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European Technical Assessment

ETA-20/0541 of 09/06/2023

English translation prepared by CSTB - Original version in French language

General Part

Technical Assessment Body issuing the European Technical Assessment:	
Centre Scientifique et Technique du Batiment (CSTB)	
Trade name:	**Injection system Hilti HIT-RE 500 V4**
Product family:	Bonded fastener with threaded rods, rebar, internally threaded sleeve HIS-(R)N and Hilti Tension anchor HZA(-R) for use in concrete for a working life of 50 and 100 years
Manufacturer:	Hilti Corporation Feldkircherstrasse 100 FL-9494 Schaan Principality of Liechtenstein
Manufacturing plants:	Hilti Plant
This European Technical Assessment contains:	68 pages including 64 pages of 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 version September 2022
This Assessment replaces:	ETA-20/0541 dated 04/09/2021
Corrigendum	

Specific Part

1 Technical description of the product

The Injection system Hilti HIT-RE 500 V4 is a bonded fastener consisting of a foil pack with injection mortar Hilti HIT-RE 500 V4 and a steel element.

These steel elements are:

- a threaded rod Hilti HAS, HAS-U, Hilti HIT-V, Hilti meter rod AM 8.8 or a commercial threaded rod with washer and hexagon nut in the range of M8 to M30 and 3/8 in. to 1 1/4 in.
- a reinforcing bar (rebar) in the range of $\phi 8$ to $\phi 32$.
- a Hilti Tension anchor HZA in the range of M12 to M27 or HZA-R in the range of M12 to M24.
- an internal threaded sleeve HIS-(R)N in the range M8 to M20 and 3/8 in. to 3/4 in.

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 illustration and the description of the product are given in Annexes A.

2 Specification of the intended use

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

The provisions made in this European technical assessment are based on an assumed working life of the fastener of 50 and 100 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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance for static and quasi static loads, Displacements	See Annexes C1 to C28
Characteristic resistance for seismic performance category C1	See Annexes C29 to C35
Characteristic resistance for seismic performance category C2, Displacements	See Annexes C36 to C38

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Fasteners satisfy requirements for Class A1
Resistance to fire	See Annexes C39 to C42

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances contained in this European technical approval, there may be requirements applicable to the products falling within its scope (e.g., transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

For Basic requirement Safety in use the same criteria are valid as for Basic Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not relevant.

3.6 Energy economy and heat retention (BWR 6)

Not relevant.

3.7 Sustainable use of natural resources (BWR 7)

For the sustainable use of natural resources no performance was determined for this product.

3.8 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B1 are kept.

4 Assessment and verification of constancy of performance (AVCP)

According to the Decision 96/582/EC of the European Commission[1], as amended, the system of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table apply.

Product	Intended use	Level or class	System
Bonded fasteners for use in concrete	For fixing and/or supporting to concrete, structural elements (which contributes to the stability of the works) or heavy units	-	1

5 Technical details necessary for the implementation of the AVCP system, as planned in the relevant EAD

Technical details necessary for the implementation of the Assessment and verification of constancy of performance (AVCP) system are laid down in the control plan deposited at Centre Scientifique et Technique du Bâtiment.

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

- EN 1992-1-1:2004 + AC:2010 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
- EN 1992-1-2:2004 + AC:2008 Eurocode 2: Design of concrete structures - Part 1-2: General rules – Structural fire design
- EN 1992-4:2018 Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for use in concrete
- EN 1993-1-4:2006 + A1:2015 Eurocode 3: Design of steel structures, Part 1-4: General rules – Supplementary rules for stainless steels
- EN 1998-1:2004 + A1:2013 Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings
- EN 10088-1:2014 Stainless steels – Part 1: List of stainless steels
- EN 206:2013 + A2:2021 Concrete: Specification, performance, production and conformity

1 Official Journal of the European Communities L 254 of 08.10.1996.

The control plan including confidential informations is not included in the published part of this ETA.

The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of fasteners for issuing the certificate of conformity CE based on the control plan.

The Notified Body shall visit the factory at least twice a year for surveillance of the manufacturer.

The original French version is signed by:

Anca Cronopol

Head of the Structure, Masonry, Partition Division

Installed condition

Figure A1: Threaded rod, HAS …, HAS-U…, HAS-…, HIT-V-…, AM…

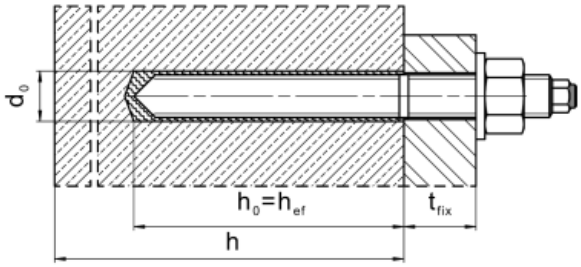


Figure A2: Threaded rod, HAS …, HAS-U-…, HIT-V-…, AM…, with Hilti Filling Set…

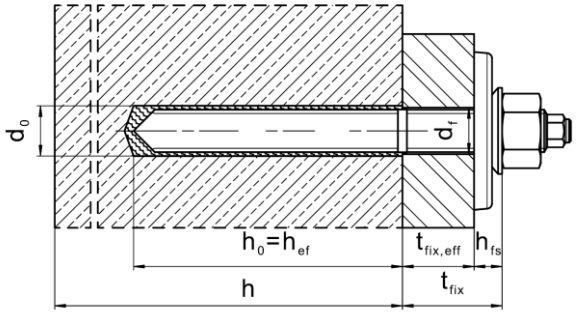


Figure A3: Internally threaded sleeve HIS-(R)N

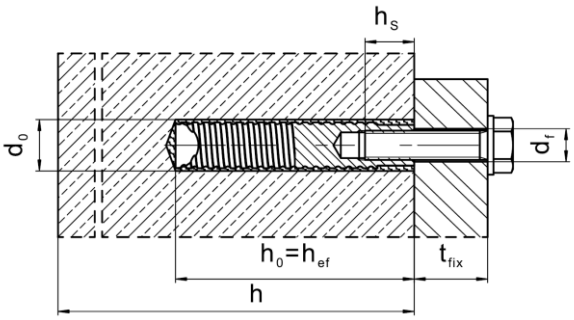
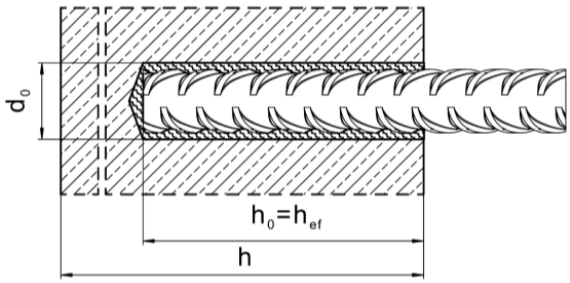


Figure A4: Reinforcing bar (rebar)



Product description: Injection mortar and steel elements

Injection mortar Hilti HIT-RE 500 V4: epoxy resin system with aggregate

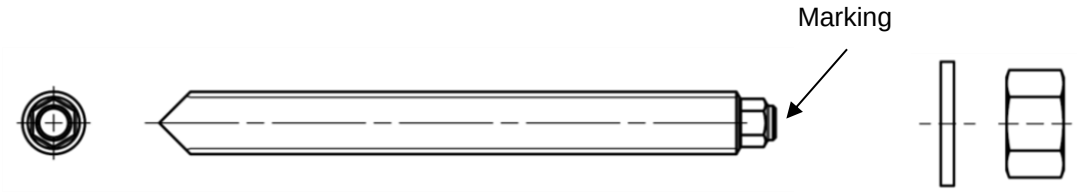
330 ml, 500 ml and 1400 ml

Marking:
HILTI HIT
Product name
Production time and line
Expiry date mm/yyyy

Product name: “Hilti HIT-RE 500 V4”

Static mixer Hilti HIT-RE-M

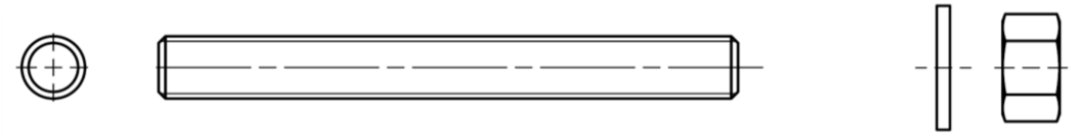
Steel elements



HAS-U…: M8 to M30

washer nut

Marking: Steel grade number and length identification number
5 = HAS-U 5.8, 5.8 HDG
8 = HAS-U 8.8, 8.8. HDG
1 = HAS-U A4
2 = HAS-U HCR



HAS …: M8 to M30

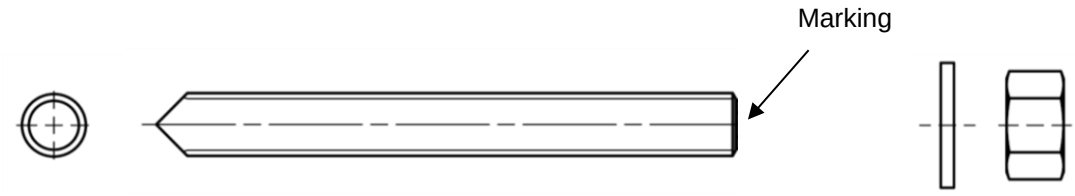
washer nut

HAS Color code marking:

5.8 = RAL 5010 (blue)
8.8 = RAL 1023 (yellow)
A4 = RAL 3000 (red)

AM … 8.8: (HDG) M8 to M30

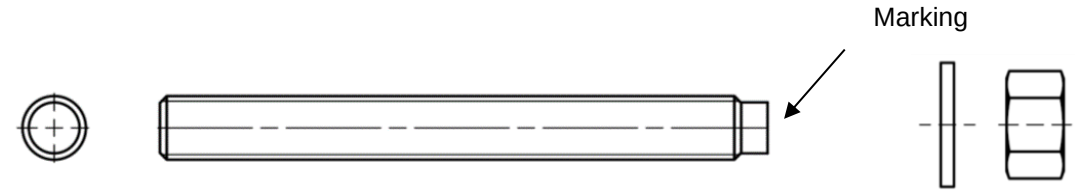
Injection system Hilti HIT-RE 500 V4	
Product description Steel elements	**Annex A2**



HAS ..: 3/8 in. to 1 1/4 in.

Marking: Steel grade and element length [in]

V	=	HAS-V-36 (HDG)
E	=	HAS-E-55
B	=	HAS-B-105 (HDG)
R1	=	HAS-R 304
R2	=	HAS-R 316



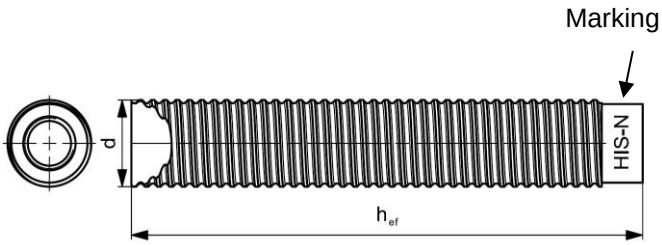
HIT-V-…: M8 to M30, 3/8 in. to 1 1/4 in.

Marking: e.g.,

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

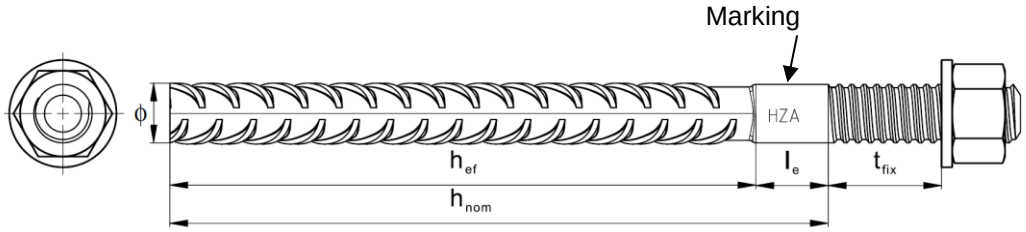
Commercial standard threaded rod: M8 to M30, 3/8 in. to 1 1/4 in.

- Materials and mechanical properties according to Table A2.
- Inspection certificate 3.1 according to EN 10204. The document shall be stored.
- Marking of embedment depth.



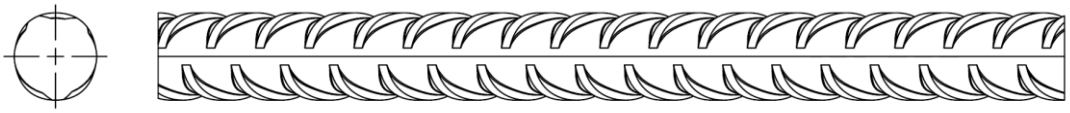
Internally threaded sleeve HIS-(R)N: M8 to M20, 3/8 in. to 3/4 in.

