Deutsches Institut für Bautechnik
Approval body for construction products and types of construction
Bautechnisches Prüfamt
An institution established by the Federal and Laender Governments

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European Technical Assessment

ETA-22/0586 of 25 October 2022

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Injection system EP 131v2 for concrete
Product family to which the construction product belongs	Bonded fastener for use in concrete
Manufacturer	Hard Produtos para Construcao Ltda Rua Dr. Humberto Pinheiro Vieira, 150 Lote 1 B Distrito Industrial Norte JOINVILLE/SC. CEP 89219-570 BRASILIEN
Manufacturing plant	Hard Plant 1
This European Technical Assessment contains	24 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 "Injection system EP 131v2 for concrete" is a bonded anchor consisting of a cartridge with injection mortar EP 131 V2 and a steel element. The steel element consists of a commercial threaded rod with washer and hexagon nut in the range of M8 to M30 or reinforcing bar in the range of ∅ 8 to ∅ 32 mm.

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 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 2, C 1, C 2, C 3 and C 5
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 4 and C 6
Displacements under short-term and long-term loading	See Annex C 7 and C 8
Characteristic resistance and displacements for seismic performance categories C1 and C2	No performance assessed

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.

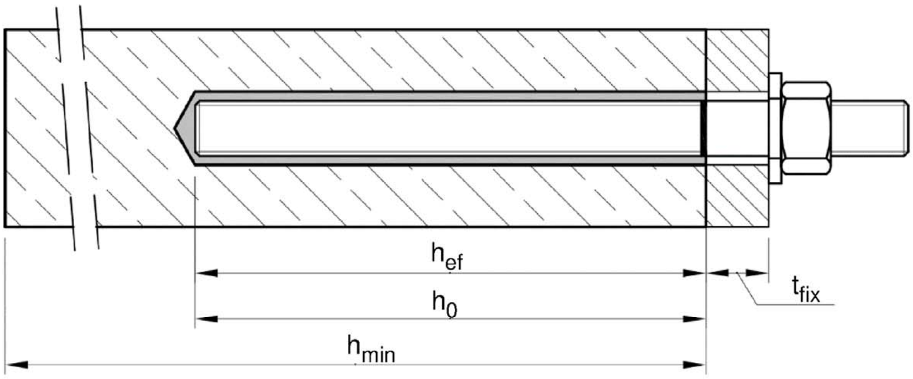
Issued in Berlin 25 October 2022 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

