Centre Scientifique et Technique du Bâtiment
84 avenue Jean Jaurès
CHAMPS-SUR-MARNE
F-77447 Marne-la-Vallée Cedex 2
Tél. : (33) 01 64 68 82 82
Fax : (33) 01 60 05 70 37

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European Technical Assessment

ETA-20/0540 dated 13/12/2023

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 for rebar connection**
Product family:	Post installed rebar connections diameter 8 to 40 mm made with Hilti HIT-RE 500 V4 injection mortar for a working life of 100 years
Manufacturer:	Hilti Corporation Feldkircherstrasse 100 FL-9494 Schaan Principality of Liechtenstein
Manufacturing plants:	Hilti plants
This European Technical Assessment contains:	33 pages including 30 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 330087-01-0601
This Assessment replaces:	ETA-20/0540 dated 09/07/2021

Specific Part

1 Technical description of the product

The Hilti HIT-RE 500 V4 is used for the connection, by anchoring or overlap joint, of reinforcing bars (rebars) in existing structures made of ordinary non-carbonated concrete C12/15 to C50/60. The design of the post-installed rebar connections is done in accordance with EN 1992-1-1 and EN 1992-1-2 under static loading and EN 1998-1 under seismic loading.

Covered are rebar anchoring systems consisting of Hilti HIT-RE 500 V4 bonding material and the Hilti tension anchor HZA sizes M12 to M27 or HZA-R sizes M12 to M24 or an embedded straight deformed reinforcing bar diameter, d, from 8 to 40 mm with properties according to Annex C of EN 1992-1-1:2004 and EN 10080:2005. The classes B and C of the rebar are recommended. 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 anchor 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 anchor of 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 under static and quasi-static loading	See Annex C1 to C3
Characteristic resistance under seismic loading	See Annex C4 and C5

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	See Annex C6 and C7

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).

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
Metal anchors 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

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

The original French version is signed by

Anca Cronopol
Head of the division

1 Official Journal of the European Communities L 254 of 08.10.1996

Installed condition

Figure A1:

Overlap joint with existing reinforcement for rebar connections of slabs and beams

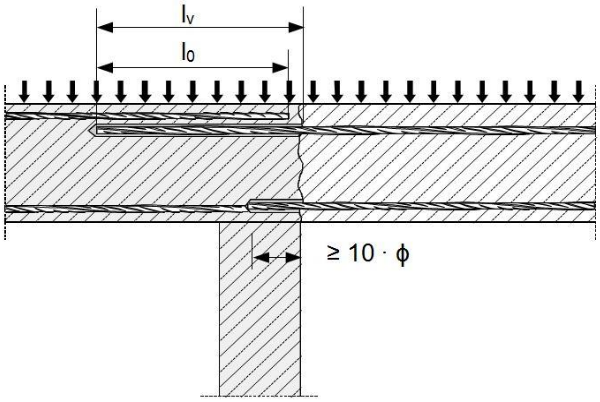


Figure A2:

Overlap joint with existing reinforcement at a foundation of a column or wall where the rebars are stressed in tension

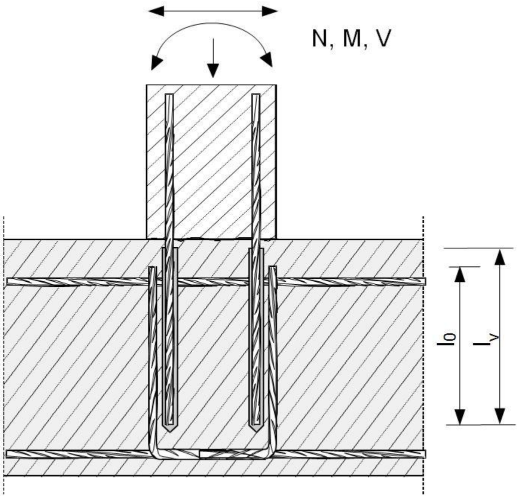


Figure A3:

End anchoring of slabs or beams

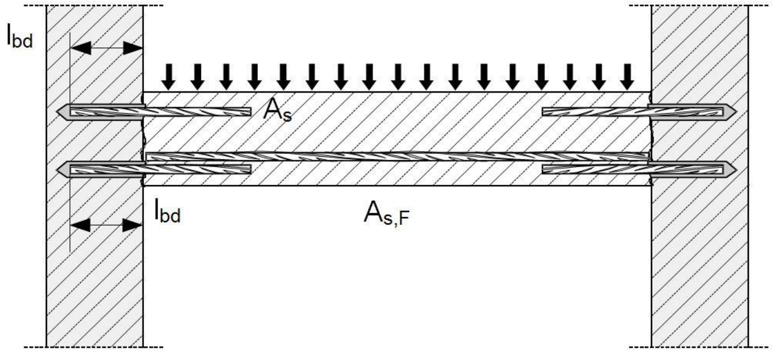


Figure A4:
Rebar connection for components stressed primarily in compression

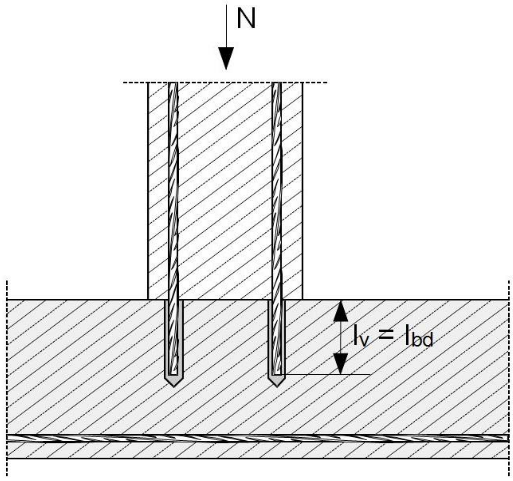
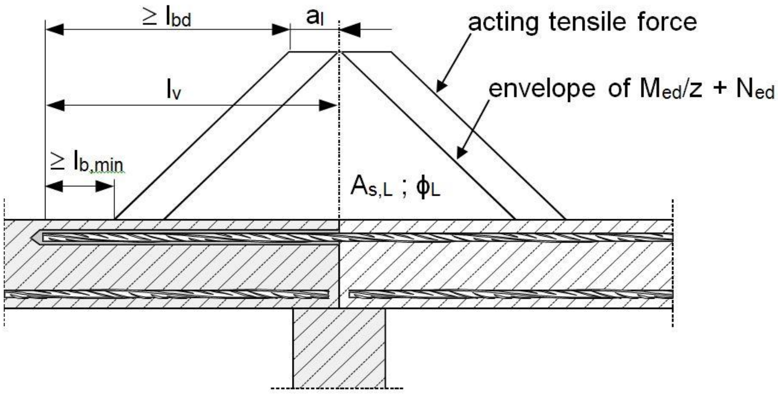


Figure A5:
Anchoring of reinforcement to cover the enveloped line of acting tensile force in the bending member



Note to Figure A1 to Figure A5:

- In the Figures no transverse reinforcement is plotted, the transverse reinforcement as required by EN 1992-1-1:2004+AC:2010 or EN 1998-1:2004+AC:2009 shall be present.
- The shear transfer between existing and new concrete shall be designed according to EN 1992-1-1:2004+AC:2010 or EN 1998-1:2004+AC:2009.
- Preparing of joints according to Annex B2.

The reference to EN 1992-1-1:2004+AC:2010 is cited in the following as EN 1992-1-1 only.
The reference to EN 1998-1:2004+AC:2009 is cited in the following as EN 1998-1 only.

Figure A6:
Overlap joint for the anchorage of a column stressed in bending to a foundation

