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-07/0299 of 9 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	Injection System VME
Product family to which the construction product belongs	Post-installed rebar connection with Injection System VME
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	19 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

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Specific Part

1 Technical description of the product

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

Reinforcing bars made of steel with a diameter ϕ from 8 to 28 mm or the tension anchor ZA sizes M12, M16, M20 and M24 according to Annex A and injection adhesive VME 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 connections 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 connnections satisfy requirements for Class A1
Resistance to fire	See Annex C 2 – 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

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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 9 November 2017 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Lange

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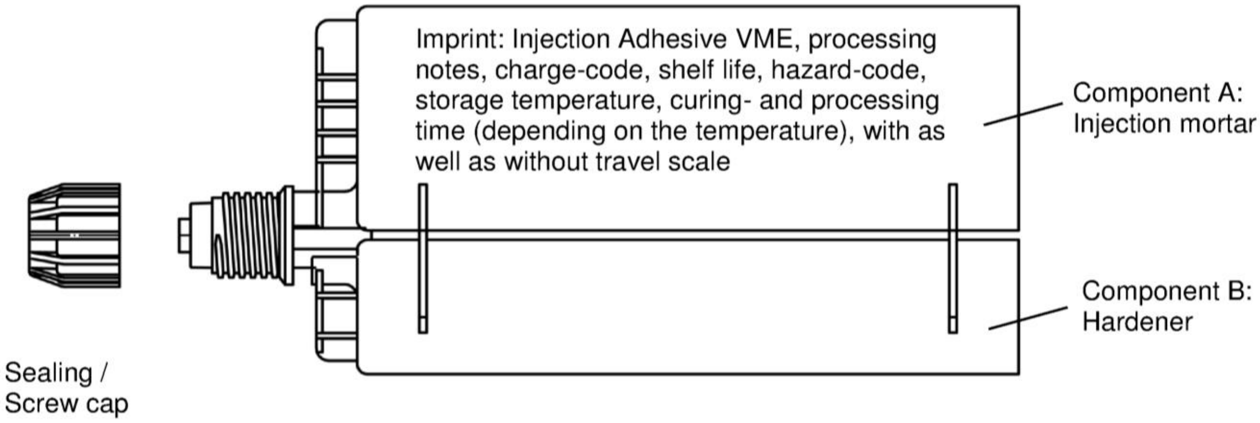
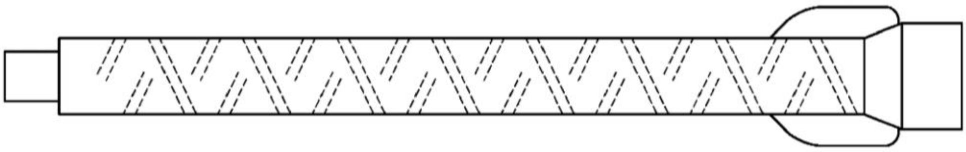
Cartridge: Injection Adhesive VME

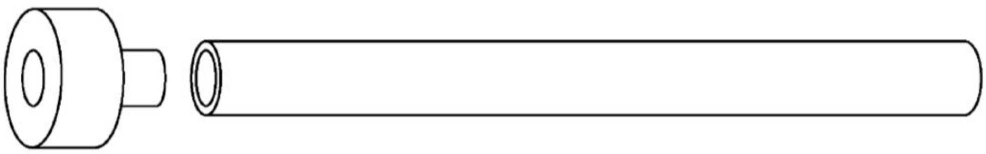
385ml, 444ml, 585ml, 999ml and 1400ml injection mortar cartridge (Type: “side-by-side”)



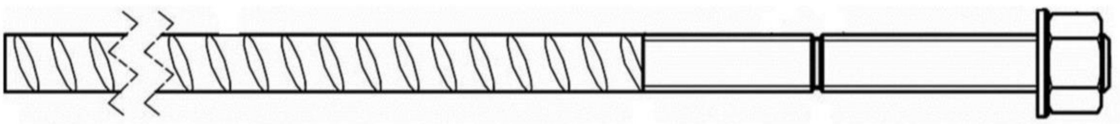
Static Mixer



Extension pipe and retaining washer



Tension anchor ZA: M12, M16, M20, M24



Reinforcing bar: Ø8, Ø10, Ø12, Ø14, Ø16, Ø20, Ø24, Ø25, Ø26, Ø28

Injection System VME	Annex A1
Product description Injection System with tension anchor or reinforcing bar	

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Application examples (reinforcing bar)