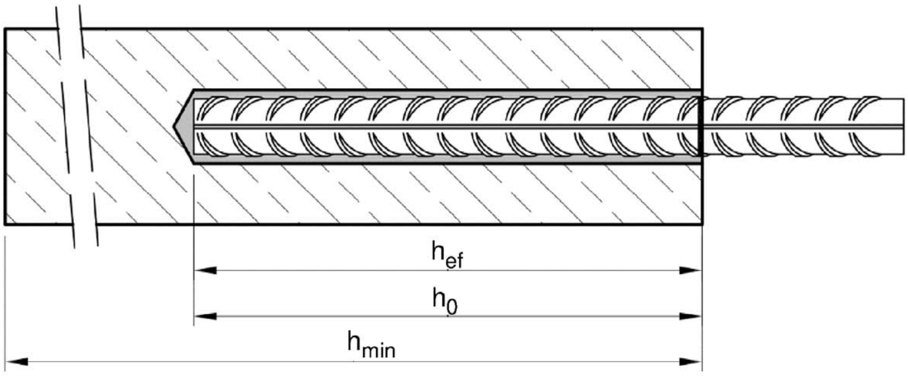
beglaubigt:
Baderschneider

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



t_{fix} = thickness of fixture

h_{ef} = effective anchorage depth

h_{min} = minum thickness of member

h_0 = nominal drill hole diameter

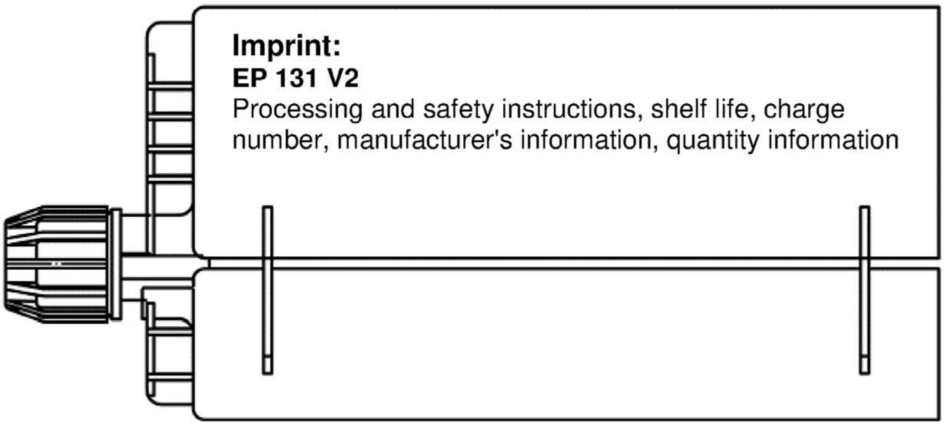
Injection system EP 131v2 for concrete

Product description
Installed condition

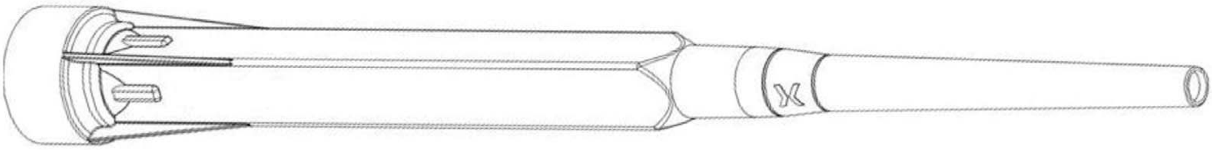
Annex A 1

Cartridge system

Side-by-Side Cartridge:
440 ml, 585 ml and 1400 ml



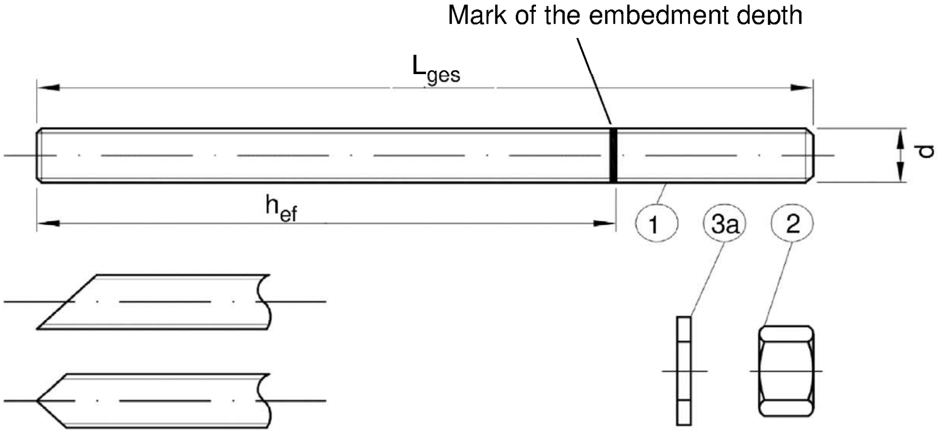
Static mixer PM-19E



Piston plug VS and mixer extension VL

Injection system EP 131v2 for concrete	**Annex A 2**
Product description Injection system	

Threaded rod M8 up to M30 with washer and hexagon nut



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

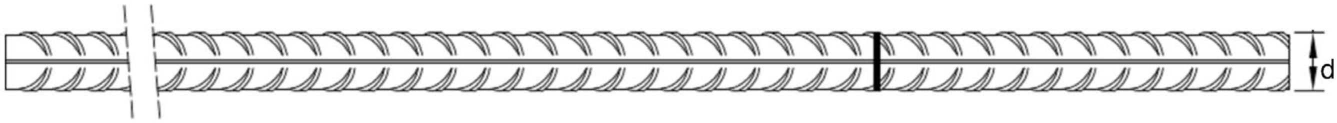
Injection system EP 131v2 for concrete	**Annex A 3**
Product description Threaded rod	

