European Technical Assessment

ETA-19/0542 of 14 April 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	Würth Injection system WIT-PE 1000 for concrete
Product family to which the construction product belongs	Bonded fastener for use in concrete
Manufacturer	Adolf Würth GmbH & Co. KG Reinhold-Würth-Straße 12-17 74653 Künzelsau DEUTSCHLAND
Manufacturing plant	Werk 3
This European Technical Assessment contains	46 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-v01 Edition 11/2020
This version replaces	ETA-19/0542 issued on 6 November 2020

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Specific Part

1 Technical description of the product

The "Würth Injection system WIT-PE 1000 for concrete" is a bonded anchor consisting of a mortar cartridge with injection mortar WIT-PE 1000 and a steel element according to Annex A 3.

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 C 1 to C 6, C 8 to C 11, C 13 to C 16, B 3
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 7, C 12, C 17
Displacements under short-term and long-term loading	See Annex C 18 to C 20
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 21 to C 28

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.

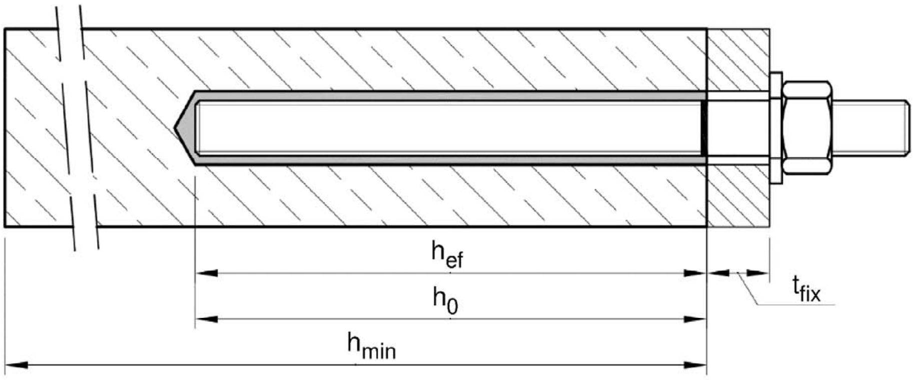
Issued in Berlin on 14 April 2022 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

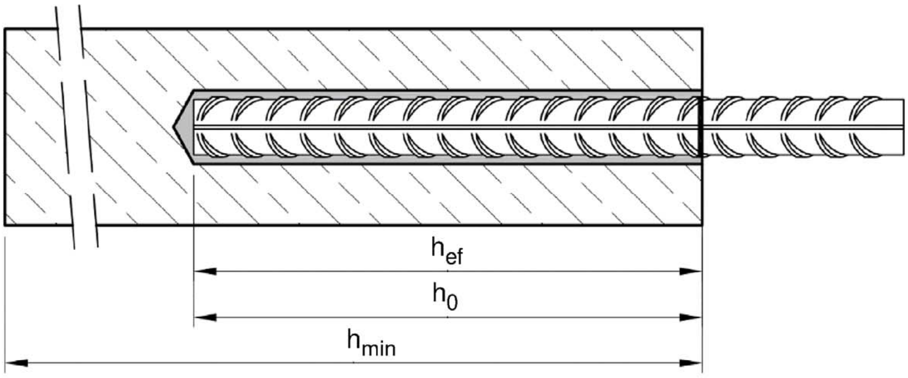
beglaubigt:
Baderschneider

Installation threaded rod M8 up to M30

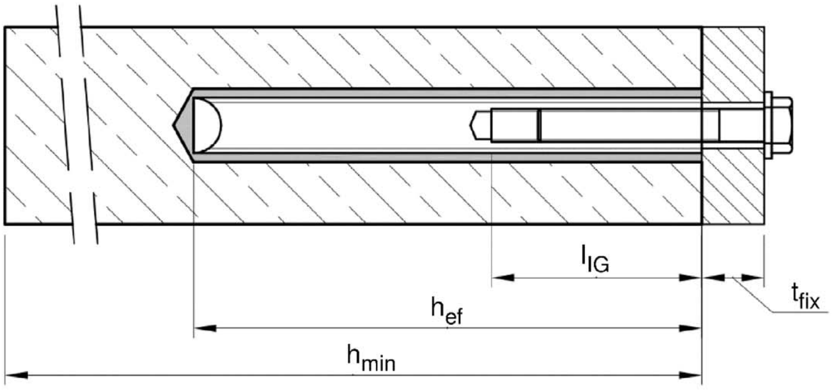
prepositioned installation or
push through installation (annular gap filled with mortar)



