

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-07/0313
of 27 February 2018

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Injection System WIT-PE 500

Product family
to which the construction product belongs

Injection system for post-installed
rebar connections

Manufacturer

Adolf Würth GmbH & Co. KG
Reinhold-Würth-Straße 12-17
74653 Künzelsau
DEUTSCHLAND

Manufacturing plant

Werk 3

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

European Technical Assessment

ETA-07/0313

English translation prepared by DIBt

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Specific Part

1 Technical description of the product

The subject of this European Technical Assessment is the post-installed connection, by anchoring or overlap connection joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete, using the "Injection system WIT-PE 500" 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 from sizes M12 to M24 according to Annex A and injection mortar WIT-PE 500 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 connections 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

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.

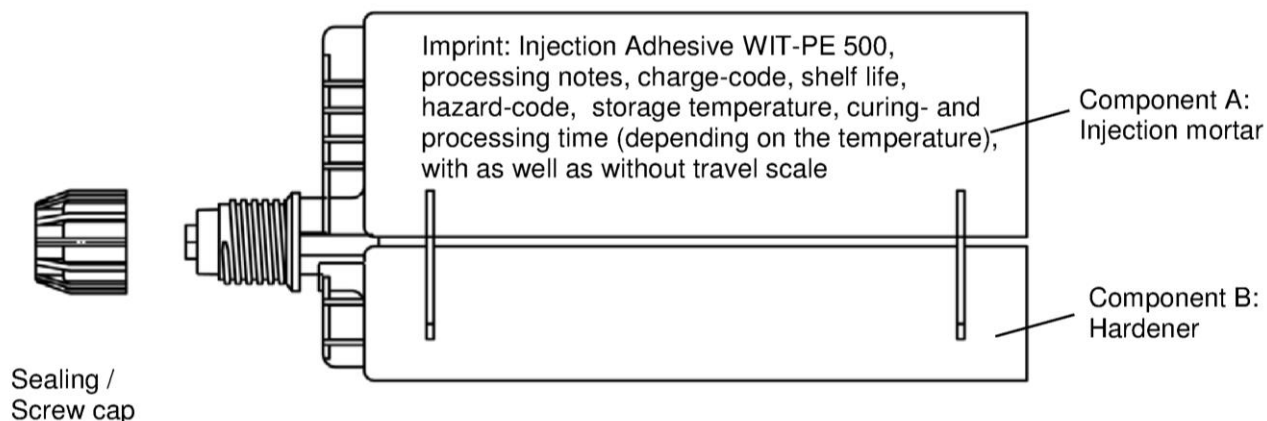
Issued in Berlin on 27 February 2018 by Deutsches Institut für Bautechnik

Dr.-Ing. Lars Eckfeldt
p.p. Head of Department

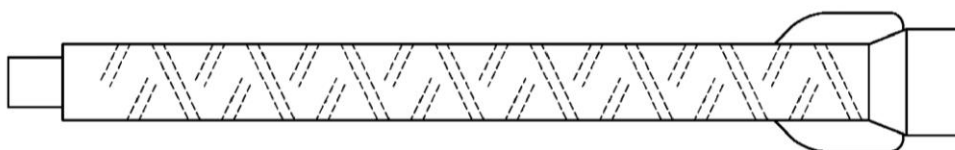
beglaubigt:
Baderschneider

Cartridge: Injection mortar WIT-PE 500

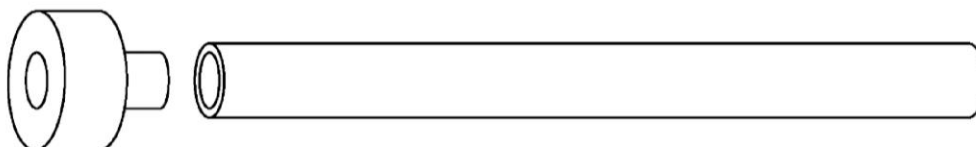
385ml, 444ml, 585ml, 999ml and 1400ml injection mortar cartridge (Type: "side-by-side")



