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-18/0978 of 22 June 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 with HAS-D
Product family to which the construction product belongs	Post-installed fasteners in concrete under fatigue cyclic loading
Manufacturer	Hilti Aktiengesellschaft Business Unit Anchors 9494 Schaan FÜRSTENTUM LIECHTENSTEIN
Manufacturing plant	Hilti Plants
This European Technical Assessment contains	23 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-18/0978 issued on 13 May 2020

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Specific Part

1 Technical description of the product

The Injection System Hilti HIT-HY 200 with HAS-D is a torque controlled bonded anchor consisting of a cartridge with injection mortar Hilti HIT-HY 200-A, Hilti HIT-HY 200-R, Hilti HIT-HY 200-A V3 or Hilti HIT-HY 200-R V3, an anchor rod Hilti HAS-D, a Hilti sealing washer, a calotte nut and a locknut.

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 anchorage ground (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, C1 and C2
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 C5
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:

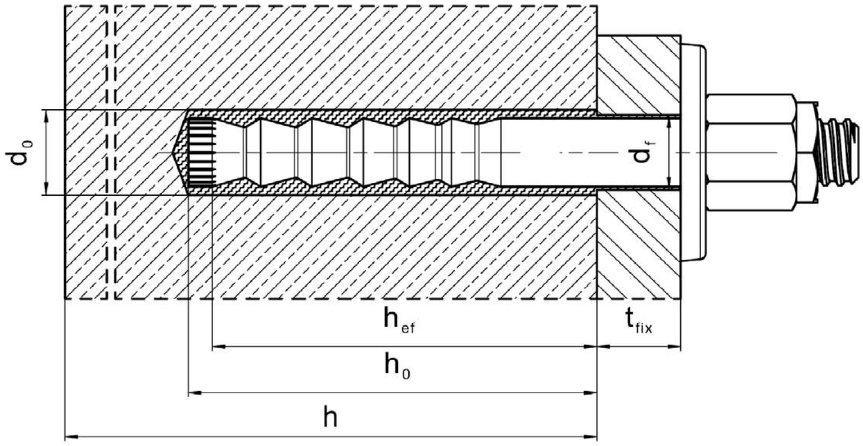
-	EN ISO 683-4:2018	Heat-treatable steels, alloy steels and free-cutting steels - Part 4: Free-cutting steels (ISO 683-4:2016)
-	EN 206:2013 + A2:2021	Concrete - Specification, performance, production and conformity
-	EN 1992-4:2018	Eurocode 2: Design of concrete structures - Part 4: Design of fastenings 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 22 June 2023 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Stiller

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
Installed condition

Annex A1

Product description: Injection mortar and fastener

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”

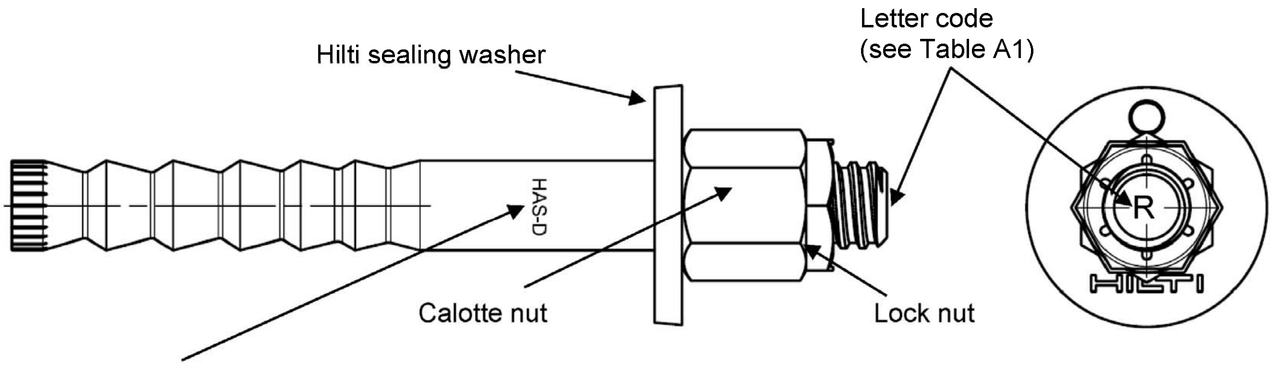
Marking:
HILTI HIT
HY 200-R V3
Production time and production line
Expiry date mm/yyyy

