

**Approval body for construction products
and types of construction**

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

**ETA-14/0204
of 12 February 2018**

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

EFCO Injection system TILCA TIM DIAMANT
for rebar connection

Product family
to which the construction product belongs

Injection system for post-installed
rebar connections

Manufacturer

EFCO Befestigungstechnik AG
Grabenstraße 1
8606 NÄNIKON
SCHWEIZ

Manufacturing plant

EFCO Befestigungstechnik AG, Plant 2

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

This version replaces

ETA-14/0204 issued on 26 June 2014

European Technical Assessment

ETA-14/0204

English translation prepared by DIBt

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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 "EFCO Injection system TILCA TIM DIAMANT 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 ZA from sizes M12 to M24 according to Annex A and injection mortar TILCA TIM DIAMANT 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
Amplification factor α_{lb} , Bond resistance f_{bd}	See Annex C 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Rebar connections satisfy requirements for 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 12 February 2018 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Baderschneider

Installation post installed rebar

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

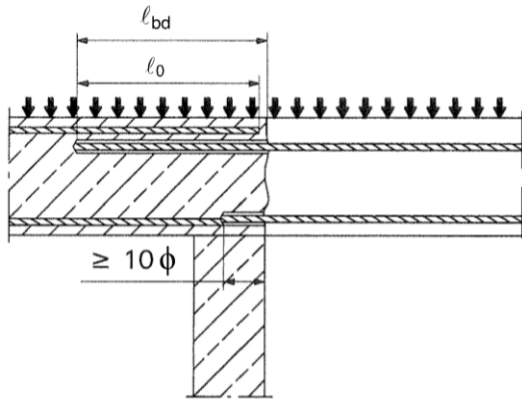


Figure A3: End anchoring of slabs or beams (e.g. designed as simply supported)

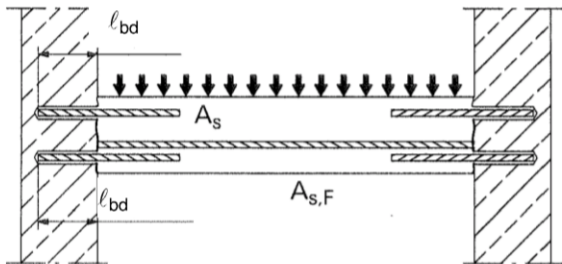


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force

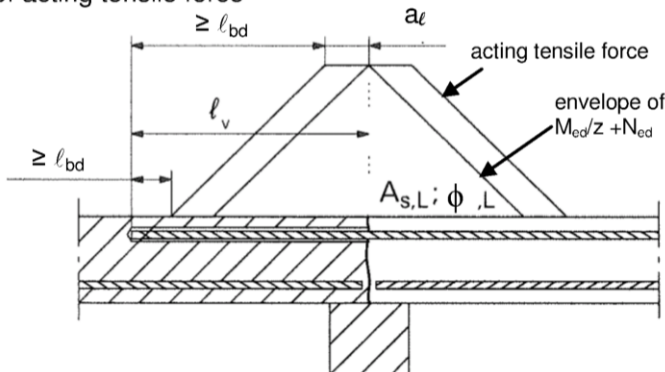


Figure A2: Overlapping joint at a foundation of a wall or column where the rebars are stressed in tension

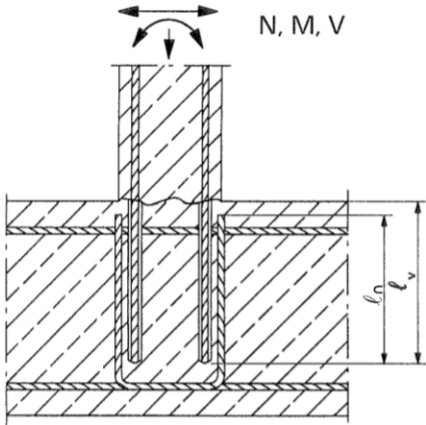
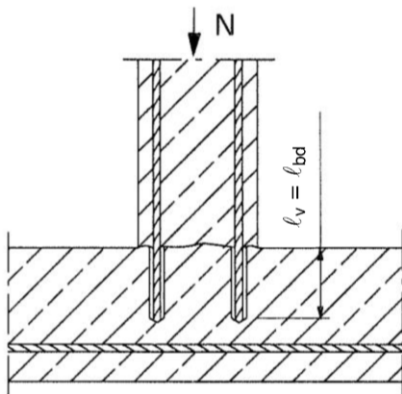