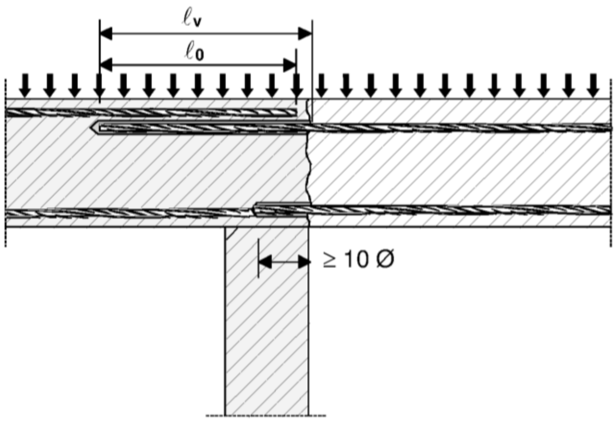

Figure A1: Overlap joint in slabs and beams

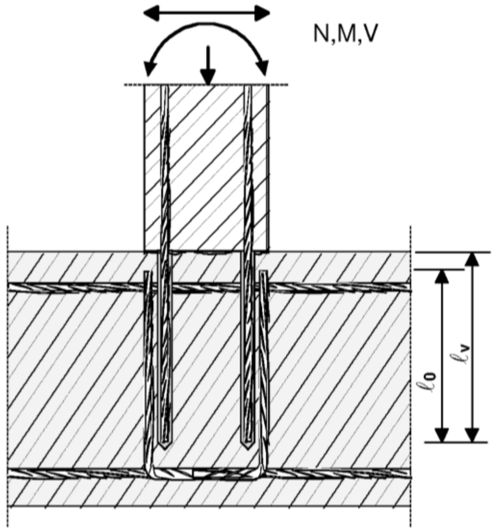

Figure A2: Overlap joint in a foundation of a column or wall where the rebars are stressed in tension

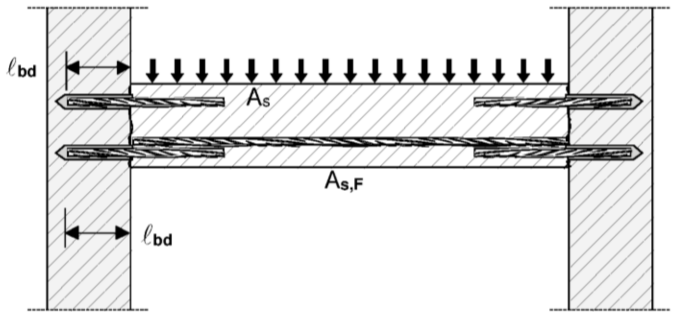

Figure A3: End anchoring of slabs or beams, designed as simply supported

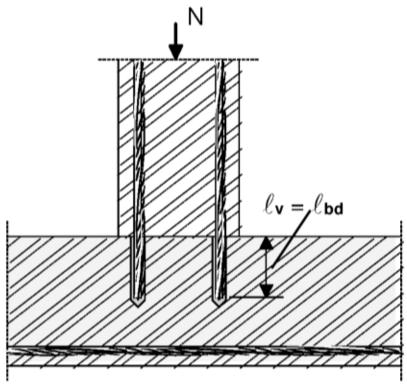

Figure A4: Rebar connection of components stressed primarily in compression. The rebars are stressed in compression.

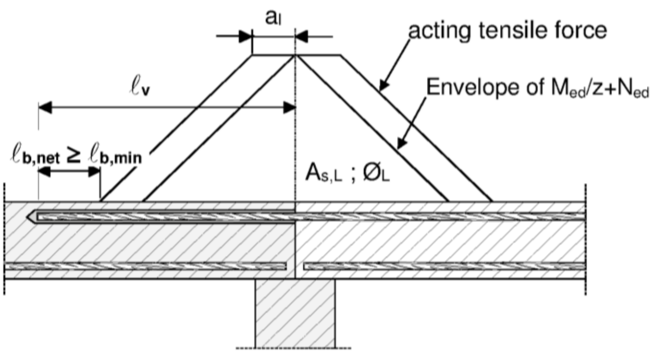

Figure A5: Anchoring of reinforcement to cover line of acting tensile force

Note to Figure A1 – A5:
No transverse reinforcement acc. to EN 1992-1-1 is pictured.
The shear transfer between old and new concrete shall be designed according to EN 1992-1-1.
Notations and definitions of anchorages and overlap joints see Annex B2

Injection System VME

Product description
Applications examples of post-installed rebars

Annex A2

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Application examples (tension anchor ZA)