Marking:
Identifying mark - HILTI and embossing “HIS-N” (for zinc coated steel) or embossing “HIS-RN” (for stainless steel)



Hilti Tension anchor HZA: M12 to M27
Hilti Tension anchor HZA-R: M12 to M24

Marking:
embossing "HZA-R" M .. / t_{fix}



Reinforcing bar (rebar): $\phi 8$ to $\phi 32$

- Materials and mechanical properties according to Table A2.
- Dimensions according to Annex B
- Minimum value of related rib area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar h_{rib} shall be in the range $0{,}05 \cdot \phi \leq h_{rib} \leq 0{,}07 \cdot \phi$
  (ϕ: nominal diameter of the bar; h_{rib}: rib height of the bar)

Hilti Filling Set to fill the annular gap between steel element and fixture

Sealing washer

Spherical washer

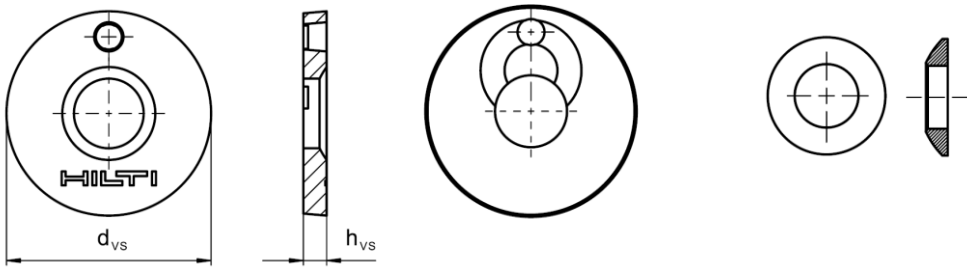


Table A1: Geometry of Hilti Filling Set

Hilti Filling Set			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Diameter of sealing washer	d_{VS}	[mm]	38	42	44	52	60	70
Thickness of sealing washer	h_{VS}	[mm]	5			6		
Thickness of Hilti Filling Set	h_{fS}	[mm]	8	9	10	11	13	15

Table A2: Materials

Designation	Material
Reinforcing bars (rebars)	
Rebar EN 1992-1-1:2004 and AC:2010, Annex C	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA:2013 $\boldsymbol{f_{uk} = f_{tk} = k \cdot f_{yk}}$
Steel elements made of zinc coated steel	
HAS 5.8 (HDG), HAS-U 5.8 (HDG), HIT-V-5.8 (F), Threaded rod 5.8	Strength class 5.8, $f_{uk} = 500$ N/mm², $f_{yk} = 400$ N/mm² Elongation at fracture ($l_0 = 5d$) > 8% ductile Electroplated zinc coated ≥ 5 µm, (F) or (HDG) hot dip galvanized ≥ 50 µm
Threaded rod 6.8	Strength class 6.8, $f_{uk} = 600$ N/mm², $f_{yk} = 480$ N/mm² Elongation at fracture ($l_0 = 5d$) > 8% ductile Electroplated zinc coated ≥ 5 µm, (F) or (HDG) hot dip galvanized ≥ 50 µm
HAS 8.8 (HDG), HAS-U-8.8 (HDG), HIT-V-8.8 (F), AM 8.8 Threaded rod 8.8	Strength class 8.8, $f_{uk} = 800$ N/mm², $f_{yk} = 640$ N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Electroplated zinc coated ≥ 5 µm, (F) or (HDG) hot dip galvanized ≥ 50 µm
Hilti Tension anchor HZA	Round steel with threaded part: electroplated zinc coated ≥ 5 µm Rebar: bars class B according to NDP or NCL of EN 1992-1-1/NA
Internally threaded sleeve HIS-N	Electroplated zinc coated ≥ 5 µm
Threaded rod, HIT-V	ASTM A 307 Grade A, $f_{uk} = 414$ N/mm², $f_{yk} = 259$ N/mm² Elongation at fracture ($l_0 = 5d$) > 8% ductile Electroplated zinc coated ≥ 5 µm
Threaded rod, HAS-V-36 (HDG)	ASTM F1554, Grade 36, $f_{uk} = 400$ N/mm², $f_{yk} = 248$ N/mm² Elongation at fracture ($l_0 = 5d$) > 23% ductile Electroplated zinc coated ≥ 5 µm, (HDG) hot dip galvanized ≥ 53 µm
Threaded rod, HAS-E-55	ASTM F1554, Grade 55, $f_{uk} = 517$ N/mm², $f_{yk} = 379$ N/mm² Elongation at fracture ($l_0 = 5d$) > 21% ductile Electroplated zinc coated ≥ 5 µm
Threaded rod, HAS-B-105 (HDG)	ASTM F1554, Grade 105, $f_{uk} = 862$ N/mm², $f_{yk} = 724$ N/mm² Elongation at fracture ($l_0 = 5d$) > 15% ductile Electroplated zinc coated ≥ 5 µm, (HDG) hot dip galvanized ≥ 53 µm
Washer	Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 50 µm
Nut	Nominal strength class equal or higher to nominal strength class of rod Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 50 µm
Hilti Filling Set (F)	Filling washer: Electroplated zinc coated ≥ 5 µm, (F) hot dip galvanized ≥ 50 µm Spherical washer: Electroplated zinc coated ≥ 5 µm, (F) hot dip galvanized ≥ 50 µm Lock nut: Electroplated zinc coated ≥ 5 µm, (F) Electroplated zinc-nickel coated 6 µm

Table A2: continued

Steel elements made of stainless steel Corrosion resistance class (CRC II) acc. to EN 1993-1-4	
Threaded rod	For ≤ M24: strength class 70, f_{uk} = 700 N/mm², f_{yk} = 450 N/mm² For > M24: strength class 50, f_{uk} = 500 N/mm², f_{yk} = 210 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Stainless steel 1.4301, 1.4307, 1.4311, 1.4541, 1.4306, 1.4567 EN 10088-1
Washer	Stainless steel 1.4301, 1.4307, 1.4311, 1.4541, 1.4306, 1.4567 EN 10088-1
Nut	For ≤ M24: strength class 70, f_{uk} = 700 N/mm², f_{yk} = 450 N/mm² For > M24: strength class 50, f_{uk} = 500 N/mm², f_{yk} = 210 N/mm² Stainless steel 1.4301, 1.4307, 1.4311, 1.4541, 1.4306, 1.4567 according to EN 10088-1: 2014
Threaded rod, HAS-R 304	Size 3/8 in. to 5/8 in.: ASTM F593 CW1, f_{uk} = 689 N/mm², f_{yk} = 448 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Size 3/4 in. to 1 in.: ASTM F593 CW2, f_{uk} = 586 N/mm², f_{yk} = 310 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Size > 1 in.: ASTM A193 Grade 8(M), class 1, f_{uk} = 515 N/mm², f_{yk} = 205 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile
Washer	Stainless steel ASTM F593 and ASTM A193
Nut	Nominal strength class equal or higher to nominal strength class of rod
Steel elements made of stainless steel Corrosion resistance class (CRC III) acc. to EN 1993-1-4	
HAS A4, HAS-U A4, HIT-V-R, Threaded rod A4	For ≤ M24: strength class 70, f_{uk} = 700 N/mm², f_{yk} = 450 N/mm² For > M24: strength class 50, f_{uk} = 500 N/mm², f_{yk} = 210 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Stainless steel 1.4401, 1.4404, 1.4578, 1.4571, 1.4439, 1.4362 EN 10088-1
Hilti Tension anchor HZA-R	Round steel with threaded part: Stainless steel according to EN 10088-1:2014 Rebar: bars class B according to NDP or NCL of EN 1992-1-1/NA:2013
Internally threaded sleeve HIS-RN	Stainless steel 1.4401, 1.4571 EN 10088-1
Threaded rod, HAS-R 316	Size 3/8 in. to 5/8 in.: ASTM F593 CW1, f_{uk} = 689 N/mm², f_{yk} = 448 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile Size 3/4 in. to 1 1/4 in.: ASTM F 593 CW2, f_{uk} = 586 N/mm², f_{yk} = 310 N/mm² Elongation at fracture ($l_0 = 5d$) > 12% ductile
Washer	Stainless steel ASTM F593
Nut	Nominal strength class equal or higher to nominal strength class of rod
Hilti Filling Set A4	Filling washer: Stainless steel according to EN 10088-1 Spherical washer: Stainless steel according to EN 10088-1 Lock nut: Stainless steel according to EN 10088-1

Table A2: continued

Steel elements made of high corrosion resistant steel Corrosion resistance class (CRC V) acc. to EN 1993-1-4	
HAS-U HCR, HIT-V-HCR, Threaded rod	For ≤ M20: $f_{uk} = 800$ N/mm², $f_{yk} = 640$ N/mm² For > M20: $f_{uk} = 700$ N/mm², $f_{yk} = 400$ N/mm² Elongation at fracture (l_0 = 5d) > 12% ductile High corrosion resistant steel 1.4529, 1.4565 EN 10088-1
Washer	High corrosion resistant steel 1.4529, 1.4565 EN 10088-1
Nut	Nominal strength class equal or higher to nominal strength class of rod High corrosion resistant steel 1.4529, 1.4565 EN 10088-1

Specifications of intended use

Fasteners subject to:

- Static and quasi static loading.
- Seismic performance category C1.
- Seismic performance category C2 (HAS (8.8, 8.8 HDG, A4), HAS-U (8.8, 8.8 HDG, A4, HCR), HIT-V (-8.8, -8.8F, -R, -HCR), AM (8.8, 8.8 HDG) and standard threaded rod (grade 8.8, A4, HCR)), with hammer drilling and hammer drilling with Hilti hollow drill bit TE-CD, TE-YD.
- Fire exposure: threaded rod size M8 to M30 (HAS (5.8, 5.8 HDG, 8.8, 8.8 HDG, A4-70), (HAS-U (5.8, 5.8 HDG, 8.8, 8.8 HDG, A4-70, HCR), HIT-V (5.8, 5.8F, 8.8, 8.8F ,R, HCR), 3/8 to 1 1/4 (HAS-E-55, HAS-B-105 (HDG)).

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 for the standard variation of temperature after installation
- **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 +55°C
  (max. long term temperature +43°C and max. short term temperature +55°C)
  Temperature range III: -40°C to +75°C
  (max. long term temperature +55°C and max. short term temperature +75°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 A (stainless steel and high corrosion resistant steel).

Design:

- Fasteners are designed under the responsibility of an engineer experienced in fasteners 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.).
- The fasteners are designed in accordance with EN 1992-4 and EOTA Technical Report 055. Fasteners under seismic actions shall be positioned outside of critical regions (e.g., plastic hinges) of the concrete structure. Fastening in stand-off installation or with a grout layer under seismic action are not covered in this European technical assessment (ETA).
- For applications with resistance to fire exposure, the fasteners are designed in accordance with EOTA TR 082 “Design of bonded fasteners in concrete under fire conditions”

Installation:

- Use category:
  - dry or wet concrete (not in water-filled drill holes): for all drilling techniques.
  - water-filled drill holes: for hammer drilling only, for uncracked concrete only.
- Drilling technique:
  - hammer drilling,
  - hammer drilling with Hilti hollow drill bit TE-CD, TE-YD,
  - diamond coring, for uncracked concrete only,
  - diamond coring with roughening with Hilti Roughening tool TE-YRT.
- Installation direction D3: downward, horizontal and upward (e.g., overhead) installation admissible for all elements.
- 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 of metric threaded rod according to Annex A

Metric threaded rod according to Annex A			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Diameter of element	d	[mm]	8	10	12	16	20	24	27	30
Nominal diameter of drill bit	d_0	[mm]	10	12	14	18	22	28	30	35
Effective embedment depth and drill hole depth	h_{ef}	[mm]	60 to 160	60 to 200	70 to 240	80 to 320	90 to 400	96 to 480	108 to 540	120 to 600
Maximum diameter of clearance hole in the fixture	d_f	[mm]	9	12	14	18	22	26	30	33
Thickness of Hilti Filling Set	h_{fS}	[mm]	8	9	10	11	13	15	-	-
Effective fixture thickness with Hilti Filling Set	$t_{fix,eff}$	[mm]	$t_{fix,eff} = t_{fix} + h_{fs}$							
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30$ $\geq 100\ mm$			$h_{ef} + 2 \cdot d_0$				
Maximum installation torque	$\max. T_{inst}$	[Nm]	10	20	40	80	150	200	270	300
Minimum spacing	s_{min}	[mm]	40	50	60	75	90	115	120	140
Minimum edge distance	c_{min}	[mm]	40	45	45	50	55	60	75	80

Table B2: Installation parameters fractional threaded rod according to Annex A

Fractional threaded rod according to Annex A			**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
Diameter of element	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	31,8
Nominal diameter of drill bit	d_0	[in.]	7/16	9/16	3/4	7/8	1	1 1/8	1 3/8
Effective cross sectional area	A_s [1)]	[mm²]	50	92	146	216	298	391	625
Effective embedment depth and drill hole depth	h_{ef}	[mm]	60 to 191	70 to 254	79 to 318	89 to 381	89 to 445	102 to 508	127 to 635
Maximum diameter of clearance hole in the fixture	d_f	[mm]	11,1	14,3	17,5	20,6	23,8	28,6	34,9
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30$ $\geq 100\ mm$		$h_{ef} + 2 \cdot d_0$				
Maximum installation torque	$\max. T_{inst}$	[Nm]	20	41	81	136	169	203	271
Minimum spacing	s_{min}	[mm]	45	60	80	90	105	115	140
Minimum edge distance	c_{min}	[mm]	45	45	50	55	60	70	80

1) Effective cross sectional area for calculation of characteristic steel resistance.