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 Injection mortar / Static mixer	

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

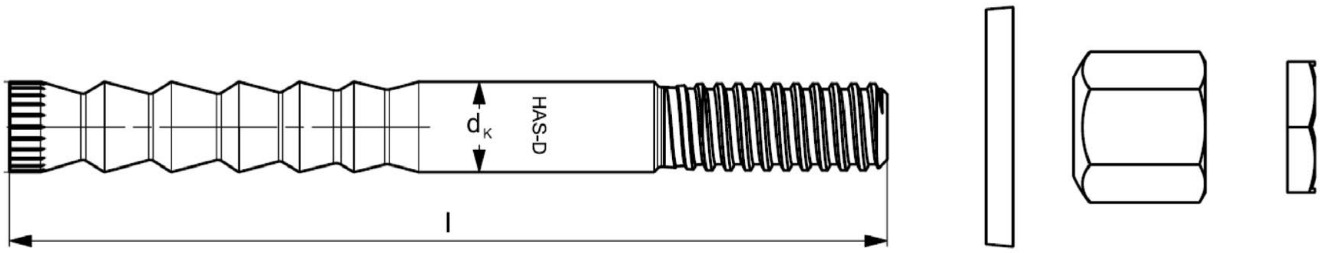


Table A1: Letter code for identification of anchor rod length[1)]

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

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

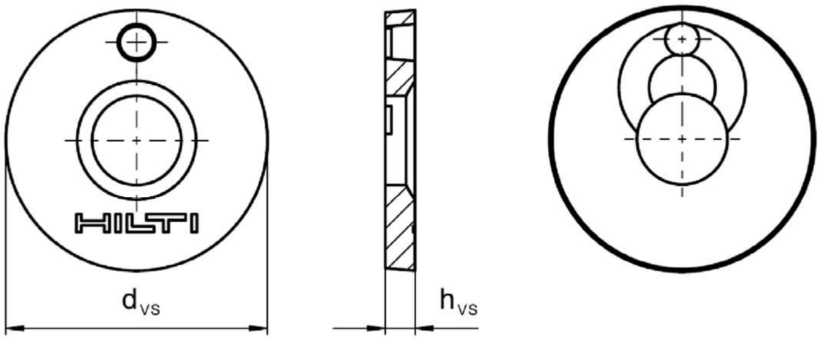


Table A3: Geometry of Hilti sealing washer

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

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 A4

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

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loading
- Fatigue cycling load.

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**
  -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 fatigue cycling load are designed in accordance with:
  EN 1992-4 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,
  - diamond coring.
- Installation direction D3: downward, horizontal and upwards (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.

Table B1: Installation parameters

HAS-D…				**M12**	**M16**	**M20**
Diameter of steel element		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: Maximum diameter of clearance hole in the fixture		d_f	[mm]	14	18	24
Through-setting: Maximum diameter of clearance hole in the fixture		d_f	[mm]	16	20	26
Fixture thickness		$t_{fix,min}$ [2)]	[mm]	12	16	20
		$t_{fix,max}$	[mm]	200		
Installation torque moment		T_{inst}	[Nm]	30	50	80
Uncracked concrete	Minimum spacing	$s_{min,ucr}$	[mm]	80	60	80
	Minimum edge distance	$c_{min,ucr}$	[mm]	75	80	110
Cracked concrete	Minimum spacing	$s_{min,cr}$	[mm]	50	60	80
	Minimum edge distance	$c_{min,cr}$	[mm]	70	80	110

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

2) The minimum fixture thickness $t_{fix,min}$ can be replaced by a reduced minimum fixture thickness $t_{fix,min,red}$ if a reduced fatigue resistance in transverse direction $\Delta V_{Rk,s,0,red}$ is considered:

$t_{fix,min,red} = t_{fix,min} \cdot (0,5 + 0,5 \cdot \Delta V_{Rk,s,0,red} / \Delta V_{Rk,s})$

with $\Delta V_{Rk,s} = \Delta V_{Rk,s,0,n}$ for design method I (Table C4)

$\Delta V_{Rk,s} = \Delta V_{Rk,s,0,\infty}$ for design method II (Table C6)

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
Installation parameters

Annex B2

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

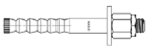
1) The minimum temperature of the foil pack is 0°C.

