

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-20/1281
of 4 March 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Kerakoll Injection system Epofix for rebar connection

Product family
to which the construction product belongs

Systems for post-installed rebar
connections with mortar

Manufacturer

KERAKOLL S.p.a
via dell' Artigianato, 9
41049 SASSUOLO (MO)
ITALIEN

Manufacturing plant

Plant 51, Germany

This European Technical Assessment
contains

22 pages including 3 annexes which form an integral part
of this assessment

This European Technical Assessment is
issued in accordance with Regulation (EU)
No 305/2011, on the basis of

EAD 330087-00-0601, Edition 05/2018

European Technical Assessment

ETA-20/1281

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Specific Part

1 Technical description of the product

The subject of this European Technical Assessment is the post-installed connection, by anchoring or overlap connection joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete, using the "Kerakoll Injection System Epofix for rebar connection" in accordance with the regulations for reinforced concrete construction.

Reinforcing bars made of steel with a diameter ϕ from 8 to 40 mm or the tension anchor from sizes M12 to M24 according to Annex A and injection mortar EPOFIX are used for rebar connections. The rebar is placed into a drilled hole filled with injection mortar and is anchored via the bond between rebar, injection mortar and concrete.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European assessment Document

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

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the rebar connection of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance under static and quasi-static loading	See Annex C 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 2 and C 3

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 330087-00-0601, the applicable European legal act is: [96/582/EC].

The system(s) to be applied is (are): 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 4 March 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

Installation post installed rebar

Figure A1: Overlapping joint for rebar connections of slabs and beams

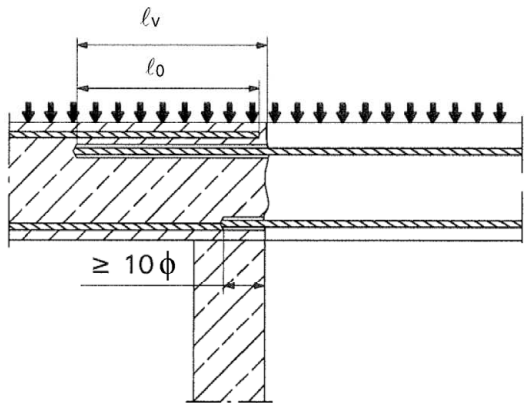


Figure A3: End anchoring of slabs or beams (e.g. designed as simply supported)

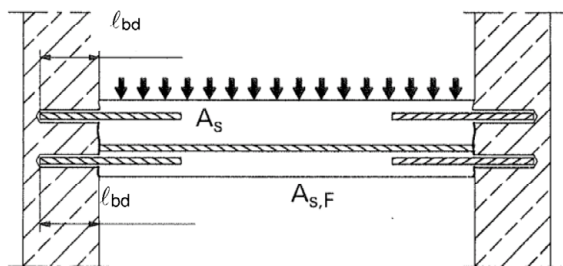


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force

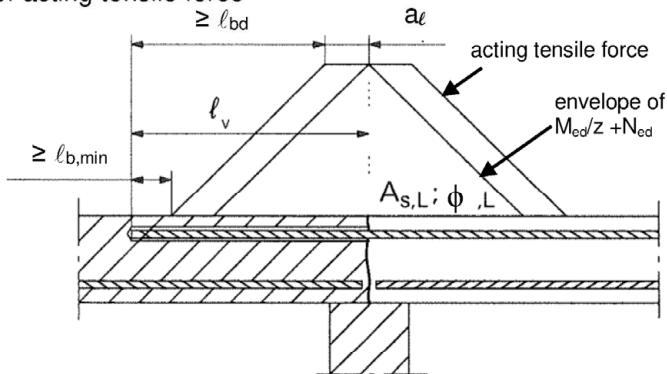


Figure A2: Overlapping joint at a foundation of a wall or column where the rebars are stressed in tension

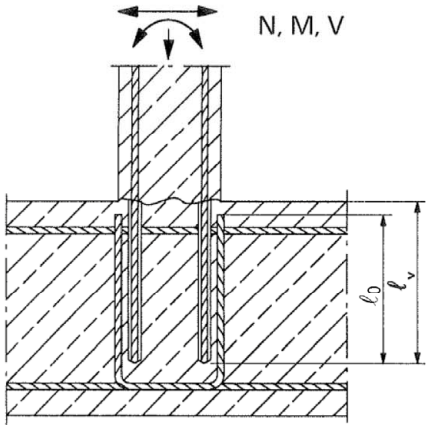
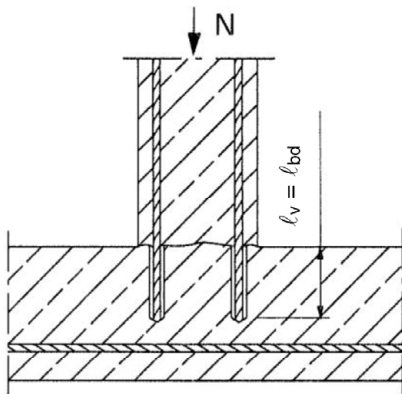


Figure A4: Rebar connection for components stressed primarily in compression. The rebars are stressed in compression



Note to Figure A1 to A5:

In the Figures no transverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1:2004+AC:2010.