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

HIS-(R)N			**M8**	**M10**	**M12**	**M16**	**M20**
Outer diameter of sleeve	d	[mm]	12,5	16,5	20,5	25,4	27,6
Nominal diameter of drill bit	d_0	[mm]	14	18	22	28	32
Effective embedment depth and drill hole depth	h_{ef}	[mm]	90	110	125	170	205
Maximum diameter of clearance hole in the fixture [3)]	d_f	[mm]	9	12	14	18	22
Thickness of Hilti Filling Set	h_{fS}	[mm]	8	9	10	11	13
Effective fixture thickness with Hilti Filling Set	$t_{fix,eff}$	[mm]	$t_{fix,eff} = t_{fix} + h_{fs}$				
Minimum thickness of concrete member	h_{min}	[mm]	120	150	170	230	270
Maximum installation torque	$\max. T_{inst}$	[Nm]	10	20	40	80	150
Thread engagement length min-max	h_s	[mm]	8 to 20	10 to 25	12 to 30	16 to 40	20 to 50
Minimum spacing	s_{min}	[mm]	60	75	90	115	130
Minimum edge distance	c_{min}	[mm]	40	45	55	65	90

Table B4: Installation parameters of internally threaded sleeve HIS-(R)N

HIS-(R)N, size		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
Outer diameter of sleeve	$\boldsymbol{d}$	[mm]	16,5	20,5	25,4	27,6
Nominal diameter of drill bit	$\boldsymbol{d_0}$	[in.]	11/16	7/8	1 1/8	1
Effective embedment depth and drill hole depth	$\boldsymbol{h_{ef}}$	[mm]	110	125	170	205
Maximum diameter of clearance hole in the fixture	$\boldsymbol{d_f}$	[mm]	11,1	14,3	17,5	20,6
Minimum thickness of concrete member	$\boldsymbol{h_{min}}$	[mm]	150	170	230	270
Maximum installation torque	$\boldsymbol{\max. T_{inst}}$	[Nm]	20	41	81	136
Thread engagement length min to max	$\boldsymbol{h_s}$	[mm]	10 to 25	12 to 30	16 to 40	20 to 50
Minimum spacing	$\boldsymbol{s_{min}}$	[mm]	70	90	115	130
Minimum edge distance	$\boldsymbol{c_{min}}$	[mm]	45	55	65	90

Table B5: Installation parameters of Hilti Tension anchor HZA / HZA-R

HZA			**M12**	**M16**	**M20**	**M24**	**M27**
HZA-R			**M12**	**M16**	**M20**	**M24**	**-**
Rebar diameter	ϕ	[mm]	12	16	20	25	28
Nominal embedment depth and drill hole depth HZA	h_0	[mm]	90 to 240	100 to 320	110 to 400	120 to 500	140 to 560
Nominal embedment depth and drill hole depth HZA-R	h_0	[mm]	170 to 240	180 to 320	190 to 400	200 to 500	-
Effective embedment depth HZA ($h_{ef} = h_{nom} - l_e$)	h_{ef}	[mm]	$h_{nom} - 20$				
Effective embedment depth HZA-R ($h_{ef} = h_{nom} - l_e$)	h_{ef}	[mm]	$h_{nom} - 100$				
Length of smooth shaft HZA	l_e	[mm]	20				
Length of smooth shaft HZA-R	l_e	[mm]	100				
Nominal diameter of drill bit	d_0	[mm]	16	20	25	32	35
Maximum diameter of clearance hole in the fixture	d_f	[mm]	14	18	22	26	30
Thickness of Hilti Filling Set	h_{fs}	[mm]	10	11	13	15	-
Effective fixture thickness with Hilti Filling Set	$t_{fix,eff}$	[mm]	$t_{fix,eff} = t_{fix} - h_{fs}$				-
Maximum installation torque	max. T_{inst}	[Nm]	40	80	150	200	270
Minimum thickness of concrete member	h_{min}	[mm]	$h_{nom} + 2 \cdot d_0$				
Minimum spacing	s_{min}	[mm]	65	80	100	130	140
Minimum edge distance	c_{min}	[mm]	45	50	55	60	75

Table B6: Installation parameters of reinforcing bar (rebar)

Reinforcing bar (rebar)			ϕ**8**	ϕ**10**	ϕ**12**		ϕ**14**	ϕ**16**	ϕ**18**	ϕ**20**	ϕ**24**	ϕ**25**	ϕ**28**	ϕ**30**	ϕ**32**
Diameter	ϕ	[mm]	8	10	12		14	16	18	20	24	25	28	30	32
Effective embedment depth and drill hole depth	h_{ef}	[mm]	60 to 160	60 to 200	70 to 240		75 to 280	80 to 320	85 to 360	90 to 400	100 to 480	100 to 500	112 to 560	120 to 600	128 to 640
Nominal diameter of drill bit	d_0	[mm]	10[1)] 12[1)]	12[1)] 14[1)]	14[1)]	16[1)]	18	20	22	25	30[1)] 32[1)]	30[1)] 32[1)]	35	37	40
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30$ $\geq 100\ mm$			$h_{ef} + 2 \cdot d_0$									
Minimum spacing	s_{min}	[mm]	40	50	60		70	80	90	100	125	125	140	150	160
Minimum edge distance	c_{min}	[mm]	40	45	45		50	50	60	65	70	70	75	80	80

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

Table B7: Working and curing time[1) 2)]

Temperature in the base material T	Maximum working time t_{work}	Minimum curing time t_{cure}[1)]
-5°C to -1°C	2 hours	168 hours
0°C to 4°C	2 hours	48 hours
5°C to 9°C	2 hours	24 hours
10°C to 14°C	1,5 hours	16 hours
15°C to 19°C	1 hour	12 hours
20°C to 24°C	30 min	7 hours
25°C to 29°C	20 min	6 hours
30°C to 34°C	15 min	5 hours
35°C to 39°C	12 min	4,5 hours
40°C	10 min	4 hours

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

2) The minimum temperature of the foil pack is +5°C.

Table B8: Parameters of cleaning and setting tools

Steel elements				**Drill and clean**					**Installa-tion**
Metric threaded rod (Annex A)	HIS-(R)N	Rebar	HZA(-R)	Hammer drilling		Diamond coring		Brush	Piston plug
					Hollow drill bit TE-CD, TE-YD[1)]		Roughen-ing tool TE-YRT		
									
Size	Size	Size	Size	d_0 [mm]	d_0 [mm]	d_0 [mm]	d_0 [mm]	HIT-RB	HIT-SZ
M8	-	$\phi 8$	-	10	10	10	-	10	-
M10	-	$\phi 8, \phi 10$	-	12	12	12	-	12	12
M12	M8	$\phi 10, \phi 12$	-	14	14	14	-	14	14
-	-	$\phi 12$	M12	16	16	16	-	16	16
M16	M10	$\phi 14$	-	18	18	18	18	18	18
-	-	$\phi 16$	M16	20	20	20	20	20	20
M20	M12	$\phi 18$	-	22	22	22	22	22	22
-	-	$\phi 20$	M20	25	25	25	25	25	25
M24	M16	-	-	28	28	28	28	28	28
M27	-	$\phi 24, \phi 25$	-	30	-	30	30	30	30
-	M20	$\phi 24, \phi 25$	M24	32	32	32	32	32	32
M30	-	$\phi 28$	M27	35	35	35	35	35	35
-	-	$\phi 30$	-	37	-	37	-	37	37
-	-	$\phi 32$	-	40	-	-	-	40	40
				-	-	42	-	42	42

[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 B9: Parameters of cleaning and setting tools

Steel elements		**Drill and clean**					**Installation**
Fractional threaded rod (Annex A)	HIS-(R)N	Hammer drilling		Diamond coring		Brush	Piston plug
			Hollow drill bit TE-CD, TE-YD[1)]		Roughen-ing tool TE-YRT		
							
Size [in]	Size [in]	d_0 [in.]	d_0 [in.]	d_0 [in.]	d_0 [in.]	HIT-RB	HIT-SZ
3/8	-	7/16	-	7/16	-	7/16	7/16
1/2	-	9/16	9/16	9/16	-	9/16	9/16
-	3/8	11/16	-	11/16	-	11/16	11/16
5/8	-	3/4	3/4	3/4	3/4	3/4	3/4
3/4	1/2	7/8	7/8	7/8	7/8	7/8	7/8
7/8	-	1	1	1	1	1	1
1	5/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8
-	3/4	1 1/4	-	1 1/4	-	1 1/4	1 1/4
1 1/4	-	1 3/8	-	1 3/8	1 3/8	1 3/8	1 3/8

[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 B10: Cleaning alternatives

Compressed Air Cleaning (CAC): air nozzle with an orifice opening of minimum 3,5 mm (1/7 in.) in diameter.	
Automatic Cleaning (AC): Cleaning is performed during drilling with Hilti TE-CD and TE-YD drilling system including vacuum cleaner.	

Table B11: Parameters for use of the Hilti Roughening tool TE-YRT

Diamond coring			Roughening tool TE-YRT		Wear gauge RTG…	
						
d_0						
nominal [mm]	nominal [in.]	measured [mm]	d_0 [mm]	d_0 [in.]	size	
18	3/4	17,9 to 18,2	18	3/4	18	3/4
20	7/8	19,9 to 20,2	20	7/8	20	7/8
22	1	21,9 to 22,2	22	1	22	1
25	1 1/8	24,9 to 25,2	25	1 1/8	25	1 1/8
28	1 3/8	27,9 to 28,2	28	1 3/8	28	1 3/8
30	-	29,9 to 30,2	30	-	30	-
32	-	31,9 to 32,2	32	-	32	-
35	-	34,9 to 35,2	35	-	35	-

Table B12: Using parameters of the Hilti Roughening tool TE-YRT

h_{ef} [mm]	Roughening time $t_{roughen}$ ($t_{roughen}$ [sec] = h_{ef} [mm] / 10)
0 to 100	10
101 to 200	20
201 to 300	30
301 to 400	40
401 to 500	50
501 to 600	60

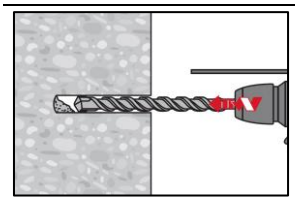
Table B13: Hilti Roughening tool TE-YRT and wear gauge RTG

TE-YRT	
RTG	

Installation instructions

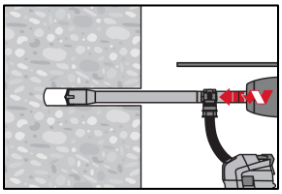
Hole drilling

a) Hammer drilling: For dry or wet concrete and installation in water-filled drill holes (no sea water).



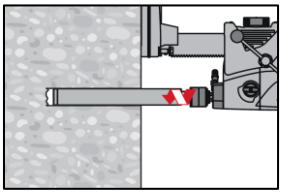
Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit.

b) Hammer drilling with Hilti hollow drill bit TE-CD, TE-YD: For dry and wet concrete only.



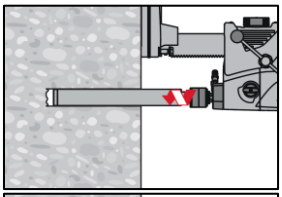
Drill hole to the required embedment depth with an appropriately sized Hilti hollow drill bit TE-CD or TE-YD attached to Hilti vacuum cleaner VC 10/20/40 (automatic filter cleaning activated, eco-mode off) or a vacuum cleaner providing equivalent performance in combination with the specified Hilti hollow drill bit TE-CD or TE-YD. This drilling system removes the dust and cleans the bore hole during drilling when used in accordance with the user's manual. After drilling is completed, proceed to the "injection preparation" step in the installation instruction.

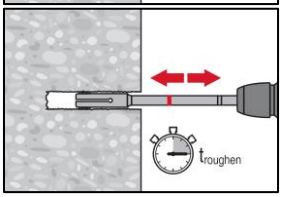
c) Diamond coring: For dry and wet concrete only.



Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.

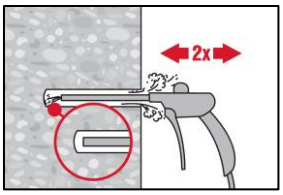
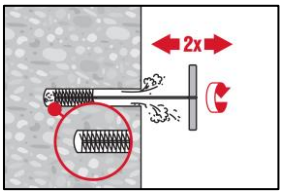
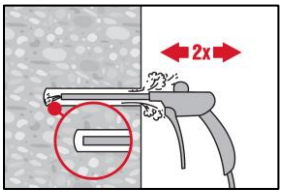
d) Diamond coring with roughening with Hilti Roughening tool TE-YRT: For dry and wet concrete only.



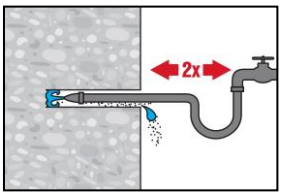
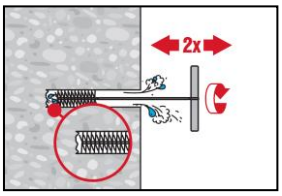
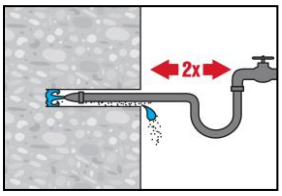
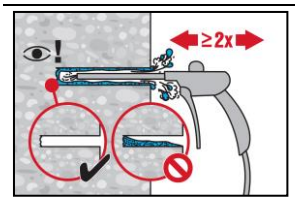
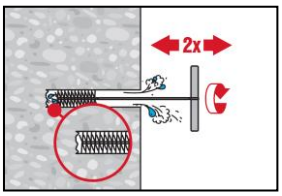
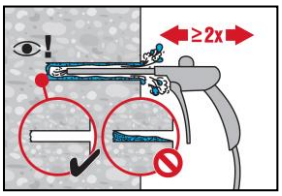


Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.

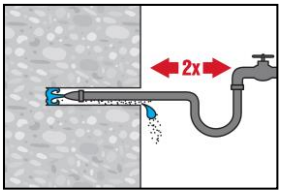
For the use in combination with Hilti Roughening tool TE-YRT see parameters in Table B8 and Table B9.
Before roughening free water needs to be removed from the borehole. Check usability of the roughening tool with the wear gauge RTG.
Roughen the borehole over the whole length to the required h_{ef}.

Drill hole cleaning:	Just before setting the steel element, the drill hole must be free of dust and debris. Inadequate hole cleaning = poor load values.
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. For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m³/h.
	Brush 2 times with the specified brush (see Table B8 and Table B9) 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 ϕ ≥ drill hole ϕ) - 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.

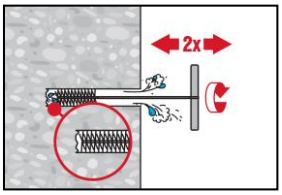
Cleaning and water removal of water filled holes drilled with hammer drilling, hammer drilling with Hilti hollow drill bit and diamond coring
For all drill hole diameters d_0 and all drill hole depths h_0.

	Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.
	Brush 2 times with the specified brush (see Table B8 and Table B9) 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 ϕ ≥ drill hole ϕ) - if not the brush is too small and must be replaced with the proper brush diameter.
	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) 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 and water. For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m³/h.
	Brush 2 times with the specified brush size (see Table B8 and Table B9) 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 – 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 and water.

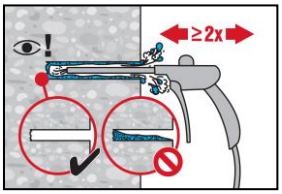
Cleaning of diamond cored holes with roughening with Hilti Roughening tool TE-YRT:
For all drill hole diameters d_0 and all drill hole depths h_0.



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

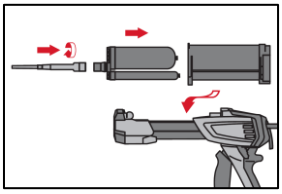


Brush 2 times with the specified brush (see Table B8 and Table B9) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush $\phi \geq$ drill hole ϕ) - if not the brush is too small and must be replaced with the proper brush diameter.

