Deutsches Institut für Bautechnik
DIBt

Public-law institution jointly founded by the federal states and the Federation

European Technical Assessment Body for construction products

European Technical Assessment ETA-17/0716 of 1 August 2024

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 VMH for concrete
Product family to which the construction product belongs	Bonded fasteners and bonded expansion fasteners for use in concrete
Manufacturer	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND
Manufacturing plant	Werk 1, D Werk 2, D
This European Technical Assessment contains	38 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 330499-02-0601, Edition 11/2023
This version replaces	ETA-17/0716 issued on 11 May 2021

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Specific Part

1 Technical description of the product

The "Injection system VMH for concrete" is a bonded anchor consisting of a cartridge with injection mortar VMH and a steel element according to Annex A 3 to A 5.

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 B3, C 1, C 3, C 4, C 5, C 9, C 10, C 12, C 13
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2, C 6, C 11, C 14
Displacements under short-term and long-term loading	See Annex C 17 to C19
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 7, C 8, C 15, C 16, C 17

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 20 to C 22

3.3 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 EAD 330499-02-0601 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.

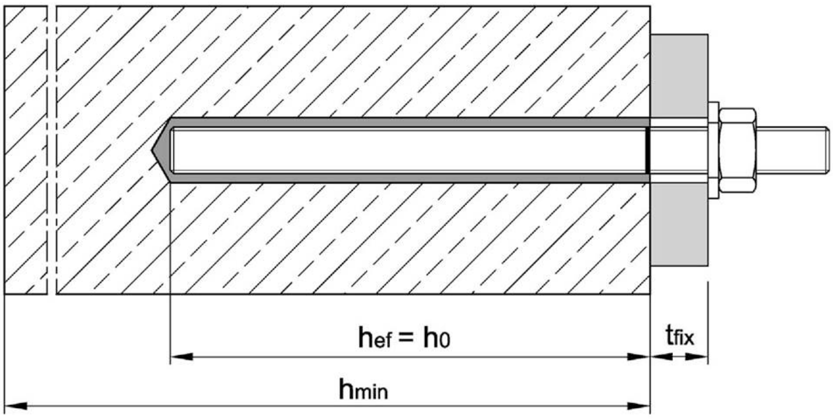
Issued in Berlin on 1 August 2024 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

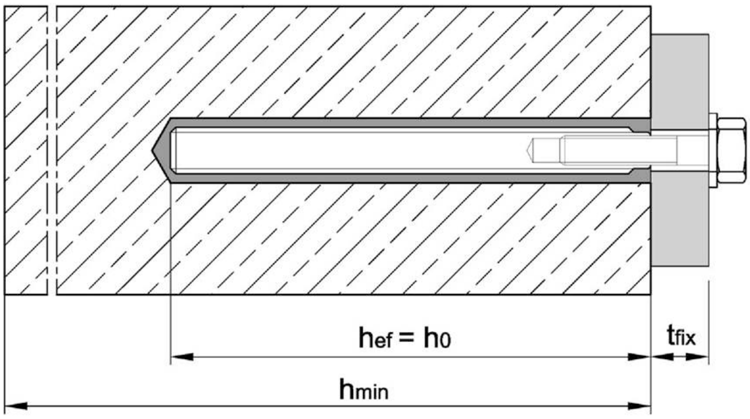
beglaubigt:
Baderschneider

Installation threaded rod M8 to M30

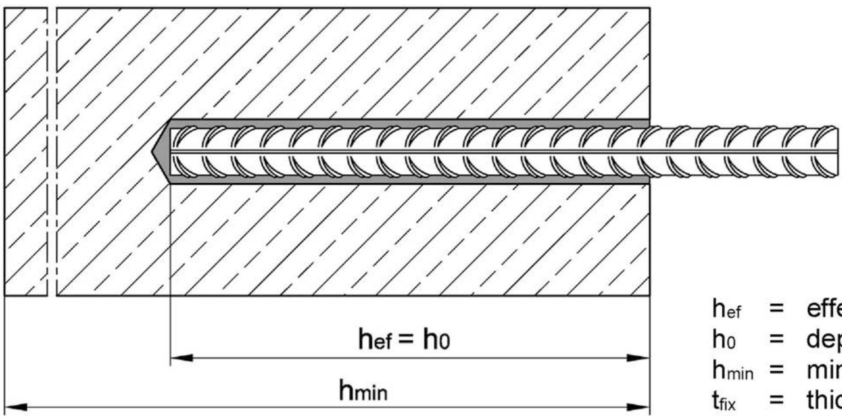
Pre-setting installation or through-setting installation (optional annular gap filled with mortar)



Installation internally threaded anchor rod IG M6 to IG M20



Installation reinforcing bar Ø8 to Ø32

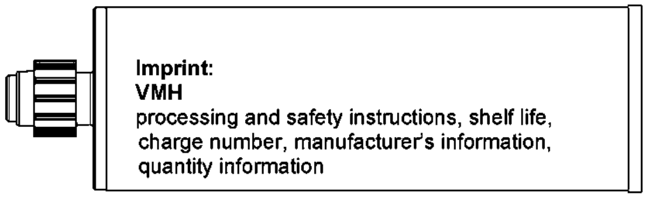


h_{ef} = effective anchorage depth
h_0 = depth of drill hole
h_{min} = minimum thickness of member
t_{fix} = thickness of fixture

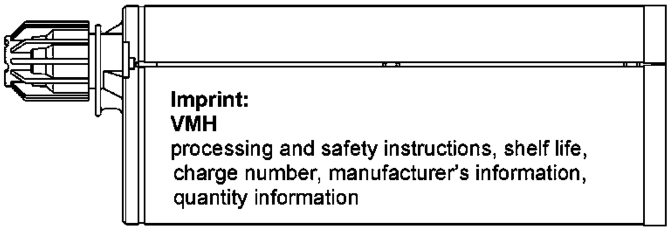
Injection System VMH for concrete	
Product description Installation situation	**Annex A1**

Cartridge Injection Mortar VMH

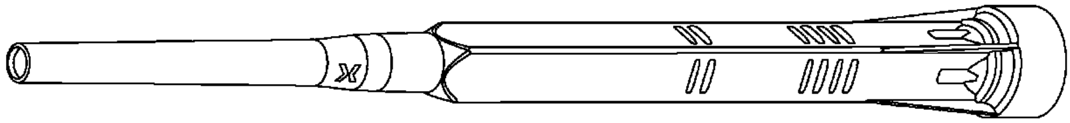
Coaxial cartridge
150 ml, 280 ml,
300 ml bis 330 ml,
380 ml bis 420 ml



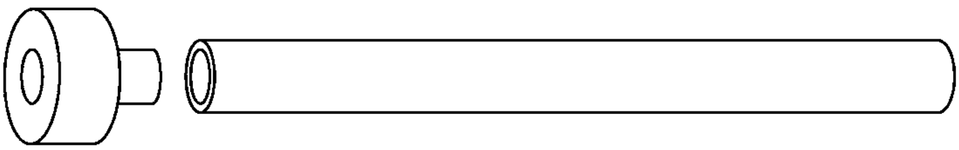
Side-by-side cartridge
235 ml,
345 ml bis 360 ml,
825 ml



Static mixer VM-XHP



Retaining washer and extension nozzle



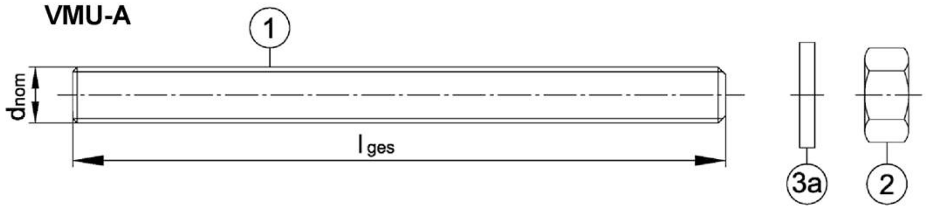
Injection System VMH for concrete	Annex A2
Product description Cartridge, static mixer and retaining washer	