Figure A4: Rebar connection for components stressed primarily in compression. The rebars are stressed in compression



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

EFCO Injection System TILCA TIM DIAMANT 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

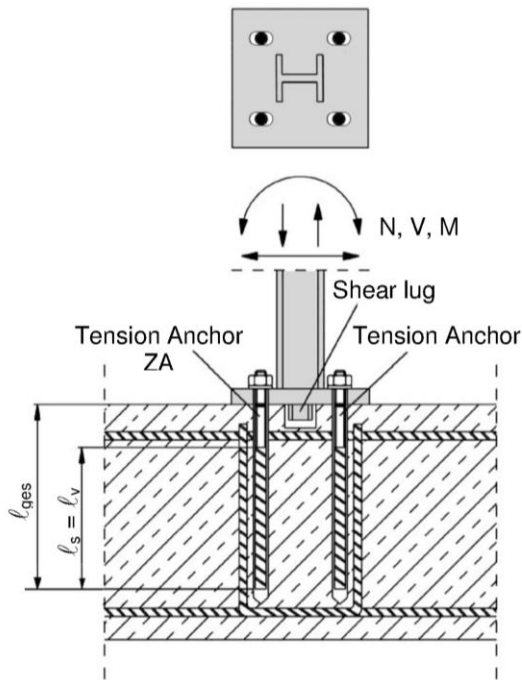


Figure A7: Overlap joint for the anchorage of barrier posts

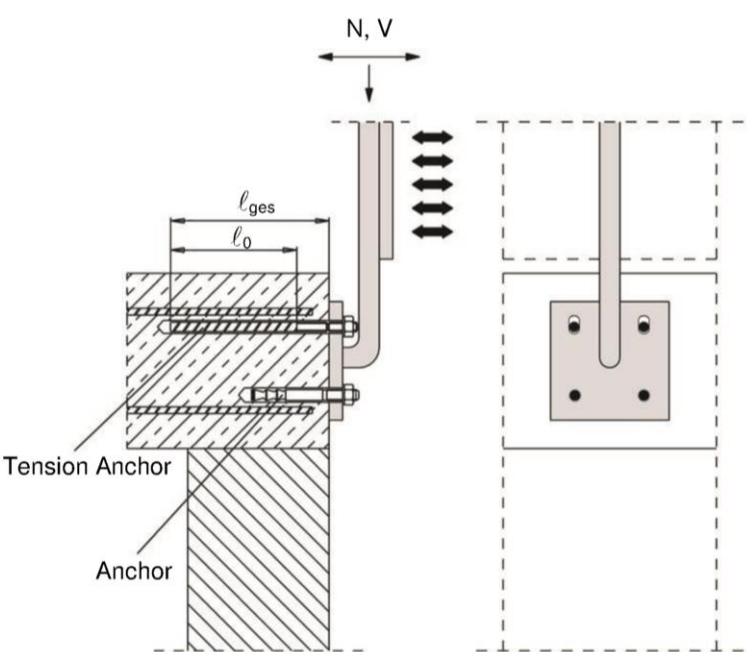
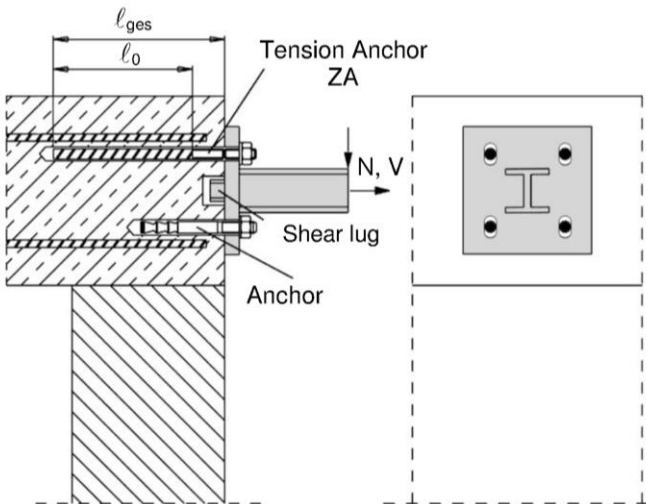


Figure A8: Overlap joint for the anchorage to cantilever members



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

EFCO Injection System TILCA TIM DIAMANT for rebar connection

Product description

Installed condition and examples of use for tension anchors ZA

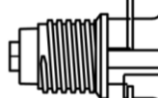
Annex A 2

EFCO Injection System TILCA TIM DIAMANT:

