

DECLARATION OF PERFORMANCE

DoP Nr.: MKT-342 - en

Unique identification code of product-type:

Injection System VMH for concrete

♦ Intended use/es:

Bonded fastener for use in concrete, see Annex B

♦ Manufacturer:

MKT Metall-Kunststoff-Technik GmbH & Co.KG

Auf dem Immel 2 67685 Weilerbach

♦ System or systems of assessment and verification of constancy of performance:

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♦ European Assessment Document:

EAD 330499-01-0601

European Technical Assessment:

ETA-17/0716, 22.11.2019

Technical Assessment Body:

DIBt, Berlin

Notified body/ies:

NB 1343 - MPA, Darmstadt

♦ Declared performance/s:

Essential characteristics	Performance
Mechanical resistance and stability (BWR 1)	
Characteristic resistance to tension load (static and quasi-static loading)	Annex C1, C3, C6, C8
Characteristic resistance to shear load (static and quasi-static loading)	Annex C2, C4, C7, C9
Displacements (static and quasi-static loading)	Annex C11 – C13
Characteristic resistance and displacements for seismic performance category C1+C2	Annex C5, C10, C11
Durability	Annex B1
Hygiene, health and the environment (BWR 3)	
Content, emission and/or release of dangerous substances	No performance assessed

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:

Stefan Weustenhagen (General manager)

Weilerbach, 22.11.2019

Dipl.-lng. Detlef Bigalke (Head of product development)



The original of this declaration of performance was written in German. In the event of deviations in the translation, the German version shall be valid.

Specification of intended use

Injection S	System VMH	Threaded rod	Internally threaded anchor rod	Rebar		
Static or qua	si-static action	M8 - M30 zinc plated, A2, A4, HCR	VMU-IG M6 - VMU-IG M20 zinc plated ¹⁾ , A4, HCR	Ø8 - Ø32		
Seismic	performance category C1	M8 - M30 zinc plated ¹⁾ , A4, HCR	-	Ø8 - Ø32		
action	performance category C2	M12 – M24 zinc plated ¹⁾ (property class 8.8) A4, HCR (poperty class ≥ 70)	-	-		
		compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013				
Base materia	als	strength classes acc. to EN 206:2013: C20/25 to C50/60				
		cracked or uncracked concrete				
Temperature	Range I -40 °C to +80 °C	max. long term temperature +50 °C and max. short term temperature +80 °C				
Temperature	Range II -40 °C to +120 °C	max. long term temperature +72 °C and max. short term temperature +120 °C				
Temperature	Range III -40 °C to +160 °C	max. long term temperature +100 °C and max. short term temperature +160 °C				

¹⁾ except hot-dip galvanised

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes:
 - Stainless steel A2 according to Annex A4, Table A1: CRC II
- Stainless steel A4 according to Annex A4, Table A1: CRC III
- High corrosion resistant steel HCR according 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 or Technical Report TR 055

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
- 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	Annex B1

Table B1: Installation parameters for threaded rods

Threaded rod				М8	M10	M12	M16	M20	M24	M27	M30
Diameter of thread	ded 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	ro donth	$h_{\text{ef,min}}$	[mm]	60	60	70	80	90	96	108	120
Enective anchorag	је аери	$h_{\text{ef,max}}$	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in	Pre-setting installation	d _f ≤	[mm]	9	12	14	18	22	26	30	33
the fixture ²⁾	Through setting installation	d _f ≤	[mm]	12	14	16	20	24	30	33	40
Installation torque		T _{inst} ≤	[Nm]	10	20	40 (35) ¹⁾	60	100	170	250	300
Minimum thickness of member h_{min} [mm]			_f + 30 m : 100 mr				h _{ef} + 2d ₀	1			
Minimum spacing		S _{min}	[mm]	40	50	60	75	95	115	125	140
Minimum edge dis	tance	C _{min}	[mm]	35	40	45	50	60	65	75	80

¹⁾ Installation torque for M12 with steel grade 4.6

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 —	$h_{\text{ef,min}}$	[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
Installation torque	T _{inst} ≤	[Nm]	10	10	20	40	60	100
Minimum screw-in depth	I_{IG}	[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 acc. to EN 1993-1-8:2005+AC:2009

Table B3: Installation parameters for rebar

Rebar			Ø8	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	32	32	35	40
Effective anchorage depth -	$h_{\text{ef,min}}$	[mm]	60	60	70	75	80	90	96	100	112	128
Effective afficionage 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	I			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

For diameter \emptyset 8, \emptyset 10 and \emptyset 12 both nominal drill hole diameter can be used

Intended use

Installation parameters

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 B4: Parameter cleaning and setting tools

Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
				d _b	Manananana
[-]	[-]	Ø [mm]	d₀ [mm]	d ь [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			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

Table B5: Retaining washer

Drill bit Ø		Installation direction and use					
d ₀ [mm]	[-]	•	→	1			
10			I _				
12		N	o y washer				
14		•	ired				
16		1040					
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



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): ≤ 10 d_{nom} for uncracked concrete

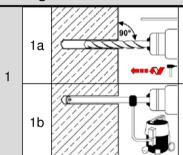
Injection System VMH for concrete

Intended Use

Cleaning and setting tools

Installation Instructions

Drilling of the hole



Hammer drill oder 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 B3

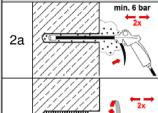
Drill hole into the base material to the embedment size and embedment depth required by the selected anchor (table B1, B2 or B3). This drilling system removes dust and cleans the drill hole during drilling. Continue with step 3. In case of aborted hole, the drill hole shall be filled with mortar.