Preparing of joints according to Annex B 2

Kerakoll Injection system Epofix for rebar connection

Product description

Installed condition and examples of use for rebars

Annex A 1

Installation tension anchor ZA

Figure A6: Overlapping joint of a column stressed in bending to a foundation

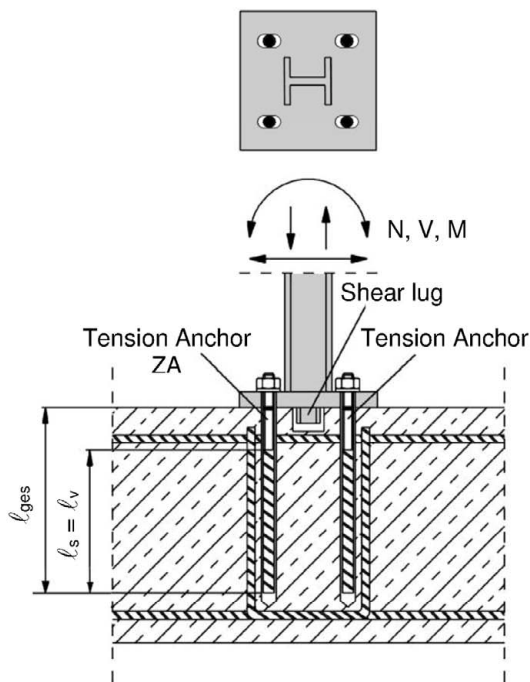


Figure A7: Overlap joint for the anchorage of barrier posts

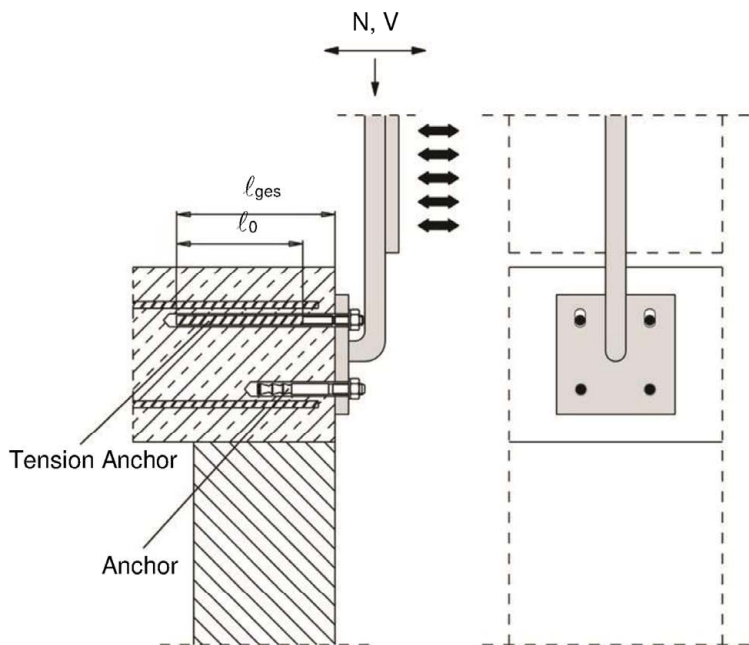
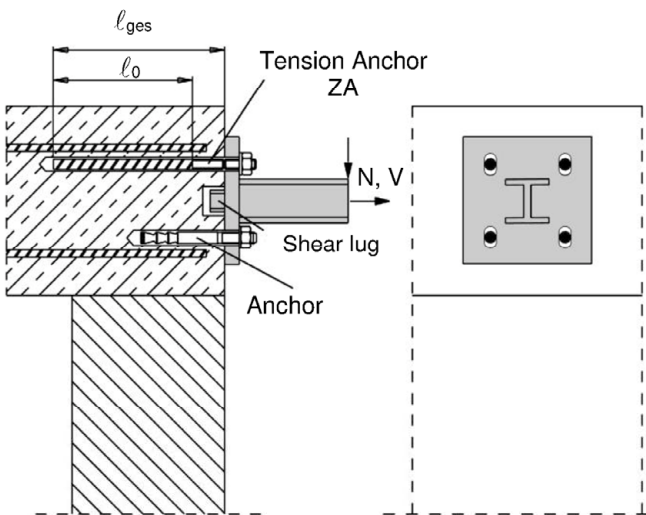


Figure A8: Overlap joint for the anchorage to cantilever members



Note to Figure A6 to A8:

In the Figures no transverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1:2002+AC:2010

Kerakoll Injection system Epofix for rebar connection

Product description

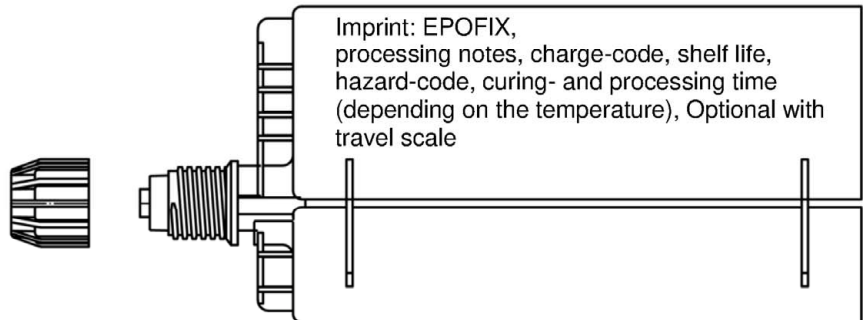
Installed condition and examples of use for tension anchors ZA

Annex A 2

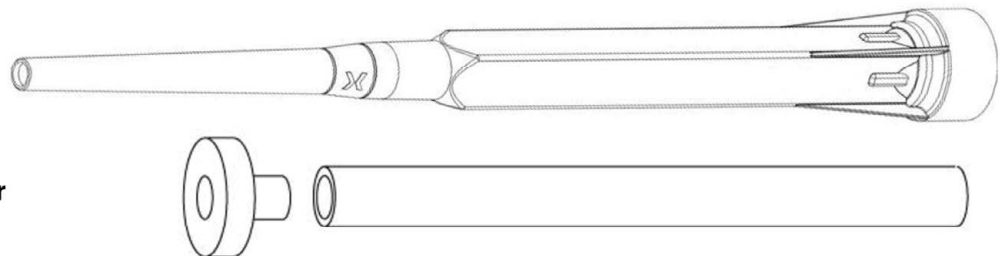
Kerakoll Injection system Epofix:

