



Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments



European Technical Assessment

ETA-17/0716 of 11 May 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:

Trade name of the construction product

Product family to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment contains

This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of

This version replaces

Deutsches Institut für Bautechnik

Injection System VMH for concrete

Bonded fastener for use in concrete

MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND

Werk 1, D Werk 2, D

33 pages including 3 annexes which form an integral part of this assessment

EAD 330499-01-0601, Edition 04/2020

ETA-17/0716 issued on 22 November 2019



European Technical Assessment ETA-17/0716 English translation prepared by DIBt

Page 2 of 33 | 11 May 2021

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Page 3 of 33 | 11 May 2021

European Technical Assessment ETA-17/0716 English translation prepared by DIBt

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 Injection mortar VMH and a steel element according to Annex A3 and A5.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

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

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

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance to tension load (static and quasi-static loading)	See Annex B 3, C 1, C 3, C4, C 5, C 8, C 9, C 11, C 12
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2, C 6, C 10, C 13
Displacements under short-term and long-term loading	See Annex C 15 to C 17
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 7, C 14, C 15

3.2 Hygiene, health and the environment (BWR 3)

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



European Technical Assessment ETA-17/0716

Page 4 of 33 | 11 May 2021

English translation prepared by DIBt

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 11 May 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock Head of Section *beglaubigt:* Baderschneider

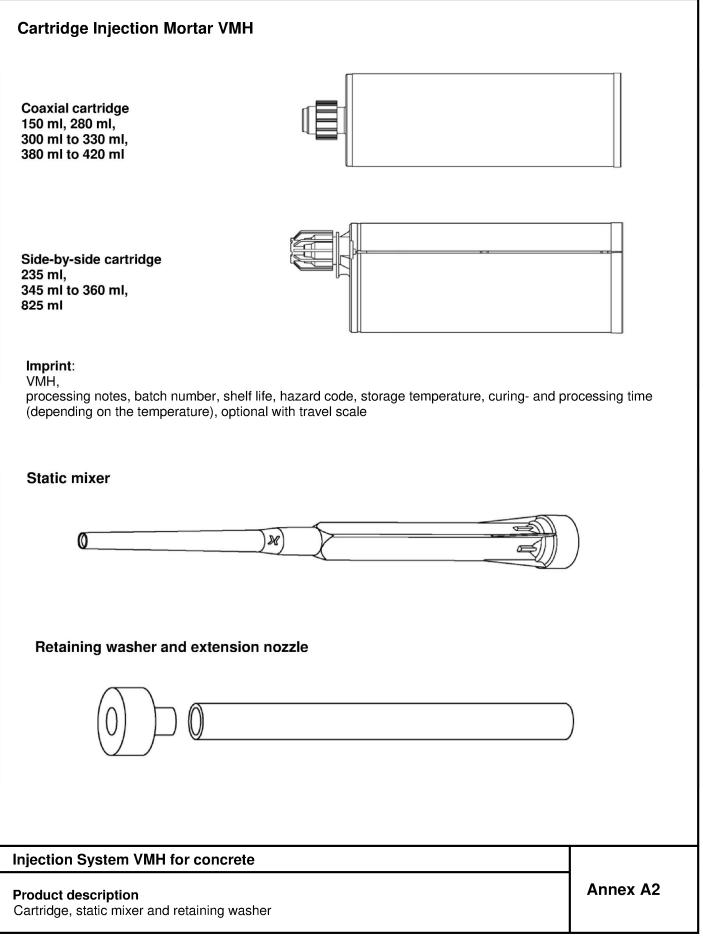


Installation threaded rod M8 to M30 Pre-setting installation or through-setting installation (optional annular gap filled with mortar) $h_{ef} = h_0$ tfix hmin Installation internally threaded anchor rod VMU-IG M6 to VMU-IG M20 $h_{ef} = h_0$ tfix hmin Installation reinforcing bar Ø8 to Ø32 $h_{ef} = h_0$ = effective anchorage depth hef = depth of drill hole h₀ hmin $h_{min} = minimum$ thickness of member = thickness of fixture tfix Injection System VMH for concrete Annex A1 **Product description** Installation situation

Page 6 of European Technical Assessment ETA-17/0716 of 11 May 2021

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Page 7 of European Technical Assessment ETA-17/0716 of 11 May 2021



Threaded rod Threaded rod VMU-A, V-A with washer and hexagon nut M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A4, HCR)	
VMU-A 	
V-A optional: mark of embedment depth	 Marking e.g.: ◇M10 identifying mark of manufacturing plant M10 size of thread additional marking: A4 stainless steel HC high corrosion resistant steel
 Threaded rod VM-A (material sold by the metre, to be cut at the required I M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR) 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 	ength)
Washer with boreand reducing adapter for filling the gap between the bore for diameter $< M24$: t = 5 mm $\ge M24$: t = 6 mm	readed rod and fixture
Internally threaded anchor rod VMU-IG M6, VMU-IG M8, VMU-IG M10, VMU-IG M12, VMU-IG M16, VMU (zinc plated, A4, HCR)	- IG M20 Marking e.g.: <i>⊲</i> ≻ M8
4 hef	 identifying mark of manufacturing plant internal thread M8 size of internal thread additional marking: A4 stainless steel HCR high corrosion resistant steel
Injection System VMH for concrete Product description Threaded rod and internally threaded anchor rod	Annex A3