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.

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

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

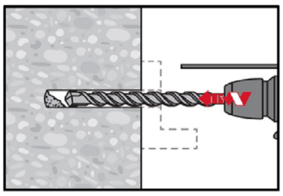
Intended Use
Drilling, cleaning and setting tools

Annex B4

Installation instruction

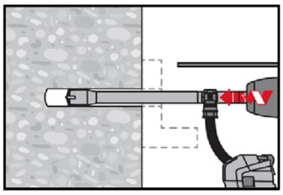
Hole drilling

a) Hammer drilling



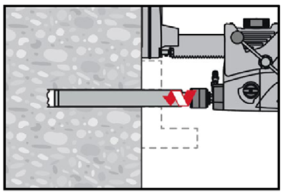
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.
Pre-setting: Drill hole to the required drilling depth with a hammer drill set in rotation-hammer mode using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

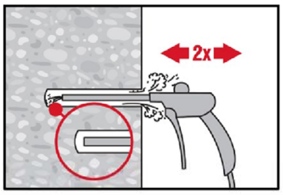
c) Diamond coring



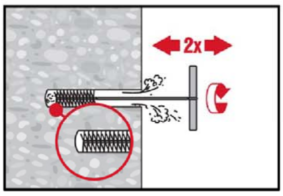
Diamond coring is permissible when suitable diamond core drilling machines and corresponding core bits are used.
Through-setting: Drill hole through the clearance hole in the fixture to the required drilling depth.
Pre-setting: Drill hole to the required embedment depth.

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

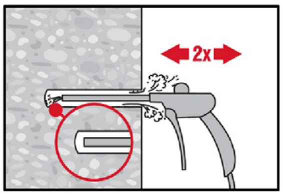
a) Compressed Air Cleaning (CAC): for all drill hole diameters d_0 and all drill hole depths h_0.



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.



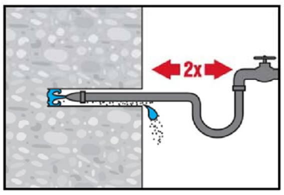
Blow again with compressed air 2 times until return air stream is free of noticeable dust.

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

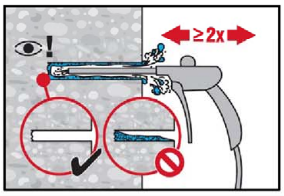
Intended use
Installation instructions

Annex B5

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

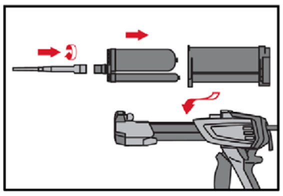


Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.

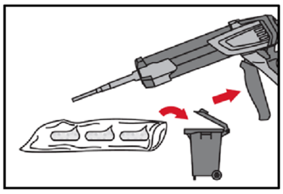


Blow 2 times from the back of the hole (if needed with nozzle extension) with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust and water.

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.

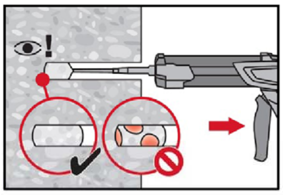


The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive must be discarded. Discarded quantities are:

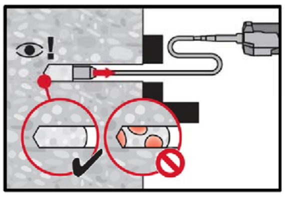
2 strokes	for 330 ml foil pack,
3 strokes	for 500 ml foil pack
4 strokes	for 500 ml foil pack ≤ 5°C.

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

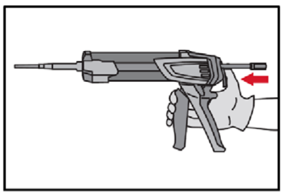
Inject adhesive from the back of the drill hole without forming air voids (through- and pre-setting).



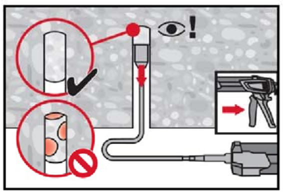
Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull. The quantity of mortar should be selected so that the annular gap in the borehole is filled.



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.