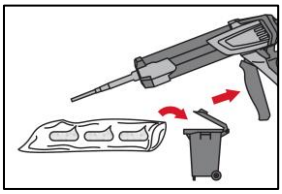


Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust and water.
For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m³/h.

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.

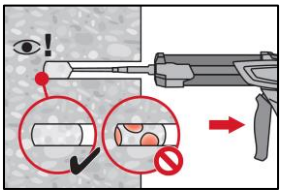


The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded.

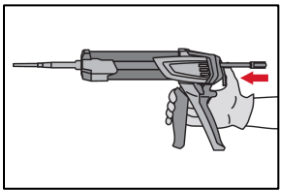
Discarded quantities are:	3 strokes	for 330 ml foil pack,
	4 strokes	for 500 ml foil pack,
	65 ml	for 1400 ml foil pack.

The minimum foil pack temperature is +5°C.

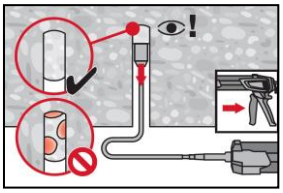
Inject adhesive from the back of the drill hole without forming air voids.



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

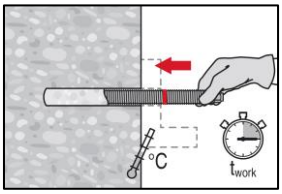


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

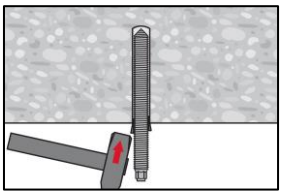


Overhead installation and/or installation with embedment depth $h_{ef} > 250$ mm.
For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B8 and Table B9). Insert piston 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.

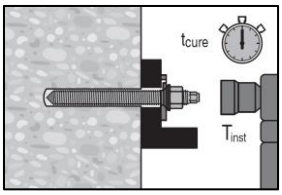
Setting the steel element



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



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



After required curing time t_{cure} (see Table B7) the fastening can be loaded.
The applied installation torque shall not exceed the values max. T_{inst} given in Table B1 to Table B5.

Installation of Hilti Filling Set

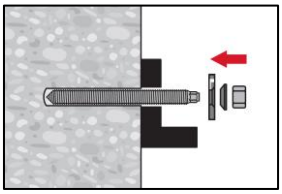
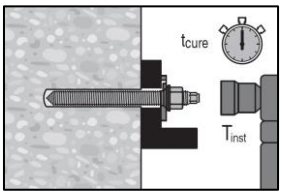
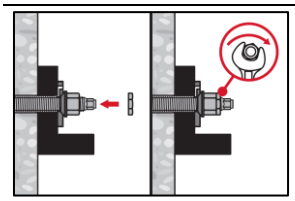
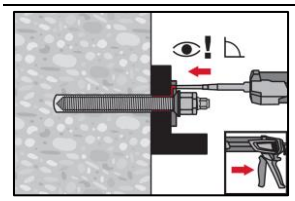
	Use Hilti Filling Set with standard nut. Observe the correct orientation of filling washer and spherical washer.
	The applied installation torque shall not exceed the values max. T_{inst} given in in Table B1 to Table B5.
	Optional: Installation of lock nut. Tighten with a ¼ to ½ turn. (Not for size M24.)
	Fill the annular gap between the anchor rod and fixture with 1-3 strokes of a Hilti injection mortar HIT-HY … or HIT-RE … . Follow the installation instructions supplied with the Hilti injection mortar. After required curing time t_{cure}, the fastening can be loaded.

Table C1: Essential characteristics for metric threaded rod according to Annex A under tension load in concrete

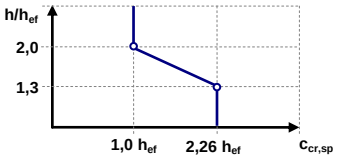
Metric threaded rod according to Annex A			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
For a working life of 50 and 100 years										
Steel failure										
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$							
Partial factor grade 5.8, 6.8, 8.8 (Table A2)	$\gamma_{Ms,N}$ [1)]	[-]	1,5							
Partial factor HAS A4, HAS-U A4, HIT-V-R, Threaded rod: CRC II and III (Table A2)	$\gamma_{Ms,N}$ [1)]	[-]	1,87						2,86	
Partial factor HAS-U HCR, HIT-V-HCR, Threaded rod: CRC V (Table A2)	$\gamma_{Ms,N}$ [1)]	[-]	1,5					2,1		
Installation factor										
Hammer drilling	γ_{inst}	[-]	1,0							
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	1,0							
Diamond coring	γ_{inst}	[-]	1,2			1,4				
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	[2)]			1,0				
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4							
Concrete cone failure										
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7							
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0							
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	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$							
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$							
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$							
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$							

Table C1: continued (1)

Metric threaded rod according to Annex A				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Combined pullout and concrete cone failure for a working life of 50 years											
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	19	18	18	17	16	15	15	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	16	15	15	14	13	13	12	12
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	6,0	6,0	5,5	5,0	5,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	13	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	11	11	11	11	11	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	5,5	5,5	5,5	5,5	5,5	5,5	5,0
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	16	16	15	15	14	13	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	12	11	11	10	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	5,0	5,0	5,0	4,5	4,5	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	7,5	9,0	11	11	10	9,5	9,0	8,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	7,0	8,0	9,0	8,5	8,0	8,0	7,5	7,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	3,5	3,5	3,5	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete											
Influence of concrete strength											
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes**											
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$							
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I to III:		ψ_c	[-]	[2)]			1,0				
Influence of sustained load											
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88							
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72							
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69							
in **diamond cored holes**											
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89							
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70							
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62							

Table C1: continued (2)

Metric threaded rod according to Annex A				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Combined pullout and concrete cone failure for a working life of 100 years											
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	19	18	18	17	16	15	15	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	15	15	15	14	13	13	12	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	6,0	6,0	6,0	5,5	5,0	5,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	13	13	13	13	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	12	12	11	11	11	11	11	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	6,0	5,5	5,5	5,5	5,5	5,5	5,5	5,0
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	16	16	15	15	14	13	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	13	13	13	12	11	11	10	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	5,0	5,0	5,0	4,5	4,5	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,cr}$	[N/mm²]	7,0	8,0	9,0	8,5	8,0	7,5	7,0	6,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,cr}$	[N/mm²]	6,0	7,0	8,0	7,5	7,0	6,5	6,5	6,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,cr}$	[N/mm²]	4,0	3,5	3,5	3,5	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete											
Influence of concrete strength											
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**											
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$							
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I to III:		ψ_c	[-]	[2]			1,0				
Influence of sustained load											
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,85							
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,72							
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,69							
in **diamond cored holes**											
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,70							
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,67							
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,62							

[1] In absence of national regulations.
[2] No performance assessed.

Table C2: Essential characteristics for fractional threaded rod according to Annex A under tension load in concrete

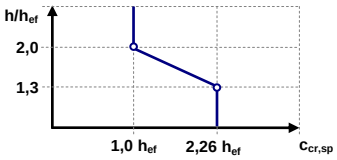
Fractional threaded rod according to Annex A		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
For a working life of 50 and 100 years									
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$						
Partial factor HIT-V	$\gamma_{Ms,N}$ 1)	[-]	1,92						
Partial factor HAS-V-36	$\gamma_{Ms,N}$ 1)	[-]	1,94						
Partial factor HAS-E-55	$\gamma_{Ms,N}$ 1)	[-]	1,64						
Partial factor HAS-B-105	$\gamma_{Ms,N}$ 1)	[-]	1,43						
Partial factor HAS-R 304	$\gamma_{Ms,N}$ 1)	[-]	1,85			2,27			3,01
Partial factor HAS-R 316	$\gamma_{Ms,N}$ 1)	[-]	1,85			2,27			
Installation factor									
Hammer drilling	γ_{inst}	[-]	1,0						
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	2)	1,0					
Diamond coring	γ_{inst}	[-]	1,2		1,4				
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	2)		1,0				
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4						
Concrete cone failure									
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7						
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0						
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	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$						
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$						
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$						
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$						

Table C2: continued (1)

Fractional threaded rod according to Annex A [in.]				**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
Combined pullout and concrete cone failure for a working life of 50 years										
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	19	18	17	16	16	15	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	15	15	14	14	13	12	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	6,0	5,5	5,5	5,0	5,0	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	12	11	11	11	11	11	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	5,5	5,0
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	16	15	15	14	13	13	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	13	13	12	12	11	11	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	5,0	5,0	4,5	4,5	4,5	4,0	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	9,0	11	11	10	9,0	9,0	8,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	8,0	9,0	8,5	8,5	8,0	7,5	7,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	3,5	3,0	3,0	3,0	2,5
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete										
Influence of concrete strength										
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**										
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$						
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I to III:		ψ_c	[-]	[2)]		1,0				
Influence of sustained load										
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88						
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72						
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69						
in **diamond cored holes**										
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89						
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70						
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62						

Table C2: continued (2)

Fractional threaded rod according to Annex A [in.]	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
Combined pullout and concrete cone failure for a working life of 100 years							
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I: 24°C / 40°C $\tau_{Rk,100,ucr}$ [N/mm²]	19	18	17	16	16	15	14
Temperature range II: 43°C / 55°C $\tau_{Rk,100,ucr}$ [N/mm²]	15	15	14	13	13	12	11
Temperature range III: 55°C / 75°C $\tau_{Rk,100,ucr}$ [N/mm²]	6,0	6,0	5,5	5,5	5,0	5,0	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**							
Temperature range I: 24°C / 40°C $\tau_{Rk,100,ucr}$ [N/mm²]	13	13	13	12	12	12	12
Temperature range II: 43°C / 55°C $\tau_{Rk,100,ucr}$ [N/mm²]	12	11	11	11	11	11	10
Temperature range III: 55°C / 75°C $\tau_{Rk,100,ucr}$ [N/mm²]	5,5	5,5	5,5	5,5	5,5	5,5	5,0
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**							
Temperature range I: 24°C / 40°C $\tau_{Rk,100,ucr}$ [N/mm²]	16	15	15	14	13	13	12
Temperature range II: 43°C / 55°C $\tau_{Rk,100,ucr}$ [N/mm²]	13	12	12	11	11	10	9,5
Temperature range III: 55°C / 75°C $\tau_{Rk,100,ucr}$ [N/mm²]	5,0	5,0	4,5	4,5	4,5	4,0	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I: 24°C / 40°C $\tau_{Rk,100,cr}$ [N/mm²]	8,0	8,5	8,5	8,0	7,5	7,5	6,5
Temperature range II: 43°C / 55°C $\tau_{Rk,100,cr}$ [N/mm²]	7,0	7,5	7,5	7,0	7,0	6,5	6,0
Temperature range III: 55°C / 75°C $\tau_{Rk,100,cr}$ [N/mm²]	3,5	3,5	3,5	3,0	3,0	3,0	2,5
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete							
Influence of concrete strength							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**							
Temperature range I to III: ψ_c [-]	$(f_{ck}/20)^{0,1}$						
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I to III: ψ_c [-]	[2]	1,0					
Influence of sustained load							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I: 24°C / 40°C $\psi^0_{sus,100}$ [-]	0,85						
Temperature range II: 43°C / 55°C $\psi^0_{sus,100}$ [-]	0,72						
Temperature range III: 55°C / 75°C $\psi^0_{sus,100}$ [-]	0,69						
in **diamond cored holes**							
Temperature range I: 24°C / 40°C $\psi^0_{sus,100}$ [-]	0,70						
Temperature range II: 43°C / 55°C $\psi^0_{sus,100}$ [-]	0,67						
Temperature range III: 55°C / 75°C $\psi^0_{sus,100}$ [-]	0,62						

[1] In absence of national regulations.
[2] No performance assessed.

Table C3: Essential characteristics for internally threaded sleeve HIS-(R)N under tension load in concrete

HIS-(R)N			**M8**	**M10**	**M12**	**M16**	**M20**
Outer diameter of sleeve	d_{nom}	[mm]	12,5	16,5	20,5	25,4	27,6
For a working life of 50 and 100 years							
Steel failure							
Characteristic resistance HIS-N with screw grade 8.8	$N_{Rk,s}$	[kN]	25	46	67	125	116
Partial factor	$\gamma_{Ms,N}$ [1)]	[-]	1,5				
Characteristic resistance HIS-RN with screw grade 70	$N_{Rk,s}$	[kN]	26	41	59	110	166
Partial factor	$\gamma_{Ms,N}$ [1)]	[-]	1,87				2,4
Installation factor							
Hammer drilling	γ_{inst}	[-]	1,0				
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	1,0				
Diamond coring	γ_{inst}	[-]	1,2	1,4			
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	[2)]	1,0			
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4				
Concrete cone failure							
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7				
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0				
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	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$				
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$				
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$				
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				

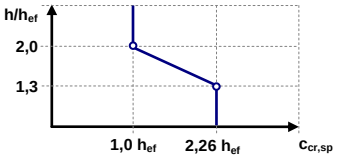


Table C3: continued (1)

HIS-(R)N				**M8**	**M10**	**M12**	**M16**	**M20**
Outer diameter of sleeve		d_{nom}	[mm]	12,5	16,5	20,5	25,4	27,6
Combined pullout and concrete cone failure for a working life of 50 years								
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12	12
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	9,0	9,5	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	8,0	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	10	10	10	10	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	9,0	9,0	9,0	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	8,0	8,0	8,0	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete								
Influence of concrete strength								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**								
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$				
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I to III:		ψ_c	[-]	[2)]	1,0			
Influence of sustained load								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88				
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72				
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69				
in **diamond cored holes**								
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89				
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70				
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62				

Table C3: continued (2)

HIS-(R)N				**M8**	**M10**	**M12**	**M16**	**M20**
Outer diameter of sleeve		d_{nom}	[mm]	12,5	16,5	20,5	25,4	27,6
Combined pullout and concrete cone failure for a working life of 100 years								
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	14	14	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	11	11	11	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,5	9,0	9,5	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,0	8,0	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	12	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,cr}$	[N/mm²]	7,0	7,0	7,0	7,0	7,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,cr}$	[N/mm²]	6,0	6,5	6,5	6,5	6,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete								
Influence of concrete strength								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**								
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$				
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I to III:		ψ_c	[-]	[2]	1,0			
Influence of sustained load								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,85				
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,72				
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,69				
in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,70				
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,67				
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,62				

[1] In absence of national regulations.
[2] No performance assessed.