	Designation		Material						
electr not-di	ip galvanized ≥ 40		n average)	acc. to E		1:2009	EN ISO 106	84:2004+AC:2009 or	
		≥ 45 μm acc. to EN ISO 17668:2016 Property characteristic characteristic fracture class ultimate strength yield strength elongation					EN ISO 683-4:2018,		
		4.6		400		240	A ₅ > 8 %	EN 10263:2001;	
1	Threaded rod	4.8		400		320	A5 > 8 %	Commercial standar	
		5.6	f _{uk} [N/mm²]	500	f _{yk} [N/mm²]	300	A₅ > 8 %	threaded rod:	
		5.8	[[N/1111-]	500	[[]]	400	A5 > 8 %	EN ISO 898-1:2013	
		8.8		800		640	A₅≥ 12% ¹⁾		
		4	for class 4	1.6 or 4.8	rods				
2	Hexagon nut	5	for class 4	4.6, 4.8, 5	6.6 or 5.8 ro	ds		EN ISO 898-2:2012	
		8	for class 4	4.6, 4.8, 5	6, 5.8 or 8	.8 rods			
3a	Washer		e.g.: EN I EN ISO 8		2000, EN I	SO 709	3:2000, EN I	SO 7094:2000,	
3b	Washer with bore		Steel, zin	c plated					
4	Internally threaded	5.8	Steel, ele	ctroplated	d or sherard	Steel, electroplated or sherardized $A_5 > 8\%$			
	anchoritou	8.8	A5 > 8%						
Stain	loss stool $A2^{2}$	0.0	CPO		01 / 1 4307			4541)	
Stain	less steel A2 ²⁾ less steel A4 corrosion resistant ste		CRO	C III (1.44		′ / 1.431 / 1.457	A₅ > 8% 1 / 1.4567 / ′ ′1 / 1.4578)	1.4541)	
Stain	less steel A4		CRO	C III (1.44 C V (1.45 teristic	01 / 1.4404	′ / 1.431 ↓ / 1.457 ວັ) eristic	1 / 1.4567 / 1		
Stain	less steel A4	eel HCR Property	CRC CRC charact ultimate	C III (1.44 C V (1.45 teristic	01 / 1.4404 29 / 1.4565 characte yield stre	′ / 1.431 ↓ / 1.457 ວັ) eristic	1 / 1.4567 / ′ 1 / 1.4578) fracture	EN 10088-1:2014	
Stain ligh	less steel A4 corrosion resistant ste	eel HCR Property class	CRC CRC charact ultimate s	CIII (1.44 CV (1.45 teristic strength	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk}	7 / 1.431 ↓ / 1.457 5) eristic ength	1 / 1.4567 / [/] 1 / 1.4578) fracture elongation		
Stain ligh	less steel A4 corrosion resistant ste	eel HCR Property class 50	CRC CRC charact ultimate	CIII (1.44 CV (1.45 teristic strength 500	01 / 1.4404 29 / 1.4565 characte yield stre	7 / 1.431 7 / 1.457 5) eristic ength 210	1 / 1.4567 / [/] 1 / 1.4578) fracture elongation A ₅ > 8%	EN 10088-1:2014	
Stain ligh	less steel A4 corrosion resistant ste	Property class 50 70 80	CRC CRC charact ultimate s	C III (1.44 C V (1.45 eristic strength 500 700 800	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk}	7 / 1.431 ↓ / 1.457 5) eristic ength 210 450	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation A ₅ > 8% A ₅ ≥ 12% ¹⁾	EN 10088-1:2014 EN ISO 3506-1:202	
Stain ligh	less steel A4 corrosion resistant ste	Property class 50 70 80 50	CRC CRC charact ultimate s f _{uk} [N/mm ²]	C III (1.44 C V (1.45 strength 500 700 800 50 rods	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk} [N/mm ²]	7 / 1.431 ↓ / 1.457 5) eristic ength 210 450	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation A ₅ > 8% A ₅ ≥ 12% ¹⁾	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014	
Stain High 1	Iless steel A4 corrosion resistant stee Threaded rod ³⁾	Property class 50 70 80 50	Charact ultimate s f _{uk} [N/mm ²] for class s	C III (1.44 C V (1.45 strength 500 700 800 50 rods 50 or 70 r	01 / 1.4404 29 / 1.4565 characte yield stre f _{yk} [N/mm ²]	7 / 1.431 ↓ / 1.457 5) eristic ength 210 450	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation A ₅ > 8% A ₅ ≥ 12% ¹⁾	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014	
Stain High 1	Iless steel A4 corrosion resistant stee Threaded rod ³⁾	Property class 50 70 80 50 70	charact ultimate s f _{uk} [N/mm²] for class s for class s e.g.: EN I	C III (1.44 C V (1.45 strength 500 700 800 50 rods 50 or 70 r 50, 70 or SO 7089	01 / 1.4404 29 / 1.4565 characte yield stre f _{yk} [N/mm ²]	7 / 1.431 9 / 1.457 eristic ength 210 450 600 SO 709	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ 3:2000,	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014 EN ISO 3506-2:202	
Stain High 1	Iless steel A4 corrosion resistant steel Threaded rod ³⁾	Property class 50 70 80 50 70	Charact ultimate s f _{uk} [N/mm ²] for class s for class s for class s for class s for class s for class s for class s	C III (1.44 C V (1.45 eristic strength 500 700 800 50 rods 50 or 70 r 50, 70 or 50, 70	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk} [N/mm ²] ods 80 rods 2000, EN I	7 / 1.431 9 / 1.457 9) eristic ength 210 450 600 SO 709 87:2006	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ 3:2000,	EN 10088-1:2014 EN ISO 3506-1:2024 EN 10088-1:2014	
Stain High 1 2 3a	Iess steel A4 corrosion resistant state Threaded rod ³) Hexagon nut ³) Washer Washer with bore Internally threaded	Property class 50 70 80 50 70 80	Charact ultimate s f _{uk} [N/mm ²] for class s for class s	C III (1.44 C V (1.45 eristic strength 500 700 800 50 rods 50 or 70 r 50, 70 or 50, 70	01 / 1.4404 29 / 1.4565 characte yield stre f _{yk} [N/mm ²] ods 80 rods 2000, EN I ; EN ISO 8	7 / 1.431 9 / 1.457 9) eristic ength 210 450 600 SO 709 87:2006	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ 3:2000, 3:2000,	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014 EN ISO 3506-2:202	
Stain ligh 1 2 3a 3b 4 1	Iess steel A4 corrosion resistant state Threaded rod ³⁾ Hexagon nut ³⁾ Washer Washer with bore	Property class 50 70 80 50 70 80 50 70 80 50 70 80	CRC CRC charact ultimate s f _{uk} [N/mm ²] for class s for class s	C III (1.44 C V (1.45 strength 500 700 800 50 rods 50 or 70 r 50, 70 or 7 50, 70 or	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk} [N/mm ²] ods 80 rods 2000, EN I ; EN ISO 8 stant steel I	7 / 1.431 9 / 1.457 9) eristic ength 210 450 600 SO 709 87:2006 HCR	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ 3:2000, 3:2000, $A_5 > 8\%$ $A_5 > 8\%$	EN 10088-1:2014 EN ISO 3506-1:2024 EN 10088-1:2014 EN ISO 3506-2:2024 EN 10088-1:2014	
Stain ligh 1 2 3a 3b 4 1 1	Iess steel A4 corrosion resistant state Threaded rod ³) Threaded rod ³) Hexagon nut ³) Washer Washer with bore Internally threaded anchor rod cture elongation A ₅ > 8 % for a operty classes 50 and 70	Property class 50 70 80 50 70 80 50 70 80 50 70 80	CRC CRC charact ultimate s f _{uk} [N/mm ²] for class s for class s	C III (1.44 C V (1.45 strength 500 700 800 50 rods 50 or 70 r 50, 70 or 7 50, 70 or	01 / 1.4404 29 / 1.4565 characte yield stro f _{yk} [N/mm ²] ods 80 rods 2000, EN I ; EN ISO 8 stant steel I	7 / 1.431 9 / 1.457 9) eristic ength 210 450 600 SO 709 87:2006 HCR	1 / 1.4567 / $^{\prime}$ 1 / 1.4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ 3:2000, 3:2000, $A_5 > 8\%$ $A_5 > 8\%$	EN 10088-1:2014 EN ISO 3506-1:2024 EN 10088-1:2014 EN ISO 3506-2:2024 EN 10088-1:2014	



Reinforcing bar Ø 8, Ø 10, Ø 12, Ø 14, Ø 16, Ø 20, Ø 24, Ø 25, Ø 28, Ø 32 ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ V V 1 1 10 1 (5) 1 1 1 1 1 Ø Ø 1 hef 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 $0,05d \le h \le 0,07d$ (d: Nominal diameter of the bar; h: Rip height of the bar) Table A2: Material reinforcing bar Part Material Designation Rebar Bars and de-coiled rods class B or C Rebar 5 fyk and k according to NDP or NCL acc. EN 1992-1-1/NA EN 1992-1-1:2004+AC:2010, Annex C $f_{uk} = f_{tk} = k \cdot f_{yk}$ Injection System VMH for concrete Annex A5 **Product description** Product description and material reinforcing bar

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Page 10 of European Technical Assessment ETA-17/0716 of 11 May 2021

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Specification of intended use									
Static and quasi-static action	working life 50 years working life 100 years								
Threaded rod Internally threaded anchor rod Rebar	M8 - M30 VMU-IG M6 - VMU-IG M20 Ø8 - Ø32								
	cracked or unc	cracked concrete							
Base material	compacted, reinforced or unre	C20/25 to C50/60 inforced normal weight concrete EN 206:2013+A1:2016							
Hole drilling	hammer drilling / compresse	d air drilling / vacuum drilling							
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 categor	y C1	performance category C2			
Threaded rod Rebar		M8 - M30 Ø8 - Ø32		M12 - M24 			
		cracke	ed or und	cracked concrete			
Base material		strength classes C20/25 to C50/60 compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013+A1:2016					
Hole drilling		hammer drilling / co	mpresse	ed air drilling / vacuum drilling			
Temperature range ¹⁾		II: -40°C to III: -40°C to +	to +80°C II: -40°C to +80°C to +120°C III: -40°C to +120°C				
¹⁾ Temperature Range I: Temperature Range II: Temperature Range III: Temperature Range IV:	max. long t max. long t	erm temperature +50°C erm temperature +72°C	and m and m	ax. short term temperature +40°C ax. short term temperature +80°C ax. short term temperature +120°C ax. short term temperature +160°C			

Injection System VMH for concrete

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 A4, Table A1 corresponding corrosion resistance classes CRC according to EN 1993-1-4:2006+A1:2015