Injection mortar: EPOFIX

Type "side-by-side":
440ml, 585 ml and 1400 ml
cartridge

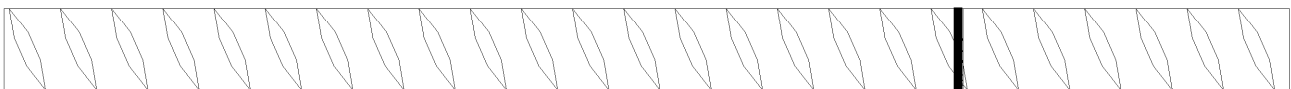


Static Mixer

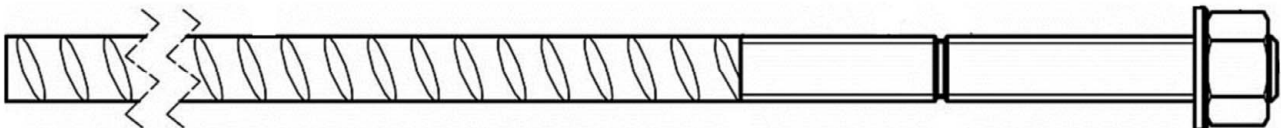


**Piston plug and mixer
extension**

Reinforcing bar (rebar): ø8, ø10, ø12, ø14, ø16, ø20, ø22, ø24, ø25, ø28, ø32, ø34, ø36, ø40



Tension Anchor ZA: M12 to M24



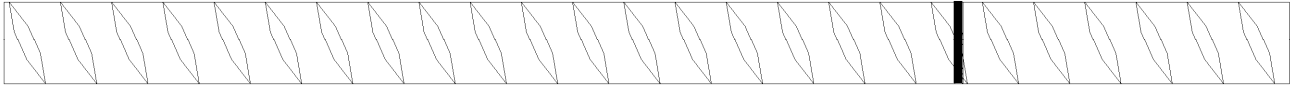
Kerakoll Injection system Epofix for rebar connection

Product description

Injection mortar / Static mixer / Rebar / Tension Anchor ZA

Annex A 3

Reinforcing bar (rebar): $\phi 8$, $\phi 10$, $\phi 12$, $\phi 14$, $\phi 16$, $\phi 20$, $\phi 22$, $\phi 24$, $\phi 25$, $\phi 28$, $\phi 32$, $\phi 34$, $\phi 36$, $\phi 40$



- Minimum value of related rib area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range $0,05\phi \leq h_{rib} \leq 0,07\phi$
(ϕ : Nominal diameter of the bar; h_{rib} : Rib height of the bar)


Table A1: Materials

Designation	Material
Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$
<p>Kerakoll Injection system Epofix for rebar connection</p> <p>Product description Materials Rebar</p>	

Annex A 4

Tension Anchor ZA: M12, M16, M20, M24

Marking: e.g.  12 A4

-  Mark of the producer
ZA Trade name
12 Rod diameter/thread
A4 for stainless steel A4
HCR for high corrosion resistance steel

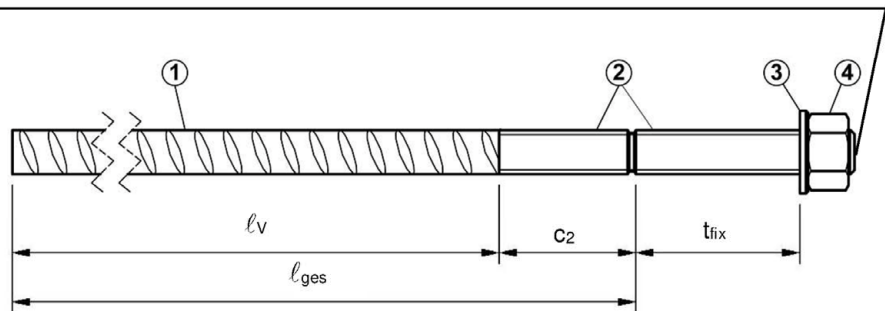


Table A2: Materials

Part	Designation	Material											
		ZA vz				ZA A4				ZA HCR			
		M12	M16	M20	M24	M12	M16	M20	M24	M12	M16	M20	M24
1	Reinforcement bar	Class B according to NDP or NCL of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$											
2	Threaded rod	Steel, zinc plated according to EN 10087:1998 or EN 10263:2001				Stainless steel, 1.4362, 1.4401, 1.4404, 1.4571, EN 10088-1:2014				High corrosion resistant steel, 1.4529, 1.4565, EN 10088-1:2014			
		f_{yk} [N/mm ²] 640				640 560				640 560			
3	Washer	Steel, zinc plated according to EN 10087:1998 or EN 10263:2001				Stainless steel, 1.4362, 1.4401, 1.4404, 1.4571, EN 10088-1:2014				High corrosion resistant steel, 1.4529, 1.4565, EN 10088-1:2014			
4	Nut												

Table A3: Dimensions and installation parameter

Size			ZA-M12	ZA-M16	ZA-M20	ZA-M24
Diameter of threaded rod	d_s	[mm]	12	16	20	24
Diameter of reinforcement bar	ϕ	[mm]	12	16	20	25
Drill hole diameter	d_o	[mm]	16	20	25	32
Diameter of clearance hole in fixture	d_f	[mm]	14	18	22	26
With across nut flats	SW	[mm]	19	24	30	36
Stress area	A_s	[mm ²]	84	157	245	353
Effective embedment depth	l_v	[mm]	according to static calculation			
Length of bonded thread	plated	c_2 [mm]	≥ 20	≥ 20	≥ 20	≥ 20
	A4/HCR		≥ 100	≥ 100	≥ 100	≥ 100
Minimum thickness of fixture	t_{fix}	[mm]	5	5	5	5
Maximum thickness of fixture	t_{fix}	[mm]	3000	3000	3000	3000
Maximum installation torque	T_{max}	[Nm]	50	100	150	150

Kerakoll Injection system Epofix for rebar connection

Product description
Specifications Tension Anchor ZA

Annex A 5

Specifications of intended use

Anchorage subject to:

- Static and quasi-static loads.
- Fire exposure

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206:2013 + A1:2016.
- Strength classes C12/15 to C50/60 according to EN 206:2013 + A1:2016.
- 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 $\phi + 60$ 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 1992-1-1:2004+AC:2010.

The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Temperature Range:

- - 40°C to +80°C (max. short term temperature +80°C and max long term temperature +50°C).

Use conditions (Environmental conditions) with tension anchor ZA:

- Structures subject to dry internal conditions or subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel).