Threaded rod

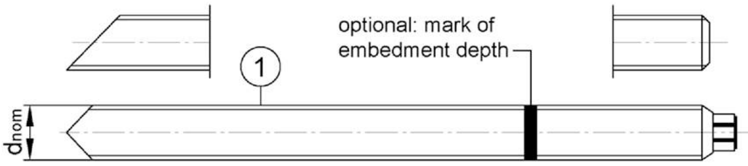
Threaded rod VMU-A and V-A

M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A4, HCR)
with washer and hexagon nut

VMU-A



V-A



Marking e.g.: ◇ M10

◇	identifying mark of manufacturing plant
M10	size of thread

additional marking:

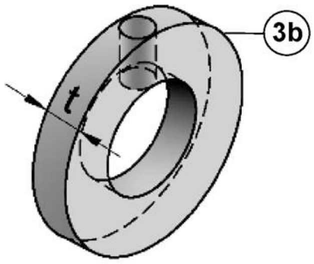
-8	strength class 8.8
A4	stainless steel
HC	high corrosion resistant steel

Threaded rod VM-A (material sold by the metre, to be cut at the required length)
M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR)
- Materials, dimensions and mechanical properties see Table A1

Commercial standard threaded rod with:
M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR)
- Materials, dimensions and mechanical properties see Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004 (documents must be retained)

Filling washer VS and reducing adapter

for filling the gap between threaded rod and fixture



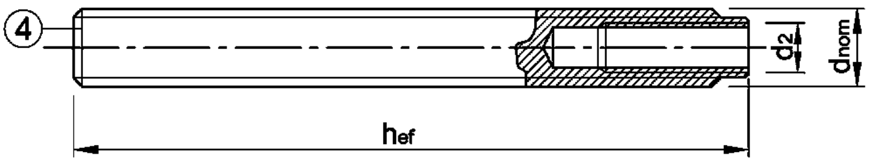
Thickness of filling washer for diameter
< M24: t = 5 mm
≥ M24: t = 6 mm

Injection System VMH for concrete	
Product description Threaded rods, Marking, Filling washer	**Annex A3**

Internally threaded anchor rod

Internally threaded anchor rod VMU-IG

VMU-IG M6, VMU-IG M8, VMU-IG M10, VMU-IG M12, VMU-IG M16, VMU-IG M20
(zinc plated, A4, HCR)



Marking e.g.: <> M8

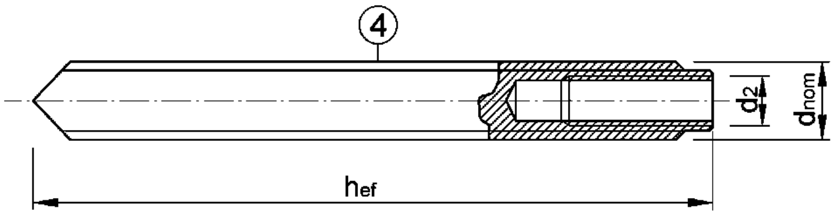
<>	identifying mark of manufacturing plant
I	internal thread (optional)
M8	size of internal thread

additional marking:

-8	strength class 8.8
A4	stainless steel
HCR	high corrosion resistant steel

Internally threaded anchor rod VZ-IG

VZ-IG M6, VZ-IG M8, VZ-IG M10, VZ-IG M12, VZ-IG M16, VZ-IG M20
(zinc plated, A4, HCR)



Requirements on the fastening screw or the threaded rod and nut according to the engineering documents:

- Minimum screw-in depth $L_{sd,min}$ see Table B2
- The length of screw or the threaded rod shall be determined depending on the thickness of fixture t_{fix}, the existing thread length and the minimum screw-in depth $L_{sd,min}$.
- Materials for screws and threaded rods (incl. nut and washer) must at least correspond to the material and strength class of the internally threaded anchor rod used.

Injection System VMH for concrete	**Annex A4**
Product description Internally threaded anchor rods, Marking	

Table A1: Materials

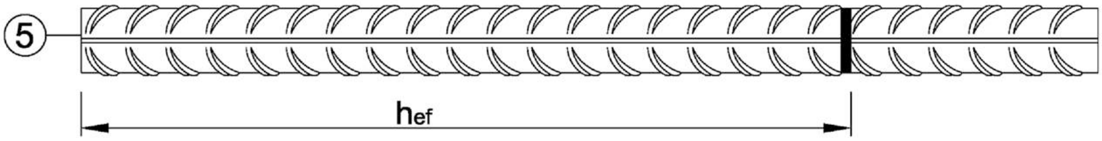
Part	Designation	Material and mechanical properties						
Steel, zinc plated electroplated ≥ 5 µm acc. to EN ISO 4042:2022 or hot-dip galvanized ≥ 50 µm in average acc. to EN ISO 1461:2022, EN ISO 10684:2004+AC:2009 or sherardized ≥ 45 µm acc. to EN ISO 17668:2016								
1	Threaded rod	Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN ISO 683-4:2018, EN 10263:2017 Commercial standard threaded rod: EN ISO 898-1:2013
		4.6	f_{uk} [N/mm²]	400	f_{yk} [N/mm²]	240	A_5 > 8 %	
		4.8		400		320	A_5 > 8 %	
		5.6		500		300	A_5 > 8 %	
		5.8		500		400	A_5 > 8 %	
		8.8		800		640	A_5 ≥ 12%[1]	
2	Hexagon nut	4	for class 4.6 or 4.8 rods					EN ISO 898-2:2022
		5	for class 4.6, 4.8, 5.6 or 5.8 rods					
		8	for class 4.6, 4.8, 5.6, 5.8 or 8.8 rods					
3a	Washer		e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000, EN ISO 887:2006					
3b	Washer with bore		Steel, zinc plated					
4	Internally threaded anchor rod	5.8	Steel, electroplated or sherardized				A_5 > 8%	EN ISO 683-4:2018
		8.8					A_5 > 8%	
Stainless steel A2 [2] **CRC II** (1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541) **Stainless steel A4** **CRC III** (1.4401 / 1.4404 / 1.4571 / 1.4578) **High corrosion resistant steel HCR** **CRC V** (1.4529 / 1.4565)								
1	Threaded rod	Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN 10088-1:2014 EN ISO 3506-1:2020
		50	f_{uk} [N/mm²]	500	f_{yk} [N/mm²]	210	A_5 > 8%	
		70		700		450 (560) [4]	A_5 ≥ 12%[1]	
		80[3]		800		600 (640) [4]	A_5 ≥ 12%[1]	
2	Hexagon nut	50	for class 50 rods					EN 10088-1:2014 EN ISO 3506-2:2020
		70	for class 50 or 70 rods					
		80[3]	for class 50, 70 or 80 rods					
3a	Washer		e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000; EN ISO 887:2006					EN 10088-1:2014
3b	Washer with bore		stainless steel A4; high corrosion resistant steel HCR					
4	Internally threaded anchor rod	50	IG-M20				A_5 > 8 %	EN 10088-1:2014
		70	IG-M6 to IG-M20				A_5 > 8 %	

1) Fracture elongation A_5 > 8 % for applications without requirements for seismic performance category C2
2) Property classes 50 and 70
3) Property classes 80: M8 up to M24
4) Value in brackets for anchor rods VMU-A and V-A

Injection System VMH for concrete	**Annex A5**
Product description Materials	

Reinforcing bar

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



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

Table A2: Material - Reinforcing bar

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

Specification of intended use

Working life	**50 years**	**100 years**
Base material	cracked or uncracked concrete	
	compacted, reinforced or unreinforced normal weight concrete strength classes C20/25 to C50/60 (without fibers) acc. to EN 206:2013+A2:2021	
Hole drilling	hammer drilling / compressed air drilling / vacuum drilling	
Static and quasi-static action		
Threaded rod **Internally threaded anchor rod** **Rebar**	**M8 - M30** **IG M6 - IG M20** **Ø8 - Ø32**	
Temperature range [1)]	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C
Seismic action		
Performance category C1		
Threaded rod **Rebar**	**M8 - M30** **Ø8 - Ø32**	
Performance category C2		
Threaded rod	**M12 – M24** Steel, zinc plated: property class 8.8; A4 / HCR property class ≥ 70	
Temperature range [1)]	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C
Fire exposure		
Threaded rod **Internally threaded anchor rod** **Rebar**	**M8 - M30** **IG M6 - IG M20** **Ø8 - Ø32**	
Temperature range [1)]	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C