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

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
- The injection mortar is assessed for installation at minimum concrete temperature of -5°C, where subsequently the temperature in the concrete does not rise at a rapid rate, i.e. from the minimum installation temperature to 24°C within a 12-hour period.
- Internally threaded anchor rod: 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

Intended Use Specifications

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Table B1: Installation parameters for threaded rods											
Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Diameter of threade	d rod	d=d _{nom}	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole dia	ameter	d ₀	[mm]	10	12	14	18	22	28	30	35
Effective anchorage	dooth	h _{ef,min}	[mm]	60	60	70	80	90	96	108	120
Ellective anchorage		h _{ef,max}	[mm]	160	200	240	320	400	480	540	600
I Diameier of	Pre-setting	d _f ≤	[mm]	9	12	14	18	22	26	30	33
the fixture ²	hrough setti	^{ing} d _f ≤	[mm]	12	14	16	20	24	30	33	40
Maximum installation	Maximum installation torque max.Tins		[Nm]	10	20	40 (35) ¹⁾	60	100	170	250	300
Minimum thickness of member h _{min}		[mm]		af + 30 m ≥ 100 mr				h _{ef} + 2d ₀	I		
Minimum spacing		Smin	[mm]	40	50	60	75	95	115	125	140
Minimum edge dista	ince	Cmin	[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	d2	[mm]	6	8	10	12	16	20
Outer diameter of threaded rod ¹⁾	d=dnom	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d₀	[mm]	12	14	18	22	28	35
Effective encharge depth	h _{ef,min}	[mm]	60	70	80	90	96	120
Effective anchorage depth —	h _{ef,max}	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	d _f ≤	[mm]	7	9	12	14	18	22
Maximum installation torque ma	x.T _{inst} ≤	[Nm]	10	10	20	40	60	100
Minimum screw-in depth	l _{iG}	[mm]	8	8	10	12	16	20
Minimum thickness of member	\mathbf{h}_{min}	[mm]	h _{ef} + 3 ≥ 100	80 mm 0 mm	h _{ef} + 2d ₀			
Minimum spacing	Smin	[mm]	50	60	75	95	115	140
Minimum edge distance	Cmin	[mm]	40	45	50	60	65	80

with metric thread acc. to EN 1993-1-8:2005+AC:2009

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 encharage depth	h _{ef,min}	[mm]	60	60	70	75	80	90	96	100	112	128
Effective anchorage depth -	h _{ef,max}	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h _{min}	[mm]		30 mn 00 mm				h _{ef}	+ 2d ₀			
Minimum spacing	Smin	[mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	Cmin	[mm]	35	40	45	50	50	60	70	70	75	85
¹⁾ for diameter \emptyset 8, \emptyset 10, \emptyset 12, \emptyset 2	24 and \emptyset	25 bot	h nomin	al drill h	ole diam	leter car	ı be use	d				

Injection System VMH for concrete

Intended use

Installation parameters

Deutsches Institut für Bautechnik

Threaded	Internally threaded	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
rod	anchor rod	nebai	Drin bit g	Didisity	
<u> </u>		411111111111		d ^p	
[-]	[-]	Ø [mm]	d ₀ [mm]	d ₅ [mm]	d _{b,min} [mm]
M8		8	10	11,5	10,5
M10	VMU-IG M 6	8 / 10	12	13,5	12,5
M12	VMU-IG M 8	10 / 12	14	15,5	14,5
		12	16	17,5	16,5
M16	VMU-IG M10	14	18	20,0	18,5
		16	20	22,0	20,5
M20	VMU-IG M12		22	24,0	22,5
		20	25	27,0	25,5
M24	VMU-IG M16		28	30,0	28,5
M27		24 / 25	30	31,8	30,5
		24 / 25	32	34,0	32,5
M30	VMU-IG M20	28	35	37,0	35,5
		32	40	43,5	40,5

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Table B5: Retaining washer

Drill bit Ø		Installation direction and use						
d ₀ [mm]	[-]	➡	+	1				
10								
12			0 Weeber					
14		retaining washer required						
16								
18	VM-IA 18							
20	VM-IA 20							
22	VM-IA 22							
25	VM-IA 25	h _{ef} >	h _{ef} >	all				
28	VM-IA 28	250mm	250mm	all				
30	VM-IA 30							
32	VM-IA 32							
35	VM-IA 35							
40	VM-IA 40							

Vacuum drill bit

Drill bit diameter (d₀): all diameters

Vacuum drill bit (MKT Hollow drill bit SB, Würth Saugbohrer 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 (d₀): all diameters



Blow-out pump (volume 750ml) Drill bit diameter (d₀): 10 mm to 20 mm Drill hole depth (h₀): \leq 10 d_{nom} for uncracked concrete

Annex B4

Intended Use Cleaning and setting tools

Injection System VMH for concrete



illing	of the hole		
_		Hammer drill or compressed air drill Drill with hammer drill or compressed air drill a hole into the bas size required by the selected anchor (Table B1, B2 or B3). Cont In case of aborted drill hole, the drill hole shall be filled with mor	inue with step 2.
1		Vacuum drill bit: see Annex B4 Drill hole into the base material to the embedment size and emb required by the selected anchor (Table B1, B2 or B3). This drillin removes dust and cleans the drill hole during drilling. Continue v In case of aborted hole, the drill hole shall be filled with mortar.	ng system
eanin	g (not applicable whe	n using a vacuum drill)	
	-	er in the drill hole must be removed before cleaning!	
	ning with compress	e d air ers according to Annex B1	
2a	min. 6 bar 2x	Starting from the bottom or back of the drill hole, blow out the hole compressed air (min. 6 bar) a minimum of two times until return of noticeable dust. If the drill hole ground is not reached, an extension must be use	air stream is free
2b	t) ⁺ 2x ⁺	Check brush diameter (Table B4). Brush the hole with an appropriate $d_{b,min}$ (Table B4) a minimum of two times. If the drill hole ground is not reached with the brush, an appropriextension must be used.	-
2c	min. 6 bar	Starting from the bottom or back of the drill hole, blow out the ho compressed air (min. 6 bar) again a minimum of two times until is free of noticeable dust. If the drill hole ground is not reached, an extension must be use	return air stream
	ual cleaning		
uncra	acked concrete, dry a	nd wet drill holes; drill hole diameter $d_0 \le 20$ mm and drill hole dep	th $h_0 \leq 10 d_{nom}$
2a		Starting from the bottom or back of the drill hole, blow out the hole blow-out pump a minimum of four times until return air stream is noticeable dust.	
2b	t) Tax	Check brush diameter (Table B4). Brush the hole with an appropriate $d_{b,min}$ (Table B4) a minimum of four times. If the drill hole ground is not reached with the brush, an appropriextension must be used.	-
2c		Starting from the bottom or back of the drill hole blow out the ho minimum of four times until return air stream is free of noticeable	
(dispensing the mortar	I hole has to be protected against re-contamination in an appropr in the drill hole. If necessary, the cleaning has to be repeated dire . In-flowing water must not contaminate the drill hole again.	
jectio	n System VMH for	concrete	
	-		Annex B5



Inj	ection	
3	THE S	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	her	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
5	min.3x	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 colour.
6a		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 as the hole fills to avoid air pockets. If the drill hole ground is not reached, an appropriate extension nozzle shall be used. Observe working times given in Table B6.
6b		 Retaining washer and mixer nozzle extensions shall be used according to Table B5 for the following applications: Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-Ø d₀ ≥ 18 mm and anchorage depth h_{ef} > 250mm Overhead installation: Drill bit-Ø d₀ ≥ 18 mm

Injection System VMH for concrete

Intended Use

Annex B6

Installation instructions (continuation)



Inst	allation instruction	s (continuation)
Set	tting the fastening elem	ent
7		Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached. The anchor shall be free of dirt, grease, oil or other foreign material.
8		After installation, the annular gap between anchor rod and concrete must be completely filled with mortar, in the case of push-through 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	Tinst	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 washer with bore 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

Conorata tomnoratura	Working time	Minimum	curing time			
Concrete temperature	Working time	dry concrete	wet 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					

