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	Annex B3
Intended use Installation parameters: member thickness, spacing and edge distances	

Table B4: Maximum working time and minimum curing time

Temperature in the base material T [1]	HIT-HY 200-A and 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}
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 foil pack temperature is 0 °C.

Table B5: Parameters of drilling and setting tools

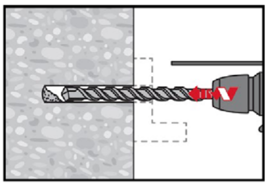
Elements	Drill			Installation
	Hammer drilling			
Anchor rod HIT-Z-(R)-D TP	Drill bit	Hollow drill bit TE-CD, TE-YD[1]	Diamond coring	Piston plug
				
Size	d_0 [mm]	d_0 [mm]	d_0 [mm]	HIT-SZ
M16	18	18	18	18

[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.

Installation instruction

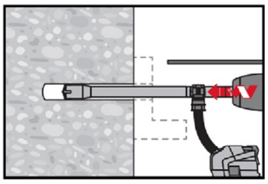
Hole drilling

a) Hammer drilling



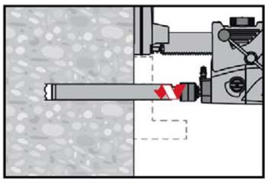
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Pre-setting: Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit. After drilling is complete, proceed to the “injection preparation” step in the installation instruction.

b) Hammer drilling with hollow drill bit



Pre- / Through-setting: Drill hole to the required embedment depth with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit with with vacuum attachment following the requirements given in Table B5. This drilling system removes the dust and cleans the drill hole during drilling when used in accordance with the user’s manual (see Annex A1 - Borehole condition ②). After drilling is completed, proceed to the “injection preparation” step in the installation instruction.

c) Diamond coring

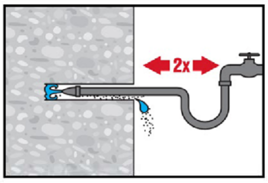


Diamond coring is permissible when suitable diamond core drilling machines and corresponding core bits are used.
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth.
Pre-setting: Drill hole to the required embedment depth.

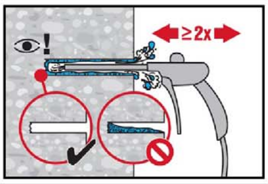
Drill hole cleaning

a) No cleaning required for hammer drilled holes.

b) Hole flushing and evacuation required for wet-drilled diamond cored holes.

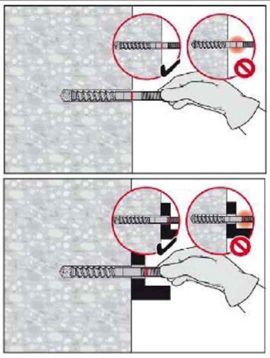


Flush 2 times from the back of the hole over the whole length until water runs clear. Water-line pressure is sufficient.



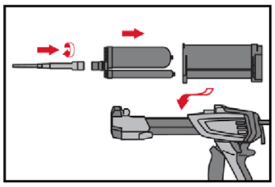
Blow 2 times from the back of the hole (if needed with nozzle extension) with oil-free compressed air (min. 6 bar at 6 m³/h) to evacuate the water.

Checking of setting depth

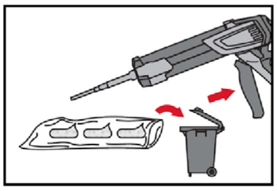


Mark the element and check the setting depth. The element has to fit in the hole until the required embedment depth. If it is not possible to insert the element to the required embedment depth, remove the dust in the drill hole or drill deeper.

Injection preparation



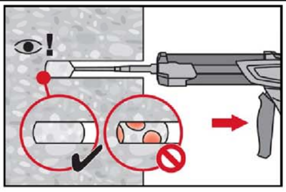
Tightly attach Hilti mixing nozzle HIT-RE-M to foil pack manifold. Do not modify the mixing nozzle.
Observe the instruction for use of the dispenser and the mortar.
Check foil pack holder for proper function. Insert foil pack into foil pack holder and put holder into dispenser.



