Deutsches Institut für Bautechnik

Member of EOTA
www.eota.eu

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment

ETA-13/0317 of 24 November 2017

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	SYMPAFIX Injection system X150-PLUS for rebar connection
Product family to which the construction product belongs	Injection system for post-installed rebar connections
Manufacturer	Sympafix BV Fluorietweg 25E 1812RR ALKMAAR NIEDERLANDE
Manufacturing plant	Sympafix, 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-13/0317 issued on 24 April 2013

Deutsches Institut für Bautechnik
Kolonnenstraße 30 B | 10829 Berlin | GERMANY | Phone: +49 30 78730-0 | Fax: +49 30 78730-320 | Email: dibt@dibt.de | www.dibt.de

The European Technical Assessment is issued by the Technical Assessment Body in its official language. Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and shall be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may only be made with the written consent of the issuing Technical Assessment Body. Any partial reproduction shall be identified as such.

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No 305/2011.

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 "SYMPAFIX Injection system X150-PLUS 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 X150-PLUS 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 24 November 2017 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Baderschneider

Deutsches Institut für Bautechnik DIBt

Installation post installed rebar

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

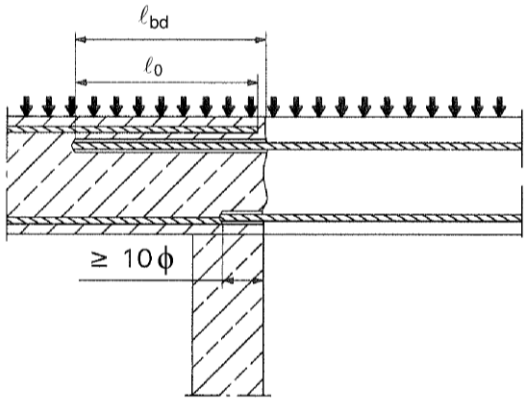


Figure A2: Overlapping joint at a foundation of a wall or column where the rebars are stressed in tension

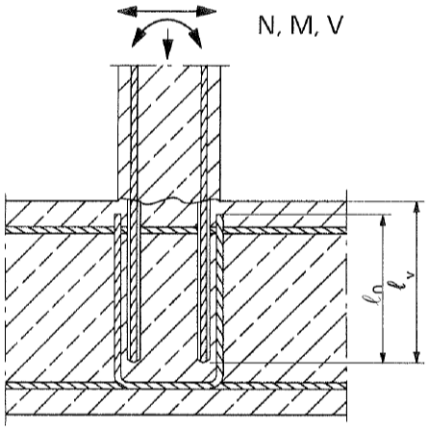


Figure A3: End anchoring of slabs or beams (e.g. designed as simply supported)

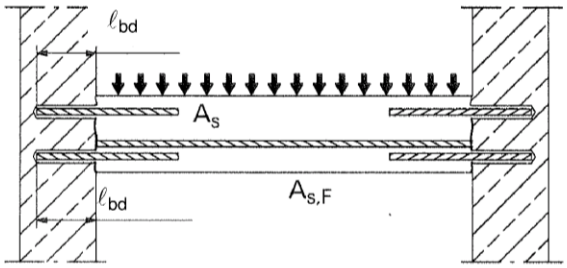


Figure A4: Rebar connection for components stressed primarily in compression. The rebars sre stressed in compression

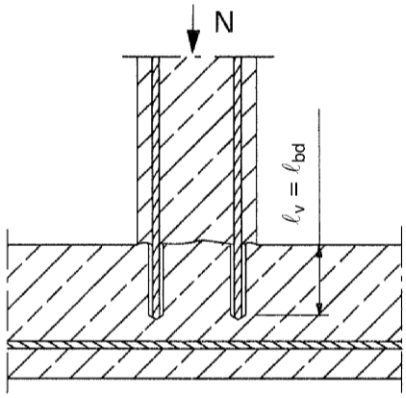
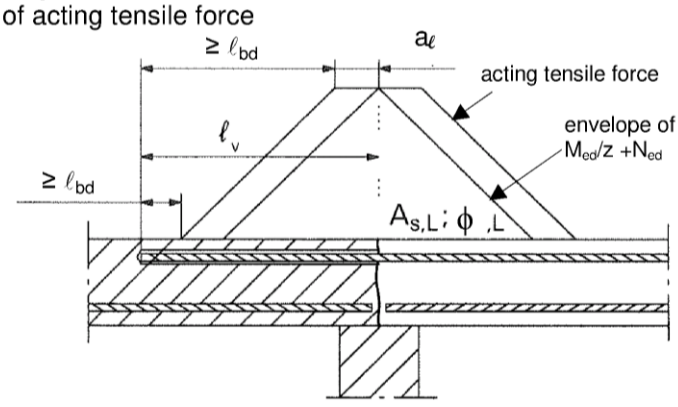