Cleaning (not applicable when using a vacuum drill)

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

Cleaning with compressed air

all subtrates and diameters according to Annex B1

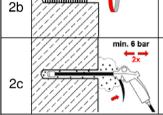


Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust.

If the drill hole ground is not reached, an extension must be used.

Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (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.

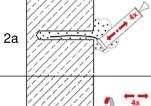


Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust.

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 d₀ ≤ 20mm and drill hole depth h₀ ≤ 10 dnom



Starting from the bottom or back of the drill hole, blow out the hole with the blowout pump a minimum of **four** times.

2b

Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (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.

Starting from the bottom or back of the drill hole blow out the hole again a minimum of **four** times.

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. In-flowing water must not contaminate the drill hole again.

Injection System VMH for concrete

Intended Use Installation instructions

Installation instructions (continuation)

Inje	ection	
3	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	hef	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 hef > 250mm • Overhead installation: Drill bit-Ø d₀ ≥ 18 mm

Installation instructions (continuation)

Ins	erting the anchor	
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	T _{inst}	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

Concrete temperature	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	Annex B6

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

Threaded rod M						M12	M16	M20	M24	M27	M30
Steel fa	ailure										
Cross s	sectional area	A_s	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Charac	teristic resistance under tension load1)		-			-					
pe	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
teel	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	-	-
Stair	A4 and HCR Property class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-
Partial	factor ²⁾										
	Property class 4.6	[-]	2,0								
pe	Property class 4.8	γ _{Ms,N}	[-]				1	,5			
Steel, zinc plated	Property class 5.6	γ _{Ms,N}	[-]				2	,0			
zir	Property class 5.8	γ _{Ms,N}	[-]				1	,5			
	Property class 8.8	γ _{Ms,N}	[-]				1	,5			
steel	A2, A4 and HCR Property class 50	γ _{Ms,N}	[-]				2,	86			
Stainless steel	A2, A4 and HCR Property class 70	γ _{Ms,N}	[-]			1,	87			-	-
Stail	A4 and HCR Property class 80	γ _{Ms,N}	[-]			1	,6			-	-

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.

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

²⁾ In absence of other national regulations

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

Threade	d rod			М 8	M 10	M 12	M 16	M 20	M 24	M 27	М 30
Steel fai	lure										
Cross se	ctional area	As	[mm²]	36,5	58,0	84,3	157	245	353	459	561
Characte	eristic resistances under shear load ¹⁾										
Steel fai	lure <u>without</u> lever arm										
p€	Property class 4.6 and 4.8	$V^0_{\rm Rk,s}$	[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
zin	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	-	-
Sta	A4 and HCR, property class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-	-
Steel fai	lure <u>with</u> lever arm						1	·	•		
ρe	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	1123
zin	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	1125
Stainless steel	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
Ste	A4 and HCR, property class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-	-
Partial fa	actor ²⁾										
	Property class 4.6	γ _{Ms,V}	[-]				1,	67			
el, lated	Property class 4.8	γ _{Ms,V}	[-]					25			
Property class 5.6 Property class 5.8		γms, v	[-]				1,	67			
S zinc	Property class 5.8	γ _{Ms,V}	[-]				1,	25			
17	Property class 8.8	γ _{Ms,V}	[-]				1,	25			
SS	A2, A4 and HCR, property class 50	γ _{Ms,V}	[-]				2,	38			
Stainless steel	A2, A4 and HCR, property class 70	γ _{Ms,V}	[-]			1	,56			-	-
St.	A4 and HCR, property class 80	γ _{Ms,V}	[-]			1	,33			-	-

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

Injection System VMH for concrete
Performance Characteristic values for threaded rods under shear loads

Table C3: Characteristic values of **tension loads** for **threaded rods** under static or quasi-static action

Threaded rod			М8	M10	M12	M16	M20	M24	M27	M30				
Steel failure														
Characteristic resistance	e	$N_{Rk,s}$	[kN]			(A _s or see T	• f _{uk} 「able C	1					
Partial factor		γ̃Ms,N	[-]	see Table C1										
Combined pull-out and	I concrete failure													
Characteristic bond re	sistance in <u>uncrack</u>	<u>ed</u> cond	rete C20)/25	/25									
Temperature range I:	80°C / 50°C	$\tau_{\text{Rk},\text{ucr}}$	[N/mm²]	17	17	16	15	14	13	13	13			
Temperature range II:	120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	12	12	11	11			
Temperature range III:	160°C / 100°C	$ au_{Rk,ucr}$	[N/mm²]	12	11	11	10	9,5	9,0	9,0	9,0			
Characteristic bond re	concre	te C20/2	5											
Temperature range I:	80°C / 50°C	$ au_{Rk,cr}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0			
Temperature range II:	120°C / 72°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0			
Temperature range III:	160°C / 100°C		[N/mm ²]	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:	80°C / 50°C	$\psi^0_{ { m sus}}$	[-]		0,79									
Temperature range II:	ψ^0_{sus}	[-]		0,75										
Temperature range III:	160°C / 100°C	ψ^0_{sus}	[-]		0,66									
			C25/30 C30/37	1,02 1,04										
Increasing factors for co	ncrete	Ψc	C35/45 C40/50	1,07 1,08										
			C45/55 C50/60		1,09 1,10									
Concrete cone failure			000,00				- ',	10						
	uncracked concrete	k _{ucr,N}	[-]				11	1,0						
Factor k ₁ ———	cracked concrete	k _{cr,N}						,7						
Splitting failure														
	h/h _{ef} ≥ 2,0						1,0) h _{ef}						
Edge distance	2,0> h/h _{ef} > 1,3	$C_{\text{cr,sp}}$	[mm]			2	• h _{ef} (2,	5 – h / h	n _{ef})					
						2,4	h _{ef}							
Spacing	S _{cr,sp}	[mm]	2 C _{cr,sp}											
Installation factor														
_	Vacuum cleani	ng γ _{inst}	[-]	1,2										
dry or wet concrete	Manual cleani	ng γ _{inst}	[-]	1,2 NPA										
	Compressed		[-]					,0						
water filled drill hole	cleani	ng _{γ_{inst}}	[-]				1	,4						