Table A1: Materials

Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN ISO 683-4:2018 or EN 10263:2001) - zinc plated ≥ 5 µm acc. to EN ISO 4042:2018 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 > 8%
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		
3	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)				
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)2)]	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture
		acc. to EN ISO 3506-1:2020	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%
			80	f_{uk} = 800 N/mm²	f_{yk} = 600 N/mm²	A_5 > 8%
2	Hexagon nut [1)2)]	acc. to EN ISO 3506-1:2020	50	for anchor rod class 50		
			70	for anchor rod class 70		
			80	for anchor rod class 80		
3	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)				

1) Property class 70 or 80 for anchor rods and hexagon nuts up to M24
2) Property class 80 only for stainless steel A4 and HCR

Reinforcing bar (rebar): ø8 up to ø32



- Minimum value of related rib 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_{rib} ≤ 0,07d
  (d: Nominal diameter of the bar; h_{rib}: Rib height of the bar)

Table A2: Materials Rebar

Part	Designation	Material
Rebar		
1	Reinforcing steel according to EN 1992 1 1:2004+AC:2010, Annex C	Bars and rebars from ring class B or C f_{yk} und k according to NDP or NCI according to EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Injection system EP 131v2 for concrete

Product description
Reinforcing bar
Materials reinforcing bar

Annex A 5

Specification of the intended use

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

	Working life 50 years	
Base material	Uncracked concrete	Base material
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling	M8 bis M30, ∅8 bis ∅32	
DD: Diamond drilling	No performance assessed	
Temperature Range:	I: - 40°C to +40°C[1)] II: - 40°C to +60°C[2)] III: - 40°C to +70°C[3)]	

1) (max. long-term temperature +24°C and max. short-term temperature +40°C)
2) (max. long-term temperature +35°C and max. short-term temperature +60°C)
3) (max. long-term temperature +35°C and max. short-term temperature +70°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 fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work.
- The fasteners 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) or compressed air mode(CD).
- Overhead installation allowed.
- Fastener installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site

Table B1: Installation parameters for threaded rod

Threaded rod			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 installation torque	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 installation torque for M12 with steel Grade 4.6 is 35 Nm

Table B2: Installation parameters for reinforcing bar

Reinforcing bar			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

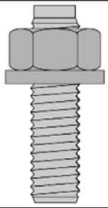
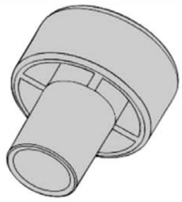
1) both nominal drill hole diameter can be used

Injection system EP 131v2 for concrete

Intended Use
Installation parameters

Annex B 2

Table B3: Parameter cleaning and setting tools

									
Threaded rod	**Reinforcing bar**	**d_0 Drill bit - Ø HD, HDB, CD**	**d_b Brush - Ø**		**$d_{b,min}$ min. Brush - Ø**	**Piston plug**	**Installation direction and use of piston plug**		
[mm]	[mm]	[mm]		[mm]	[mm]		↓	→	↑
M8	8	10	RB10	11,5	10,5	No plug required			
M10	8 / 10	12	RB12	13,5	12,5				
M12	10 / 12	14	RB14	15,5	14,5				
	12	16	RB16	17,5	16,5				
M16	14	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		22	RB22	24,0	22,5	VS22			
	20	25	RB25	27,0	25,5	VS25			
M24		28	RB28	30,0	28,5	VS28			
M27		30	RB30	31,8	30,5	VS30			
	24 / 25	32	RB32	34,0	32,5	VS32			
M30	28	35	RB35	37,0	35,5	VS35			
	32	40	RB40	43,5	40,5	VS40			

Cleaning and installation tools

HDB – Hollow drill bit system

The hollow drill system consists of Heller Duster Expert Hohlbohrer and a class M hoover with a minimum negative pressure of 253 hPa and a flow rate of minimum 150 m³/h (42 l/s).