Installation reinforcing bar Ø8 up to Ø32



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



t_{fix}	=	thickness of fixture	h_0	=	nominal drill hole diameter
h_{ef}	=	effective embedment depth	l_{IG}	=	thread engagement length
h_{min}	=	minum thickness of member			

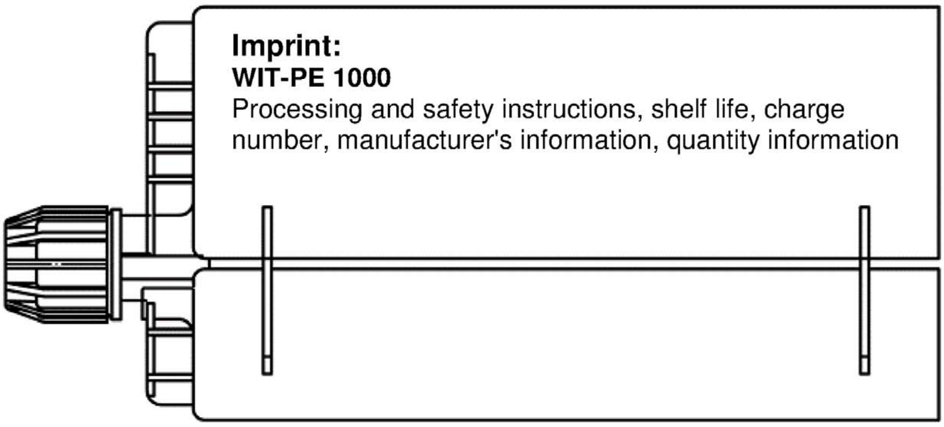
Würth injection system WIT-PE 1000 for concrete

Product description
Installed condition

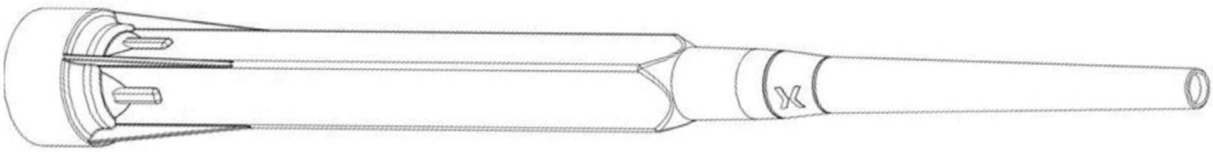
Annex A 1

Cartridge system

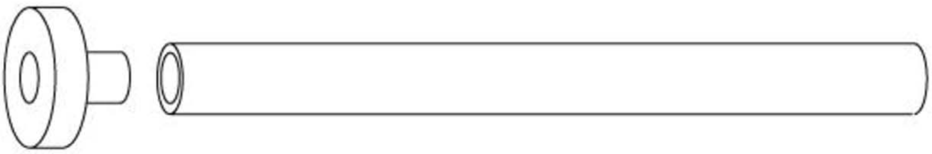
Side-by-Side Cartridge:
440 ml, 585 ml and 1400 ml