Injection Syst	tem VMH f	or concrete
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Performance

Characteristic values of tension loads for threaded rods

Table C4: Characteristic values of **shear loads** for **threaded rods** under static or quasi-static action

Threaded rod	Threaded rod						M20	M24	M27	M30				
Steel failure without lever arm										<u>'</u>				
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V^0_{Rk,s}$	[kN]					A _s • f _{uk} Table C2							
Characteristic resistance Steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR	$V^0_{ m Rk,s}$	[kN]					A _s • f _{uk} Γable C2							
Ductility factor	k ₇	[-]				1	,0							
Partial factor	$\gamma_{\text{Ms,V}}$	[-]	see Table C2											
Steel failure with lever arm														
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]					V _{el} ∙ f _{uk} Γable C2							
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874				
Partial factor	γ _{Ms,V}	[-]				see Ta	able C2							
Concrete pry-out failure														
Pry-out factor	k ₈	[-]				2	,0							
Concrete edge failure														
Effective length of anchor	I _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	

Table C5: Characteristic values of tesion loads for threaded rods under seismic action, performance category C1 + C2 1)

Threaded roo	d					M8	M10	M12	M16	M20	M24	M27	M30			
Steel failure																
Characteristic	$N_{Rk,s,\epsilon}$	eq,C1	[kN]	1,0 • N _{Rk,s}												
Gharacteristic	haracteristic resistanceartial factor		$N_{Rk,s,\epsilon}$	eq,C2	[kN]	NI	PA		1,0 •	NPA						
Partial factor			γ	Ms,N	[-]			S	iehe Ta	abelle C	:1					
Combined po	ull-ou	t and concrete failure	•													
Characterist	ic bor	nd resistance														
	1:	80°C / 50°C	$ au_{Rk,\epsilon}$	eq,C1	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0			
	1.	00 0 7 00 0	$ au_{Rk,\epsilon}$	eq,C2	[N/mm²]	NI	PA	3,6	3,5	3,3	2,3	NF	P A			
Temperatur-	II:	120°C / 72°C	$ au_{Rk,\epsilon}$	eq,C1	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0			
range	11.		τ _{Rk,eq,C2}		[N/mm²]	NI	PA	3,1	3,0	2,8	2,0	NF	PA			
					160°C / 100°C	$ au_{Rk,\epsilon}$	eq,C1	[N/mm²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
	III:	160°C / 100°C	τ _{Rk,eq,C2}		[N/mm²]	NPA		2,5	2,7	2,5	1,8	NF	PA			
Installation fa	actor	-														
Compressed	air	dry or wet co	ncrete	.,	r 1	1,0										
cleaning			lrill hole γ _{ir}		[-]	1,4										
Vacuum cleaning dry or wet co			ncrete	γ_{inst}	[-]				1	,2						

¹⁾ Materials and property classes according to Annex B1

Table C6: Characteristic values of tesion loads for threaded rods under seismic action, performance category C1 + C2 1)

Threaded ro	d		·	М8	M10	M12	M16	M20	M24	M27	M30		
Steel failure	without lever arm												
Characteristic		$V_{\text{Rk,s,eq,C1}}$	[kN]				0,7 •	$V^0_{Rk,s}$					
Characteristic resistance		$V_{\text{Rk},\text{s},\text{eq},\text{C2}}$	[kN]	NI	PA		0,7 • V ⁰ _{Rk,s}			NPA			
Partial factor	$\gamma_{\text{Ms},\text{N}}$	[-]	siehe Tabelle C2										
Steel failure	Steel failure <u>without</u> lever arm												
Charactersition	c bending resistance	$M^0_{Rk,s,eq}$	[Nm]		N	o Perfo	mance	Assess	ed (NP	A)			
Installation fa	nstallation factor		[-]				1	,0					
Factor for	without hole clearance	e α _{gap}	[-]	1,0									
anchorages	with hole clearance between fastener and fixture	nce between g					0	,5					

¹⁾ Materials and property classes according to Annex B1

Injection System VMH for concrete	
Performance Characteristic values under seismic action for threaded rods	Annex C5

Table C7: Characteristic values of **tension loads** for **internally threaded anchor rod** under static or quasi-static action