Hand pump
(Volumen 750 ml, $h_0 \geq 10\ d_s$, $d_0 \leq 20$mm)

Compressed air tool
(min 6 bar)

Brush RB

Pistole Plug VS

Brush extension RBL

Injection system EP 131v2 for concrete	**Annex B 3**
Intended Use Cleaning and setting tools	

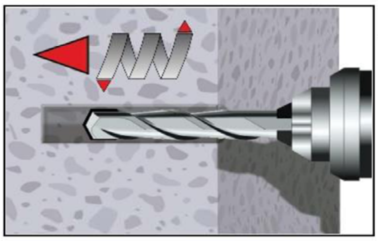
Table B4: Working and curing time

Temperature in base material			Maximum working time	Minimum curing time [1]
	T		t_{work}	t_{cure}
+ 5 °C	to	+ 9 °C	80 min	60 h
+ 10 °C	to	+ 14 °C	60 min	48 h
+ 15 °C	to	+ 19 °C	40 min	24 h
+ 20 °C	to	+ 24 °C	30 min	12 h
+ 25 °C	to	+ 34 °C	12 min	10 h
+ 35 °C	to	+ 39 °C	8 min	7 h
	+ 40 °C		8 min	4 h
Cartridge temperature			+5°C to +40°C	

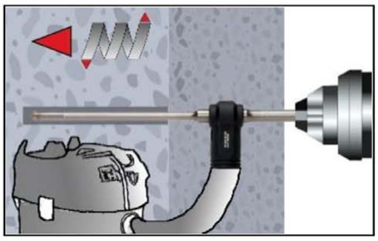
[1] The minimum curing time is only valid for dry base material.
In wet base material the curing time must be doubled.

Installation instructions

Drilling of the bore hole



1a. Hammer drilling (HD) / Compressed air drilling (CD)
Drill a hole for the required embedment depth
Drill bit diameter according to Table B1 or B2. Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.

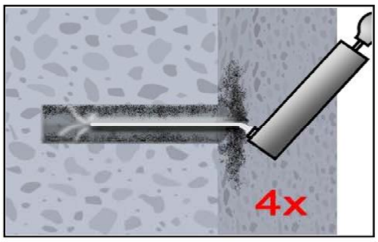


1b. Hammer drilling with Hollow drill bit (HDB) (see Annex B 4)
Drill a hole for the required embedment depth Drill bit diameter according to Table B1 or B2. The hollow drill bit system removes the dust and cleans the bore hole during drilling (all conditions).
Proceed with Step 3.
In case of aborted drill hole, the drill hole shall be filled with mortar.

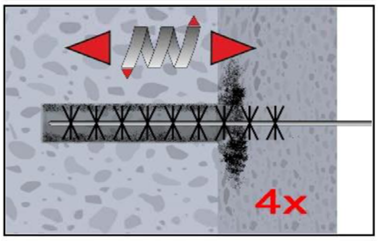
Attention! Standing water in the bore hole must be removed before cleaning.

Manual Air Cleaning (MAC)

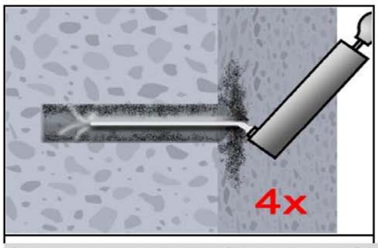
for drill hole diameter $d_0 \leq 20$mm and drill hole depth $h_0 \leq 10d_{nom}$ (uncracked concrete only!)



2a. Blow the bore hole clean minimum 4x from the bottom or back by hand pump (Annex B 4).



