Deutsches Institut für Bautechnik DIBt

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European Technical Assessment Body for construction products

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

European Technical Assessment ETA-19/0671 of 30 April 2024

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	Injection System VME plus for rebar connection
Product family to which the construction product belongs	Systems for post-installed rebar connections with mortar
Manufacturer	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND
Manufacturing plant	Werk 1, D Werk 2, D
This European Technical Assessment contains	26 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 330087-01-0601, Edition 06/2021
This version replaces	ETA-19/0671 issued on 10 December 2019

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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 "Injection system VME 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 of sizes M12 to M24 according to Annex A and injection mortar VME 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 rebar connection 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 connections of at least 50 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product 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 and C 2
Characteristic resistance under seismic loading	See Annex B 5 and C 3

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 4 to C 5

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. 330087-01-0601, the applicable European legal act is: [96/582/EC].

The system to be applied is: 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.

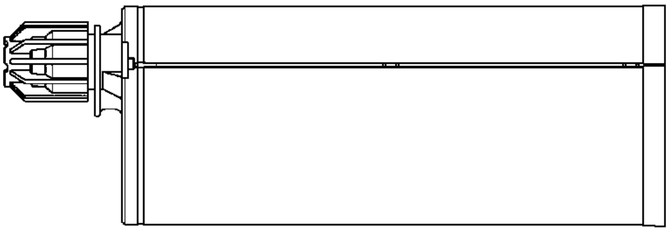
Issued in Berlin on 30 April 2024 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

Cartridge: Injection Mortar VME plus

Side-by-side cartridge
440 ml,
585 ml,
1400 ml

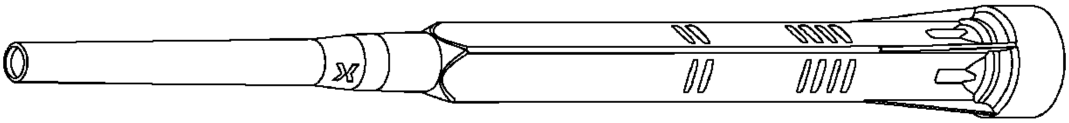


Imprint:

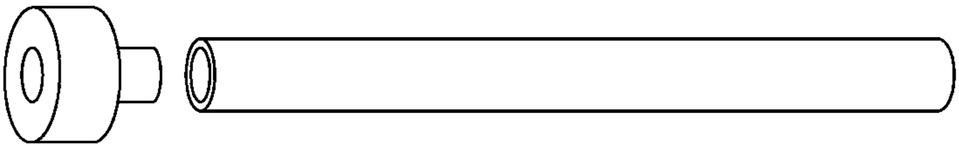
VME plus

VME plus, processing notes, charge-code, shelf life, hazard-code, storage temperature, curing- and working time (depending on the temperature), optional with travel scale

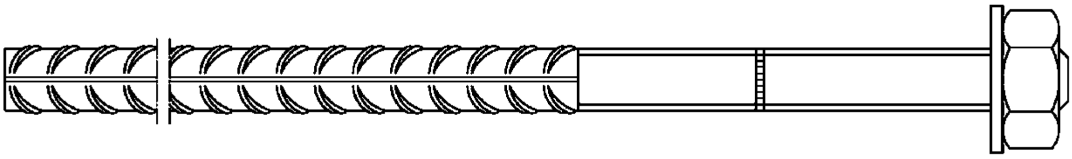
Static mixer VM-XHP



Retaining washer with extension pipe



Tension Anchor ZA: M12, M16, M20, M24



Reinforcing bar: Ø8, Ø10, Ø12, Ø14, Ø16, Ø20, Ø22, Ø24, Ø25, Ø28, Ø32, Ø34, Ø36, Ø40

Injection System VME plus for rebar connections	**Annex A1**
Product description Cartridge / Static mixer / Retaining washer + extension pipe / Tension anchor / Reinforcing bar	

Application examples reinforcing bar

Figure A1: Overlap joint in slabs and beams

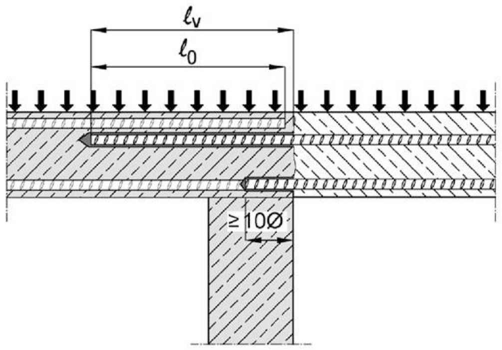


Figure A2: Overlap joint in a foundation of a column or wall where the rebars are stressed in tension

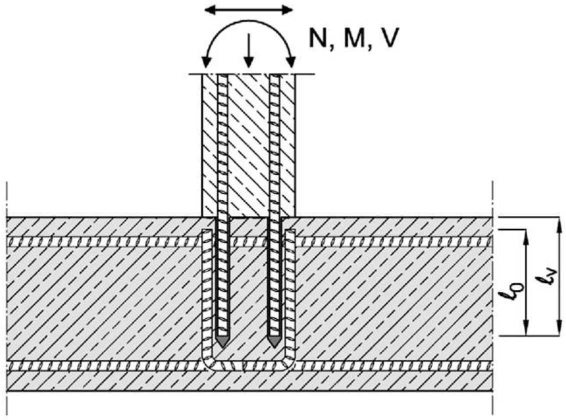


Figure A3: End anchoring of slabs or beams, designed as simply supported

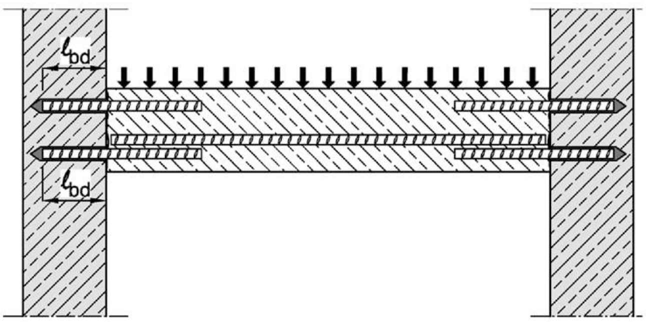


Figure A4: Rebar connection of components stressed primarily in compression.

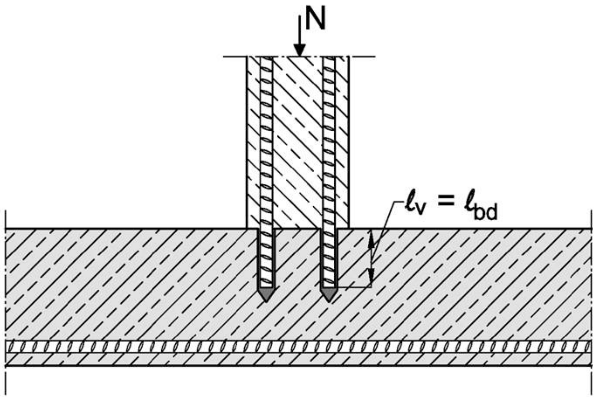
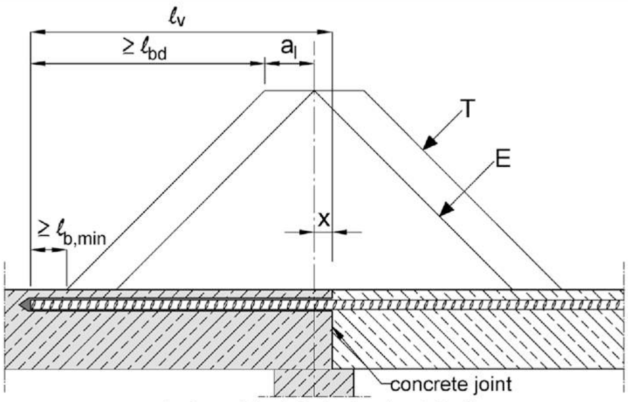


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force



(only post-installed rebar is plotted)

Note to Figure A1 to A5

No transverse reinforcement acc. to EN 1992-1-1:2011 is pictured.
The shear transfer between old and new concrete shall be designed according to EN 1992-1-1:2011 .
Notations and definitions of anchorages and overlap joints see Annex B3.