[1)] Temperature Range I: max. long term temperature +24°C and max. short term temperature +40°C
Temperature Range II: max. long term temperature +50°C and max. short term temperature +80°C
Temperature Range III: max. long term temperature +72°C and max. short term temperature +120°C
Temperature Range IV: max. long term temperature +100°C and max. short term temperature +160°C

Injection System VMH for concrete	**Annex B1**
Intended Use Specifications	

Specification of intended use

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions: all materials
- For all other conditions:
  Intended use of Materials according to Annex A5, Table A1 corresponding corrosion resistance classes CRC according to EN 1993-1-4:2006+A2:2020
  - Stainless steel A2 acc. to Annex A4, Table A1: CRC II
  - Stainless steel A4 acc. to Annex A2, Table A1: CRC III
  - High corrosion resistant steel HCR, acc. to Annex A4, Table A1: CRC V

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Anchorages are designed in accordance with EN 1992-4:2018 and Technical Report TR 055, Edition February 2018
- Anchorages under fire exposure are designed in accordance with Technical Report TR 082, Edition June 2023

Installation:

- Dry or wet concrete or waterfilled drill holes (not seawater)
- Hole drilling by hammer or compressed air drill or vacuum drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person competent for technical matters on site.
- Installation temperature in concrete:
  -5°C up to +40°C for the standard variation of temperature after installation.
- Clean the drill hole immediately before installing the anchor or protect it against contamination in a suitable manner until installation. In case of water inflow or renewed contamination, cleaning must be repeated before installation.

Table B1: Installation parameters, threaded rods

Threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Diameter of threaded rod		$d = d_{nom}$	[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 anchorage 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 2)	Pre-setting installation	$d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Through setting installation	$d_f \leq$	[mm]	12	14	16	20	24	30	33	40
Maximum installation torque		$max.T_{inst} \leq$	[Nm]	10	20	40 (35)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) Max. installation torque for M12 with steel grade 4.6
2) For applications under seismic loading the diameter of clearance hole in the fixture shall be at maximum d_{nom} + 1mm or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

Table B2: Installation parameters for internally threaded anchor rods

Internally threaded anchor rod			**IG-M 6**	**IG-M 8**	**IG-M 10**	**IG-M 12**	**IG-M 16**	**IG-M 20**
Inner diameter of threaded rod	d_2	[mm]	6	8	10	12	16	20
Outer diameter of threaded 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 anchorage 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
Minimum screw-in depth	$L_{sd,min}$	[mm]	8	8	10	12	16	20
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 thread

Table B3: Installation parameters for rebar

Rebar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Diameter of rebar	$d = d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter 1)	d_0	[mm]	10, 12	12, 14	14, 16	18	20	25	30, 32	30, 32	35	40
Effective anchorage 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 may be used

Injection System VMH for concrete

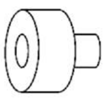
Intended use
Installation parameters

Annex B3

Table B4: Parameter cleaning and setting tools

Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
				 d_b	
[-]	[-]	Ø [mm]	d_0 [mm]	d_b [mm]	$d_{b,min}$ [mm]
M8	-	8	10	11,5	10,5
M10	IG M6	8 / 10	12	13,5	12,5
M12	IG M8	10 / 12	14	15,5	14,5
-	-	12	16	17,5	16,5
M16	IG M10	14	18	20,0	18,5
-	-	16	20	22,0	20,5
M20	IG M12	-	22	24,0	22,5
-	-	20	25	27,0	25,5
M24	IG M16	-	28	30,0	28,5
M27	-	24 / 25	30	31,8	30,5
-	-	24 / 25	32	34,0	32,5
M30	IG M20	28	35	37,0	35,5
-	-	32	40	43,5	40,5

Table B5: Retaining washer

Drill bit Ø 		Installation direction and use		
d_0 [mm]	[-]	↓	→	↑
10	No **retaining washer** required			
12				
14				
16				
18	VM-IA 18	h_{ef} > 250mm	h_{ef} > 250mm	all
20	VM-IA 20			
22	VM-IA 22			
25	VM-IA 25			
28	VM-IA 28			
30	VM-IA 30			
32	VM-IA 32			
35	VM-IA 35			
40	VM-IA 40			

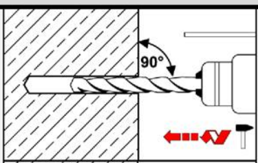
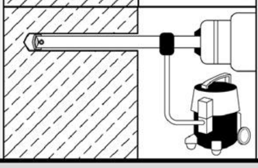
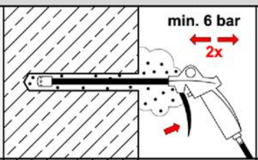
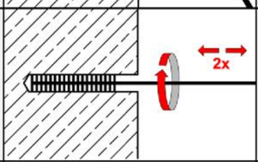
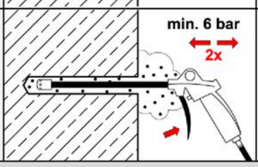
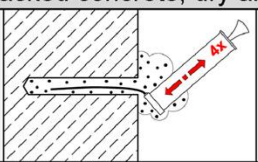
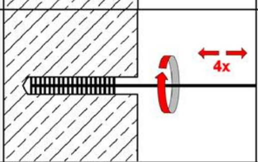
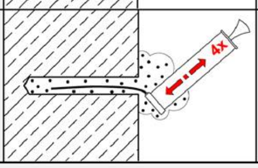
Vacuum drill bit
Drill bit diameter (d_0): all diameters
Vacuum drill bit (MKT Hollow drill bit SB, Würth Extraction Drill Bit or Heller Duster Expert) and a class M vacuum with minimum negative pressure of 253 hPa and a flow rate of minimum 42 l/s (150 m³/h)

Recommended compressed air tool (min 6 bar)
Drill bit diameter (d_0): all diameters

Blow-out pump (volume 750ml)
Drill bit diameter (d_0): ≤ 20 mm
Drill hole depth (h_0): ≤ 10 d_{nom}
for uncracked concrete

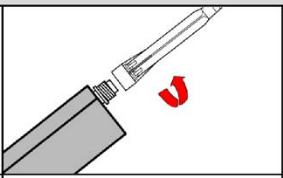
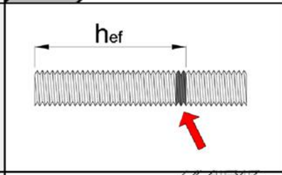
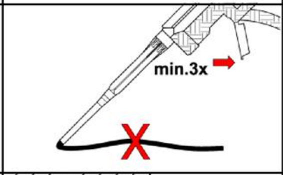
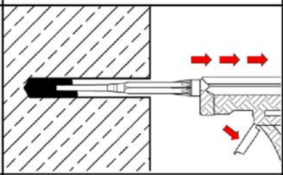
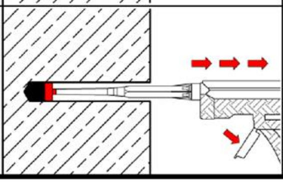
Injection System VMH for concrete	Annex B4
Intended Use Cleaning and setting tools	

Installation Instructions

Step	Figure	Description
Drilling		
1		**Hammer drill or compressed air drill** Drill with hammer drill or compressed air drill a hole into the base material to the size required by the selected anchor (Table B1, B2 or B3). Continue with step 2. In case of aborted drill hole, the drill hole shall be filled with mortar.
		**Vacuum drill bit**: see Annex B4 Drill hole into the base material to the embedment size and embedment depth required by the selected anchor (Table B1, B2 or B3). This drilling system removes dust and cleans the drill hole during drilling. Continue with step 3. In case of aborted hole, the drill hole shall be filled with mortar.
Cleaning (not applicable when using a vacuum drill)		
2		**Attention! Standing water in the drill hole must be removed before cleaning!**
		Cleaning with compressed air all substrates and diameters according to Annex B1
2a		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
2b		Check brush diameter (Table B4). Brush the hole with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **two** times. If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.
2c		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
		Manual cleaning uncracked concrete, dry and wet drill holes; drill hole diameter d_0 ≤ 20mm and drill hole depth h_0 ≤ 10 d_{nom}
2a		Starting from the bottom or back of the drill hole, blow out the hole with the blow-out pump a minimum of **four** times until return air stream is free of noticeable dust.
2b		Check brush diameter (Table B4). Brush the hole with an appropriately sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **four** times. If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.
2c		Starting from the bottom or back of the drill hole blow out the hole again a minimum of **four** times until return air stream is free of noticeable dust.
After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar.		