Table C4: Essential characteristics for internally threaded sleeve HIS-(R)N under tension load in concrete

HIS-(R)N, size		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
Outer diameter of sleeve	d_{nom}	[mm]	16,5	20,5	25,4	27,6
For a working life of 50 and 100 years						
Steel failure						
Characteristic resistance HIS-N Screw acc. to SAE J429 Grade 5 or ASTM A325 (1/2 in. to 3/4 in.)	$N_{Rk,s}$	[kN]	41	76	121	130
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,57			1,50
Characteristic resistance HIS-N Screw acc. to ASTM A193 Grade B7	$N_{Rk,s}$	[kN]	43	77	128	130
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,43	1,50		
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8M	$N_{Rk,s}$	[kN]	38	110	182	185
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,40	2,40		
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8T	$N_{Rk,s}$	[kN]	43	110	182	185
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,50	2,40		
Installation factor						
Hammer drilling	γ_{inst}	[-]	1,0			
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	2)	1,0		2)
Diamond coring	γ_{inst}	[-]	1,4			
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	2)	1,0		2)
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4			
Concrete cone failure						
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7			
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0			
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	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$			
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$			
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$			
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$			

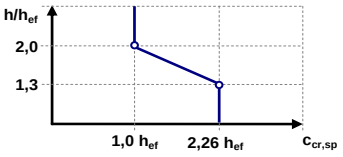


Table C4: continued (1)

HIS-(R)N, size			**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
Outer diameter of sleeve		d_{nom}	[mm]	16,5	20,5	25,4	27,6
Combined pullout and concrete cone failure for a working life of 50 years							
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	9,0	9,5	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	10	10	10	10
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	9,0	9,0	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	8,0	8,0	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete							
Influence of concrete strength							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**							
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$			
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I to III:		ψ_c	[-]	2)	1,0		2)
Influence of sustained load							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88			
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72			
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69			
in **diamond cored holes**							
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89			
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70			
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62			

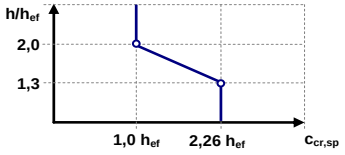
Table C4: continued (2)

HIS-(R)N, size			**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
Outer diameter of sleeve		d_{nom}	[mm]	16,5	20,5	25,4	27,6
Combined pullout and concrete cone failure for a working life of 100 years							
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	14	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	11	11	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	9,0	9,5	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,0	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,cr}$	[N/mm²]	7,0	7,0	7,0	7,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,cr}$	[N/mm²]	6,5	6,5	6,5	6,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,cr}$	[N/mm²]	3,0	3,0	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete							
Influence of concrete strength							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**							
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$			
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I to III:		ψ_c	[-]	2)	1,0		2)
Influence of sustained load							
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,85			
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,72			
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,69			
in **diamond cored holes**							
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,70			
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,67			
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,62			

1) In absence of national regulations.
2) No performance assessed.

Table C5: Essential characteristics for Hilti Tension anchor HZA / HZA-R under tension load in concrete

HZA / HZA-R			**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter	ϕ	[mm]	12	16	20	25	28
For a working life of 50 and 100 years							
Steel failure							
Characteristic resistance HZA	$N_{Rk,s}$	[kN]	46	86	135	194	253
Characteristic resistance HZA-R	$N_{Rk,s}$	[kN]	62	111	173	248	1)
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,4				
Installation factor							
Hammer drilling	γ_{inst}	[-]	1,0				
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	1,0				
Diamond coring	γ_{inst}	[-]	1,2	1,4			
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	2)	1,0			
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4				
Concrete cone failure							
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7				
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0				
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	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$				
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$				
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$				
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				



1) In absence of national regulations.
2) No performance assessed.

Table C5: continued (1)

HZA / HZA-R				**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter		ϕ	[mm]	12	16	20	25	28
Combined pullout and concrete cone failure for a working life of 50 years								
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	15	15	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	5,0	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,5	8,5	8,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	13	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	11	10	10	10	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	12	12	12	11	11
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	10	10	10	9,5	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	3,5	3,5	3,5
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete								
Influence of concrete strength								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**								
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$				
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I to III:		ψ_c	[-]	[1)]	1,0			
Influence of sustained load								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88				
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72				
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69				
in **diamond cored holes**								
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89				
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70				
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62				

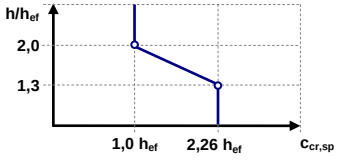
Table C5: continued (2)

HZA / HZA-R				**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter		ϕ	[mm]	12	16	20	25	28
Combined pullout and concrete cone failure for a working life of 100 years								
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	15	15	14	14	14
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	12	12	12	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	5,0	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,5	8,5	8,5	8,5	8,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	13	12	12	12	12
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	10	10	10	9,5	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,cr}$	[N/mm²]	10	9,5	9,5	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,cr}$	[N/mm²]	9,0	8,5	8,5	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,cr}$	[N/mm²]	4,0	4,0	3,5	3,5	3,5
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete								
Influence of concrete strength								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**								
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$				
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I to III:		ψ_c	[-]	[1)]	1,0			
Influence of sustained load								
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,85				
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,72				
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,69				
in **diamond cored holes**								
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,70				
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,67				
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,62				

1) No performance assessed.

Table C6: Essential characteristics for reinforcing bars (rebars) under tension load in concrete

Reinforcing bar (rebar)			$\phi 8$	$\phi 10$	$\phi 12$	$\phi 14$	$\phi 16$	$\phi 18$	$\phi 20$	$\phi 24$	$\phi 25$	$\phi 28$	$\phi 30$	$\phi 32$
For a working life of 50 and 100 years														
Steel failure														
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ [1]											
Characteristic resistance Rebar B500B acc. to DIN 488 [2]	$N_{Rk,s}$	[kN]	28	43	62	85	111	140	173	249	270	339	389	442
Partial factor Rebar B500B acc. to DIN 488 [3]	$\gamma_{Ms,N}$ [4]	[-]	1,4											
Installation factor														
Hammer drilling	γ_{inst}	[-]	1,0											
Hammer drilling with Hilti hollow drill bit TE-CD or TE-YD	γ_{inst}	[-]	1,0											
Diamond coring	γ_{inst}	[-]	1,2				1,4							
Diamond coring with roughening with Hilti Roughening tool TE-YRT	γ_{inst}	[-]	[5]			1,0							[5]	
Hammer drilling in water-filled drill holes	γ_{inst}	[-]	1,4											
Concrete cone failure														
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7											
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0											
Edge distance	$c_{cr,N}$	[mm]	$1{,}5 \cdot hef$											
Spacing	$s_{cr,N}$	[mm]	$3{,}0 \cdot hef$											
Splitting failure														
Edge distance $c_{cr,sp}$ [mm] for	$h/h_{ef} \geq 2{,}0$		$1{,}0 \cdot h_{ef}$											
	$2{,}0 > h/h_{ef} > 1{,}3$		$4{,}6 \cdot h_{ef} - 1{,}8 \cdot h$											
	$h/h_{ef} \leq 1{,}3$		$2{,}26 \cdot h_{ef}$											
Spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$											



Injection system Hilti HIT-RE 500 V4

Performance
Essential characteristics under tension load in concrete

Annex C16

Table C6: continued (1)

Reinforcing bar (rebar)				$\phi 8$	$\phi 10$	$\phi 12$	$\phi 14$	$\phi 16$	$\phi 18$	$\phi 20$	$\phi 24$	$\phi 25$	$\phi 28$	$\phi 30$	$\phi 32$
Combined pullout and concrete cone failure for a working life of 50 years															
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	10	15	15	15	15	14	14	14	14	14	13	13
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	13	12	12	12	12	12	12	11	11	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	3,5	5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	9,5	9,5	9,5	9,5	9,5	10	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	13	13	13	12	12	12	12	12	12	11	11
Temperature range II:	43°C / 55°C	$\tau_{Rk,ucr}$	[N/mm²]	7,0	11	11	10	10	10	10	10	10	9,5	9,5	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,ucr}$	[N/mm²]	3,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	3,5	3,5	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	5,5	10	12	12	12	12	12	11	11	11	11	11
Temperature range II:	43°C / 55°C	$\tau_{Rk,cr}$	[N/mm²]	5,0	8,5	10	10	10	10	10	9,5	9,5	9,5	9,5	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,cr}$	[N/mm²]	2,0	4,0	4,0	4,0	4,0	4,0	3,5	3,5	3,5	3,5	3,5	3,5
Influence factors ψ on bond resistance τ_{Rk} in cracked and uncracked concrete															
Influence of concrete strength															
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**															
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$											
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I to III:		ψ_c	[-]	[5]				1,0						[5]	
Influence of sustained load															
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,88											
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,72											
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,69											
in **diamond cored holes**															
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,89											
Temperature range II:	43°C / 55°C	ψ^0_{sus}	[-]	0,70											
Temperature range III:	55°C / 75°C	ψ^0_{sus}	[-]	0,62											

Table C6: continued (2)

Reinforcing bar (rebar)				ϕ**8**	ϕ**10**	ϕ**12**	ϕ**14**	ϕ**16**	ϕ**18**	ϕ**20**	ϕ**24**	ϕ**25**	ϕ**28**	ϕ**30**	ϕ**32**
Combined pullout and concrete cone failure for a working life of 100 years															
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	10	15	15	15	15	14	14	14	14	14	13	13
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,0	12	12	12	12	12	12	11	11	11	11	11
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	3,0	5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **diamond cored holes**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	9,5	9,5	9,5	9,5	9,5	10	10	10
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	9,0	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,5	4,5	4,5	4,5	4,5
Characteristic resistance in uncracked concrete C20/25 in **hammer drilled holes and installation in water-filled drill holes**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,ucr}$	[N/mm²]	8,5	13	13	13	12	12	12	12	12	12	11	11
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,ucr}$	[N/mm²]	7,0	11	10	10	10	10	10	9,5	9,5	9,5	9,5	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,ucr}$	[N/mm²]	2,5	4,0	4,0	4,0	4,0	4,0	4,0	4,0	4,0	3,5	3,5	3,5
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,cr}$	[N/mm²]	5,0	9,0	10	10	9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,cr}$	[N/mm²]	4,5	8,0	9,0	9,0	8,5	8,5	8,5	8,0	8,0	8,0	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,cr}$	[N/mm²]	2,0	4,0	4,0	4,0	4,0	4,0	3,5	3,5	3,5	3,5	3,5	3,5
Influence factors ψ on bond resistance $\tau_{Rk,100}$ in cracked and uncracked concrete															
Influence of concrete strength															
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bitTE-CD or TE-YD** and **diamond cored holes**															
Temperature range I to III:		ψ_c	[-]	$(f_{ck}/20)^{0,1}$											
in **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I to III:		ψ_c	[-]	[5]				1,0						[5]	
Influence of sustained load															
in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**															
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,85											
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,72											
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,69											
in **diamond cored holes**															
Temperature range I:	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,70											
Temperature range II:	43°C / 55°C	$\psi^0_{sus,100}$	[-]	0,67											
Temperature range III:	55°C / 75°C	$\psi^0_{sus,100}$	[-]	0,62											

1) f_{uk} according to rebar specification.
2) Values need to be calculated acc. EAD 330499-02, Eq. 2.1, if rebars do not fulfil the requirements acc. DIN 488.
3) Values need to be calculated acc. EN 1992-4:2018, tab 4.1, if rebars do not fulfil the requirements acc. DIN 488.
4) In absence of national regulations.
5) No performance assessed.

Table C7: Essential characteristics for metric threaded rod according to Annex A under shear load in concrete

Metric threaded rod according to Annex A			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
For a working life of 50 and 100 years										
Steel failure without lever arm										
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$k_6 \cdot A_s \cdot f_{uk}$							
Factor grade 5.8	k_6	[-]	0,6							
Factor grade 6.8, 8.8	k_6	[-]	0,5							
Factor HAS A4, HAS-U A4, HIT-V-R, Threaded rod: CRC II and III (Table A2)	k_6	[-]	0,5							
Factor HAS-U HCR, HIT-V-HCR, Threaded rod: CRC V (Table A2)	k_6	[-]	0,5							
Partial factor grade 5.8, 6.8, 8.8	$\gamma_{Ms,V}$ [1)]	[-]	1,25							
Partial factor Factor HAS A4, HAS-U A4, HIT-V-R, Threaded rod: CRC II and III (Table A2)	$\gamma_{Ms,V}$ [1)]	[-]	1,56						2,38	
Partial factor HAS-U HCR, HIT-V-HCR, Threaded rod: CRC V (Table A2)	$\gamma_{Ms,V}$ [1)]	[-]	1,25					1,75		
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$							
Ductility factor	k_7	[-]	1,0							
Concrete pry-out failure										
Pry-out factor	k_8	[-]	2,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$						$\min(hef;\ 8 \cdot d_{nom};\ 300)$	
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30

1) In absence of national regulations.

Table C8: Essential characteristics for fractional threaded rod according to Annex A under shear load in concrete

Fractional threaded rod according to Annex A		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
For a working life of 50 and 100 years									
Steel failure without lever arm									
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$k_6 \cdot A_s \cdot f_{uk}$						
Factor HIT-V	k_6	[-]	0,6						
Factor HAS-E-36	k_6	[-]	0,6						
Factor HAS-E-55	k_6	[-]	0,5						
Factor HAS-B-105	k_6	[-]	0,5						
Factor HAS-R 304	k_6	[-]	0,5						
Factor HAS-R 316	k_6	[-]	0,5						
Partial factor HIT-V	$\gamma_{Ms,V}$ 1)	[-]	1,60						
Partial factor HAS-E-36	$\gamma_{Ms,V}$ 1)	[-]	1,61						
Partial factor HAS-E-55	$\gamma_{Ms,V}$ 1)	[-]	1,36						
Partial factor HAS-B-105	$\gamma_{Ms,V}$ 1)	[-]	1,50						
Partial factor HAS-R 304	$\gamma_{Ms,V}$ 1)	[-]	1,54			1,89			2,51
Partial factor HAS-R 316	$\gamma_{Ms,V}$ 1)	[-]	1,54			1,89			
Ductility factor	k_7	[-]	1,0						
Steel failure with lever arm									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$						
Ductility factor	k_7	[-]	1,0						
Concrete pry-out failure									
Pry-out factor	k_8	[-]	2,0						
Concrete edge failure									
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$					$\min(hef;\ 8 \cdot d_{nom};\ 300)$	
Outside diameter of fastener	d_{nom}	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	31,8

1) In absence of national regulations.