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force



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

SYMPAFIX Injection system X150-PLUS for rebar connection	**Annex A 1**
Product description Installed condition and examples of use for rebars	

Deutsches Institut für Bautechnik DIBt

Installation tension anchor ZA

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

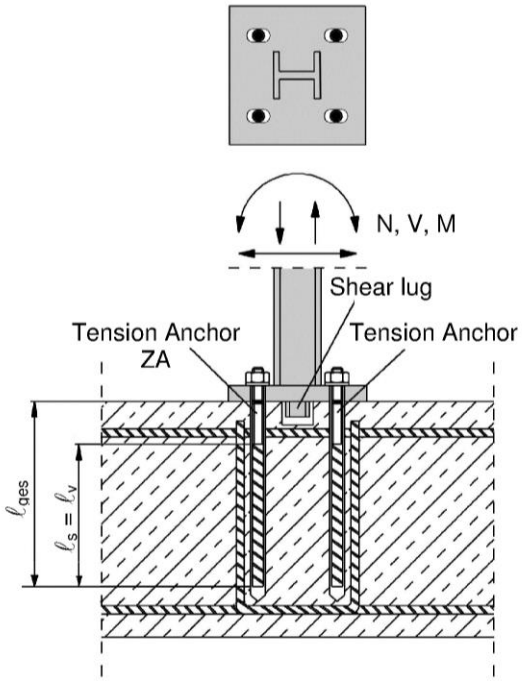


Figure A7: Overlap joint for the anchorage of barrier posts

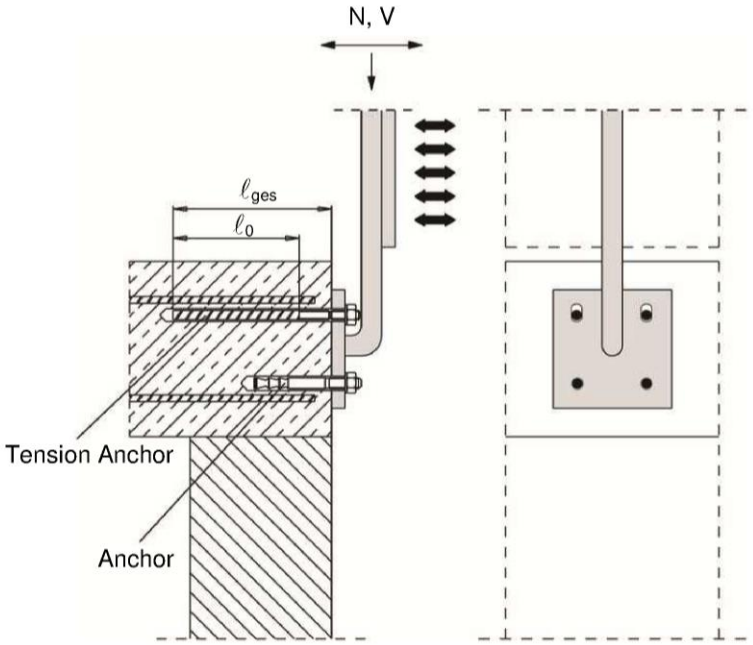
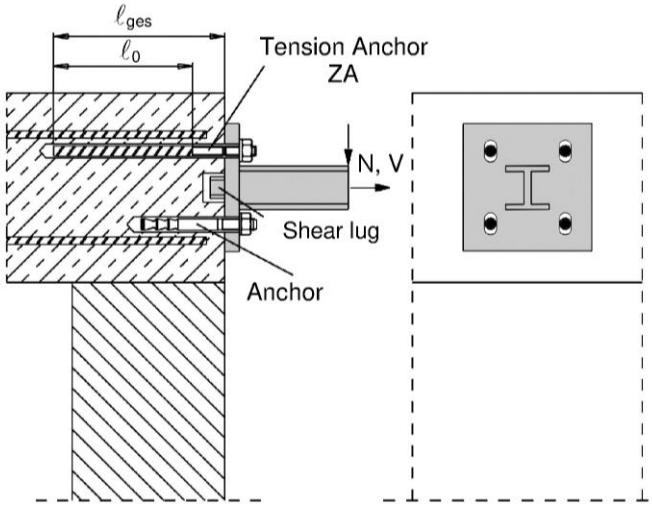