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design according to EN 1992-1-1:2004+AC:2010, EN 1992-1-2:2004+AC:2008 and Annex B 2 and B 3.
- 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:

- Dry or wet concrete.
- It must not be installed in flooded holes.
- Hole drilling by hammer drill (HD), hollow drill (HDB), diamond drill (DD) or compressed air drill (CD).
- The installation of post-installed rebar resp. tension anchors shall be done only by suitable trained installer and under supervision on site; the conditions under which an installer may be considered as suitable trained and the conditions for supervision on site are up to the Member States in which the installation is done.
- 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).

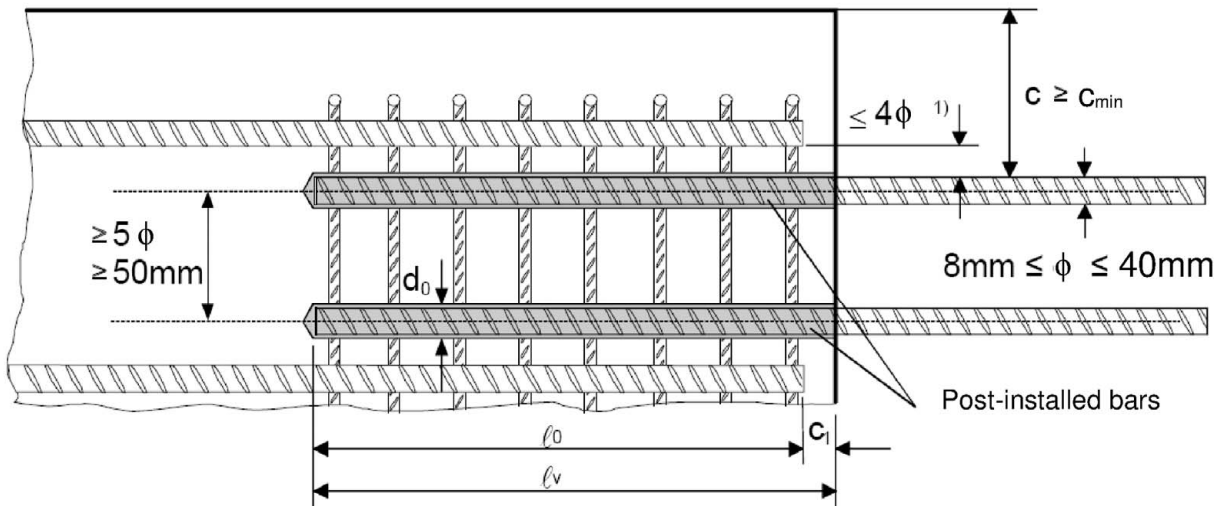
Kerakoll Injection system Epofix for rebar connection

Intended use
Specifications

Annex B 1

Figure B1: General construction rules for post-installed rebars

- Only tension forces in the axis of the rebar may be transmitted
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1:2004+AC:2010.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.



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

The following applies to Figure B1:

- 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 B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
 ϕ diameter of post-installed rebar
 ℓ_0 lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
 ℓ_v effective embedment depth, $\geq \ell_0 + c_1$
 d_0 nominal drill bit diameter, see Annex B 4

Kerakoll Injection system Epofix for rebar connection

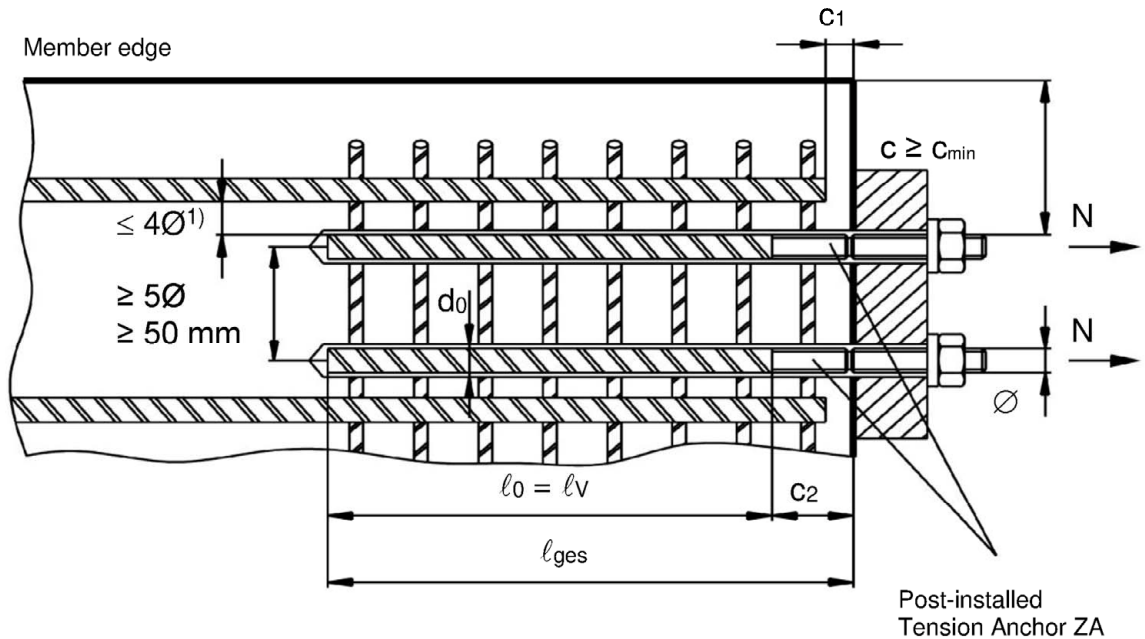
Intended use

General construction rules for post-installed rebars

Annex B 2

Figure B2: General construction rules for tension anchors ZA

- The length of the bonded-in thread may not be accounted as anchorage
- Only tension forces in the direction of the bar axis may be transmitted by the tension anchor ZA
- The tension force must be transferred via an overlap joint to the reinforcement in the building part.
- The transfer of shear forces shall be ensured by appropriate additional measures, e.g. shear lugs or by anchors with an European technical assessment.
- In the anchor plate, the holes for the tension anchors shall be executed as elongated holes with axis in the direction of the shear force.



¹⁾ If the clear distance between lapped bars exceeds 4ϕ , then the lap length shall be increased by the difference between the clear bar distance and 4ϕ .