Table C9: Essential characteristics for internally threaded sleeve HIS-(R)N under shear load in concrete

HIS-(R)N			M8	M10	M12	M16	M20
For a working life of 50 and 100 years							
Steel failure without lever arm							
Characteristic resistance	$V^0_{Rk,s}$	[kN]	13	23	34	63	58
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,25				
Characteristic resistance HIS-RN with screw grade 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	83
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56				2,0
Ductility factor	k_7	[-]	1,0				
Steel failure with lever arm							
Characteristic resistance HIS-N	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519
Characteristic resistance HIS-RN	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454
Ductility factor	k_7	[-]	1,0				
Concrete pry-out failure							
Pry-out factor	k_8	[-]	2,0				
Concrete edge failure							
Effective length of fastener	l_f	[mm]	90	110	125	170	205
Outside diameter of fastener	d_{nom}	[mm]	12,5	16,5	20,5	25,4	27,6

1) In absence of national regulations.

Table C10: Essential characteristics for internally threaded sleeve HIS-(R)N under shear load in concrete

HIS-(R)N, size		[in.]	3/8	1/2	5/8	3/4
For a working life of 50 and 100 years						
Steel failure without lever arm						
Characteristic resistance HIS-N Screw acc. to SAE J429 Grade 5 or ASTM A325 (1/2 in. to 3/4 in.)	$V^0_{Rk,s}$	[kN]	21	38	60	65
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,50			1,25
Characteristic resistance HIS-N Screw acc. to ASTM A193 Grade B7	$V^0_{Rk,s}$	[kN]	22	40	63	65
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,50			1,25
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8M (AISI 316)	$V^0_{Rk,s}$	[kN]	19	35	55	93
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,50			2,00
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8T (AISI 321)	$V^0_{Rk,s}$	[kN]	22	40	63	93
Partial factor	$\gamma_{Ms,V}$ [1)]	[-]	1,50			2,00
Ductility factor	k_7	[-]	1,0			
Steel failure with lever arm						
Characteristic resistance HIS-N Screw acc. to SAE J429 Grade 5 or ASTM A325 (1/2 in. to 3/4 in.)	$M^0_{Rk,s}$	[Nm]	50	123	247	444
Characteristic resistance HIS-N Screw acc. to ASTM A193 Grade B7	$M^0_{Rk,s}$	[Nm]	52	128	257	463
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8M (AISI 316)	$M^0_{Rk,s}$	[Nm	45	113	226	407
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8T (AISI 321)	$M^0_{Rk,s}$	[Nm]	52	128	257	463
Ductility factor	k_7	[-]	1,0			
Concrete pry-out failure						
Pry-out factor	k_8	[-]	2,0			
Concrete edge failure						
Effective length of fastener	l_f	[mm]	110	125	170	205
Outside diameter of fastener	d_{nom}	[mm]	16,5	20,5	25,4	27,6

1) In absence of national regulations.

Table C11: Essential characteristics for Hilti Tension anchor HZA / HZA-R under shear load in concrete

HZA / HZA-R			**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter	ϕ	[mm]	12	16	20	25	28
For a working life of 50 and 100 years							
Steel failure without lever arm							
Characteristic resistance HZA	$V^0_{Rk,s}$	[kN]	23	43	67	97	126
Characteristic resistance HZA-R	$V^0_{Rk,s}$	[kN]	31	55	86	124	2)
Partial factor	$\gamma_{Ms,V}$ 1)	[-]	1,5				
Ductility factor	k_7	[-]	1,0				
Steel failure with lever arm							
Characteristic resistance HZA	$M^0_{Rk,s}$	[Nm]	72	183	357	617	915
Characteristic resistance HZA-R	$M^0_{Rk,s}$	[Nm]	97	234	457	790	2)
Ductility factor	k_7	[-]	1,0				
Concrete pry-out failure							
Pry-out factor	k_8	[-]	2,0				
Concrete edge failure							
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$			$\min(hef;\ 8 \cdot d_{nom};\ 300)$	
Outside diameter of fastener	d_{nom}	[mm]	12	16	20	24	27

1) In absence of national regulations.
2) No performance assessed.

Table C12: Essential characteristics for reinforcing bars (rebars) under shear load in concrete

Reinforcing bar (rebar)			$\phi 8$	$\phi 10$	$\phi 12$	$\phi 14$	$\phi 16$	$\phi 18$	$\phi 20$	$\phi 24$	$\phi 25$	$\phi 28$	$\phi 30$	$\phi 32$
For a working life of 50 and 100 years														
Steel failure without lever arm														
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$ [1]											
Characteristic resistance Rebar B500B acc. to DIN 488 [2]	$V^0_{Rk,s}$	[kN]	14	22	31	42	55	70	86	124	135	169	194	221
Partial factor Rebar B500B acc. to DIN 488 [3]	$\gamma_{Ms,V}$ [4]	[-]	1,5											
Ductility factor	k_7	[-]	1,0											
Steel failure with lever arm														
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$ [1]											
Characteristic resistance Rebar B500B acc. to DIN 488	$M^0_{Rk,s}$	[Nm]	33	65	112	178	265	378	518	896	1012	1422	1749	2123
Ductility factor	k_7	[-]	1,0											
Concrete pry-out failure														
Pry-out factor	k_8	[-]	2,0											
Concrete edge failure														
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$								$\min(hef;\ 8 \cdot d_{nom};\ 300)$			
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	18	20	24	25	28	30	32

[1] f_{uk} according to rebar specification.
[2] Values need to be calculated acc. EAD 330499-02, Eq. 2.1, if rebars do not fulfil the requirements acc. DIN 488.
[3] Values need to be calculated acc. EN 1992-4:2018, tab 4.1, if rebars do not fulfil the requirements acc. DIN 488.
[4] In absence of national regulations.

Table C13: Displacements for threaded rod under tension load in concrete

Threaded rod, HAS-U-…, HIT-V-…, AM…8.8			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Threaded rod, HAS-…, HIT-V, size		**[in.]**	**-**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
Displacement in uncracked concrete										
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,04	0,05	0,05	0,06	0,06	0,07	0,08	0,08
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,10	0,11	0,12	0,13	0,15	0,17	0,18	0,19
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,05	0,06	0,07	0,07	0,08	0,09	0,10
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,13	0,14	0,16	0,18	0,20	0,21	0,23
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,06	0,06	0,07	0,08	0,09	0,09	0,10
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,13	0,15	0,17	0,19	0,21	0,23	0,24
Displacement in cracked concrete										
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,03	0,05	0,08	0,10	0,13	0,15	0,18
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,19	0,14	0,19	0,16	0,16	0,15	0,18
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,06	0,09	0,12	0,16	0,18	0,21
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,15	0,23	0,17	0,23	0,19	0,19	0,18	0,21
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,06	0,10	0,13	0,17	0,19	0,22
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,16	0,24	0,18	0,24	0,20	0,20	0,19	0,22

Table C14: Displacements for internally threaded HIS-(R)N under tension load in concrete

HIS-(R)N			**M8**	**M10**	**M12**	**M16**	**M20**
HIS-(R)N, size		**[in.]**	**-**	**3/8**	**1/2**	**5/8**	**3/4**
Displacement in uncracked concrete							
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,06	0,06	0,07	0,08
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,13	0,15	0,17	0,18
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,06	0,07	0,07	0,08	0,09
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,14	0,16	0,18	0,20	0,21
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,06	0,07	0,07	0,09	0,10
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,15	0,16	0,19	0,21	0,22
Displacement in cracked concrete							
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,03	0,05	0,08	0,10
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,19	0,14	0,19	0,16
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,06	0,09	0,12
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,15	0,23	0,17	0,23	0,19
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,06	0,10	0,13
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,16	0,24	0,18	0,24	0,20

Table C15: Displacements for Hilti Tension anchor HZA / HZA-R under tension load in concrete

HZA / HZA-R				**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter		ϕ	[mm]	12	16	20	25	28
Displacement in uncracked concrete								
Temperature range I:	24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,06	0,07	0,07	0,08
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,15	0,17	0,18	0,19
Temperature range II:	43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,06	0,07	0,09	0,09	0,09
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,14	0,18	0,20	0,21	0,22
Temperature range III:	55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,07	0,08	0,09	0,09	0,10
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,15	0,19	0,22	0,22	0,23
Displacement in cracked concrete								
Temperature range I:	24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,06	0,10	0,14	0,15	0,16
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,06	0,16	0,16	0,15	0,16
Temperature range II:	43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,07	0,12	0,17	0,17	0,19
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,07	0,19	0,19	0,18	0,19
Temperature range III:	55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,08	0,13	0,17	0,18	0,20
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,08	0,20	0,20	0,19	0,20

Table C16: Displacements for reinforcing bar (rebar) under tension load in concrete

Reinforcing bar (rebar)				ϕ**8**	ϕ**10**	ϕ**12**	ϕ**14**	ϕ**16**	ϕ**18**
Displacement in uncracked concrete									
Temperature range I:	24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,04	0,05	0,05	0,06	0,06	0,07
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,10	0,11	0,12	0,13	0,15	0,16
Temperature range II:	43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,05	0,06	0,07	0,07	0,08
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,13	0,14	0,16	0,18	0,19
Temperature range III:	55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,05	0,06	0,07	0,07	0,08	0,08
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,13	0,15	0,17	0,19	0,21
Displacement in cracked concrete									
Temperature range I:	24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,03	0,06	0,08	0,10	0,11
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,12	0,19	0,06	0,19	0,16	0,16
Temperature range II:	43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,07	0,09	0,12	0,14
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,15	0,23	0,07	0,23	0,19	0,19
Temperature range III:	55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,02	0,04	0,08	0,10	0,13	0,14
		$\delta_{N\infty}$	[mm/(N/mm²)]	0,16	0,24	0,08	0,24	0,20	0,20

Table C17: Displacements for reinforcing bar (rebar) under tension load in concrete

Reinforcing bar (rebar)			$\phi 20$	$\phi 24$	$\phi 25$	$\phi 28$	$\phi 30$	$\phi 32$
Displacement in uncracked concrete								
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,07	0,07	0,07	0,08	0,08	0,08
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,17	0,19	0,18	0,19	0,19	0,20
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,09	0,08	0,09	0,09	0,10	0,10
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,20	0,21	0,21	0,22	0,23	0,24
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,09	0,09	0,09	0,10	0,10	0,11
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,22	0,22	0,22	0,23	0,24	0,25
Displacement in cracked concrete								
Temperature range I: 24°C / 40°C	δ_{N0}	[mm/(N/mm²)]	0,14	0,15	0,15	0,16	0,18	0,19
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,16	0,16	0,15	0,16	0,18	0,19
Temperature range II: 43°C / 55°C	δ_{N0}	[mm/(N/mm²)]	0,17	0,17	0,17	0,19	0,21	0,22
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,19	0,19	0,18	0,19	0,21	0,22
Temperature range III: 55°C / 75°C	δ_{N0}	[mm/(N/mm²)]	0,17	0,18	0,18	0,20	0,22	0,24
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,20	0,20	0,19	0,20	0,22	0,24

Table C18: Displacements for threaded rod under shear load in concrete

Metric threaded rod according to Annex A			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Fractional threaded rod according to Annex A		**[in.]**	**-**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
Displacement	δ_{V0}	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

Table C19: Displacements for internally threaded HIS-(R)N under shear load in concrete

HIS-(R)N			**M8**	**M10**	**M12**	**M16**	**M20**
HIS-(R)N, size		**[in.]**	**-**	**3/8**	**1/2**	**5/8**	**3/4**
Displacement	δ_{V0}	[mm/kN]	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,08	0,06	0,06

Table C20: Displacements for Hilti Tension anchor HZA / HZA-R under shear load in concrete

HZA / HZA-R			**M12**	**M16**	**M20**	**M24**	**M27**
Displacement	δ_{V0}	[mm/kN]	0,05	0,04	0,04	0,03	0,03
	$\delta_{V\infty}$	[mm/kN]	0,08	0,06	0,06	0,05	0,05

Table C21: Displacements for reinforcing bar (rebar) under shear load in concrete

Reinforcing bar (rebar)			ϕ**10**	ϕ**12**	ϕ**14**	ϕ**16**	ϕ**18**	ϕ**20**
Displacement	δ_{V0}	[mm/kN]	0,05	0,05	0,05	0,04	0,04	0,04
	$\delta_{V\infty}$	[mm/kN]	0,08	0,08	0,07	0,06	0,06	0,06

Table C22: Displacements for reinforcing bar (rebar) under shear load in concrete

Reinforcing bar (rebar)			ϕ**24**	ϕ**25**	ϕ**28**	ϕ**30**	ϕ**32**	ϕ**24**
Displacement	δ_{V0}	[mm/kN]	0,04	0,03	0,03	0,03	0,03	0,03
	$\delta_{V\infty}$	[mm/kN]	0,05	0,05	0,05	0,05	0,04	0,04

Table C23: Essential characteristics for metric threaded rod according Annex A under tension load for seismic category C1 in concrete

Metric threaded rod according to Annex A				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
For a working life of 50 and 100 years											
Steel failure											
Characteristic resistance		$N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}$							
Combined pullout and concrete cone failure for a working life of 50 years											
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	6,8	8,2	10,1	10,5	9,7	9,4	9,0	8,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	6,3	7,3	8,3	8,1	7,8	7,9	7,5	7,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	3,6	3,2	3,2	3,3	2,9	3,0	3,0	3,0
Combined pullout and concrete cone failure for a working life of 100 years											
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**											
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	6,3	7,3	8,3	8,1	7,8	7,4	7,0	6,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	5,4	6,4	7,4	7,1	6,8	6,4	6,5	6,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	3,6	3,2	3,2	3,3	2,9	3,0	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$											
Influence of concrete strength											
Temperature range I to III:		ψ_c	[-]	1,0							