			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	M 16	VMU-IG M 20				
e, 5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123				
erty class 8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196				
	γ _{Ms,N}	[-]			1,	5						
e, stainless y class	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 ²⁾				
	γ _{Ms,N}	[-]			1,87			2,86				
d concrete failure			·									
sistance in <u>uncrack</u>	<u>ed</u> conc	rete C20/	25									
I: 80°C / 50°C	$ au_{Rk,ucr}$	[N/mm ²]	17	16	15	14	13	13				
II: 120°C / 72°C	τ _{Rk,ucr}	[N/mm ²]	14	14	13	12	12	11				
III: 160°C / 100°C	$ au_{Rk,ucr}$		11	11	10	9,5	9,0	9,0				
	concre	te C20/25										
I: 80°C / 50°C	$ au_{Rk,cr}$	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0				
II: 120°C / 72°C	$ au_{Rk,cr}$		6,5	7,0	7,5	7,0	6,0	6,0				
III: 160°C / 100°C	$ au_{Rk,cr}$	[N/mm ²]	5,5	6,0	6,5	6,0	5,5	5,5				
in concrete C20/25												
I: 80°C / 50°C	Ψ ⁰ sus	[-]			0,7	⁷ 9						
II: 120°C / 72°C	Ψ^0_{sus}	[-]			0,7	⁷ 5						
III: 160°C / 100°C	Ψ^0_{sus}	[-]			0,6	66						
		C25/30	1,02									
		C30/37	1,04									
norete))/(C35/45	1,07									
niciete	Ψο	C40/50	1,08									
		C45/55	1,09									
		C50/60	1,10									
uncracked concrete	k _{ucr,N}	[-]			11	,0						
cracked concrete	k _{cr,N}	[-]			7,	7						
h/h _{ef} ≥ 2,0					1,0	h _{ef}						
$2.0 > h/h_{ef} > 1.3$	C _{cr,sp}	[mm]		:								
h/h _{ef} ≤ 1,3					2,4	h _{ef}						
	S _{cr,sp}	[mm]	2 c _{cr,sp}									
vaccum cleaning	γ _{inst}	[-]	1,2									
manual cleaning	γ _{inst}	[-]		1,2			NPA					
compressed air	γ _{inst}				1,	0						
cleaning	γinst	[-]										
	e, stainless v class 70 d concrete failure esistance in uncrack l: $80^{\circ}\text{C} / 50^{\circ}\text{C}$ ll: $120^{\circ}\text{C} / 72^{\circ}\text{C}$ ll: $160^{\circ}\text{C} / 100^{\circ}\text{C}$ esistance in cracked l: $80^{\circ}\text{C} / 50^{\circ}\text{C}$ ll: $120^{\circ}\text{C} / 72^{\circ}\text{C}$ ll: $120^{\circ}\text{C} / 100^{\circ}\text{C}$ in concrete C20/25 l: $80^{\circ}\text{C} / 50^{\circ}\text{C}$ ll: $120^{\circ}\text{C} / 100^{\circ}\text{C}$ oncrete uncracked concrete cracked concrete $\frac{h/h_{\text{ef}} \ge 2,0}{2,0 > h/h_{\text{ef}} > 1,3}$ $\frac{h/h_{\text{ef}} \le 1,3}{h/h_{\text{ef}}} \le 1,3$ vaccum cleaning manual cleaning compressed air	rity class $\frac{1}{8.8}$ $\frac{1}{N_{Rk,s}}$ $\frac{1}{\gamma_{Ms,N}}$ e, stainless $\frac{1}{\gamma_{Class}}$ $\frac{1}{\gamma_{Cl$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	rty class	rty class	Section Se	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				

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 are valid for the internally threaded anchor rod and the fastening element

Performance

Characteristic values of **tension loads** for **internally threaded anchor rod**

²⁾ For VMU-IG M20: property class 50

Table C8: Characteristic values of **shear loads** for **internally threaded anchor rod** under static or quasi-static action

Interr	nally threaded anch	or 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		
Steel	failure without leve	er arm ¹⁾							-			
fed	Characteristic resistance	property class 5.8	$V^0_{Rk,s}$	[kN]	5	9	15	21	38	61		
Steel, zinc plated	Characteristic resistance	property class 8.8	$V^0_{ Rk,s}$	[kN]	8	14	23	34	60	98		
zi	Partial factor		$\gamma_{\text{Ms,V}}$	[-]			1,:	25				
Stainless steel	Characteristic resistance A4 / HCR	property class 70	$ m V^0_{Rk,s}$	[kN]	7	13	20	30	55	62 ²⁾		
St	Partial factor		$\gamma_{\text{Ms,V}}$	[-]			1,56			2,38		
Ductil	ity factor		k ₇	[-]			1	,0				
Steel	failure <u>with</u> lever aı	rm ¹⁾										
, ted	Characteristic bending resistance	property class 5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325		
Steel, zinc plated	Characteristic bending resistance	property class 8.8	$M^0_{\ Rk,s}$	[Nm]	12	30	60	105	267	519		
zi	Partial factor		γ _{Ms,V}	[-]			1,:	25				
Stainless steel	Characteristic bending resistance A4 / HCR	property class 70	$M^0_{Rk,s}$	[Nm]	11	26	53	92	234	643 ²⁾		
ž	Partial factor		γ _{Ms,V}	[-]			1,56			2,38		
Conc	rete pry-out failure				-							
Pry-o	ut factor		k ₈	[-]	2,0							
Conc	rete edge failure											
Effect	ive length of anchor		I _f	[mm]		mi	n (h _{ef} ;12 d _{no}	om)		min (h _{ef} ; 300mm)		
Outsid	de diameter of ancho	or	d_{nom}	[mm]	10	12	16	20	24	30		
Install	ation factor		γ_{inst}	[-]	1,0							

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: VMU-IG M20). The characteristic shear resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element

Injection System VMH for concrete
Performance Characteristic values of shear loads for internally threaded anchor rod

²⁾ For VMU-IG M20: Internally threaded rod: property class 50; Fastening screws or threaded rods (incl. nut and washer): property class 70