Figure A8: Overlap joint for the anchorage to centilever members



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

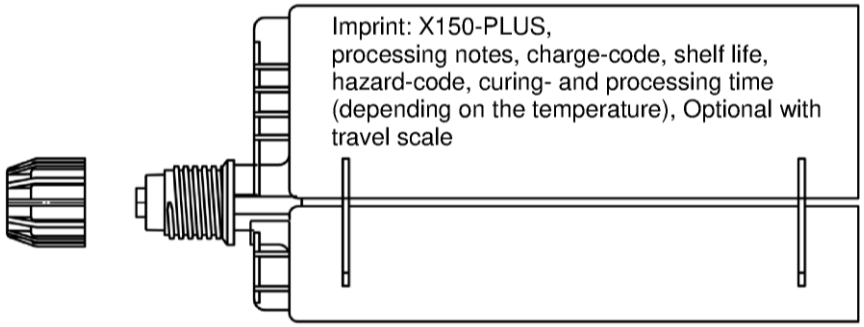
SYMPAFIX Injection system X150-PLUS for rebar connection	Annex A 2
Product description Installed condition and examples of use for tension anchors ZA	

Deutsches Institut für Bautechnik DIBt

SYMPAFIX Injection system X150-PLUS:

Injection mortar: X150-PLUS

Type "side-by-side":
385 ml, 444ml, 585 ml, 999 ml and 1400 ml



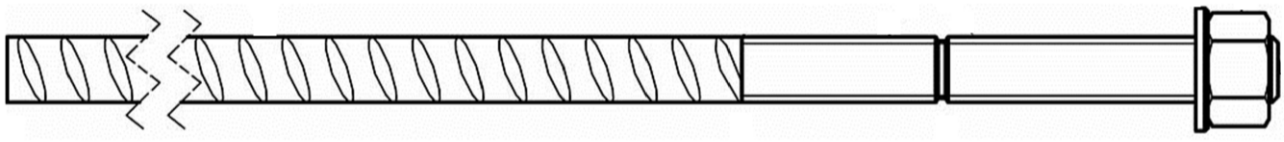
Static Mixer

TAH 18W

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



SYMPAFIX Injection system X150-PLUS for rebar connection

Product description
Injection mortar / Static mixer / Rebar / Tension Anchor ZA

Annex A 3

Deutsches Institut für Bautechnik DIBt

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

- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range $0{,}05\phi \le h \le 0{,}07\phi$
  (ϕ: Nominal diameter of the bar; h: Rip 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 $f_{uk} = f_{tk} = k \cdot f_{yk}$

SYMPAFIX Injection system X150-PLUS for rebar connection

Product description
Materials Rebar

Annex A 4

Deutsches Institut für Bautechnik DIBt

Tension Anchor ZA: M12, M16, M20, M24

Marking: e.g. ◇ ZA 12 A4

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

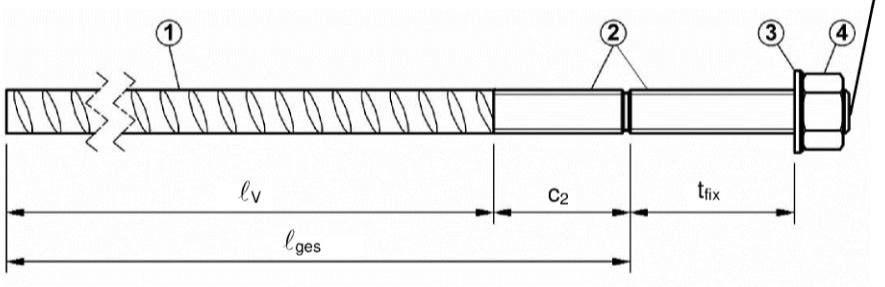


Table A2: Materials

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 $f_{uk} = f_{tk} = k \cdot f_{yk}$											
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/mm²]	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			[mm]	12	16	20	24
Diameter of reinforcement bar			[mm]	12	16	20	25
With across nut flats		SW	[mm]	19	24	30	36
Stress area		A_s	[mm²]	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