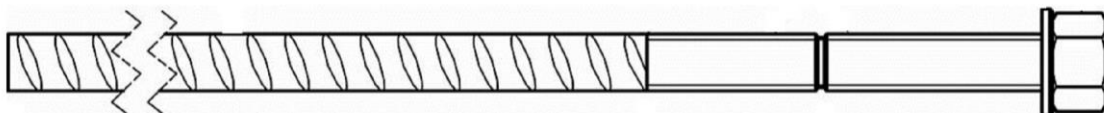
Static Mixer



Mixer extension WIT-MV and piston plug WIT-VS



Tension anchor ZA: M12, M16, M20, M24



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



Injection System WIT-PE 500

Product description

Injection System with tension anchor or reinforcing bar

Annex A1

Application examples (reinforcing bar)

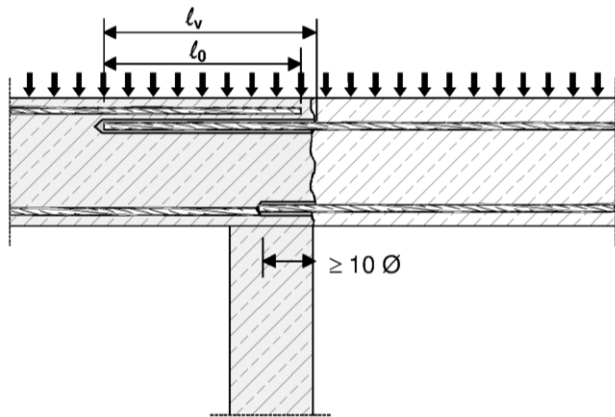


Figure A1: Overlap joint in slabs and beams

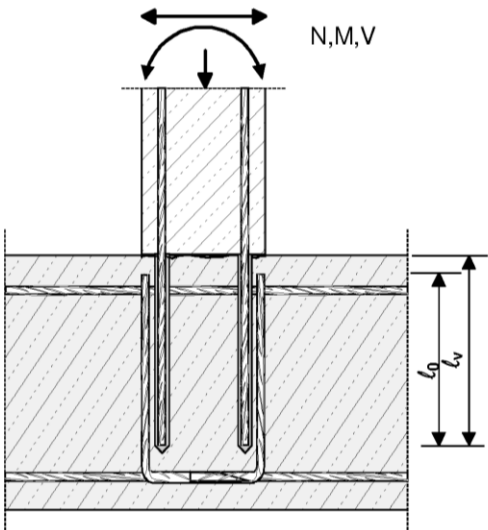


Figure A2: Overlap joint in a foundation of a column or wall where the rebars are stressed in tension

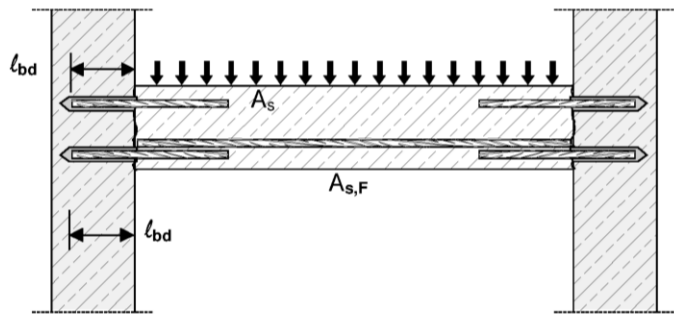


Figure A3: End anchoring of slabs or beams, designed as simply supported

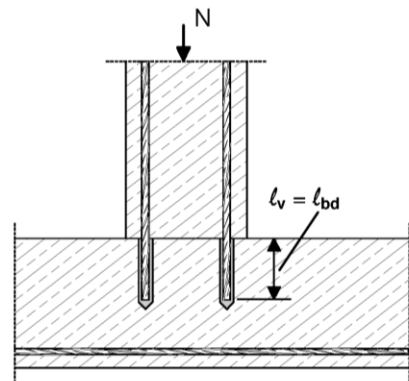


Figure A4: Rebar connection of components stressed primarily in compression. The rebars are stressed in compression.