Partial factor	Reinforcing bar					Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 3
Cross sectional area A _B [mm²] 50 79 113 154 201 314 452 491 616 616 Combined pull read and concrete failure γMs/N [-] Total read and concrete con	Steel failure														
Partial factor γ _{Ms,N} [-] 1,42° Combined pull-out and concrete failure Characteristic bord resistance in uncracked concrete C20/25 Temperature range I: 80°C / 50°C Tr _{Rs,cor} [N/mm²] 14 14 14 14 13 <t< td=""><td>Characteristic res</td><td>istanc</td><td>е</td><td>$N_{Rk,s}$</td><td>[kN]</td><td></td><td></td><td></td><td></td><td>A_s •</td><td>$f_{uk}^{ 1)}$</td><td></td><td></td><td></td><td></td></t<>	Characteristic res	istanc	е	$N_{Rk,s}$	[kN]					A_s •	$f_{uk}^{ 1)}$				
Combined pull-out and concrete failure Characteristic bond resistance in uncracked concrete C20/25	Cross sectional a	rea		A_s	[mm²]	50	79	113	154			452	491	616	804
Characteristic bond resistance in uncracked correte C20/25 Temperature range 1: 80°C / 50°C Trak,uor (N/mm²) 14 14 14 14 13 13 13 13	Partial factor			$\gamma_{\text{Ms},N}$	[-]					1,	4 ²⁾				
Second S	•														
Temperature range II: 120°C / 72°C Textustr	Characteristic be	ond re		acked o	oncrete (220/25	5								
Tange III 160°C / 100°C TRIKLOUT [N/mm²] 9,5 9,5 9,5 9,0 9,0 9,0 9,0 9,0 8,5	Tompovotuvo	I:	80°C / 50°C			14	14	14	14	13	13	13	13	13	13
III: 160°C / 100°C Trik,ur N/mm² 9,5 9,5 9,5 9,0 9,0 9,0 9,0 9,0 9,0 9,0 8,5 S. Characteristic bond resistance in gracked concrete C20/25 II: 80°C / 50°C Trik,cr N/mm² 5,5 5,5 5,0 5,0 5,5	•	II:		$\tau_{\text{Rk},\text{ucr}}$		13	12	12	12	12	11	11	11	11	11
Temperature range 1							9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
Temperature range II: 120°C / 72°C Trik,cr [N/mm²] 4,5 5,0 5,0 5,5 5,5 5,5 5,0 6,0 6,0 III: 160°C / 100°C Trik,cr [N/mm²] 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 II: 80°C / 50°C Ψ ⁰ _{sus} [-] 0,79 III: 120°C / 72°C Ψ ⁰ _{sus} [-] 0,75 III: 160°C / 100°C Ψ ⁰ _{sus} [-] 0,66 C25/30 1,02 C30/37 1,04 C35/45 1,07 C40/50 1,10 C40/50 1,10 C40/50 1,10 C40/50 1,10 C50/60 1,10	Characteristic be	ond re		<u>ked</u> cor	crete C20)/25									
Tange Tange	Tomporaturo	<u>l:</u> _		$ au_{Rk,cr}$	[N/mm ²]	_	5,5	6,0					7,0	7,0	7,0
III: 160°C / 100°C TRIKOT [N/mm²] 4,0 4,5 4,5 5,0	•	II:		$ au_{Rk,cr}$	[N/mm ²]			-						6,0	6,0
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$					[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
$ \begin{array}{ c c c c c }\hline \text{Temperature range} & \hline \text{II:} & 120^{\circ}\text{C} \ / 72^{\circ}\text{C} \\ \hline \text{III:} & 160^{\circ}\text{C} \ / 100^{\circ}\text{C} \\ \hline \hline \text{III:} & 160^{\circ}\text{C} \ / 100^{\circ}\text{C} \\ \hline \hline \text{III:} & 160^{\circ}\text{C} \ / 100^{\circ}\text{C} \\ \hline \hline \text{III:} & 160^{\circ}\text{C} \ / 100^{\circ}\text{C} \\ \hline \hline \text{V}_{0} \\ \hline & & & & & & & & & & & & \\ \hline \hline & & & &$	Reduction factor	'Ψ ⁰ sus	in concrete C20/												
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Tamanavatuva	l:	80°C / 50°C		[-]	0,79									
III: 160°C / 100°C ψ^o_{sus} [-] 0,66		II:	120°C / 72°C			0,75									
$ \text{Increasing factor for concrete} \\ \text{Vec} \\ \hline $		III:	160°C / 100°C	$\psi^0_{ m sus}$	[-]	0,66									
$ \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$					C25/30	1,02									
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$					C30/37					1,	04				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Incressing factor	for on	acroto							1,	07				
	increasing factor	ioi coi	icrete	Ψс	C40/50					1,	80				
					C45/55					1,	09				
$Factor \ k_1 = \frac{uncracked \ concrete}{cracked \ concrete} \frac{k_{ucr,N}}{k_{cr,N}} [-] \qquad \qquad 11,0$ $7,7$ $Splitting failure$ $\frac{h/h_{ef} \geq 2,0}{2,0 > h/h_{ef} > 1,3} c_{cr,sp} [mm] \qquad \qquad 2 \cdot h_{ef} \ (2,5 - h \ / h_{ef})$ $2,4 \ h_{ef}$ $Spacing$ $Spacing \qquad \qquad s_{cr,sp} [mm] \qquad \qquad 2 \ c_{cr,sp}$ $Installation factor$ $vacuum \ cleaning \qquad \gamma_{inst} [-] \qquad \qquad 1,2$ $manual \ cleaning \qquad \gamma_{inst} [-] \qquad \qquad 1,2$ NPA					C50/60					1,	10				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Concrete cone fa	ailure													
	Eactor k	unc	racked concrete	$k_{\text{ucr},N}$	[-]	11,0									
	racior K ₁	-	cracked concrete		[-]					7	,7				
	Splitting failure														
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			h/h _{ef} ≥ 2,0							1,0	h _{ef}				
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	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 c	cr,sp				
dry or wet concrete manual cleaning γ_{inst} [-] 1,2 NPA	Installation facto	r			•										
			vacuum cleaning	γ _{inst}	[-]					1.	,2				
	dry or wet concre	te _	manual cleaning					1,2					NPA		
compressed air γ_{inst} [-] 1,0			compressed air	γ̃inst	[-]					1	,0				
waterfilled drill hole cleaning $\gamma_{\rm inst}$ [-] 1,4	waterfilled drill ho	le								1	,4				
f _{uk} shall be taken from the specifications of reinforcing bars in absence of national regulation	f _{uk} shall be taken fro	m the s	specifications of reinfo												