Static mixer WIT-PE / WIT-MX



Piston plug WIT-VS and mixer extension WIT-MV

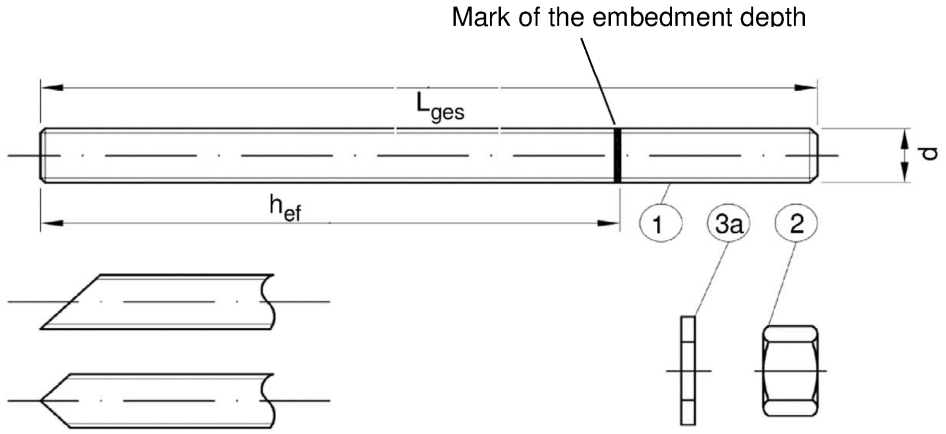


Würth injection system WIT-PE 1000 for concrete

Product description
Injection system

Annex A 2

Threaded rod M8 up to M30 with washer and hexagon nut

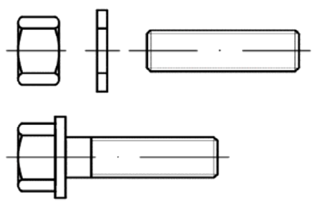


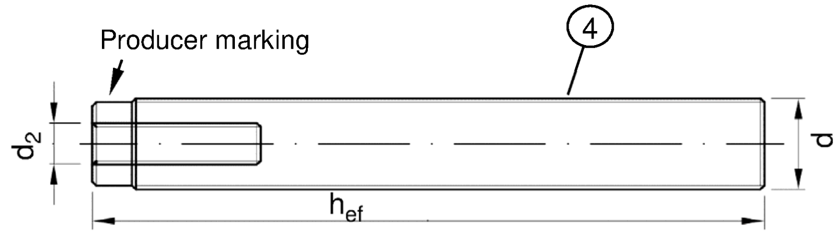
Commercial standard rod with:

- 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

Internal threaded rod IG-M6 to IG-M10

Threaded rod or screw

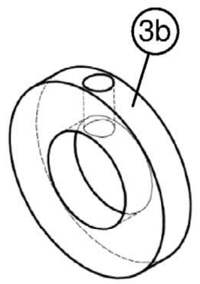




Producer marking: e.g. ◇I M8

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 WIT-SHB



Mixer reduction nozzle WIT-MR-X

Würth injection system WIT-PE 1000 for concrete	Annex A 3
Product description Threaded rod; Internal threaded rod Filling washer; Mixer reduction nozzle	

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 ≥ 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 3506-1:2020	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 ≥ 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 3506-1:2020	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 3506-1:2020	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%

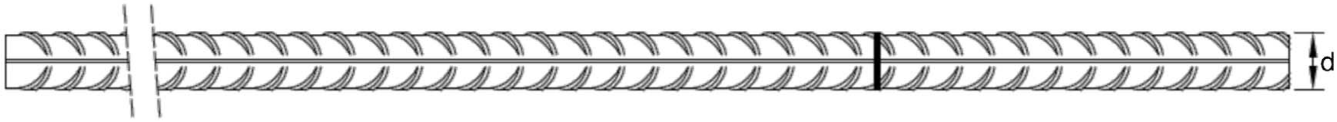
1) Property class 70 or 80 for anchor rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IG-M16

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

Reinforcing bar: ø8 up to ø32



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

Table A2: Materials Reinforcing bar

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} and k according to NDP or NCI according to EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Würth injection system WIT-PE 1000 for concrete

Product description
Materials reinforcing bar

Annex A 5

Specification of the intended use

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

	Working life 50 years		Working life 100 years	
Base material	uncracked concrete	cracked concrete	uncracked concrete	cracked concrete
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling	M8 to M30, ∅8 to ∅32, IG-M6 to IG-M20		M8 to M30, ∅8 to ∅32, IG-M6 to IG-M20	
DD: Diamond drilling	M8 to M30, ∅8 to ∅32, IG-M6 to IG-M20	No performance assessed	M8 to M30, ∅8 to ∅32, 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)]	

Fasteners subject to (seismic action):

	Performance Category C1	Performance Category C2
Base material	Cracked and uncracked concrete	Cracked and uncracked concrete
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling	M8 to M30, ∅8 to ∅32	M12 to M30
DD: Diamond drilling	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

Würth injection system WIT-PE 1000 for concrete	**Annex B 1**
Intended Use Specifications	

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), compressed air (CD) or diamond drill mode (DD).
- 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

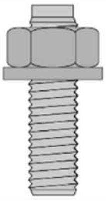
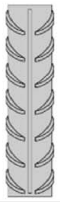
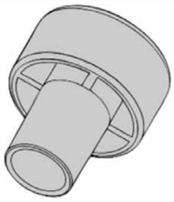
1) both nominal drill hole diameter can be used

Table B3: Installation parameters for Internal threaded anchor rod

Internal threaded anchor rod			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 installation torque	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