The following applies to Figure B2:

c	concrete cover of tension anchor ZA
c ₁	concrete cover at end-face of existing rebar
c ₂	Length of bonded thread
c _{min}	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	diameter of tension anchor
ℓ_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
ℓ_v	effective embedment depth, $\geq \ell_0 + c_1$
ℓ_{ges}	overall embedment depth, $\geq \ell_0 + c_2$
d ₀	nominal drill bit diameter, see Annex B 4

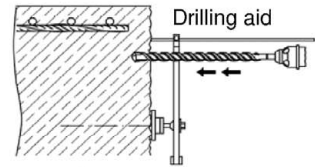
Kerakoll Injection system Epofix for rebar connection

Intended use

General construction rules for tension anchors

Annex B 3

Table B1: Minimum concrete cover $\min c^{1)}$ of post-installed rebar and tension anchor ZA depending of drilling method



Drilling method	Rebar diameter	Without drilling aid	With drilling aid
Hammer drilling (HD)	< 25 mm	$30 \text{ mm} + 0,06 \cdot l_v \geq 2 \phi$	$30 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
Hollow drilling (HDB)	$\geq 25 \text{ mm}$	$40 \text{ mm} + 0,06 \cdot l_v \geq 2 \phi$	$40 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
Diamond drilling (DD)	< 25 mm	Drill rig used as drilling aid	$30 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
	$\geq 25 \text{ mm}$		$40 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
Compressed air drilling (CD)	< 25 mm	$50 \text{ mm} + 0,08 \cdot l_v$	$50 \text{ mm} + 0,02 \cdot l_v$
	$\geq 25 \text{ mm}$	$60 \text{ mm} + 0,08 \cdot l_v$	$60 \text{ mm} + 0,02 \cdot l_v$

¹⁾ see Annex B 2, Figure B1 and Annex B 3, Figure B2

Comments: The minimum concrete cover acc. EN 1992-1-1:2004+AC:2010 must be observed

Table B2: maximum embedment depth $l_{v,max}$

Rebar ϕ	Tension anchor ϕ	HD / CD / DD $l_{v,max}$ [mm]	HDB $l_{v,max}$ [mm]
8 mm		800	800
10 mm		1000	1000
12 mm	ZA-M12	1200	1000
14 mm		1400	1000
16 mm	ZA-M16	1600	1000
20 mm	ZA-M20	2000	1000
22 mm		2000	1000
24 mm		2000	1000
25 mm	ZA-M24	2000	1000
28 mm		2000	1000
32 mm		2000	1000
34 mm		2000	-
36 mm		2000	-
40 mm		2000	-

Table B3: Base material temperature, gelling time and curing time

Concrete temperature	Gelling- / working time ¹⁾ t_{gel}	Minimum curing time in dry concrete $t_{cure,dry}$	Minimum curing time in wet concrete $t_{cure,wet}$
+ 5 °C to + 9 °C	80 min	48 h	96 h
+ 10 °C to + 14 °C	60 min	28 h	56 h
+ 15 °C to + 19 °C	40 min	18 h	36 h
+ 20 °C to + 24 °C	30 min	12 h	24 h
+ 25 °C to + 34 °C	12 min	9 h	18 h
+ 35 °C to + 39 °C	8 min	6 h	12 h
+40 °C	8 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		

¹⁾ t_{gel} : maximum time from starting of mortar injection to completing of rebar setting.





Kerakoll Injection system Epofix for rebar connection

Intended use

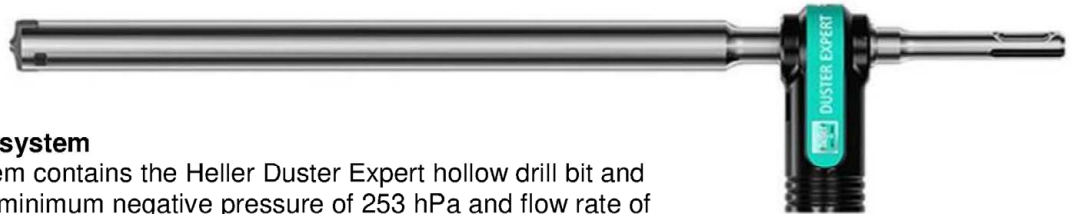
Minimum concrete cover
Maximum embedment depth

Annex B 4

Table B4: Dispensing tools

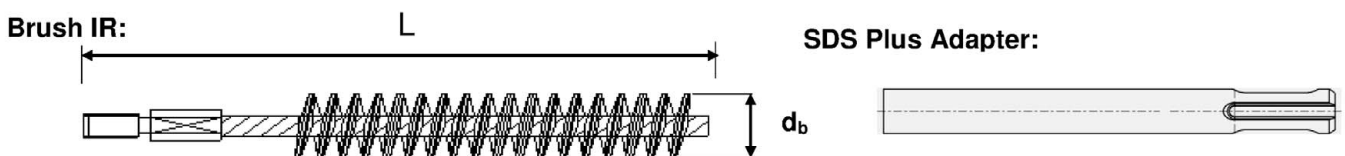
Cartridge type/size	Hand tool		Pneumatic tool
Side-by-side cartridges 440, 585 ml	 e.g. SA 296C585	 e.g. Typ H 244 C	 e.g. Typ TS 444 KX
Side-by-side cartridges 1400 ml	-	-	 e.g. Typ TS 471

Cleaning and installation tools



HDB – Hollow drill bit system

The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m³/h (42 l/s).



