Deutsches Institut für Bautechnik DIBt

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

European Technical Assessment

ETA-21/0172 of 9 March 2021

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	Team Pro Injection system TP E SD+ for concrete
Product family to which the construction product belongs	Bonded fastener for use in concrete
Manufacturer	TEAM PRO INTERNATIONAL FZ-LLC Office No 1006A, Bldg No A2 PO BOX 41010, RAK Vereinigte Arabische Emirate
Manufacturing plant	Team Pro Plant, Germany
This European Technical Assessment contains	39 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 330499-01-0601, Edition 04/2020

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Specific Part

1 Technical description of the product

The "Team Pro Injection system TP E SD+ for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar TP E SD+ and a steel element according to Annex A3 and A5.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, 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 anchor 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 to tension load (static and quasi-static loading)	See Annex B 3, C 1 to C 5, C 7 to C 9, C 11 to C13
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 6, C 10, C 14
Displacements under short-term and long-term loading	See Annex C 15 to C 17
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 18 to C 21

3.2 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release of dangerous substances	No performance assessed

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with the European Assessment Document EAD 330499-01-0601 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

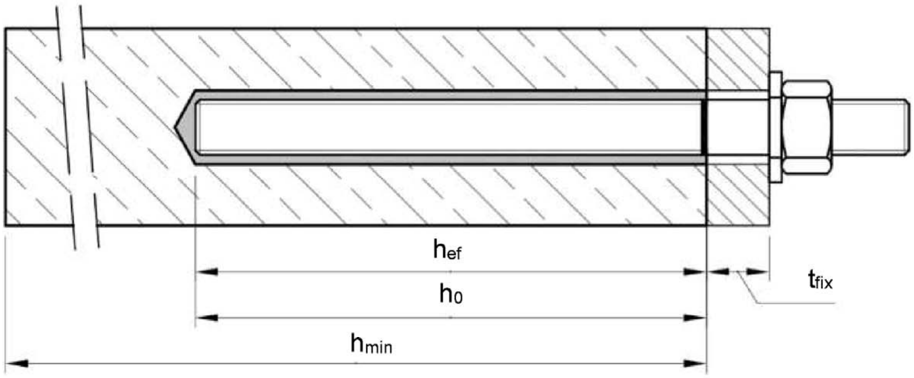
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 9 March 2021 by Deutsches Institut für Bautechnik

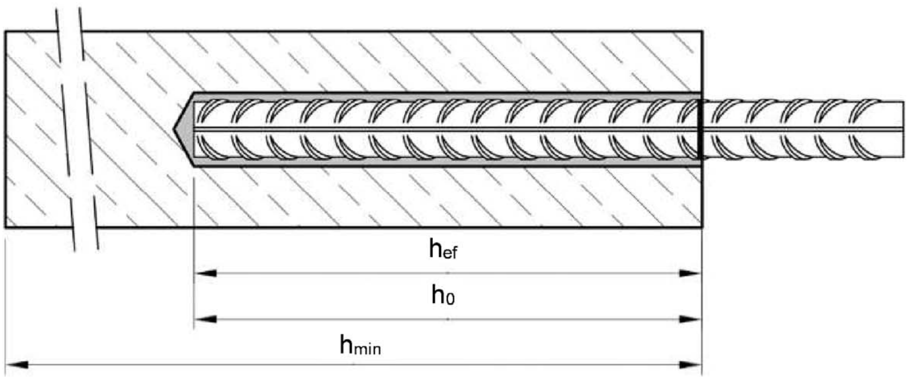
Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

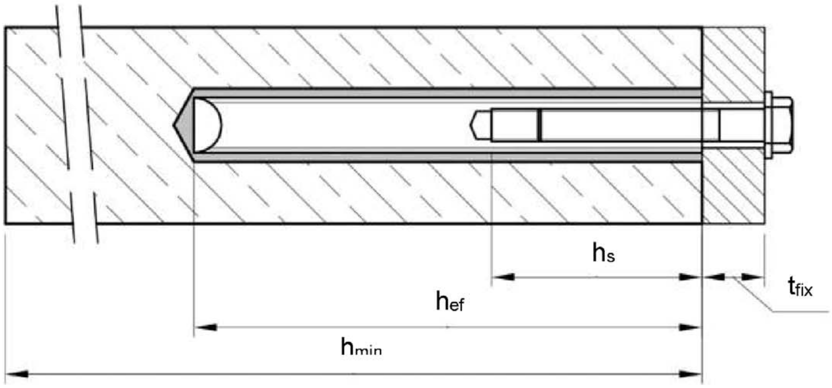
Installation threaded rod M8 up to M30
prepositioned installation or
push through installation (annular gap filled with mortar)



Installation reinforcing bar Ø8 up to Ø32



Installation internal threaded anchor rod IG-M6 up to IG-M20



t_{fix} = thickness of fixture

h_{ef} = effective anchorage depth

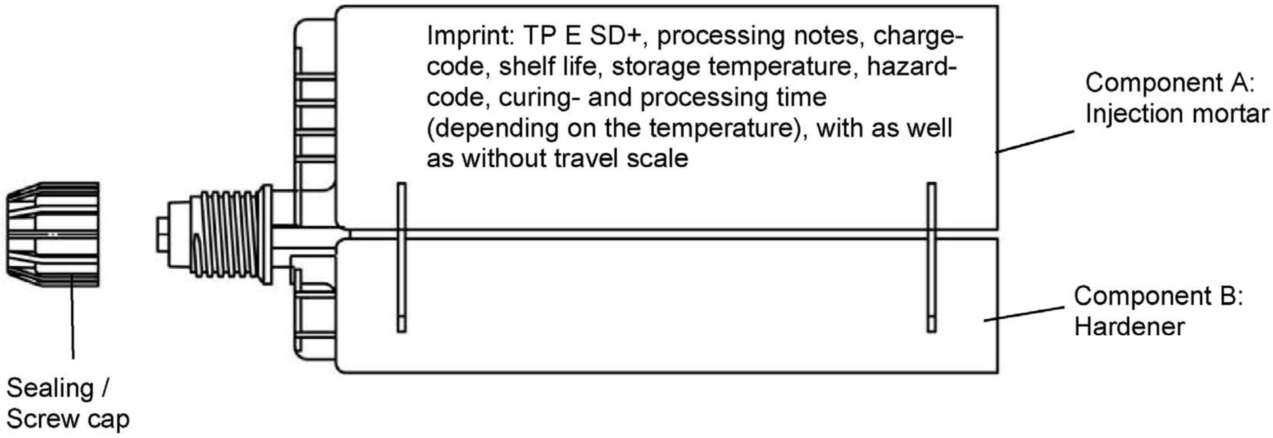
h_0 = depth of drill hole

h_{min} = minimum thickness of member

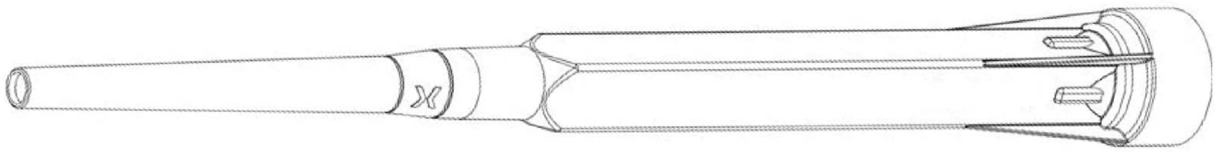
Team Pro Injection system TP E SD+ for concrete	**Annex A 1**
Product description Installed condition	

Cartridge: TP E SD+

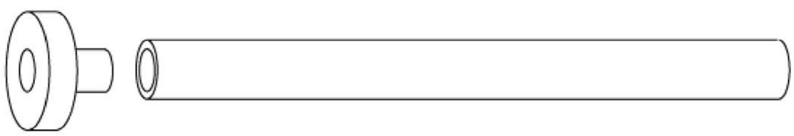
440ml, 585ml and 1400ml cartridge (Type: "side-by-side")



Static Mixer

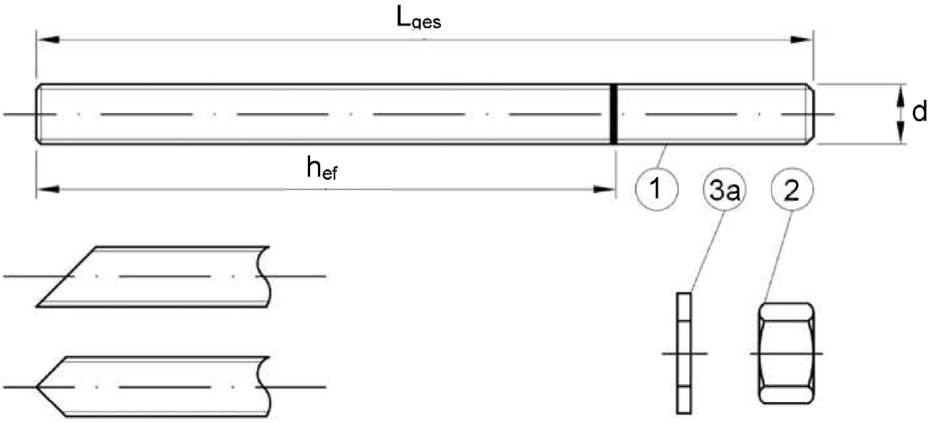


Piston Plug and Mixer Extension



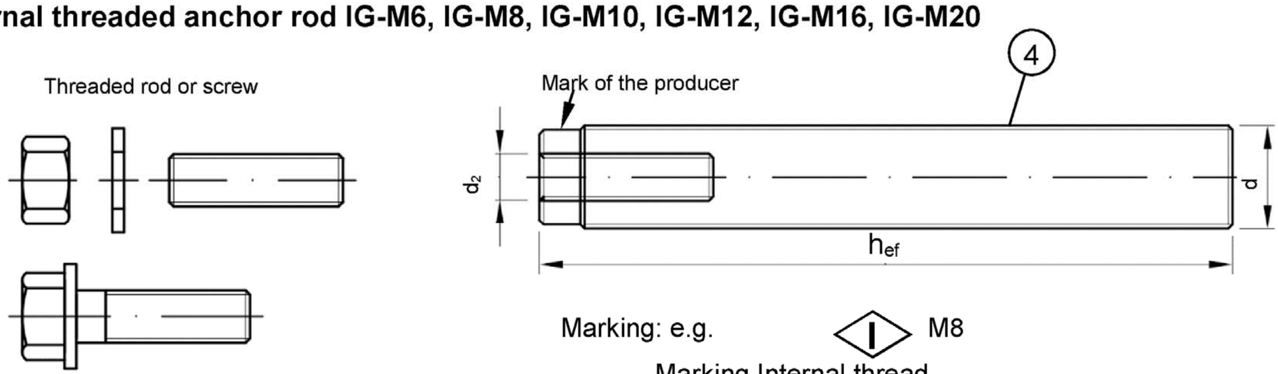
Team Pro Injection system TP E SD+ for concrete	**Annex A 2**
Product description Injection system	

Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut



Commercial standard threaded rod with:
- Materials, dimensions and mechanical properties acc. Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

Internal threaded anchor rod IG-M6, IG-M8, IG-M10, IG-M12, IG-M16, IG-M20



Marking: e.g. ◇I M8

I Marking Internal thread

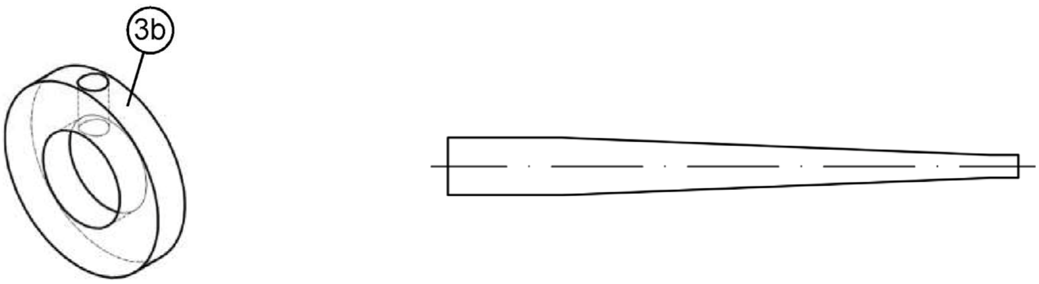
◇ Mark

M8 Thread size (Internal thread)

A4 additional mark for stainless steel

HCR additional mark for high-corrosion resistance steel

Filling washer and mixer reduction nozzle for filling the annular gap between anchor rod and fixture



Team Pro Injection system TP E SD+ for concrete	Annex A 3
Product description Threaded rod, internal threaded rod and filling washer	