SYMPAFIX Injection system X150-PLUS for rebar connection

Product description
Specifications Tension Anchor ZA

Annex A 5

Deutsches Institut für Bautechnik DIBt

Specifications of intended use

Anchorages 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 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 1992-1-1:2004+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:

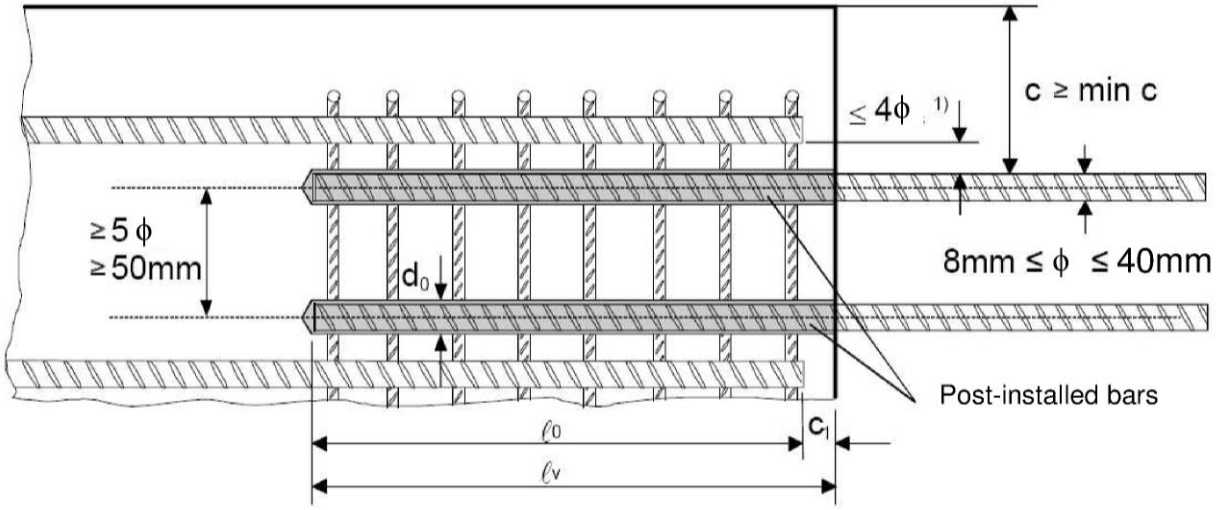
- Dry or wet concrete.
- It must not be installed in flooded holes.
- Hole drilling by hammer drill (HD), hollow drill (HDB), compressed air drill (CD) or diamond drill mode (DD).
- The installation of post-installed rebar resp. tension anchors shall be done only by suitable trained installer and under 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).

SYMPAFIX Injection system X150-PLUS for rebar connection	**Annex B 1**
Intended use Specifications	

Deutsches Institut für Bautechnik DIBt

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, ≥ $\ell_0 + c_1$
d_0	nominal drill bit diameter, see Annex B 4

SYMPAFIX Injection system X150-PLUS for rebar connection

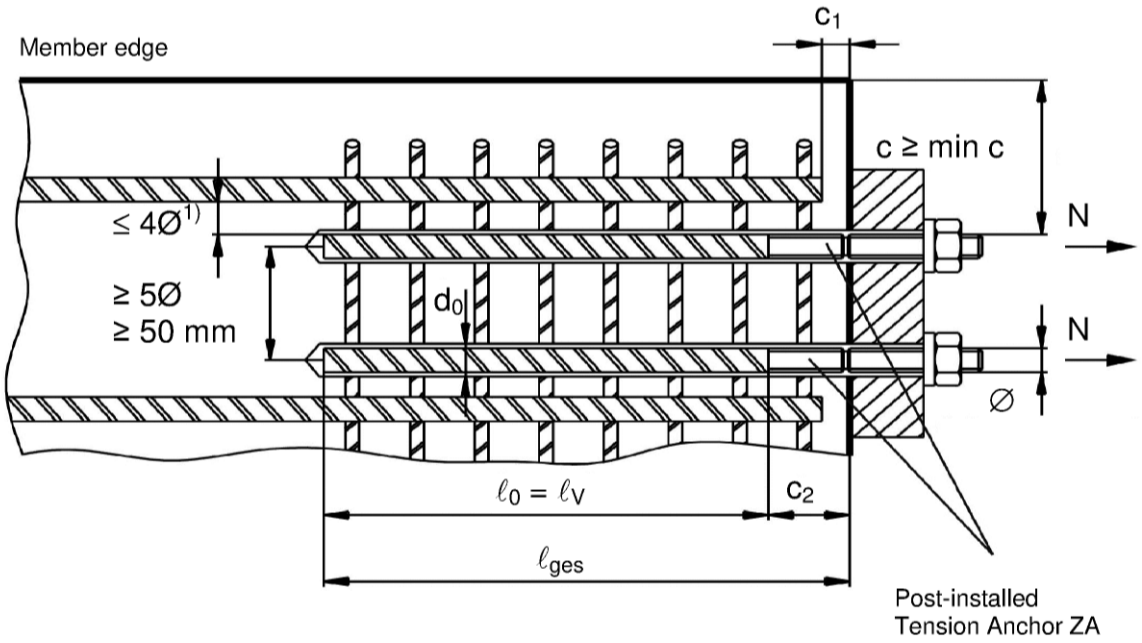
Intended use
General construction rules for post-installed rebars