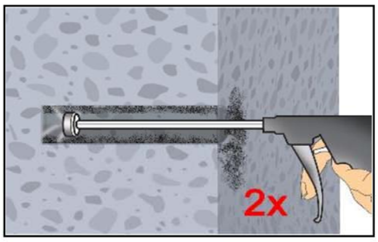
2b. Brush the bore hole minimum 4x with brush RB according to Table B3 over the entire embedment depth in a twisting motion (if necessary, use a brush extension RBL).



2c. Finally blow the bore hole clean minimum 4x from the bottom or back by hand pump (Annex B 4).

Compressed Air Cleaning (CAC):

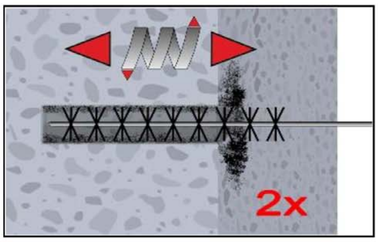
All diameter in cracked and uncracked concrete



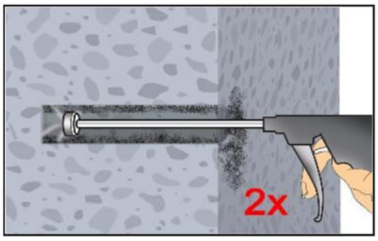
2a. Blow the bore hole clean minimum of 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

Injection system EP 131v2 for concrete	**Annex B 5**
Intended Use Installation instructions	

Installation instructions (continuation)

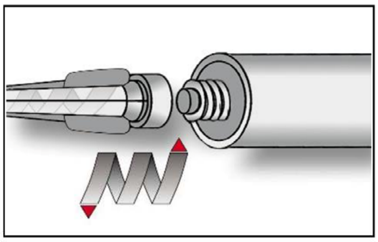


2b. Brush the bore hole minimum 2x with brush RB according to Table B3 over the entire embedment depth in a twisting motion. (If necessary, a brush extension RBL shall be used.)

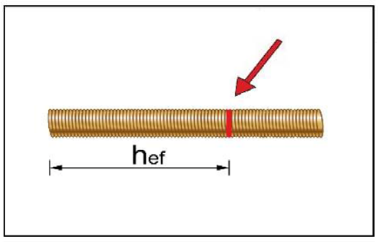


2c. Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

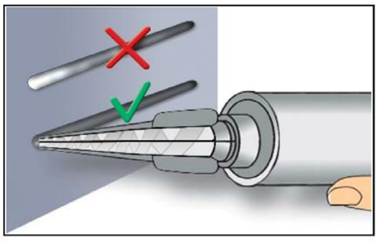
Cleaned bore hole has to be protected against re-contamination in an appropriate way,
If necessary, repeat cleaning process directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.



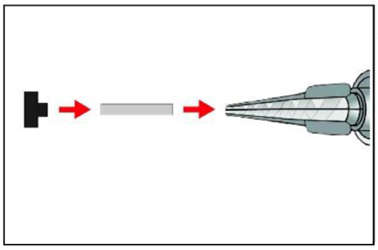
3. Screw on static-mixing nozzle PM-19E, and load the cartridge into an appropriate dispensing tool.
For every working interruption longer than the maximum working time t_{work} (Annex B 4) as well as for new cartridges, a new static-mixer shall be used.



4. Mark embedment depth on the anchor rod.
The anchor rod shall be free of dirt, grease, oil or other foreign material.



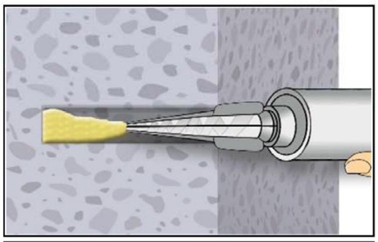
5. Not proper mixed mortar is not sufficient for fastening.
Dispense and discard mortar until an uniform grey or red colour is shown (at least 3 full strokes).