Table B4: Parameter cleaning and installation tools

										
Threaded Rod	**Re-inforcing bar**	**Internal threaded anchor rod**	**d_0 Drill bit - Ø HD, HDB, CD, DD**	**d_b Brush - Ø**		**$d_{b,min}$ min. Brush - Ø**	**Piston plug**	**Installation direction and use of piston plug**		
[mm]	[mm]	[mm]	[mm]	WIT-	[mm]	[mm]	WIT-	⬇	➡	⬆
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			

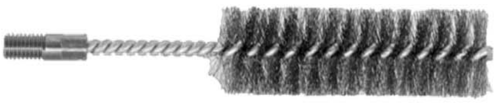
Cleaning and installation tools

HDB – Hollow drill bit system

The hollow drill system consists of Würth Extraction drill bit, MKT Extraction drill bit 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).

CAC - Compressed air tool
(min 6 bar)

Brush WIT-RB



Pistole Plug WIT-VS

Brush extension

Würth injection system WIT-PE 1000 for concrete

Intended Use
Cleaning and installation tools

Annex B 4

Table B5: Working and curing time

Temperature in base material			Maximum working time	Minimum curing time [1]
T			t_{work}	t_{cure}
+ 0 °C	to	+ 4 °C	90 min	144 h
+ 5 °C	to	+ 9 °C	80 min	48 h
+ 10 °C	to	+ 14 °C	60 min	28 h
+ 15 °C	to	+ 19 °C	40 min	18 h
+ 20 °C	to	+ 24 °C	30 min	12 h
+ 25 °C	to	+ 34 °C	12 min	9 h
+ 35 °C	to	+ 39 °C	8 min	6 h
+ 40 °C			8 min	4 h
Cartridge temperature			+5°C to +40°C	

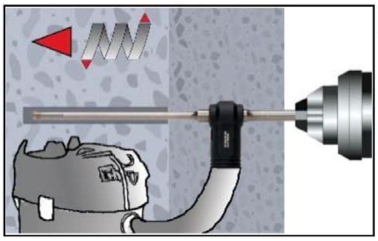
[1] The minimum curing time is only valid for dry base material.
In wet base material the curing time must be doubled.

Würth injection system WIT-PE 1000 for concrete	**Annex B 5**
Intended Use Working time and curing time	

Installation instructions

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

1a. Hammer drilling (HD) / Compressed air drilling (CD)
Drill a hole to the required embedment depth.
Drill bit diameter according to Table B1, B2 or B3.
Aborted drill holes shall be filled with mortar.
Proceed with Step 2.Proceed with Step 2.

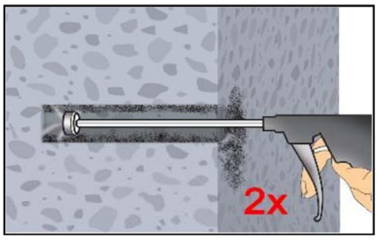


1b. Hollow drill bit system (HDB) (see Annex B 4)
Drill a hole to the required embedment depth.
Drill bit diameter according to Table B1, B2 or B3.
The hollow drilling system removes the dust and cleans the bore hole.
Proceed with Step 3.

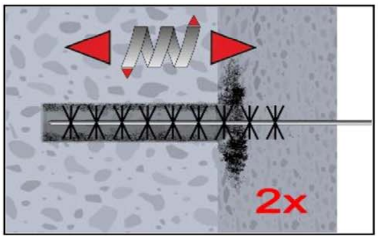
Attention! Standing water in the bore hole must be removed before cleaning.

Compressed Air Cleaning (CAC):

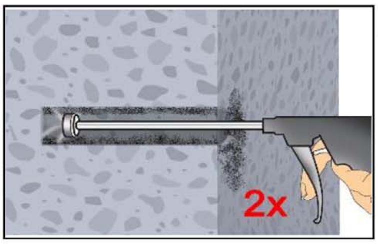
All diameter in cracked and uncracked concrete



2a. 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.)



2b. Brush the bore hole minimum 2x with brush WIT-RB according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)

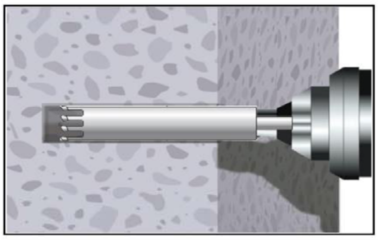


2c. Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

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.