Figure A5:

T= acting tensile force
E= envelope of $M_{Ed}/Z + N_{Ed}$
(see EN 1992-1-1:2011, Figure 9.2)
x= distance between the theoretical point of support and concrete joint

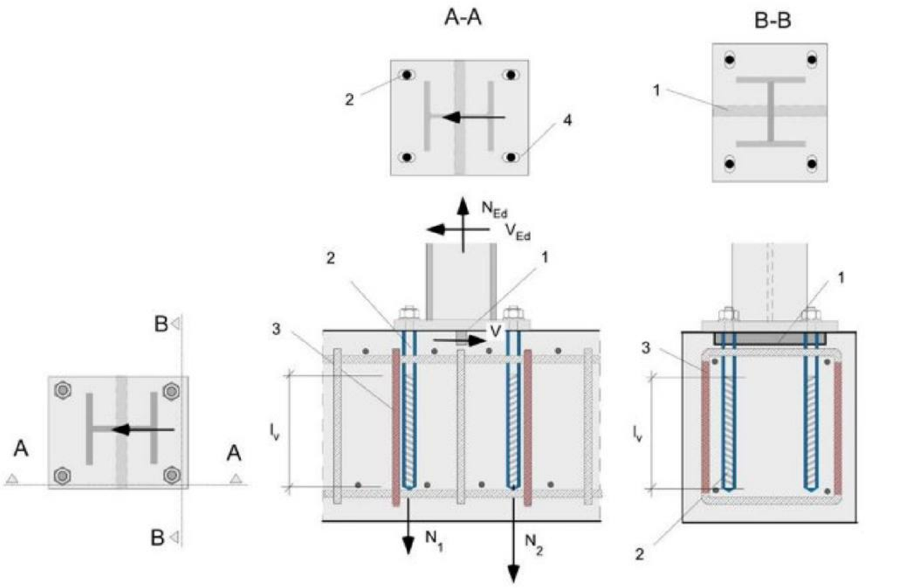
Injection System VME plus for rebar connections

Product description
Application examples for post-installed rebar

Annex A2

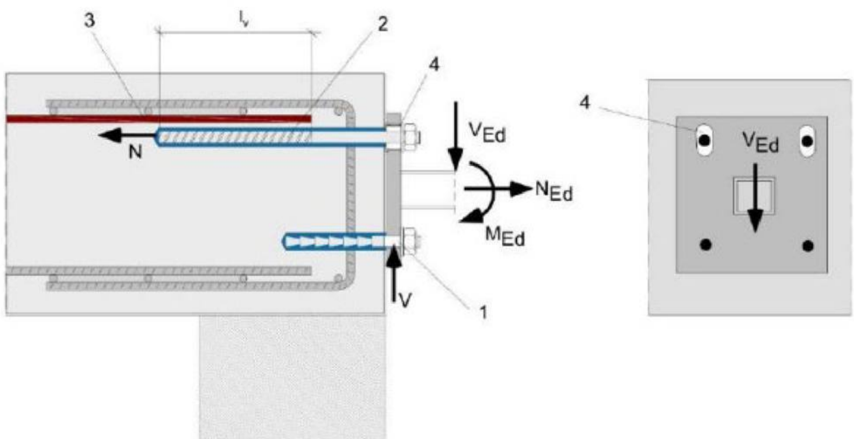
Application examples for tension anchor ZA

Figure A6: Lap to a foundation of a column under bending.



1 Shear lug (or fastener loaded in shear)
2 Tension anchor (tension only)
3 Existing stirrup / reinforcement for overlap (lap splice)
4 Slotted hole

Figure A7: Lap of the anchoring of guardrail posts for anchoring of cantilevered building components. In the anchor plate, the drill holes for the tension anchors have to be designed as slotted holes with axial direction to the shear force.



1 Fastener for shear load transfer
2 Tension anchor (tension only)
3 Existing stirrup / reinforcement for overlap (lap splice)
4 Slotted hole

Note to Figure A6 and A7: The required transverse reinforcement acc. to EN 1992-1-1:2011 is not shown in the figures. The tension anchor may be only used for axial tensile force. The tensile force must be transferred by lap to the existing reinforcement of the building. The transfer of the shear force has to be ensured by suitable measures, e.g. by means of shear force or anchors with European Technical Assessment (ETA). General construction rules see Annex B3.

Injection System VME plus for rebar connections

Product description
Application examples for tension anchor ZA

Annex A3

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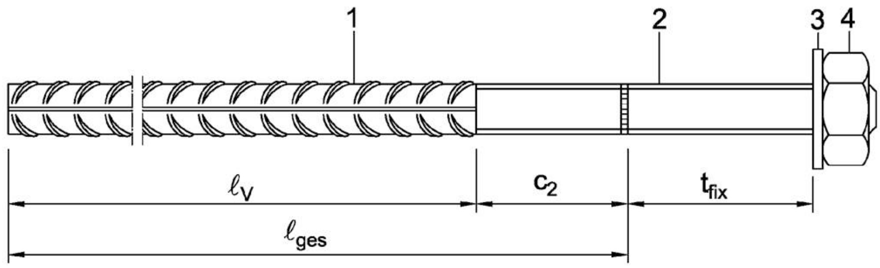
Table A1: Material

<table>
<tr><th>Part</th><th>Description</th><th colspan="12">Material</th></tr>
<tr><td colspan="2" rowspan="2">Tension anchor ZA</td><td colspan="4">ZA vz</td><td colspan="4">ZA A4</td><td colspan="4">ZA HCR</td></tr>
<tr><td>M12</td><td>M16</td><td>M20</td><td>M24</td><td>M12</td><td>M16</td><td>M20</td><td>M24</td><td>M12</td><td>M16</td><td>M20</td><td>M24</td></tr>
<tr><td rowspan="2">1</td><td>Rebar</td><td colspan="12">Class B according to NDP or NCI acc. to EN 1992-1-1/NA
$f_{uk} = f_{tk} = k•f_{yk}$</td></tr>
<tr><td>f_{yk} [N/mm²]</td><td colspan="4">500</td><td colspan="4">500</td><td colspan="4">500</td></tr>
<tr><td rowspan="2">2</td><td>Threaded rod</td><td colspan="4">steel, zinc plated acc. to EN ISO 683-4:2018 or EN 10263:2001</td><td colspan="4">stainless steel, EN 10088-1:2014</td><td colspan="4">high corrosion resistant steel, EN 10088-1:2014</td></tr>
<tr><td>f_{yk} [N/mm²]</td><td colspan="4">640</td><td colspan="3">640</td><td>560</td><td colspan="3">640</td><td>560</td></tr>
<tr><td>3</td><td>Washer</td><td colspan="4">steel, zinc plated</td><td colspan="4">stainless steel</td><td colspan="4">high corrosion resistant steel</td></tr>
<tr><td>4</td><td>Hexagon nut</td><td colspan="4">steel, zinc plated acc. to EN ISO 683-4:2018 or EN 10263:2001</td><td colspan="4">stainless steel, EN 10088-1:2014</td><td colspan="4">high corrosion resistant steel, EN 10088-1:2014</td></tr>
<tr><td colspan="14">Rebar</td></tr>
<tr><td>5</td><td>Rebar acc. EN 1992-1-1:2011, Annex C</td><td colspan="12">Bars and de-coiled rods class B or C
f_{yk} and k according to NDP or NCI of EN 1992-1-1/NA
$f_{uk} = f_{tk} = k•f_{yk}$</td></tr>
</table>