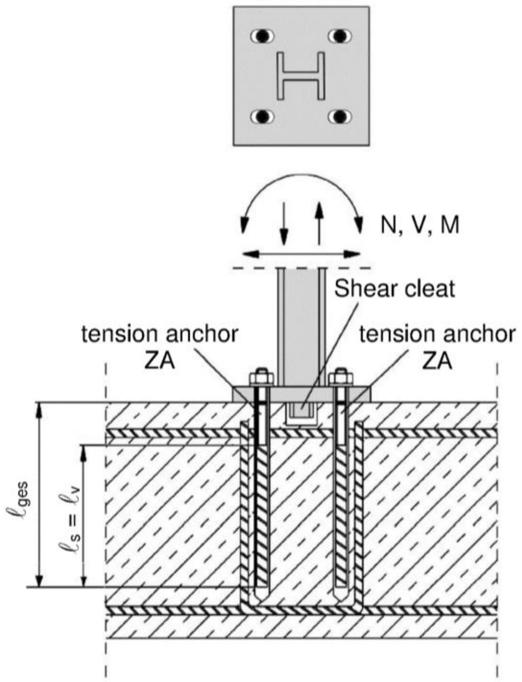


Figure A6: Overlap joint at the foundation of columns

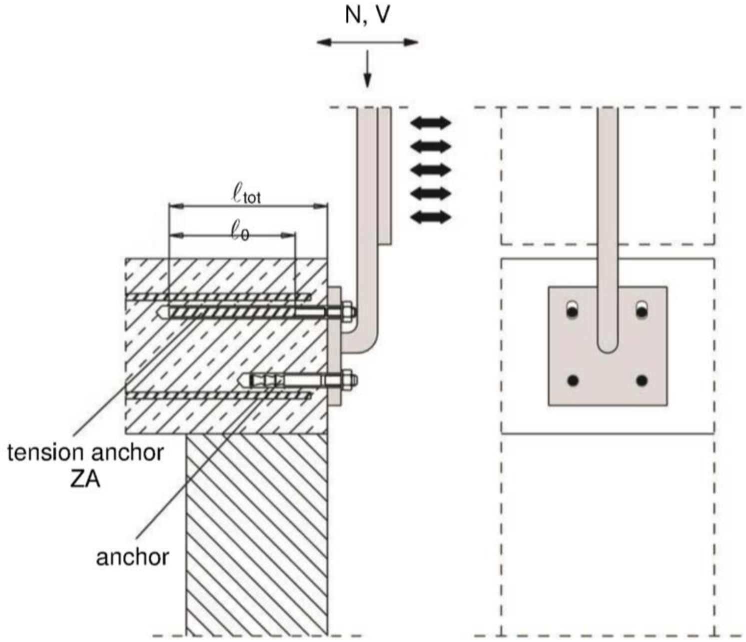
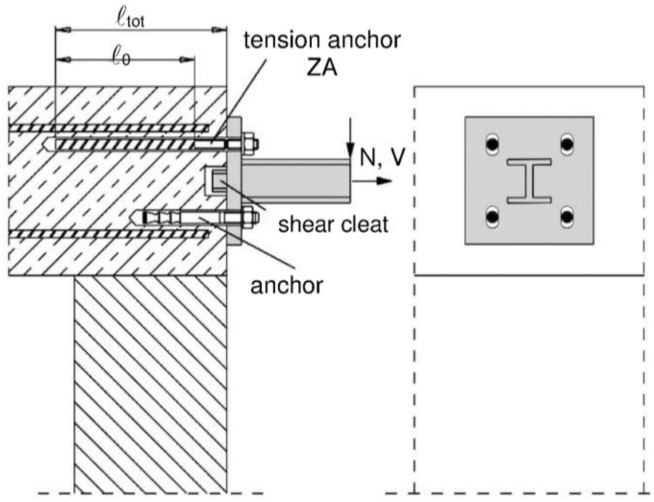


Figure A7: Overlap joint for the anchorage of guardrail posts



Note to Figure A6 to A8:
No transverse reinforcement according to EN 1992-1-1 is pictured. Notations and definitions of anchorage and overlap joints see Annex B2.

Figure A8: Overlap joint for the anchorage of cantilevers

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 designed as slotted holes towards the shear force.

Injection System VME	**Annex A3**
Product description Applications examples of tension anchor ZA	

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Table A1: Material

Part	Description	Material											
Tension anchor ZA		**ZA vz**				**ZA A4**				**ZA HCR**			
		M12	M16	M20	M24	M12	M16	M20	M24	M12	M16	M20	M24
1	Rebar	Class B according to NDP or NCL of EN 1992-1-1 $f_{uk} = f_{tk} = k \cdot f_{yk}$											
2	Threaded rod	Steel, zinc plated acc. to EN 10087:1998 or EN 10263:2001				Stainless steel, 1.4362, 1.4401, 1.4404, 1.4571, EN 10088:2014				High corrosion resistant steel, 1.4529, 1.4565, EN 10088:2014			
	f_{yk} [N/mm²]	640				640			560	640			560
3	Washer	Steel, zinc plated				Stainless steel				High corrosion resistant steel			
4	Hexagon nut	Steel, zinc plated acc. to EN 10087:1998 or EN 10263:2001				Stainless steel, 1.4362, 1.4401, 1.4404, 1.4571, EN 10088:2014				High corrosion resistant steel, 1.4529, 1.4565, EN 10088:2014			
Rebar													
5	Rebar EN 1992-1-: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 $f_{uk} = f_{tk} = k \cdot f_{yk}$											