Injection System VMH for concrete	Annex B5
Intended Use Installation instructions	

Installation instructions (continuation)

Injection		
3		Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B6) as well as for new cartridges, a new static-mixer shall be used.
4		Prior to inserting the rod into the filled drill hole, the position of the embedment depth shall be marked on the threaded rod or rebar. For through-setting installation, observe t_{fix}. The fastening element must be free of dirt, grease, oil and other foreign materials.
5		Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey color.
6a		**Filling without retaining washer:** Starting from the bottom or back of the cleaned drill hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle (with mixer extension if necessary) as the hole fills to avoid air pockets. Observe working times given in Table B6.
6b		**Filling with retaining washer** (according to Table B5): Insert the retaining washer up to the bottom of the drill hole (use a mixer extension if necessary) and fill the drill hole approx. 2/3 with mortar. During injection, the back pressure of the mortar pushes the retaining washer out of the drill hole. The processing times according to table B6 must be observed.

Injection System VMH for concrete	**Annex B6**
Intended Use Installation instructions (continuation)	

Installation instructions (continuation)

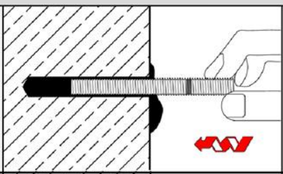
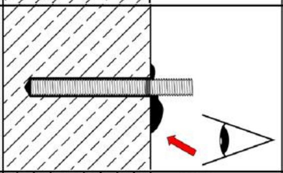
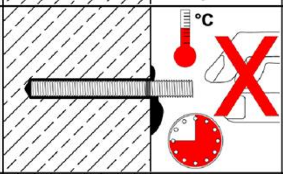
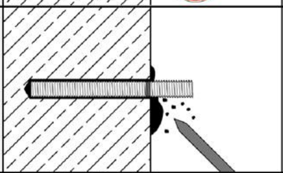
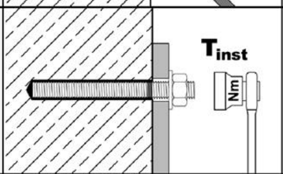
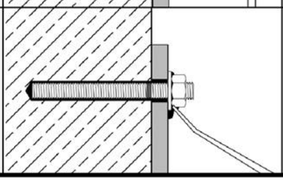
Setting the fastening element		
7		Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.
8		After installation, the annular gap between anchor rod and must be completely filled with mortar, in the case of through-setting installation also in the fixture. If these requirements are not fulfilled, repeat application before end of working time! For overhead installation, the anchor should be fixed (e.g. by wedges).
9		Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B6).
10		Remove excess mortar.
11		The fixture can be mounted after curing time. Apply installation torque ≤ T_{inst} according to Table B1 or B2.
12		In case of pre-setting installation, the annular gap between anchor rod and fixture may optionally be filled with mortar. Therefore, replace regular washer by filling washer and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.

Table B6: Working time and curing time

Concrete temperature	Working time	Minimum curing time	
		dry concrete	dry concrete
-5°C to -1°C	50 min	5 h	10 h
0°C to +4°C	25 min	3,5 h	7 h
+5°C to +9°C	15 min	2 h	4 h
+10°C to +14°C	10 min	1 h	2 h
+15°C to +19°C	6 min	40 min	80 min
+20°C to +29°C	3 min	30 min	60 min
+30°C to +40°C	2 min	30 min	60 min
Cartridge temperature	+ 5°C to + 40°C		

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Table C1: Characteristic **steel resistance** for **threaded rods** under **tension load**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Cross sectional area		A_s	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Characteristic resistance under tension load [1]											
Steel, zinc plated	Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15 (13)[1]	23 (21)[1]	34	63	98	141	184	224
	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)[1]	29 (27)[1]	42	79	123	177	230	281
	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)[1]	46 (43)[1]	67	126	196	282	367	449
Stainless steel	Property class 50 (A2 / A4 / HCR)	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
	Property class 70 (A2 / A4 / HCR)	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
	Property class 80 (A4 / HCR)	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-[4]	-[4]
Partial factor [2]											
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,N}$	[-]	2,0							
	Property class 4.8	$\gamma_{Ms,N}$	[-]	1,5							
	Property class 5.6	$\gamma_{Ms,N}$	[-]	2,0							
	Property class 5.8	$\gamma_{Ms,N}$	[-]	1,5							
	Property class 8.8	$\gamma_{Ms,N}$	[-]	1,5							
Stainless steel	Property class 50 (A2 / A4 / HCR)	$\gamma_{Ms,N}$	[-]	2,86							
	Property class 70 (A2 / A4 / HCR)	$\gamma_{Ms,N}$	[-]	1,87 (1,5) [3]							
	Property class 80 (A4 / HCR)	$\gamma_{Ms,N}$	[-]	1,6 (1,5) [3]						-[4]	-[4]

[1] The characteristic resistances apply for all anchor rods with the cross-sectional area A_s specified here: VMU-A, V-A, VM-A. For commercial standard threaded rods with a smaller cross-sectional area (e.g. hot-dip galvanized threaded rods M8, M10 according to EN ISO 10684:2004 + AC:2009), the values in brackets are valid.
[2] In absence of other national regulations
[3] Value in brackets for anchor rods VMU-A or V-A
[4] Anchor type not part of the ETA

Injection System VMH for concrete	**Annex C1**
Performance Characteristic values for **threaded rods** under **tension loads**	

Table C2: Characteristic **steel resistance** for **threaded rods** under **shear load**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Cross sectional area		A_s	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Characteristic resistances under shear load[1]											
Steel failure <u>without</u> lever arm											
Steel, zinc plated	Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
	Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
	Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Stainless steel	Property class 50 (A2 / A4 / HCR)	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Property class 70 (A2 / A4 / HCR)	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
	Property class 80 (A4 / HCR)	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-[4]	-[4]
Steel failure <u>with</u> lever arm											
Steel, zinc plated	Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
	Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	325	561	832	1124
	Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	898	1332	1799
Stainless steel	Property class 50 (A2 / A4 / HCR)	$M^0_{Rk,s}$	[Nm]	19	37	65	166	325	561	832	1124
	Property class 70 (A2 / A4 / HCR)	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	785	1165	1574
	Property class 80 (A4 / HCR)	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	-[4]	-[4]
Partial factor [2]											
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,V}$	[-]	1,67							
	Property class 4.8	$\gamma_{Ms,V}$	[-]	1,25							
	Property class 5.6	$\gamma_{Ms,V}$	[-]	1,67							
	Property class 5.8	$\gamma_{Ms,V}$	[-]	1,25							
	Property class 8.8	$\gamma_{Ms,V}$	[-]	1,25							
Stainless steel	Property class 50 (A2 / A4 / HCR)	$\gamma_{Ms,V}$	[-]	2,38							
	Property class 70 (A2 / A4 / HCR)	$\gamma_{Ms,V}$	[-]	1,56 (1,25) [3]							
	Property class 80 (A4 / HCR)	$\gamma_{Ms,V}$	[-]	1,33 (1,25) [3]						-[4]	-[4]

[1] The characteristic resistances apply for all anchor rods with the cross-sectional area A_s specified here: VMU-A, V-A, VM-A. For commercial standard threaded rods with a smaller cross-sectional area (e.g. hot-dip galvanized threaded rods M8, M10 according to EN ISO 10684:2004 + AC:2009), the values in brackets are valid
[2] In absence of other national regulations
[3] Value in brackets for anchor rods VMU-A or V-A
[4] Anchor type not part of the ETA

Table C3: Characteristic values of **concrete cone failure and splitting failure**, working life **50 and 100 years**

Threaded rods / Internally threaded anchor rods / Rebars				**all sizes**
Concrete cone failure				
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0
	cracked concrete	$k_{cr,N}$	[-]	7,7
Edge distance		$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$
Spacing		$s_{cr,N}$	[mm]	$2{,}0 \cdot c_{cr,N}$
Splitting failure				
Characteristic resistance		$N^0_{Rk,sp}$	[kN]	$\min (N_{Rk,p} ; N^0_{Rk,c})$
Edge distance	$h/h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef}$
	$2{,}0 > h/h_{ef} > 1{,}3$			$2 \cdot h_{ef} (2{,}5 - h / h_{ef})$
	$h/h_{ef} \leq 1{,}3$			$2{,}4 \cdot h_{ef}$
Spacing		$s_{cr,sp}$	[mm]	$2{,}0 \cdot c_{cr,sp}$