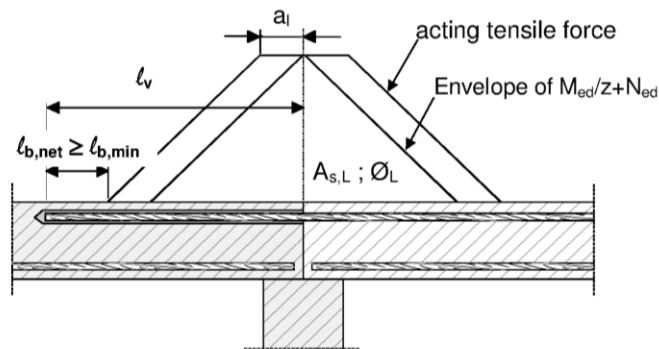


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force

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 WIT-PE 500

Product description
Applications examples of post-installed rebars

Annex A2

Application examples (tension anchor ZA)

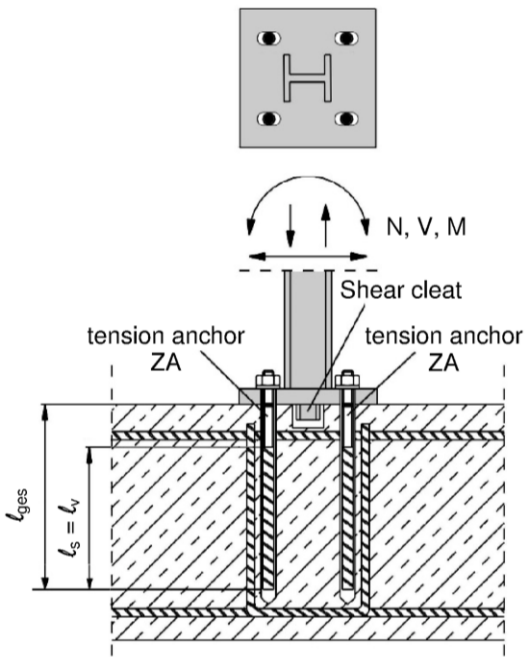


Figure A6: Overlap joint at the foundation of columns

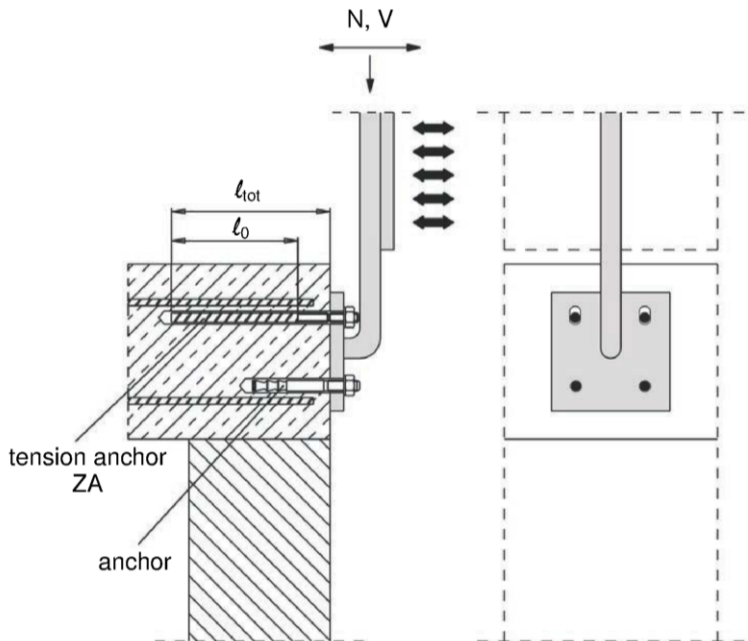


Figure A7: Overlap joint for the anchorage of guardrail posts

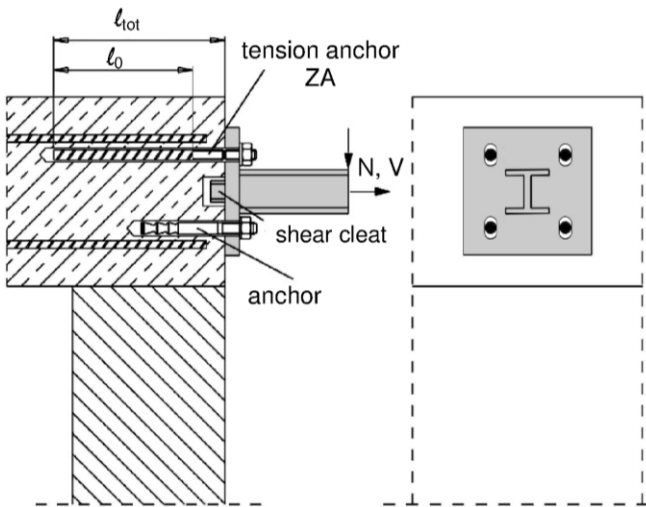


Figure A8: Overlap joint for the anchorage of cantilevers

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.