Injection System VMH for concrete

Intended Use

Installation instructions (continuation) / Working and curing time



Threa	ded rod			M8	M10	M12	M16	M20	M24	M27	М30	
Steel	failure					1						
Cross	sectional area	As	[mm ²]	36,6	58,0	84,3	157	245	353	459	561	
Chara	cteristic resistance under tensi	on load ¹⁾										
ed	Property class 4.6 and 4.8	N _{Rk,s}	[kN]	15 (13)	23 (21)	34	63	98	141	184	224	
Steel, zinc plated	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280	
zir	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449	
steel	A2, A4 and HCR Property class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281	
Stainless steel	A2, A4 and HCR Property class 70	N _{Rk,s}	[kN]	26	41	59	110	171	247	_3)	_3)	
	A4 and HCR Property class 80	N _{Rk,s}	[kN]	29	46	67	126	196	282	_3)	_3)	
Partia	I factor ²⁾											
	Property class 4.6	γMs,N	[-]	2,0								
ted	Property class 4.8	γMs,N	[-]				1,	,5				
Steel, zinc plated	Property class 5.6	γMs,N	[-]				2	,0				
zin	Property class 5.8	γMs,N	[-]				1,	,5				
	Property class 8.8	γMs,N	[-]				1	,5				
steel	A2, A4 and HCR Property class 50	γMs,N	[-]				2,	86				
Stainless steel	A2, A4 and HCR Property class 70	γMs,N	[-]			1,	87			_3)	_3)	
Stain	A4 and HCR Property class 80	γMs,N	[-]			1	,6			_3)	_3)	

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⁾ Anchor type not part of the ETA

Injection System VMH for concrete

Performance

Characteristic values for threaded rods under tension loads



Threade	d rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel fai	ilure				1		1	I			
Cross se	ectional area	As	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Charact	eristic resistances under shear load	1 ¹⁾									
Steel fai	lure <u>without</u> lever arm										
ted	Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
Steel, zinc plated	Property class 5.6 and 5.8	V ⁰ Rk,s	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
zii	Property class 8.8	V ⁰ Rk,s	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
SS	A2, A4 and HCR, property class 50	V^0 Rk,s	[kN]	9	15	21	39	61	88	115	140
Stainless steel	A2, A4 and HCR, property class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	_3)	_3)
St	A4 and HCR, property class 80	V^0Rk,s	[kN]	15	23	34	63	98	141	_3)	_3)
Steel fai	ilure <u>with</u> lever arm				1						
ed	Property class 4.6 and 4.8	M ⁰ Rk,s	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
Steel, zinc plated	Property class 5.6 and 5.8	M ⁰ Rk,s	[Nm]	19 (16)	37 (33)	65	166	324	560	833	112:
zir	Property class 8.8	M ⁰ Rk,s	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
SS	A2, A4 and HCR, property class 50	M^0 Rk,s	[Nm]	19	37	66	167	325	561	832	112
Stainless steel	A2, A4 and HCR, property class 70	M ⁰ Rk,s	[Nm]	26	52	92	232	454	784	_3)	_3)
Š	A4 and HCR, property class 80	M ⁰ Rk,s	[Nm]	30	59	105	266	519	896	_3)	_3)
Partial f	actor ²⁾		1								
	Property class 4.6	γMs,V	[-]				1,	67			
Steel, zinc plated	Property class 4.8	γMs,V	[-]				1,	25			
Steel, ic plate	Property class 5.6	γMs,V	[-]				1,	67			
zind S	Property class 5.8	γMs,V	[-]				1,	25			
	Property class 8.8	γMs,V	[-]				1,	25			
SS	A2, A4 and HCR, property class 50	γMs,V	[-]				2,	38			
Stainless steel	A2, A4 and HCR, property class 70	γMs,V	[-]	1,56						_3)	_3)
Š	A4 and HCR, property class 80	γMs,V	[-]			1	,33			_3)	_3)
For con accordii	racteristic resistances apply for all anchor in imercial standard threaded rods with a sm ing to EN ISO 10684:2004 + AC:2009), the ince of other national regulations	aller cros	ss sectio	onal are	a (e.g. I						

Injection System VMH for concrete

Performance

Characteristic values for threaded rods under shear loads



Table C3: Chai	racteristic values of c	oncrete o	cone fai	lure and splitting failure
Threaded rods /	Internally threaded ancl	hor rods / I	Rebars	all sizes
Concrete cone f	ailure			
Factor k ₁	uncracked concrete	kucr,N	[-]	11,0
	cracked concrete	k cr,N	[-]	7,7
Edge distance		Ccr,N	[mm]	1,5 • h _{ef}
Spacing		Scr,N	[mm]	2,0 • C _{cr,N}
Splitting failure				
Characteristic res	sistance	N^0 Rk,sp	[kN]	min(N _{Rk,p} ;N ⁰ _{Rk,c})
	h/h _{ef} ≥ 2,0			1,0 • h _{ef}
Edge distance	2,0> h/h _{ef} > 1,3	C cr,sp	[mm]	2 ∙ h _{ef} (2,5 - h / h _{ef})
	h/h _{ef} ≤ 1,3			2,4• h _{ef}
Spacing		S cr,sp	[mm]	2,0 • c _{cr,sp}

Injection System VMH for concrete

Performance Characteristic values of concrete cone failure and splitting failure



Threaded rod				M8	M10	M12	M16	M20	M24	M27	М30
Steel failure					1	1	1	1	1		
Characteristic	resistance	N _{Rk,s}	[kN]			<u> </u>		• f _{uk} Table C	1		
Partial factor		γMs,N	[-]					able C1	1		
	Il-out and concrete failure										
Characteristic	bond resistance in <u>uncr</u>	acked (concrete (C20/25							
	I 40°C / 24°C			17	17	16	15	14	13	13	13
Temperature	II 80°C / 50°C			17	17	16	15	14	13	13	13
range	III 120°C / 72°C	τRk,ucr	[N/mm²]	15	14	14	13	12	12	11	11
	VI 160°C / 100°C			12	11	11	10	9,5	9,0	9,0	9,0
Characteristic	c bond resistance in <u>crac</u>	<u>ked</u> cor	ncrete C20)/25				1			
	I 40°C / 24°C			7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
Temperature	II 80°C / 50°C			7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
range	III 120°C / 72°C	τRk,cr	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	VI 160°C / 100°C			5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Reduction fac	ctor ψ ⁰ sus in concrete C20/	25	11		1	1					
	I 40°C / 24°C						0,	90			
Femperature ange	II 80°C / 50°C	Ψ^0 sus	[-]				0,	87			
	III 120°C / 72°C	φ 303		0,75							
	VI 160°C / 100°C			0,66							
			C25/30					02			
			C30/37 C35/45					04 07			
Increasing fact	tors for concrete	Ψc	C33/43 C40/50					07			
			C45/55					09			
			C50/60					10			
Concrete con	e failure										
Relevant para	meter						see Ta	able C3			
Splitting failu	re										
Relevant para	Imeter						see Ta	able C3			
Installation fa	ctor										
dry or wet –	vacuum cleaning						1	,2			
concrete –	manual cleaning	γinst	[-]		1	,2			erformar	nce ass	esse
water filled	compressed air cleaning			1,0							
drill hole	compressed air cleaning	γinst	[-]				1	,4			
Injection Cv/	stem VMH for concrete								1		