Table A1: Materials

Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN 10087:1998 or EN 10263:2001) - zinc plated ≥ 5 µm acc. to EN ISO 4042:1999 or - hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or - sherardized ≥ 45 µm acc. to EN ISO 17668:2016						
1	Threaded rod	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture
		acc. to EN ISO 898-1:2013	4.6	f_{uk} = 400 N/mm²	f_{yk} = 240 N/mm²	A_5 > 8%
			4.8	f_{uk} = 400 N/mm²	f_{yk} = 320 N/mm²	A_5 > 8%
			5.6	f_{uk} = 500 N/mm²	f_{yk} = 300 N/mm²	A_5 > 8%
			5.8	f_{uk} = 500 N/mm²	f_{yk} = 400 N/mm²	A_5 > 8%
			8.8	f_{uk} = 800 N/mm²	f_{yk} = 640 N/mm²	A_5 ≥ 12% [3]
2	Hexagon nut	acc. to EN ISO 898-2:2012	4	for anchor rod class 4.6 or 4.8		
			5	for anchor rod class 5.6 or 5.8		
			8	for anchor rod class 8.8		
3a	Washer	Steel, zinc plated, hot-dip galvanised or sherardized (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Steel, zinc plated, hot-dip galvanised or sherardized				
4	Internal threaded anchor rod	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture
		acc. to EN ISO 898-1:2013	5.8	f_{uk} = 500 N/mm²	f_{yk} = 400 N/mm²	A_5 > 8%
			8.8	f_{uk} = 800 N/mm²	f_{yk} = 640 N/mm²	A_5 > 8%
Stainless steel A2 (Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014) **Stainless steel A4** (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014) **High corrosion resistance steel** (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)						
1	Threaded rod[1)4)]	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture
		acc. to EN ISO 3506-1:2009	50	f_{uk} = 500 N/mm²	f_{yk} = 210 N/mm²	A_5 ≥ 8%
			70	f_{uk} = 700 N/mm²	f_{yk} = 450 N/mm²	A_5 ≥ 12% [3]
			80	f_{uk} = 800 N/mm²	f_{yk} = 600 N/mm²	A_5 ≥ 12% [3]
2	Hexagon nut [1)4)]	acc. to EN ISO 3506-1:2009	50	for anchor rod class 50		
			70	for anchor rod class 70		
			80	for anchor rod class 80		
3a	Washer	A2: Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014 A4: Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014 HCR: Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014 (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Stainless steel A4, High corrosion resistance steel				
4	Internal threaded anchor rod[1)2)]	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture
		acc. to EN ISO 3506-1:2009	50	f_{uk} = 500 N/mm²	f_{yk} = 210 N/mm²	A_5 > 8%
			70	f_{uk} = 700 N/mm²	f_{yk} = 450 N/mm²	A_5 > 8%

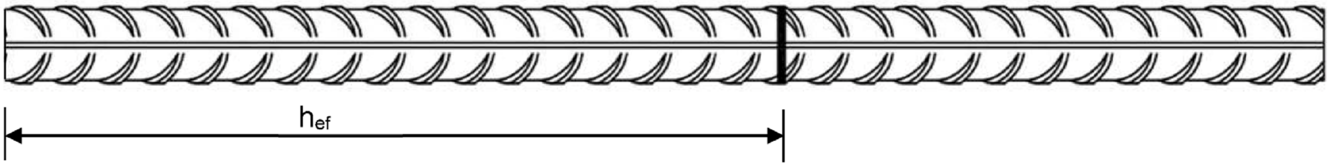
[1)] Property class 70 or 80 for anchor rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IG-M16
[2)] for IG-M20 only property class 50
[3)] A_5 > 8% fracture elongation if no use for seismic performance category C2
[4)] Property class 80 only for stainless steel A4 and HCR

Team Pro Injection system TP E SD+ for concrete

Product description
Materials threaded rod and internal threaded rod

Annex A 4

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 24, ∅ 25, ∅ 28, ∅ 32



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
  (d: Nominal diameter of the bar; h: Rip height of the bar)

Table A2: Materials

Part	Designation	Material
Reinforcing bars		
1	Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Team Pro Injection system TP E SD+ for concrete

Product description
Materials reinforcing bar

Annex A 5

Specifications of intended use

Anchorages subject to (Static and quasi-static loads):

	for a working life of 50 years		for a working life of 100 years	
Base material	Non-cracked concrete	cracked concrete	Non-cracked concrete	cracked concrete
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20		M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	
Diamond drilling (DD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed
Temperature Range:	I: - 40 °C to +40 °C[1)] II: - 40 °C to +72 °C[2)]		I: - 40 °C to +40 °C[1)] II: - 40 °C to +72 °C[2)]	

Anchorages subject to (Seismic action):

	for Performance Category C1	for Performance Category C2
Base material	Cracked and non-cracked concrete	
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32	M12 to M24
Diamond drilling (DD)	No performance assessed	No performance assessed
Temperature Range:	I: - 40 °C to +40 °C[1)] II: - 40 °C to +72 °C[2)]	I: - 40 °C to +40 °C[1)] II: - 40 °C to +72 °C[2)]

[1)] (max long term temperature +24 °C and max short term temperature +40 °C)
[2)] (max long term temperature +50 °C and max short term temperature +72 °C)

Base materials:
- Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016.
- Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016.

Use conditions (Environmental conditions):
- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance class:
  - Stainless steel Stahl A2 according to Annex A 4, Table A1: CRC II
  - Stainless steel Stahl A4 according to Annex A 4, Table A1: CRC III
  - High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V

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.
- The anchorages are designed in accordance to EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB), compressed air (CD) or diamond drill mode (DD).
- Overhead installation allowed.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

Team Pro Injection system TP E SD+ for concrete	**Annex B 2**
Intended Use Specifications	

Table B1: Installation parameters for threaded rod

Anchor size				M8	M10	M12	M16	M20	M24	M27	M30
Diameter of element		$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter		d_0	[mm]	10	12	14	18	22	28	30	35
Effective embedment depth		$h_{ef,min}$	[mm]	60	60	70	80	90	96	108	120
		$h_{ef,max}$	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	Prepositioned installation	$d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Push through installation	d_f	[mm]	12	14	16	20	24	30	33	40
Maximum torque moment		max $T_{inst} \leq$	[Nm]	10	20	40[1)]	60	100	170	250	300
Minimum thickness of member		h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm			$h_{ef} + 2d_0$				
Minimum spacing		s_{min}	[mm]	40	50	60	75	95	115	125	140
Minimum edge distance		c_{min}	[mm]	35	40	45	50	60	65	75	80

[1)] Maximum Torque moment for M12 with steel Grade 4.6 is 35 Nm

Table B2: Installation parameters for rebar

Anchor size			Ø 8[1)]	Ø 10[1)]	Ø 12[1)]	Ø 14	Ø 16	Ø 20	Ø 24[1)]	Ø 25[1)]	Ø 28	Ø 32
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	d_0	[mm]	10 | 12	12 | 14	14 | 16	18	20	25	30 | 32	30 | 32	35	40
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$							
Minimum spacing	s_{min}	[mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	c_{min}	[mm]	35	40	45	50	50	60	70	70	75	85

[1)] both nominal drill hole diameter can be used

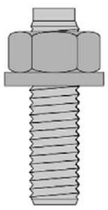
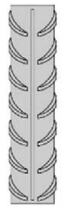
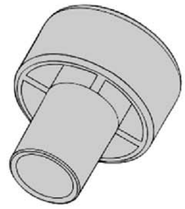
Table B3: Installation parameters for Internal threaded anchor rod

Anchor size			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Internal diameter of anchor rod	d_2	[mm]	6	8	10	12	16	20
Outer diameter of anchor rod[1)]	$d = d_{nom}$	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0	[mm]	12	14	18	22	28	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	70	80	90	96	120
	$h_{ef,max}$	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	7	9	12	14	18	22
Maximum torque moment	max $T_{inst} \leq$	[Nm]	10	10	20	40	60	100
Thread engagement length min/max	l_{IG}	[mm]	8/20	8/20	10/25	12/30	16/32	20/40
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$			
Minimum spacing	s_{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c_{min}	[mm]	40	45	50	60	65	80

[1)] With metric threads according to EN 1993-1-8:2005+AC:2009

Team Pro Injection system TP E SD+ for concrete	**Annex B 3**
Intended Use Installation parameters	

Table B4: Parameter cleaning and setting tools

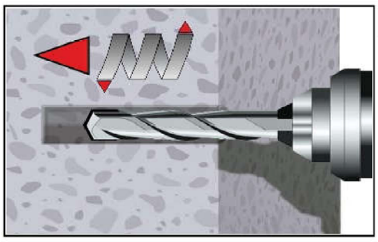
										
Threaded Rod	**Rebar**	**Internal threaded anchor rod**	**d_0 Drill bit - ⌀ HD, HDB, CD, DD**	**d_b Brush - ⌀**		**$d_{b,min}$ min. Brush - ⌀**	**Piston plug**	**Installation direction and use of piston plug**		
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]		↓	→	↑
M8	8		10	RB10	11,5	10,5	No plug required			
M10	8 / 10	IG-M6	12	RB12	13,5	12,5				
M12	10 / 12	IG-M8	14	RB14	15,5	14,5				
	12		16	RB16	17,5	16,5				
M16	14	IG-M10	18	RB18	20,0	18,5	VS18	h_{ef} > 250 mm	h_{ef} > 250 mm	all
	16		20	RB20	22,0	20,5	VS20			
M20		IG-M12	22	RB22	24,0	22,5	VS22			
	20		25	RB25	27,0	25,5	VS25			
M24		IG-M16	28	RB28	30,0	28,5	VS28			
M27	24 / 25		30	RB30	31,8	30,5	VS30			
	24 / 25		32	RB32	34,0	32,5	VS32			
M30	28	IG-M20	35	RB35	37,0	35,5	VS35			
	32		40	RB40	43,5	40,5	VS40			

CAC - Rec. compressed air tool (min 6 bar)
Drill bit diameter (d_0): all diameters

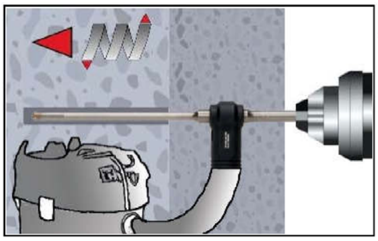
HDB – Hollow drill bit system
Drill bit diameter (d_0): all diameters
The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa <u>and</u> flow rate of minimum 150 m³/h (42 l/s).

Installation instructions

Drilling of the bore hole (HD, HDB, CD)



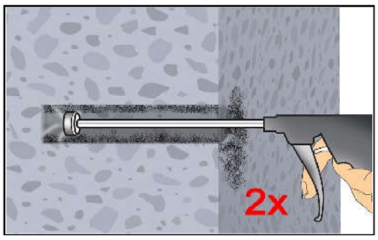
1a. **Hammer (HD) or compressed air drilling (CD)**
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3).
Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.



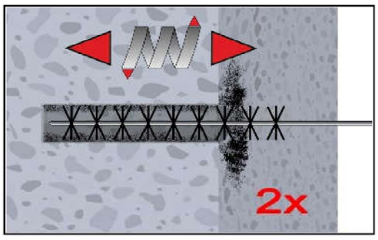
1b. **Hollow drill bit system (HDB) (see Annex B 3)**
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3). This drilling system removes the dust and cleans the bore hole during drilling (all conditions).
Proceed with Step 3.
In case of aborted drill hole, the drill hole shall be filled with mortar.

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

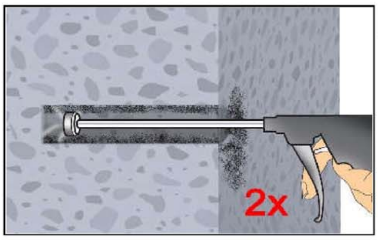
CAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension must be used.

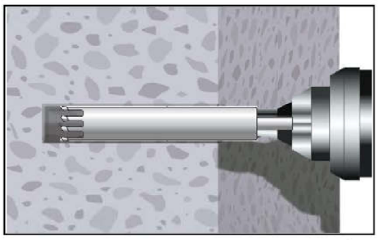


2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

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

Installation instructions (continuation)

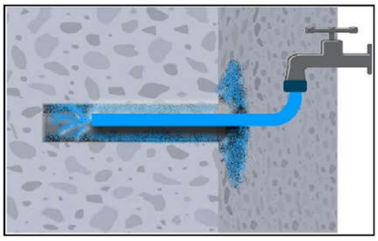
Drilling of the bore hole (DD)



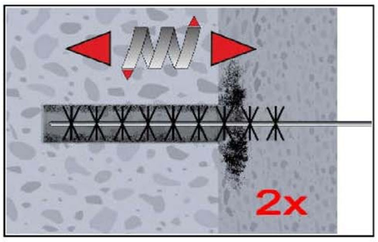
1a. **Diamond drilling (DD)**
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3).
Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.