Injection mortar: TILCA TIM DIAMANT

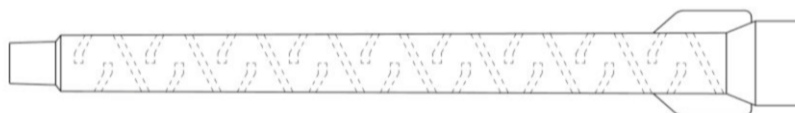
Type "side-by-side":

385 ml, 444ml, 585 ml, 999 ml
and 1400 ml



Imprint: TILCA TIM DIAMANT,
processing notes, charge-code, shelf life,
hazard-code, curing- and processing time
(depending on the temperature), Optional with
travel scale

Static Mixer



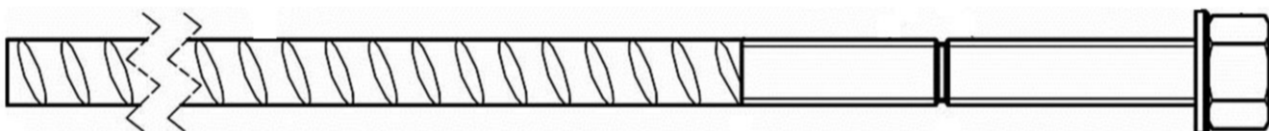
Piston plug and mixer extension



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



Tension Anchor ZA: M12 to M24



EFCO Injection System TILCA TIM DIAMANT for rebar connection

Product description

Injection mortar / Static mixer / Rebar / Tension Anchor ZA

Annex A 3

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




- 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 $0,05\phi \leq h \leq 0,07\phi$
(ϕ : Nominal diameter of the bar; h: 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:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$
<p>EFCO Injection System TILCA TIM DIAMANT 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

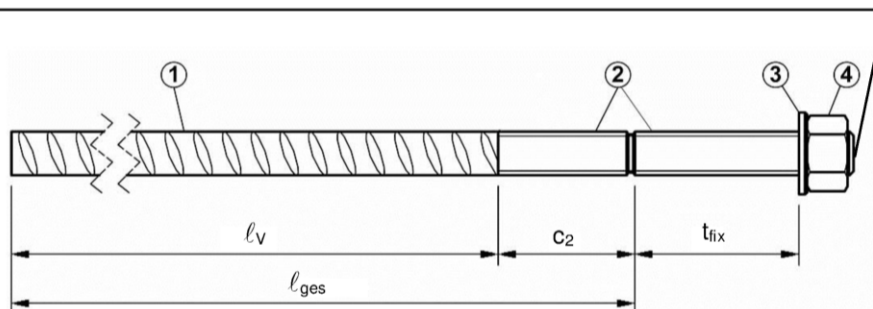


Table A2: Materials

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:2013 $f_{yk} = f_{tk} = k \cdot f_{yk}$											
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				640			
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		[mm]	12	16	20	24
Diameter of reinforcement bar		[mm]	12	16	20	25
Drill hole diameter		[mm]	16	20	25	32
Diameter of clearance hole in the fixture		[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
	A4/HCR			≥ 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

EFCO Injection System TILCA TIM DIAMANT 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 206-1:2000.
- Strength classes C12/15 to C50/60 according to EN 206-1:2000.
- Maximum chloride concrete of 0,40% (CL 0.40) related to the cement content according to EN 206-1:2000.
- 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):

- 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 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), compressed air drill (CD) or diamond drill mode (DD).
- 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).

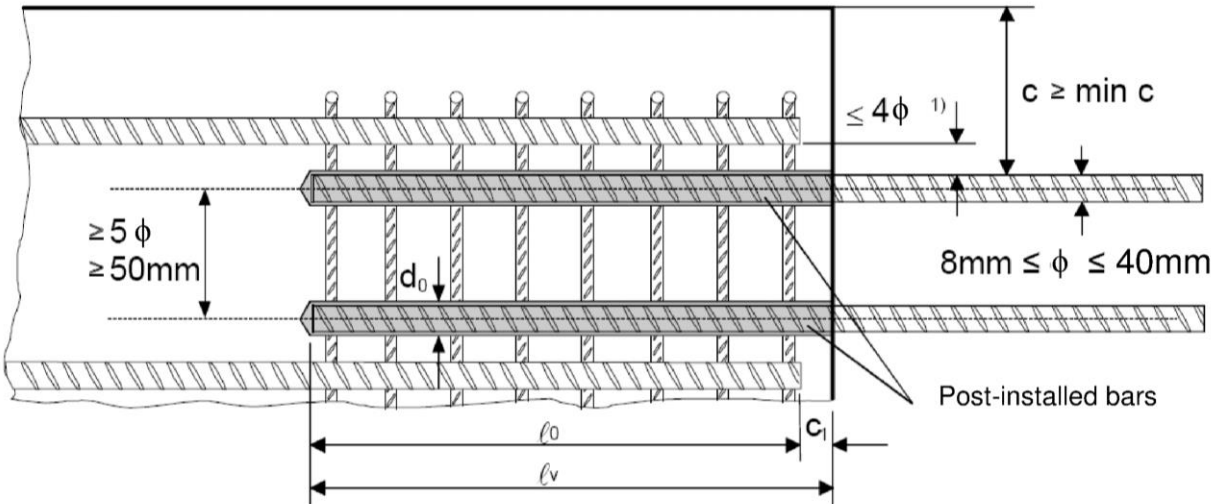
EFCO Injection System TILCA TIM DIAMANT for rebar connection