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 WIT-PE 500

Product description
Applications examples of tension anchor ZA

Annex A3

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/mm ²]	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

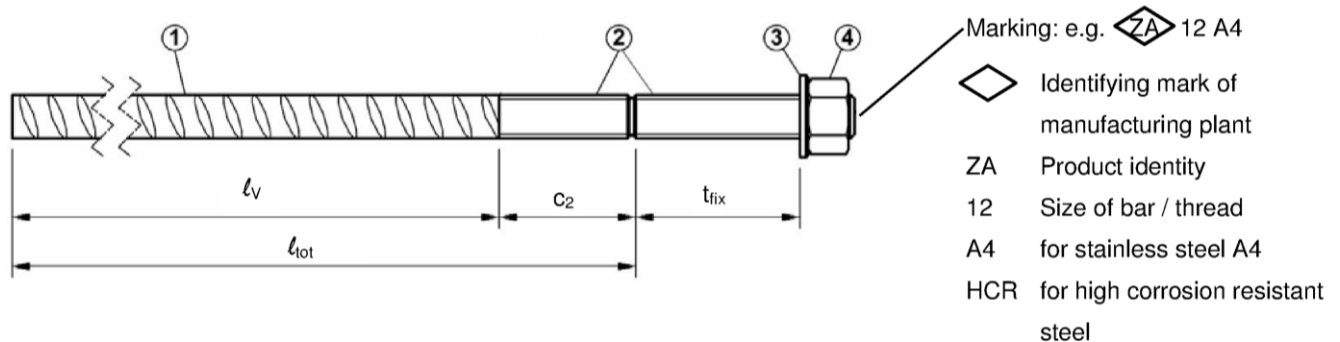


Figure A10: Rebar



Injection System WIT-PE 500

Product description
Materials, Marking

Annex A4

Specifications of intended use

Anchorage 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 $\varnothing + 60$ 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 WIT-PE 500

Intended use

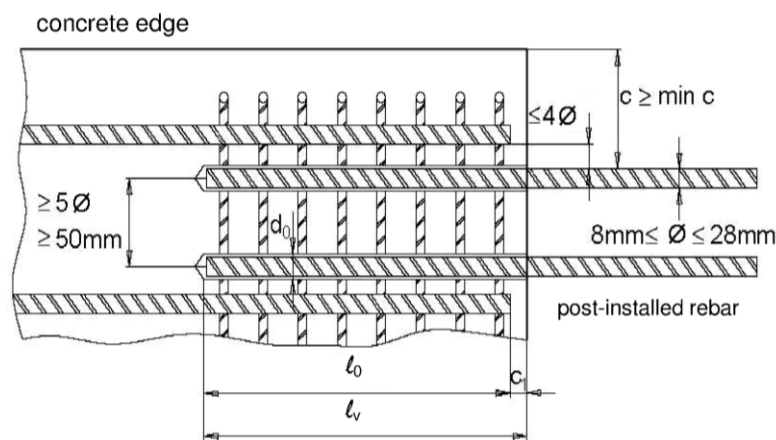
Specifications of intended use

Annex B1

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

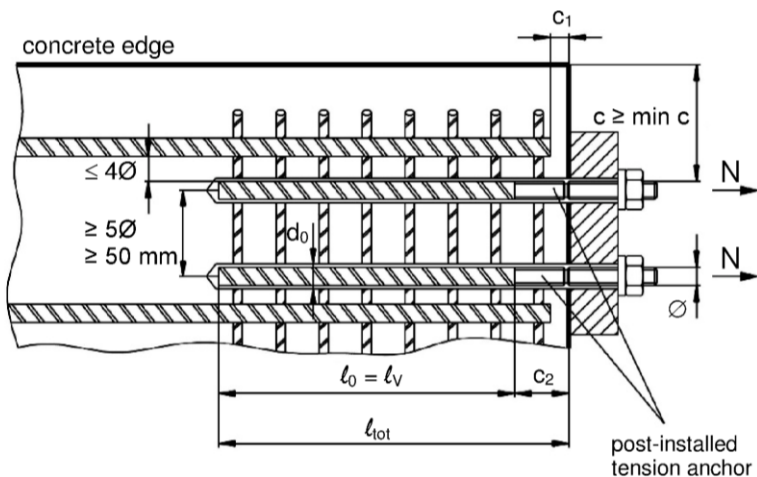
- Bond strength f_{bd} acc. to EN 1992-1-1 may be applied.
- The shear transfer between old and new concrete shall be designed acc. to EN 1992-1-1.
- If the clear distance of overlapping bars is greater than $4 \varnothing$, the lap length must be increased by a length equal to the clear space where it exceeds $4 \varnothing$.
- 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
 \varnothing diameter of post-installed rebar
 l_0 lap length acc. to EN 1992-1-1
 l_v embedment depth $\lambda_v \geq \lambda_0 + c_1$
 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)
 \varnothing diameter of tension anchor
 l_0 lap length acc. to EN 1992-1-1
 l_{tot} embedment depth $l_{tot} \geq l_0 + c_2$
 d_0 nominal drill bit diameter according Annex B4, Table B4