Figure A9: Tension anchor ZA, marking

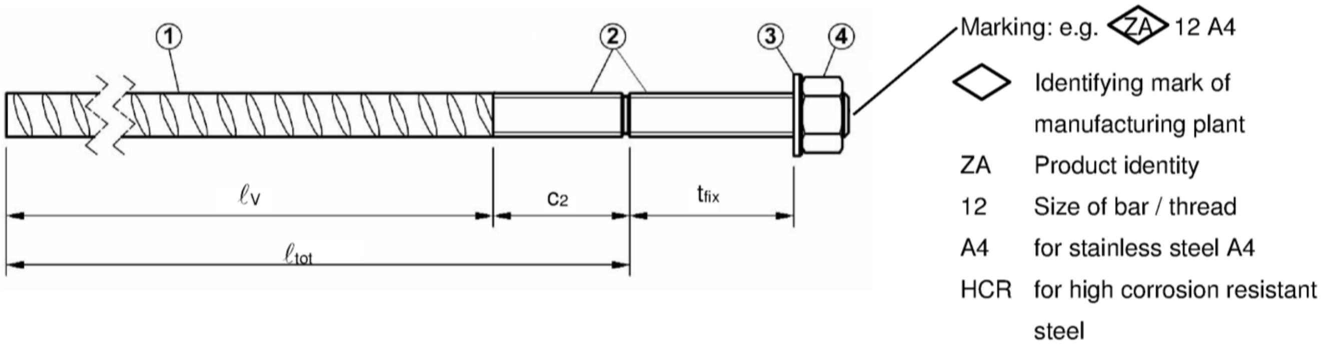
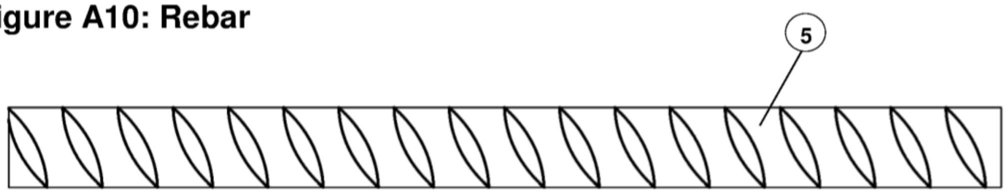


Figure A10: Rebar



Injection System VME	**Annex A4**
Product description Materials, Marking	

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Specifications of intended use

Anchorages subject to:

- Static or quasi static action
- Fire exposure

Base material:

- Reinforced or unreinforced normal weight concrete acc. to EN 206-1:2000.
- Strength classes C12/15 to C50/60 acc. to EN 206-1:2000.
- Maximum chloride concrete of 0,40 % (CL 0,40) related to the cement content acc. 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 ∅ + 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. long term temperature +80 °C and max. short term temperature +50 °C)

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc plated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure including industrial and marine environment or exposure 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 (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 pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Anchorages are designed in accordance with EN 1992-1-1 and Annex B2.
- 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:

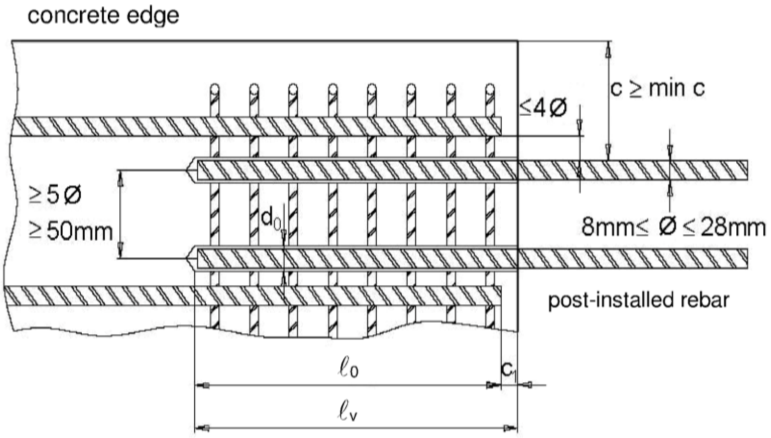
- Dry or wet concrete
- The rebar connection must not be placed in water-filled boreholes.
- Overhead installation admissible
- Check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint)
- Hole drilling by hammer drill, vacuum drill, compressed air drill or diamond drill mode.
- While curing of the injection mortar, the temperature of the member shall not fall below +5°C and must not exceed +40°C.
- 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.

Injection System VME	**Annex B1**
Intended use Specifications of intended use	

General construction rules for post-installed reinforcing bars and tension anchor ZA

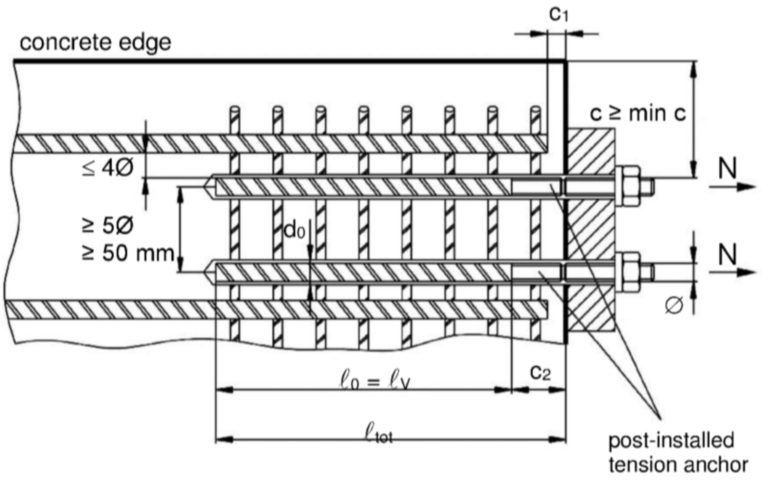
- Bond strength f_{bd} acc. to EN 1992-1-1 may be applied.
- The shear transfer between old and new concrete shall be designed acc. to EN 1992-1-1.
- If the clear distance of overlapping bars is greater than 4 Ø, the lap length must be increased by a length equal to the clear space where it exceeds 4 Ø.
- The minimum concrete cover acc. to EN 1992-1-1 shall be kept.