Tension Anchor ZA: M12, M16, M20, M24

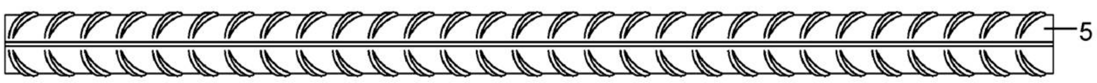


Marking: e.g. ◇ZA 12 A4

◇ Identifying mark of manufacturing plant
ZA Product identity
12 Anchor size / thread

Additional marking:
A4 Stainless steel A4
HCR High corrosion resistant steel

Rebar: ∅8, ∅10, ∅12, ∅14, ∅16, ∅20, ∅22, ∅24, ∅25, ∅28, ∅32, ∅34, ∅36, ∅40



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2011
- Rib height of the bar shall be in the range 0,05∅ ≤ h_{rib} ≤ 0,07∅
  (∅: nominal diameter of the bar; h_{rib}: rip height of the bar)

Injection System VME plus for rebar connections

Product description
Materials, marking

Annex A4

Specifications of intended use

Anchorages subject to:		static or quasi-static action	seismic action
Vacuum drill (VD) Hammer drill (HD) Compressed air drill (CD) Diamand drill (DD)	Working life 50 years	Ø8 to Ø40 ZA M12 to M24	Ø10 to Ø40
	Working life 100 years	Ø8 to Ø40 ZA M12 to M24	Ø10 to Ø40
	Fire exposure	Ø8 to Ø40 ZA M12 to M24	no performance assessed
Temperature range	- 40 °C to +80 °C max. long term temperature +50 °C and max. short term temperature +72°C		

Base material:

- Reinforced or unreinforced normal weight concrete acc. to EN 206-1:2013+A1:2016
- Strength classes C12/15 to C50/60 acc. EN 206-1:2013+A1:2016
- Maximum chloride content of 0,40 % (CL 0,40) related to the cement content acc. to EN 206-1:2013+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 ∅ + 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 1992-1-1:2011. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Use conditions (Environmental conditions) with tension anchor ZA:

- Structures subject to dry internal conditions: all materials
- For all other conditions corresponding to corrosion resistance classes CRC according to EN 1993-1-4:2006 +A1:2015:
  - stainless steel A4, according to Annex A4, Table A1: CRC III
  - high corrosion resistant steel HCR, according to Annex A4, Table A1: CRC V

Injection System VME plus for rebar connections	**Annex B1**
Intended Use Specification of intended use	

Specifications of intended use - continuation

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 loads to be anchored.
- Anchorages under static or quasi-static loads are designed in accordance with EN 1992-1-1:2011 and Annex B3 and B4
- Anchorages under seismic actions are designed in accordance with EN 1998-1:2004+AC:2009.
- Anchorages under fire exposure are designed in accordance with EN 1992-1-2:2011.
- The actual position of the reinforcement in the existing structure shall be determined based on the construction documentation and taken into account when designing.

Installation:

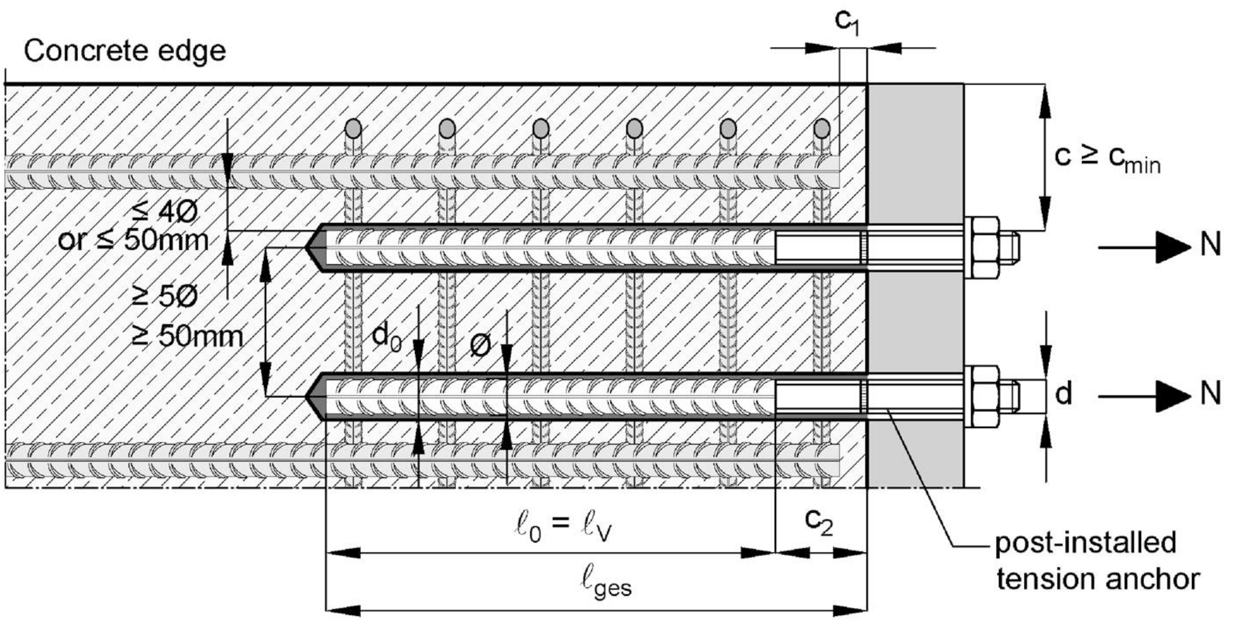
- Dry or wet concrete.
- Installation in water filled bore holes is not admissible.
- Overhead installation allowed.
- Hole drilling by hammer drill, compressed air drill, diamond drill or vacuum drill
- The installation of post-installed rebar or tension anchor ZA shall be done only by suitable trained 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).
- Minimum concrete cover acc. to EN 1992-1-1:2011 must be observed.
- Use Retaining washer for horizontal or overhead installation and bore holes deeper than 250mm.

Injection System VME plus for rebar connections	**Annex B2**
Intended use Specifications of intended use - continuation	

General construction rules for tension anchor ZA

- Tension anchors ZA must be designed for the welded-on rebar.
- The length for the post-installed thread must not be added to the anchoring length.
- The tension anchor ZA can only transfer forces towards the bar axis.
- Tension forces must be transferred by an overlap joint into the present reinforcement of the member.
- The transmission of shear forces must be ensured by additional measures, e.g. by shear cleats or anchors with an European Technical Assessment (ETA)
- In the anchor plate the holes for the tension anchors must be executed as elongated holes with axis in the direction of the shear force
- If the clear distance of overlapping bars is greater than 4Ø or 50 mm, the lap length must be increased by a length equal to the clear space where it exceeds 4Ø or 50 mm.