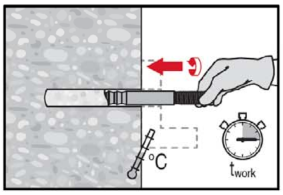


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

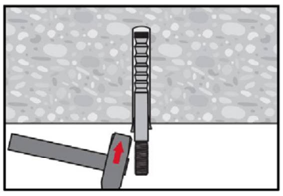


For overhead installation, the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B4). Insert piston plug to back of the hole and inject adhesive. During injection, the piston plug will be naturally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

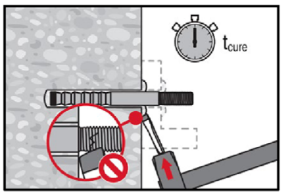
Setting the fastener



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.

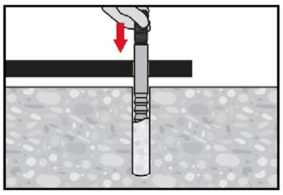


For overhead installation fix embedded parts with e.g. wedges.

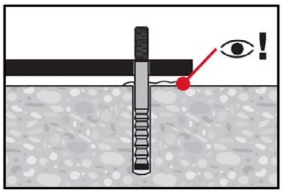


After required curing time t_{cure} (see Table B2 and B3) remove excess mortar.

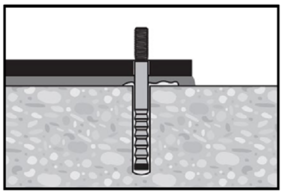
Setting the fastener with clearance between concrete and anchor plate
(only if the fastener is loaded in axial direction)



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.

Final assembly with sealing washer

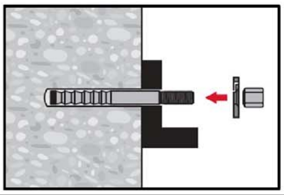
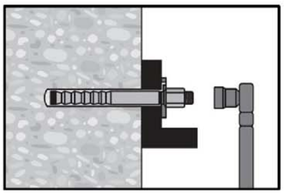
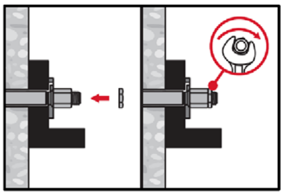
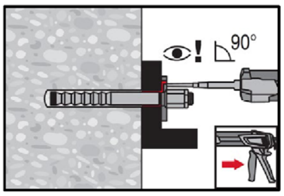
	Orient round part of the calotte nut to the sealing washer and install.
	The required installation torque moment is given in Table B1.
	Apply the lock nut and tighten with a ¼ to ½ turn.
	Fill the annular gap between the anchor rod and fixture completely with Hilti injection mortar HIT-HY 200. The static 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 B2 and B3), the fastener can be loaded.

Table C1: Essential characteristics under static and quasi-static tension load in concrete

HAS-D…				**M12**	**M16**	**M20**
Effective embedment depth		h_{ef}	[mm]	100	125	170
Installation safety factor		γ_{inst}	[-]	1,0		
Steel failure						
Characteristic resistance		$N_{Rk,s}$	[kN]	[1)]		
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 resistance in cracked concrete C20/25						
Temperature range: 50 °C / 80 °C		$N_{Rk,p,cr}$	[kN]	34,4	48,1	76,3
Increasing factor for $N_{Rk,p}$ in concrete		ψ_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

Injection system Hilti HIT-HY 200 with HAS-D

Performances
Essential characteristics under static and quasi-static load in concrete

Annex C1

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

Table C2: Essential characteristics under static and quasi-static shear load in concrete

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

1) No performance assessed based on EAD 330250-00-0601.
2) In absence of national regulations.