Threaded roo	I				M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure													
Characteristic	resistan	ce	N _{Rk,s}	[kN]			C		• f _{uk} āble C	1			
Partial factor			γMs,N	[-]	see Table C1								
Combined pu	III-out ar	d concrete fai	lure	•									
Characteristi	c bond r	esistance in <u>u</u>	ncracked o	concrete (220/25								
Temperature	1	40°C / 24°C			17	17	16	15	14	13	13	13	
range	Ш	80°C / 50°C	$\tau_{Rk,ucr,100}$	[N/mm ²]	17	17	16	15	14	13	13	13	
Characteristi	c bond r	esistance in <u>c</u>	<u>racked</u> cor	ncrete C2)/25			-		-			
Temperature	Ι	40°C / 24°C		[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5	
range	II	80°C / 50°C	τ Rk,cr,100	[[N/11111-]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5	
				C25/30				1,	02				
				C30/37	1,04								
Increasing fac	tore for a	oporata		C35/45	1,07								
increasing lac		UNCIELE	Ψc	C40/50				1,	08				
				C45/55				1,	09				
				C50/60				1,	10				
Concrete cor	e failure	•											
Relevant para	ameter							see Ta	uble C3				
Splitting failu	re												
Relevant para	ameter							see Ta	uble C3				
Installation fa	actor												
	va	cuum cleaning						1	,2				
dry or wet	ma	anual cleaning	γinst	[-]		1	,2		No pe	rformar	nce ass	essed	
	С	ompressed air cleaning						1	,0				
water filled drill hole	С	ompressed air cleaning	γinst	[-]	[-] 1,4								

Injection System VMH for concrete

Performance

Characteristic values of tension loads for threaded rods, working life 100 years

Annex C5

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Steel failure <u>without</u> lever ar			M8	M10	M12	M16	M20	M24	M27	M30		
Steel failure <u>without</u> level a	m								•			
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	0,6 • A _s • 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 • A _s • f _{uk} or see Table C2									
Ductility factor	k 7	[-]				1	,0					
Partial factor	γMs,V	[-]				see Ta	ble C2					
Steel failure <u>with</u> lever arm												
Characteristic bending resistance	M ⁰ Rk,s	[Nm]					V _{el} ∙ f _{uk} āble C2					
Elastic section modulus	Wel	[mm³]	31	62	109	277	541	935	1387	1874		
Partial factor	γMs,V	[-]	see Table C2									
Concrete pry-out failure												
Pry-out factor	k ₈	[-]				2	,0					
Concrete edge failure												
Effective length of anchor	lf	[mm]			min (h _{ef}	;12 d _{nom})			1	iin)0mm)		
Dutside diameter of anchor	d _{nom}	[mm]	8	10	12	16	20	24	27	30		
nstallation factor	γinst	[-]				1	,0					

Characteristic values of shear loads for threaded rods



Table C7: Ch sei		action (perform						•	50 and	d 100	years		
Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure													
Characteristic re	seietan	co	NRk,s,C1	[kN]				1,0 •	N _{Rk,s}				
Characteristic is	Sistan		N _{Rk,s,C2}	[kN]	-	1)	1,0 • N _{Rk,s}					_1)	
Partial factor			γMs,N	[-]	see Table C1								
Combined pull	-out a	nd concrete failu	re										
Characteristic	bond I	resistance in con	crete C20	0/25 to C5	0/60								
_	l:	40°C / 24°C	τ _{Rk,C1}	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0	
		+0 0 / 2+ 0	TRk,C2	[N/mm²]	-	1)	3,6	3,5	3,3	2,3	-	1)	
	II:	80°C / 50°C -	τRk,C1	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0	
Temperature			τ _{Rk,C2}	[N/mm²]	-	1)	3,6	3,5	3,3	2,3		1)	
range	111:	120°C / 72°C	τ _{Rk,C1}	[N/mm ²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0	
		120 07 72 0	τRk,C2	[N/mm²]	-	1)	3,1	3,0	2,8	2,0	-	1)	
	VI:	160°C / 100°C	τRk,C1	[N/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5	
	v1.	100 07 100 0	τrk,C2	[N/mm²]	-	1)	2,5	2,7	2,5	1,8	-	1)	
Installation fac	tor												
	Compressed air	dry or wet conc	Vinct	[-]					,0				
cleaning water filled drill hole		iole '						1,4					
Vacuum cleanir	ng	dry or wet conc	rete yinst	[-]				1,	,2				

Table C8: Characteristic values of shear loads for threaded rods,

seismic action (performance category **C1 + C2**)

Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30		
Steel failure <u>wi</u>	<u>thout</u> lever arm													
Characteristic	alatanaa	V	Rk,s,C1	[kN]				0,7 ·	V^0Rk,s					
Characteristic re	esistance	V	Rk,s,C2	[kN]	-	1)	0,7 • V ⁰ _{Rk,s}				1)			
Partial factor	Partial factor γ _{Ms,N}						see Table C2							
	earance	α_{gap}	[-]	1,0										
Factor for — anchorages	with hole cle between faste		α _{gap}	[-]	0,5									
¹⁾ No performar	ce assessed													
Injection Sys	tem VMH for cor	ncrete												
Performance Characteristic values for threaded rods under seismic action										Annex C7				



		tic values of te Juasi-static a d					readed	anchor	rod,	
Internally threa	aded anch	nor rod			VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
Steel failure ¹⁾										
Characteristic re	esistance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123
steel, zinc plate	d, property	class 8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196
Partial factor			γMs.N	[-]			1,	5		
Characteristic resteel A4 / HCR,			N _{Rk,s}	[kN]	14	26	41	59	110	124 ²⁾
Partial factor			γMs,N	[-]			1,87			2,86
		concrete failure								
Characteristic	bond resi	stance in <u>uncra</u>	<u>cked</u> co	ncrete C	20/25	-				
_	l:	40°C / 24°C			17	16	15	14	13	13
Temperature	11:	80°C / 50°C	~	[N/mm²]	17	16	15	14	13	13
range	III:	120°C / 72°C	τRk,ucr	[[N/11111-]	14	14	13	12	12	11
	VI:	160°C / 100°C			11	11	10	9,5	9,0	9,0
Characteristic	bond resi	stance in <u>cracke</u>	ed conc	rete C20/	25					
	1:	40°C / 24°C			7,5	8,0	9,0	8,5	7,0	7,0
Temperature	II:	80°C / 50°C		[N] /	7,5	8,0	9,0	8,5	7,0	7,0
range	III:	120°C / 72°C	$ au_{Rk,cr}$	[N/mm ²]	6,5	7,0	7,5	7,0	6,0	6,0
-	VI:	160°C / 100°C			5,5	6,0	6,5	6,0	5,5	5,5
Reduction fact	or ψ ⁰ sus in	concrete C20/2	5							
	:	40°C / 24°C					0,9	90		
Temperature	ll:	80°C / 50°C	0				9,0			
range	III:	120°C / 72°C	ψ^0 sus	[-]			0,7			
-	VI:	160°C / 100°C					0,6			
				C25/30			1,0)2		
				C30/37						
	_			C35/45			1,0 1,0			
Increasing facto	ors for conc	crete	ψc	C40/50			1,0			
				C45/55			1,0			
				C50/60			10			
Concrete cone	failure				<u> </u>					
Relevant paran	neter						see Ta	ble C3		
Splitting failure	9									
Relevant paran	neter						see Ta	ble C3		
Installation fac	tor									
	v	acuum cleaning					1,	2		
dry or wet	r	manual cleaning	γinst	[-]		1,2		No perfo	rmance as	ssessed
concrete -	compres	sed air cleaning	•				1,	0		
waterfilled drill hole	•	sed air cleaning	γinst	[-]			1,			
¹⁾ fastening screws internally threade	ed anchor ro ed anchor ro	d rods (incl. nut and od. The characteris od and the fastenin lass 50	tic tensio	n resistan						
Injection Sys	tem VMH	for concrete								
Performance Characteristic values of tension loads for internally threaded anchor rod, working life 50 years									Annex	C8