Table C4: Characteristic values of **tension load** for **threaded rods static and quasi-static action,** working life **50 years**

Threaded rod					**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic 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	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	17	17	16	15	14	13	13	13
	II	50°C / 80°C			17	17	16	15	14	13	13	13
	III	72°C / 120°C			15	14	14	13	12	12	11	11
	IV	100°C / 160°C			12	11	11	10	9,5	9,0	9,0	9,0
Characteristic bond resistance in cracked concrete C20/25												
Temperature range	I	24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	II	50°C / 80°C			7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	III	72°C / 120°C			6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	IV	100°C / 160°C			5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Reduction factor ψ^0_{sus} in concrete C20/25												
Temperature range	I	24°C / 40°C	ψ^0_{sus}	[-]	0,90							
	II	50°C / 80°C			0,87							
	III	72°C / 120°C			0,75							
	IV	100°C / 160°C			0,66							
Characteristic bond resistance in concrete ≥ C25/30												
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$			ψ_c	[-]	$(f_{ck} / 20)^{0,1}$							
Concrete cone failure												
Relevant parameter					see Table C3							
Splitting failure												
Relevant parameter					see Table C3							
Installation factor												
dry or wet concrete	vacuum cleaning		γ_{inst}	[-]	1,2							
	manual cleaning				1,2				No performance assessed			
	compressed air cleaning				1,0							
water filled drill hole	compressed air cleaning		γ_{inst}	[-]	1,4							

Table C5: Characteristic values of **tension load** for **threaded rods**, **static and quasi-static action,** working life **100 years**

Threaded rod					**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ or see Table C1							
Partial factor			$\gamma_{Ms,N}$	[-]	or see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in <u>uncracked</u> concrete C20/25												
Temperature range	I	24°C / 40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	17	17	16	15	14	13	13	13
Temperature range	II	50°C / 80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	17	17	16	15	14	13	13	13
Characteristic bond resistance in <u>cracked</u> concrete C20/25												
Temperature range	I	24°C / 40°C	$\tau_{Rk,cr,100}$	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
Temperature range	II	50°C / 80°C	$\tau_{Rk,cr,100}$	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
Reduction factor ψ^0_{sus} in concrete C20/25												
Temperature range	I	24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,90							
Temperature range	II	50°C / 80°C	$\psi^0_{sus,100}$	[-]	0,87							
Characteristic bond resistance in concrete ≥ C25/30												
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$			ψ_c	[-]	$(f_{ck} / 20)^{0,1}$							
Concrete cone failure												
Relevant parameter					see Table C3							
Splitting failure												
Relevant parameter					see Table C3							
Installation factor												
dry or wet concrete	vacuum cleaning		γ_{inst}	[-]	1,2							
dry or wet concrete	manual cleaning		γ_{inst}	[-]	1,2				No performance assessed			
dry or wet concrete	compressed air cleaning		γ_{inst}	[-]	1,0							
water filled drill hole	compressed air cleaning		γ_{inst}	[-]	1,4							

Table C6: Characteristic values of **shear load** for **threaded rods, static and quasi-static action,** working life **50 and 100 years**

Threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure <u>without</u> lever arm										
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	$0,6 \cdot A_s \cdot f_{uk}$ or see Table C2							
Characteristic resistance Steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR	$V^0_{Rk,s}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$ or see Table C2							
Ductility factor	k_7	[-]	1,0							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C2							
Steel failure <u>with</u> lever arm										
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$ or see Table C2							
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	$\gamma_{Ms,V}$	[-]	or see Table C2							
Concrete pry-out failure										
Pry-out Faktor	k_8	[-]	2,0							
Concrete edge failure										
Effective length of anchor	l_f	[mm]	min (h_{ef};12 d_{nom})						min (h_{ef};300mm)	
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

Injection System VMH for concrete

Performance
Characteristic values of **shear loads** for **threaded rods**

Annex C6

Table C7: Characteristic values of **tension load** for **threaded rods**, **seismic action** (performance category **C1 + C2**), working life **50 years**

Threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure											
Characteristic resistance [1]		$N_{Rk,s,C1}$	[kN]	$1{,}0 \cdot N_{Rk,s}$							
		$N_{Rk,s,C2}$	[kN]	-[2]		$1{,}0 \cdot N_{Rk,s}$				-[2]	
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure											
Characteristic bond resistance in concrete C20/25 to C50/60											
Temperature range	I: 24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		3,6	3,5	3,3	2,3	-[2]	
	II: 50°C / 80°C	$\tau_{Rk,C1}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		3,6	3,5	3,3	2,3	-[2]	
	III: 72°C / 120°C	$\tau_{Rk,C1}$	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		3,1	3,0	2,8	2,0	-[2]	
	IV: 100°C / 160°C	$\tau_{Rk,C1}$	[N/mm²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		2,5	2,7	2,5	1,8	-[2]	
Installation factor											
Compressed air cleaning	dry or wet concrete	γ_{inst}	[-]	1,0							
	water filled drill hole			1,4							
Vacuum cleaning	dry or wet concrete	γ_{inst}	[-]	1,2							

[1] Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class ≥ 70
[2] No performance assessed

Table C8: Characteristic values of **tension load** for **threaded rods**, **seismic action** (performance category **C1 + C2**), working life **100 years**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Characteristic resistance [1]		$N_{Rk,s,C1}$	[kN]	1,0 • $N_{Rk,s}$							
		$N_{Rk,s,C2}$	[kN]	-[2]		1,0 • $N_{Rk,s}$				-[2]	
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure											
Characteristic bond resistance in concrete C20/25 to C50/60											
Temperature range	I: 24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		3,6	3,5	3,3	2,3	-[2]	
	II: 50°C / 80°C	$\tau_{Rk,C1}$	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
		$\tau_{Rk,C2}$	[N/mm²]	-[2]		3,6	3,5	3,3	2,3	-[2]	
Installation factor											
Compressed air cleaning	dry or wet concrete	γ_{inst}	[-]	1,0							
	water filled drill hole			1,4							
Vacuum cleaning	dry or wet concrete	γ_{inst}	[-]	1,2							

[1] Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class ≥ 70
[2] No performance assessed

Table C9: Characteristic values of **shear load** for **threaded rods, seismic action (performance category C1 + C2)**, working life **50 and 100 years**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure <u>without</u> lever arm											
Characteristic resistance[1]		$V_{Rk,s,C1}$	[kN]	0,7 • $V^0_{Rk,s}$							
		$V_{Rk,s,C2}$	[kN]	-[2]		0,7 • $V^0_{Rk,s}$				-[2]	
Partial factor		$\gamma_{Ms,V}$	[-]	see Table C2							
Factor for anchorages	without hole clearance	α_{gap}	[-]	1,0							
	with hole clearance between fastener and fixture			0,5							

[1] Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class ≥ 70
[2] No performance assessed

Table C10: Characteristic values of **tension load** for **internally threaded anchor rod, static and quasi-static action,** working life **50 years**

Internally threaded anchor rod VMU-IG and VZ-IG				IG M6	IG M8	IG M10	IG M12	IG M16	IG M20
Steel failure [1]									
Characteristic resistance, steel, zinc plated, property 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		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic resistance, stainless steel A4 / HCR, property class	70	$N_{Rk,s}$	[kN]	14	26	41	59	110	172 (123) [2]
Partial factor		$\gamma_{Ms,N}$	[-]	1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure									
Characteristic bond resistance in uncracked concrete C20/25									
Temperature range	I: 24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	17	16	15	14	13	13
	II: 50°C / 80°C			17	16	15	14	13	13
	III: 72°C / 120°C			14	14	13	12	12	11
	IV: 100°C / 160°C			11	11	10	9,5	9,0	9,0
Characteristic bond resistance in cracked concrete C20/25									
Temperature range	I: 24°C / 40°C	$\tau_{Rk,cr}$	[N/mm²]	7,5	8,0	9,0	8,5	7,0	7,0
	II: 50°C / 80°C			7,5	8,0	9,0	8,5	7,0	7,0
	III: 72°C / 120°C			6,5	7,0	7,5	7,0	6,0	6,0
	IV: 100°C / 160°C			5,5	6,0	6,5	6,0	5,5	5,5
Reduction factor ψ^0_{sus} in concrete C20/25									
Temperature range	I: 24°C / 40°C	ψ^0_{sus}	[-]	0,90					
	II: 50°C / 80°C			0,87					
	III: 72°C / 120°C			0,75					
	IV: 100°C / 160°C			0,66					
Characteristic bond resistance in concrete ≥ C25/30									
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$					
Concrete cone failure									
Relevant parameter				see Table C3					
Splitting failure									
Relevant parameter				see Table C3					
Installation factor									
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	1,2					
	manual cleaning			1,2			No performance assessed		
	compressed air cleaning			1,0					
waterfilled drill hole	compressed air cleaning	γ_{inst}	[-]	1,4					