Figure B1: Post-installed rebars



c	concrete cover of post-installed reinforcement
c_1	concrete cover at front end of cast-in-place rebar
min c	minimum concrete cover according Table B1
Ø	diameter of post-installed rebar
ℓ_0	lap length acc. to EN 1992-1-1
ℓ_v	embedment depth $\ell_v \geq \ell_0 + c_1$
d_0	nominal drill bit diameter according to Annex B4, Table B4

Figure B2: Tension anchor ZA



c	concrete cover of post-installed tension anchor ZA
c_1	concrete cover at front side of cast-in-place rebar
min c	minimum concrete cover acc. to Table B1
c_2	length of bonded thread ($c_2 > c_1$; see Table B1)
∅	diameter of tension anchor
ℓ_0	lap length acc. to EN 1992-1-1
ℓ_{tot}	embedment depth $\ell_{tot} \geq \ell_0 + c_2$
d_0	nominal drill bit diameter according Annex B4, Table B4

Injection System VME

Intended use
General construction rules

Annex B2

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Table B1: Minimum concrete cover min c[1)] of post-installed rebars and tension anchor ZA depending on drilling method and drilling tolerances

Drilling method	Rebar diameter	min c (without drilling aid device)	min c (with drilling aid device)
Hammer drilling, vacuum drilling, diamond core 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
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	60 mm + 0,02 ℓ_v

1) Minimum concrete cover acc. to EN 1992-1-1 must be observed.

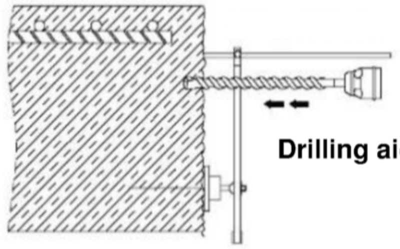

Table B2: Dimensions and installation parameters of tension anchor ZA

Anchor size				M12	M16	M20	M24
Rebar diameter		∅	[mm]	12	16	20	25
Cross-section area (threaded part)		A_s	[mm²]	84	157	245	353
Width across nut flats		SW	[mm]	19	24	30	36
Effective embedment depth		ℓ_v	[mm]	$\ell_v = \ell_{tot} - c_2$			
Length of bonded thread	steel, zinc plated	c_2	[mm]	≥ 20	≥ 20	≥ 20	≥ 20
	A4 / HCR			≥ 100	≥ 100	≥ 100	≥ 100
Maximum installation torque		T_{inst}	[Nm]	50	100	150	150

Table B3: Maximum embedment depth

Rebar / Tension Anchor ZA	Motar temperature	Max. embedment depth $\ell_{v,\max}$
∅ 8 to 12 mm	+5°C to +19°C	130 cm
	≥20°C	200 cm
∅ 14 to 28 mm	+5°C to +19°C	200 cm
	≥20° C	280 cm

Injection System VME

Intended use
Minimum concrete cover, installation parameters, maximum embedment depth

Annex B3

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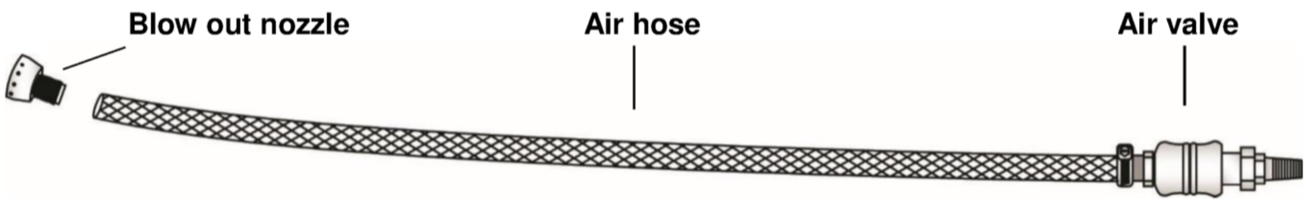
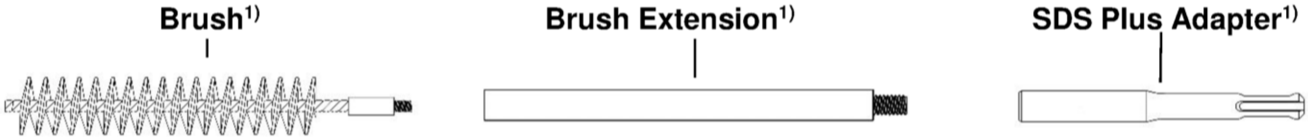
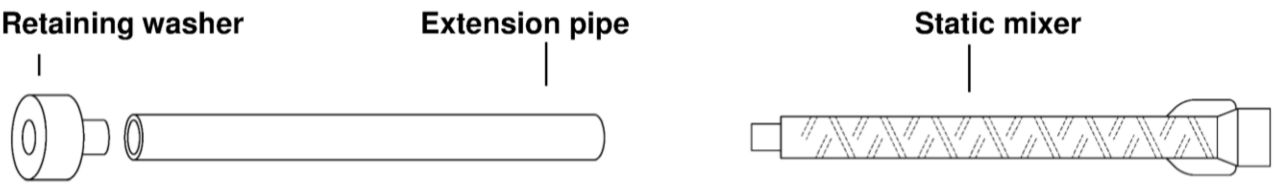
Table B4: Cleaning and installation tools