Annex B 2

Deutsches Institut für Bautechnik DIBt

Figure B2: General construction rules for tension anchors ZA

- The length of the bonded-in thread may be 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.

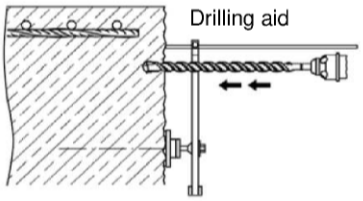
The following applies to Figure B2:

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, ≥ $\ell_0 + c_1$
ℓ_{ges}	overall embedment depth, ≥ $\ell_0 + c_2$
d_0	nominal drill bit diameter, see Annex B 4

SYMPAFIX Injection system X150-PLUS for rebar connection	Annex B 3
Intended use General construction rules for tension anchors	

Deutsches Institut für Bautechnik DIBt

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 mm + 0,06 · ℓ_v ≥ 2 ϕ	30 mm + 0,02 · ℓ_v ≥ 2 ϕ
	≥ 25 mm	40 mm + 0,06 · ℓ_v ≥ 2 ϕ	40 mm + 0,02 · ℓ_v ≥ 2 ϕ
Compressed air drilling (CD)	< 25 mm	50 mm + 0,08 · ℓ_v	50 mm + 0,02 · ℓ_v
	≥ 25 mm	60 mm + 0,08 · ℓ_v	60 mm + 0,02 · ℓ_v
Diamond coring (DD)	< 25 mm	Drill stand used as drilling aid	30 mm + 0,02 · ℓ_v ≥ 2 ϕ
	≥ 25 mm		40 mm + 0,02 · ℓ_v ≥ 2 ϕ

[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: Bore hole diameter and maximum embedment depth $\ell_{v,max}$

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	VL 10/0,75	800	VL 10/0,75	800	VL 10/0,75
10		14	-	14			1000		1000	
12	M12	16							1200	VL 16/1,8
14		18							1400	
16	M16	20							1600	
20	M20	25	26	25	500		700		2000	
22		28								
24		32					500			
25	M24	32								
28		35								
32		40			-					
34		40								
36		45								
40		55	55	52						

SYMPAFIX Injection system X150-PLUS for rebar connection

Intended use
Minimum concrete cover
Maximum embedment depth

Annex B 4

Deutsches Institut für Bautechnik DIBt

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}	$t_{cure,dry}$	$t_{cure,wet}$
≥ 5 °C	120 min	50 h	100 h
≥ + 10 °C	90 min	30 h	60 h
≥ + 20 °C	30 min	10 h	20 h
≥ + 30 °C	20 min	6 h	12 h
≥ + 40 °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.