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

HAS-D…				**M12**	**M16**	**M20**
Steel failure						
Characteristic resistance		[kN]		$\Delta N_{Rk,s,0,n}$ 1)		
Number of cycles	n		= 1	53,9	83,4	112,1
			$\leq 10^3$	48,3	78,8	92,7
			$\leq 3 \cdot 10^3$	45,9	77,1	89,9
			$\leq 10^4$	41,4	73,1	83,4
			$\leq 3 \cdot 10^4$	35,9	66,3	73,8
			$\leq 10^5$	29,1	55,8	60,9
			$\leq 3 \cdot 10^5$	24,2	45,5	50,7
			$\leq 10^6$	21,1	37,4	44,9
			$> 10^6$	20,1	34,0	43,5
Partial factor	$\gamma_{Ms,N,fat}$	[-]		acc. to TR 061, Eq. (3)		
Concrete failure				$\Delta N_{Rk,(c/p/sp),0,n} = \eta_{k,c,N,fat,n} \cdot N_{Rk,(c/p/sp)}$ 2)		
Effective embedment depth	h_{ef}	[mm]		100	125	170
Reduction factor		[-]		$\eta_{k,c,N,fat,n}$		
Number of cycles	n		= 1	1,0		
			$\leq 10^3$	0,932		
			$\leq 3 \cdot 10^3$	0,893		
			$\leq 10^4$	0,841		
			$\leq 3 \cdot 10^4$	0,794		
			$\leq 10^5$	0,75		
			$\leq 3 \cdot 10^5$	0,722		
			$\leq 10^6$	0,704		
			$> 10^6$	0,693		
Partial factor	$\gamma_{Mc,fat}$	[-]		1,5		
Load transfer factor for fastener group	ψ_{FN}	[-]		0,79		

1) Failure in cracked concrete due to combined pull-out / concrete cone failure $\Delta N_{Rk,p,0,n}$ in low-cycle loading range has been taken into account.

2) $N_{Rk,(c/p/sp)}$ according to Table C1.

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

HAS-D…			M12	M16	M20
Steel failure					
Characteristic resistance		[kN]	$\Delta V_{Rk,s,0,n}$		
Number of cycles	n	= 1	34,0	63,0	149,0
		$\leq 10^3$	27,6	54,0	113,5
		$\leq 3 \cdot 10^3$	23,8	47,2	91,6
		$\leq 10^4$	18,6	36,5	65,0
		$\leq 3 \cdot 10^4$	14,1	26,2	43,9
		$\leq 10^5$	10,5	18,4	29
		$\leq 3 \cdot 10^5$	8,9	15,6	23,2
		$\leq 10^6$	8,2	15,0	21,3
		$> 10^6$	8,2	15,0	21,1
Partial factor	$\gamma_{Ms,V,fat}$	[-]	acc. to TR 061, Eq. (3)		
Concrete 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]	100	125	170
Effective outside diameter of fastener	d_{nom}	[mm]	14	18	24
Reduction factor		[-]	$\eta_{k,c,V,fat,n}$		
Number of cycles	n	= 1	1,0		
		$\leq 10^3$	0,799		
		$\leq 3 \cdot 10^3$	0,760		
		$\leq 10^4$	0,725		
		$\leq 3 \cdot 10^4$	0,700		
		$\leq 10^5$	0,68		
		$\leq 3 \cdot 10^5$	0,668		
		$\leq 10^6$	0,660		
		$> 10^6$	0,652		
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5		
Load transfer factor for fastener group	ψ_{FV}	[-]	0,81		

1) $V_{Rk,(c,cp)}$ according to Table C2

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

HAS-D…			M12	M16	M20
Steel failure					
Characteristic resistance	$\Delta N_{Rk,s,0,\infty}$	[kN]	20,1	34,0	43,5
Partial factor	$\gamma_{Ms,N,fat}$	[-]	1,35		
Concrete 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]	100	125	170
Reduction factor	$\eta_{k,c,N,fat,\infty}$	[-]	0,693		
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5		
Load transfer factor for fastener group	ψ_{FN}	[-]	0,79		

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

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

HAS-D…			M12	M16	M20
Steel failure					
Characteristic resistance	$\Delta V_{Rk,s,0,\infty}$	[kN]	8,2	15,0	21,1
Partial factor	$\gamma_{Ms,V,fat}$	[-]	1,35		
Concrete 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]	100	125	170
Effective outside diameter of fastener	d_{nom}	[mm]	14	18	24
Reduction factor	$\eta_{k,c,V,fat,\infty}$	[-]	0,652		
Partial factor	$\gamma_{Mc,fat}$	[-]	1,5		
Load transfer factor for fastener group	ψ_{FV}	[-]	0,81		

[1] $V_{Rk,(c,cp)}$ according to Table C2.

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

HAS-D…			M12	M16	M20
Exponent for combined fatigue load	α_{sn}	[-]	1,5		
	α_c	[-]	1,5		