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
$\min c$	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

EFCO Injection System TILCA TIM DIAMANT for rebar connection

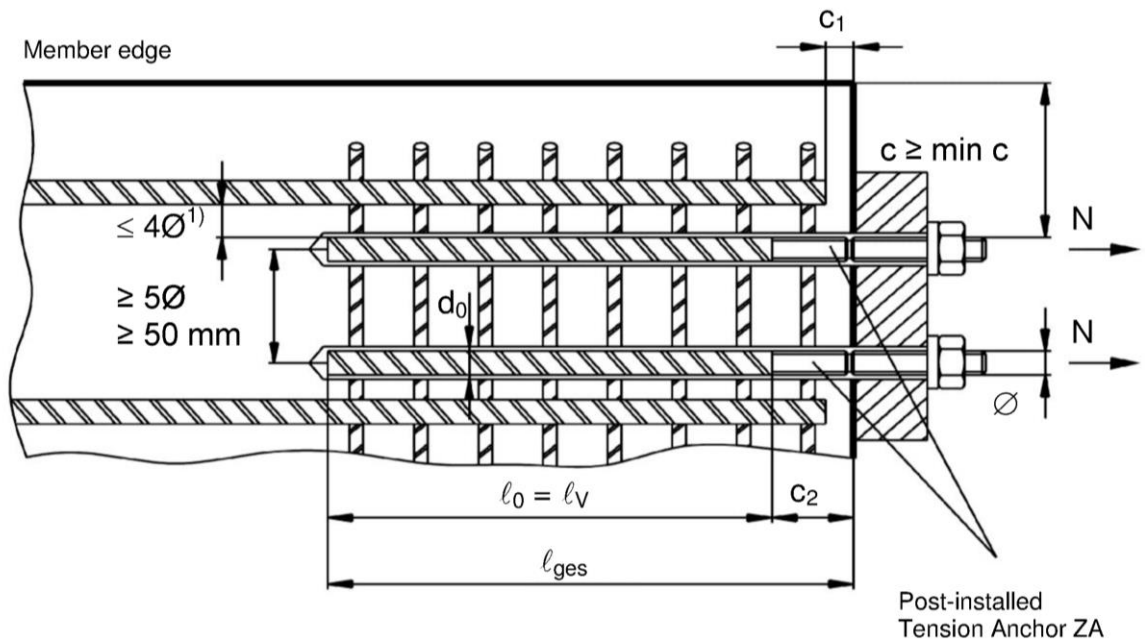
Intended use

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:

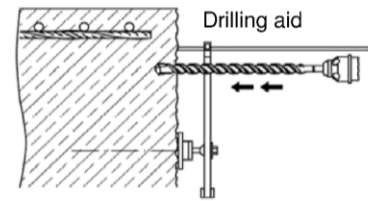
c	concrete cover of tension anchor ZA
c ₁	concrete cover at end-face of existing rebar
c ₂	Length of bonded thread
min c	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	diameter of tension anchor
l_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section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

EFCO Injection System TILCA TIM DIAMANT 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) Hollow drilling (HDB)	< 25 mm	$30 \text{ mm} + 0,06 \cdot l_v \geq 2 \phi$	$30 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
	$\geq 25 \text{ mm}$	$40 \text{ mm} + 0,06 \cdot l_v \geq 2 \phi$	$40 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
Compressed air drilling (CD)	< 25 mm	$50 \text{ mm} + 0,08 \cdot l_v$	$50 \text{ mm} + 0,02 \cdot l_v$
	$\geq 25 \text{ mm}$	$60 \text{ mm} + 0,08 \cdot l_v$	$60 \text{ mm} + 0,02 \cdot l_v$
Diamond coring (DD)	< 25 mm	Drill stand used as drilling aid	$30 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$
	$\geq 25 \text{ mm}$		$40 \text{ mm} + 0,02 \cdot l_v \geq 2 \phi$