[1] Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class is valid for the internally threaded anchor rod and the fastening element

[2] Value in brackets: property class 50

Table C11: Characteristic values of **tension load** for **internally threaded anchor rod, static and quasi-static action,** working life **100 years**

Internally threaded anchor rod VMU-IG and VZ-IG				IG M6	IG M8	IG M10	IG M12	IG M16	IG M20
Steel failure [1]									
Characteristic resistance, steel, zinc plated, property 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		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic resistance, stainless steel A4 / HCR, property class	70	$N_{Rk,s}$	[kN]	14	26	41	59	110	172 (123) [2]
Partial factor		$\gamma_{Ms,N}$	[-]	1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure									
Characteristic bond resistance in <u>uncracked</u> concrete C20/25									
Temperature range	I: 24°C / 40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	17	16	15	14	13	13
	II: 50°C / 80°C			17	16	15	14	13	13
Characteristic bond resistance in <u>cracked</u> concrete C20/25									
Temperature range	I: 24°C / 40°C	$\tau_{Rk,cr100}$	[N/mm²]	6,0	6,5	6,5	6,5	6,5	6,5
	II: 50°C / 80°C			6,0	6,5	6,5	6,5	6,5	6,5
Reduction factor ψ^0_{sus} in concrete C20/25									
Temperature range	I: 24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,90					
	II: 50°C / 80°C			0,87					
Characteristic bond resistance in concrete ≥ C25/30									
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$					
Concrete cone failure									
Relevant parameter				see Table C3					
Splitting failure									
Relevant parameter				see Table C3					
Installation factor									
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	1,2					
	manual cleaning			1,2			No performance assessed		
	compressed air cleaning			1,0					
waterfilled drill hole	compressed air cleaning	γ_{inst}	[-]	1,4					

[1] Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class is valid for the internally threaded anchor rod and the fastening element
[2] Value in brackets: property class 50

Table C12: Characteristic values of **shear load** for **internally threaded anchor rod, static and quasi-static action,** working life **50 and 100 years**

<table>
<tr><th colspan="5">Internally threaded anchor rod VMU-IG and VZ-IG</th><th>IG M6</th><th>IG M8</th><th>IG M10</th><th>IG M12</th><th>IG M16</th><th>IG M20</th></tr>
<tr><td colspan="11">Steel failure <u>without</u> lever arm [1)]</td></tr>
<tr><td rowspan="3">Steel, zinc plated</td><td>Characteristic resistance</td><td>property class 5.8</td><td>$V^0_{Rk,s}$</td><td>[kN]</td><td>6</td><td>10</td><td>17</td><td>25</td><td>45</td><td>74</td></tr>
<tr><td>Characteristic resistance</td><td>property class 8.8</td><td>$V^0_{Rk,s}$</td><td>[kN]</td><td>8</td><td>14</td><td>23</td><td>34</td><td>61</td><td>98</td></tr>
<tr><td colspan="2">Partial factor</td><td>$\gamma_{Ms,V}$</td><td>[-]</td><td colspan="6">1,25</td></tr>
<tr><td rowspan="2">Stainless steel</td><td>Characteristic resistance A4 / HCR</td><td>property class 70</td><td>$V^0_{Rk,s}$</td><td>[kN]</td><td>7</td><td>13</td><td>20</td><td>30</td><td>55</td><td>86
(62) [2)]</td></tr>
<tr><td colspan="2">Partial factor</td><td>$\gamma_{Ms,V}$</td><td>[-]</td><td colspan="5">1,56</td><td>1,56
(2,38) [2)]</td></tr>
<tr><td colspan="3">Ductility factor</td><td>k_7</td><td>[-]</td><td colspan="6">1,0</td></tr>
<tr><td colspan="11">Steel failure <u>with</u> lever arm [1)]</td></tr>
<tr><td rowspan="3">Steel, zinc plated</td><td>Characteristic bending resistance</td><td>property class 5.8</td><td>$M^0_{Rk,s}$</td><td>[Nm]</td><td>8</td><td>19</td><td>37</td><td>66</td><td>167</td><td>325</td></tr>
<tr><td>Characteristic bending resistance</td><td>property class 8.8</td><td>$M^0_{Rk,s}$</td><td>[Nm]</td><td>12</td><td>30</td><td>60</td><td>105</td><td>267</td><td>519</td></tr>
<tr><td colspan="2">Partial factor</td><td>$\gamma_{Ms,V}$</td><td>[-]</td><td colspan="6">1,25</td></tr>
<tr><td rowspan="2">Stainless steel</td><td>Characteristic bending resistance A4 / HCR</td><td>property class 70</td><td>$M^0_{Rk,s}$</td><td>[Nm]</td><td>11</td><td>26</td><td>53</td><td>92</td><td>234</td><td>454</td></tr>
<tr><td colspan="2">Partial factor</td><td>$\gamma_{Ms,V}$</td><td>[-]</td><td colspan="6">1,56</td></tr>
<tr><td colspan="11">Concrete pry-out failure</td></tr>
<tr><td colspan="3">Pry-out factor</td><td>k_8</td><td>[-]</td><td colspan="6">2,0</td></tr>
<tr><td colspan="11">Concrete edge failure</td></tr>
<tr><td colspan="3">Effective length of anchor</td><td>l_f</td><td>[mm]</td><td colspan="5">min (h_{ef};12 d_{nom})</td><td>min (h_{ef}; 300mm)</td></tr>
<tr><td colspan="3">Outside diameter of anchor</td><td>d_{nom}</td><td>[mm]</td><td>10</td><td>12</td><td>16</td><td>20</td><td>24</td><td>30</td></tr>
<tr><td colspan="3">Installation factor</td><td>γ_{inst}</td><td>[-]</td><td colspan="6">1,0</td></tr>
</table>

[1)] Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod (exception: IG M20). The characteristic shear resistance for steel failure of the given strength class is valid for the internally threaded anchor rod and the fastening element.

[2)] Value in brackets: Internally threaded rod: property class 50 with fastening screws or threaded rods (incl. nut and washer): property class 70

Injection System VMH for concrete

Performance
Characteristic values of **shear loads** for **internally threaded anchor rod**

Annex C11

Table C13: Characteristic values of **tension load** for **rebar, static** and **quasi-static action,** working life **50 years**

Reinforcing bar				**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 24**	**∅ 25**	**∅ 28**	**∅ 32**
Steel failure													
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ 1)									
Cross sectional 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: 24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	14	13	13	13	13	13	13
	II: 50°C / 80°C			14	14	14	14	13	13	13	13	13	13
	III: 72°C / 120°C			13	12	12	12	12	11	11	11	11	11
	IV: 100°C / 160°C			9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
Characteristic bond resistance in cracked concrete C20/25													
Temperature range	**I: 24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	II: 50°C / 80°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	III: 72°C / 120°C			4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	IV: 100°C / 160°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Reduction factor ψ^0_{sus} in concrete C20/25													
Temperature range	**I: 24°C / 40°C**	ψ^0_{sus}	[-]	0,90									
	II: 50°C / 80°C			0,87									
	III: 72°C / 120°C			0,75									
	IV: 100°C / 160°C			0,66									
Characteristic bond resistance in concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$									
Concrete cone failure													
Relevant parameter				see Table C3									
Splitting failure													
Relevant parameter				see Table C3									
Installation factor													
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	1,2									
	manual cleaning			1,2					No performance assessed				
	compressed air cleaning			1,0									
waterfilled drill hole	compressed air cleaning	γ_{inst}	[-]	1,4									