Performance

Characteristic values of **tension loads** for **rebar**

Table C10: Characteristic values of shear loads for rebar under static or quasi-static action

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever arm												
Characteristic shear resistance	$V^0_{ \text{Rk},s}$	[kN]					0,50 • /	A _s • f _{uk} 1)				
Cross sectional area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γ _{Ms,V}	[-]					1,	ō 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	γ _{Ms,V}	[-]					1,	5 ²⁾				
Concrete pry-out failure												
Pry-out Factor	k ₈	[-]					2	,0				
Concrete edge failure												
Effective length of rebar	I_{f}	[mm]			min	(h _{ef} ;12	d _{nom})			min ((h _{ef} ; 300)mm)
Outside diameter of rebar	d_{nom}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation factor	γ _{inst}	[-]					1	,0				

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

Table C11: Characteristic values of tension loads for rebar under seismic action. performance category C1

Reinforcing bar					Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure														
Characteristic resi	istan	ce N	I _{Rk,s,eq,C1}	[kN]	$A_s \cdot f_{uk}^{1)}$									
Cross sectional ar	ea		A_s	[mm²]									804	
Partial factor	[-]					1,4	4 ²⁾							
Combined pull-o														
Characteristic bo	ond r	esistance in con	crete C2	0/25										
	I:	80°C / 50°C	τ _{Rk,eq,C1}	[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Temperature range	II:	120°C / 72°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	$\frac{\text{III:} 160^{\circ}\text{C} / 100^{\circ}\text{C}}{\text{III:} 160^{\circ}\text{C} / 100^{\circ}\text{C}} \tau_{\text{Rk,eq}}$					4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Installation facto														
dry or wet concret	[-]	1,2												
compressed air γ _{inst} [-]					1,0									
waterfilled drill hole cleaning γ_{inst} [-]						1,4								

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

Characteristic values of shear loads for rebar under seismic action, Table C12: performance category C1

Reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever				•								
Characteristic resistance	[kN]	0,35 • A _s • f _{uk} ¹⁾										
Cross sectional area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γ̃Ms,V	[-]		•			1,	5 ²⁾				
Ductility factor	k ₇	[-]					1	,0				
Steel failure with lever arm	n	·										
Characteristic bending resistance	[Nm]	No Performance Assessd (NPA)										
Installation factor γ_{inst} [-]							1	,0	•	•		

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

Injection System VMH for concrete	
Performance Characteristic values under seismic action for rebar	Annex C10

 Table C13: Displacements under tension load (threaded rod)

Threaded rod			М8	M10	M12	M16	M20	M24	M27	M30
Displacement factor ¹) for uncrac	ked concrete	under st	atic and	quasi-sta	atic actio	n			
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
II: 120°C / 72°C	$\delta_{N\infty}\text{-factor}$	[mm/(N/mm²)]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range	$\delta_{\text{No}}\text{-factor}$	[mm/(N/mm²)]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Displacement factor ¹) for cracke	d concrete un	der statio	c and qu	asi-statio	action				
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
I: 80°C / 50°C	$\delta_{N\infty}\text{-factor}$	[mm/(N/mm²)]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range	δ_{No} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
II: 120°C / 72°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range	$\delta_{\text{N0}}\text{-factor}$	[mm/(N/mm²)]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
Cracked concrete un	der seismic	action (C2)								
All temperature	$\delta_{\text{N,eq (DLS)}}$	[mm]	NII	PA	0,24	0,27	0,29	0,27	Ni	٥٨
ranges	$\delta_{\text{N,eq (ULS)}}$	[mm]	INI		0,55	0,51	0,50	0,58	INI	^

¹⁾ Calculation of the displacement

 $\delta_{\text{N0}} = \delta_{\text{N0}}\text{- factor } \cdot \tau;$

τ: acting bond stress for tension

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

Table C14: Displacements under shear load (threaded rod)

Threaded rod			М 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Displacement factor	or ¹⁾ for concre	te under statio	and qua	asi-statio	action					
All temperature	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03		
ranges	-		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Cracked concrete under seismic action (C2)		action (C2)								
All temperature	$\delta_{\text{V,eq(DLS)}}$	[mm]	, NI	ο Λ	3,6	3,0	3,1	3,5	NF	ο Λ
ranges	$\delta_{ m V,eq(ULS)}$	[mm]	NPA		7,0	6,6	7,0	9,3	INI	-4

¹⁾Calculation of the displacement

 $\delta_{V0} = \delta_{V0}$ -factor · V;