¹⁾ see Annex B 2, Figure B1 and Annex B 3, Figures B2
Comments: The minimum concrete cover acc. EN 1992-1-1:2004+AC:2010 must be observed

Table B2: Bore hole diameter and maximum embedment depth $l_{v,max}$

Bar size Φ rebar	Bar size Φ tension anchor ZA	Drill bit - Ø			Cartridge: side-by-side (385, 444, 585, 999, 1400 ml)				Cartridge: side-by-side (999, 1400 ml)		
					Hand or battery tool		Pneumatic tool		Pneumatic tool		
		HD + HDB	CD	DD	l _{v,max}	Mixer extension	l _{v,max}	Mixer extension	l _{v,max}	Mixer extension	
(mm)	(mm)	(mm)			(mm)		(mm)		(mm)		
8		12	-	12	700	MV-C 10/0,75	800	MV-C 10/0,75	800	MV-C 10/0,75	
10		14	-	14			1000		1000		
12	M12	16							1200	1200	MV-C 16/1,8
14		18								1400	
16	M16	20								1600	
20	M20	25	26	25	700		2000				
22		28			500						
24		32									
25	M24	32									
28		35									
32		40			-	500					
34		40									
36		45									
40		55	55	52							

EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended use
Minimum concrete cover
Maximum embedment depth






Annex B 4

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

Concrete temperature	Gelling- / working time ¹⁾	Minimum curing time in dry concrete	Minimum curing time in wet concrete
	t_{gel}	$t_{cure,dry}$	$t_{cure,wet}$
$\geq + 5\text{ °C}$	120 min	50 h	100 h
$\geq + 10\text{ °C}$	90 min	30 h	60 h
$\geq + 20\text{ °C}$	30 min	10 h	20 h
$\geq + 30\text{ °C}$	20 min	6 h	12 h
$\geq + 40\text{ °C}$	12 min	4 h	8 h

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

Table B4: Dispensing tools

Cartridge type/size	Hand tool		Pneumatic tool
Side-by-side cartridges 385, 444, 585 ml	 e.g. SA 296C585	 e.g. Type H 244 C	 e.g. Type TS 444 KX
Side-by-side cartridge 999 ml	-	-	 e.g. Type TS 4104
Side-by-side cartridge 1400 ml	-	-	 e.g. Type TS 471

All cartridges could also be extruded by a battery tool.

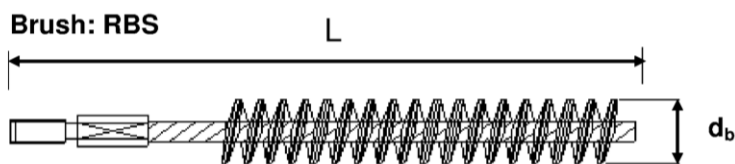
EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended use
Working time and curing times
Dispensing tools

Annex B 5

Table B5: Installation tools

Bar size Ø rebar	Bar size Ø tension anchor ZA	Drill and clean						Installation			
		Drill bit - Ø			Brush		min Brush - Ø	Air Nozzle	Piston plug	Mixer extension	Max embedment depth
		HD + HDB	CD	DD	RBS	d _b	d _{b,min}				l _v or l _{e,ges}
[mm]	[mm]	[mm]			[mm]	[mm]	[mm]	RD	IA-C	MV-C	[mm]
8		12	-	12	12	14	12,5	12/14	-	MV-C 10/0,75 oder MV-C 16/1,8	800
10		14	-	14	14	16	14,5		14		1000
12	M12	16			16	18	16,5	16/18	16		1200
14		18			18	20	18,5		18		1400
16	M16	20			20	22	20,5	20/25	20		1600
20	M20	25	-	25	25	27	25,5		25		2000
		-	26	-	25	27	26,5		25		2000
22		28			28	30	28,5		28		2000
24		32			32	34	32,5	30/35	32		2000
25	M24	32			32	34	32,5		32		2000
28		35			35	37	35,5		35		2000
32		40			40	42	40,5		40		2000
34		40			40	42	40,5	40	2000		
36		45			45	47	45,5	40	45		2000
40		-	-	52	52	54	52,5		52		2000
		55	55	-	55	58	55,5		55		2000