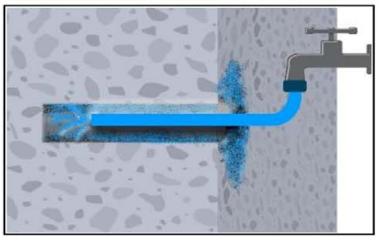
Installation instructions (continuation)

Drilling of the bore hole (DD)

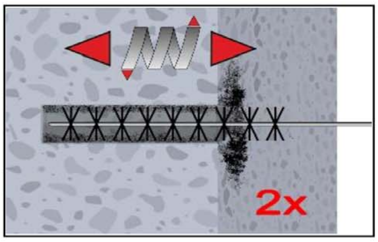


1a. Diamond drilling (DD)
Drill a hole to the required embedment depth required
Drill bit diameter according to Table B1, B2 or B3.
Aborted drill holes shall be filled with mortar.
Proceed with Step 2.

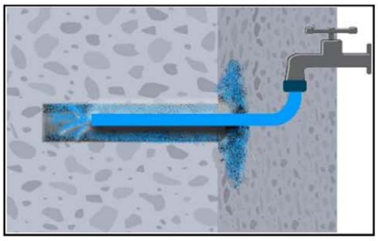
Flush & Compressed Air Cleaning (SPCAC):
All diameter in uncracked concrete



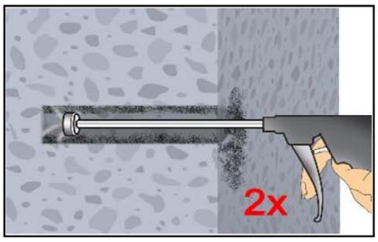
2a. Flushing with water until clear water comes out.



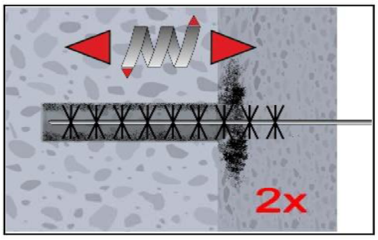
2b. Brush the bore hole minimum 2x with brush WIT-RB according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)



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



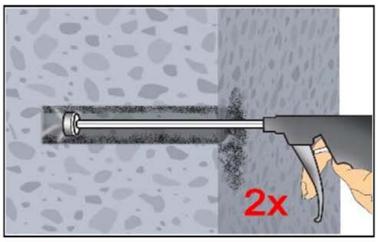
2d. Blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)



2e. Brush the bore hole minimum 2x with brush WIT-RB according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)

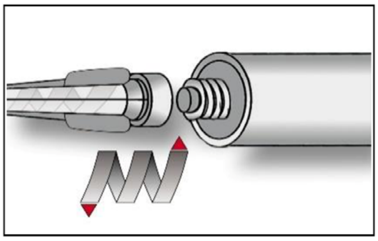
Würth injection system WIT-PE 1000 for concrete	**Annex B 7**
Intended Use Installation instructions (continuation)	

Installation instructions (continuation)

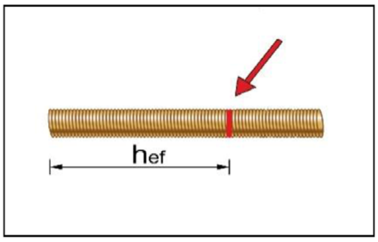


2f. Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

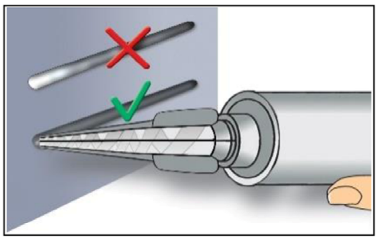
Cleaned bore hole has to be protected against re-contamination in an appropriate way,
If necessary, repeat cleaning process directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.



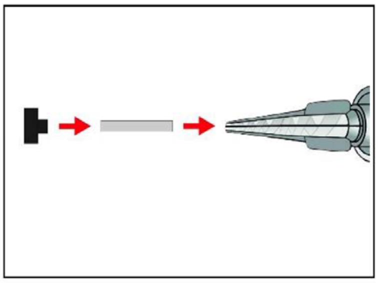
3. Screw on static-mixing nozzle WIT-PE / WIT-MX, and load the cartridge into an appropriate dispensing tool.
For every working interruption longer than the maximum working time t_{work} (Annex B 5) as well as for new cartridges, a new static-mixer shall be used.