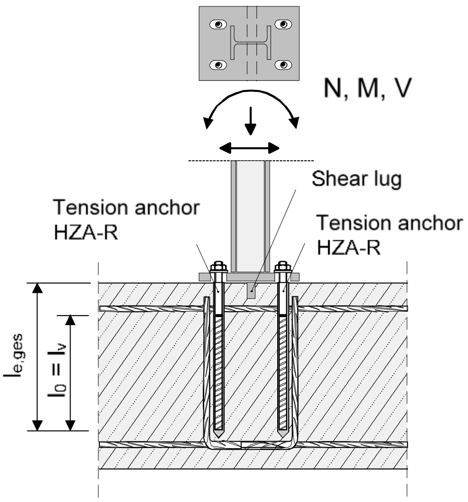


Figure A7:
Overlap joint for the anchorage of barrier posts

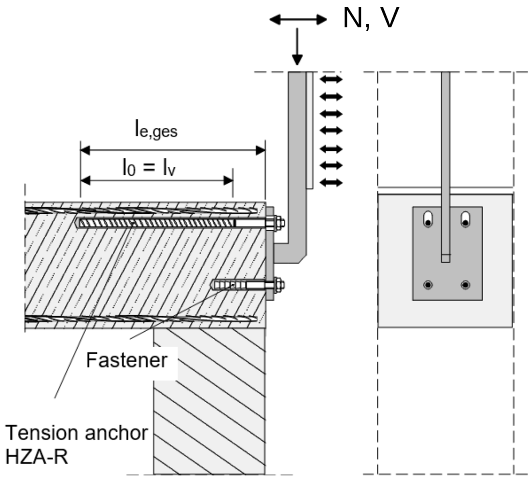
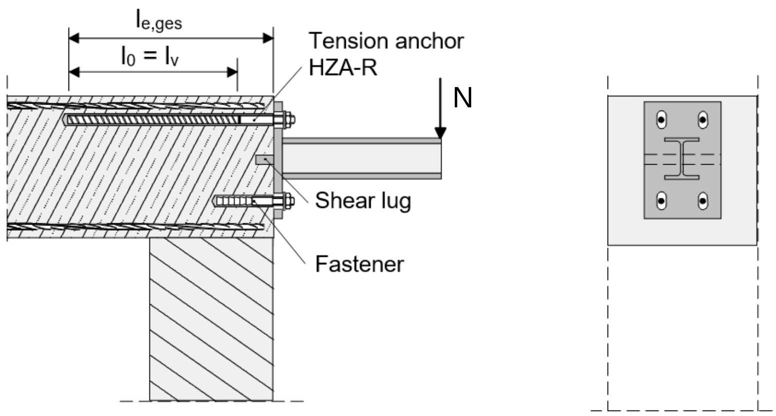


Figure A8:
Overlap joint for the anchorage of cantilever members



Note to Figure A6 to Figure A8:

- In the Figures no transverse reinforcement is plotted, the transverse reinforcement as required by EN 1992-1-1 shall be present.

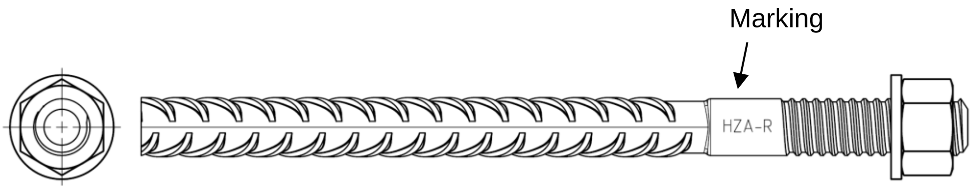
Product description: Injection mortar and steel elements

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

330 ml, 500 ml and 1400 ml

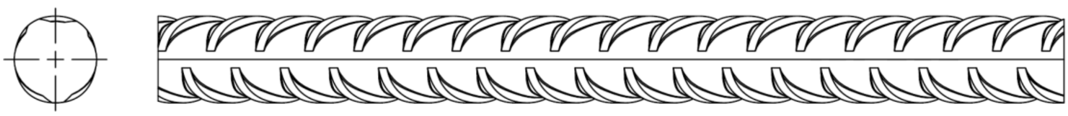
Static mixer Hilti HIT-RE-M

Steel elements



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

Marking:
embossing "HZA-R" M .. / tfix



Reinforcing bar (rebar): ϕ 8 to ϕ 40

- Materials and mechanical properties according to Table A1.
- Minimum value of related rib area f_R according to EN 1992-1-1.
- Rib height of the bar h_{rib} shall be in the range:
  $0{,}05\cdot\phi \leq h_{rib} \leq 0{,}07\cdot\phi$
- The maximum outer rebar diameter over the ribs shall be:
  $\phi + 2\cdot 0{,}07\cdot\phi = 1{,}14\cdot\phi$
  (ϕ: nominal diameter of the bar; h_{rib}: rib height of the bar)

Injection system Hilti HIT-RE 500 V4	Annex A4
Product description Injection mortar / Static mixer / Steel elements	

Table A1: Materials

Designation	Material
Reinforcing bars (rebars)	
Rebar EN 1992-1-1 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 $f_{uk} = f_{tk} = k \cdot f_{yk}$
Metal parts made of zinc coated steel	
Hilti tension anchor HZA	Round steel with threaded part: electroplated zinc coated ≥ 5 µm Rebar: f_{yk} = 500 N/mm² class B according to NDP or NCL of EN 1992-1-1/NA:2013
Washer	Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 50 µm
Nut	Nominal strength class of nut equal or higher than nominal strength class of rod. Electroplated zinc coated ≥ 5 µm, hot dip galvanized ≥ 50 µm
Metal parts made of stainless steel Corrosion class III according to EN 1993-1-4:2006+A1:2015	
Hilti tension anchor HZA-R	Round steel with threaded part: Stainless steel according to EN 10088-1:2014 Rebar: f_{yk} = 500 N/mm² class B according to NDP or NCL of EN 1992-1-1/NA:2013
Washer	Stainless steel according to EN 10088-1:2014
Nut	Nominal strength class of nut equal or higher than nominal strength class of rod. Stainless steel according to EN 10088-1:2014

Specifications of intended use

Anchorages subject to:

- Static and quasi static loading: rebar ϕ 8 to ϕ 40, HZA M12 to M27 and HZA-R M12 to M24.
- Seismic loading: rebar ϕ 8 to ϕ 40.
- Fire exposure: rebar ϕ 8 to ϕ 40, HZA M12 to M27 and HZA-R M12 to M24.

Base material:

- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A1:2016.
- Strength classes C12/15 to C50/60 according to EN 206:2013+A1:2016 for static and quasi static loading and under fire exposure.
- Strength classes C16/20 to C50/60 according to EN 206:2013+A1:2016 for seismic loading.
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2013+A1:2016.
- Non-carbonated concrete.
  Note: In case of a carbonated surface of the existing concrete structure the carbonated layer shall be removed in the area of the post-installed rebar connection with a diameter of ϕ + 60 mm prior to the installation of the new rebar. The depth of concrete to be removed shall correspond to at least the minimum concrete cover in accordance with EN 1992-1-1. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Temperature in the base material:

- **at installation**
  -5 °C to +40 °C
- **in-service**
  -40 °C to +80 °C (max. long term temperature +50 °C and max. short term temperature +80 °C)

Use conditions for HZA(-R) (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions according EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes Annex A6, Table A1 (stainless steels).

Design:

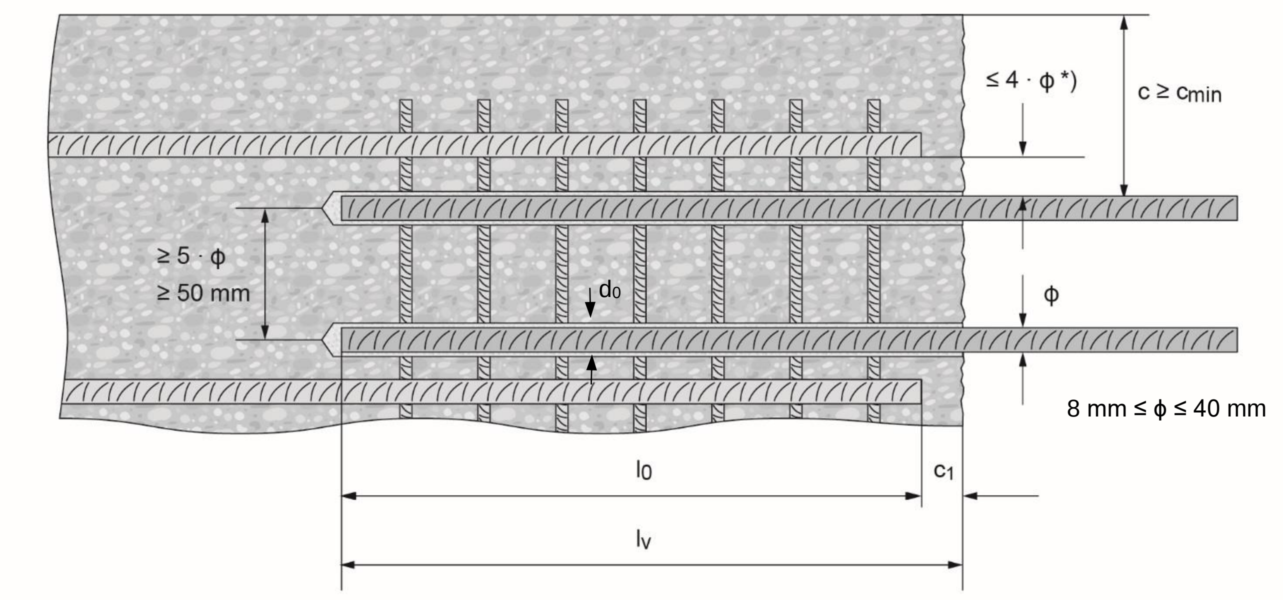
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design of rebar under static or quasi static loading in accordance with EN 1992-1-1 and under seismic action in accordance with EN 1998-1.
- Design of Hilti Tension anchor part embedded in the concrete under static or quasi static loading in accordance with EN 1992-1-1.
- Design of Hilti Tension anchor part extending above the concrete surface for steel failure under static or quasi static tension load in accordance with EN 1992-4.
- Design under fire exposure in accordance with EN 1992-1-2 and for Hilti Tension anchor in addition in accordance with EN 1992-4, Annex D.
- The actual position of the reinforcement in the existing structure shall be determined on the basis of the construction documentation and taken into account when designing.