Tension anchor ZA



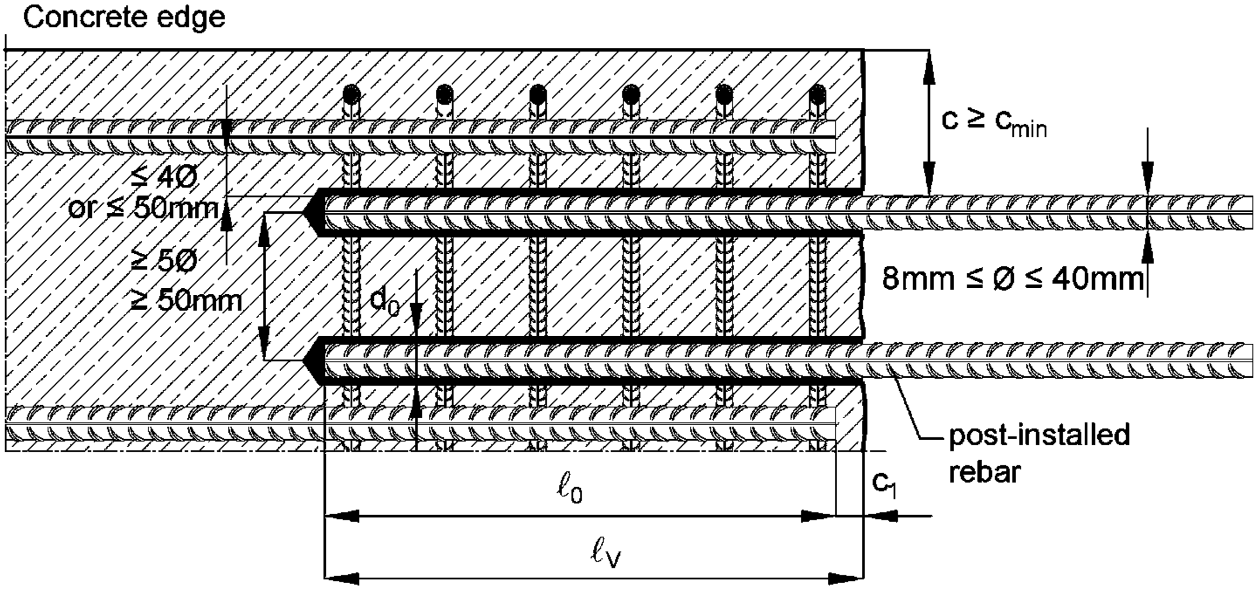
c	concrete cover of tension anchor ZA	
c_1	concrete cover at front end of cast-in-place rebar	
c_2	length of bonded thread	
c_{min}	minimum concrete cover according Table B1 and EN 1992-1-1:2011, section 4.4.1.2	
Ø	diameter of tension anchor (rebar part)	
d	diameter of tension anchor (threaded part)	
ℓ_0	lap length acc. to EN 1992-1-1:2011, section 8.7.3	
ℓ_v	embedment depth	$\ell_v \geq \ell_0 + c_1$
ℓ_{ges}	overall embedment depth	$\ell_{ges} \geq \ell_0 + c_2$
d_0	nominal drill bit diameter according Annex B6	

Injection System VME plus for rebar connections	**Anhang B3**
Intended use General construction rules **(Tension anchor ZA)**	

General construction rules for post-installed rebars

- The shear transfer between old and new concrete shall be designed acc. to EN 1992-1-1:2011
- Only tension forces in the axis of the rebar may be transmitted.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.
- If the clear distance of overlapping bars is greater than 4Ø or 50 mm, the lap length must be increased by a length equal to the clear space where it exceeds 4Ø or 50 mm.

Post-installed rebars



c	concrete cover of post-installed rebar
c_1	concrete cover at front end of cast-in-place rebar
c_{min}	minimum concrete cover according Table B1, $c_{min,seis}$ according to Table B2 and EN 1992-1-1:2011, Section 4.4.1.2 shall be observed
Ø	diameter of post-installed rebar
ℓ_0	lap length acc. to EN 1992-1-1:2011, Section 8.7.3 for static loading and according to EN 1998-1:2004+AC:2009, Section 5.6.3 for seismic actions
ℓ_v	embedment depth $\ell_v \geq \ell_0 + c_1$
d_0	nominal drill bit diameter according to Annex B6

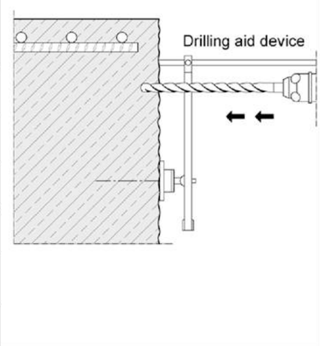
Injection System VME plus for rebar connections

Intended use
General construction rules (**post-installed rebar**)

Anhang B4

Table B1: Minimum concrete cover c_{min}[1)] of post-installed rebar and tension anchor ZA under static or quasi-static action

Drilling method	Rod diameter	c_{min} without drilling aid	c_{min} with drilling aid
Hammer drilling Vacuum drilling	< 25 mm	30 mm + 0,06 ℓ_v ≥ 2 Ø	30 mm + 0,02 ℓ_v ≥ 2 Ø
	≥ 25 mm	40 mm + 0,06 ℓ_v ≥ 2 Ø	40 mm + 0,02 ℓ_v ≥ 2 Ø
Diamond drilling	< 25 mm	Drill rig used as drilling aid	30 mm + 0,02 ℓ_v ≥ 2 Ø
	≥ 25 mm		40 mm + 0,02 ℓ_v ≥ 2 Ø
Compressed air drilling	< 25 mm	50 mm + 0,08 ℓ_v	50 mm + 0,02 ℓ_v
	≥ 25 mm	60 mm + 0,08 ℓ_v ≥ 2 Ø	60 mm + 0,02 ℓ_v ≥ 2 Ø



1) See Annex B3 and B4; minimum concrete cover acc. to EN 1992-1-1:2011 must be observed.

Table B2: Minimum concrete cover $c_{min,seis}$ of post-installed rebar under seismic action

Drilling method	Design condition	Distance to the 1. edge	Distance to the 2. edge
Hammer drilling Vacuum drilling Compressed air drilling	edge	≥ 2 Ø	≥ 2 Ø
	corner	≥ 2 Ø	≥ 2 Ø
Diamond drilling	edge	≥ 4 Ø	≥ 8 Ø
	corner	≥ 6 Ø	≥ 6 Ø

Table B3: Dimensions and installation parameters of tension anchor ZA

Anchor size				M12	M16	M20	M24
Thread diameter		d	[mm]	12	16	20	24
Rebar diameter		∅	[mm]	12	16	20	25
Nominal drill hole diameter		d_0	[mm]	see Table B4 and B5			
Diameter of clearance hole in fixture		d_f	[mm]	14	18	22	26
Width across nut flats		SW	[mm]	19	24	30	36
Cross section area (threaded part)		A_s	[mm²]	84	157	245	353
Effective embedment depth		ℓ_v	[mm]	according to static calculation			
Length of bonded thread	steel, zinc plated	c_2	[mm]	≥ 20			
	A4/HCR			≥ 100			
Minimum thickness of fixture		t_{fix}	[mm]	5			
Maximum thickness of fixture		t_{fix}	[mm]	3000			
Maximum installation torque		T_{inst}	[Nm]	50	100	150	150