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

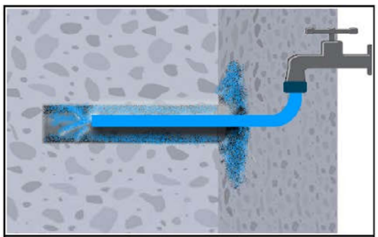
SPCAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete



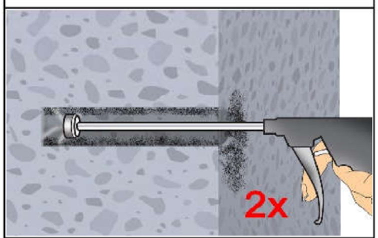
2a. Rinsing with water until clear water comes out.



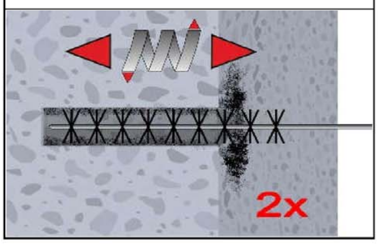
2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension must be used.



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



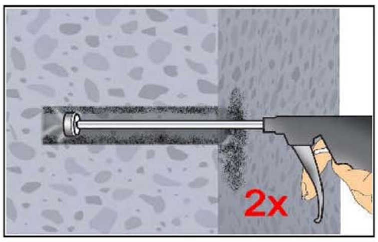
2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



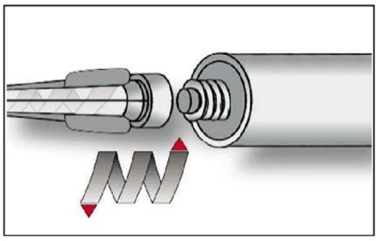
2e. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension must be used.

Team Pro Injection system TP E SD+ for concrete	**Annex B 6**
Intended Use Installation instructions (continuation)	

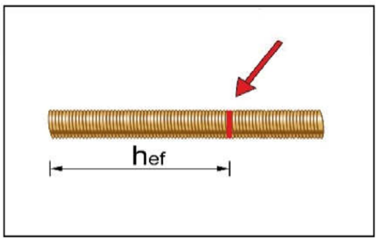
Installation instructions (continuation)



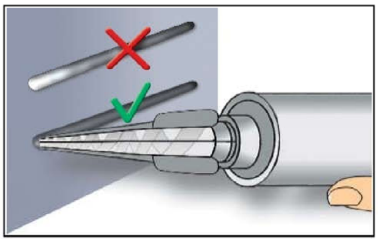
2f. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



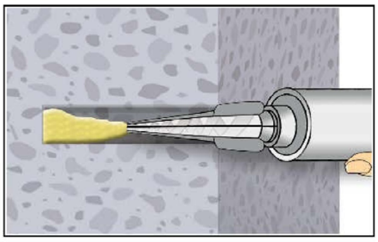
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used.



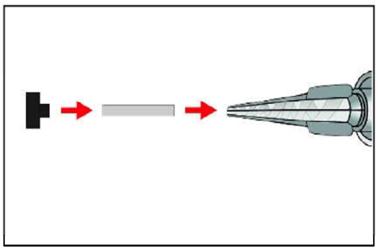
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



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



6. Starting from the bottom or back of the cleaned anchor hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. Observe the gel-/ working times given in Table B5.

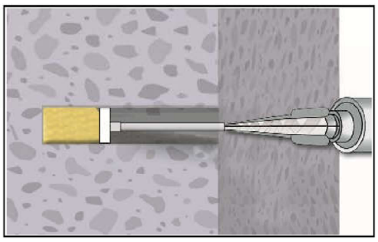


7. Piston plugs shall be used according to Table B4 for the following applications:
- Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$mm
- Overhead assembly (vertical upwards direction): Drill bit-Ø $d_0 \geq 18$ mm

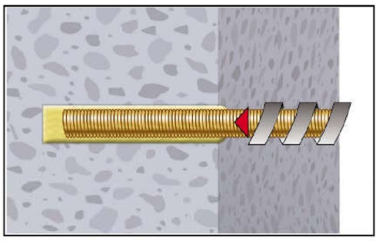
Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.

Team Pro Injection system TP E SD+ for concrete	Annex B 7
Intended Use Installation instructions (continuation)	

Installation instructions (continuation)

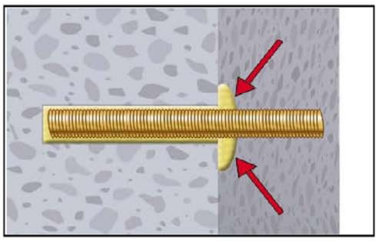


8. Insert piston plug to back of the hole and inject adhesive. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used.
During injection the piston plug is naturally pushed out of the borehole by the back pressure of the mortar. Observe the gel-/ working times given in Table B5.

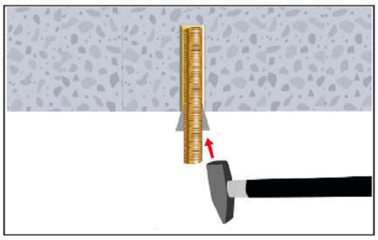


9. Push the fixing element into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment mark has reached the surface level.

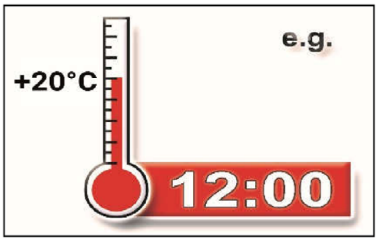
The anchor shall be free of dirt, grease, oil or other foreign material.



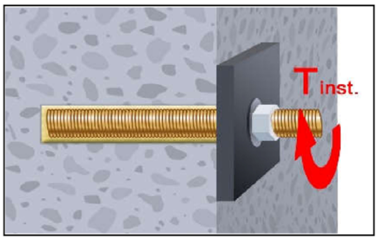
10. After inserting the anchor, the annular gab between anchor rod and concrete, in case of a push through installation additionally also the fixture, must be complete filled with mortar. If excess mortar is not visible at the top of the hole, the requirement is not fulfilled and the application has to be renewed.



11. For overhead application the anchor rod shall be fixed (e.g. wedges) until the mortar has started to harden.



12. Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B5).



13. After full curing, the add-on part can be installed with up to the max. torque (Table B1 or B3) by using a calibrated torque wrench. In case of prepositioned installation the annular gab between anchor and fixture can be optional filled with mortar. Therefor substitute the washer by the filling washer and connect the mixer reduction nozzle to the tip of the mixer. The annular gap is filled with mortar, when mortar oozes out of the washer.

Team Pro Injection system TP E SD+ for concrete	**Annex B 8**
Intended Use Installation instructions (continuation)	

Table B5: Maximum working time and minimum curing time

Concrete temperature	Gelling working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
0 °C to + 4 °C	90 min	144 h	288 h
+ 5 °C to + 9 °C	80 min	48 h	96 h
+ 10 °C to + 14 °C	60 min	28 h	56 h
+ 15 °C to + 19 °C	40 min	18 h	36 h
+ 20 °C to + 24 °C	30 min	12 h	24 h
+ 25 °C to + 34 °C	12 min	9 h	18 h
+ 35 °C to + 39 °C	8 min	6 h	12 h
+40 °C	8 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		

Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods

	Size			M8	M10	M12	M16	M20	M24	M27	M30
	Cross section area	A_s	[mm²]	36,6	58	84,3	157	245	353	459	561
Characteristic tension resistance, Steel failure [1)]											
	Steel, Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Steel, Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280
	Steel, Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449
	Stainless steel A2, A4 and HCR, class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
	Stainless steel A2, A4 and HCR, class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-[3)]	-[3)]
	Stainless steel A4 and HCR, class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-[3)]	-[3)]
Characteristic tension resistance, Partial factor [2)]											
	Steel, Property class 4.6 and 5.6	$\gamma_{Ms,N}$	[-]	2,0							
	Steel, Property class 4.8, 5.8 and 8.8	$\gamma_{Ms,N}$	[-]	1,5							
	Stainless steel A2, A4 and HCR, class 50	$\gamma_{Ms,N}$	[-]	2,86							
	Stainless steel A2, A4 and HCR, class 70	$\gamma_{Ms,N}$	[-]	1,87							
	Stainless steel A4 and HCR, class 80	$\gamma_{Ms,N}$	[-]	1,6							
Characteristic shear resistance, Steel failure [1)]											
Without lever arm	Steel, Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
Without lever arm	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
Without lever arm	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Without lever arm	Stainless steel A2, A4 and HCR, class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Without lever arm	Stainless steel A2, A4 and HCR, class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	-[3)]	-[3)]
Without lever arm	Stainless steel A4 and HCR, class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-[3)]	-[3)]
With lever arm	Steel, Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
With lever arm	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
With lever arm	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
With lever arm	Stainless steel A2, A4 and HCR, class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
With lever arm	Stainless steel A2, A4 and HCR, class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-[3)]	-[3)]
With lever arm	Stainless steel A4 and HCR, class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-[3)]	-[3)]
Characteristic shear resistance, Partial factor [2)]											
	Steel, Property class 4.6 and 5.6	$\gamma_{Ms,V}$	[-]	1,67							
	Steel, Property class 4.8, 5.8 and 8.8	$\gamma_{Ms,V}$	[-]	1,25							
	Stainless steel A2, A4 and HCR, class 50	$\gamma_{Ms,V}$	[-]	2,38							
	Stainless steel A2, A4 and HCR, class 70	$\gamma_{Ms,V}$	[-]	1,56							
	Stainless steel A4 and HCR, class 80	$\gamma_{Ms,V}$	[-]	1,33							

[1)] Values are only valid for the given stress area A_s. Values in brackets are valid for undersized threaded rods with smaller stress area A_s for hot-dip galvanised threaded rods according to EN ISO 10684:2004+AC:2009.
[2)] in absence of national regulation
[3)] Anchor type not part of the ETA

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values for steel tension resistance and steel shear resistance of threaded rods

Annex C 1

Table C2: Characteristic values for Concrete cone failure and Splitting with all kind of action

Anchor				**All Anchor type and sizes**
Concrete cone failure				
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0
Cracked concrete		$k_{cr,N}$	[-]	7,7
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}
Axial distance		$s_{cr,N}$	[mm]	2 $c_{cr,N}$
Splitting				
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right)$
	$h/h_{ef} \leq 1,3$			2,4 h_{ef}
Axial distance		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$

Team Pro Injection system TP E SD+ for concrete	**Annex C 2**
Performances Characteristic values for Concrete cone failure and Splitting with all kind of action	

Table C3: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

Anchor size threaded rod					**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic tension resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	20	20	19	19	18	17	16	16
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	15	15	15	14	13	13	12	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	17	16	16	16	15	14	14	13
Temperature range	II: 72°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	13	13	12	12	11
Temperature range	I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	16	16	16	15	15	14	14	13
Temperature range	II: 72°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,80							
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,68							
Increasing factors for concrete ψ_c			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)			γ_{inst}	[-]	1,2							

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 3

Table C4: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size threaded rod					**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic tension resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	20	20	19	19	18	17	16	16
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm²]	17	16	16	16	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
	I: 40°C/24°C	flooded bore hole			16	16	16	15	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ_c			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)					1,2							

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 4

Table C5: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years

Anchor size threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic tension resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure for a working life of 50 years												
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	12	12	11	11
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	12	12	11	10	9,5	9,5	9,0	9,0
Reduction factor ψ^0_{sus} in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,77							
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,72							
Increasing factors for concrete ψ_c			C25/30		1,04							
			C30/37		1,08							
			C35/45		1,12							
			C40/50		1,15							
			C45/55		1,17							
			C50/60		1,19							
Combined pull-out and concrete failure for a working life of 100 years												
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	15	14	14	13	12	12	11	11
Temperature range	II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	11	11	10	10	9,5	9,0	8,5	8,5
Increasing factors for concrete ψ_c			C25/30		1,04							
			C30/37		1,08							
			C35/45		1,12							
			C40/50		1,15							
			C45/55		1,17							
			C50/60		1,19							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete (DD)			γ_{inst}	[-]	1,0							
for flooded bore hole (DD)			γ_{inst}	[-]	1,2			1,4				