Installation:

- Use category: dry or wet concrete (not in flooded holes).
- Drilling technique:
  - hammer drilling,
  - hammer drilling with Hilti hollow drill bit TE-CD, TE-YD,
  - compressed air drilling,
  - diamond coring (dry/wet),
  - diamond coring with roughening with Hilti Roughening tool TE-YRT.
- Overhead installation is admissible.
- Rebar installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint).

Figure B1: General construction rules for post-installed rebars

- Post-installed rebar may be designed for tension forces only.
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1.
- The joints for concreting must be roughened to at least such an extent that aggregate protrudes.

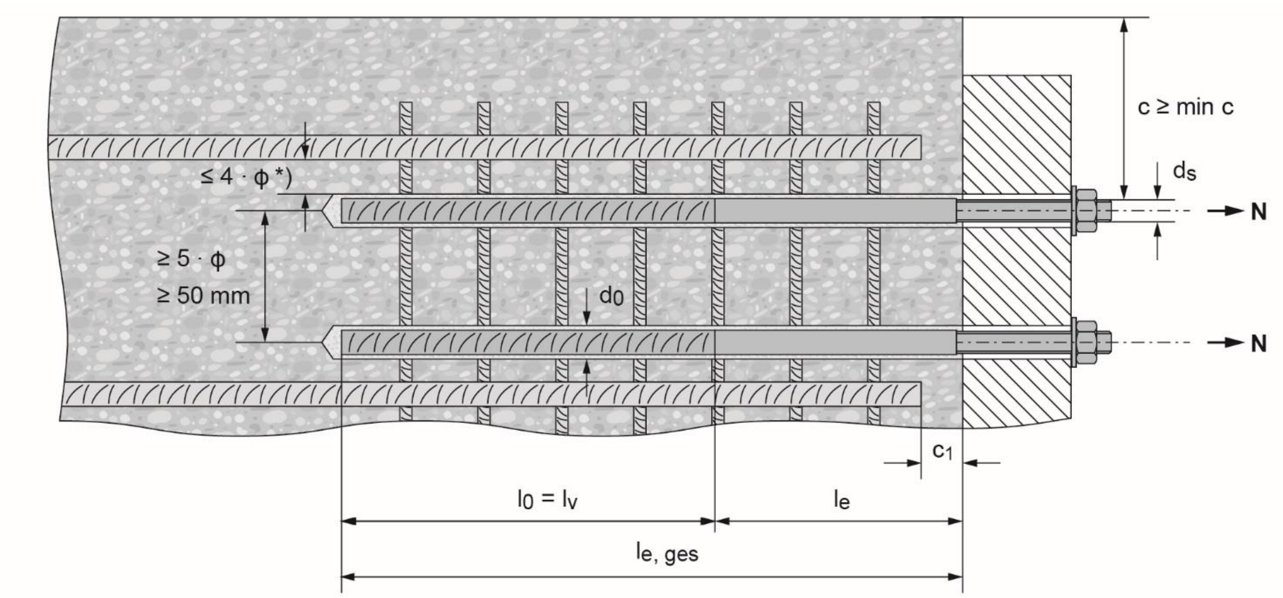


*) If the clear distance between lapped bars exceeds 4·ϕ, then the lap length shall be increased by the difference between the clear bar distance and 4·ϕ.

- c concrete cover of post-installed rebar
- c_1 concrete cover at end-face of existing rebar
- c_{min} minimum concrete cover according to Table B3 and to EN 1992-1-1
- ϕ diameter of reinforcement bar
- l_0 lap length, according to EN 1992-1-1 for static loading and according to EN 1998-1, chapter 5.6.3 for seismic loading
- l_v embedment length $\geq l_0 + c_1$
- d_0 nominal drill bit diameter

Figure B2: General construction rules for Hilti tension anchor HZA / HZA-R

- Hilti tension anchor HZA / HZA-R may be designed for tension forces only.
- The tension forces must be transferred via an overlap joint to the reinforcement in the existing structure.
- The length of the bonded-in smooth shaft may not be accounted as anchorage.
- The transfer of shear forces shall be ensured by appropriate additional measures, e.g. by shear lugs or by anchors with a European technical assessment (ETA).
- In the anchor plate the holes for the Hilti tension anchor shall be executed as elongated holes with the axis in the direction of the shear force.



*) If the clear distance between lapped bars exceeds 4·ϕ, then the lap length shall be increased by the difference between the clear bar distance and 4·ϕ.

c concrete cover of Hilti tension anchor HZA / HZA-R
c_1 concrete cover at end-face of existing rebar
c_{min} minimum concrete cover according to Table B3 and to EN 1992-1-1
ϕ diameter of reinforcement bar
l_0 lap length, according to EN 1992-1-1
l_v embedment length
l_e length of the smooth shaft or the bonded-in threaded part
$l_{e,ges}$ overall embedment length
d_0 nominal drill bit diameter

Table B1: Hilti tension anchor HZA-R, dimensions

Hilti tension anchor HZA-R			M12	M16	M20	M24
Rebar diameter	ϕ	[mm]	12	16	20	25
Overall embedment length and drill hole depth	$l_{e,ges}$	[mm]	170 to 800	180 to 1300	190 to 1300	200 to 1300
Embedment length ($l_v = l_{e,ges} - l_e$)	l_v	[mm]	$l_{e,ges} - 100$			
Length of smooth shaft	l_e	[mm]	100			
Nominal diameter of drill bit	d_0	[mm]	16	20	25	32
Maximum diameter of clearance hole in the fixture	d_f	[mm]	14	18	22	26
Maximum installation torque	max. T_{inst}	[Nm]	40	80	150	200

Table B2: Hilti tension anchor HZA, dimensions

Hilti tension anchor HZA			M12	M16	M20	M24	M27
Rebar diameter	ϕ	[mm]	12	16	20	25	28
Overall embedment length and drill hole depth	$l_{e,ges}$	[mm]	90 to 800	100 to 1300	110 to 1300	120 to 1300	140 to 1300
Embedment length ($l_v = l_{e,ges} - l_e$)	l_v	[mm]	$l_{e,ges} - 20$				
Length of smooth shaft	l_e	[mm]	20				
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
Maximum installation torque	max. T_{inst}	[Nm]	40	80	150	200	270

Table B3: Minimum concrete cover c_{min}[1)] of the post-installed rebar or tension anchor HZA-(R) depending on drilling method and drilling tolerance

Drilling method	Rebar diameter [mm]	Minimum concrete cover c_{min}[1)] [mm]	
		Without drilling aid[2)]	With drilling aid[2)]
Hammer drilling and hammer drilling with Hilti hollow drill bit TE-CD, TE-YD	$\phi < 25$	$30 + 0{,}06 \cdot l_v \geq 2 \cdot \phi$	$30 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
	$\phi \geq 25$	$40 + 0{,}06 \cdot l_v \geq 2 \cdot \phi$	$40 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
Compressed air drilling	$\phi < 25$	$50 + 0{,}08 \cdot l_v$	$50 + 0{,}02 \cdot l_v$
	$\phi \geq 25$	$60 + 0{,}08 \cdot l_v \geq 2 \cdot \phi$	$60 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
Diamond coring (wet/dry)	$\phi < 25$	Drill stand works like a drilling aid	$30 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
	$\phi \geq 25$		$40 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
Diamond coring with roughening with Hilti Roughening tool TE-YRT	$\phi < 25$	$30 + 0{,}06 \cdot l_v \geq 2 \cdot \phi$	$30 + 0{,}02 \cdot l_v \geq 2 \cdot \phi$
	$\phi \geq 25$	$40 + 0{,}06 \cdot l_v \geq 2 \cdot \phi$	$40 + 0{,}02 \cdot lv \geq 2 \cdot \phi$

1) See Annexes B2 and B3, Figures B1 and B2.
Comments: The minimum concrete cover acc. EN 1992-1-1. The same minimum concrete covers apply for rebar elements in the case of seismic loading, i.e. $c_{min,seis} = 2\ \phi$.

2) For HZA(-R) $l_{e,ges}$ instead of l_v.