Injection System WIT-PE 500

Intended use
General construction rules

Annex B2

Table B1: Minimum concrete cover $\min c^{1)}$ of post-installed rebars and tension anchor

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 $\ell_v \geq 2 \varnothing$	30 mm + 0.02 $\ell_v \geq 2 \varnothing$
	≥ 25 mm	40 mm + 0.06 $\ell_v \geq 2 \varnothing$	40 mm + 0.02 $\ell_v \geq 2 \varnothing$
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

ZA depending on drilling method and drilling tolerances

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

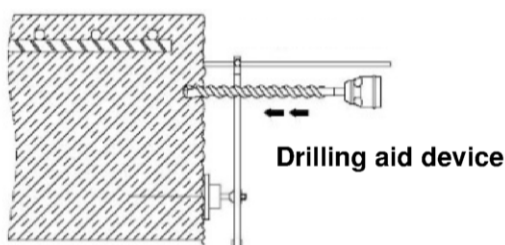


Table B2: Dimensions and installation parameters of tension anchor ZA

Anchor size			M12	M16	M20	M24
Rebar diameter	\varnothing	[mm]	12	16	20	25
Cross-section area (threaded part)	A_s	[mm ²]	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
	A4 / HCR			≥ 100	≥ 100	≥ 100
Maximum installation torque	T_{inst}	[Nm]	50	100	150	150

Table B3: Maximum embedment depth

Rebar / Tension Anchor ZA	Mortar temperature	Max. embedment depth $\ell_{v, max}$
\varnothing 8 to 12 mm	+5°C to +19°C	130 cm
	$\geq 20^\circ\text{C}$	200 cm
\varnothing 14 to 28 mm	+5°C to +19°C	200 cm
	$\geq 20^\circ\text{C}$	280 cm