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

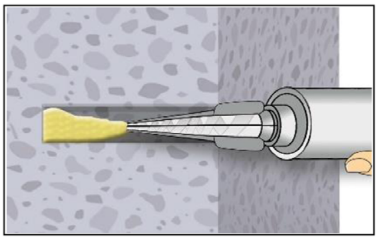


5. Not proper mixed mortar is not sufficient for fastening.
Dispense and discard mortar until an uniform grey or red colour is shown (at least 3 full strokes).



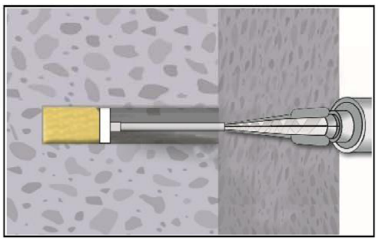
6. Piston plugs WIT-VS and mixer nozzle extensions WIT-MV shall be used according to
Table B4 for the following applications:
- Horizontal and vertical downwards direction: Drill bit-Ø d_0 ≥ 18 mm and embedment depth h_{ef} > 250mm
- Vertical upwards direction: Drill bit-Ø d_0 ≥ 18 mm

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

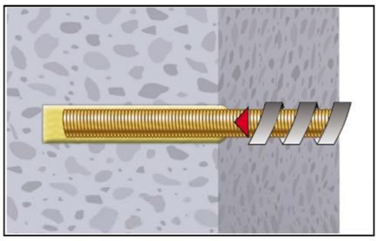


7a. **Injecting mortar without piston plug WIT-VS:**
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.)
Slowly withdraw of the static mixing nozzle avoid creating air pockets
Observe the temperature related working time t_{work} (Annex B 5).

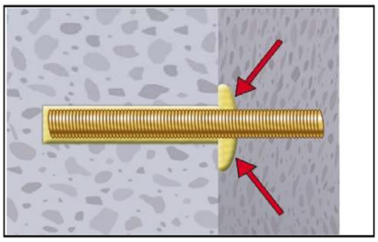
Installation instructions (continuation)



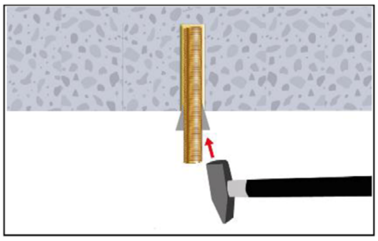
7b. **Injecting mortar with piston plug WIT-VS:**
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.)
During injection the piston plug is pushed out of the bore hole by the back pressure of the mortar.
Observe the temperature related working time t_{work} (Annex B 5).



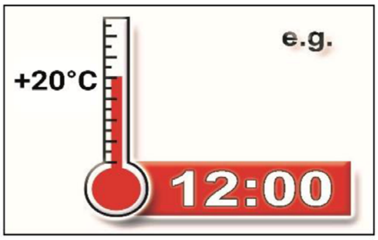
8. Insert the anchor rod while turning slightly up to the embedment mark.



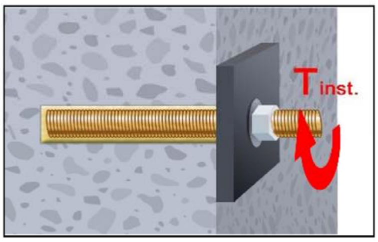
9. Annular gap between anchor rod and base material must be completely filled with mortar. In case of push through installation the annular gap in the fixture must be filled with mortar also.
Otherwise, the installation must be repeated starting from step 7 before the maximum working time t_{work} has 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 5) 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 or B3).
In case of static requirements (e.g. seismic), fill the annular gab in the fixture with mortar according to Annex 2. Therefore replace the washer by the filling washer WIT-SHB and use the mixer reduction nozzle WIT-MR-X.