Brush extension:



Rec. compressed air tool
hand slide valve (min 6 bar)



Kerakoll Injection system Epofix for rebar connection

Intended Use

Dispensing, cleaning and installation tools

Annex B 5

Table B5: Brushes, piston plugs, max anchorage depth and mixer extension, hammer (HD), diamond (DD) and compressed air (CD) drilling

Bar size ϕ	Tension anchor ϕ	Drill bit - Ø			d _b Brush - Ø	d _{b,min} min. Brush - Ø	Piston plug	Cartridge: 440 ml or 585 ml				Cartridge: 1400 ml			
		HD	DD	CD				Hand or battery tool		Pneumatic tool		Pneumatic tool			
								l _{v,max}	Mixer extension	l _{v,max}	Mixer extension	l _{v,max}	Mixer extension		
[mm]	[mm]		[mm]		[mm]	[mm]		[mm]		[mm]		[mm]			
8	-	10		-	IR10	11,5	10,5	-	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8	250		
	-	12		-	IR12	13,5	12,5	-	700		800		800		
-	250								250		250				
10	-	14		-	IR14	15,5	14,5	PG14	700		1000		1000		
-	250							250	250						
12	ZA-M12	16			IR16	17,5	16,5	PG16	700		VL10/0,75 or VL16/1,8		1300	VL10/0,75 or VL16/1,8	250
															1200
14	-	18			IR18	20,0	18,5	PG18	1400		1400				
16	ZA-M16	20			IR20	22,0	20,5	PG20	1600		1600				
20	ZA-M20	25	-		IR25	27,0	25,5	PG25	500		VL10/0,75 or VL16/1,8	1000	VL10/0,75 or VL16/1,8		2000
		-	26		IR26	28,0	26,5	PG25							
22	-	28			IR28	30,0	28,5	PG28							
24/25	ZA-M24	32			IR32	34,0	32,5	PG32							
28	-	35			IR35	37,0	35,5	PG35							
32/34	-	40			IR40	43,5	40,5	PG40							
36	-	45			IR45	47,0	45,5	PG45	-	-					
40	-	-	52	-	IR52	54,0	52,5	PG52							
		55	-	55	IR55	58,0	55,5	PG55							

Table B6: Brushes, piston plugs, max anchorage depth and mixer extension, hammer drilling with hollow drill bit system (HDB)

Bar size ϕ [mm]	Tension anchor ϕ [mm]	Drill bit - \emptyset	d_b Brush - \emptyset	$d_{b,min}$ min. Brush - \emptyset	Piston plug	Cartridge: 440 ml or 585 ml				Cartridge: 1400 ml	
		HDB				Hand or battery tool		Pneumatic tool		Pneumatic tool	
						$l_{v,max}$	Mixer extension	$l_{v,max}$	Mixer extension	$l_{v,max}$	Mixer extension
[mm]	[mm]	[mm]	No cleaning required			[mm]		[mm]		[mm]	
8	-	10			-	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8
	-	12			-	700		800		800	
10	-				-	250		250		250	
	-	14			700	1000		1000			
12	ZA-M12				250	250		250			
14	-	18			PG16	700		1000		VL10/0,75 or VL16/1,8	
16	ZA-M16	20			PG18						
20	ZA-M20	25			PG20						
22	-	28			PG25						
24/25	ZA-M24	32			PG28						
28	-	35			PG32						
32/34	-	40			PG35						
					PG40						

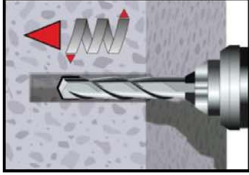
Kerakoll Injection system Epofix for rebar connection

Intended use
Installation tools

Annex B 6

A) Bore hole drilling

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

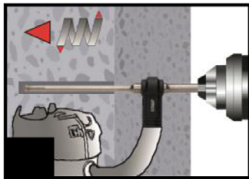


1a. Hammer (HD) or compressed air drilling (CD)

Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar
Proceed with Step B1.

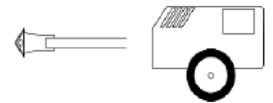


Hammer drill (HD + HDB)

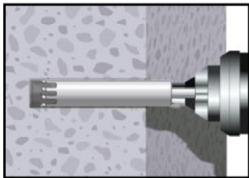


1b. Hollow drill bit system (HDB) (see Annex B 5)

Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar.
This drilling system removes the dust and cleans the bore hole during drilling. Proceed with Step C.



Compressed air drill (CD)



1c. Diamond drilling (DD)

Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor
Proceed with Step B2.



Diamond coring (DD)

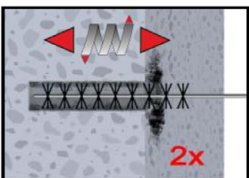
B1) Bore hole cleaning

CAC: Cleaning for all bore hole diameter and bore hole depth with drilling method HD and CD

Attention! Standing water in the bore hole must be removed before cleaning.



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



2b. Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B5) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension shall be used (Table B5).



2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

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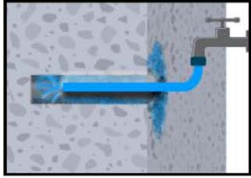
Intended use

Installation instruction: Bore hole drilling and cleaning (HD, HDB and CD)

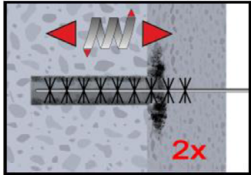
Annex B 7

B2) Bore hole cleaning

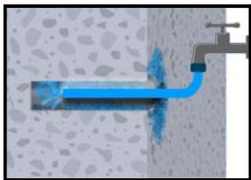
SPCAC: Cleaning for all bore hole diameter and bore hole depth with drilling method DD



2a. Rinsing with water until clear water comes out.

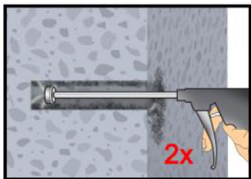


2b. Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B5) a minimum of two times in a twisting motion.
If the bore hole ground is not reached with the brush, a brush extension must be used.

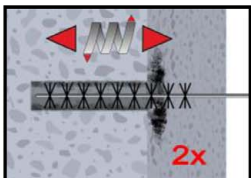


2c. Rinsing again with water until clear water comes out.

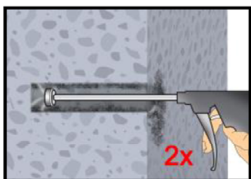
Attention! Standing water in the bore hole must be removed before proceed cleaning.



2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



2e. Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B5) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension shall be used (Table B5).