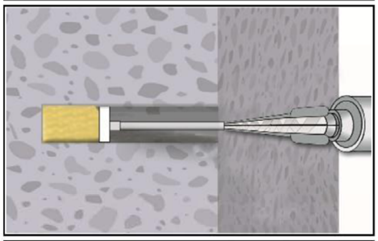
6. Piston plugs VS and mixer nozzle extensions VL shall be used according to Table B4 for the following applications:
- Horizontal and vertical downwards direction: Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$mm
- Vertical upwards direction: Drill bit-Ø $d_0 \geq 18$ mm

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

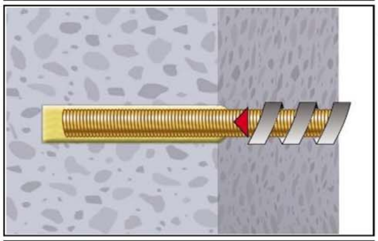
Installation instructions (continuation)



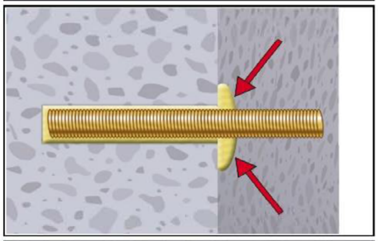
7a. **Injecting mortar without piston plug VS**
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.)
Slowly withdraw of the static mixing nozzle avoid creating air pockets
Observe the temperature related working time t_{work} (Annex B 4).



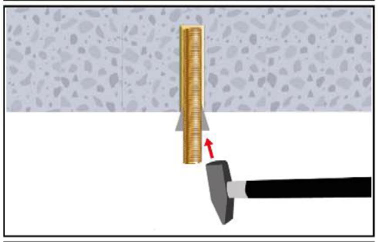
7b. **Injecting mortar with piston plug VS**
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.)
During injection the piston plug is pushed out of the bore hole by the back pressure of the mortar.
Observe the temperature related working time t_{work} (Annex B 4).



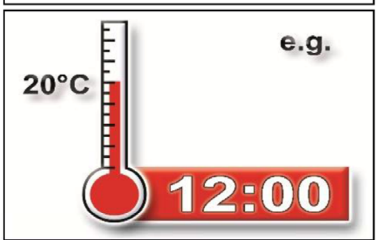
8. Insert the anchor rod while turning slightly up to the embedment mark.



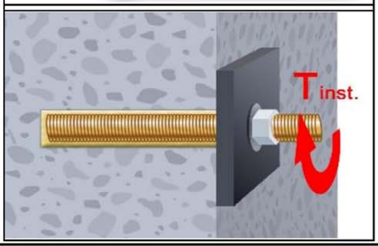
9. Annular gap between anchor rod and base material must be completely filled with mortar. In case of push through installation the annular gap in the fixture must be filled with mortar also.
Otherwise, the installation must be repeated starting from step 7 before the maximum working time t_{work} has expired.



10. For application in vertical upwards direction the anchor rod shall be fixed (e.g. wedges).



11. Temperature related curing time t_{cure} (Annex B 4) must be observed.
Do not move or load the fastener during curing time.



12. Install the fixture by using a calibrated torque wrench. Observe maximum installation torque (Table B1).

Injection system EP 131v2 for concrete	**Annex B 7**
Intended Use Installation instructions (continuation)	

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

Threaded rod				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] Fastener type not part of the ETA

Injection system EP 131v2 for concrete

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

Annex C 1

Table C2: Characteristic values of tension loads under static and quasi-static action

Fastener				**All Fastener type and sizes**
Concrete cone failure				
Uncracked 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 $c_{cr,sp}$

Table C3: Characteristic values of tension loads under static and quasi-static action

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 uncracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	15	15	15	14	14	13	13	13
	II: 60°C/35°C				10	10	10	9,5	9,5	9,0	9,0	9,0
	III: 70°C/43°C				7,0	7,0	7,0	6,5	6,5	6,0	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,0	7,0	7,0	6,0	6,0	6,0
	II: 60°C/35°C				5,0	5,0	5,0	5,0	5,0	4,5	4,5	4,5
	III: 70°C/43°C				3,5	3,5	3,5	3,5	3,5	3,0	3,0	3,0
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,60							
	II: 60°C/35°C				0,60							
	III: 70°C/43°C				0,60							
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,1}$							
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr}$ =		$\psi_c \cdot \tau_{Rk,ucr}$(C20/25)							
			$\tau_{Rk,cr}$ =		$\psi_c \cdot \tau_{Rk,cr}$(C20/25)							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete or flooded bore hole			γ_{inst}	[-]	1,4							