Table C24: Essential characteristics for fractional threaded rod according Annex A under tension load for seismic category C1 in concrete

Fractional threaded rod according to Annex A			**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
For a working life of 50 and 100 years										
Steel failure										
Characteristic resistance		$N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}$						
Combined pullout and concrete cone failure for a working life of 50 years										
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	8,2	10,1	10,5	9,7	8,9	9,0	8,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	7,3	8,3	8,1	8,2	7,9	7,5	7,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	3,2	3,2	3,3	2,9	3,0	3,0	2,5
Combined pullout and concrete cone failure for a working life of 100 years										
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**										
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	7,3	7,8	8,1	7,8	7,4	7,5	6,5
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	6,4	6,9	7,1	6,8	6,9	6,5	6,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	3,2	3,2	3,3	2,9	3,0	3,0	2,5
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$										
Influence of concrete strength										
Temperature range I to III:		ψ_c	[-]	1,0						

Table C25: Essential characteristics for internally threaded sleeve HIS-(R)N under tension load for seismic category C1 in concrete

HIS-(R)N				**M8**	**M10**	**M12**	**M16**	**M20**
For a working life of 50 and 100 years								
Steel failure								
Characteristic resistance HIS-N		$N_{Rk,s,C1}$	[kN]	25	46	67	125	116
Characteristic resistance HIS-RN		$N_{Rk,s,C1}$	[kN]	26	41	59	110	166
Combined pullout and concrete cone failure for a working life of 50 years								
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	8,4	8,6	8,7	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	7,4	7,6	7,8	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	2,8	3,3	3,4	3,5	3,5
Combined pullout and concrete cone failure for a working life of 100 years								
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	6,5	6,7	6,8	7,0	7,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	5,6	6,2	6,3	6,5	6,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	2,8	2,9	2,9	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$								
Influence of concrete strength								
Temperature range I to III:		ψ_c	[-]	1,0				

Table C26: Essential characteristics for threaded rod under tension load for seismic category C1 in concrete

HIS-(R)N, size			**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
For a working life of 50 and 100 years							
Steel failure							
Characteristic resistance HIS-N Screw acc. to SAE J429 Grade 5 or ASTM A325 (1/2 in. to 3/4 in.)		$N_{Rk,s,C1}$	[kN]	41	76	121	130
Characteristic resistance HIS-N Screw acc. to ASTM A193 Grade B7		$N_{Rk,s,C1}$	[kN]	43	77	128	130
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8M (AISI 316)		$N_{Rk,s,C1}$	[kN]	38	110	182	185
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8T (AISI 321)		$N_{Rk,s,C1}$	[kN]	43	110	182	185
Combined pullout and concrete cone failure for a working life of 50 years							
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	8,6	8,7	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	7,6	7,8	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	2,9	2,9	3,0	3,0
Combined pullout and concrete cone failure for a working life of 100 years							
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**							
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	6,7	6,8	7,0	7,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	6,2	6,3	6,5	6,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	2,9	2,9	3,0	3,0
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$							
Influence of concrete strength							
Temperature range I to III:		ψ_c	[-]	1,0			

Table C27: Essential characteristics for Hilti Tension anchor HZA / HZA-R under tension load for seismic category C1 in concrete

HZA / HZA-R				**M12**	**M16**	**M20**	**M24**	**M27**
Rebar diameter		ϕ	[mm]	12	16	20	25	28
For a working life of 50 and 100 years								
Steel failure								
Characteristic resistance HZA		$N_{Rk,s,C1}$	[kN]	46	86	135	194	253
Characteristic resistance HZA-R		$N_{Rk,s,C1}$	[kN]	62	111	173	248	[1]
Combined pullout and concrete cone failure for a working life of 50 years								
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	11,0	11,4	11,6	10,9	11,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	9,2	9,5	9,7	9,4	9,5
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	3,7	3,8	3,4	3,5	3,5
Combined pullout and concrete cone failure for a working life of 100 years								
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**								
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	9,2	9,0	9,2	8,9	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	8,3	8,1	8,2	7,9	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	3,7	3,8	3,4	3,5	3,5
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$								
Influence of concrete strength								
Temperature range I to III:		ψ_c	[-]	1,0				

[1] No performance assessed.

Table C28: Essential characteristics for reinforcing bars (rebars) under tension load for seismic category C1 in concrete

Reinforcing bar (rebar)				ϕ**10**	ϕ**12**	ϕ**14**	ϕ**16**	ϕ**18**	ϕ**20**	ϕ**24**	ϕ**25**	ϕ**28**	ϕ**30**	ϕ**32**
For a working life of 50 and 100 years														
Steel failure														
Characteristic resistance		$N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}$ [1)]										
Characteristic resistance Rebar B500B acc. to DIN 488 [2)]		$N_{Rk,s,C1}$	[kN]	43	62	85	111	140	173	249	270	339	389	442
Combined pullout and concrete cone failure for a working life of 50 years														
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**														
Temperature range I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	9,1	11,0	11,0	11,4	11,5	11,6	10,8	10,9	11,0	11,0	11,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,C1}$	[N/mm²]	7,7	9,2	9,2	9,5	9,6	9,7	9,3	9,4	9,5	9,5	9,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,C1}$	[N/mm²]	3,6	3,7	3,7	3,8	3,8	3,4	3,4	3,5	3,5	3,5	3,5
Combined pullout and concrete cone failure for a working life of 100 years														
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD** and **diamond cored holes with roughening with Hilti Roughening tool TE-YRT**														
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C1}$	[N/mm²]	8,2	9,2	9,2	9,0	9,1	9,2	8,8	8,9	9,0	9,0	9,0
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C1}$	[N/mm²]	7,3	8,3	8,3	8,1	8,2	8,2	7,8	7,9	8,0	8,0	8,0
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C1}$	[N/mm²]	3,6	3,7	3,7	3,8	3,8	3,4	3,4	3,5	3,5	3,5	3,5
Influence factors ψ on bond resistance $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$														
Influence of concrete strength														
Temperature range I to III:		ψ_c	[-]	1,0										

1) f_{uk} according to rebar specification.

2) Values need to be calculated acc. EAD 330499-02, Eq. 2.1, if rebars do not fulfil the requirements acc. DIN 488.

Table C29: Essential characteristics for metric threaded rod according Annex A under shear load for seismic category C1 in concrete

Threaded rod, HAS-U-…, HIT-V-…, AM…8.8			M8	M10	M12	M16	M20	M24	M27	M30
For a working life of 50 and 100 years										
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5							
Annular gap factor with Hilti Filling Set	α_{gap}	[-]	1,0						[1)]	
Steel failure without lever arm										
Characteristic resistance HAS 5.8, HAS-U-5.8, HIT-V-5.8	$V_{Rk,s,C1}$	[kN]	$0,6 \cdot A_s \cdot f_{uk}$							
Characteristic resistance HAS 8.8, HAS-U-8.8., HIT-V-8.8, AM…8.8	$V_{Rk,s,C1}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$							
Characteristic resistance Commercial standard threaded rod	$V_{Rk,s,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}$							

1) No performance assessed.

Table C30: Essential characteristics for fractional threaded rod according Annex A under shear load for seismic category C1 in concrete

Threaded rod, HAS-…, HIT-V, size		[in.]	3/8	1/2	5/8	3/4	7/8	1	1 1/4
For a working life of 50 and 100 years									
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5						
Steel failure without lever arm									
Characteristic resistance HAS-…, HIT-V	$V_{Rk,s,C1}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$						
Characteristic resistance Commercial standard threaded rod	$V_{Rk,s,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}$						

Table C31: Essential characteristics for internally threaded sleeve HIS-(R)N under shear load for seismic category C1 in concrete

HIS-(R)N			M8	M10	M12	M16	M20
For a working life of 50 and 100 years							
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5				
Annular gap factor with Hilti Filling Set	α_{gap}	[-]	1,0				
Steel failure without lever arm							
Characteristic resistance HIS-N with screw 8.8	$V_{Rk,s,C1}$	[kN]	9,0	16	27	41	39
Characteristic resistance HIS-RN with screw grade 70	$V_{Rk,s,C1}$	[kN]	9,0	14	21	39	58

Table C32: Essential characteristics for internally threaded sleeve HIS-(R)N under shear load for seismic category C1 in concrete

HIS-(R)N, size		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**
For a working life of 50 and 100 years						
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5			
Steel failure without lever arm						
Characteristic resistance HIS-N Screw acc. to SAE J429 Grade 5 or ASTM A325 (1/2 in. to 3/4 in.)	$V_{Rk,s,C1}$	[kN]	14	27	42	45
Characteristic resistance HIS-N Screw acc. to ASTM A193 Grade B7	$V_{Rk,s,C1}$	[kN]	15	28	44	45
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8M (AISI 316)	$V_{Rk,s,C1}$	[kN]	13	24	39	65
Characteristic resistance HIS-RN Screw acc. to ASTM A193 Grade B8T (AISI 321)	$V_{Rk,s,C1}$	[kN]	15	28	44	65

Table C33: Essential characteristics for Hilti Tension anchor HZA / HZA-R under shear load for seismic category C1 in concrete

HZA / HZA-R			**M12**	**M16**	**M20**	**M24**	**M27**
For a working life of 50 and 100 years							
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5				
Steel failure without lever arm							
Characteristic resistance HZA	$V_{Rk,s,C1}$	[kN]	23	43	67	97	126
Characteristic resistance HZA-R	$V_{Rk,s,C1}$	[kN]	31	55	86	124	1)

1) No performance assessed.

Table C34: Essential characteristics for reinforcing bars (rebars) under shear load for seismic category C1 in concrete

Reinforcing bar (rebar)			ϕ**10**	ϕ**12**	ϕ**14**	ϕ**16**	ϕ**18**	ϕ**20**	ϕ**24**	ϕ**25**	ϕ**28**	ϕ**30**	ϕ**32**
For a working life of 50 and 100 years													
Steel failure without lever arm													
Characteristic resistance	$V_{Rk,s,C1}$	[kN]	$0{,}35 \cdot A_s \cdot f_{uk}$ 1)										
Characteristic resistance Rebar B500B acc. to DIN 488 2)	$V_{Rk,s,C1}$	[kN]	15	22	30	39	49	60	87	95	118	136	155

1) f_{uk} according to rebar specification.
2) Values need to be calculated acc. EAD 330499-02, Eq. 2.1, if rebars do not fulfil the requirements acc. DIN 488.

Table C35: Essential characteristics for metric threaded rod according Annex A under tension load for seismic category C2 in concrete

Metric threaded rod according Annex A				**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
For a working life of 50 and 100 years									
Steel failure									
Characteristic resistance HAS (8.8, 8.8 HDG, A4), HAS-U (8.8, 8.8 HDG, A4, HCR), HIT-V (-8.8, -8.8F, -R, -HCR), AM (8.8, 8.8 HDG), Threaded rod (electroplated zinc coated 8.8, CRC II, CRC III and CRC V, see Table A1)		$N_{Rk,s,C2}$	[kN]	$A_s \cdot f_{uk}$					
Combined pullout and concrete cone failure for a working life of 50 years									
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD**									
Temperature range I:	24°C / 40°C	$\tau_{Rk,C2}$	[N/mm²]	3,7	6,5	5,8	6,0	5,0	5,2
Temperature range II:	43°C / 55°C	$\tau_{Rk,C2}$	[N/mm²]	3,1	5,3	4,8	5,0	4,2	4,3
Temperature range III:	55°C / 75°C	$\tau_{Rk,C2}$	[N/mm²]	1,2	2,1	1,9	1,9	1,6	1,7
Combined pullout and concrete cone failure for a working life of 100 years									
Characteristic resistance in cracked concrete C20/25 in **hammer drilled holes** and **hammer drilled holes with Hilti hollow drill bit TE-CD or TE-YD**									
Temperature range I:	24°C / 40°C	$\tau_{Rk,100,C2}$	[N/mm²]	3,7	6,5	5,8	6,0	5,0	5,2
Temperature range II:	43°C / 55°C	$\tau_{Rk,100,C2}$	[N/mm²]	3,0	5,3	4,8	4,9	4,1	4,3
Temperature range III:	55°C / 75°C	$\tau_{Rk,100,C2}$	[N/mm²]	1,2	2,1	1,9	1,9	1,6	1,7
Influence factor ψ on bond resistance $\tau_{Rk,C2}$ and $\tau_{Rk,100,C2}$									
Influence of concrete strength									
Temperature range I to III:		ψ_c	[-]	1,0					

Table C36: Essential characteristics for metric threaded rod according Annex A under shear load for seismic category C2 in concrete

Metric threaded rod according Annex A			**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
For a working life of 50 and 100 years								
Annular gap factor without Hilti Filling Set	α_{gap}	[-]	0,5					
Annular gap factor with Hilti Filling Set	α_{gap}	[-]	1,0				[1]	
Steel failure without lever arm with Hilti Filling Set								
Characteristic resistance HAS 8.8, HAS-U 8.8, HIT-V-8.8, AM 8.8	$V_{Rk,s,C2}$	[kN]	28	46	77	103	[1]	
Steel failure without lever arm without Hilti Filling Set								
Characteristic resistance HAS 8.8, HAS-U 8.8, HIT-V-8.8, AM 8.8	$V_{Rk,s,C2}$	[kN]	24	40	71	90	121	135
Characteristic resistance HAS 8.8, HAS-U 8.8 HDG, HIT-V-8.8F, AM HDG 8.8	$V_{Rk,s,C2}$	[kN]	18	30	46	66	[1]	
Characteristic resistance HAS A4, HAS-U A4, HIT-V-R	$V_{Rk,s,C2}$	[kN]	21	35	62	79	76	84
Characteristic resistance HAS-U HCR, HIT-V-HCR	$V_{Rk,s,C2}$	[kN]	24	40	71	79	106	118
Characteristic resistance Commercial standard threaded rod 8.8	$V_{Rk,s,C2}$	[kN]	17	28	50	63	85	95
Characteristic resistance Commercial standard threaded rod A4	$V_{Rk,s,C2}$	[kN]	15	25	43	55	53	59
Characteristic resistance Commercial standard threaded rod HCR	$V_{Rk,s,C2}$	[kN]	17	28	50	55	74	83

[1] No performance assessed.