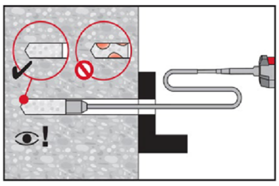
The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded. Discarded quantities are:

	2 strokes	for 330 ml foil pack,
	3 strokes	for 500 ml foil pack.

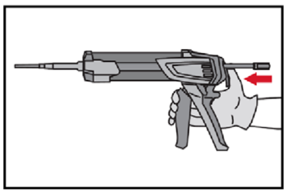
Inject adhesive from the back of the drill hole without forming air voids



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



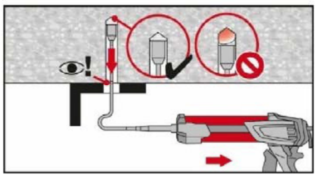
Injection is possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug HIT-SZ 18. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the 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.

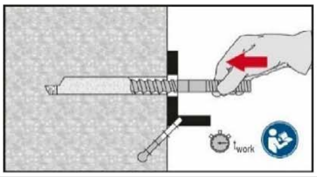
Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	**Annex B6**
Intended use Installation instructions	

Overhead installation

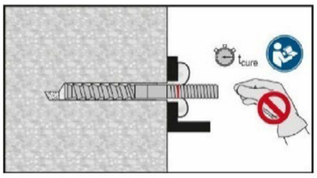


For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug HIT-SZ 18. Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the adhesive pressure.

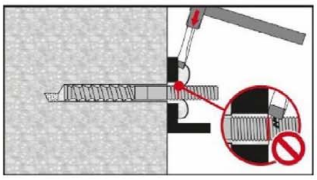
Setting the element



Before use, verify that the element is dry and free of oil and other contaminants.
Set element to the required embedment depth before working time t_{work} has elapsed. The working time t_{work} is given in Table B4.

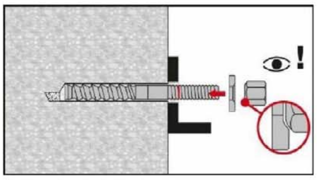


After required curing time t_{cure} (see Table B4) remove excess mortar.

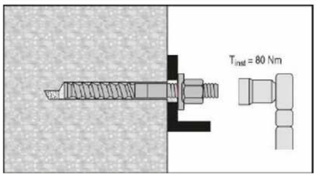


Do not damage thread of HIT-Z(-R)-D TP while removing excess mortar.

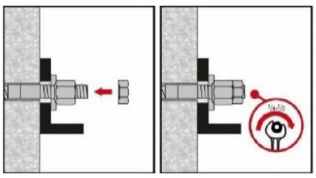
Final assembly with sealing washer



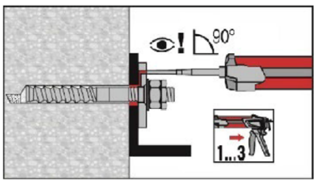
Orient the round part of the calotte nut to the sealing washer and install.



The required installation torque moment is given in Table B1.



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

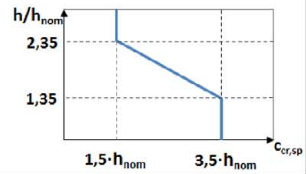


Fill the annular gap between the anchor and fixture completely with Hilti injection mortar HIT-HY 200 or HIT-HY 200 V3. The static mixer nozzle must be put orthogonally on the filling hole. Follow the installation instructions supplied with the HIT-HY 200 or HIT-HY 200 V3 foil pack.
After required curing time t_{cure} (see Table B4), the fastener can be loaded.

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	**Annex B7**
Intended use Installation instructions	

Table C1: Essential characteristics for HIT-Z(-R)-D TP under tension load in case of static and quasi-static loading