Rebar ∅	Tension anchor ZA	Drill bit diameter d_0	Blow out nozzle ∅	Brush ∅ (diamond drilling)	Extension pipe (outer ∅)	Retaining washer ∅
[mm]	[-]	[mm]	[mm]	[mm]	[mm]	[mm]
8	-	12	10	13,0	10	10
10	-	14	10	15,5		13
12	M12	16	14	17,5		15
14	-	18	14	19,5	16	17
16	M16	20	17	22		19
20	M20	25	17	27		24
24	-	30	27	32		29
25	M24	32	27	34		31
26	-	32	27	34		31
28	-	35	27	37		34





1) Additional cleaning tools for diamond core drilling



Injection System VME

Intended use
Cleaning and Installation tools

Annex B4

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Table B5: Working time and curing time

Temperature in the bore hole	Working time	Minimum curing time
+5°C to +9°C	60 min	72 h
+10°C to +19°C	45 min	36 h
+20°C to +29°C	30 min	10 h
+30°C to +39°C	20 min	6 h
+40°C	12 min	4 h

Note: A mortar temperature > + 20 ° C reduces the press out forces and accelerates the injection of the mortar. When using the adhesive in wet concrete the curing times have to be doubled.

Installation instructions

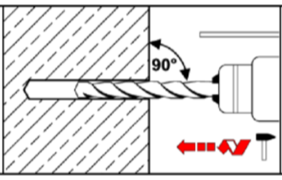
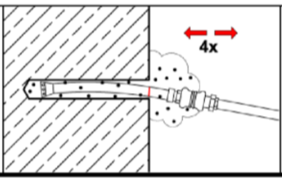
Preperation:

a. Remove carbonated concrete and roughen concrete surface prior to installation of post-installed rebars.

b. Determine position and diameter of existing reinforcement. Only the admissible force of the existing reinforcement can be transmitted into the post-installed rebar connection

c. The drilling aid device must be adjusted towards the existing reinforcement

d. The concreting joints must be roughened to at least such an extent that the aggregates protrude

Making and cleaning of hammer drilled, vacuum drilled and compressed air drilled holes		
Bore hole drilling		
1		Select drill bit diameter according to Table B4. Build drill hole by hammer drilling, vacuum drilling or compressed air drilling. In case of aborted holes, the bore holes must be filled with mortar.
Cleaning		
2a		Assemble provided blow out nozzles, air hoses and air valve and connect to compressed air (≥ 6 bar). Place marking on the air hose at a distance from the end equal to the drill hole depth. Open compressed air valve and blow out **4x** from top to bottom and reverse. The air hose marking has to get below the concrete surface in order to ensure cleaning to the very bottom of the hole.

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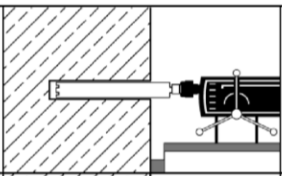
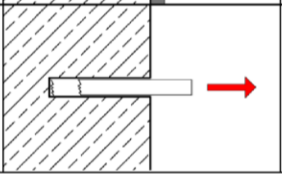
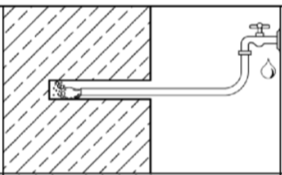
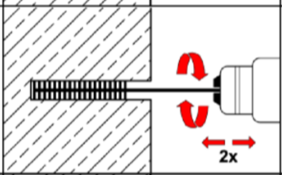
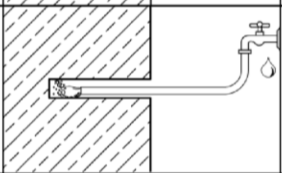
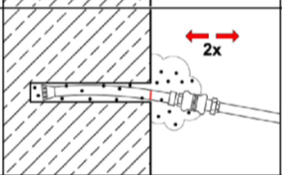
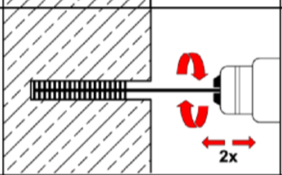
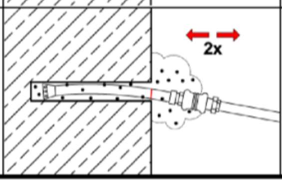
Injection System VME	Annex B5
Intended use Working and curing time, Installation instructions – Preperation; Making and cleaning of hammer drilled, vacuum drilled and compressed air drilled holes	