Internally threade	d anchor rod				VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IC M20
Steel failure 1)										
Characteristic resis	tance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123
steel, zinc plated, p	roperty class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196
Partial factor			γMs,N	[-]			1,	5		
Characteristic resis stainless steel A4 / property class		70	N _{Rk,s}	[kN]	14	26	41	59	110	124 ²⁾
Partial factor			γMs,N	[-]			1,87			2,86
Combined pull-ou	t and concrete	failur	re							
Characteristic bor	nd resistance i	n <u>unc</u>	racked co	oncrete C	20/25					
Temperature	I: 40°C / 2	24°C	_	[N]/maga2]	17	16	15	14	13	13
range	II: 80°C / 5	50°C	τRk,ucr,100	[N/mm ²]	17	16	15	14	13	13
Characteristic bor	nd resistance i	n <u>crac</u>	<u>ked</u> conc	rete C20	/25					
Temperature	l: 40°C / 2	24°C		[]] /	6,0	6,5	6,5	6,5	6,5	6,5
range	II: 80°C / 5	50°C	τRk,cr,100	[N/mm ²]	6,0	6,5	6,5	6,5	6,5	6,5
				C25/30			1,()2		
				C30/37			1,()4		
Increacing factors f	or concrete			C35/45			1,()7		
Increasing factors f	or concrete		Ψc	C40/50			1,()8		
				C45/55			1,()9		
				C50/60			1,1	0		
Concrete cone fai	lure									
Relevant paramete	er						see Ta	ble C3		
Splitting failure										
Relevant paramete	er						see Ta	ble C3		
Installation factor		I								
	vacuum clea	nina					1,	2		
dry or wet	manual clear		γinst	[-]		1,2			mance as	sesse
concrete	compressed	-	,			-	1,	•		
	clear						١,	0		
waterfilled drill hole	compressed clea		γinst	[-]			1,	2		
) fastening screws or internally threaded a internally threaded a 2) for VMU-IG M20: pro	threaded rods (in nchor rod. The ch nchor rod and the	cl. nut naracte	eristic tensio	on resistan						

Injection System VMH for concrete

Performance

Characteristic values of **tension loads** for **internally threaded anchor rod**, working life **100 years**



Table C11: Characteristic values of shear loads for internally threaded anchor rod,static and quasi-static action

Interr	nally threaded ar	nchor rod			VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
Steel	failure <u>without</u> l	ever arm ¹⁾								
, ted	Characteristic resistance	property class 5.8	$V^0_{Rk,s}$	[kN]	6	10	17	25	45	74
Steel, zinc plated	Characteristic resistance	property class 8.8	V^0 Rk,s	[kN]	8	14	23	34	60	98
zi.	Partial factor		γMs,V	[-]			1,	25		
Stainless steel	Characteristic resistance A4 / HCR	property class 70	V ⁰ Rk,s	[kN]	7	13	20	30	55	62 ²⁾
Sta	Partial factor		γMs,V	[-]			1,56			2,38
Ductil	lity factor		k 7	[-]			1	,0		
Steel	failure <u>with</u> leve	er arm ¹⁾			•					
, ted	Characteristic bending resistance	property class 5.8	M ⁰ Rk,s	[Nm]	8	19	37	66	167	325
<u> </u>	Characteristic bending resistance	property class 8.8	M ⁰ Rk,s	[Nm]	12	30	60	105	267	519
	Partial factor		γMs,∨	[-]			1,	25		
Stainless steel	Characteristic bending resistance A4 / HCR	property class 70	M ⁰ Rk,s	[Nm]	11	26	53	92	234	643 ²⁾
S	Partial factor		γMs,V	[-]			1,56			2,38
Conc	rete pry-out failu	ure								
Pry-o	ut factor		k ₈	[-]			2	,0		
Conc	rete edge failure	9								
Effect	tive length of ancl	hor	lf	[mm]		mi	n (h _{ef} ;12 d _n	om)		min (h _{ef} ; 300mm)
Outsi	de diameter of an	nchor	d _{nom}	[mm]	10	12	16	20	24	30
Instal	lation factor		γinst	[-]			1	,0		
interr	ning screws or thre nally threaded anch gth class are valid f	or rod (except	ion: VMl	J-IG M20). The chara	acteristic she	ear resistanc	material and e for steel fa	property cla ailure of the	ass of the given

 ¹⁾ fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and internally threaded anchor rod (exception: VMU-IG M20). The characteristic shear resistance for steel fai strength class are valid for the internally threaded anchor rod and the fastening element ²⁾ for VMU-IG M20: Internally threaded rod: property class 50; 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 C10	



Reinforcing b	bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure														I
Characteristic	resistai	nce	N _{Rk,s}	[kN]					As •	f _{uk} 1)				
Cross section	al area		As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			γMs,N	[-]		1			1,4	4 ²⁾				
Combined pu	Ill-out a	nd concrete fail	ure											
Characteristi	c bond	resistance in un	cracke	d concret	te C20	0/25								
	1:	40°C / 24°C			14	14	14	14	13	13	452 491 13 13 13 13 11 11 9,0 9,0 6,5 7,0 6,5 7,0 5,5 6,0 5,0 5,0 9,0 9,0	13	13	13
Temperature	II:	80°C / 50°C		[N]/mama2]	14	14	14	14	13	13		13	13	13
range	III:	120°C / 72°C	τRk,ucr	[N/mm²]	13	12	12	12	12	11		11	11	11
	VI:	160°C / 100°C			9,5	9,5	9,5	9,0	9,0	9,0	9,0	13 13 11 11 9,0 9,0 6,5 7,0 6,5 7,0 5,5 6,0	8,5	8,5
Characteristi	c bond	resistance in cra	acked c	oncrete (C20/2	5								
	1:	40°C / 24°C			5,5	5,5	6,0	6,5	6,5	6,5	13 13 13 11 11 11 9,0 9,0 8,5 6,5 7,0 7,0 6,5 7,0 7,0 5,5 6,0 6,0	7,0	7,0	
Temperature	II:	80°C / 50°C	_	[N]/mm2]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	13 13 13 13 13 13 13 13 13 11 11 11 9,0 9,0 8,5 6,5 7,0 7,0 6,5 7,0 7,0 6,5 6,0 6,0	7,0	7,0
range	III:	120°C / 72°C	τRk,cr	[N/mm²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5		6,0	6,0
	VI:	160°C / 100°C			4,0	4,5	4,5	5,0	5,0	5,0	13 13 13 11 11 11 9,0 9,0 8,5 6,5 7,0 7,0 6,5 7,0 7,0 5,5 6,0 6,0	5,0		
Reduction fa	ctor ψ⁰₅	us in concrete C2	20/25											
	l:	40°C / 24°C							0,9	90				
Temperature	11:	80°C / 50°C	0	r 1					0,8	37				
range	III:	120°C / 72°C	$\psi^0 sus$	[-]					0,	75				
	VI:	160°C / 100°C							0,0	66		3 13 3 13 1 11 ,0 9,0 ,5 7,0 ,5 7,0 ,5 6,0		
				C25/30					1,0	02				
				C30/37					1,(04				
Increasing fac	tor for a	oporata		C35/45					1,0)7				
increasing fac		oncrete	Ψc	C40/50					1,(08				
				C45/55					1,(09				
				C50/60					1,	10				
Concrete cor	ne failur	e												
Relevant para	ameter							5	ее Та	ble C	3			
Splitting failu	Ire													
Relevant para	ameter							5	ее Та	ble C	3			
Installation fa	actor													
		vacuum cleaning							1,	2				
dry or wet		manual cleaning	γinst	[-]			1,2			No	perforr	nance	asses	sed
concrete	compre	ssed air cleaning							1,	0				
waterfilled		ssed air cleaning	γinst	[-]					1,	4				
		he specifications of regulation	reinforci	ng bars	1									
Injection Sv	stem \	/MH for concre	te											