Table B4: Maximum embedment length $l_{v,max}$[1)] depending on rebar diameter and dispenser

<table>
<tr><th colspan="2">Element</th><th colspan="3">Dispensers</th></tr>
<tr><td>Rebar</td><td>Hilti tension anchor</td><td>HDM 330, HDM 500</td><td>HDE 500</td><td>HIT-P8000D</td></tr>
<tr><td>Size</td><td>Size</td><td>$l_{v,max}$[1)] [mm]</td><td>$l_{v,max}$[1)] [mm]</td><td>$l_{v,max}$[1)] [mm]</td></tr>
<tr><td>ϕ 8</td><td>-</td><td rowspan="6">1000</td><td>1000</td><td>-</td></tr>
<tr><td>ϕ 10</td><td>-</td><td>1000</td><td>-</td></tr>
<tr><td>ϕ 12</td><td>HZA(-R) M12</td><td>1200</td><td>1200</td></tr>
<tr><td>ϕ 13</td><td>-</td><td>1300</td><td>1300</td></tr>
<tr><td>ϕ 14</td><td>-</td><td>1400</td><td>1400</td></tr>
<tr><td>ϕ 16</td><td>HZA(-R) M16</td><td>1600</td><td>1600</td></tr>
<tr><td>ϕ 18</td><td>-</td><td>700</td><td>1800</td><td>1800</td></tr>
<tr><td>ϕ 20</td><td>HZA(-R) M20</td><td>600</td><td>2000</td><td>2000</td></tr>
<tr><td>ϕ 22</td><td>-</td><td>500</td><td>1800</td><td>2200</td></tr>
<tr><td>ϕ 24</td><td>-</td><td>300</td><td>1300</td><td>2400</td></tr>
<tr><td>ϕ 25</td><td>HZA(-R) M24</td><td>300</td><td>1500</td><td>2500</td></tr>
<tr><td>ϕ 26</td><td>-</td><td>300</td><td>1000</td><td>2600</td></tr>
<tr><td>ϕ 28</td><td>HZA M27</td><td>300</td><td>1000</td><td>2800</td></tr>
<tr><td>ϕ 30</td><td>-</td><td rowspan="5">-</td><td>1000</td><td>3000</td></tr>
<tr><td>ϕ 32</td><td>-</td><td>700</td><td rowspan="4">3200</td></tr>
<tr><td>ϕ 34</td><td>-</td><td>600</td></tr>
<tr><td>ϕ 36</td><td>-</td><td>600</td></tr>
<tr><td>ϕ 40</td><td>-</td><td>400</td></tr>
</table>

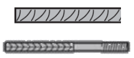
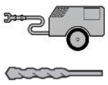
1) For HZA(-R) $l_{e,ges,max}$ instead of $l_{v,max}$.

Table B5: Working time and curing time[1) 2)]

Temperature in the base material T			Maximum working time t_{work}	Initial curing time $t_{cure,ini}$	Minimum curing time t_{cure}
-5 °C	to	-1 °C	2 hours	48 hours	168 hours
0 °C	to	4 °C	2 hours	24 hours	48 hours
5 °C	to	9 °C	2 hours	16 hours	24 hours
10 °C	to	14 °C	1,5 hours	12 hours	16 hours
15 °C	to	19 °C	1 hour	8 hours	16 hours
20 °C	to	24 °C	30 min	4 hours	7 hours
25 °C	to	29 °C	20 min	3,5 hours	6 hours
30 °C	to	34 °C	15 min	3 hours	5 hours
35 °C	to	39 °C	12 min	2 hours	4,5 hours
40 °C			10 min	2 hours	4 hours

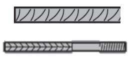
1) The curing time data are valid for dry base material only. In wet base material the curing times must be doubled.
2) The minimum temperature of the foil pack is +5° C.

Table B6: Parameters of drilling, cleaning and setting tools hammer drilling and compressed air drilling

Element	Drill and clean					Installation		
Rebar / Hilti tension anchor	Hammer drilling	Compressed air drilling	Brush HIT-RB	Air nozzle HIT-DL	Extension for air nozzle	Piston plug HIT-SZ	Extension for piston plug	Maximum embedment length
							 [1]	-
size	d_0 [mm]	d_0 [mm]	size	size	[-]	size	[-]	$l_{v,max}$[2] [mm]
ϕ 8	10	-	10	10	HIT-DL 10/0,8 or HIT-DL V10/1	-	HIT-VL 9/1,0	250
	12	-	12	12		12		1000
ϕ 10	12	-	12	12		12		1000
	14	-	14	14		14	HIT-VL 11/1,0	1000
ϕ 12	14	-	14	14		14		1000
ϕ 12 / HZA(-R) M12	16	-	16	16		16		1200
ϕ 12	-	17	18	16		16		1200
ϕ 13	16	-	16	16		16		1300
	-	17	18	16		16		
ϕ 14	18	-	18	18		18		1400
	-	17	18	16		16		
ϕ 16 / HZA(-R) M16	20	20	20	20	HIT-DL 16/0,8 or HIT-DL B and/or HIT-VL 16/0,7 and/or HIT-VL 16	20	HIT-VL 16/0,7 and/or HIT-VL 16	1600
ϕ 18	22	22	22	22		22		1800
ϕ 20 / HZA(-R) M20	25	-	25	25		25		2000
	-	26	28	25		25		
ϕ 22	28	28	28	28		28		2200
ϕ 24	30	30	30	30		30		1000
	32	32	32	32		32		2400
ϕ 25 / HZA(-R) M24	30	30	30	30		30		1000
	32	32	32	32		32		2500
ϕ 26	35	35	35	32		35		2600
ϕ 28 / HZA M27	35	35	35	32		35		2800
ϕ 30	-	35	35	32		35		3000
	37	37	37	32		37		
ϕ 32	40	40	40	32		40		3200
ϕ 34	-	42	42	32		42		3200
	45	-	45	32		45		
ϕ 36	45	45	45	32		45		3200
ϕ 40	55	-	55	32		55		3200
	-	57	55	32		55		

[1] Assemble extension HIT-VL 16/0,7 with coupler HIT-VL K for deeper drill holes.
[2] For HZA(-R) $l_{e,ges,max}$ instead of $l_{v,max}$.

Table B7: Parameters of drilling, cleaning and setting tools hammer drilling with Hilti hollow drill bit and diamond coring (dry)

Element	Drill and clean					Installation		
Rebar / Hilti tension anchor	Hammer-drilling with hollow drill bit[3]	Diamond coring (dry)	Brush HIT-RB	Air nozzle HIT-DL	Extension for air nozzle	Piston plug HIT-SZ	Extension for piston plug	Maximum embedment lenght
							 1)	-
Size	d_0 [mm]	d_0 [mm]	Size	Size	[-]	Size	[-]	$l_{v,max}$[4] [mm]
ϕ 8	10	-	No cleaning required.			-	HIT-VL 9/1,0	250
	12	-				12		1000
ϕ 10	12	-				12		1000
	14	-				14	HIT-VL 11/1,0	1000
ϕ 12	14	-				14		1000
ϕ 12 / HZA(-R) M12	16	-				16		1000
ϕ 13	16	-				16		1000
ϕ 14	18	-				18		1000
ϕ 16 / HZA(-R) M16	20	-				20	HIT-VL 16/0,7 and/or HIT-VL 16	1000
ϕ 18	22	-				22		1000
ϕ 20 / HZA(-R) M20	25	-				25		1000
ϕ 22	28	-				28		1000
ϕ 24	32	-				32		1000
	-	35				35		2400
ϕ 25 / HZA(-R) M24	32	-				32		1000
	-	35				35		2500
ϕ 26	35	35				35		1000 [2] / 2600
ϕ 28 / HZA M27	35	35				35		1000 [2] / 2800
ϕ 30	-	35				35		3000
ϕ 32	-	40				40		3200
ϕ 34	-	42				42		3200
		45				45		3200
ϕ 36	-	47				47		3200
ϕ 40	-	52				52		3200

1) Assemble extension HIT-VL 16/0,7 with coupler HIT-VL K for deeper drill holes.
2) Maximum embedment length for use with Hilti hollow drill bit TE-CD / TE-YD.
3) With vacuum cleaner Hilti VC 10/20/40 (automatic filter cleaning activated, eco-mode off) or vacuum cleaner providing equivalent cleaning performance in combination with the specified Hilti hollow drill bit TE-CD or TE-YD.
4) For HZA(-R) $l_{e,ges,max}$ instead of $l_{v,max}$.