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

Injection System VMH for concrete

Performance
Characteristic values of **tension loads** for **rebar,** working life **50 years**

Annex C12

Table C14: Characteristic values of **tension load** for **rebar, static** and **quasi-static action,** working life **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 resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ 1)									
Cross sectional 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 <u>uncracked</u> concrete C20/25													
Temperature range	I: 24°C / 40°C	$\tau_{Rk,ucr,100}$	[N/mm²]	14	14	14	14	13	13	13	13	13	13
Temperature range	II: 50°C / 80°C	$\tau_{Rk,ucr,100}$	[N/mm²]	14	14	14	14	13	13	13	13	13	13
Characteristic bond resistance in <u>cracked</u> concrete C20/25													
Temperature range	I: 24°C / 40°C	$\tau_{Rk,cr,100}$	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Temperature range	II: 50°C / 80°C	$\tau_{Rk,cr,100}$	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Reduction factor ψ^0_{sus} in concrete C20/25													
Temperature range	I: 24°C / 40°C	$\psi^0_{sus,100}$	[-]	0,90									
Temperature range	II: 50°C / 80°C	$\psi^0_{sus,100}$	[-]	0,87									
Characteristic bond resistance in concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk\,(C20/25)}$		ψ_c	[-]	$(f_{ck} / 20)^{0,1}$									
Concrete cone failure													
Relevant parameter				see Table C3									
Splitting failure													
Relevant parameter				see Table C3									
Installation factor													
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	1,2									
dry or wet concrete	manual cleaning	γ_{inst}	[-]	1,2					No performance assessed				
dry or wet concrete	compressed air cleaning	γ_{inst}	[-]	1,0									
waterfilled drill hole	compressed air cleaning	γ_{inst}	[-]	1,4									

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

Table C15: Characteristic values of **shear load** for **rebar, static** and **quasi-static action,** working life 50 **and 100 year**

Reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure <u>without</u> lever arm												
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]	$0{,}50 \cdot A_s \cdot f_{uk}$ 1)									
Cross sectional 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 <u>with</u> lever arm												
Characteristic bending resistance	$M^0_{Rk,s}$	[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												
Pry-out Factor	k_8	[-]	2,0									
Concrete edge failure												
Effective length of rebar	l_f	[mm]	min (h_{ef}; 12 d_{nom})							min (h_{ef}; 300mm)		
Outside diameter of rebar	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 C16: Characteristic values of **tension load** for **rebar, seismic action** (performance category **C1**), working life **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 resistance			$N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}$ 1)									
Cross sectional 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 concrete C20/25 to C50/60														
Temperature range	I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	II:	50°C / 80°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	III:	72°C / 120°C			4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	IV:	100°C / 160°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Installation factor														
dry or wet concrete	vacuum cleaning		γ_{inst}	[-]	1,2									
	compressed air cleaning		γ_{inst}	[-]	1,0									
waterfilled drill hole			γ_{inst}	[-]	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 **tension load** for **rebar, seismic action** (performance category **C1**), working life **100 years**

Reinforcing bar					**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 24**	**∅ 25**	**∅ 28**	**∅ 32**
Steel failure														
Characteristic resistance			$N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}$ [1]									
Cross sectional 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 concrete C20/25 to C50/60														
Temperature range	I:	24°C / 40°C	$\tau_{Rk,C1}$	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
	II:	50°C / 80°C			4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Installation factor														
dry or wet concrete	vacuum cleaning		γ_{inst}	[-]	1,2									
	compressed air cleaning		γ_{inst}	[-]	1,0									
waterfilled drill hole			γ_{inst}	[-]	1,4									

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

Table C18: Characteristic values of **shear load** for **rebar**, **seismic action** (performance category **C1**), working life **50 and 100 years**

Reinforcing bar			**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 24**	**∅ 25**	**∅ 28**	**∅ 32**
Steel failure <u>without</u> lever arm												
Characteristic resistance	$V_{Rk,s,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}$ [1]									
Cross sectional area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 [2]									

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

Table C19: Displacements under tension load (threaded rod)

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Displacement factor 1) uncracked concrete, static and quasi-static action										
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	[mm/(N/mm²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
	$\delta_{N\infty}$-factor		0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$-factor		0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
	$\delta_{N\infty}$-factor		0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Displacement factor 1) cracked concrete, static and quasi-static action										
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	[mm/(N/mm²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
	$\delta_{N\infty}$-factor		0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
	$\delta_{N\infty}$-factor		0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
	$\delta_{N\infty}$-factor		0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
Displacement, seismic action (C2)										
All temperature ranges	$\delta_{N,C2\ (DLS)}$	[mm]	- 2)		0,24	0,27	0,29	0,27	- 2)	
	$\delta_{N,C2\ (ULS)}$				0,55	0,51	0,50	0,58		

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: acting bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;
2) No performance assessed

Table C20: Displacements under shear load (threaded rod)

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Displacement factor 1) cracked and uncracked concrete, 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		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Displacement, seismic action (C2)										
All temperature ranges	$\delta_{V,C2(DLS)}$	[mm]	- 2)		3,6	3,0	3,1	3,5	- 2)	
	$\delta_{V,C2(ULS)}$				7,0	6,6	7,0	9,3		

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;
2) No performance assessed

Injection System VMH for concrete

Performance
Displacements (threaded rod)

Annex C17

Table C21: Displacements under tension load (internally threaded anchor rod)

Internally threaded anchor rod VMU-IG and VZ-IG			IG M 6	IG M8	IG M10	IG M12	IG M16	IG M20
Displacement factor [1)] uncracked concrete, static and quasi-static action								
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	$[\frac{mm}{N/mm^2}]$	0,032	0,034	0,037	0,039	0,042	0,046
	$\delta_{N\infty}$-factor		0,042	0,044	0,047	0,051	0,054	0,060
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,034	0,035	0,038	0,041	0,044	0,048
	$\delta_{N\infty}$-factor		0,044	0,045	0,049	0,053	0,056	0,062
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,126	0,131	0,142	0,153	0,163	0,179
	$\delta_{N\infty}$-factor		0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor [1)] cracked concrete, static and quasi-static action								
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	$[\frac{mm}{N/mm^2}]$	0,083	0,085	0,090	0,095	0,099	0,106
	$\delta_{N\infty}$-factor		0,107	0,110	0,116	0,122	0,128	0,137
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,086	0,088	0,093	0,098	0,103	0,110
	$\delta_{N\infty}$-factor		0,111	0,114	0,121	0,127	0,133	0,143
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,321	0,330	0,349	0,367	0,385	0,412
	$\delta_{N\infty}$-factor		0,330	0,340	0,358	0,377	0,396	0,424

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

Table C22: Displacements under shear load (internally threaded anchor rod)

Internally threaded anchor rod VMU-IG and VZ-IG			IG M 6	IG M8	IG M10	IG M12	IG M16	IG M20
Displacement factor [1)] cracked and uncracked concrete, static and quasi-static action								
All temperature ranges	δ_{V0}-factor	$[\frac{mm}{kN}]$	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$-factor		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: acting shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Performance Displacements (internally threaded anchor rod)	

Table C23: Displacements under tension load (rebar)

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor [1)] uncracked concrete, static and quasi-static action												
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	[mm/(N/mm²)]	0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,048
	$\delta_{N\infty}$-factor		0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
	$\delta_{N\infty}$-factor		0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
	$\delta_{N\infty}$-factor		0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Displacement factor [1)] cracked concrete, static and quasi-static action												
Temperature range I: 24°C / 40°C II: 50°C / 80°C	δ_{N0}-factor	[mm/(N/mm²)]	0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,108
	$\delta_{N\infty}$-factor		0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range III: 72°C / 120°C	δ_{N0}-factor		0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
	$\delta_{N\infty}$-factor		0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range IV: 100°C / 160°C	δ_{N0}-factor		0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
	$\delta_{N\infty}$-factor		0,321	0,330	0,340	0,349	0,358	0,377	0,396	0,396	0,410	0,449