	: Characte 100 years	ristic value s working I		sion 108		or rel	bar, s		and	qua	si-Sta		ctior	1,
Reinforcing	g bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure	е										•	•		
Characterist	tic resistance		N _{Rk,s}	[kN]					As •	$f_{uk}^{1)}$				
Cross section	onal area		As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial facto	r		γMs,N	[-]					1,	4 ²⁾				
Combined	pull-out and	concrete fa	ilure											
Characteris	stic bond res	sistance in <u>u</u>	Incracke	<u>d</u> concret	te C20)/25								
Temperature	e I: 40	0°C / 24°C		[N1/mm2]	14	14	14	14	13	13	13	13	13	13
range	II: 80	0°C / 50°C	τRk,ucr,100	[N/mm²]	14	14	14	14	13	13	13	13	13	13
Characteris	stic bond res	sistance in <u>c</u>	racked c	oncrete	C20/2	5								
Temperature	e I: 40	0°C / 24°C		[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
range	II: 80	0°C / 50°C	τRk,cr,100	[[N/11111-]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
				C25/30					1,	02				
				C30/37					1,	04				
Increacing f	antar for anno	rata		C35/45					1,	07				
increasing is	actor for conc	crete	Ψc	C40/50					1,	08				
				C45/55					1,	09				
				C50/60					1,	10				
Concrete c	one failure													
Relevant pa	arameter							5	see Ta	able C	3			
Splitting fai	ilure													
Relevant pa	arameter							5	see Ta	able C	3			
Installation	factor													
_	vac	uum cleaning	g						1	,2				
dry or wet concrete	ma	inual cleaning	g γinst	[-]			1,2			No	perfori	mance	asses	sed
	compresse	d air cleaning	g						1	,0				
waterfilled drill hole	compresse	d air cleaning	g γ _{inst}	[-]					1	,4				
¹⁾ f _{uk} shall be ta	aken from the s		of reinforci	ng bars	1									
Injection S	System VMI	H for concr	rete											
Performan Characteris	ce tic values of t	ension load	s for reb a	ar, 100 ye	ears w	vorking	g life					Anne	ex C1	12



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 a	arm		I	L					I	L		
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]				(0,50 • A	As ∙ f _{uk} ¹)			
Cross sectional area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γMs,V	[-]					1,5	5 ²⁾				
Ductility factor	k 7	[-]					1,	,0				
Steel failure with lever arm												
Characteristic bending resistance	M ⁰ Rk,s	[Nm]					1,2 • W	el • f _{uk} 1)	_		
Elastic section modulus	W_{el}	[mm ³]	50	98	170	269	402	785	1357	1534	2155	3217
Partial factor	γMs,V	[-]					1,5	5 ²⁾				
Concrete pry-out failure												
Pry-out Factor	k ₈	[-]					2	,0				
Concrete edge failure												
Effective length of rebar	lf	[mm]			min ((h _{ef} ;12	d _{nom})			min (h _{ef} ; 300)mm)
Outside diameter of rebar	d _{no}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation factor	γinst	[-]					1	,0				

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



Table C15: Char (perfe	acteristic values ormance categor								ction				
Reinforcing bar				Ø	3 Ø 10) Ø 12	Ø 14	Ø 16	Ø 20 Ø	ð 24 g	ð 25	Ø 28	Ø 32
Steel failure													
Characteristic resist	tance	NRk,s,C1	[kN]					A _s •	f _{uk} 1)				
Cross sectional are	a	As	[mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor		γMs,N	[-]					1,4	1 ²⁾				
Combined pull-out	t and concrete fail	ure											
Characteristic bon	nd resistance in cor	ncrete C	C20/25 t	o C50/	/60	-1							
<u></u> :	40°C / 24°C			5,5	5 5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Temperature	80°C / 50°C	τ _{Rk.C1}	 [N/mm ⁱ	21 5,5	5 5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
range III:	120°C / 72°C	UNK,OT		4,5	5 5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
VI:	160°C / 100°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Installation factor	1		1										
dry or wet concrete	vacuum cleaning	γinst	[-]					1,	2				
	compressed air	γinst	[-]					1,	0				
waterfilled drill hole	cleaning	γinst	[-]					1,	4				
Table C16: Char seisi Reinforcing bar	acteristic values mic action (perfe		ce cat	tegory			Ø 16	Ø 20) Ø 24	Ø2	5 0	28	Ø 32
Steel failure witho	ut lever arm		20			2 14					<u> </u>	20	0.02
Characteristic resist		[kN]					0,35 ·	As • fuk	,1)				
Cross sectional are			50	79	113	154	201	314	-	49	1 6	16	804
Partial factor	γMs,V	[-]					1,	5 ²⁾		1	I	I	
Ductility factor	k ₇	[-]					1	,0					
 ¹⁾ f_{uk} shall be taken from ²⁾ in absence of national 		reinforci	ing bars										
Injection System	NVMH for concre	te											
Performance Characteristic value	es for rebar under s	eismic	action							4	Anne	ex C	14



Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Displacement facto										
uncracked concrete, Temperature range		lasi-static acti		-		-		0.040	0.044	
I: 40°C / 24°C	δ _{N0} -factor		0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
II: 80°C / 50°C	δ _{N∞} -factor		0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range	δ_{N0} -factor	$\left[\frac{\text{mm}}{\text{N/mm}^2}\right]$	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
III: 120°C / 72°C	δ _{N∞} -factor	^c N/mm ²³	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range	δ _{N0} -factor		0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
VI: 160°C / 100°C	δ _{N∞} -factor		0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Displacement facto cracked concrete, sta		si-static action	, working	, life 50 a	ind 100 y	/ears				
Temperature range	δ_{N0} -factor		0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
I: 40°C / 24°C II: 80°C / 50°C	δ _{N∞} -factor		0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range	δ_{N0} -factor	mm ا	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
III: 120°C / 72°C	δ _{N∞} -factor	$\left[\frac{1}{N/mm^2}\right]$	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range	δ _{N0} -factor		0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
VI: 160°C / 100°C	δ _{N∞} -factor		0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
Displacement, seis	mic action (C2)								
All temperature	$\delta_{\text{N,C2}\;(\text{DLS})}$	[mm]		2)	0,24	0,27	0,29	0,27		2)
ranges	$\delta_{\text{N,C2}}(\text{ULS})$	[IIIII]	-	,	0,55	0,51	0,50	0,58	-	,
$\delta_{N0} = \delta_{N0} - factor \cdot \tau$	·	τ: acting bo	nd stress	for tensio	n					
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot \pi^{2}$ No performance as: Table C18: Displ	; ; sessed	-	ar load	(thread	ed rod)		M20	M24	M27	M30
$δ_{N\infty} = \delta_{N\infty}$ - factor · π ²⁾ No performance ass Γable C18: Displ Threaded rod	; sessed acements	-				M16	M20	M24	M27	M30
$δ_{N\infty} = \delta_{N\infty}$ - factor · π ²⁾ No performance ass Γable C18: Displ Threaded rod Displacement facto	; sessed acements r ¹⁾	under shea	nr load M8	(thread M10	ed rod)		M20	M24	M27	M30
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot \pi^{2}$ No performance ass Table C18: Disple Threaded rod Displacement facto cracked and uncrack	; sessed acements r ¹⁾	under shea	nr load M8	(thread M10	ed rod)		M20	M24	M27	
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot a$ ²⁾ No performance ass Table C18: Displ Threaded rod Displacement facto cracked and uncrack All temperature	; sessed acements r ¹⁾ :ed concrete;	under shea	M8 M8 asi-static	(thread	ed rod) M12	M16				0,03
$\delta_{N^{\infty}} = \delta_{N^{\infty}} \text{- factor} \text{(a)}$	r ¹⁾ sed concrete, δvo-factor δv∞-factor	under shea static and qu [mm/(kN)]	M8 M8 asi-static 0,06	(thread M10 action 0,06	ed rod) M12 0,05	M16 0,04	0,04	0,03	0,03	0,03
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot a$ ²⁾ No performance as Table C18: Displ Threaded rod Displacement facto cracked and uncrack All temperature ranges Displacement, seis	r ¹⁾ sed concrete, δvo-factor δv∞-factor	under shea static and qu [mm/(kN)] C2)	M8 M8 asi-static 0,06 0,09	(thread M10 action 0,06 0,08	ed rod) M12 0,05	M16 0,04	0,04	0,03	0,03	0,03 0,05
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot a$ ²⁾ No performance as Table C18: Displ Threaded rod Displacement facto cracked and uncrack All temperature ranges Displacement, seis All temperature	r ¹⁾ ed concrete δvo-factor δv∞-factor	under shea static and qu [mm/(kN)]	M8 M8 asi-static 0,06 0,09	(thread M10 action 0,06	ed rod) M12 0,05 0,08	M16 0,04 0,06	0,04	0,03 0,05	0,03	0,03
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot a$ ²⁾ No performance as Table C18: Displ Threaded rod Displacement facto cracked and uncrack All temperature ranges	r ¹⁾ acements acements r ¹⁾ and concrete, δvo-factor δv∞-factor mic action (δv,c2(DLS) δv,c2(ULS) isplacement	under shea static and qu [mm/(kN)] C2) [mm]	M8 M8 asi-static 0,06 0,09	(thread M10 action 0,06 0,08 ²⁾	ed rod) M12 0,05 0,08 3,6	M16 0,04 0,06 3,0	0,04 0,06 3,1	0,03 0,05 3,5	0,03	M30 0,03 0,05
$\delta_{N\infty} = \delta_{N\infty}$ - factor $\cdot \alpha$ ²⁾ No performance ass Table C18: Disple Threaded rod Displacement facto cracked and uncrack All temperature ranges Displacement, seise All temperature ranges ¹⁾ Calculation of the di $\delta_{V0} = \delta_{V0}$ -factor $\cdot V$; $\delta_{V\infty} = \delta_{V\infty}$ -factor $\cdot V$;	r ¹⁾ red concrete, δvo-factor δv∞-factor mic action (δv,c2(DLS) δv,c2(ULS) isplacement	under shea static and qu [mm/(kN)] C2) [mm] V: acting	M8 M8 asi-static 0,06 0,09	(thread M10 action 0,06 0,08 ²⁾	ed rod) M12 0,05 0,08 3,6	M16 0,04 0,06 3,0	0,04 0,06 3,1	0,03 0,05 3,5	0,03	0,03 0,05