Table B8: Parameters of drilling, cleaning and setting tools diamond coring (wet) and diamond coring with roughening

Element	Drill and clean					Installation		
Rebar / Hilti tension anchor	Diamond coring (wet)	Diamond coring with roughening	Brush HIT-RB	Air nozzle HIT-DL	Extension for air nozzle	Piston plug HIT-SZ	Extension for piston plug	Maximum embedment length
							1)	-
Size	d_0 [mm]	d_0 [mm]	Size	Size	[-]	Size	[-]	$l_{v,max}$ 3) [mm]
ϕ 8	10	-	10	10	HIT-DL 10/0,8 or HIT-DL V10/1	-	HIT-VL 9/1,0	250
	12	-	12	12		12		1000
ϕ 10	12	-	12	12		12		1000
	14	-	14	14		14	HIT-VL 11/1,0	1000
ϕ 12	14	-	14	14		14		1000
ϕ 12 / HZA(-R) M12	16	-	16	16		16		1200
ϕ 13	16	-	16	16		16		1300
ϕ 14	18	18	18	18		18		1400 / 900 2)
ϕ 16 / HZA(-R) M16	20	20	20	20	HIT-DL 16/0,8 or HIT-DL B and/or HIT-VL 16/0,7 and/or HIT-VL 16	20	HIT-VL 16/0,7 and/or HIT-VL 16	1600 / 1000 2)
ϕ 18	22	22	22	22		22		1800 / 1200 2)
ϕ 20 / HZA(-R) M20	25	25	25	25		25		2000 / 1300 2)
ϕ 22	28	28	28	28		28		2200 / 1400 2)
ϕ 24	30	30	30	30		30		1000
	32	32	32	32		32		2400 / 1600 2)
ϕ 25 / HZA(-R) M24	30	30	30	30		30		1000
	32	32	32	32		32		2500 / 1600 2)
ϕ 26	35	35	35	32		35		2600 / 1800 2)
ϕ 28 / HZA M27	35	35	35	32		35		2800 / 1800 2)
ϕ 30	37	-	37	32		37		3000
ϕ 32	40	-	40	32		40		3200
ϕ 34	42	-	42	32		42		3200
	45	-	45	32		45		
ϕ 36	47	-	47	32		47		3200
ϕ 40	52	-	52	32		52		3200

1) Assemble extension HIT-VL 16/0,7 with coupler HIT-VL K for deeper drill holes.
2) Maximum embedment length for use with Hilti Roughening tool TE-YRT.
3) For HZA(-R) $l_{e,ges,max}$ instead of $l_{v,max}$.

Table B9: Cleaning alternatives

Automatic Cleaning (AC): Cleaning is performed during drilling with Hilti hollow drill bit TE-CD, TE-YD including vacuum cleaner.	
Compressed Air Cleaning (CAC): air nozzle with an orifice opening of minimum 3,5 mm in diameter. + brush HIT-RB	
Manual Cleaning (MC): Hilti hand pump + brush HIT-RB for cleaning of drill holes with diameters $d_0 \leq 20$ mm and drill hole depths $\leq 10 \cdot \phi$.	
Compressed Air without brushing (C): air nozzle with an orifice opening of minimum 3,5 mm in diameter. for cleaning of drill holes with diameters $d_0 \leq 32$ mm.	

Table B10: Parameters for use of the Hilti Roughening tool TE-YRT

Diamond coring		Roughening tool TE-YRT	Wear gauge RTG…
			
d_0			
nominal [mm]	measured [mm]	d_0 [mm]	size
18	17,9 to 18,2	18	18
20	19,9 to 20,2	20	20
22	21,9 to 22,2	22	22
25	24,9 to 25,2	25	25
28	27,9 to 28,2	28	28
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 B11: Installation parameters for use of the Hilti Roughening tool TE-YRT

l_v[1)] [mm]	Roughening time $t_{roughen}$ ($t_{roughen}$ [sec] = l_v[1)] [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

1) For HZA(-R) $l_{e,ges}$ instead of l_v.

Table B12: Hilti Roughening tool TE-YRT and wear gauge RTG

TE-YRT	
RTG	

Installation instruction

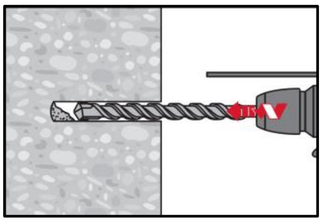
Safety Regulations:

Review the Material Safety Data Sheet (MSDS) before use for proper and safe handling!
Wear well-fitting protective goggles and protective gloves when working with Hilti HIT-RE 500 V4.
Important: Observe the installation instruction provided with each foil pack.

Hole drilling

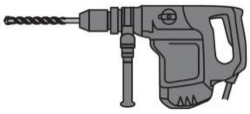
Before drilling remove carbonized concrete and clean contact areas (see Annex B1).
In case of aborted drill hole the drill hole shall be filled with mortar.

a) Hammer drilling

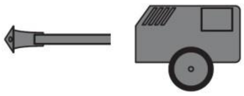


Drill hole to the required embedment length with a hammer drill set in rotation-hammer mode or a compressed air drill using an appropriately sized carbide drill bit.

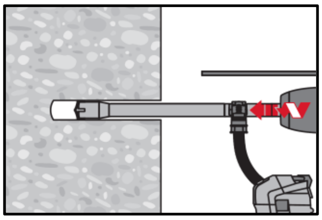
Hammer drill



Compressed air drill

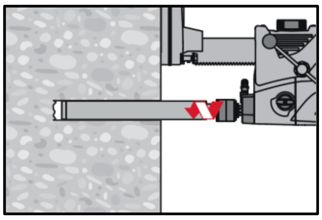


b) Hammer drilling with Hilti hollow drill bit TE-CD, TE-YD



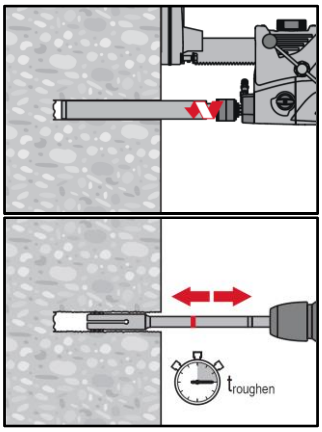
Drill hole to the required embedment length with an appropriately sized Hilti TE-CD or TE-YD hollow drill bit attached to Hilti vacuum cleaner VC 20/40/60 or a vacuum cleaner acc. to Table B7 with automatic filter cleaning activated. This drilling system removes the dust and cleans the drill hole during drilling when used in accordance with the user's manual. After drilling is completed, proceed to the "injection preparation" step in the installation instruction.

c) Diamond coring



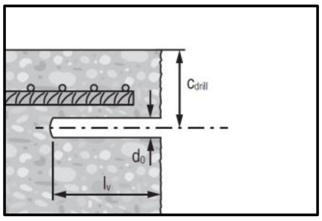
Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.

d) Diamond coring with roughening with Hilti Roughening tool TE-YRT



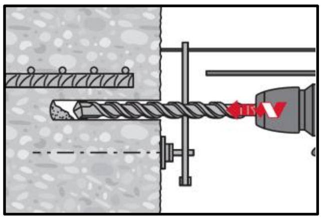
Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used.
For the use in combination with Hilti Roughening tool TE-YRT see parameters in Table B8.
Before roughening water needs to be removed from the drill hole. Check usability of the roughening tool with the wear gauge RTG.
Roughen the drill hole over the whole length to the required l_v or $l_{e,ges}$.

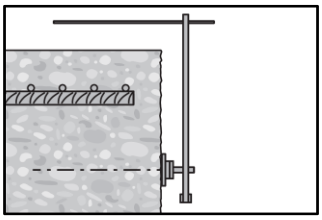
Splicing applications



Measure and control concrete cover c.
$c_{drill} = c + d_0/2$.
Drill parallel to surface edge and to existing rebar.
Where applicable use Hilti drilling aid HIT-BH.

Drilling aid: for drill holes depths > 20 cm use drilling aid.



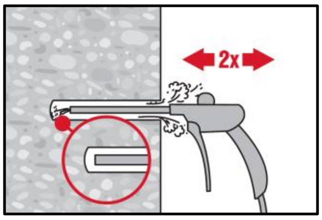


Ensure that the drill hole is parallel to the existing rebar.
Three different options can be considered:

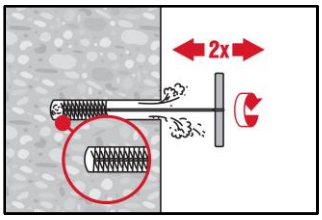
- Hilti drilling aid HIT-BH
- Lath or spirit level
- Visual check

Drill hole cleaning: just before setting the bar the drill hole must be free of dust and debris.
Inadequate hole cleaning = poor load values.

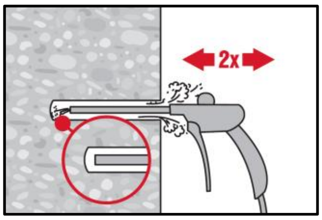
Compressed Air Cleaning (CAC) for hammer drilled holes:
for all drill hole diameters d_0 and all drill hole depths ≤ 20·ϕ.



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 m^3/h) until return air stream is free of noticeable dust.

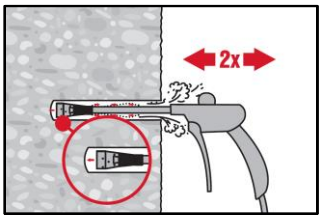


Brush 2 times with the specified brush (see Table B6) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole
(brush Ø ≥ drill hole Ø) - if not the brush is too small and must be replaced with the proper brush diameter.

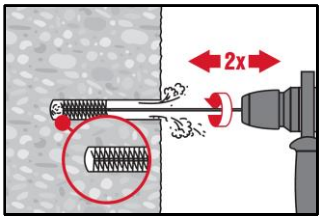


Blow again with compressed air 2 times until return air stream is free of noticeable dust.