SDS Plus Adapter: RBS-A



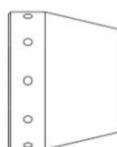
Rec. compressed air tool
hand slide valve (min 6 bar)



Hand pump (volume 750 ml)



Air nozzle AN: RD



Brush extension: RBS-L

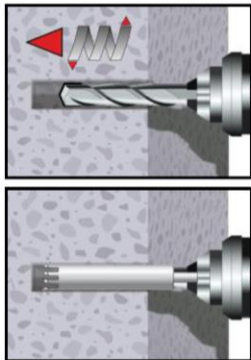


EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended use
Installation tools

Annex B 6

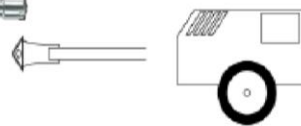
1) Bore hole drilling



1. Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar with carbide hammer drill (HD) hollow drill (HDB), a compressed air drill (CD) or diamond core (DD). In case of aborted drill hole: the drill hole shall be filled with mortar. Drill bit sizes see Table B5.



Hammer drilling (HD)
Hollow drilling (HDB)



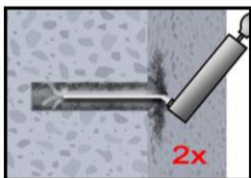
Compressed air drilling (CD)



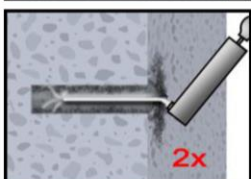
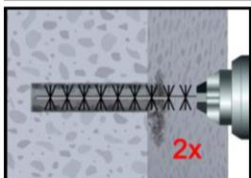
Diamond coring (DD)

2a) Bore hole cleaning (HD, HDB and CD)

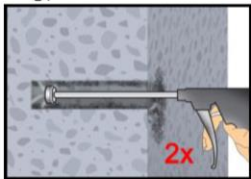
Attention! Standing water in the bore hole must be removed before cleaning.



or



or



- 2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) or a hand pump a minimum of two times. If the bore hole ground is not reached an extension shall be used.

For bore holes deeper than 240 mm, compressed air (min. 6 bar **must** be used. For bore holes larger than 32 mm, compressed air (min. 6 bar) and the appropriate air nozzle (see Table B5) **must** be used.

- 2b. Check brush diameter (Table B5) and attach the brush to a drilling machine or a battery screwdriver. 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.

Safety information:

Only switch on the drill after inserting the brush into the borehole.
Start brushing out with the machine carefully and slowly turning.
Always turn the machine clockwise

- 2c. Finally blow the hole clean again with compressed air (min. 6 bar) or a hand pump a minimum of two times. If the bore hole ground is not reached an extension shall be used.

For bore holes deeper than 240 mm, compressed air (min. 6 bar **must** be used. For bore holes larger than 32 mm, compressed air (min. 6 bar) and the appropriate air nozzle (see Table B5) **must** 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.

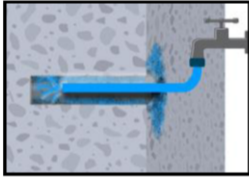
EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended use

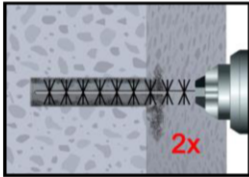
Installation instruction: Bore hole drilling and cleaning (HD, HDB and CD)

Annex B 7

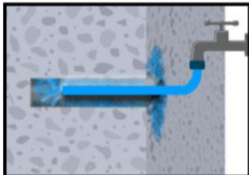
2b) Bore hole cleaning (DD)



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

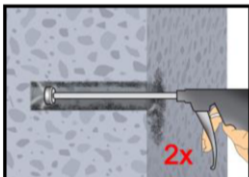


2b. Check brush diameter acc. Table B5 and attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B5) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension shall be used (Table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

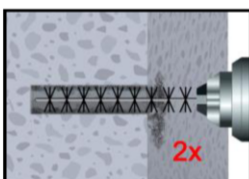


2c. Rinsing again with water until clear water comes out.

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



2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) with the appropriate air nozzle (see Table B5) a minimum of two times. If the bore hole ground is not reached an extension shall be used.



2e. Check brush diameter (Table B5) and attach the brush to a drilling machine or a battery screwdriver. 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.



2f. Finally blow the hole clean again with compressed air (min. 6 bar) with the appropriate air nozzle (see Table B5) a minimum of two times. 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.