Injection System WIT-PE 500

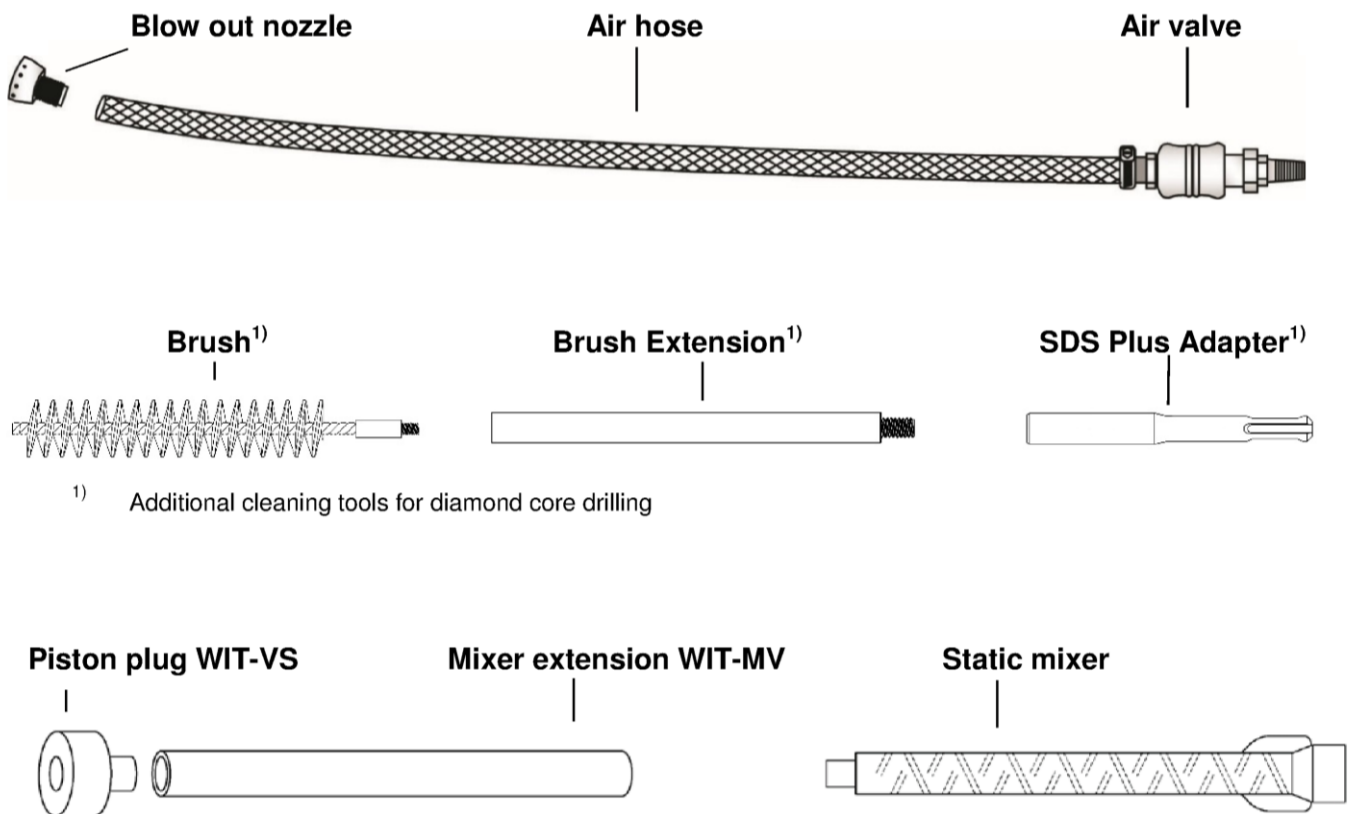
Intended use

Minimum concrete cover, installation parameters, maximum embedment depth

Annex B3

Table B4: Cleaning and installation tools

Rebar Ø	Tension anchor ZA	Drill bit diameter d ₀	Blow out nozzle Ø	Brush Ø (diamond drilling)	Mixer extension (outer Ø)	Piston plug WIT-VS
[mm]	[-]	[mm]	[mm]	[mm]	[mm]	[-]
8	-	12	10	13.0	10	-
10	-	14	10	15.5		14
12	M12	16	14	17.5		16
14	-	18	14	19.5		18
16	M16	20	17	22	16	20
20	M20	25	17	27		25
24	-	30	27	32		28
25	M24	32	27	34		32
26	-	32	27	34		32
28	-	35	27	37		35



¹⁾ Additional cleaning tools for diamond core drilling

Injection System WIT-PE 500

Intended use
Cleaning and Installation tools

Annex B4

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 $> +20^{\circ}\text{C}$ 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.

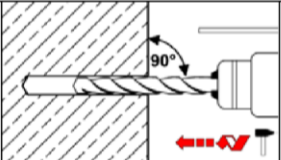
Installation instructions

Preperation:

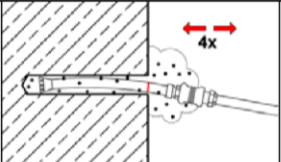
- Remove carbonated concrete and roughen concrete surface prior to installation of post-installed rebars.
- Determine position and diameter of existing reinforcement. Only the admissible force of the existing reinforcement can be transmitted into the post-installed rebar connection
- The drilling aid device must be adjusted towards the existing reinforcement
- 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.
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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 WIT-PE 500

Intended use

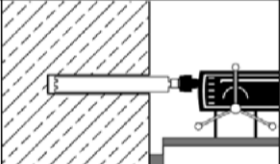
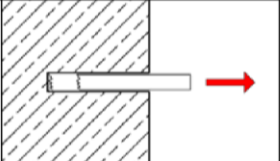
Working and curing time, Installation instructions – Preperation;
Making and cleaning of hammer drilled, vacuum drilled and compressed air drilled holes