Installation instruction (continuation)

Marking and cleaning of diamond core drilled holes

Bore hole drilling		
1a		Drill hole by using a diamond drill with diamond drill bit.
1b		Remove drill core at least up to the nominal hole depth and check drill hole depth.
Cleaning		
2a		Flush drill hole with water, staring from the bottom, until clear water gets out of the drill hole.
2b		Choose brush suitable to the hole. Brush bore hole 2x using a cordless screwdriver or a drilling machine. Use brush extension for deep holes.
2c		Flush drill hole again with water, staring from the bottom, until clear water gets out of the drill hole.
2d		Assemble provided blow out nozzles, air hoses and air valve and connect to compressed air (≥ 6 bar). Place marking on the air hose at a distance from the end equal to the drill hole depth. Open compressed air valve and blow out 2x from top to bottom and reverse. The air hose marking has to get below the concrete surface in order to ensure cleaning to the very bottom of the hole.
2e		Brush the hole again 2x (according to step 2b).
2f		Blow out again 2x (according to step 2d).

Injection System VME

Intended use
Installation instructions
Making and cleaning of diamond core drilled holes

Annex B6

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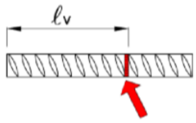
Installation Instruction (continuation)

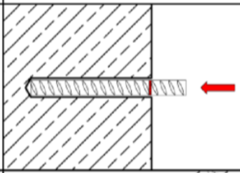
Injection into bore hole

3a



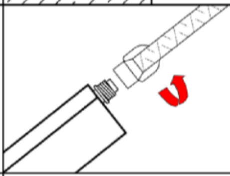
Mark the position of the embedment depth ℓ_v on the rebar.

3b



Check bore hole depth by inserting rebar or tension anchor up to the marking in the empty hole.

4



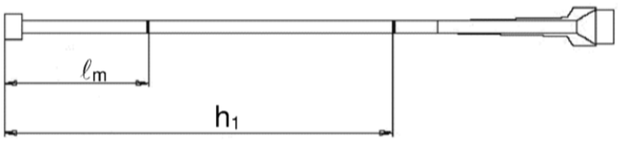
Prepare cartridge with static mixer, extension pipe and retaining washer. Extension pipe must correspond the hole depth.

5

Attach marking length ℓ_m on extension pipe for injection of adhesive:

a) Estimation:

$\ell_m = 1/3 * h_1$ [mm]

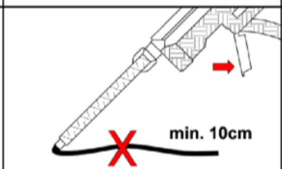


b) Precise formula for optimum volume (compressed air drilling):

$$l_m = h_1 * (1{,}2 * \frac{Ø^2}{d_0^2} - 0{,}2) \quad \text{[mm]}$$

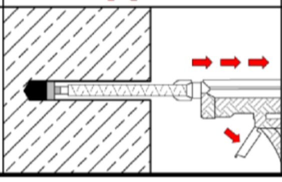
ℓ_m Length from the end of the retailing washer to the mark on the mixer extension
h_1 drill hole depth = embedment depth (ℓ_v resp. ℓ_{tot})
Ø rebar diameter
d_0 nominal drill bit diameter
When using hammer drill or diamond core, the length ℓ_m may be multiplied by 1,10.

6



Prior to applying, discard at least a 10 cm line of mortar (forerun) until the mortar shows a consistent colour. Never use this mortar!

7



Fill the hole starting from the bottom with injection mortar VME without air bubbles. Inject until the marking ℓ_m on the extension pipe can be seen.

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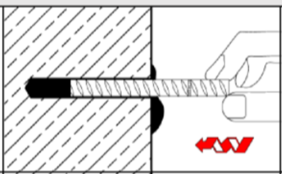
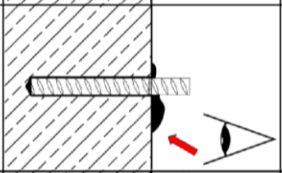
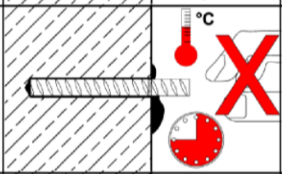
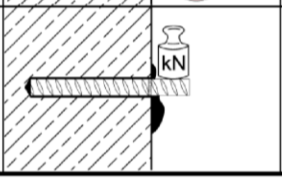
Installation Instruction (continuation)

Installation of rebar or tension anchor		
7		Push the rebar or tension anchor into the hole while turning slightly until the embedment depth is reached. The bar should be free of dirt, grease, oil or other foreign material.
8		Excessive adhesive must exceed out of the drill hole. Otherwise pull out rebar, drill out hole after curing of the adhesive and start again from No. 2.
9		Keep curing time according to Annex B5, Table B5. Do not move or load the rod during curing time.
10		After curing, the rod can be loaded.

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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 ($\ell_{b,min}$ 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 C1.