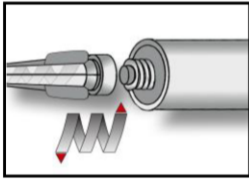
EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended Use

Installation instruction: Bore hole cleaning (DD)

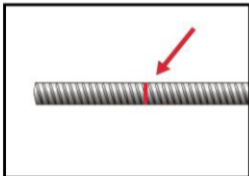
Annex B 8

3) Preparation of bar and cartridge



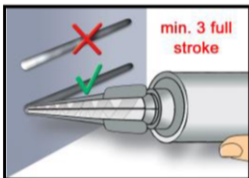
3a. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.

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.



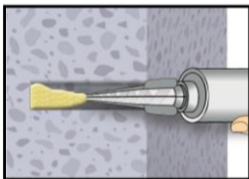
3b. Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar and insert bar in empty hole to verify hole and depth ℓ_v .

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

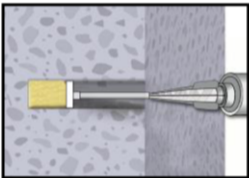


3c. Prior to dispensing into the anchor hole, squeeze out separately the mortar until it shows a consistent grey or red colour, but a minimum of three full strokes, and discard non-uniformly mixed adhesive components.

4) Filling the bore hole

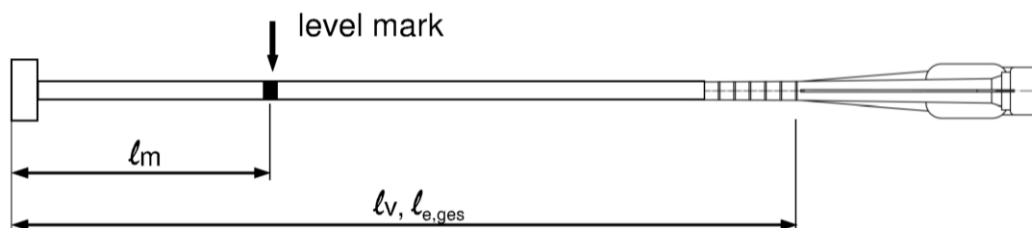


4. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used.



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

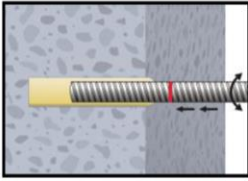
EFCO Injection System TILCA TIM DIAMANT for rebar connection

Intended Use

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

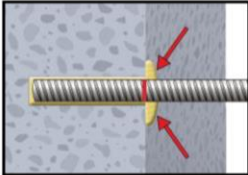
Annex B 9

5) Setting the rebar

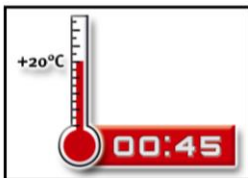


- 5a. Push the reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

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). It is not allowed to move the bar after gelling time t_{gel} has elapsed. Allow the adhesive to cure to the specified time prior to applying any load. Do not move or load the bar until it is fully cured (attend Table B3). After full curing time t_{cure} has elapsed, the add-on part can be installed.

EFCO Injection System TILCA TIM DIAMANT 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	Hammer drilling (HD), Hollow drilling (HDB) and compressed air drilling (CD)	8 mm to 32 mm ZA-M12 to ZA-M24	1,0
C12/15 to C50/60	Hammer drilling (HD), Hollow drilling (HDB) and compressed air drilling (CD)	> 32 mm	1,5
C12/15 to C50/60	Diamond coring (DD)	8 mm to 40 mm ZA-M12 to ZA-M24	1,5

Table C2: Design values of the ultimate bond stress f_{bd} in N/mm² for hammer drilling (HD), hollow drilling (HDB) and compressed air drilling (CD) methods for good conditions

according to EN 1992-1-1:2004+AC:2010 for good bond conditions
(for all other bond conditions multiply the values by 0.7)

Rebar - Ø	Concrete class								
Ø	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

Table C3: Design values of the ultimate bond stress f_{bd} in N/mm² for Diamond coring (DD) method for good conditions

according to EN 1992-1-1:2004+AC:2010 for good bond conditions
(for all other bond conditions multiply the values by 0.7)

Rebar - Ø	Concrete class								
φ	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 28 mm ZA-M12 to ZA-M24	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
32 mm	1,6	2,0	2,3	2,7					
34 mm	1,6	2,0	2,3	2,6					
36 mm	1,5	1,9	2,2	2,6					
40 mm	1,5	1,8	2,1	2,5					