V: acting shear load

 $\delta_{V_{\infty}} = \delta_{V_{\infty}}$ -factor · V;

Injection System VMH for concrete

Performance

Displacements (threaded rod)

Table C15: Displacements under tension load (internally threaded anchor rod)

Internally threaded and	hor 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⁾ f	or uncrack	ed concrete un	der static	and quasi-	static action	on		
Temperature range I:	$\delta_{\text{N0}}\text{-}\text{factor}$	[mm/(N/mm²)]	0,032	0,034	0,037	0,039	0,042	0,046
80°C / 50°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,042	0,044	0,047	0,051	0,054	0,060
Temperature range II:	δ_{N0} -factor	[mm/(N/mm²)]	0,034	0,035	0,038	0,041	0,044	0,048
120°C / 72°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range III:	δ_{N0} -factor	[mm/(N/mm²)]	0,126	0,131	0,142	0,153	0,163	0,179
160°C / 100°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor ¹⁾ f	or cracked	concrete unde	r static an	d quasi-sta	atic action			
Temperature range I:	δ_{N0} -factor	[mm/(N/mm²)]	0,083	0,085	0,090	0,095	0,099	0,106
80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,107	0,110	0,116	0,122	0,128	0,137
Temperature range II:	δ_{N0} -factor	[mm/(N/mm²)]	0,086	0,088	0,093	0,098	0,103	0,110
120°C / 72°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range III:	δ_{N0} -factor	[mm/(N/mm²)]	0,321	0,330	0,349	0,367	0,385	0,412
160°C / 100°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,330	0,340	0,358	0,377	0,396	0,424

¹⁾ Calculation of the displacement

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

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

Table C16: Displacements under shear load (internally threaded anchor rod)

Internally threaded and	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⁾ u	nder static a	nd quasi-sta	tic action					
All to propose the result of	δ_{V0} -factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04
All temperature ranges	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,10	0,09	0,08	0,08	0,06	0,06

¹⁾ Calculation of the displacement

 $\delta_{V0} = \delta_{V0} \text{-factor } \cdot V; \qquad \qquad V\text{: acting shear load}$

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

Injection System VMH for concrete

Performance

Displacements (internally threaded anchor rod)

Table C17: 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⁾ for uncre	cked concret	e unde	r static	and qu	ıasi-sta	itic acti	ion				
Temperature range	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
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range	δ_{No} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
II: 120°C / 72°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Displacement factor	1) for crack	ed concrete u	ınder s	tatic ar	ıd quas	i-static	action					
Temperature range	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
I: 80°C / 50°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm²)]	0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range	δ_{No} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
II: 120°C / 72°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range	δ_{No} -factor	[mm/(N/mm²)]	0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	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 $\delta_{N1} = \delta_{N1}$ - factor $\cdot \tau$:

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

Table C18: Displacements under shear load (rebar)

Rebar				Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor ¹⁾ under static and quasi-				ction								
All temperature	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
ranges	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

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

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

Injection System VMH for concrete

Performance

Displacements (rebar)

Specification of intended use

Injection S	ystem VMH	Threaded rod	Internally threaded anchor rod	Rebar			
Static or quasi-static action		M8 - M30 zinc plated, A2, A4, HCR	VMU-IG M6 - VMU-IG M20 zinc plated ¹⁾ , A4, HCR	Ø8 - Ø32			
Seismic	performance category C1	M8 - M30 zinc plated ¹⁾ , A4, HCR	-	Ø8 - Ø32			
action	performance category C2	M12 – M24 zinc plated¹¹ (property class 8.8) A4, HCR (poperty class ≥ 70)	-	-			
		compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013					
Base materia	lls	strength classes acc	to EN 206:2013: C20/25	to C50/60			
		cracked or uncracked concrete					
Temperature	Range I -40 °C to +80 °C	max. long term temperature +50 °C and max. short term temperature +80 °C					
Temperature	Range II -40 °C to +120 °C	max. long term temperature +72 °C and max. short term temperature +120 °C					
Temperature	Range III -40 °C to $+160$ °C	max. long term temperature +10	0 °C and max. short term t	emperature +160 °C			

¹⁾ except hot-dip galvanised

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes:
 - Stainless steel A2 according to Annex A4, Table A1: CRC II.
- Stainless steel A4 according to Annex A4, Table A1: CRC III
- High corrosion resistant steel HCR according 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 or Technical Report TR 055

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
- 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	Annex B1

Table B1: Installation parameters for threaded rods

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Diameter of thread	ded rod	$d=d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole	diameter	d _o	[mm]	10	12	14	18	22	28	30	35
Effective anchorage	an donth	$h_{\rm ef,min}$	[mm]	60	60	70	80	90	96	108	120
Ellective anchoraç	је аерт	h _{ef,max}	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in	Pre-setting installation		[mm]	9	12	14	18	22	26	30	33
the fixture ²⁾	Through setting installation	d _f ≤	[mm]	12	14	16	20	24	30	33	40
Installation torque		T _{inst} ≤	[Nm]	10	20	40 (35) ¹⁾	60	100	170	250	300
Minimum thicknes	s of member	h _{min}	[mm]	_	_i + 30 m : 100 mr				h _{ef} + 2d ₀	1	
Minimum spacing		Smin	[mm]	40	50	60	75	95	115	125	140
Minimum edge dis	tance	C _{min}	[mm]	35	40	45	50	60	65	75	80