Annex B5

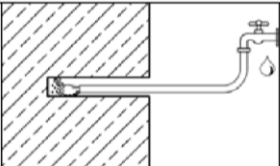
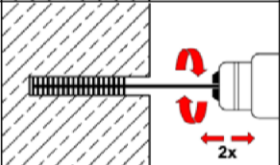
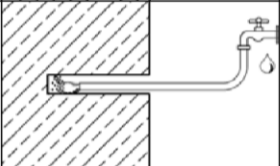
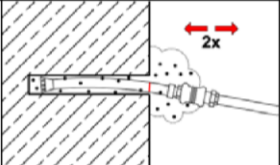
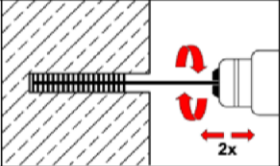
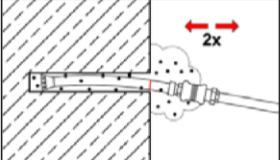
Installation instruction (continuation)

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, starting 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, starting 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 WIT-PE 500

Intended use

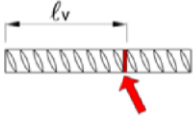
Installation instructions
Making and cleaning of diamond core drilled holes

Annex B6

Installation Instruction (continuation)

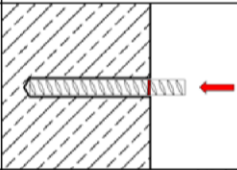
Injection into bore hole

3a



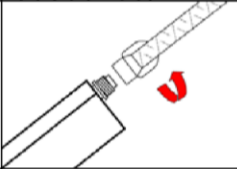
Mark the position of the embedment depth l_v on the rebar.

3b



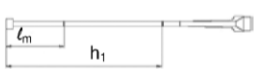
Check bore hole depth by inserting rebar or tension anchor up to the marking in the empty hole.

4



Prepare cartridge with static mixer, mixer extension and piston plug. Mixer extension must correspond the hole depth.

5



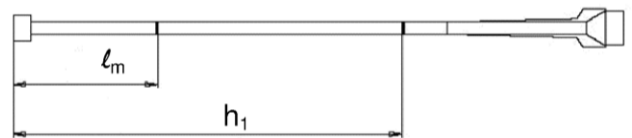
Attach marking length l_m on mixer extension for injection of adhesive:

a) Estimation:

$$l_m = 1/3 * h_1 \quad [\text{mm}]$$

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

$$l_m = h_1 * (1.2 * \frac{\phi^2}{d_0^2} - 0.2) \quad [\text{mm}]$$



l_m Length from the end of the piston plug to the mark on the mixer extension

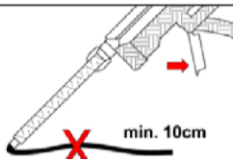
h_1 drill hole depth = embedment depth (l_v resp. l_{tot})

ϕ rebar diameter

d_0 nominal drill bit diameter

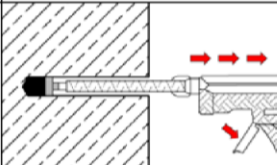
When using hammer drill or diamond core, the length l_m may be multiplied by 1,10.

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 WIT-PE 500 without air bubbles. Inject until the marking l_m on the extension pipe can be seen.

Injection System WIT-PE 500

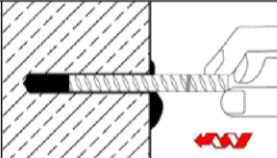
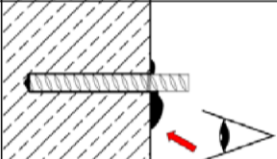
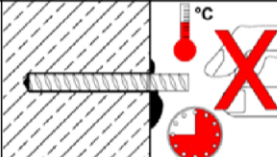
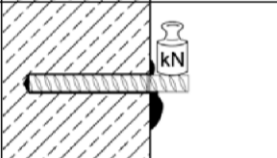
Intended use

Installation instructions
Injection into bore hole

Annex B7

Installation Instruction (continuation)

Installation of rebar or tension anchor

7		<p>Push the rebar or tension anchor into the hole while turning slightly until the embedment depth is reached.</p> <p>The bar should be free of dirt, grease, oil or other foreign material.</p>
8		<p>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.</p>
9		<p>Keep curing time according to Annex B5, Table B5.</p> <p>Do not move or load the rod during curing time.</p>
10		<p>After curing, the rod can be loaded.</p>