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 5

Deutsches Institut für Bautechnik DIBt

Table C6: Characteristic values of shear loads under static and quasi-static action										
Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic shear resistance Steel, strength class 4.6, 4.8 and 5.6, 5.8	$V^0_{Rk,s}$	[kN]	$0,6 \cdot A_s \cdot f_{uk}$ (or see Table C1)							
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A2, A4 and HCR, all strength classes	$V^0_{Rk,s}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$ (or see Table C1)							
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Concrete pry-out failure										
Factor	k_8	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$						$\min(h_{ef};\ 300mm)$	
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

Table C7: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

Anchor size internal threaded anchor rods					**IG-M6**	**IG-M8**	**IG-M10**	**IG-M12**	**IG-M16**	**IG-M20**
Steel failure[1]										
Characteristic tension resistance, Steel, strength class		5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123
		8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor, strength class 5.8 and 8.8			$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 [2]			$N_{Rk,s}$	[kN]	14	26	41	59	110	124
Partial factor			$\gamma_{Ms,N}$	[-]	1,87					2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	20	19	19	18	17	16
	II: 72°C/50°C				15	15	14	13	13	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	16	16	16	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole			16	16	15	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,80					
	II: 72°C/50°C				0,68					
Increasing factors for concrete ψ_c			C25/30		1,02					
			C30/37		1,04					
			C35/45		1,07					
			C40/50		1,08					
			C45/55		1,09					
			C50/60		1,10					
Concrete cone failure										
Relevant parameter					see Table C2					
Splitting failure										
Relevant parameter					see Table C2					
Installation factor										
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0					
for flooded bore hole (HD; HDB, CD)					1,2					

[1] Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
[2] For IG-M20 strength class 50 is valid

Team Pro Injection system TP E SD+ for concrete

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Characteristic values of tension loads under static and quasi-static action

Annex C 7

Table C8: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size internal threaded anchor rods					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure[1]										
Characteristic tension resistance, Steel, strength class	5.8		$N_{Rk,s}$	[kN]	10	17	29	42	76	123
	8.8		$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor, strength class 5.8 and 8.8			$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 [2]			$N_{Rk,s}$	[kN]	14	26	41	59	110	124
Partial factor			$\gamma_{Ms,N}$	[-]	1,87					2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	20	19	19	18	17	16
	II: 72°C/50°C				15	15	14	13	13	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm²]	16	16	16	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole			16	16	15	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	6,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ_c			C25/30		1,02					
			C30/37		1,04					
			C35/45		1,07					
			C40/50		1,08					
			C45/55		1,09					
			C50/60		1,10					
Concrete cone failure										
Relevant parameter					see Table C2					
Splitting failure										
Relevant parameter					see Table C2					
Installation factor										
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0					
for flooded bore hole (HD; HDB, CD)					1,2					

3) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
4) For IG-M20 strength class 50 is valid

Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

Anchor size internal threaded anchor rods					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure[1)]										
Characteristic tension resistance, Steel, strength class	5.8		$N_{Rk,s}$	[kN]	10	17	29	42	76	123
	8.8		$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor, strength class 5.8 and 8.8			$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 [2)]			$N_{Rk,s}$	[kN]	14	26	41	59	110	124
Partial factor			$\gamma_{Ms,N}$	[-]	1,87					2,86
Combined pull-out and concrete cone failure for a working life of 50 years										
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	12	12	11
	II: 72°C/50°C				12	11	10	9,5	9,5	9,0
Reduction factor ψ^0_{sus} in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,77					
	II: 72°C/50°C				0,72					
Increasing factors for concrete ψ_c			C25/30		1,04					
			C30/37		1,08					
			C35/45		1,12					
			C40/50		1,15					
			C45/55		1,17					
			C50/60		1,19					
Combined pull-out and concrete cone failure for a working life of 100 years										
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	14	14	13	12	12	11
	II: 72°C/50°C				11	10	10	9,5	9,0	8,5
Increasing factors for concrete ψ_c			C25/30		1,04					
			C30/37		1,08					
			C35/45		1,12					
			C40/50		1,15					
			C45/55		1,17					
			C50/60		1,19					
Concrete cone failure										
Relevant parameter					see Table C2					
Splitting failure										
Relevant parameter					see Table C2					
Installation factor										
for dry and wet concrete (DD)			γ_{inst}	[-]	1,0					
for flooded bore hole (DD)					1,2		1,4			

1) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
2) For IG-M20 strength class 50 is valid

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 9

Table C10: Characteristic values of shear loads under static and quasi-static action

Anchor size for internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure without lever arm[1]									
Characteristic shear resistance, Steel, strength class	5.8	$V^0_{Rk,s}$	[kN]	5	9	15	21	38	61
	8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60	98
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70[2]		$V^0_{Rk,s}$	[kN]	7	13	20	30	55	40
Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Ductility factor		k_7	[-]	1,0					
Steel failure with lever arm[1]									
Characteristic bending moment, Steel, strength class	5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
	8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70[2]		$M^0_{Rk,s}$	[Nm]	11	26	52	92	233	456
Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Concrete pry-out failure									
Factor		k_8	[-]	2,0					
Installation factor		γ_{inst}	[-]	1,0					
Concrete edge failure									
Effective length of fastener		l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$					$\min(h_{ef};\ 300mm)$
Outside diameter of fastener		d_{nom}	[mm]	10	12	16	20	24	30
Installation factor		γ_{inst}	[-]	1,0					

[1] Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
[2] For IG-M20 strength class 50 is valid

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Performances
Characteristic values of shear loads under static and quasi-static action

Annex C 10

Table C11: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

Anchor size reinforcing bar					Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure														
Characteristic tension resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ [1)]									
Cross section area			A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			$\gamma_{Ms,N}$	[-]	1,4[2)]									
Combined pull-out and concrete failure														
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	16	16	16	16	16	16	15	15	15	15
	II: 72°C/50°C				12	12	12	12	12	12	12	12	11	11
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	13	13	13	13	13	13	13
	II: 72°C/50°C				12	12	12	11	11	11	11	11	11	11
	I: 40°C/24°C	flooded bore hole			13	13	13	13	13	13	13	13	13	13
	II: 72°C/50°C				11	11	11	11	11	11	11	11	11	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,80									
	II: 72°C/50°C				0,68									
Increasing factors for concrete ψ_c			C25/30		1,02									
			C30/37		1,04									
			C35/45		1,07									
			C40/50		1,08									
			C45/55		1,09									
			C50/60		1,10									
Concrete cone failure														
Relevant parameter					see Table C2									
Splitting														
Relevant parameter					see Table C2									
Installation factor														
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0									
for flooded bore hole (HD; HDB, CD)					1,2									

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 11

Table C12: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ [1)]									
Cross section area		A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 [2)]									
Combined pull-out and concrete failure													
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	16	16	16	16	16	16	15	15	15	15
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	12	12	12	12	12	12	12	12	11	11
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)													
Temperature range I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm²]	14	14	13	13	13	13	13	13	13	13
Temperature range II: 72°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm²]	12	12	12	11	11	11	11	11	11	11
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	13	13	13	13	13	13	13	13	13	13
Temperature range II: 72°C/50°C	flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	11	11	11	11	11	11	11	11	11	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ_c		C25/30		1,02									
		C30/37		1,04									
		C35/45		1,07									
		C40/50		1,08									
		C45/55		1,09									
		C50/60		1,10									
Concrete cone failure													
Relevant parameter				see Table C2									
Splitting													
Relevant parameter				see Table C2									
Installation factor													
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0									
for flooded bore hole (HD; HDB, CD)		γ_{inst}	[-]	1,2									

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

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Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 12

Table C13: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ [1)]									
Cross section area		A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4[2)]									
Combined pull-out and concrete failure for a working life of 50 years													
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	14	13	13	13	12	12	11	11	11	11
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	11	11	10	10	10	9,5	9,5	9,5	9,0	9,0
Reduction factor ψ^0_{sus} in non-cracked concrete C20/25 in diamond drilled holes (DD)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,77									
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,72									
Increasing factors for concrete ψ_c		C25/30		1,04									
		C30/37		1,08									
		C35/45		1,12									
		C40/50		1,15									
		C45/55		1,17									
		C50/60		1,19									
Combined pull-out and concrete failure for a working life of 100 years													
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	14	13	13	13	12	12	11	11	11	11
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5
Increasing factors for concrete ψ_c		C25/30		1,04									
		C30/37		1,08									
		C35/45		1,12									
		C40/50		1,15									
		C45/55		1,17									
		C50/60		1,19									
Concrete cone failure													
Relevant parameter				see Table C2									
Splitting													
Relevant parameter				see Table C2									
Installation factor													
for dry and wet concrete (DD)		γ_{inst}	[-]	1,0									
for flooded bore hole (DD)		γ_{inst}	[-]	1,2				1,4					

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 13

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Table C14: Characteristic values of shear loads under static and quasi-static action

Anchor size reinforcing bar			**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 24**	**∅ 25**	**∅ 28**	**∅ 32**
Steel failure without lever arm												
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$ 1)									
Cross section area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 2)									
Ductility factor	k_7	[-]	1,0									
Steel failure with lever arm												
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}$ 1)									
Elastic section modulus	W_{el}	[mm³]	50	98	170	269	402	785	1357	1534	2155	3217
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 2)									
Concrete pry-out failure												
Factor	k_8	[-]	2,0									
Installation factor	γ_{inst}	[-]	1,0									
Concrete edge failure												
Effective length of fastener	l_f	[mm]	$\min(h_{ef};\ 12 \cdot d_{nom})$							$\min(h_{ef};\ 300mm)$		
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation factor	γ_{inst}	[-]	1,0									

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of shear loads under static and quasi-static action

Annex C 14

Table C15: Displacements under tension load[1] in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,038	0,039	0,040	0,044	0,047	0,051	0,052	0,055
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,047	0,049	0,051	0,055	0,059	0,064	0,067	0,070
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,069	0,071	0,072	0,074	0,076	0,079	0,081	0,082
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,100	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,092	0,095	0,096	0,099	0,102	0,106	0,109	0,110
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,134	0,154	0,163	0,172	0,181	0,189	0,207	0,229

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C16: Displacements under tension load[1] in diamond drilled holes (DD)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Non-cracked concrete under static and quasi-static action for a working life of 50 years										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,018	0,019	0,019	0,020	0,022	0,023	0,024	0,025
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,052	0,053	0,055	0,058	0,062	0,065	0,068	0,070
Non-cracked concrete under static and quasi-static action for a working life of 100 years										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,020	0,021	0,021	0,023	0,024	0,025	0,026	0,027
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,038	0,039	0,040	0,043	0,045	0,047	0,049	0,051

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C17: Displacements under shear load[1] for all drilling methods

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Non-cracked and cracked concrete under static and quasi-static action										
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Team Pro Injection system TP E SD+ for concrete

Performances
Displacements under static and quasi-static action (threaded rods)

Annex C 15

Table C18: Displacements under tension load[1] in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,029	0,030	0,033	0,035	0,038	0,041
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,029	0,030	0,033	0,035	0,038	0,041
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,039	0,040	0,044	0,047	0,051	0,055
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,049	0,051	0,055	0,059	0,064	0,070
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,071	0,072	0,074	0,076	0,079	0,082
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,115	0,122	0,128	0,135	0,142	0,171
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,095	0,096	0,099	0,102	0,106	0,110
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,154	0,163	0,172	0,181	0,189	0,229

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C19: Displacements under tension load[1] in diamond drilled holes (DD)

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Non-cracked concrete under static and quasi-static action for a working life of 50 years								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,019	0,019	0,020	0,022	0,023	0,025
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,053	0,055	0,058	0,062	0,065	0,070
Non-cracked concrete under static and quasi-static action for a working life of 100 years								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,021	0,021	0,023	0,024	0,025	0,027
Temperature range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,039	0,040	0,043	0,045	0,047	0,051

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C20: Displacements under shear load[1] for all drilling methods

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Non-cracked and cracked concrete under static and quasi-static action								
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$-factor	[mm/kN]	0,10	0,09	0,08	0,08	0,06	0,06

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Team Pro Injection system TP E SD+ for concrete

Performances
Displacements under static and quasi-static action (Internal threaded anchor rod)

Annex C 16

Table C21: Displacements under tension load[1)] in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temp.- range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
Temp.- range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	0,058
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	0,072
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temp.- range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	0,084
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	0,194
Temp.- range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,092	0,095	0,096	0,098	0,099	0,102	0,106	0,106	0,109	0,113
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,154	0,163	0,172	0,181	0,189	0,207	0,229	0,229	0,242	0,260

1) Calculation of the displacement

$\delta_{N0} = \delta_{N0}$-factor $\cdot \tau$; τ: action bond stress for tension

$\delta_{N\infty} = \delta_{N\infty}$-factor $\cdot \tau$;