Table C4: Characteristic values of shear loads under static and quasi-static action

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							

Injection system EP 131v2 for concrete

Performances
Characteristic values of shear loads under static and quasi-static action
(Threaded rod)

Annex C 4

Table C5: Characteristic values of tension loads under static and quasi-static action

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 uncracked concrete C20/25													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	12	12	12	12	11	11	11
Temperature range II: 60°C/35°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	8,5	8,5	8,5	7,5	7,5	7,5	7,5
Temperature range III: 70°C/43°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	6,0	6,0	6,0	6,0	6,0	5,5	5,5	5,5	5,0	5,0
Characteristic bond resistance in cracked concrete C20/25													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	7,0	7,0	6,5	6,5	6,0	6,0	6,0	5,5	5,5
Temperature range II: 60°C/35°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,5	4,5	4,5	4,0	4,0	4,0	4,0	3,5	3,5
Temperature range III: 70°C/43°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,60									
Temperature range II: 60°C/35°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,60									
Temperature range III: 70°C/43°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,60									
Increasing factors for concrete		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$									
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,ucr}$ =		$\psi_c \cdot \tau_{Rk,ucr}(C20/25)$									
		$\tau_{Rk,cr}$ =		$\psi_c \cdot \tau_{Rk,cr}(C20/25)$									
Concrete cone failure													
Relevant parameter				see Table C2									
Splitting													
Relevant parameter				see Table C2									
Installation factor													
for dry and wet concrete or flooded bore hole		γ_{inst}	[-]	1,4									

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

Table C6: Characteristic values of shear loads under static and quasi-static action

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 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

Injection system EP 131v2 for concrete

Performances
Characteristic values of shear loads under static and quasi-static action (Reinforcing bar)

Annex C 6

Table C7: Displacements under tension load[1)]

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked concrete under static and quasi-static action										
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: 60°C/35°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
Temperature range III: 70°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,042	0,043	0,044	0,048	0,052	0,056	0,057	0,061
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,052	0,054	0,056	0,061	0,065	0,070	0,074	0,077
Cracked concrete under static and quasi-static action										
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)]	0,193	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 60°C/35°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)]	0,259	0,154	0,163	0,172	0,181	0,189	0,207	0,229
Temperature range III: 70°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,101	0,105	0,106	0,109	0,112	0,117	0,120	0,121
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,285	0,169	0,179	0,189	0,199	0,208	0,228	0,252

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 C8: Displacements under shear load[1)]

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked 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

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

Injection system EP 131v2 for concrete

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

Annex C 7

Table C9: Displacements under tension load[1)]

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Uncracked concrete under static and quasi-static action												
Temperature 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)]	0,015	0,015	0,016	0,017	0,017	0,019	0,020	0,020	0,021	0,023
Temperature range II: 60°C/35°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
Temperature range III: 70°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,042	0,043	0,044	0,046	0,048	0,052	0,056	0,056	0,059	0,064
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,052	0,054	0,056	0,058	0,061	0,065	0,072	0,072	0,075	0,079
Cracked concrete under static and quasi-static action												
Temperature 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
Temperature range II: 60°C/35°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
Temperature range III: 70°C/43°C	δ_{N0}-factor	[mm/(N/mm²)]	0,101	0,105	0,106	0,108	0,109	0,112	0,117	0,117	0,120	0,124
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,169	0,179	0,189	0,199	0,208	0,228	0,252	0,252	0,266	0,286

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 C10: Displacements under shear load[1)]

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Uncracked 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
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Injection system EP 131v2 for concrete

Performances
Displacements under static and quasi-static action (reinforcing bar)

Annex C 8