2f. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

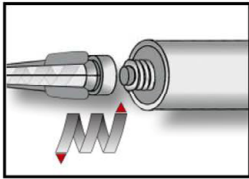
Kerakoll Injection system Epofix for rebar connection

Intended use

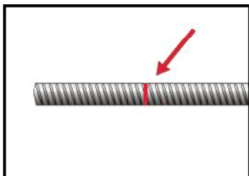
Installation instruction: Bore hole drilling and cleaning (DD)

Annex B 8

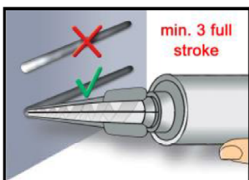
C) Preparation of bar and cartridge



- 3a. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the recommended working time (Table B3) as well as for every new cartridges, a new static-mixer shall be used.

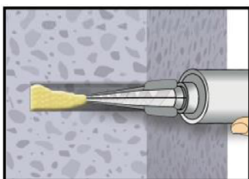


- 3b. Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar and insert bar in empty hole to verify hole and depth ℓ_v .
The anchor should be free of dirt, grease, oil or other foreign material.

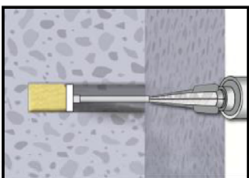


- 3c. Prior to dispensing into the bore hole, squeeze out separately the mortar until it shows a consistent grey or red colour, but a minimum of three full strokes, and discard non-uniformly mixed adhesive components.

D) Filling the bore hole

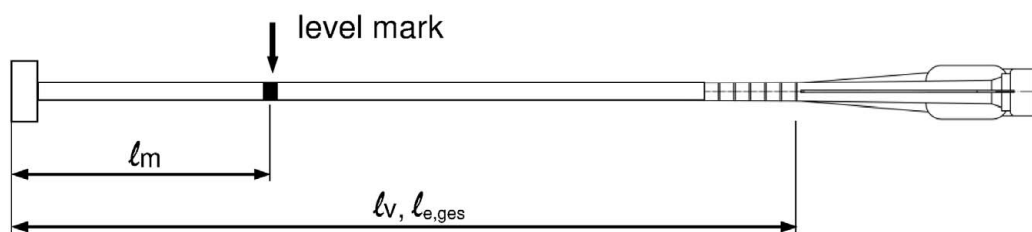


4. Starting from the bottom or back of the cleaned bore hole fill the hole with adhesive, until the level mark at the mixer extension (see below) is visible at the top of the hole. For embedment larger than 190 mm an extension nozzle shall be used. Slowly withdraw the static mixing nozzle and using a piston plugs during injection of the mortar, helps to avoid creating air pockets.



For overhead and horizontal installation and bore holes deeper than 240 mm a piston plug and the appropriate mixer extension must be used.

Observe the gel-/ working times given in Table B3.



Injection tool must be marked by mortar level mark ℓ_m and anchorage depth ℓ_v resp. $\ell_{e,ges}$ with tape or marker.

Quick estimation: $\ell_m = 1/3 \cdot \ell_v$

Continue injection until the mortar level mark ℓ_m becomes visible.

Optimum mortar volume: $\ell_m = \ell_v$ resp. $\ell_{e,ges} \cdot \left(1,2 \cdot \frac{\phi^2}{d_0^2} - 0,2 \right)$ [mm]

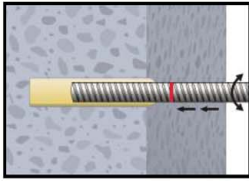
Kerakoll Injection system Epofix for rebar connection

Intended Use

Installation instruction: Preparation of bar and cartridge
Filling the bore hole

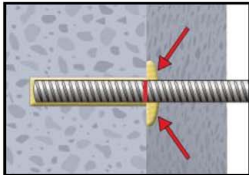
Annex B 9

E) Setting the rebar

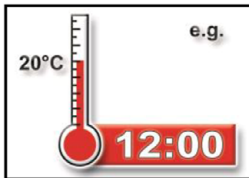


- 5a. Push the reinforcing bar into the bore hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

The bar should be free of dirt, grease, oil or other foreign material.



- 5b. Be sure that the bar is inserted in the bore hole until the embedment mark is at the concrete surface and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For horizontal and overhead installation fix embedded part (e.g. with wedges).



- 5c. Observe gelling time t_{gel} . Attend that the gelling time can vary according to the base material temperature (see Table B3). Do not move or load the bar until full curing time t_{cure} has elapsed (attend Table B3).

Kerakoll Injection system Epofix for rebar connection

Intended Use

Installation instruction: Inserting rebar

Annex B 10

Minimum anchorage length and minimum lap length

The minimum anchorage length $\ell_{b,min}$ and the minimum lap length $\ell_{0,min}$ according to EN 1992-1-1:2004+AC:2010 ($\ell_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $\ell_{0,min}$ acc. to Eq. 8.11) shall be multiply by the amplification factor α_{lb} according to Table C1.

Table C1: Amplification factor α_{lb} related to concrete class and drilling method

Concrete class	Drilling method	Bar size	Amplification factor α_{lb}
C12/15 to C50/60	all drilling methods	8 mm to 40 mm ZA-M12 to ZA-M24	1,0

Table C2: Reduction factor k_b for all drilling methods

Rebar	Concrete class								
ϕ	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 40 mm ZA-M12 to ZA-M24	1,0								

Table C3: Design values of the ultimate bond stress $f_{bd,PIR}$ in N/mm² for all drilling methods and for good conditions

$$f_{bd,PIR} = k_b \cdot f_{bd}$$

with

f_{bd} : Design value of the ultimate bond stress in N/mm² considering the concrete classes, the rebar diameter, the drilling method for good bond condition (for all other bond conditions multiply the values by $\eta_1 = 0.7$) and recommended partial factor $\gamma_c = 1,5$ according to EN 1992-1-1:2004+AC:2010.

k_b : Reduction factor according to Table C2

Rebar	Concrete class								
ϕ	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 32 mm ZA-M12 to ZA-M24	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
34 mm	1,6	2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
36 mm	1,5	1,9	2,2	2,6	2,9	3,3	3,6	3,8	4,1
40 mm	1,5	1,8	2,1	2,5	2,8	3,1	3,4	3,7	4,0