EFCO Injection System TILCA TIM DIAMANT for rebar connection

Performances

Amplification factor

Design values of ultimate bond resistance f_{bd}

Annex C 1

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

The design value of the bond strength $f_{bd,fi}$ under fire exposure has to be calculated by the following equation:

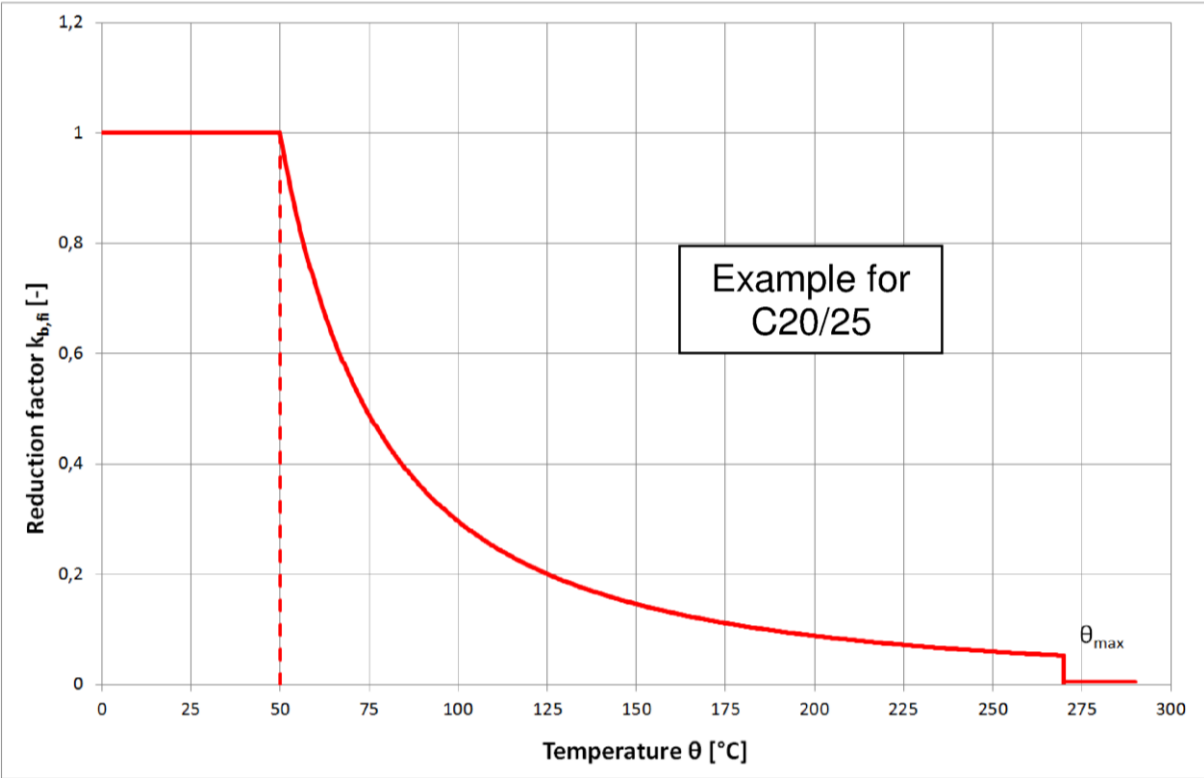
$$f_{bd,fi} = k_{b,fi}(\theta) \cdot f_{bd} \cdot \gamma_c / \gamma_{M,fi}$$

with: $\theta \leq 270^{\circ}\text{C}$: $k_{b,fi}(\theta) = 9221,2 \cdot \theta^{-1,747} / (f_{bd} \cdot 4,3) \leq 1,0$
 $\theta > 270^{\circ}\text{C}$: $k_{b,fi}(\theta) = 0$

- $f_{bd,fi}$ Design value of the ultimate bond stress in case of fire in N/mm²
- θ Temperature in °C in the mortar layer.
- $k_{b,fi}(\theta)$ Reduction factor under fire exposure.
- f_{bd} Design value of the ultimate bond stress in N/mm² in cold condition according to Table C2 or C3 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1.
- γ_c partially safety factor according to EN 1992-1-1
- $\gamma_{M,fi}$ partially safety 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 ultimate bond stress $f_{bd,fi}$.

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



EFCO Injection System TILCA TIM DIAMANT for rebar connection

Performances

Design value of bond strength $f_{bd,fi}$ under fire exposure

Annex C 2

Table C4: 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

EFCO Injection System TILCA TIM DIAMANT for rebar connection

Performances

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

Annex C 3