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

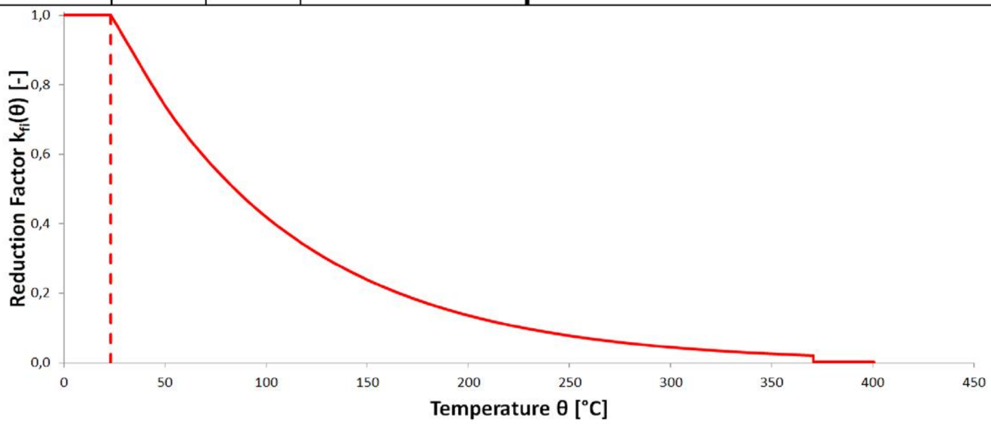
Table C24: Displacements under shear load (rebar)

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor [1)] cracked and uncracked concrete, 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		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

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

Table C25: Characteristic values of tension and shear loads under fire exposure (threaded rod)

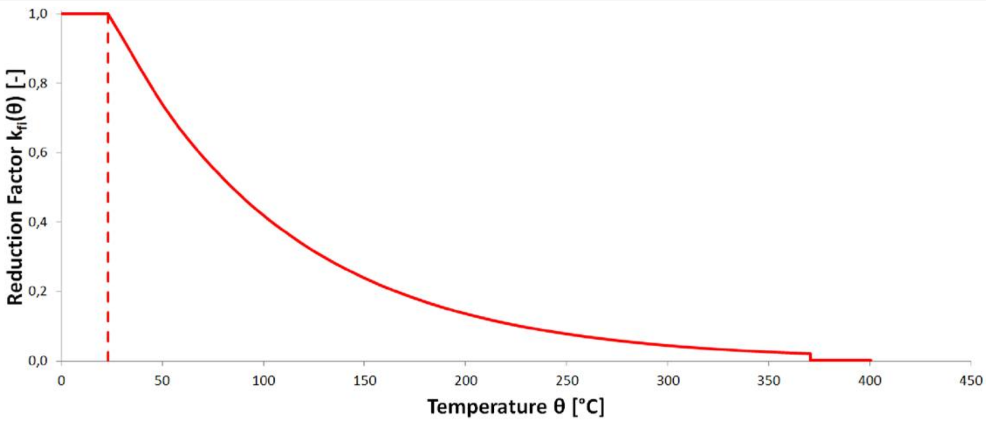
Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)											
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,2
			R60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,1
			R90	0,7	1,0	1,6	3,0	6,7	6,7	8,7	10,7
			R120	0,5	0,8	1,2	2,2	4,9	4,9	6,4	7,9
Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire exposure for temperature θ											
Temperature-dependent reduction factor	$k_{fi,p}(\theta)$	[-]	θ < 24°C	1,0							
			24°C ≤ θ ≤ 379°C	$1,301 * e^{-0,011*\theta} \leq 1,0$							
			θ > 379°C	0,0							
Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]		$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1)]							
Steel failure without lever arm											
Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)											
Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,2
			R60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,1
			R90	0,7	1,0	1,6	3,0	4,7	6,7	8,7	10,7
			R120	0,5	0,8	1,2	2,2	3,4	4,9	6,4	7,9
Steel failure with lever arm											
Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)											
Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	1,1	2,2	4,7	12,0	23,4	40,4	59,9	81,0
			R60	0,9	1,8	3,5	9,0	17,5	30,3	44,9	60,7
			R90	0,7	1,3	2,5	6,3	12,3	21,3	31,6	42,7
			R120	0,5	1,0	1,8	4,7	9,1	15,7	23,3	31,5



[1)] $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

Table C26: Characteristic values of tension and shear loads under fire exposure
(internally threaded anchor rod)

Internally threaded anchor rod VMU-IG and VZ-IG				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure									
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)									
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	0,3	1,1	1,7	3,0	5,7	8,8
			R60	0,2	0,9	1,4	2,3	4,2	6,6
			R90	0,2	0,7	1,0	1,6	3,0	4,7
			R120	0,1	0,5	0,8	1,2	2,2	3,4
Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire conditions for a given temperature θ									
Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	θ < 24°C	1,0					
			24°C ≤ θ ≤ 379°C	$1{,}301 * e^{-0{,}011*\theta} \leq 1{,}0$					
			θ > 379°C	0,0					



Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]		$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1)]					
Steel failure without lever arm									
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)									
Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	0,3	1,1	1,7	3,0	5,7	8,8
			R60	0,2	0,9	1,4	2,3	4,2	6,6
			R90	0,2	0,7	1,0	1,6	3,0	4,7
			R120	0,1	0,5	0,8	1,2	2,2	3,4
Steel failure with lever arm									
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)									
Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	0,2	1,1	2,2	4,7	12,0	23,4
			R60	0,2	0,9	1,8	3,5	9,0	17,5
			R90	0,1	0,7	1,3	2,5	6,3	12,3
			R120	0,1	0,5	1,0	1,8	4,7	9,1

[1)] $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

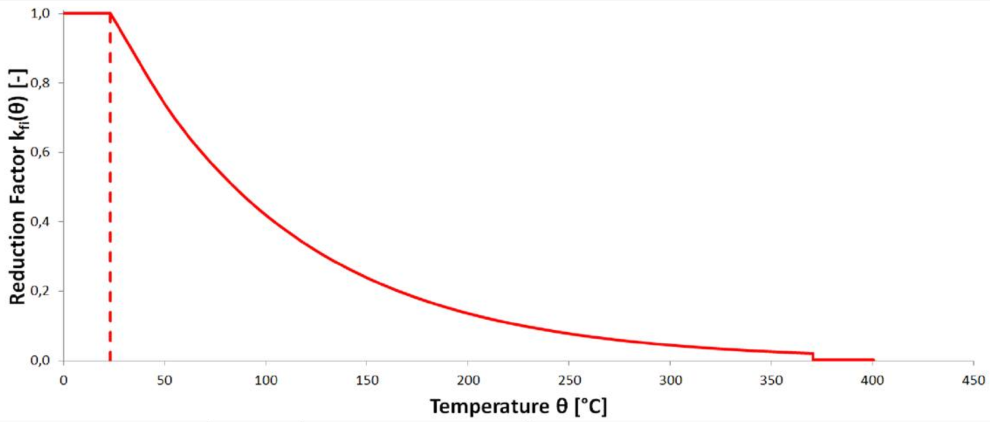
Injection System VMH for concrete

Performance
Characteristic values of tension and shear loads under fire exposure
(internally threaded anchor rod)

Annex C21

Table C27: Characteristic values of tension and shear loads under fire exposure (rebar)

Rebar				Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø30
Steel failure													
BSt 500													
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,1
			R60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,1
			R90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,5
			R120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,0	8,0
Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire conditions for a given temperature θ													
Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	$\theta < 22°C$	1,0									
			$22°C \leq \theta \leq 370°C$	$1{,}268 * e^{-0{,}011*\theta} \leq 1{,}0$									
			$\theta > 370°C$	0,0									
Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]		$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1)]									
Steel failure without lever arm													
BSt 500													
Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,1
			R60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,1
			R90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,5
			R120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,0	8,0
Steel failure with lever arm													
BSt 500													
Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	0,6	1,8	4,1	6,5	9,7	18,8	32,6	36,8	51,7	77,2
			R60	0,5	1,5	3,1	4,8	7,2	14,1	24,4	27,6	38,8	57,9
			R90	0,4	1,2	2,6	4,2	6,3	12,3	21,2	23,9	33,6	50,2
			R120	0,3	0,8	2,0	3,2	4,8	9,4	16,3	18,4	25,9	38,6



1) $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

Injection System VMH for concrete

Performance
Characteristic values of tension and shear loads under fire exposure (rebar)

Annex C22