Würth injection system WIT-PE 1000 for concrete	**Annex B 9**
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

Würth injection system WIT-PE 1000 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 for a working life of 50 and 100 years

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 for a working life of 50 years

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 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
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in uncracked 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
	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 in hammer drilled holes 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
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	[-]	$(f_{ck} / 20)^{0,1}$							
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 (HD; HDB, CD)			γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)					1,2							

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (threaded rod)

Annex C 3

Deutsches Institut für Bautechnik DIBt

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

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 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 uncracked 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 in hammer drilled holes 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
Reduction factor $\psi^0_{sus,100}$ in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,80							
	II: 72°C/50°C				0,68							
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,1}$							
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr,100}$ =		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$							
			$\tau_{Rk,cr,100}$ =		$\psi_c \cdot \tau_{Rk,cr,100,(C20/25)}$							
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							

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (threaded rod)

Annex C 4

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

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 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
	II: 72°C/50°C				12	12	11	10	9,5	9,5	9,0	9,0
Reduction factor ψ^0_{sus} in uncracked 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	[-]	$(f_{ck} / 20)^{0,2}$							
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr}$ =		$\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$							
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)					1,2			1,4				

Table C6: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

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 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
	II: 72°C/50°C				11	11	10	10	9,5	9,0	8,5	8,5
Reduction factor $\psi^0_{sus,100}$ in uncracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,73							
	II: 72°C/50°C				0,70							
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,2}$							
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$							
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)					1,2			1,4				

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (threaded rod)

Annex C 6

Table C7: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years

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							

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (threaded rod)

Annex C 7

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Table C8: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

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 uncracked 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
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	15	15	14	13	13	12
Characteristic bond resistance in uncracked 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
Temperature range II: 72°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	13	12	11
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	16	16	15	15	14	13
Temperature range II: 72°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	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 in hammer drilled holes with hollow drill bit (HDB)									
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,0	8,5	8,5	8,5	8,5	8,5
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	6,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	[-]	$(f_{ck} / 20)^{0,1}$					
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 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)		γ_{inst}	[-]	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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (Internal threaded anchor rod)

Annex C 8

Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

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			$\gamma_{Ms,N}$	[-]	[-]					
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70[2]			$N_{Rk,s}$	[kN]	[kN]	26	41	59	110	124
Partial factor			$\gamma_{Ms,N}$	[-]	[-]					2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked 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 uncracked 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 in hammer drilled holes 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
Reduction factor $\psi^0_{sus,100}$ in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,80					
	II: 72°C/50°C				0,68					
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,1}$					
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$					
			$\tau_{Rk,cr,100} =$		$\psi_c \cdot \tau_{Rk,cr,100,(C20/25)}$					
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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (Internal threaded anchor rod)

Annex C 9

Table C10: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

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 uncracked 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		$\tau_{Rk,ucr}$	[N/mm²]	12	11	10	9,5	9,5	9,0
Reduction factor ψ^0_{sus} in uncracked 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		ψ^0_{sus}	[-]	0,72					
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,2}$					
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr} =$		$\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$					
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)			γ_{inst}	[-]	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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (Internal threaded anchor rod)

Annex C 10

Table C11: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

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 uncracked 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
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm²]	11	10	10	9,5	9,0	8,5
Reduction factor $\psi^0_{sus,100}$ in uncracked concrete C20/25 in diamond drilled holes (DD)									
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,73					
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,70					
Increasing factors for concrete		ψ_c	[-]	$(f_{ck} / 20)^{0,2}$					
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$					
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)		γ_{inst}	[-]	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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (Internal threaded anchor rod)

Annex C 11

Table C12: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years

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

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 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
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12	12	12	12	12	11	11
Characteristic bond resistance in uncracked 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
Temperature range II: 72°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	11	11	11	11	11	11	11
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	13	13	13	13	13	13	13
Temperature range II: 72°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[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 in hammer drilled holes 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
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	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	[-]	$(f_{ck} / 20)^{0,1}$									
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,ucr}$ =		$\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$									
		$\tau_{Rk,cr}$ =		$\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$									
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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (reinforcing bar)

Annex C 13

Table C14: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

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 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 uncracked 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 in hammer drilled holes 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	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	$\tau_{Rk,ucr,100}$	[N/mm²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5
Reduction factor $\psi^0_{sus,100}$ in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)													
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,80									
Temperature range II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,68									
Increasing factors for concrete		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$									
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$									
		$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$									
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

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (reinforcing bar)

Annex C 14

Table C15: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

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 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 uncracked 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	[-]	$(f_{ck} / 20)^{0,2}$									
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,ucr}$ =		$\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$									
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

Table C16: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

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 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
	II: 72°C/50°C				11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5
Reduction factor $\psi^0_{sus,100}$ in uncracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus,100}$	[-]	0,73									
	II: 72°C/50°C				0,70									
Increasing factors for concrete			ψ_c	[-]	$(f_{ck} / 20)^{0,2}$									
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,ucr,100} =$		$\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$									
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)					1,2				1,4					