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Table B4: Installation tools and max. embedment depth – Hammer drilling (HD), diamond drilling (DD) or compressed air drilling (CD)

Rebar size Ø	Tension anchor ZA	Drill bit diameter d_0			Brush- Ø d_b		Brush- Ø $d_{b,min}$	Retaining washer	Cartridge 440ml or 585ml				Cartridge 1400 ml	
									Hand- or akku-tool		Compressed air tool		Compressed air tool	
		HD	DD	CD					$\ell_{v,max}$		$\ell_{v,max}$		$\ell_{v,max}$	
[mm]	[-]	[mm]	[mm]	[mm]	[-]	[mm]	[mm]	[-]	[cm]	[-]	[cm]	[-]	[cm]	[-]
8	-	10	10	-	RB10	11,5	10,5	-	25	Extension pipe VM-XE 10 or VM-XLE 16	25	Extension pipe VM-XE 10 or VM-XLE 16	25	VM-XE 10
	-	12	12	-	RB12	13,5	12,5	-	70		80		80	
10	-	12	12	-	RB12	13,5	12,5	-	25		25		25	
	-	14	14	-	RB14	15,5	14,5	VM-IA 14	70		100		100	
12	M12	14	14	-	RB14	15,5	14,5	VM-IA 14	25		25		25	
		16	16	16	RB16	17,5	16,5	VM-IA 16	70		130		120	Extension pipe VM-XE 10 or VM-XLE 16
14	-	18	18	18	RB18	20,0	18,5	VM-IA 18	70		130		140	
16	M16	20	20	20	RB20	22,0	20,5	VM-IA 20	70		130		160	
20	M20	25	25	-	RB25	27,0	25,5	VM-IA 25	50		100		200	
		-	-	26	RB26	28,0	26,5	VM-IA 25	50		100		200	
22	-	28	28	28	RB28	30,0	28,5	VM-IA 28	50		100		200	
24/25	M24	30	30	30	RB30	32,0	30,5	VM-IA 30	50		100		200	
		32	32	32	RB32	34,0	32,5	VM-IA 32	50		100		200	
28	-	35	35	35	RB35	37,0	35,5	VM-IA 35	50		100		200	
32/34	-	40	40	40	RB40	43,5	40,5	VM-IA 40	-		100		200	
36	-	45	45	45	RB45	47,0	45,5	VM-IA 45	-		100		200	
40	-	-	52	-	RB52	54,0	52,5	VM-IA 52	-		100		200	
	-	55	-	55	RB55	58,0	55,5	VM-IA 55	-		100		200	

Table B5: Installation tools and max. embedment depth – vacuum drilling (VD)

Rebar size Ø	Tension anchor ZA	Drill bit diameter d_0	Brush- Ø d_b	Brush- Ø $d_{b,min}$	Retaining washer	Cartridge 440ml or 585ml				Cartridge 1400 ml	
						Hand- or akku-tool		Compressed air tool		Compressed air tool	
		VD				$\ell_{v,max}$		$\ell_{v,max}$		$\ell_{v,max}$	
[mm]	[-]	[mm]	[mm]	[mm]	[-]	[cm]	[-]	[cm]	[-]	[cm]	[-]
8	-	10	No cleaning required		-	25	Extension pipe VM-XE 10 or VM-XLE 16	25	Extension pipe VM-XE 10 or VM-XLE 16	25	Extension pipe VM-XE 10 or VM-XLE 16
	-	12			-	70		80		80	
10	-	12			-	25		25		25	
	-	14			VM-IA 14	70		100		100	
12	M12	14			VM-IA 14	25		25		25	
		16			VM-IA 16	70		100		100	
14	-	18			VM-IA 18	70		100		100	
16	M16	20			VM-IA 20	70		100		100	
20	M20	25			VM-IA 25	50		100		100	
22	-	28			VM-IA 28	50		100		100	
24/25	M24	30			VM-IA 30	50		100		100	
		32			VM-IA 32	50		100		100	
28	-	35			VM-IA 35	50		100		100	
32/34	-	40			VM-IA 40	50		100		100	

Injection System VME plus for rebar connections

Intended use
Installation tools and maximum embedment depth – all drilling methods

Annex B6

Cleaning and installation tools

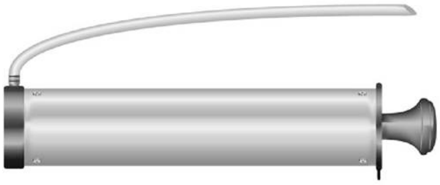
Vacuum drill bit

Vacuum drill bit (MKT Hollow drill bit SB, Würth Hammer drill bit with suction or Heller Duster Expert hollow drill bit system) and a vacuum cleaner with minimum negative pressure of 253 hPa and flow rate of min. 150m³/h (42 l/s)

Compressed air hose (min. 6 bar) with air valve

Recommended compressed air tool (min. 6 bar)

Blow-out pump (Volume 750ml)



Brush RB

Brush extension

SDS Plus Adapter

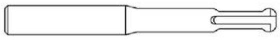


Table B6: Dispensing tools

Cartridge		Hand tool	Pneumatic tool
Type	**Size**		
side-by-side	**440 ml, 585 ml**	e.g.: VM-P 585 Profi or VM-P 585 Akku	e.g.: VM-P 585 Pneumatik
	1400 ml	-	e.g.: VM-P 1400 Pneumatik

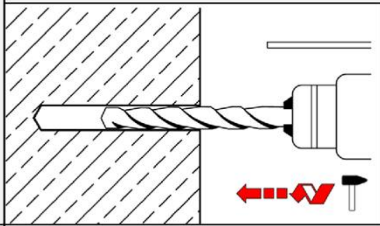
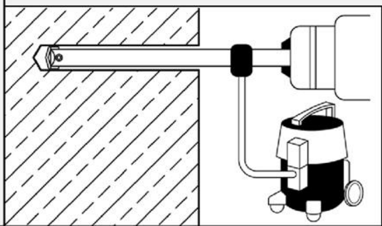
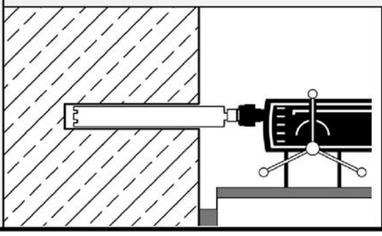
All cartridges can also be extruded by battery tool (e.g. VM-P Akku)

Table B7: Working and curing time

Bore hole temperature	Working time [1]	Initial curing time in dry concrete [2]	Minimum curing time in dry concrete [3]
[-]	t_{gel}	$t_{cure,ini}$	t_{cure}
0°C to +4°C	80 min	30 h	144 h
+5°C to +9°C	80 min	20 h	48 h
+ 10°C to + 14°C	60 min	15 h	28 h
+ 15°C to + 19°C	40 min	9 h	18 h
+ 20°C to + 24°C	30 min	6 h	12 h
+ 25°C to + 34°C	12 min	4 h	9 h
+ 35°C to + 39°C	8 min	3 h	6 h
+40 °C	8 min	1,5 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.
[2] After $t_{cure,ini}$ has elapsed, the installation of the connecting reinforcement and the construction of the formwork can be continued
[3] In wet concrete, the curing times must be doubled.