Injection System WIT-PE 500

Intended use

Installation instructions
Installation of rebar or tension anchor

Annex B8

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/mm ²]	1.6	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.3
Diamond coring	[N/mm ²]	1.6	2.0	2.3	2.7	3.0	3.0	3.4	3.7	3.7

¹⁾ With $\eta_1 = 1,0$ acc. to EN 1992-1-1 for good bond conditions (for all other bond conditions multiply the values by 0,7)

Injection System WIT-PE 500

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

Annex C1

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: $\theta \leq 270^\circ\text{C}$ $k_{b,fi}(\theta) = 9221.2 \cdot \theta^{-1.747} / (f_{bd} \cdot 4.3) \leq 1.0$

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

$f_{bd,fi}$ design value of 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

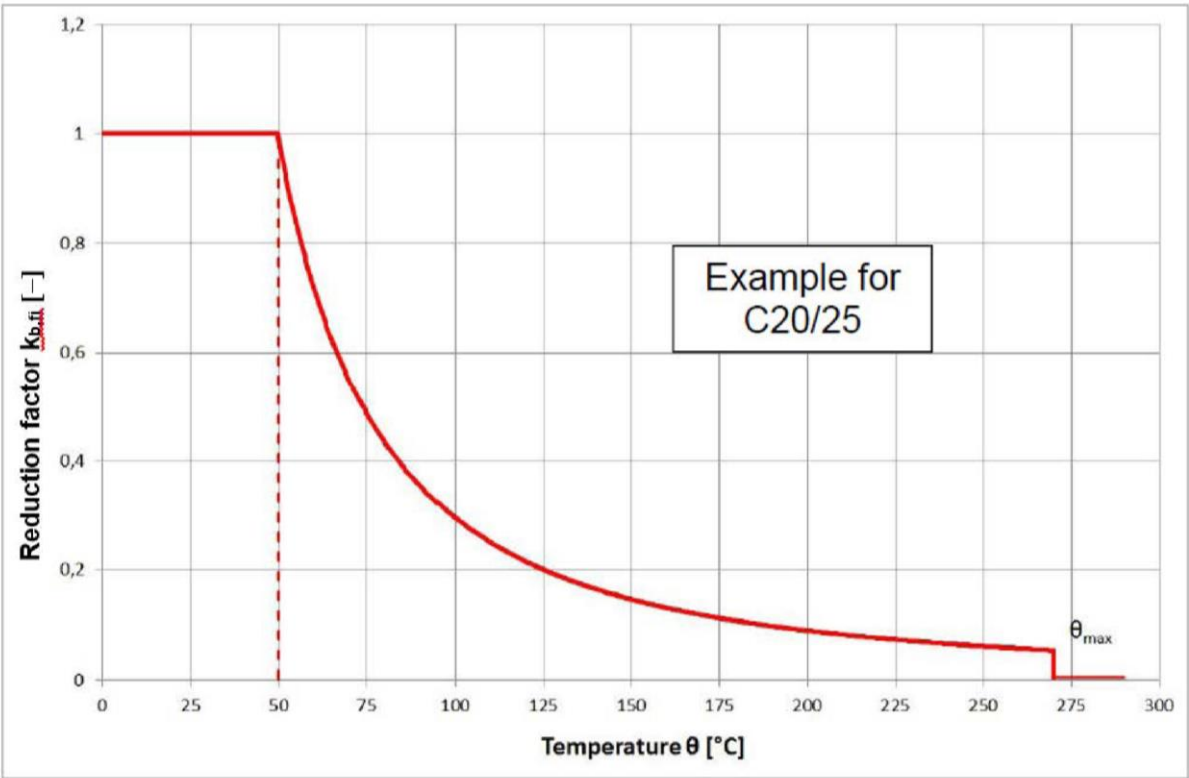
f_{bd} Design value of the ultimate bond stress in N/mm² in cold condition according to Table C2 considering concrete class, rebar diameter, drilling method and the bond conditions according to EN 1992-1-1.

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 WIT-PE 500

Performances

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

Annex C2

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

Injection System WIT-PE 500

Performances

Steel strength for tension anchor ZA under fire exposure

Annex C3