Table C22: Displacements under tension load[1)] in diamond drilled holes (DD)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Non-cracked concrete under static and quasi-static action for a working life of 50 years												
Temp.- range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,008	0,009	0,009	0,01	0,011	0,012	0,013	0,013	0,014	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,018	0,018	0,019	0,020	0,021	0,024	0,027	0,027	0,028	0,031
Temp.- range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,048	0,051	0,054	0,058	0,061	0,068	0,076	0,076	0,081	0,088
Non-cracked concrete under static and quasi-static action for a working life of 100 years												
Temp.- range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	0,015
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,018	0,020	0,021	0,022	0,024	0,026	0,029	0,029	0,031	0,034
Temp.- range II: 72°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,035	0,037	0,040	0,042	0,045	0,049	0,055	0,055	0,059	0,064

1) Calculation of the displacement

$\delta_{N0} = \delta_{N0}$-factor $\cdot \tau$; τ: action bond stress for tension

$\delta_{N\infty} = \delta_{N\infty}$-factor $\cdot \tau$;

Table C23: Displacements under shear load[1)] for all drilling methods

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Non-cracked and cracked concrete under static and quasi-static action												
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

1) Calculation of the displacement

$\delta_{V0} = \delta_{V0}$-factor $\cdot V$; V: action shear load

$\delta_{V\infty} = \delta_{V\infty}$-factor $\cdot V$;

Team Pro Injection system TP E SD+ for concrete	**Annex C 17**
Performances Displacements under static and quasi-static action (rebar)	

Table C24: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years

Anchor size threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Characteristic tension resistance		$N_{Rk,s,eq,C1}$	[kN]	$1{,}0 \cdot N_{Rk,s}$							
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure											
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)											
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0							
Installation factor											
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)		γ_{inst}	[-]	1,2							

Table C25: Characteristic values of shear loads under seismic action (performance category C1)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Characteristic shear resistance (Seismic C1)	$V_{Rk,s,eq,C1}$	[kN]	$0{,}70 \cdot V^0_{Rk,s}$							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[1)]							

1) Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

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Table C26: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years

Anchor size reinforcing bar					∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 24	∅ 25	∅ 28	∅ 32
Steel failure														
Characteristic tension resistance			$N_{Rk,s,eq,C1}$	[kN]	$1{,}0 \cdot A_s \cdot f_{uk}$ [1)]									
Cross section area			A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			$\gamma_{Ms,N}$	[-]	1,4[2)]									
Combined pull-out and concrete failure														
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete ψ_c			C25/30 to C50/60		1,0									
Installation factor														
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0									
for flooded bore hole (HD; HDB, CD)					1,2									

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

Table C27: Characteristic values of shear loads under seismic action (performance category C1)

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 24	∅ 25	∅ 28	∅ 32
Steel failure												
Characteristic shear resistance	$V_{Rk,s,eq,C1}$	[kN]	$0{,}35 \cdot A_s \cdot f_{uk}$ [1)]									
Cross section area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5[2)]									
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[3)]									

1) f_{uk} shall be taken from the specifications of reinforcing bars
2) in absence of national regulation
3) Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

Team Pro Injection system TP E SD+ for concrete

Performances
Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (rebar)

Annex C 19

Table C28: Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 and 100 years

Anchor size threaded rod				M12	M16	M20	M24
Steel failure							
Characteristic tension resistance, Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥70		$N_{Rk,s,eq,C2}$	[kN]	$1,0 \cdot N_{Rk,s}$			
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1			
Combined pull-out and concrete failure							
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)							
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C2}$	[N/mm²]	5,8	4,8	5,0	5,1
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C2}$	[N/mm²]	5,0	4,1	4,3	4,4
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0			
Installation factor							
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0			
for flooded bore hole (HD; HDB, CD)		γ_{inst}	[-]	1,2			

Table C29: Characteristic values of shear loads under seismic action (performance category C2)

Anchor size threaded rod			M12	M16	M20	M24
Steel failure						
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥70	$V_{Rk,s,eq,C2}$	[kN]	$0,70 \cdot V^0_{Rk,s}$			
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1			
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[1)]			

[1)] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

Table C30: Displacements under tension load (threaded rod)

Anchor size threaded rod			**M12**	**M16**	**M20**	**M24**
Non-cracked and cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{N,eq,C2(DLS)}$	[mm]	0,21	0,24	0,27	0,36
	$\delta_{N,eq,C2(ULS)}$	[mm]	0,54	0,51	0,54	0,63

Table C31: Displacements under shear load (threaded rod)

Anchor size threaded rod			**M12**	**M16**	**M20**	**M24**
Non-cracked and cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{V,eq,C2(DLS)}$	[mm]	3,1	3,4	3,5	4,2
	$\delta_{V,eq,C2(ULS)}$	[mm]	6,0	7,6	7,3	10,9

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Bautechnisches Prüfamt

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European Technical Assessment

ETA-21/0171 of 4 March 2021

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	Team Pro Injection system TP E SD+ for rebar connection
Product family to which the construction product belongs	Systems for post-installed rebar connections with mortar
Manufacturer	TEAM PRO INTERNATIONAL FZ-LLC Office No 1006A, Bldg No A2 PO BOX 41010, RAK Vereinigte Arabische Emirate
Manufacturing plant	Team Pro Plant, Germany
This European Technical Assessment contains	22 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330087-00-0601, Edition 05/2018

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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 "Team Pro Injection System TP E SD+ 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 from sizes M12 to M24 according to Annex A and injection mortar TP E SD+ are used for rebar connections. The rebar is placed into a drilled hole filled with injection mortar and is anchored via the bond between rebar, injection mortar and concrete.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the rebar connection of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance under static and quasi-static loading	See Annex C 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 2 and C 3

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 330087-00-0601, the applicable European legal act is: [96/582/EC].

The system(s) to be applied is (are): 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 4 March 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Referatsleiterin

beglaubigt:
Baderschneider

Installation post installed rebar

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

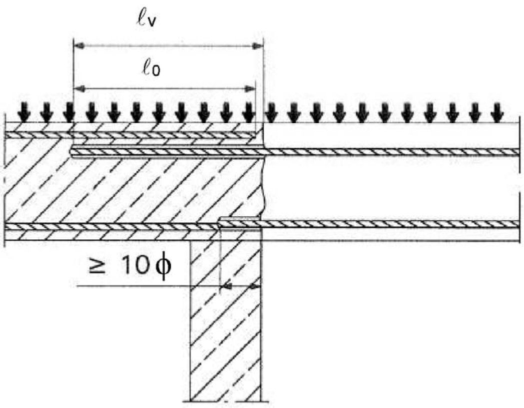


Figure A2: Overlapping joint at a foundation of a wall or column where the rebars are stressed in tension

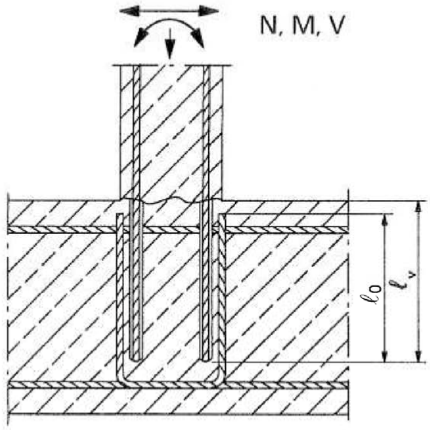


Figure A3: End anchoring of slabs or beams (e.g. designed as simply supported)

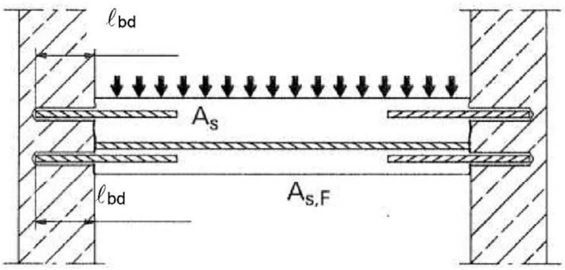


Figure A4: Rebar connection for components stressed primarily in compression. The rebars sre stressed in compression

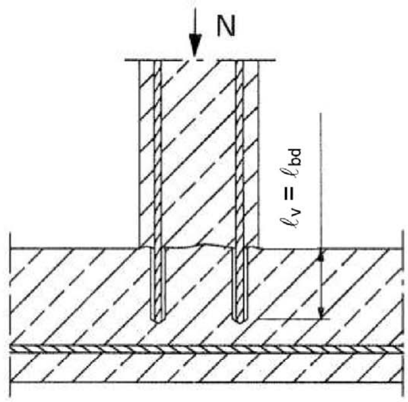
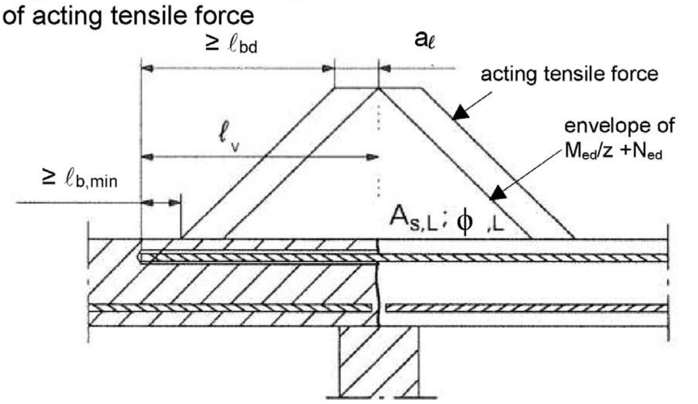


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force



Note to Figure A1 to A5:

In the Figures no transverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1:2004+AC:2010.

Preparing of joints according to Annex B 2

Team Pro Injection system TP E SD+ for rebar connection	**Annex A 1**
Product description Installed condition and examples of use for rebars	

Installation tension anchor ZA

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

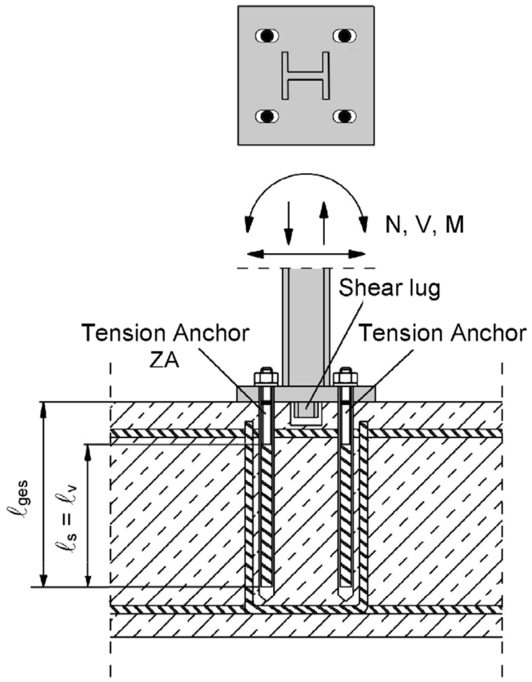


Figure A7: Overlap joint for the anchorage of barrier posts

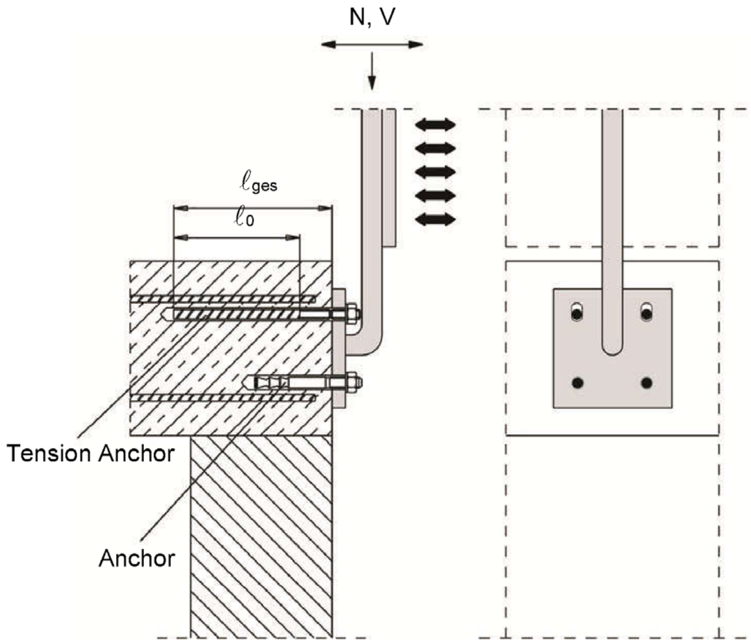
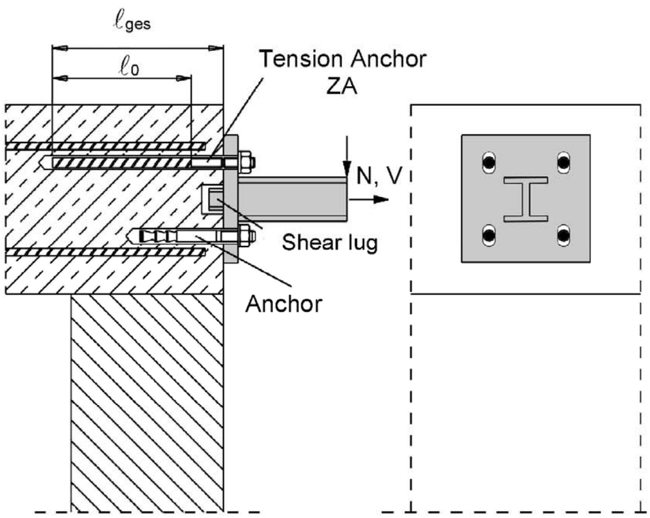