SYMPAFIX Injection system X150-PLUS for rebar connection

Intended use
Working time and curing times
Dispensing tools

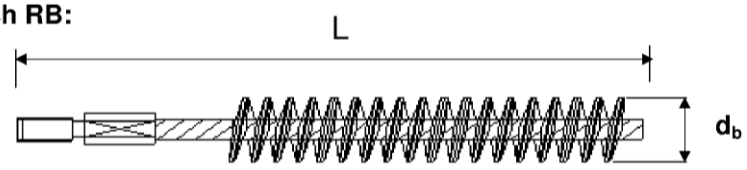
Annex B 5

Deutsches Institut für Bautechnik DIBt

Table B5: Installation tools

Bar size Φ rebar	Bar size Φ 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		d_b	$d_{b,min}$				l_v or $l_{e,ges}$
[mm]	[mm]	[mm]				[mm]	[mm]	AN	VS	VL	[mm]
8		12	-	12	RBT12	14	12,5	10	-	VL 10/0,75 or VL 16/1,8	800
10		14	-	14	RBT14	16	14,5		VS14		1000
12	M12	16			RBT16	18	16,5	14	VS16		1200
14		18			RBT18	20	18,5		VS18		1400
16	M16	20			RBT20	22	20,5	17	VS20		1600
20	M20	25	-	25	RBT25	27	25,5		VS25		2000
		-	26	-	RBT25	27	26,5		VS25		2000
22		28			RBT28	30	28,5	27	VS28		2000
24		32			RBT32	34	32,5		VS32		2000
25	M24	32			RBT32	34	32,5		VS32		2000
28		35			RBT35	37	35,5		VS35		2000
32		40			RBT40	42	40,5		VS40		2000
34		40			RBT40	42	40,5		VS40		2000
36		45			RBT45	47	45,5	40	VS45		2000
40		-	-	52	RBT52	54	52,5		VS52		2000
		55	55	-	RBT55	58	55,5		VS55		2000

Brush RB:

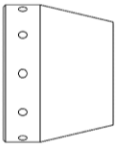


SDS Plus Adapter:

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

Hand pump (volume 750 ml)

Air nozzle AN:



Brush extension:

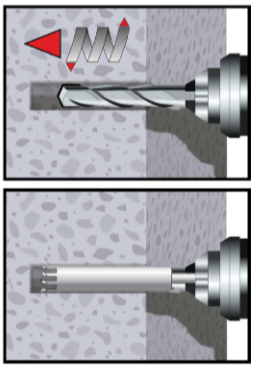
SYMPAFIX Injection system X150-PLUS for rebar connection

Intended use
Installation tools

Annex B 6

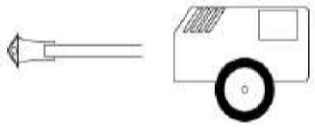
Deutsches Institut für Bautechnik DIBt

1) Bore hole drilling

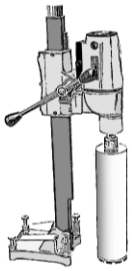


1. Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar with carbide hammer drill (HD) hollow drill (HDB), a compressed air drill (CD) or diamond core (DD). In case of aborted drill hole: the drill hole shall be filled with mortar. Drill bit sizes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

Hammer drilling (HD)
Hollow drilling (HDB)



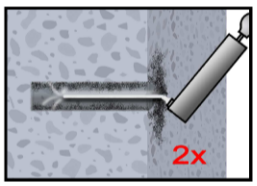
Compressed air drilling (CD)



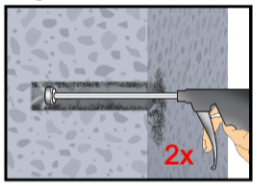
Diamond coring (DD)

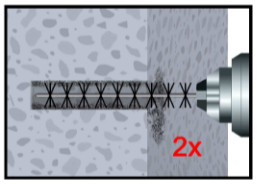
2a) Bore hole cleaning (HD, HDB and CD)

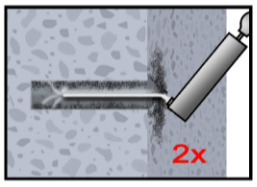
Attention! Standing water in the bore hole must be removed before cleaning.



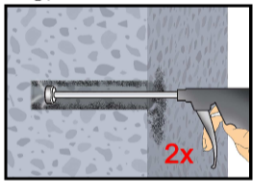
or







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.

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.

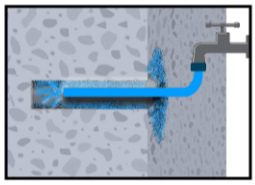
For bore holes deeper than 240 mm, compressed air (min. 6 bar **must** be used. For bore holes larger than 32 mm, compressed air (min. 6 bar) and the appropriate air nozzle (see Table B5) **must** be used.

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.