Installation instructions

Bore hole drilling			
1	**Attention: Before drilling, remove carbonated concrete and clean contact surface (see Annex B1). In case of aborted holes, the bore holes must be filled with mortar.**		
	1a	**HD / CD - Hammer drilling or compressed air drilling**	
			Drill hole with drill bit diameter according to Table B4 and selected embedment depth. Proceed with step 2.
	1b	**VD - Vacuum drilling**	
			Drill hole with drill bit diameter according to Table B5 and selected embedment depth. This drilling method removes dust and cleans the bore hole during drilling. Proceed with step 3.
	1c	**DD – Diamond drilling**	
			Drill a hole into the base material with prescribed nominal drill hole diameter (Table B4) and selected drill hole depth. Continue with step 2 (DD).

Installation instructions (continuation)

Cleaning: HD / CD - Hammer drilling or compressed air drilling

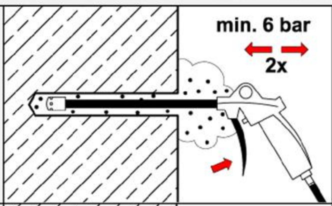
Step 2

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

Cleaning with compressed air

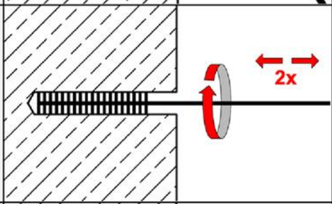
All drill hole diameter and drill hole depth

2a



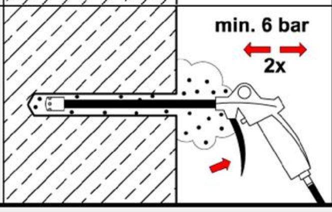
Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar, see Annex B7) a minimum of **two** times until return air stream is free of noticeable dust.
If bore hole ground is not reached, an extension must be used.

2b



Brush the hole with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4, check minimum brush diameter $d_{b,min}$) a minimum of **two** times using a drilling machine or battery screwdriver.
If bore hole ground is not reached, a brush extension must be used.

2c

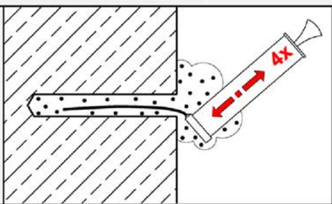


Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B7) a minimum of **two** times until return air stream is free of noticeable dust.
If bore hole ground is not reached, an extension must be used.

Manual cleaning

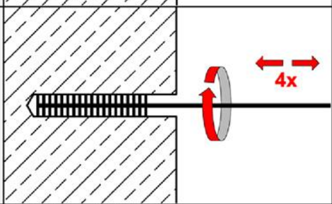
Drill hole diameter d_0 ≤ 20mm and drill hole depth h_0 ≤ 10 d_{nom}

2a



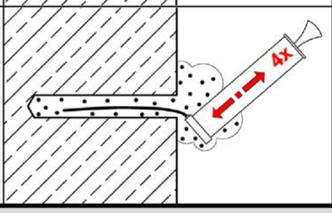
Starting from the bottom or back of the drill hole, blow out the hole with the blow-out pump (Annex B7) a minimum of **four** times until return air stream is free of noticeable dust.

2b



Check brush diameter (Table B4). Brush the hole with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **four** times.
If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.

2c



Starting from the bottom or back of the drill hole blow out the hole again a minimum of **four** times until return air stream is free of noticeable dust.

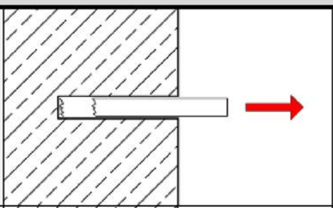
After cleaning, the drill hole must be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning must be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.

Installation instructions (continuation)

Cleaning: DD – diamond drilling (all drill hole diameter and drill hole depth)

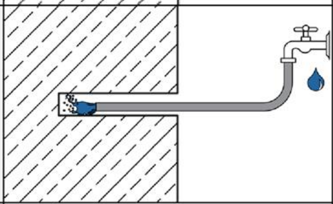
2 (DD)

2a



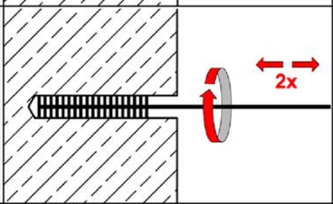
Remove drill core at least up to the nominal drill hole depth and check drill hole depth.

2b



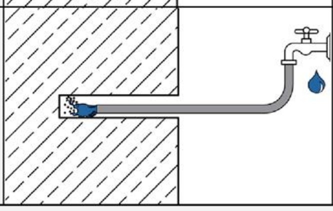
Flush drill hole with water, starting from the bottom until clear water gets out of the drill hole.

2c



Check brush diameter (Table B4). Brush the hole with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **two** times.
If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.

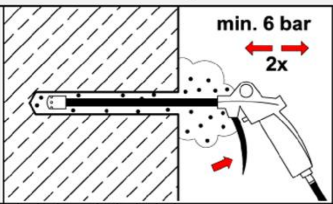
2d



Flush drill hole again with water, starting from the bottom until clear water gets out of the drill hole.

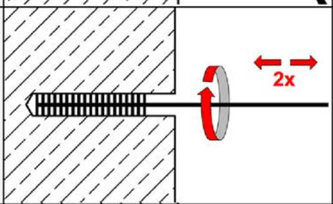
Attention: standing water in the drill hole must be removed before cleaning!

2e



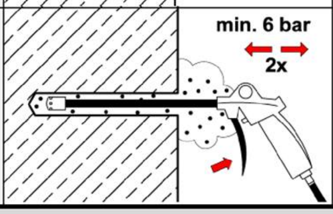
Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar, see Annex B7) again a minimum of **two** times until return air stream is free of noticeable dust.
If the drill hole ground is not reached, an extension must be used.

2f



Check brush diameter (Table B4). Brush the hole again with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **two** times.
If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.

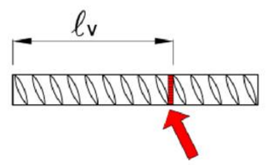
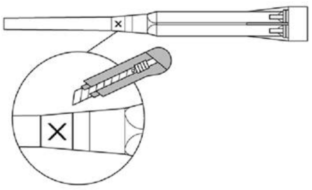
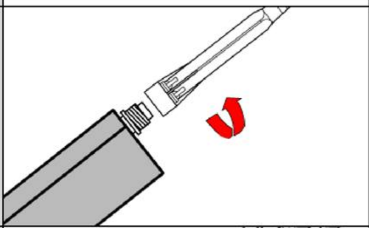
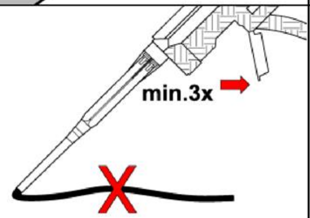
2g



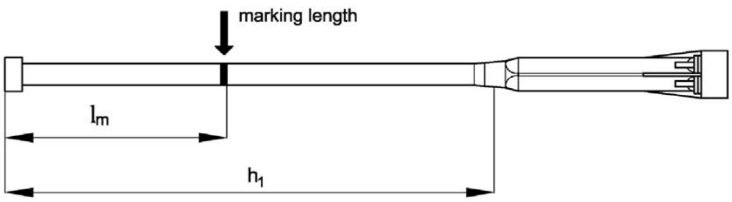
Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust.
If the drill hole ground is not reached, an extension must be used.