Internally threaded a	anchor rod		VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20
Displacement factor uncracked concrete, s		si-static action	n, working l	ife 50 and	100 years			
Temperature range I: 40°C / 24°C	δ_{N0} -factor		0,032	0,034	0,037	0,039	0,042	0,046
ll: 80°C / 50°C	$\delta_{N\infty}$ -factor		0,042	0,044	0,047	0,051	0,054	0,060
Temperature range	δ_{N0} -factor	[mm [N/mm ²]	0,034	0,035	0,038	0,041	0,044	0,048
III: 120°C / 72°C	$\delta_{N\infty}$ -factor	$\left[\frac{N}{mm^2}\right]$	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range	δ _{N0} -factor		0,126	0,131	0,142	0,153	0,163	0,179
VI: 160°C / 100°Č	δ _{N∞} -factor		0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor cracked concrete, sta		static action, v	vorking life	50 and 10	0 years			
Temperature range I: 40°C / 24°C	δ_{N0} -factor		0,083	0,085	0,090	0,095	0,099	0,106
II: 80°C / 50°C	$\delta_{N\infty}$ -factor		0,107	0,110	0,116	0,122	0,128	0,137
Temperature range	δ _{N0} -factor	r mm	0,086	0,088	0,093	0,098	0,103	0,110
III: 120°C / 72°C	δ _{N∞} -factor	$\left[\frac{\text{mm}}{\text{N/mm}^2}\right]$	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range	δ _{N0} -factor		0,321	0,330	0,349	0,367	0,385	0,412
VI: 160°C / 100°Č	δ _{N∞} -factor		0,330	0,340	0,358	0,377	0,396	0,424

¹⁾ Calculation of the displacement

 $\delta_{\text{N0}} = \delta_{\text{N0}} \text{-factor} \quad \tau; \qquad \tau: \text{ acting bond stress for tension}$

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

Table C20: Displacements under shear load (internally threaded anchor rod)

Internally threaded a	nchor rod		VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20
Displacement factor ¹ cracked and uncracke		atic and quas	i-static acti	on				
All temperature	δ_{V0} -factor	[mm////NI\]	0,07	0,06	0,06	0,05	0,04	0,04
ranges	δv∞-factor	[mm/(kN)]	0,10	0,09	0,08	0,08	0,06	0,06
¹⁾ Calculation of the disp $\delta v_0 = \delta v_0$ -factor · V; $\delta v_{\infty} = \delta v_{\infty}$ -factor · V;		ing shear load						
Injection System V	MH for cond	crete						

Performance

Displacements (internally threaded anchor rod)



Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement facto uncracked concrete,		uasi-static ad	ction, w	orking	life 50 a	and 100) years					
Temperature range	δ _{N0} -factor		0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,04
I: 40°C / 24°C II: 80°C / 50°C	$\delta_{N\infty}$ -factor		0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,06
Temperature range	δ _{N0} -factor	mm ا	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,05
III: 120°C / 72°C	$\delta_{N\infty}$ -factor	$\left[\frac{1}{N/mm^2}\right]$	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,06
Temperature range	δ _{N0} -factor		0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,18
VI: 160°C / 100°C	δ _{N∞} -factor		0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,19
Displacement facto cracked concrete, sta		si-static actic	on, worł	king life	50 an	d 100 y	ears					
Temperature range	δ_{N0} -factor		0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,10
l: 40°C / 24°C ll: 80°C / 50°C	$\delta_{N\infty}$ -factor		0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,14
Temperature range	δ _{N0} -factor	1	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,11
III: 120°C / 72°C	$\delta_{N\infty}$ -factor	$\left[\frac{1}{N/mm^2}\right]$	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,14
Temperature range	δ _{N0} -factor		0,312	0,321	0,330	0,340	0,349	0,367	0,385	0.385	0,399	0,42
VI: 160°C / 100°Č										,		-,
¹⁾ Calculation of the dia $\delta_{NO} = \delta_{NO}$ -factor $\cdot \tau$:		acting bond s	-		0,340	0,349	0,358	0,377	-			
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \cdot \tau; \\ \delta_{N\infty} &= \delta_{N\infty} \text{-} \text{factor} \cdot \tau; \end{split}$ Table C22: Displ	isplacement τ:	acting bond s s under sh	tress for	tensior ad (re	ebar)	1	1	1	0,396	0,396	0,410	0,44
$\delta_{N0} = \delta_{N0} - factor \cdot \tau;$ $\delta_{N\infty} = \delta_{N\infty} - factor \cdot \tau;$ Table C22: Displ Rebar Displacement factor	isplacement τ: lacements	s under sh	tress for ear lo Ø 8	tensior ad (re	ebar) Ø 12	1	1	1	0,396	0,396	0,410	0,44
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \cdot \tau; \\ \delta_{N\infty} &= \delta_{N\infty} \text{-factor} \cdot \tau; \end{split}$ Table C22: Displ Rebar Displacement factor cracked and uncracked	isplacement τ: lacements or ¹⁾ ked concrete	s under sh	tress for ear lo Ø 8 quasi-s	tensior ad (re Ø 10	ebar) Ø 12	Ø 14	Ø 16	Ø 20	0,396 Ø 24	0,396 Ø 25	0,410	0,44 Ø:
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-} factor \cdot \tau; \\ \delta_{N\infty} &= \delta_{N\infty} \text{-} factor \cdot \tau; \end{split}$ Table C22: Displ Rebar Displacement factor cracked and uncract All temperature	isplacement τ: lacements or ¹⁾ ked concrete δνο-factor	s under sh	tress for ear lo Ø 8 quasi-s 0,06	tensior ad (re Ø 10 tatic ac 0,05	ebar) Ø 12 stion 0,05	Ø 14 0,04	Ø 16	Ø 20 0,04	0,396 Ø 24	0,396 Ø 25	0,410 Ø 28	0,44
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \cdot \tau; \\ \delta_{N\infty} &= \delta_{N\infty} \text{- factor} \cdot \tau; \end{split}$ Table C22: Displ Rebar Displacement factor	isplacement τ : accements br ¹⁾ ked concrete δv_0 -factor δv_{∞} -factor isplacement V:	s under sh	tress for ear lo Ø 8 quasi-s 0,06 0,09	tensior ad (re Ø 10	ebar) Ø 12 stion 0,05	Ø 14 0,04	Ø 16	Ø 20 0,04	0,396 Ø 24	0,396 Ø 25	0,410 Ø 28	0,4 Ø

Displacements (rebar)