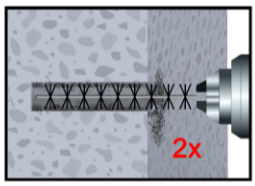
SYMPAFIX Injection system X150-PLUS for rebar connection	**Annex B 7**
Intended use Installation instruction: Bore hole drilling and cleaning (HD, HDB and CD)	

Deutsches Institut für Bautechnik DIBt

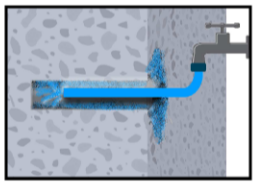
2b) Bore hole cleaning (DD)



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

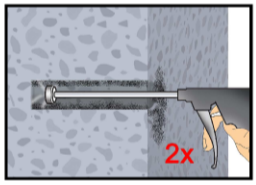


2b. Check brush diameter acc. Table B5 and attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B5) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension shall be used (Table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

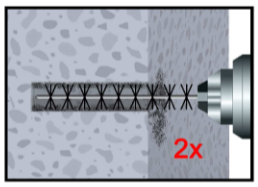


2c. Rinsing again with water until clear water comes out.

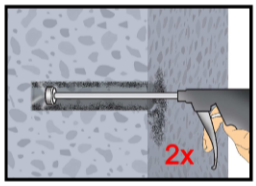
Attention! Standing water in the bore hole must be removed before cleaning.



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.



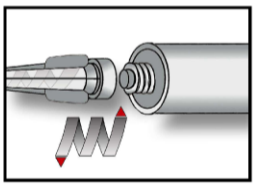
2f. Finally blow the hole clean again with compressed air (min. 6 bar) with the appropriate air nozzle (see Table B5) a minimum of two times. If the bore hole ground is not reached an extension shall be used.

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.

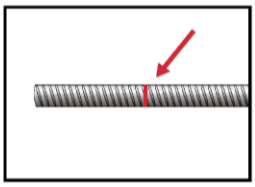
SYMPAFIX Injection system X150-PLUS for rebar connection	**Annex B 8**
Intended Use Installation instruction: Bore hole cleaning (DD)	

Deutsches Institut für Bautechnik DIBt

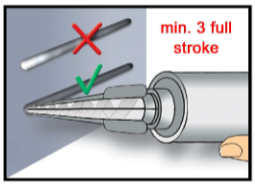
3) Preparation of bar and cartridge



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.

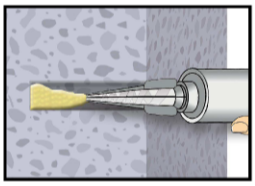


3b. Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar and insert bar in empty hole to verify hole and depth ℓ_v.
The anchor should be free of dirt, grease, oil or other foreign material.

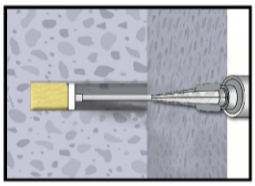


3c. Prior to dipensing into the anchor hole, squeeze out separately the mortar until it shows a consistent grey or red colour, but a minimum of three full strokes, and discard non-uniformly mixed adhesive components.

4) Filling the bore hole

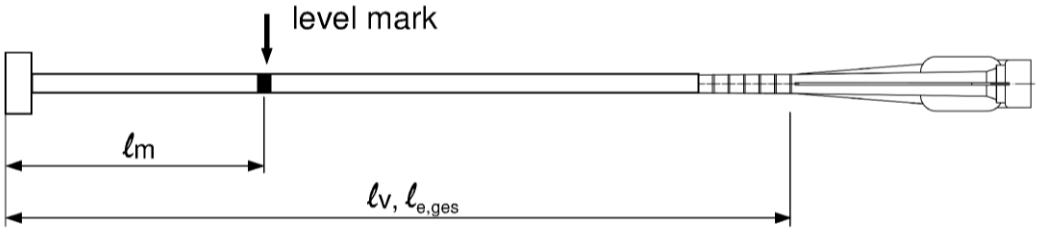


4. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used.



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

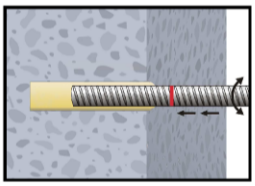
SYMPAFIX Injection system X150-PLUS for rebar connection

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

Annex B 9

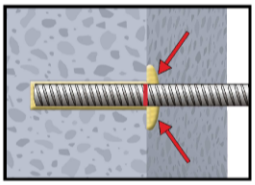
Deutsches Institut für Bautechnik DIBt

5) Setting the rebar

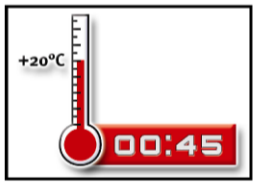


5a. Push the reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

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 geling 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 $\mathbf{t_{cure}}$ has elapsed, the add-on part can be installed.