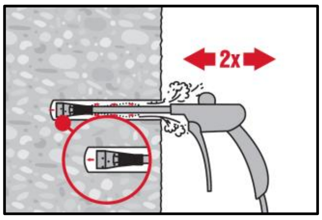
Compressed Air Cleaning (CAC) for hammer drilled holes:
for drill holes deeper than 250 mm (for ϕ8 to ϕ12) or deeper than 20·ϕ (for ϕ > 12 mm)



Use the appropriate air nozzle Hilti HIT-DL (see Table B6).
Blow 2 times from the back of the hole over the whole length with oil-free compressed air until return air stream is free of noticeable dust.
Safety tip:
Do not inhale concrete dust.

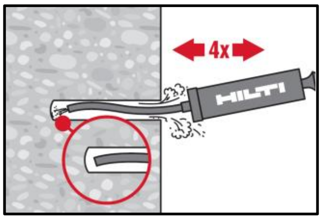


Screw the round steel brush HIT-RB in one end of the brush extension(s) HIT-RBS, so that the overall length of the brush is sufficient to reach the base of the drill hole. Attach the other end of the extension to the TE-C/TE-Y chuck.
Safety tip:
Start machine brushing operation slowly.
Start brushing operation once the brush is inserted in the drill hole.

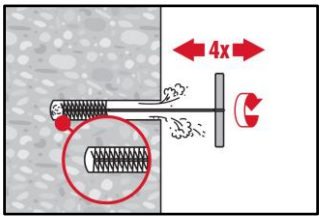


Use the appropriate air nozzle Hilti HIT-DL (see Table B6).
Blow 2 times from the back of the hole over the whole length with oil-free compressed air until return air stream is free of noticeable dust.
Safety tip:
Do not inhale concrete dust.

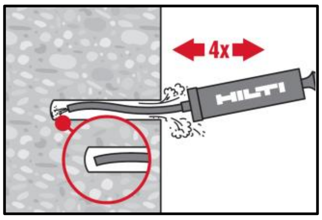
Manual Cleaning (MC) for hammer drilled holes:
for drill hole diameters d_0 ≤ 20 mm and all drill hole depths ≤ 10·ϕ.



The Hilti hand pump may be used for blowing out drill holes up to diameters d_0 ≤ 20 mm and drill hole depths ≤ 10·ϕ.
Blow out at least 4 times from the back of the drill hole until return air stream is free of noticeable dust.



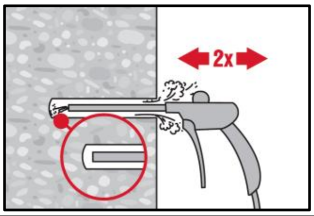
Brush 4 times with the specified brush (see Table B6) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - if not the brush is too small and must be replaced with the proper brush diameter.



Blow again with the Hilti hand pump at least 4 times until return air stream is free of noticeable dust.

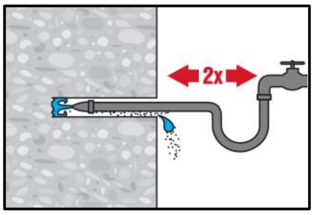
Injection system Hilti HIT-RE 500 V4	**Annex B14**
Intended use Installation instruction	

Compressed Air without brushing: for hammer drilled holes: For drill hole diameters $d_0 \leq 32$ mm

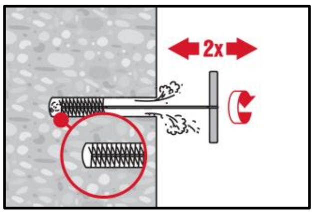


Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust.

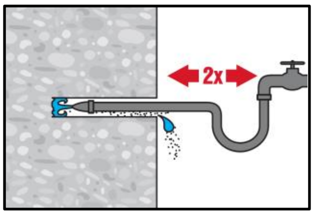
Cleaning of diamond cored holes: for all drill hole diameters d_0 and all drill hole depths



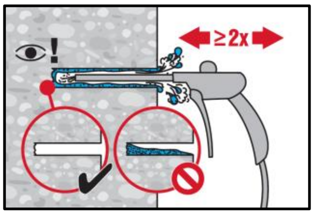
Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.



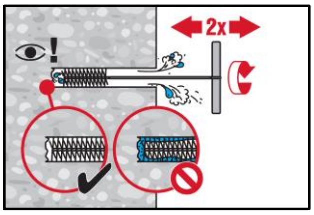
Brush 2 times with the specified brush (see Table B8) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - if not the brush is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



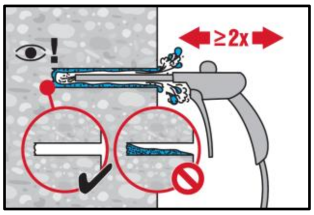
Flush 2 times by inserting a water hose (water-line pressure) to the back of the hole until water runs clear.



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.

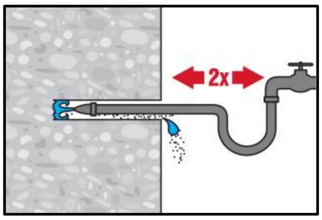


Brush 2 times with the specified brush size (brush Ø ≥ drill hole Ø, see Table B8) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole – if not the brush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

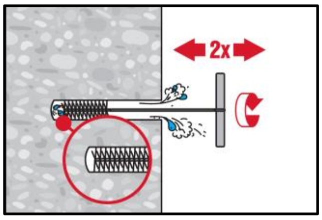


Blow again with compressed air 2 times until return air stream is free of noticeable dust and water.

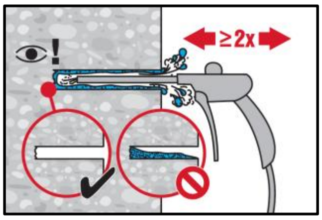
Cleaning of diamond cored holes with roughening with Hilti Roughening tool TE-YRT:
for all drill hole diameters d_0 and all drill hole depths



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

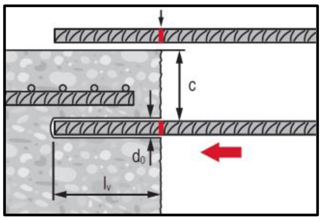


Brush 2 times with the specified brush (see Table B8) by inserting the steel brush Hilti HIT-RB to the back of the hole (if needed with extension) in a twisting motion and removing it.
The brush must produce natural resistance as it enters the drill hole (brush Ø ≥ drill hole Ø) - if not the brush is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



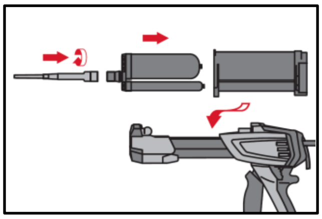
Blow 2 times from the back of the hole (if needed with nozzle extension) over the whole length with oil-free compressed air (min. 6 bar at 6 m³/h) until return air stream is free of noticeable dust and water.
For drill hole diameters ≥ 32 mm the compressor has to supply a minimum air flow of 140 m³/h.

Rebar preparation

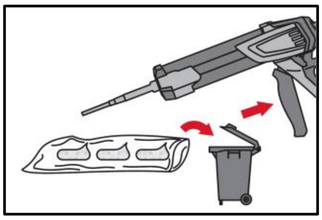


Before use, make sure the rebar is dry and free of oil or other residue.
Mark the embedment length on the rebar (e.g. with tape) → l_v or $l_{e,ges}$.
Insert rebar in drill hole to verify hole depth and embedment length l_v or $l_{e,ges}$.

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.



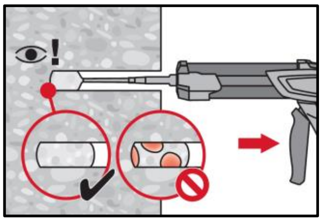
The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive has to be discarded. Discarded quantities are:

3 strokes	for 330 ml foil pack,
4 strokes	for 500 ml foil pack,
65 ml	for 1400 ml foil pack.

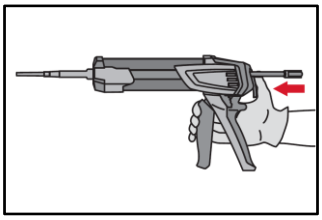
The minimum foil pack temperature is +5°C.

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

Injection method for drill hole depths ≤ 250 mm (without overhead applications)

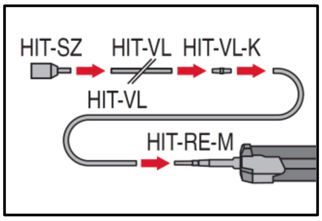


Inject the adhesive starting at the back of the hole, slowly withdrawing the mixer with each trigger pull.
Fill approximately 2/3 of the drill hole to ensure that the annular gap between the anchor and the concrete is completely filled with adhesive along the embedment length.