Table C37: Displacements for metric threaded rod according Annex A under tension load for seismic category C2 in concrete

Metric threaded rod according Annex A			**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Threaded rod, HAS 8.8, HAS-U-…, HIT-V-…, AM…8.8	$\delta_{N,C2(DLS)}$	[mm]	0,2	0,5	0,5	0,4	0,4	0,5
	$\delta_{N,C2(ULS)}$	[mm]	0,6	1,2	0,9	0,8	1,0	0,9

Table C38: Displacements for metric threaded rod according Annex A under shear load for seismic category C2 in concrete

Metric threaded rod according Annex A			**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Installation with Hilti Filling Set								
HAS 8.8, HAS-U 8.8, HIT-V 8.8, AM 8.8	$\delta_{V,C2(DLS)}$	[mm]	0,6	1,2	1,4	1,1	[1]	
	$\delta_{V,C2(ULS)}$	[mm]	3,1	3,2	3,7	2,6	[1]	
Installation without Hilti Filling Set								
Threaded rod, HAS…, HAS-U-…, HIT-V-…, AM 8.8	$\delta_{V,C2(DLS)}$	[mm]	1,9	3,2	2,5	3,5	3,0	1,9
	$\delta_{V,C2(ULS)}$	[mm]	4,4	9,2	7,1	10,2	7,2	6,3
HAS 8.8 HDG, HAS-U 8.8 HDG, HIT-V-F 8.8, AM HDG 8.8	$\delta_{V,C2(DLS)}$	[mm]	2,2	2,3	3,8	3,4	[1]	
	$\delta_{V,C2(ULS)}$	[mm]	4,1	4,3	9,1	8,4	[1]	

[1] No performance assessed.

Characteristic bond resistance of a single bonded fastener $\tau_{Rk,fi,p}(\theta)$ for concrete strength classes C20/25 to C50/60 with all drilling methods under fire conditions[2]

The characteristic bond resistance of a single bonded fastener under fire conditions $\tau_{Rk,fi,p}$ for a given temperature (θ) shall be calculated using the following equations:

$$\tau_{Rk,fi,p}(\theta) = k_{fi,p}(\theta) \cdot \tau_{Rk,cr,C20/25}$$

where: $\theta \leq \theta_{max}$: $k_{fi,p}(\theta) = k_{fi,p,100y}(\theta) = 39{,}83 \cdot \theta^{-1{,}266} \leq 1{,}0$

and $\theta < \theta_{max}$: $k_{fi,p}(\theta) = k_{fi,p,100y}(\theta) = 0{,}0$

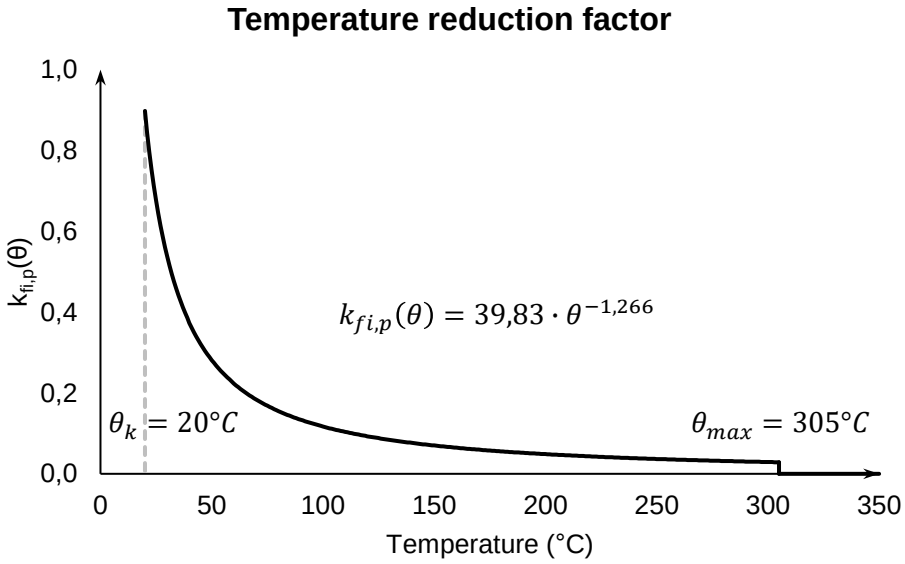
θ_{max} = 305°C

$\tau_{Rk,fi,p}$ = characteristic bond resistance for cracked concrete under fire exposure for a given temperature (θ)

$k_{fi,p}(\theta)$ = reduction factor for bond resistance under fire exposure

$\tau_{Rk,cr,C20/25}$ = characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

Figure C5: Reduction factor $k_{fi,p}(\theta)$



2 Refer to Annex B1 for the characteristic resistance of a fastener, a group of fasteners and the tensioned fasteners of a group of fasteners in case of combined pull-out and concrete failure under fire conditions $N_{Rk,p,fi}$

Table C39: Characteristic resistance under tension load in case of steel failure under fire conditions

Fastener size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
HAS 5.8, 5.8 HDG HAS 8.8, 8.8 HDG HAS-U 5.8, 5.8 HDG HAS-U 8.8, 8.8 HDG HIT-V 5.8, 5.8F HIT-V 8.8, 8.8F	$N_{Rk,s,fi(30)}$	[kN]	1,04	1,77	2,76	5,15	8,04	11,58	15,05	18,40
	$N_{Rk,s,fi(60)}$	[kN]	0,81	1,34	2,03	3,79	5,91	8,51	11,07	13,53
	$N_{Rk,s,fi(90)}$	[kN]	0,59	0,91	1,30	2,42	3,78	5,45	7,09	8,66
	$N_{Rk,s,fi(120)}$	[kN]	0,47	0,70	0,94	1,74	2,72	3,92	5,09	6,22
HAS A4 HAS-U A4-70 HAS-U HCR	$N_{Rk,s,fi(30)}$	[kN]	2,67	4,85	7,94	14,78	23,06	33,23	43,21	52,81
	$N_{Rk,s,fi(60)}$	[kN]	1,93	3,44	5,57	10,37	16,18	23,32	30,32	37,06
	$N_{Rk,s,fi(90)}$	[kN]	1,18	2,03	3,20	5,96	9,30	13,40	17,43	21,30
	$N_{Rk,s,fi(120)}$	[kN]	0,80	1,33	2,02	3,76	5,86	8,44	10,98	13,42

Table C40: Characteristic resistance under tension load in case of steel failure under fire conditions

Fastener size		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
HAS-E-55 HAS-B-105 (HDG)	$N_{Rk,s,fi(30)}$	[kN]	1,50	3,00	4,78	7,08	9,77	12,82	20,50
	$N_{Rk,s,fi(60)}$	[kN]	1,15	2,21	3,52	5,20	7,18	9,42	15,08
	$N_{Rk,s,fi(90)}$	[kN]	0,79	1,41	2,25	3,33	4,60	6,03	9,65
	$N_{Rk,s,fi(120)}$	[kN]	0,61	1,02	1,62	2,39	3,31	4,34	6,94

Table C41: Characteristic resistance under tension load in case of concrete cone and splitting failure under fire conditions

Fastener size			**M8, M10, M12, M16, M20, M24, M27, M30 [in.] 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4**
HAS 5.8, 5.8 HDG HAS 8.8, 8.8 HDG HAS-U 5.8, 5.8 HDG HAS-U 8.8, 8.8 HDG HIT-V 5.8, 5.8F HIT-V 8.8, 8.8F HAS-E-55 HAS-B-105 (HDG) HAS A4 HAS-U A4-70 HAS-U HCR	$N^0_{Rk,c,fi(30)}$	[kN]	$\frac{h_{ef}}{200} \cdot N^0_{Rk,c} \leq N^0_{Rk,c}$
	$N^0_{Rk,c,fi(60)}$	[kN]	
	$N^0_{Rk,c,fi(90)}$	[kN]	
	$N^0_{Rk,c,fi(120)}$	[kN]	$0{,}8 \cdot \frac{h_{ef}}{200} \cdot N^0_{Rk,c} \leq N^0_{Rk,c}$
Characteristic spacing	$s_{cr,N,fi}$	[mm]	$4h_{ef}$
Characteristic edge distance	$c_{cr,N,fi}$	[mm]	$2h_{ef}$

Table C42: Characteristic resistance under shear load in case of steel failure under fire conditions

Fastener size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
HAS 5.8, 5.8 HDG HAS 8.8, 8.8 HDG HAS-U 5.8, 5.8 HDG HAS-U 8.8, 8.8 HDG HIT-V 5.8, 5.8F HIT-V 8.8, 8.8F	$V_{Rk,s,fi(30)}$	[kN]	1,04	1,77	2,76	5,15	8,04	11,58	15,05	18,40
	$V_{Rk,s,fi(60)}$	[kN]	0,81	1,34	2,03	3,79	5,91	8,51	11,07	13,53
	$V_{Rk,s,fi(90)}$	[kN]	0,59	0,91	1,30	2,42	3,78	5,45	7,09	8,66
	$V_{Rk,s,fi(120)}$	[kN]	0,47	0,70	0,94	1,74	2,72	3,92	5,09	6,22
	$M^0_{Rk,s,fi(30)}$	[Nm]	1,06	2,28	4,29	10,92	21,28	36,81	54,58	73,76
	$M^0_{Rk,s,fi(60)}$	[Nm]	0,83	1,73	3,15	8,02	15,65	27,07	40,14	54,23
	$M^0_{Rk,s,fi(90)}$	[Nm]	0,60	1,17	2,02	5,13	10,01	17,32	25,69	34,71
	$M^0_{Rk,s,fi(120)}$	[Nm]	0,48	0,89	1,45	3,69	7,20	12,45	18,46	24,95
HAS A4 HAS-U A4-70 HAS-U HCR	$V_{Rk,s,fi(30)}$	[kN]	2,67	4,85	7,94	14,78	23,06	33,23	43,21	52,81
	$V_{Rk,s,fi(60)}$	[kN]	1,93	3,44	5,57	10,37	16,18	23,32	30,32	37,06
	$V_{Rk,s,fi(90)}$	[kN]	1,18	2,03	3,20	5,96	9,30	13,40	17,43	21,30
	$V_{Rk,s,fi(120)}$	[kN]	0,80	1,33	2,02	3,76	5,86	8,44	10,98	13,42
	$M^0_{Rk,s,fi(30)}$	[Nm]	2,73	6,25	12,33	31,34	61,10	105,67	156,68	211,71
	$M^0_{Rk,s,fi(60)}$	[Nm]	1,97	4,43	8,65	21,99	42,87	74,14	109,93	148,55
	$M^0_{Rk,s,fi(90)}$	[Nm]	1,20	2,62	4,97	12,64	24,64	42,61	63,19	85,38
	$M^0_{Rk,s,fi(120)}$	[Nm]	0,82	1,71	3,13	7,96	15,52	26,85	39,81	53,80

Table C43: Characteristic resistance under shear load in case of steel failure under fire conditions

Fastener size		**[in.]**	**3/8**	**1/2**	**5/8**	**3/4**	**7/8**	**1**	**1 1/4**
HAS-E-55 HAS-B-105 (HDG)	$V_{Rk,s,fi(30)}$	[kN]	1,50	3,00	4,78	7,08	9,77	12,82	20,50
	$V_{Rk,s,fi(60)}$	[kN]	1,15	2,21	3,52	5,20	7,18	9,42	15,08
	$V_{Rk,s,fi(90)}$	[kN]	0,79	1,41	2,25	3,33	4,60	6,03	9,65
	$V_{Rk,s,fi(120)}$	[kN]	0,61	1,02	1,62	2,39	3,31	4,34	6,94
	$M^0_{Rk,s,fi(30)}$	[Nm]	1,96	4,45	9,77	17,59	28,54	42,88	86,77
	$M^0_{Rk,s,fi(60)}$	[Nm]	1,44	3,39	7,18	12,94	20,98	31,53	63,81
	$M^0_{Rk,s,fi(90)}$	[Nm]	0,92	2,34	4,59	8,28	13,43	20,18	40,84
	$M^0_{Rk,s,fi(120)}$	[Nm]	0,66	1,81	3,30	5,95	9,65	14,50	29,35

Table C44: Characteristic resistance under shear load in case of pryout failure under fire conditions

Fastener size			**M8, M10, M12, M16, M20, M24, M27, M30 [in.] 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4**
HAS 5.8, 5.8 HDG HAS 8.8, 8.8 HDG HAS-U 5.8, 5.8 HDG HAS-U 8.8, 8.8 HDG HIT-V 5.8, 5.8F HIT-V 8.8, 8.8F HAS-E-55 HAS-B-105 (HDG) HAS A4 HAS-U A4-70 HAS-U HCR	$V_{Rk,cp,fi(30)}$	[kN]	$k_8 \cdot N_{Rk,c,fi(90)}$
	$V_{Rk,cp,fi(60)}$	[kN]	
	$V_{Rk,cp,fi(90)}$	[kN]	
	$V_{Rk,cp,fi(120)}$	[kN]	$k_8 \cdot N_{Rk,c,fi(120)}$

Table C45: Characteristic resistance under shear load in case of concrete edge failure under fire conditions

Fastener size			**M8, M10, M12, M16, M20, M24, M27, M30 [in.] 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4**
HAS 5.8, 5.8 HDG HAS 8.8, 8.8 HDG HAS-U 5.8, 5.8 HDG HAS-U 8.8, 8.8 HDG HIT-V 5.8, 5.8F HIT-V 8.8, 8.8F HAS-E-55 HAS-B-105 (HDG) HAS A4 HAS-U A4-70 HAS-U HCR	$V_{Rk,c,fi(30)}$	[kN]	$0{,}25 \cdot V^0_{Rk,c}$
	$V_{Rk,c,fi(60)}$	[kN]	
	$V_{Rk,c,fi(90)}$	[kN]	
	$V_{Rk,c,fi(120)}$	[kN]	$0{,}20 \cdot V^0_{Rk,c}$