SYMPAFIX Injection system X150-PLUS for rebar connection	Annex B 10
Intended Use Installation instruction: Inserting rebar	

Deutsches Institut für Bautechnik DIBt

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 bis 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 bis 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								
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 bis 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 bis 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					

SYMPAFIX Injection system X150-PLUS for rebar connection

Performances
Amplification factor
Design values of ultimate bond resistance f_{bd}

Annex C 1

Deutsches Institut für Bautechnik DIBt

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:

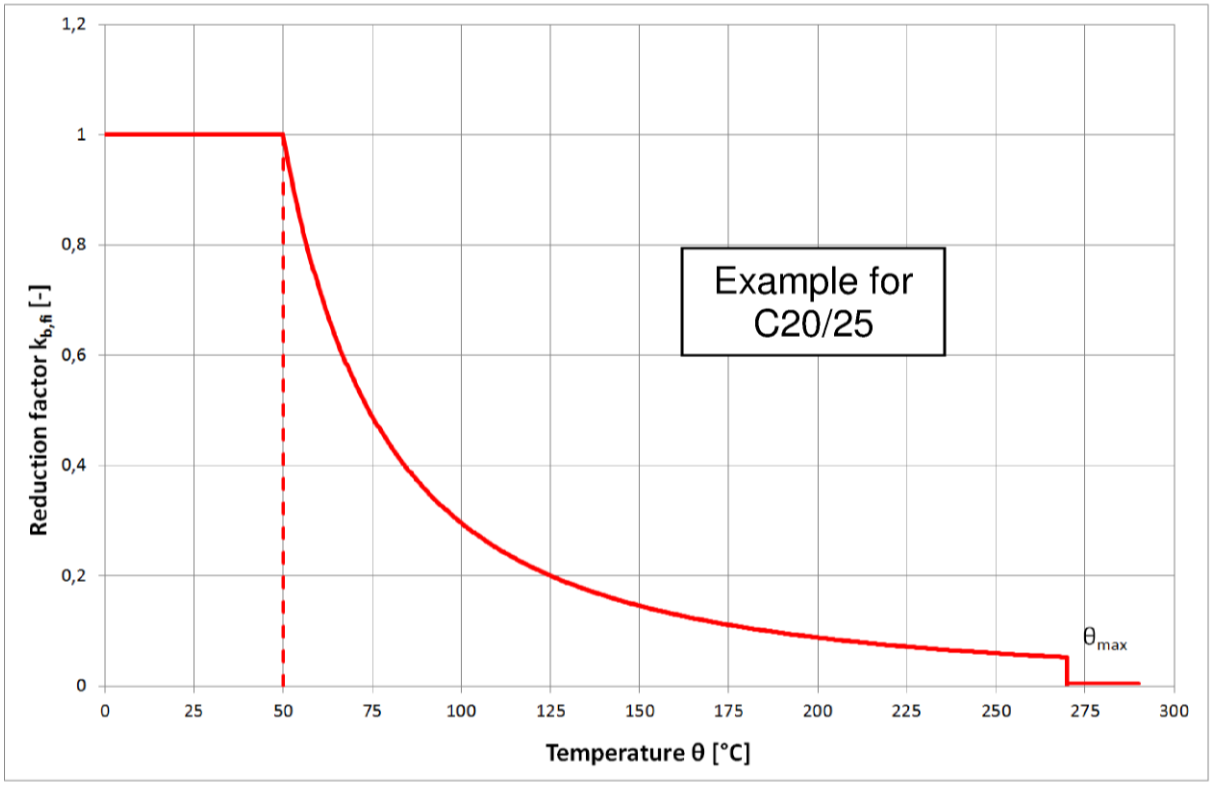
$$f_{bd,fi} = k_{b,fi}(\theta) \cdot f_{bd} \cdot \gamma_c / \gamma_{M,fi}$$

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

$f_{bd,fi}$	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:



SYMPAFIX Injection system X150-PLUS for rebar connection

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

Annex C 2

Deutsches Institut für Bautechnik DIBt

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

SYMPAFIX Injection system X150-PLUS for rebar connection

Performances

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

Annex C 3