1) f_{uk} shall be taken from the specifications of reinforcing bars

2) in absence of national regulation

Table C17: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years

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	Aσ	[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

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

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked 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 C19: Displacements under tension load[1) in diamond drilled holes (DD)

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked 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
Uncracked 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 C20: Displacements under shear load[1) for all drilling methods

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V;$

Würth injection system WIT-PE 1000 for concrete

Performances
Displacements under static and quasi-static action
for a working life of 50 and 100 years (threaded rod)

Annex C 18

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

Internal threaded anchor rods			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Uncracked 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 C22: Displacements under tension load[1) in diamond drilled holes (DD)

Internal threaded anchor rods			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Uncracked 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
Uncracked 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 C23: Displacements under shear load[1) for all drilling methods

Internal threaded anchor rods			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Würth injection system WIT-PE 1000 for concrete

Performances
Displacements under static and quasi-static action
for a working life of 50 and 100 years (Internal threaded anchor rod)

Annex C 19

Table C24: Displacements under tension load[1)] in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)

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

Table C25: Displacements under tension load[1)] in diamond drilled holes (DD)

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

Table C26: Displacements under shear load[1)] for all drilling methods

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 for a working life of 50 and 100 years												
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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V;$

Würth injection system WIT-PE 1000 for concrete

Performances
Displacements under static and quasi-static action
for a working life of 50 and 100 years (reinforcing bar)

Annex C 20

Table C27: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years

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 uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	[-]	1,0							
Characteristic bond resistance depending on the concrete strength class		$\tau_{Rk,eq,C1} =$		$\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$							
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 C28: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years

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 uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete			ψ_c	[-]	1,0							
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,eq,C1} =$		$\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$							
Installation factor												
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)					1,2							

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years (threaded rod)

Annex C 22

Table C29: Characteristic values of shear loads under seismic action (performance category C1) for a working life of 50 and 100 years

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 fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

Table C30: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years

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			$N_{Rk,s,eq,C1}$	[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 uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	[-]	1,0									
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,eq,C1} =$		$\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$									
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 C31: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years

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			$N_{Rk,s,eq,C1}$	[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 uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[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	[-]	1,0									
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,eq,C1} =$		$\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$									
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 C32: Characteristic values of shear loads under seismic action (performance category C1) for a working life of 50 and 100 years

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 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 fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

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Table C33: Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 and 100 years

Threaded rod					M12	M16	M20	M24	M27	M30
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 uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes 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	4,8	5,0
	II: 72°C/50°C		$\tau_{Rk,eq,C2}$	[N/mm²]	5,0	4,1	4,3	4,4	4,1	4,3
Increasing factors for concrete			ψ_c	[-]	1,0					
Characteristic bond resistance depending on the concrete strength class			$\tau_{Rk,eq,C2} =$		$\psi_c \cdot \tau_{Rk,eq,C2,(C20/25)}$					
Installation factor										
for dry and wet concrete (HD; HDB, CD)			γ_{inst}	[-]	1,0					
for flooded bore hole (HD; HDB, CD)					1,2					

Table C34: Characteristic values of shear loads under seismic action (performance category C2) for a working life of 50 and 100 years

Threaded rod			M12	M16	M20	M24	M27	M30
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 fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

Würth injection system WIT-PE 1000 for concrete

Performances
Characteristic values of tension and shear loads under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)

Annex C 27

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Table C35: Displacements under tension load (threaded rod)

Threaded rod			M12	M16	M20	M24	M27	M30
Uncracked and cracked concrete under seismic action (performance category C2) for a working life of 50 and 100 years								
All temperature ranges	$\delta_{N,eq,C2(DLS)}$	[mm]	0,21	0,24	0,27	0,36	0,92	0,70
	$\delta_{N,eq,C2(ULS)}$	[mm]	0,54	0,51	0,54	0,63	1,70	0,92

Table C36: Displacements under shear load (threaded rod)

Threaded rod			M12	M16	M20	M24	M27	M30
Uncracked and cracked concrete under seismic action (performance category C2) for a working life of 50 and 100 years								
All temperature ranges	$\delta_{V,eq,C2(DLS)}$	[mm]	3,1	3,4	3,5	4,2	4,0	3,8
	$\delta_{V,eq,C2(ULS)}$	[mm]	6,0	7,6	7,3	10,9	11,1	11,2