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

Installation instruction (continuation)

Preparing the borehole		
3		Mark the position of the embedment depth ℓ_v (e.g. with tape). Check drill hole depth by inserting rebar or anchor rod into the empty hole. The anchor should be free of dirt, grease, oil or foreign material.
4		In case of using the mixer extension VM-XLE 16 the tip of the mixer nozzle has to be cut off at position "X".
5		Prepare cartridge with static mixer (if necessary with extension pipe and retaining washer). Attach the supplied static mixer to the cartridge and load the cartridge into the correct dispensing tool (Table B6). For every working interruption longer than the recommended working time (Table B7) as well as for new cartridges, a new static-mixer shall be used.
6		Prior to applying, discard mortar (forerun) until the mortar shows a consistent grey or red color, but at least three full strokes and discard non-uniformly mixed adhesive components.

Making of extension pipe:
(all drilling methods):



On the static mixer and the extension pipe the mortar filling mark l_m and the drill hole depth h_1 must be marked with an adhesive tape or text marker. Rough estimate: $l_m = \frac{1}{3} \cdot h_1$
Fill in the mortar as long until the filling mark l_m will be visible.

Optimal mortar volume: $l_m = h_1 * (1{,}2 * \frac{\varnothing^2}{d_0^2} - 0{,}2)$ [mm]

l_m length from the end of the retaining washer to the mark on the mixer extension
h_1 drill hole depth = embedment depth (ℓ_v resp. ℓ_{ges})
Ø rebar diameter
d_o nominal drill bit diameter

Injection System VME plus for rebar connections	**Annex B12**
Intended Use Installation Instructions – preparing the borehole	

Installation instruction (continuation)

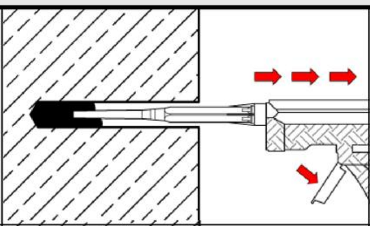
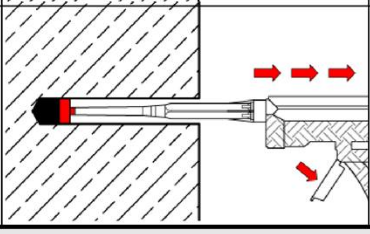
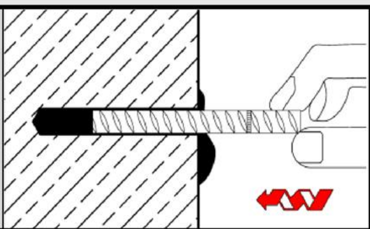
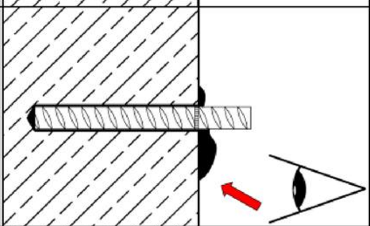
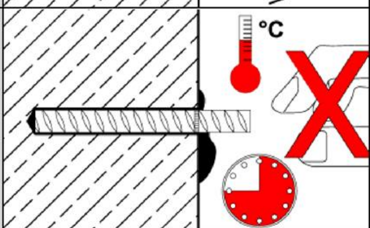
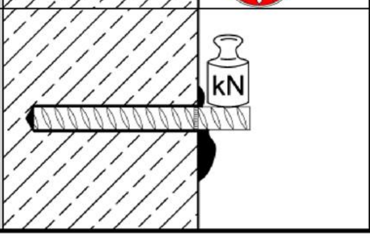
Injection into borehole		
7		Start from the bottom or the back of the cleaned bore hole, fill with adhesive until the level mark at the mixer extension (Annex B12) is visible at the top of the hole. Slowly withdraw the static mixer and using a retaining washer during injection of the mortar, helps to avoid air pockets. If the drill hole ground is not reached, an appropriate extension pipe shall be used (Annex B6). Observe temperature dependent working times given in Table B7.
8		For horizontal or overhead installations and bore holes deeper than 250 mm, retaining washer (and appropriate extension pipe) must be used. Observe temperature dependent working times given in Table B7.
Installation of rebar or tension anchor		
9		Push the reinforcing bar or tension anchor into the bore hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.
10		Be sure that the rebar or tension anchor is inserted in the bore hole until the embedment mark is at the concrete surface and excess mortar is visible at the top of the hole. If these requirements are not maintained, repeat application before end of working time! For overhead installation, the anchor should be fixed (e.g. by wedges).
11		Observe working and curing time according to Table B7. Slight correction of the fastening element is possible within the processing time t_{gel}. Once the time $t_{cure,ini}$ has been reached, the installation of the connecting reinforcement and the formwork can be continued.
12		The full load may only be applied after the full curing time t_{cure} has been reached. The working and curing times depend on the substrate temperature.

Table C1: Characteristic tension resistance for Tension Anchor ZA

Tension Anchor ZA			M12	M16	M20	M24
Steel, zinc plated						
Characteristic tension resistance	$N_{Rk,s}$	[kN]	67	125	196	282
Partial factor	$\gamma_{Ms,N}$	[-]	1,4			
Stainless steel A4, HCR						
Characteristic tension resistance	$N_{Rk,s}$	[kN]	67	125	171	247
Partial factor	$\gamma_{Ms,N}$	[-]	1,4	1,4	1,3	1,4

Minimum anchorage length and minimum lap length under static or quasi-static action

The minimum anchorage length $\ell_{b,min}$ and the minimum lap length $\ell_{0,min}$ according to EN 1992-1-1:2011 ($\ell_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $\ell_{0,min}$ acc. to Eq. 8.11) shall be multiplied by the amplification factor α_{lb} acc. to Table C2.

Table C2: Amplification factor α_{lb} – all drilling methods, working life 50 and 100 years

Amplification factor	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
$\alpha_{lb} = \alpha_{lb,100y}$ [-]	Ø8 to Ø40 ZA-M12 to ZA-M24	1,0								

Table C3: Reduction factor k_b – all drilling methods, working life 50 and 100 years

Reduction-factor	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
$k_b = k_{b,100}$ [-]	Ø8 to Ø40 ZA-M12 to ZA-M24	1,0								

Table C4: Design values of the ultimate bond strength $f_{bd,PIR}$ for all drilling methods and for good bond conditions; working life 50 and 100 years

$$f_{bd,PIR} = k_b \cdot f_{bd}$$
$$f_{bd,PIR,100y} = k_{b,100y} \cdot f_{bd}$$

with

f_{bd}: Design value of the ultimate bond stress in N/mm² considering the concrete strength classes and the rebar diameter
for all other bond conditions multiply the values by 0,7
recommended partial safety factor γ_c = 1,5 according to EN 1992-1-1:2011

k_b: $k_{b,100y}$: Reduction factor according to Table C3

Bond strength	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
f_{bd} [N/mm²]	Ø8 to Ø32 ZA-M12 to ZA-M24	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
	Ø34	1,6	2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
	Ø36	1,5	1,9	2,2	2,6	2,9	3,3	3,6	3,8	4,1
	Ø40	1,5	1,8	2,1	2,5	2,8	3,1	3,4	3,7	4,0

Minimum anchorage length and minimum lap length under seismic action

The minimum anchorage length $\ell_{b,min}$ and the minimum lap length $\ell_{0,min}$ according to EN 1992-1-1:2011 ($\ell_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $\ell_{0,min}$ acc. to Eq. 8.11) shall be multiplied by the amplification factor $\alpha_{lb,seis}$ = $\alpha_{lb,100y,seis}$ acc. to Table C5.