HIT-Z-D TP; HIT-Z-R-D TP			**M16**
Installation factor	γ_{inst}	[-]	1,0
Steel failure			
HIT-Z-D TP, HIT-Z-R-D TP	$N_{Rk,s}$	[kN]	[1]
Pull-out failure			
In uncracked concrete C20/25			
Temperature range I: 24 °C / 40 °C	$N_{Rk,p,ucr}$	[kN]	115
Temperature range II: 50 °C / 80 °C	$N_{Rk,p,ucr}$	[kN]	105
In cracked concrete C20/25			
Temperature range I: 24 °C / 40 °C	$N_{Rk,p,cr}$	[kN]	105
Temperature range II: 50 °C / 80 °C	$N_{Rk,p,cr}$	[kN]	95
Factor for the influence of concrete strength class $N_{Rk,p} = N_{Rk,p,(C20/25)} \cdot \psi_c$	ψ_c	[-]	1,0
Concrete cone failure			
Effective embedment depth	h_{ef}	[mm]	125
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			
Edge distance $c_{cr,sp}$ [mm] for	$h / h_{ef} \geq 2,35$		$1,5 \cdot h_{ef}$
	$2,35 > h / h_{ef} > 1,35$		$6,2 \cdot h_{ef} - 2,0 \cdot h$
	$h / h_{ef} \leq 1,35$		$3,5 \cdot h_{ef}$
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$



[1] No performance assessed based on EAD 330250-00-0601.

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Table C2: Essential characteristics for HIT-Z(-R)-D TP under shear load in case of static and quasi-static loading

HIT-Z-D TP; HIT-Z-R-D TP			**M16**
Installation factor	γ_{inst}	[-]	1,0
Steel failure without lever arm			
HIT-Z-D TP, HIT-Z-R-D TP	$V^0_{Rk,s}$	[kN]	1)
Ductility factor	k_7		1,0
Steel failure with lever arm			
HIT-Z-D TP, HIT-Z-R-D TP	$M^0_{Rk,s}$	[Nm]	1)
Concrete pry-out failure			
Pry-out factor	k_8	[-]	2,56
Concrete edge failure			
Effective length of fastener in shear loading	l_f	[mm]	h_{ef}
Outside diameter of fastener	d_{nom}	[mm]	16

1) No performance assessed based on EAD 330250-00-0601.

Table C3: Essential characteristics under tension fatigue load in concrete (design method I acc. to TR 061)

Fastener			HIT-Z-D TP M16	HIT-Z-R-D TP M16
Steel failure				
Characteristic resistance		[kN]	$\Delta N_{Rk,s,0,n}$	
Number of cycles	n	1	96,0	96,0
		$\leq 10^3$	70,0	70,3
		$\leq 3 \cdot 10^3$	60,0	59,1
		$\leq 10^4$	48,9	46,4
		$\leq 3 \cdot 10^4$	39,7	35,7
		$\leq 10^5$	31,6	26,2
		$\leq 3 \cdot 10^5$	26,3	20,0
		$\leq 10^6$	22,5	15,9
		∞	18,8	12,4
Partial factor	$\gamma_{Ms,N,fat}$	[-]	acc. to TR 061, Eq. (3)	
Concrete cone, pull-out and splitting failure			$\Delta N_{Rk,(c/p/sp),0,n} = \eta_{k,c,N,fat,n} \cdot N_{Rk,(c/p/sp)}$ [1)]	
Effective embedment depth	h_{ef}	[mm]	125	
Reduction factor		[-]	$\eta_{k,c,N,fat,n}$	
Number of cycles	n	1	1,00	
		$\leq 10^3$	0,75	
		$\leq 3 \cdot 10^3$	0,71	
		$\leq 10^4$	0,66	
		$\leq 3 \cdot 10^4$	0,62	
		$\leq 10^5$	0,58	
		$\leq 3 \cdot 10^5$	0,55	
		$\leq 10^6$	0,52	
		∞	0,50	
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5	
Load transfer factor for fastener groups	ψ_{FN}	[-]	0,79	

1) $N_{Rk,(c/p/sp)}$ according to EN 1992-4 and Table C1.

Table C4: Essential characteristics under shear fatigue load in concrete (design method I acc. to TR 061)