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Performances

Amplification factor α_{lb} , Reduction factor k_b

Design values of ultimate bond resistance $f_{bd,PIR}$

Annex C 1

Design value of the ultimate bond stress $f_{bd,fi}$ at increased temperature for concrete classes C12/15 to C50/60, (all drilling methods):

The design value of the bond stress $f_{bd,fi}$ at increased temperature has to be calculated by the following equation:

$$f_{bd,fi} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \gamma_c / \gamma_{M,fi}$$

with: $\theta \leq 278^\circ\text{C}$: $k_{fi}(\theta) = 4673,8 \cdot \theta^{-1,598} / (f_{bd,PIR} \cdot 4,3) \leq 1,0$
 $\theta > 278^\circ\text{C}$: $k_{fi}(\theta) = 0$

$f_{bd,fi}$ Design value of the ultimate bond stress at increased temperature in N/mm^2

θ Temperature in $^\circ\text{C}$ in the mortar layer.

$k_{fi}(\theta)$ Reduction factor at increased temperature.

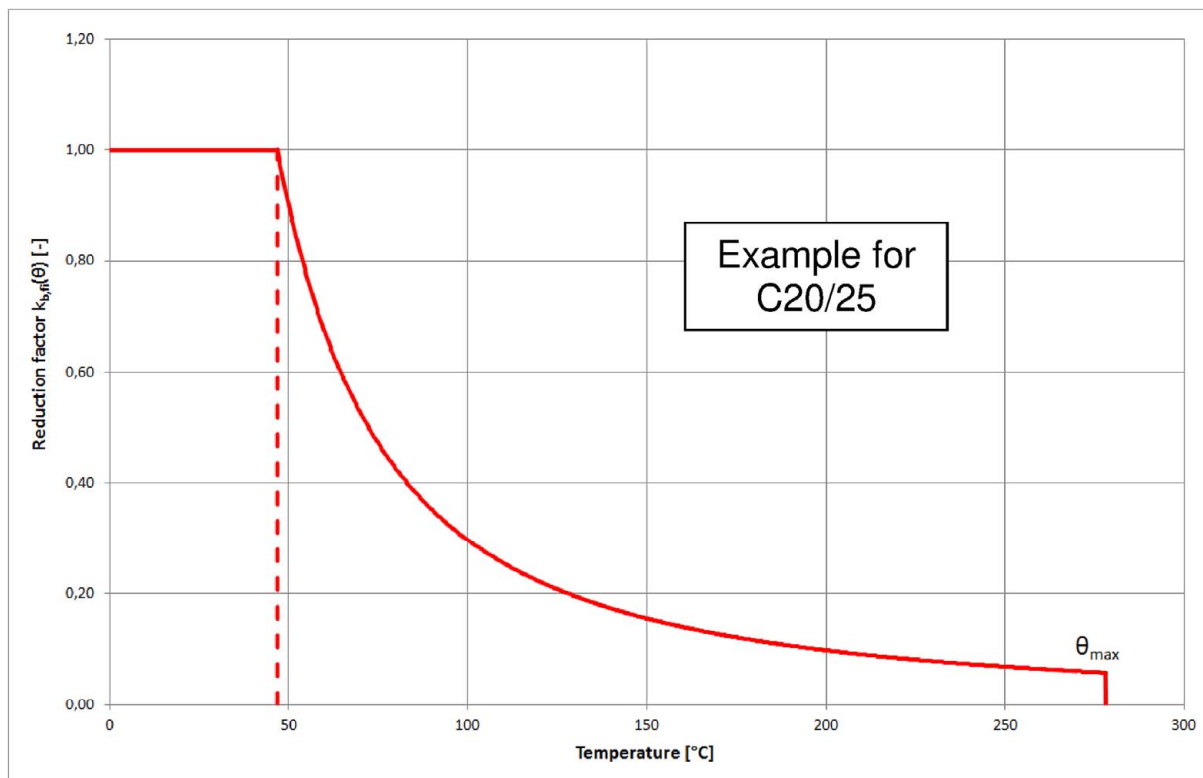
$f_{bd,PIR}$ Design value of the bond stress in N/mm^2 in cold condition according to Table C3 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2004+AC:2010.

γ_c = 1,5, recommended partially safety factor according to EN 1992-1-1:2004+AC:2010

$\gamma_{M,fi}$ = 1,0, recommended partially safety factor according to EN 1992-1-2:2004+AC:2008

For evidence at increased temperature the anchorage length shall be calculated according to EN 1992-1-1:2004+AC:2010 Equation 8.3 using the temperature-dependent design value of ultimate bond stress $f_{bd,fi}$.

Example graph of Reduction factor $k_{fi}(\theta)$ for concrete classes C20/25 for good bond conditions:



Kerakoll Injection system Epofix for rebar connection

Performances

Design value of ultimate bond stress $f_{bd,fi}$ at increased temperature

Annex C 2

Table C6: Characteristic tension strength for tension anchor ZA under fire exposure,
concrete classes C12/15 to C50/60, according to Technical Report TR 020

Tension Anchor			M12	M16	M20	M24
Steel, zinc plated (ZA vz)						
Characteristic steel strength	R30	$\sigma_{Rk,s,fi}$	[N/mm²]	20		
	R60			15		
	R90			13		
	R120			10		
Stainless Steel (ZA A4 or ZA HCR)						
Characteristic steel strength	R30	$\sigma_{Rk,s,fi}$	[N/mm²]	30		
	R60			25		
	R90			20		
	R120			16		

Design value of the steel strength $\sigma_{Rd,s,fi}$ under fire exposure

The design value of the steel strength $\sigma_{Rd,s,fi}$ under fire exposure has to be calculated by the following equation:

$$\sigma_{Rd,s,fi} = \sigma_{Rk,s,fi} / \gamma_{M,fi}$$

with:

$\sigma_{Rk,s,fi}$ characteristic steel strength according to Table C4
 $\gamma_{M,fi}$ partially safety factor according to EN 1992-1-2:2004+AC:2008

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Performances

Design value of the steel strength $\sigma_{Rd,s,fi}$ for tension anchor ZA under fire exposure

Annex C 3