Figure A8: Overlap joint for the anchorage to centilever members



Note to Figure A6 to A8:

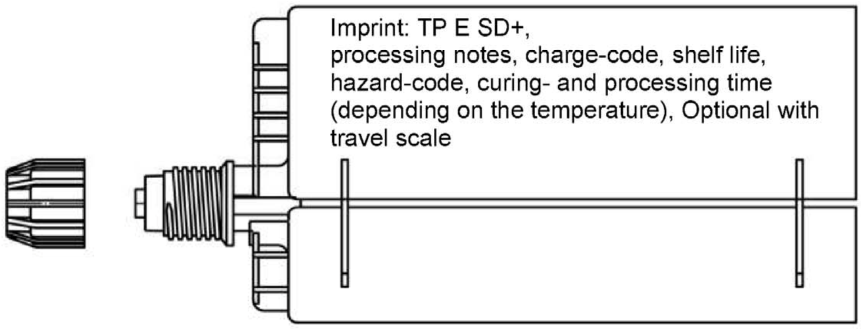
In the Figures no transverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1:2002+AC:2010

Team Pro Injection system TP E SD+ for rebar connection	**Annex A 2**
Product description Installed condition and examples of use for tension anchors ZA	

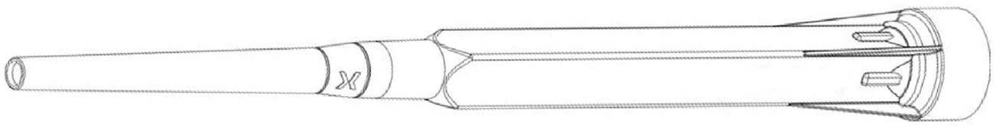
Team Pro Injection system TP E SD+:

Injection mortar: TP E SD+

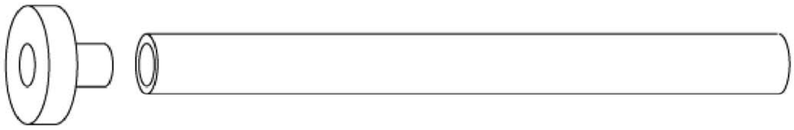
Type “side-by-side”:
440ml, 585 ml and 1400 ml cartridge



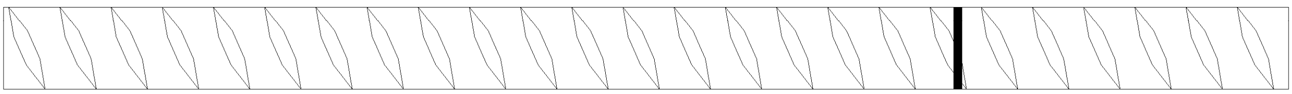
Static Mixer



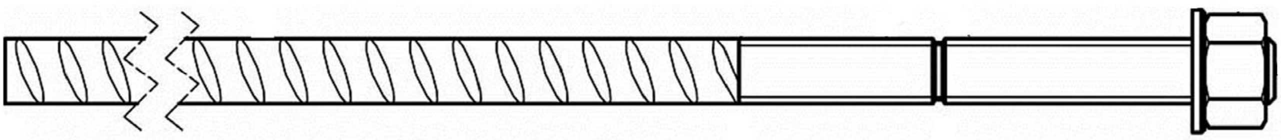
Piston plug and mixer extension



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

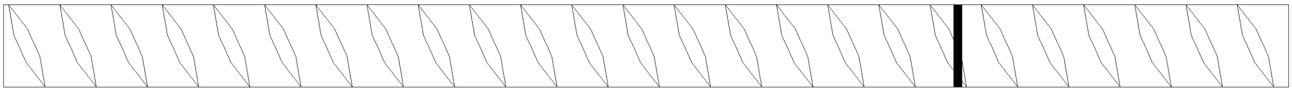


Tension Anchor ZA: M12 to M24



Team Pro Injection system TP E SD+ for rebar connection	**Annex A 3**
Product description Injection mortar / Static mixer / Rebar / Tension Anchor ZA	

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



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range $0{,}05\phi \leq h_{rib} \leq 0{,}07\phi$
  (ϕ: Nominal diameter of the bar; h_{rib}: Rib height of the bar)

Table A1: Materials

Designation	**Material**
Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Team Pro Injection system TP E SD+ for rebar connection

Product description
Materials Rebar

Annex A 4

Tension Anchor ZA: M12, M16, M20, M24

Marking: e.g. ◇ZA◇12 A4

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

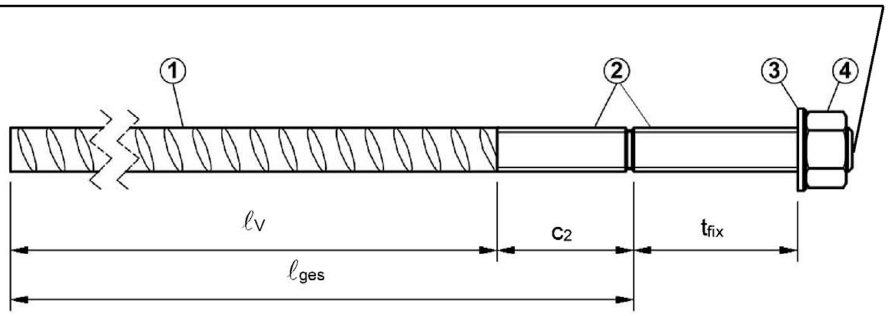


Table A2: Materials

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

Table A3: Dimensions and installation parameter

Size				ZA-M12	ZA-M16	ZA-M20	ZA-M24
Diameter of threaded rod		d_s	[mm]	12	16	20	24
Diameter of reinforcement bar		ϕ	[mm]	12	16	20	25
Drill hole diameter		d_0	[mm]	16	20	25	32
Diameter of clearance hole in fixture		d_f	[mm]	14	18	22	26
With across nut flats		SW	[mm]	19	24	30	36
Stress area		A_s	[mm²]	84	157	245	353
Effective embedment depth		ℓ_v	[mm]	according to static calculation			
Length of bonded thread	plated	c_2	[mm]	≥ 20	≥ 20	≥ 20	≥ 20
	A4/HCR			≥ 100	≥ 100	≥ 100	≥ 100
Minimum thickness of fixture		t_{fix}	[mm]	5	5	5	5
Maximum thickness of fixture		t_{fix}	[mm]	3000	3000	3000	3000
Maximum installation torque		T_{max}	[Nm]	50	100	150	150

Team Pro Injection system TP E SD+ for rebar connection

Product description
Specifications Tension Anchor ZA

Annex A 5

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads.
- Fire exposure

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206:2013 + A1:2016.
- Strength classes C12/15 to C50/60 according to EN 206:2013 + A1:2016.
- Maximum chloride content of 0,40% (CL 0.40) related to the cement content according to EN 206:2013 + 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 ϕ + 60 mm prior to the installation of the new rebar.

  The depth of concrete to be removed shall correspond to at least the minimum concrete cover in accordance with EN 1992-1-1:2004+AC:2010.

  The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Temperature Range:

- \- 40°C to +80°C (max. short term temperature +80°C and max long term temperature +50°C).

Use conditions (Environmental conditions) with tension anchor ZA:

- Structures subject to dry internal conditions or subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist
  (high corrosion resistant steel).

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design according to EN 1992-1-1:2004+AC:2010, EN 1992-1-2:2004+AC:2008 and Annex B 2 and B 3.
- The actual position of the reinforcement in the existing structure shall be determined on the basis of the construction documentation and taken into account when designing.

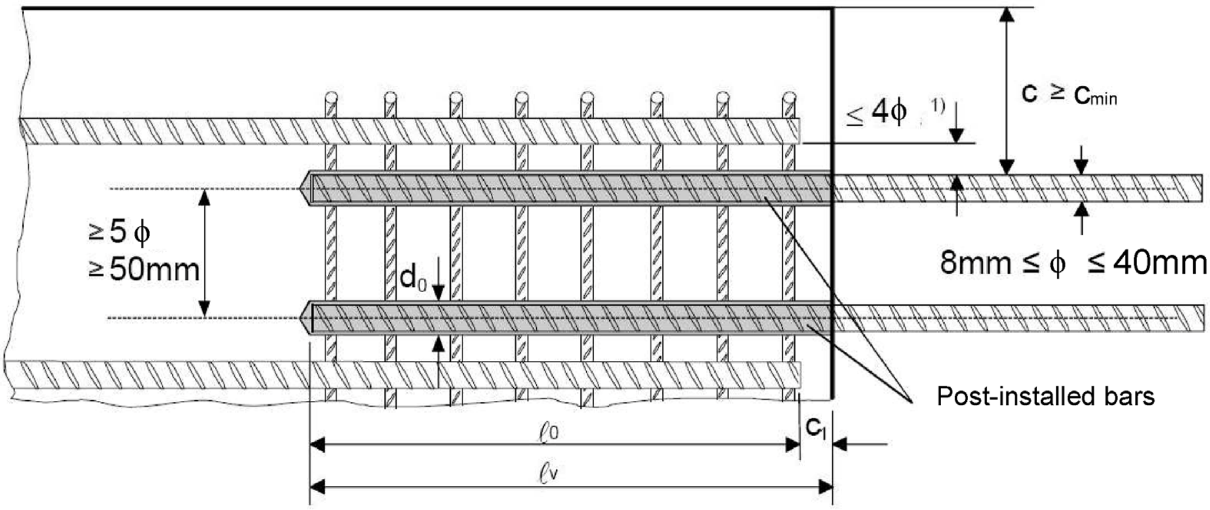
Installation:

- Dry or wet concrete.
- It must not be installed in flooded holes.
- Hole drilling by hammer drill (HD), hollow drill (HDB), diamond drill (DD) or compressed air drill (CD).
- The installation of post-installed rebar resp. tension anchors shall be done only by suitable trained installer and under supervision on site; the conditions under which an installer may be considered as suitable trained and the conditions for supervision on site are up to the Member States in which the installation is done.
- Check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint).

Team Pro Injection system TP E SD+ for rebar connection	**Annex B 1**
Intended use Specifications	

Figure B1: General construction rules for post-installed rebars

- Only tension forces in the axis of the rebar may be transmitted
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1:2004+AC:2010.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.



1) If the clear distance between lapped bars exceeds 4ϕ, then the lap length shall be increased by the difference between the clear bar distance and 4ϕ.