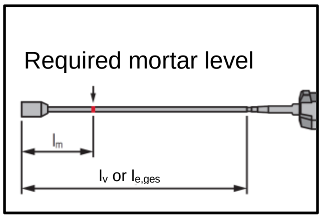


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

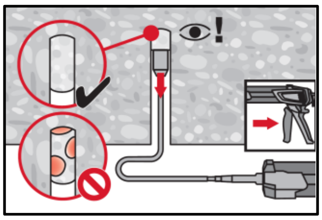
Injection method for drill hole depths > 250 mm or overhead applications



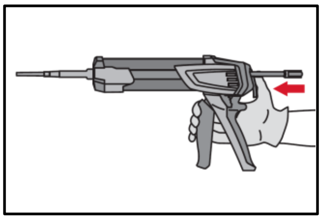
Assemble mixing nozzle HIT-RE-M, extension(s) and piston plug HIT-SZ (see Table B6, B7 or B8).
For combinations of several injection extensions use coupler HIT-VL-K.
A substitution of the injection extension for a plastic hose or a combination of both is permitted.
The combination of HIT-SZ piston plug with HIT-VL 16 pipe and then HIT-VL 16 tube support proper injection.



Mark the required mortar level l_m and embedment length l_v or $l_{e,ges}$ with tape or marker on the injection extension.
Estimation:
$l_m = 1/3 \cdot l_v$ for rebar,
$l_m = 1/3 \cdot l_{e,ges}$ for HZA(-R).
Precise formula for optimum mortar volume:
$l_m = l_v \cdot (1{,}2 \cdot (\phi^2 / d_0^2) - 0{,}2)$ for rebar,
$l_m = l_{e,ges} \cdot (1{,}2 \cdot (\phi^2 / d_0^2) - 0{,}2)$ for HZA(-R).

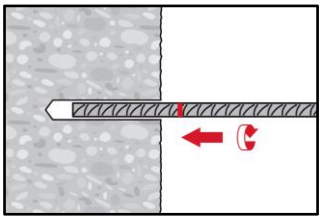


For overhead installation the injection is only possible with the aid of extensions and piston plugs. Assemble HIT-RE-M mixer, extension(s) and appropriately sized piston plug (see Table B6, B7 or B8). Insert piston plug to back of the hole and inject adhesive. During injection the piston plug will be naturally extruded out of the drill hole by the adhesive pressure.

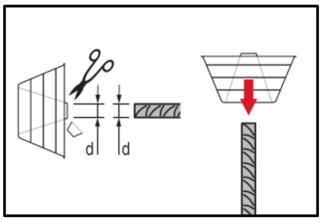


After injection is completed, depressurize the dispenser by pressing the release trigger. This will prevent further adhesive discharge from the mixer.

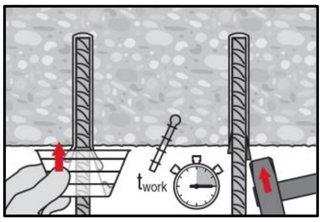
Setting the element: before use, verify that the element is dry and free of oil and other contaminants.



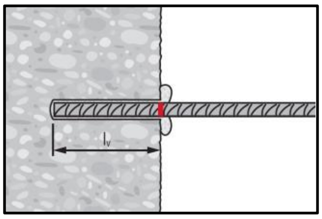
For easy installation insert the rebar into the drill hole while slowly twisting until the embedment mark is at the concrete surface level.



For overhead application:
During insertion of the rebar mortar might flow out of the drill hole. For collection of the flowing mortar overhead dripping cup HIT-OHC may be used.

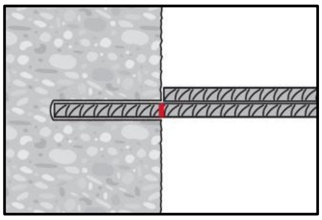


Support the rebar and secure it from falling until mortar has started to harden, e.g. using wedges HIT-OHW.

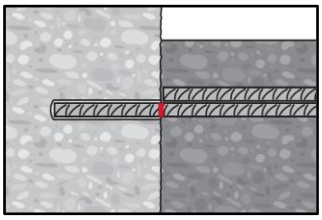


After installing the rebar the annular gap must be completely filled with mortar.
Proper installation:

- desired anchoring embedment l_v or $l_{e,ges}$ is reached: embedment mark at concrete surface.
- excess mortar flows out of the drill hole after the rebar has been fully inserted until the embedment mark.



Observe the working time t_{work} (see Table B5), which varies according to temperature of base material. Minor adjustments to the rebar position may be performed during the working time.



Full load may be applied only after the curing time t_{cure} has elapsed (see Table B5).

Essential characteristics under static and quasi-static loading

Minimum anchorage length, minimum lap length and design values of the bond strength for a working life of 50 and 100 years for following drilling techniques:

- hammer drilling,
- hammer drilling with Hilti hollow drill bit TE-CD, TE-YD,
- compressed air drilling,
- diamond coring (dry),
- diamond coring with roughening with Hilti Roughening tool TE-YRT.

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ given in Table C1.

The design values of the bond strength $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ are given in Table C3. It is obtained by multiplying the design value of the bond strength f_{bd} according to EN 1992-1-1 (Eq. 8.3) by the bond efficiency factor $k_b = k_{b,100y}$ according to Table C2.

Table C1: Amplification factor α_{lb} and $\alpha_{lb,100y}$

Rebar diameter	Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ [-]								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 40	1,0								

Table C2: Bond efficiency factor k_b and $k_{b,100y}$

Rebar diameter	Bond efficiency factor $k_b = k_{b,100y}$ [-]								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 40	1,0								

Table C3: Design values of the bond strength $f_{bd,PIR}$[1)] and $f_{bd,PIR,100y}$[1)]

Rebar diameter	Bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 32	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
ϕ 34	1,6	2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
ϕ 36	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8	4,1
ϕ 40	1,5	1,8	2,1	2,5	2,8	3,1	3,4	3,7	3,9

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Essential characteristics under static and quasi-static loading

Minimum anchorage length, minimum lap length and design values of the bond strength for a working life of 50 and 100 years for diamond coring (wet).

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ given in Table C4.

The design values of the bond strength $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ are given in Table C6. It is obtained by multiplying the design value of the bond strength f_{bd} according to EN 1992-1-1 (Eq. 8.3) by the bond efficiency factor $k_b = k_{b,100y}$ according to Table C5.

Table C4: Amplification factor α_{lb} and $\alpha_{lb,100y}$

Rebar diameter	**Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ [-]**								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 12	1,0								
ϕ 13 to ϕ 36	Linear interpolation between diameters								
ϕ 40	1,0				1,2	1,3	1,4		

Table C5: Bond efficiency factor k_b and $k_{b,100y}$

Rebar diameter	**Bond efficiency factor $k_b = k_{b,100y}$ [-]**								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 12	1,0								0,93
ϕ 13 and ϕ 16	1,0							0,93	0,86
ϕ 18 to ϕ 36	1,0						0,92	0,85	0,79
ϕ 40	1,0					0,90	0,82	0,76	0,71

Table C6: Design values of the bond strength $f_{bd,PIR}$ 1) and $f_{bd,PIR,100y}$ 1)

Rebar diameter	**Bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]**								
	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 12	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,0
ϕ 13 and ϕ 16	1,6	2,0	2,3	2,7	3,0	3,4	3,7	3,7	3,7
ϕ 18 to ϕ 32	1,6	2,0	2,3	2,7	3,0	3,4	3,4	3,4	3,4
ϕ 34	1,6	2,0	2,3	2,6	2,9	3,3	3,3	3,3	3,3
ϕ 36	1,6	1,9	2,2	2,6	2,9	3,2	3,2	3,2	3,2
ϕ 40	1,5	1,8	2,1	2,5	2,8	2,8	2,8	2,8	2,8

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Essential characteristics under static and quasi-static loading

Tensile steel strength of Hilti tension anchor HZA and HZA-R

Table C7: Characteristic tensile yield strength for rebar part of Hilti tension anchor HZA and HZA-R

Hilti tension anchor HZA, HZA-R			M12	M16	M20	M24	M27
Rebar diameter	ϕ	[mm]	12	16	20	25	28
Characteristic tensile yield strength	f_{yk}	[N/mm²]	500	500	500	500	500[1)]
Partial factor for rebar part	$\gamma_{Ms,N}$[2)]	[-]	1,15				

1) HZA-R size M27 not available.
2) In absence of national regulations.

Table C8: Characteristic tensile steel strength for threaded/smooth part of Hilti tension anchor HZA and HZA-R

Hilti tension anchor HZA, HZA-R			M12	M16	M20	M24	M27
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 for threaded part	$\gamma_{Ms,N}$[2)]	[-]	1,4				

1) HZA-R size M27 not available.
2) In absence of national regulations.

Essential characteristics under seismic loading

Minimum anchorage length, minimum lap length and design values of the bond strength for a working life of 50 and 100 years for following drilling techniques:

- hammer drilling,
- hammer drilling with Hilti hollow drill bit TE-CD, TE-YD,
- compressed air drilling,
- diamond coring (dry),
- diamond coring with roughening with Hilti Roughening tool TE-YRT.