Table C5: Amplification factor $\alpha_{lb,seis}$ – all drilling methods, working life 50 and 100 years

Amplification factor	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
$\alpha_{lb,seis}$ = $\alpha_{lb,seis,100y}$ [-]	Ø10 to Ø40	-[1)]	1,0							

[1)] No performance assessed

Table C6: Reduction factor $k_{b,seis}$ – all drilling methods, working life 50 and 100 years

Reduction-factor	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
$k_{b,seis}$ = $k_{b,seis,100}$ [-]	Ø10 to Ø40	-[1)]	1,0							

[1)] No performance assessed

Table C7: Design values of the ultimate bond stress for good bond conditions; seismic action; working life 50 and 100 years

$$f_{bd,PIR,seis} = k_{b,seis} \cdot f_{bd}$$
$$f_{bd,PIR,seis,100y} = k_{b,seis,100y} \cdot f_{bd}$$

with

f_{bd}: Design value of the ultimate bond stress in N/mm² considering the concrete strength classes and the rebar diameter
for all other bond conditions multiply the values by 0,7
recommended partial safety factor γ_c = 1,5 according to EN 1992-1-1:2011

$k_{b,seis}$ or $k_{b,seis,100}$: Reduction factor according to Table C6

Bond strength	Rod diameter	Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
f_{bd} [N/mm²]	Ø10 to Ø32	–[1)]	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
	Ø34		2,0	2,3	2,6	2,9	3,3	3,6	3,9	4,2
	Ø36		1,9	2,2	2,6	2,9	3,3	3,6	3,8	4,1
	Ø40		1,8	2,1	2,5	2,8	3,1	3,4	3,7	4,0

[1)] No performance assessed

Design value of ultimate bond stress $f_{bd,fi}$ at increased temperature for concrete classes C12/15 to C50/60, all drilling methods, working life 50 and 100 years

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

Working life 50 years: $\mathbf{f_{bd,fi} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \gamma_c / \gamma_{M,fi}}$

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

$\theta > 278°C$: $k_{fi}(\theta) = 0$

Working life 100 years: $\mathbf{f_{bd,fi,100y} = k_{fi,100y}(\theta) \cdot f_{bd,PIR,100y} \cdot \gamma_c / \gamma_{M,fi}}$

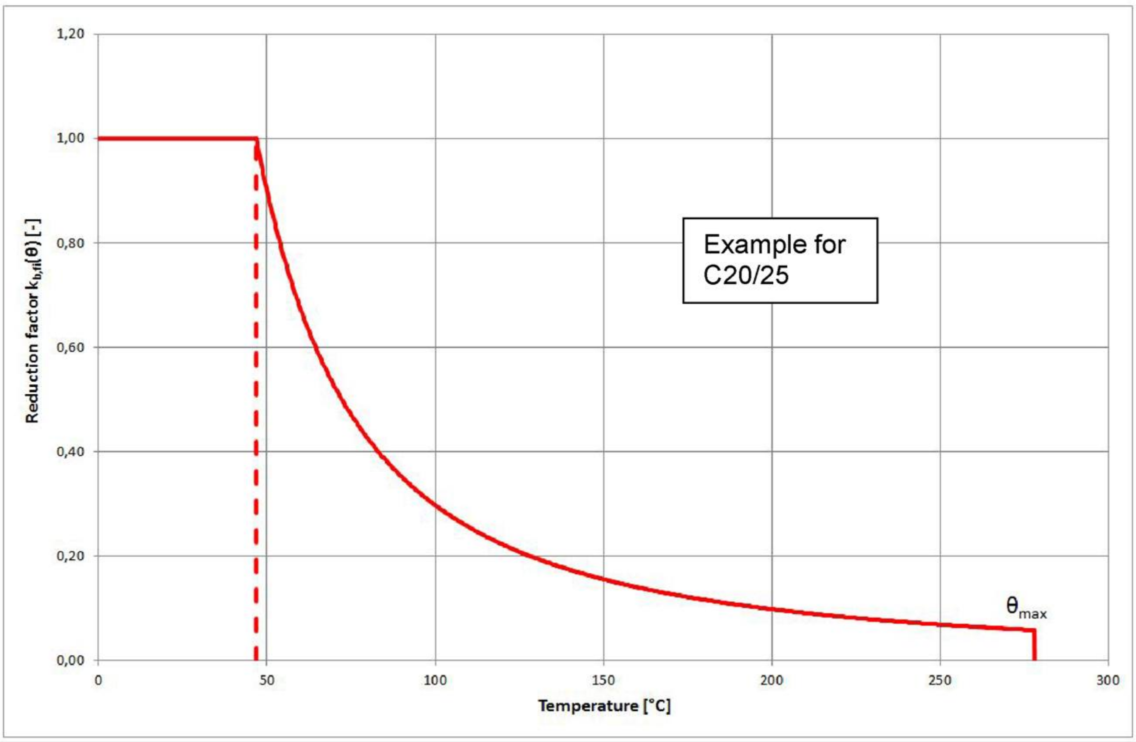
with: $\theta \leq 278°C$: $k_{fi,100y}(\theta) = 4673{,}8 * \theta^{-1{,}598} / (f_{bd,PIR,100y} * 4{,}3) \leq 1{,}0$

$\theta > 278°C$: $k_{fi,100y}(\theta) = 0$

$f_{bd,fi\ (100y)}$	design value of ultimate bond stress at increased temperature in N/mm²
θ	Temperature in °C in the mortar layer
$k_{fi(100y)}(\theta)$	Reduction factor at increased temperature
$f_{bd,PIR(100y)}$	Design value of the ultimate bond stress in N/mm² in cold condition according to Table C3 considering concrete class, rebar diameter, drilling method and the bond conditions according to EN 1992-1-1:2011
γ_c	= 1,5; recommended partial factor acc. to EN 1992-1-1:2011
$\gamma_{M,fi}$	= 1,0; recommended partial factor acc. to EN 1992-1-2:2011

For evidence under fire exposure the anchorage length shall be calculated acc. to EN 1992-1-1:2011 Equation 8.3 using the temperature-dependent design value of ultimate bond stress $f_{bd,fi}$.

Example graph of reduction factor $k_{fi}(\theta)$
Concrete strength class C20/25 for good bond conditions



Injection System VME plus for rebar connections	**Anhang C4**
Performances Design value of ultimate bond stress $f_{bd,fi}$ for rebar at increased temperature	

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Table C8: Characteristic tension strength in case of fire for tension anchor ZA,
concrete strength class C12/15 to C50/60, acc. to EN 1992-4:2018

Tension anchor ZA				**M12**	**M16**	**M20**	**M24**
Steel failure							
Steel, zinc plated							
Characteristic tension strength	R30	$N_{Rk,s,fi}$	[kN]	2,3	4,0	6,3	9,0
	R60			1,7	3,0	4,7	6,8
	R90			1,5	2,6	4,1	5,9
	R120			1,1	2,0	3,1	4,5
Stainless steel A4, HCR							
Characteristic tension strength	R30	$N_{Rk,s,fi}$	[kN]	3,4	6,0	9,4	13,6
	R60			2,8	5,0	7,9	11,3
	R90			2,3	4,0	6,3	9,0
	R120			1,8	3,2	5,0	7,2