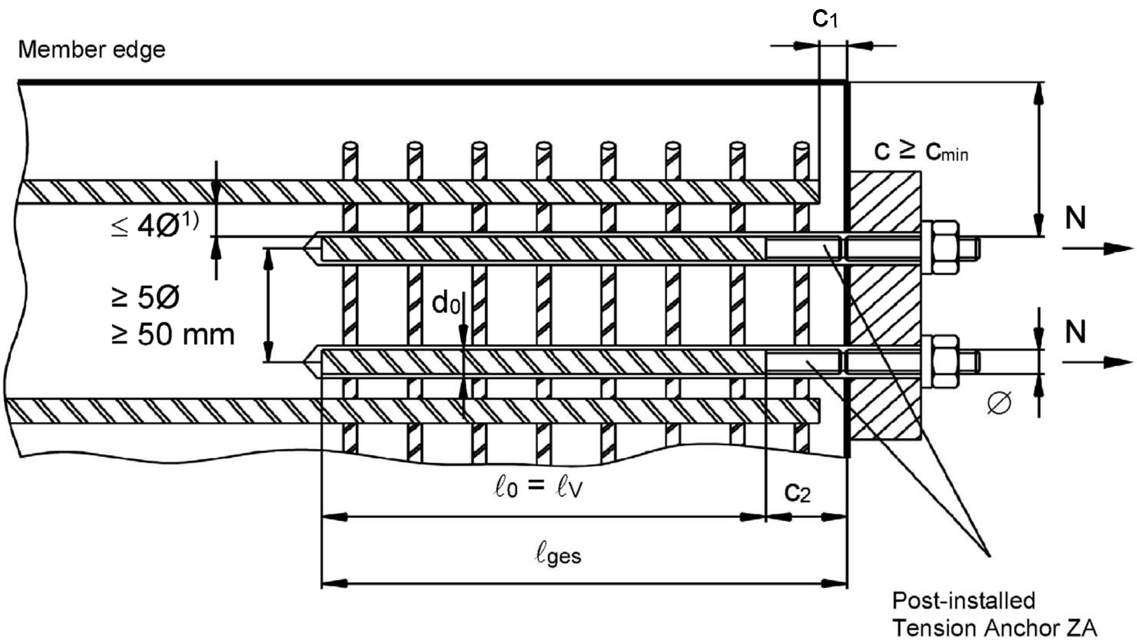
The following applies to Figure B1:

c	concrete cover of post-installed rebar
c_1	concrete cover at end-face of existing rebar
c_{min}	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	diameter of post-installed rebar
ℓ_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
ℓ_v	effective embedment depth, $\geq \ell_0 + c_1$
d_0	nominal drill bit diameter, see Annex B 4

Team Pro Injection system TP E SD+ for rebar connection	**Annex B 2**
Intended use General construction rules for post-installed rebars	

Figure B2: General construction rules for tension anchors ZA

- The length of the bonded-in thread may be not be accounted as anchorage
- Only tension forces in the direction of the bar axis may be transmitted by the tension anchor ZA
- The tension force must be transferred via an overlap joint to the reinforcement in the building part.
- The transfer of shear forces shall be ensured by appropriate additional measures, e.g shear lugs or by anchors with an European technical assessment.
- In the anchor plate, the holes for the tension anchors shall be executed as elongated holes with axis in the direction of the shear force.



[1] If the clear distance between lapped bars exceeds 4ϕ, then the lap length shall be increased by the difference between the clear bar distance and 4ϕ.

The following applies to Figure B2:

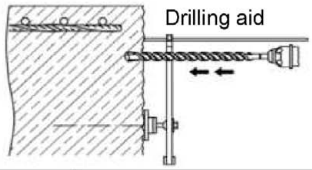
c	concrete cover of tension anchor ZA
c_1	concrete cover at end-face of existing rebar
c_2	Length of bonded thread
c_{min}	minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2
ϕ	diameter of tension anchor
ℓ_0	lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3
ℓ_v	effective embedment depth, $\geq \ell_0 + c_1$
ℓ_{ges}	overall embedment depth, $\geq \ell_0 + c_2$
d_0	nominal drill bit diameter, see Annex B 4

Team Pro Injection system TP E SD+ for rebar connection

Intended use
General construction rules for tension anchors

Annex B 3

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



Drilling method	Rebar diameter	Without drilling aid	With drilling aid
Hammer drilling (HD) Hollow drilling (HDB)	< 25 mm	30 mm + 0,06 · ℓ_v ≥ 2 ϕ	30 mm + 0,02 · ℓ_v ≥ 2 ϕ
	≥ 25 mm	40 mm + 0,06 · ℓ_v ≥ 2 ϕ	40 mm + 0,02 · ℓ_v ≥ 2 ϕ
Diamond drilling (DD)	< 25 mm	Drill rig used as drilling aid	30 mm + 0,02 · ℓ_v ≥ 2 ϕ
	≥ 25 mm		40 mm + 0,02 · ℓ_v ≥ 2 ϕ
Compressed air drilling (CD)	< 25 mm	50 mm + 0,08 · ℓ_v	50 mm + 0,02 · ℓ_v
	≥ 25 mm	60 mm + 0,08 · ℓ_v	60 mm + 0,02 · ℓ_v

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

Table B2: maximum embedment depth $\ell_{v,max}$

Rebar	Tension anchor	HD / CD / DD	HDB
ϕ	ϕ	$\ell_{v,max}$ [mm]	$\ell_{v,max}$ [mm]
8 mm		800	800
10 mm		1000	1000
12 mm	ZA-M12	1200	1000
14 mm		1400	1000
16 mm	ZA-M16	1600	1000
20 mm	ZA-M20	2000	1000
22 mm		2000	1000
24 mm		2000	1000
25 mm	ZA-M24	2000	1000
28 mm		2000	1000
32 mm		2000	1000
34 mm		2000	-
36 mm		2000	-
40 mm		2000	-

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

Concrete temperature	Gelling- / working time[1]	Minimum curing time in dry concrete	Minimum curing time in wet concrete
	t_{gel}	$t_{cure,dry}$	$t_{cure,wet}$
+ 5 °C to + 9°C	80 min	48 h	96 h
+ 10 °C to + 14°C	60 min	28 h	56 h
+ 15 °C to + 19°C	40 min	18 h	36 h
+ 20 °C to + 24°C	30 min	12 h	24 h
+ 25 °C to + 34°C	12 min	9 h	18 h
+ 35 °C to + 39°C	8 min	6 h	12 h
+40 °C	8 min	4 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.

Team Pro Injection system TP E SD+ for rebar connection

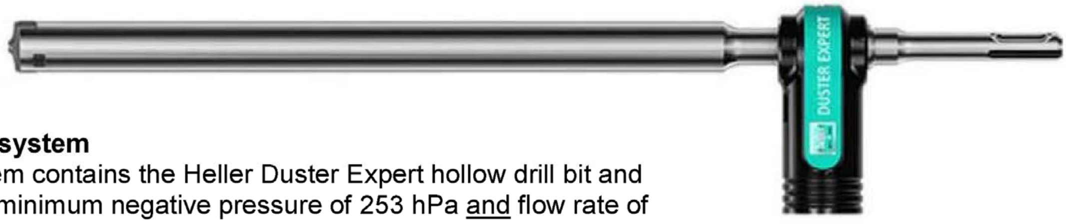
Intended use
Minimum concrete cover
Maximum embedment depth

Annex B 4

Table B4: Dispensing tools

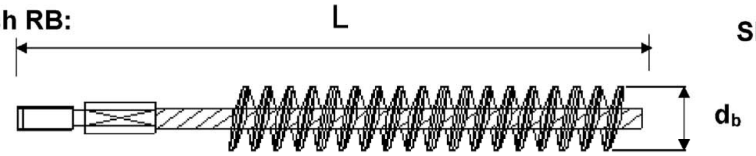
Cartridge type/size	Hand tool		Pneumatic tool
Side-by-side cartridges 440, 585 ml	 e.g. SA 296C585	 e.g. Typ H 244 C	 e.g. Typ TS 444 KX
Side-by-side cartridges 1400 ml	-	-	 e.g. Typ TS 471

Cleaning and installation tools



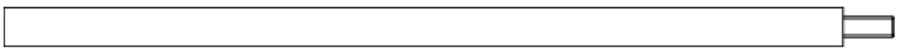
HDB – Hollow drill bit system
The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m³/h (42 l/s).

Brush RB:

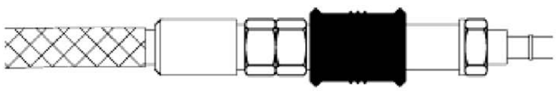


SDS Plus Adapter:

Brush extension:



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



Team Pro Injection system TP E SD+ for rebar connection	**Annex B 5**
Intended Use Dispensing, cleaning and installation tools	

Table B5: Brushes, piston plugs, max anchorage depth and mixer extension, hammer (HD), diamond (DD) and compressed air (CD) drilling

Bar size ϕ	Tension anchor ϕ	Drill bit - Ø HD	Drill bit - Ø DD	Drill bit - Ø CD	d_b Brush - Ø		$d_{b,min}$ min. Brush - Ø	Piston plug	Cartridge: 440 ml or 585 ml, Hand or battery tool, $l_{v,max}$	Cartridge: 440 ml or 585 ml, Hand or battery tool, Mixer extension	Cartridge: 440 ml or 585 ml, Pneumatic tool, $l_{v,max}$	Cartridge: 440 ml or 585 ml, Pneumatic tool, Mixer extension	Cartridge: 1400 ml, Pneumatic tool, $l_{v,max}$	Cartridge: 1400 ml, Pneumatic tool, Mixer extension
[mm]	[mm]		[mm]			[mm]	[mm]		[mm]		[mm]		[mm]	
8	-	10		-	RB10	11,5	10,5	-	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8
	-	12		-	RB12	13,5	12,5	-	700		800		800	
10	-								250		250		250	
	-	14		-	RB14	15,5	14,5	VS14	700		1000		1000	
12	ZA-M12								250		250		250	
		16			RB16	17,5	16,5	VS16	700		1300		1200	VL16/1,8
14	-	18			RB18	20,0	18,5	VS18					1400	
16	ZA-M16	20			RB20	22,0	20,5	VS20					1600	
20	ZA-M20	25		-	RB25	27,0	25,5	VS25	500		1000		2000	
		-		26	RB26	28,0	26,5	VS25						
22	-	28			RB28	30,0	28,5	VS28						
24/25	ZA-M24	32			RB32	34,0	32,5	VS32						
28	-	35			RB35	37,0	35,5	VS35						
32/34	-	40			RB40	43,5	40,5	VS40						
36	-	45			RB45	47,0	45,5	VS45	-	-				
40	-	-	52	-	RB52	54,0	52,5	VS52						
		55	-	55	RB55	58,0	55,5	VS55						

Table B6: Brushes, piston plugs, max anchorage depth and mixer extension, hammer drilling with hollow drill bit system (HDB)

Bar size ϕ	Tension anchor ϕ	Drill bit - Ø HDB	d_b Brush - Ø	$d_{b,min}$ min. Brush - Ø	Piston plug	Cartridge: 440 ml or 585 ml, Hand or battery tool, $l_{v,max}$	Cartridge: 440 ml or 585 ml, Hand or battery tool, Mixer extension	Cartridge: 440 ml or 585 ml, Pneumatic tool, $l_{v,max}$	Cartridge: 440 ml or 585 ml, Pneumatic tool, Mixer extension	Cartridge: 1400 ml, Pneumatic tool, $l_{v,max}$	Cartridge: 1400 ml, Pneumatic tool, Mixer extension
[mm]	[mm]	[mm]				[mm]		[mm]		[mm]	
8	-	10	No cleaning required		-	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8	250	VL10/0,75 or VL16/1,8
	-	12			-	700		800		800	
10	-				-	250		250		250	
	-	14			VS14	700		1000		1000	
12	ZA-M12					250		250		250	
		16			VS16	700		1000		1000	
14	-	18			VS18						
16	ZA-M16	20			VS20						
20	ZA-M20	25			VS25	500					
22	-	28			VS28						
24/25	ZA-M24	32			VS32						
28	-	35			VS35						
32/34	-	40			VS40						

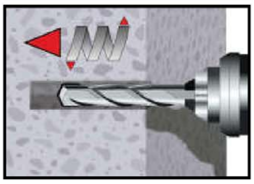
Team Pro Injection system TP E SD+ for rebar connection

Intended use
Installation tools

Annex B 6

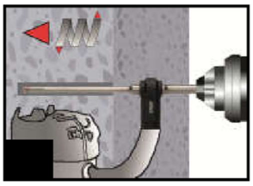
A) Bore hole drilling

Note: Before drilling, remove carbonated concrete and clean contact areas (see Annex B1)
In case of aborted drill hole: the drill hole shall be filled with mortar.

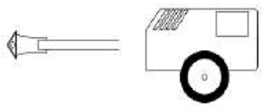


1a. **Hammer (HD) or compressed air drilling (CD)**
Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar
Proceed with Step B1.

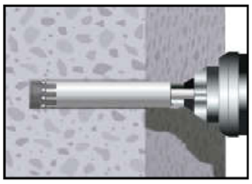
Hammer drill (HD + HDB)



1b. **Hollow drill bit system (HDB)** (see Annex B 5)
Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar. This drilling system removes the dust and cleans the bore hole during drilling. Proceed with Step C.



Compressed air drill (CD)



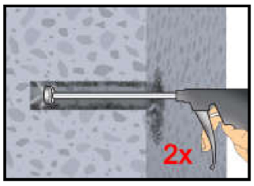
1c. **Diamond drilling (DD)**
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor
Proceed with Step B2.