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ given in Table C9.

The design values of the bond strength $f_{bd,PIR,seis}$ and $f_{bd,PIR,seis,100y}$ are given in Table C11. It is obtained by multiplying the design value of the bond strength f_{bd} according to EN 1992-1-1 (Eq. 8.3) by the seismic bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$ according to Table C10.

The minimum concrete cover between the value according to Table B3 and $c_{min,seis} = 2\ \phi$ applies.

Table C9: Amplification factor α_{lb} and $\alpha_{lb,100y}$

Rebar diameter	Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ [-]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 40	1,0							

Table C10: Seismic bond efficiency factor $k_{b,seis}$ and $k_{b,seis,100y}$

Rebar diameter	Seismic bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$ [-]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 40	1,0							

Table C11: Design values of the bond strength $f_{bd,PIR,seis}$[1)] and $f_{bd,PIR,seis,100y}$[1)]

Rebar diameter	Bond strength $f_{bd,PIR,seis} = f_{bd,PIR,seis,100y}$ [N/mm²]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 8 to ϕ 32	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
ϕ 34	2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
ϕ 36	1,9	2,2	2,6	2,9	3,2	3,5	3,8	4,1
ϕ 40	1,8	2,1	2,5	2,8	3,1	3,4	3,7	3,9

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Essential characteristics under seismic loading

Minimum anchorage length, minimum lap length and design values of the bond strength for a working life of 50 and 100 years for diamond coring (wet).

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ given in Table C12.

The design values of the bond strengths $f_{bd,PIR,seis}$ and $f_{bd,PIR,seis,100y}$ are given in Table C14. It is obtained by multiplying the design value of the bond strength f_{bd} according to EN 1992-1-1 (Eq. 8.3) by the seismic bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$ according to Table C13.

The minimum concrete cover between the value according to Table B3 and $c_{min,seis} = 2\ \phi$ applies.

Table C12: Amplification factor α_{lb} and $\alpha_{lb,100y}$

Rebar diameter	Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ [-]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 12	1,0							
ϕ 13 to ϕ 36	Linear interpolation between diameters							
ϕ 40	1,0			1,2	1,3	1,4		

Table C13: Seismic bond efficiency factor $k_{b,seis}$ and $k_{b,seis,100y}$

Rebar diameter	Seismic bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$ [-]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 12	1,00							0,93
ϕ 13 to ϕ 32	1,00					0,91	0,84	0,79
ϕ 34 to ϕ 40	1,00		0,86	0,75	0,69	0,63	0,58	0,54

Table C14: Design values of the bond strength $f_{bd,PIR,seis}$[1)] and $f_{bd,PIR,seis,100y}$[1)]

Rebar diameter	Bond strength $f_{bd,PIR,seis} = f_{bd,PIR,seis,100y}$ [N/mm²]							
	Concrete class							
	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ 12	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,0
ϕ 13 to ϕ 32	2,0	2,3	2,7	3,0	3,3	3,4	3,4	3,4
ϕ 34	1,9	2,3	2,3	2,3	2,3	2,3	2,3	2,3
ϕ 36	1,9	2,2	2,2	2,2	2,2	2,2	2,2	2,2
ϕ 40	1,8	2,1	2,1	2,1	2,1	2,1	2,1	2,1

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Essential characteristics under fire exposure

Design value of the bond strength $f_{bd,fi}$ for a working life of 50 years and design value of the bond strength $f_{bd,fi,100y}$ for a working life of 100 years under fire exposure for concrete classes C12/15 to C50/60 for all drilling techniques.

The design values of the bond strength $f_{bd,fi}$ and $f_{bd,fi,100y}$ under fire exposure have to be calculated by the following equation:

$$f_{bd,fi} = k_{b,fi}(\theta) \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{M,fi}}$$ for a working life of 50 years

$$f_{bd,fi,100y} = k_{b,fi,100y}(\theta) \cdot f_{bd,PIR,100y} \cdot \frac{\gamma_c}{\gamma_{M,fi}}$$ for a working life of 100 years

with $\theta \leq 305°C$:

$$k_{b,fi}(\theta) = \frac{651{,}24 \cdot \theta^{-1{,}115}}{f_{bd,PIR} \cdot 4{,}3} \leq 1{,}0$$ for a working life of 50 years

$$k_{b,fi,100y}(\theta) = \frac{651{,}24 \cdot \theta^{-1{,}115}}{f_{bd,PIR,100y} \cdot 4{,}3} \leq 1{,}0$$ for a working life of 100 years

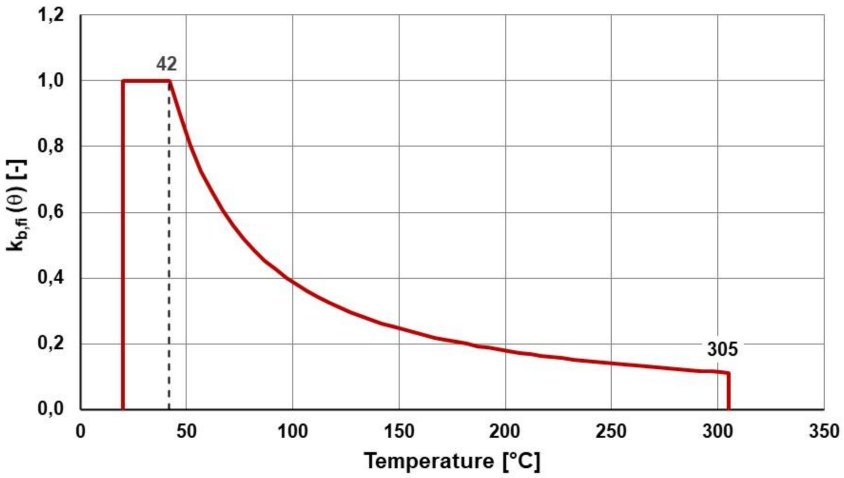
$\theta > 305°C$:

$$k_{b,fi}(\theta) = k_{b,fi,100y}(\theta) = 0{,}0$$

$f_{bd,fi}$	Design value of the bond strength in case of fire in N/mm² for a working life of 50 years.
$f_{bd,fi,100y}$	Design value of the bond strength in case of fire in N/mm² for a working life of 100 years.
(θ)	Temperature in °C in the mortar layer.
$k_{b,fi}(\theta)$	Reduction factor under fire exposure for a working life of 50 years.
$k_{b,fi,100y}(\theta)$	Reduction factor under fire exposure for a working life of 100 years.
$f_{bd,PIR}$	Design value of the bond strength in N/mm² in cold condition according to Table C3 or Table C6 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1 for a working life of 50 years.
$f_{bd,PIR,100y}$	Design value of the bond strength in N/mm² in cold condition according to Table C3 or Table C6 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1 for a working life of 100 years.
γ_c	Partial factor according to EN 1992-1-1.
$\gamma_{M,fi}$	Partial factor according to EN 1992-1-2.

For evidence under fire exposure the anchorage length shall be calculated according to EN 1992-1-1:2004+AC:2010 Equation 8.3 using the temperature-dependent bond strength $f_{bd,fi}$.

Figure C1: Example graph of temperature reduction factor $k_{b,fi}(\theta)$ for concrete class C20/25 for good bond conditions



Essential characteristics under fire exposure

Characteristic and design value of the tensile steel strength of Hilti tension anchor HZA and HZA-R

Table C15: Characteristic tensile steel strength under direct fire exposure for Hilti tension anchor HZA

Hilti tension anchor HZA				M12	M16	M20	M24	M27
Characteristic tensile strength	R30	$N_{Rk,s,fi}$	[kN]	1,7	3,1	4,9	7,1	9,2
	R60			1,3	2,4	3,7	5,3	6,9
	R90			1,1	2,0	3,2	4,6	6,0
	R120			0,8	1,6	2,5	3,5	4,6

Table C16: Characteristic tensile steel strength under direct fire exposure for Hilti tension anchor HZA-R

Hilti tension anchor HZA-R				M12	M16	M20	M24
Characteristic tensile strength	R30	$N_{Rk,s,fi}$	[kN]	2,5	4,7	7,4	10,6
	R60			2,1	3,9	6,1	8,8
	R90			1,7	3,1	4,9	7,1
	R120			1,3	2,5	3,9	5,6

The design value of the tensile steel strength $N_{Rd,s,fi}$ under direct fire exposure for Hilti tension anchor HZA and HZA-R has to be calculated by the following equation:

$$N_{Rd,s,fi} = \frac{N_{Rk,s,fi}}{\gamma_{M,fi}}$$

$N_{Rk,s,fi}$ Characteristic value of the tensile steel strength under direct fire exposure in kN.
$N_{Rd,s,fi}$ Design value of the tensile steel strength under direct fire exposure in kN.
$\gamma_{M,fi}$ Partial factor according to EN 1992-1-2.