Table C1: Amplification factor α_{lb}

Concrete strength class	Drilling method	Amplification factor α_{lb}
C12/15 to C50/60	Hammer drilling, vacuum drilling or compressed air drilling	1,0
	Diamond coring	1,5

Table C2: Design values of the ultimate bond resistance f_{bd}[1)]

Rebar Tension Anchor ZA		Concrete strength class								
		C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
Design value of bond resistance f_{bd}										
Hammer drilling, vacuum drilling or compressed air drilling	[N/mm²]	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
Diamond coring	[N/mm²]	1,6	2,0	2,3	2,7	3,0	3,0	3,4	3,7	3,7

1) With η_1 =1,0 acc. to EN 1992-1-1 for good bond conditions (for all other bond conditions multiply the values by 0,7)

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Injection System VME

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

Annex C1

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

The design value of ultimate bond stress $f_{bd,fi}$ under fire exposure will be calculated by the following equation:

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

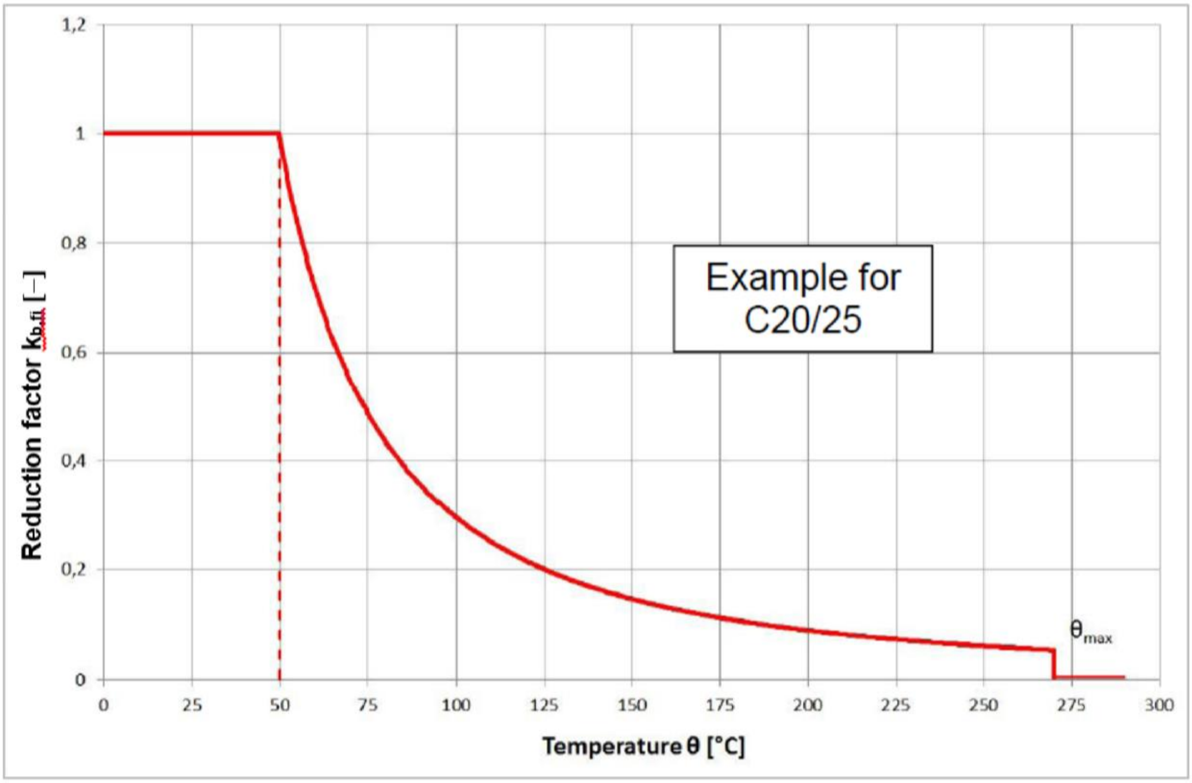
with: $\theta \leq 270°C$ $k_{b,fi}(\theta) = 9221{,}2 * \theta^{-1{,}747} / (f_{bd} * 4{,}3) \leq 1{,}0$

$\theta > 270°C$ $k_{b,fi}(\theta) = 0$

$f_{bd,fi}$	design value of 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 considering concrete class, rebar diameter, drilling method and the bond conditions according to EN 1992-1-1.
γ_c	partial factor acc. to EN 1992-1-1
$\gamma_{M,fi}$	partial factor acc. 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 $f_{bd,fi}$.

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



Injection System VME	**Annex C2**
Performances Design value of ultimate bond stress $f_{bd,fi}$ under fire exposure	

Table C3: Characteristic tension strength in case of fire for tension anchor ZA,
concrete strength class C12/15 to C50/60, acc. to Technical Report TR 020

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

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

The design value of the steel strength $\sigma_{Rd,s,fi}$ under fire exposure will 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 acc. to Table C3
$\gamma_{M,fi}$ partial factor under fire exposure acc. to EN 1992-1-2

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Injection System VME

Performances
Steel strength for tension anchor ZA under fire exposure

Annex C3