Diamond coring (DD)

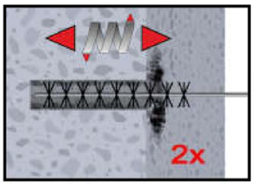
B1) Bore hole cleaning

CAC: Cleaning for all bore hole diameter and bore hole depth with drilling method HD and CD

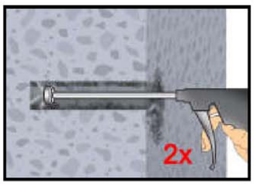
Attention! Standing water in the bore hole must be removed before cleaning.



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



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



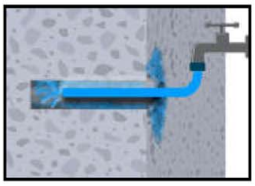
2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

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

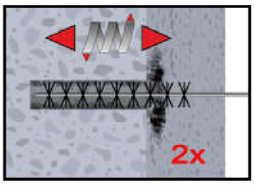
Team Pro Injection system TP E SD+ for rebar connection	**Annex B 7**
Intended use Installation instruction: Bore hole drilling and cleaning (HD, HDB and CD)	

B2) Bore hole cleaning

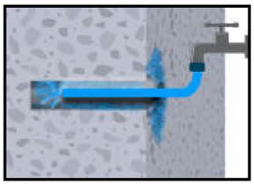
SPCAC: Cleaning for all bore hole diameter and bore hole depth with drilling method DD



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

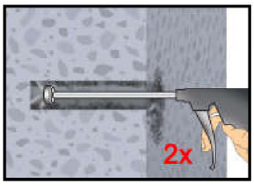


2b. Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B5) a minimum of two times in a twisting motion.
If the bore hole ground is not reached with the brush, a brush extension must be used.

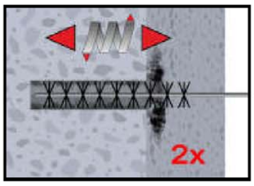


2c. Rinsing again with water until clear water comes out.

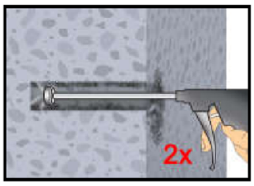
Attention! Standing water in the bore hole must be removed before proceed cleaning.



2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



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

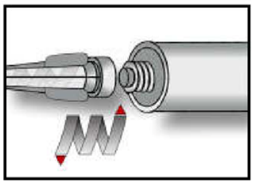


2f. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 7) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

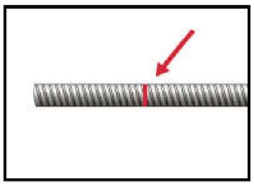
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

Team Pro Injection system TP E SD+ for rebar connection	**Annex B 8**
Intended use Installation instruction: Bore hole drilling and cleaning (DD)	

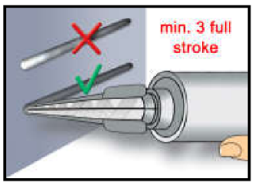
C) Preparation of bar and cartridge



3a. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the recommended working time (Table B3) as well as for every new cartridges, a new static-mixer shall be used.

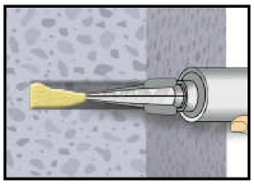


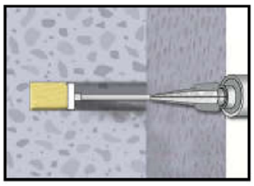
3b. Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar and insert bar in empty hole to verify hole and depth ℓ_v.
The anchor should be free of dirt, grease, oil or other foreign material.



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

D) Filling the bore hole

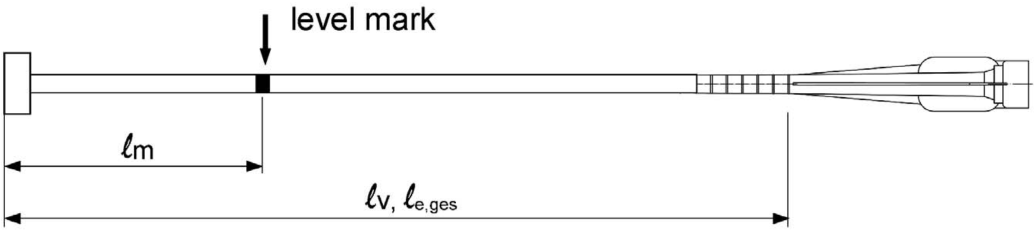




4. Starting from the bottom or back of the cleaned bore hole fill the hole with adhesive, until the level mark at the mixer extension (see below) is visible at the top of the hole. For embedment larger than 190 mm an extension nozzle shall be used.
Slowly withdraw the static mixing nozzle and using a piston plugs during injection of the mortar, helps to avoid creating air pockets.

For overhead and horizontal installation and bore holes deeper than 240 mm a piston plug and the appropriate mixer extension must be used.

Observe the gel-/ working times given in Table B3.



Injection tool must be marked by mortar level mark ℓ_m and anchorage depth ℓ_v resp. $\ell_{e,ges}$ with tape or marker.

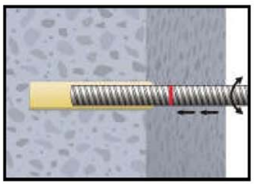
Quick estimation: $\ell_m = 1/3 \cdot \ell_v$

Continue injection until the mortar level mark ℓ_m becomes visible.

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

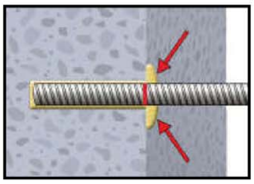
Team Pro Injection system TP E SD+ for rebar connection	**Annex B 9**
Intended Use Installation instruction: Preparation of bar and cartridge Filling the bore hole	

E) Setting the rebar

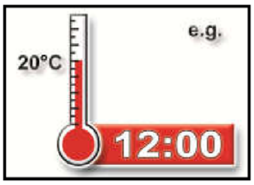


5a. Push the reinforcing bar into the bore hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

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



5b. Be sure that the bar is inserted in the bore hole until the embedment mark is at the concrete surface and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For horizontal and overhead installation fix embedded part (e.g. with wedges).



5c. Observe gelling time t_{gel}. Attend that the gelling time can vary according to the base material temperature (see Table B3).
Do not move or load the bar until full curing time t_{cure} has elapsed (attend Table B3).

Team Pro Injection system TP E SD+ for rebar connection	**Annex B 10**
Intended Use Installation instruction: Inserting rebar	

Minimum anchorage length and minimum lap length

The minimum anchorage length $\ell_{b,min}$ and the minimum lap length $\ell_{0,min}$ according to EN 1992-1-1:2004+AC:2010 ($\ell_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $\ell_{0,min}$ acc. to Eq. 8.11) shall be multiply by the amplification factor α_{lb} according to Table C1.

Table C1: Amplification factor α_{lb} related to concrete class and drilling method

Concrete class	Drilling method	Bar size	Amplification factor α_{lb}
C12/15 to C50/60	all drilling methods	8 mm to 40 mm ZA-M12 to ZA-M24	1,0

Table C2: Reduction factor k_b for all drilling methods

Rebar	Concrete class								
ϕ	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
8 to 40 mm ZA-M12 to ZA-M24	1,0								

Table C3: Design values of the ultimate bond stress $f_{bd,PIR}$ in N/mm² for all drilling methods and for good conditions

$$f_{bd,PIR} = k_b \cdot f_{bd}$$

with

f_{bd}: Design value of the ultimate bond stress in N/mm² considering the concrete classes, the rebar diameter, the drilling method for good bond condition (for all other bond conditions multiply the values by η_1 =0.7) and recommended partial factor γ_c = 1,5 according to EN 1992-1-1:2004+AC:2010.

k_b: Reduction factor according to Table C2

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

Team Pro Injection system TP E SD+ for rebar connection

Performances
Amplification factor α_{lb}, Reduction factor k_b
Design values of ultimate bond resistance $f_{bd,PIR}$

Annex C 1

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

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

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

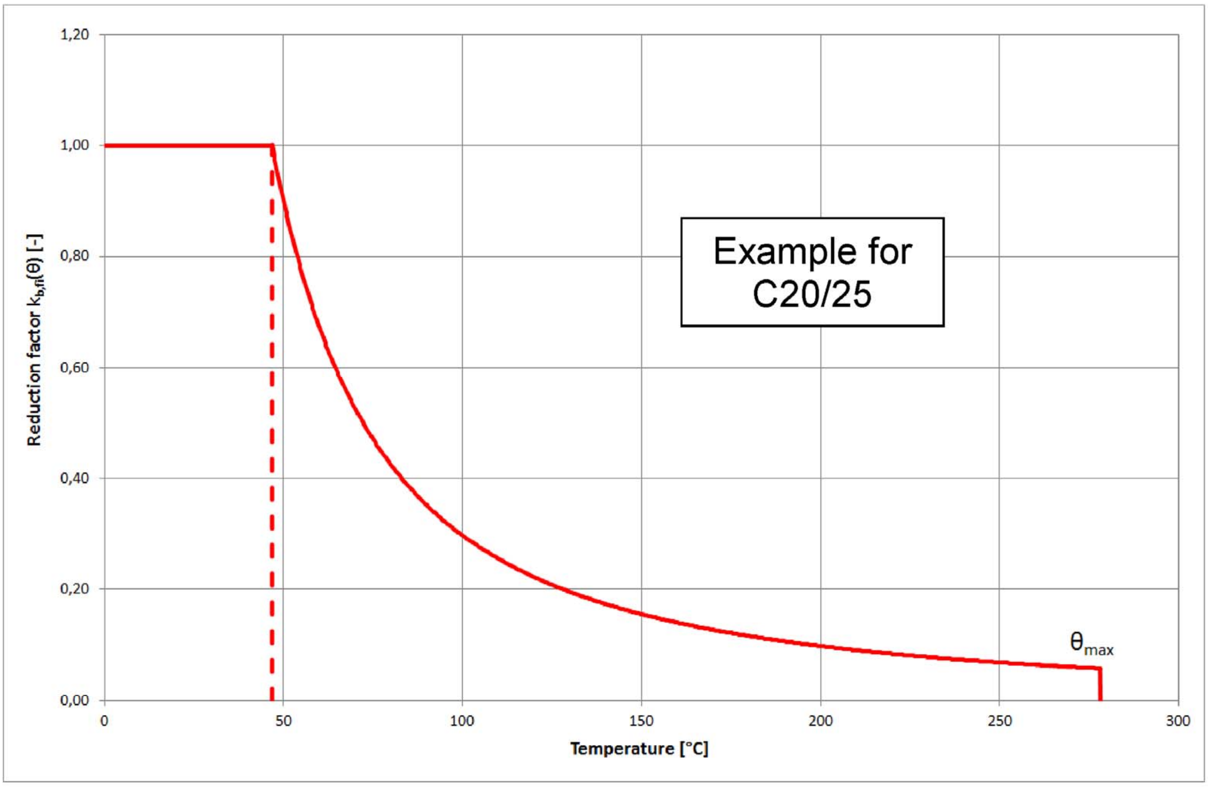
with: $\theta \leq 278°C$: $k_{fi}(\theta) = 4673{,}8 \cdot \theta^{-1{,}598} / (f_{bd,PIR} \cdot 4{,}3) \leq 1{,}0$
$\theta > 278°C$: $k_{fi}(\theta) = 0$

$f_{bd,fi}$ Design value of the ultimate bond stress at increased temperature in N/mm²

θ Temperature in °C in the mortar layer.
$k_{fi}(\theta)$ Reduction factor at increased temperature.
$f_{bd,PIR}$ Design value of the bond stress in N/mm² in cold condition according to Table C3 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2004+AC:2010.
γ_c = 1,5, recommended partially safety factor according to EN 1992-1-1:2004+AC:2010
$\gamma_{M,fi}$ = 1,0, recommended partially safety factor according to EN 1992-1-2:2004+AC:2008

For evidence at increased temperature the anchorage length shall be calculated according to EN 1992-1-1:2004+AC:2010 Equation 8.3 using the temperature-dependent design value of ultimate bond stress $f_{bd,fi}$.

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



Team Pro Injection system TP E SD+ for rebar connection	**Annex C 2**
Performances Design value of ultimate bond stress $f_{bd,fi}$ at increased temperature	

Table C6: Characteristic tension strength for tension anchor ZA under fire exposure, concrete classes C12/15 to C50/60, according to Technical Report TR 020

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

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

The design value of the steel strength $\sigma_{Rd,s,fi}$ under fire exposure has to be calculated by the following equation:

$$\sigma_{Rd,s,fi} = \sigma_{Rk,s,fi} / \gamma_{M,fi}$$

with:

$\sigma_{Rk,s,fi}$ characteristic steel strength according to Table C4
$\gamma_{M,fi}$ partially safety factor according to EN 1992-1-2:2004+AC:2008