Fastener				HIT-Z-D TP M16	HIT-Z-R-D TP M16
Steel failure					
Characteristic resistance		[kN]		$\Delta V_{Rk,s,0,n}$	
Number of cycles	n		1	48,0	57,0
			$\leq 10^3$	34,3	35,5
			$\leq 3\cdot10^3$	28,9	28,7
			$\leq 10^4$	23,0	21,9
			$\leq 3\cdot10^4$	18,3	16,8
			$\leq 10^5$	14,1	12,9
			$\leq 3\cdot10^5$	11,4	10,5
			$\leq 10^6$	9,6	9,1
			∞	8,0	8,0
Partial factor	$\gamma_{Ms,V,fat}$	[-]		acc. to TR 061, Eq. (3)	
Concrete edge failure, pry-out failure				$\Delta V_{Rk,(c,cp),0,n} = \eta_{k,c,V,fat,n} \cdot V_{Rk,(c,cp)}$ [1)]	
Effective length of fastener	l_f	[mm]		125	
Outside diameter of fastener	d_{nom}	[mm]		16	
Reduction factor		[-]		$\eta_{k,c,V,fat,n}$	
Number of cycles	n		1	1,00	
			$\leq 10^3$	0,69	
			$\leq 3\cdot10^3$	0,63	
			$\leq 10^4$	0,57	
			$\leq 3\cdot10^4$	0,53	
			$\leq 10^5$	0,50	
			$\leq 3\cdot10^5$	0,50	
			$\leq 10^6$	0,50	
			∞	0,50	
Partial factor	$\gamma_{Mc,fat}$	[-]		1,5	
Load transfer factor for fastener groups	ψ_{FV}	[-]		0,75	

[1)] $V_{Rk,(c,cp)}$ according to EN 1992-4 and Table C2

Injection System Hilti HIT-HY 200-A, HIT-HY 200-A V3 and HIT-HY 200-R V3 with HIT-Z-D TP; HIT-Z-R-D TP	Annex C4
Performances Essential characteristics under shear fatigue load in concrete (design method I acc. to TR 061)	

Table C5: Essential characteristics under tension fatigue load in concrete (design method II acc. to TR 061)

Fastener			HIT-Z-D TP M16	HIT-Z-R-D TP M16
Steel failure				
Characteristic resistance	$\Delta N_{Rk,s,0,\infty}$	[kN]	18,8	12,4
Partial factor	$\gamma_{Ms,N,fat}$	[-]	1,35	
Concrete cone, pull-out and splitting failure			$\Delta N_{Rk,(c/p/sp),0,\infty} = \eta_{k,c,N,fat,\infty} \cdot N_{Rk,(c/p/sp)}$ [1)]	
Effective embedment depth	h_{ef}	[mm]	125	
Reduction factor[1)]	$\eta_{k,c,N,fat,\infty}$	[-]	0,50	
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5	
Load transfer factor for fastener groups	ψ_{FN}	[-]	0,79	

[1)] $N_{Rk,(c/p/sp)}$ according to EN 1992-4 and Table C1.

Table C6: Essential characteristics under shear fatigue load in concrete (design method II acc. to TR 061)

Fastener			HIT-Z-D TP M16	HIT-Z-R-D TP M16
Steel failure				
Characteristic resistance	$\Delta V_{Rk,s,0,\infty}$	[kN]	8,0	8,0
Partial factor	$\gamma_{Ms,V,fat}$	[-]	1,35	
Concrete edge failure, pry-out failure			$\Delta V_{Rk,(c,cp),0,\infty} = \eta_{k,c,V,fat,\infty} \cdot V_{Rk,(c,cp)}$ [1)]	
Effective length of fastener	l_f	[mm]	125	
Outside diameter of fastener	d_{nom}	[mm]	16	
Reduction factor[1)]	$\eta_{k,c,V,fat,\infty}$	[-]	0,50	
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5	
Load transfer factor for fastener groups	ψ_{FV}	[-]	0,75	

[1)] $V_{Rk,(c,cp)}$ according to EN 1992-4 and Table C2

Table C7: Essential characteristics under combined tension and shear fatigue load in concrete (design method I and II acc. to TR 061)

Fastener			HIT-Z-D TP M16	HIT-Z-R-D TP M16
Steel failure				
Exponent for combined fatigue load		[-]	α_{sn}	
Number of cycles	n	1	2,00	2,00
		≤ 10^3	1,42	1,27
		≤ $3 \cdot 10^3$	1,41	1,19
		≤ 10^4	1,40	1,13
		≤ $3 \cdot 10^4$	1,40	1,11
		≤ 10^5	1,40	1,10
		≤ $3 \cdot 10^5$	1,40	1,10
		≤ 10^6	1,40	1,10
		∞	1,40	1,10
Concrete failure				
Exponent for combined fatigue load		[-]	α_c	
Number of cycles	n	≥ 1	1,5	