¹⁾ Installation torque for M12 with steel grade 4.6

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 —	$h_{\text{ef},\text{min}}$	[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
Installation torque	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 h _{min} [mm]			30 mm) mm		h _{et} +	· 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 acc. to EN 1993-1-8:2005+AC:2009

Table B3: Installation parameters for rebar

Rebar			Ø8	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 _o	[mm]	10 12	12 14	14 16	18	20	25	32	32	35	40
Effective anchorage depth -	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128
Enective anchorage depth -	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h _{min}	[mm]		30 mm 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 \varnothing 8. \varnothing 10 and \varnothing 12 both nominal drill hole diameter can be used

Intended use

Installation parameters

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 B4: Parameter cleaning and setting tools

Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
		(77777777777		d _b AMM	Manananana
[-]	[-]	Ø [mm]	d₀ [mm]	d ь [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			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

Table B5: Retaining washer

Drill bit Ø		Installa	tion direc	tion and
d₀ [mm]	[-]	1	→	1
10			i.	
12			lo y washer	
14			uired	
16		7.040		
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

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



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): ≤ 10 d_{nom} for uncracked concrete

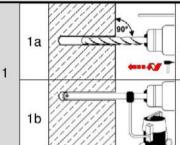
Injection System VMH for concrete

Intended Use

Cleaning and setting tools

Installation Instructions

Drilling of the hole



Hammer drill oder 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 <u>step 2</u>. In case of aborted drill hole, the drill hole shall be filled with mortar.

Vacuum drill bit: see Annex B3

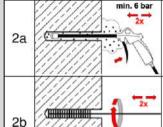
Drill hole into the base material to the embedment size and embedment depth required by the selected anchor (table B1, B2 or B3). This drilling system removes dust and cleans the drill hole during drilling. Continue with step 3. In case of aborted hole, the drill hole shall be filled with mortar.

Cleaning (not applicable when using a vacuum drill)

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

Cleaning with compressed air

all subtrates and diameters according to Annex B1

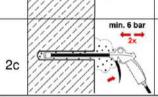


Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust.

If the drill hole ground is not reached, an extension must be used.

Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (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.

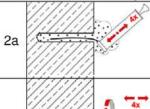


Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust.

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 d₀ ≤ 20mm and drill hole depth h₀ ≤ 10 dnom



Starting from the bottom or back of the drill hole, blow out the hole with the blowout pump a minimum of **four** times.

2b

Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (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.

Starting from the bottom or back of the drill hole blow out the hole again a minimum of **four** times.

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. In-flowing water must not contaminate the drill hole again.

Injection System VMH for concrete

Intended Use Installation instructions

Installation instructions (continuation)

Inje	ection	
3	Mark 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	hef	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 hef > 250mm • Overhead installation: Drill bit-Ø d₀ ≥ 18 mm

Injection System VMH for concrete

Installation instructions (continuation)

Ins	erting the anchor	
7	65	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	X	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	T _{inst}	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

Concrete temperature	Mayking 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	Annex B6

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

Thread	ed rod			М8	M10	M12	M16	M20	M24	M27	M30
Steel fa	ailure				<u>'</u>		<u>'</u>	'			
Cross s	sectional area	As	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Charac	teristic resistance under tension load ¹⁾						-				
9	Property class 4.6 and 4.8	N _{Rk.\$}	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Steel, Stainless steel zinc plated by Ed. A. D.	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280
zìr	Property class 8.8	N _{Rk.s}	[kN]	29 (27)	46 (43)	67	125	196	282	368	449
iteel	A2, A4 and HCR Property class 50	N _{Rk.s}	[kN]	18	29	42	79	123	177	230	281
ainless s	A2, A4 and HCR Property class 70	$N_{Rk,\mathbf{s}}$	[kN]	26	41	59	110	171	247	-	-
Property class 80		$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-
Partial	factor ²⁾										
	Property class 4.6	∛Ms.N	_{AS.N} [-] 2,0								
p eg	Property class 4.8	Yms,N	[-]				1	,5			
Steel,	Property class 5.6	∛Ms.N	[-]				2	,0			
Zir	Property class 5.8	∛Ms.N	[-]				1	,5			
Property class	Property class 8.8	γ̃Ms.N	[-]				1	,5			
	A2, A4 and HCR Property class 50	γ̃Ms.N	[-]				2,	86			
Stainless steel	A2, A4 and HCR Property class 70	ŶMs _. N	[-]			1,	87			-	-
Stail	A4 and HCR Property class 80	YMs.N	[-]			1	,6			-	-

The characteristic resistances apply for all anchor rods with the cross sectional area. As 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.

lr	njection	System	VMH for	concrete

²⁾ In absence of other national regulations

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

Threade	d rod			М 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel fai	lure										
Cross se	ectional area	As	[mm²]	36,5	58,0	84,3	157	245	353	459	561
Characte	eristic resistances under shear load ¹⁾				•						
Steel fai	lure <u>without</u> lever arm										
Property class 4.6 and 4.8 Property class 5.6 and 5.8 Property class 8.8 A2 A4 and HCR property class 50	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
) Zin	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	$V^0_{\text{Rk},s}$	[kN]	9	15	21	39	61	88	115	140
Stainless steel	A2, A4 and HCR, property class 70	$V^0_{\rm Rk,s}$	[kN]	13	20	30	55	86	124	-	-
Sts	A4 and HCR, property class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-	-
Steel fai	lure <u>with</u> lever arm			•		ı				•	
pe	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	1123
Sizinc	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	1125
Stainless steel	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
St	A4 and HCR, property class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-	-
Partial fa	actor ²⁾										
	Property class 4.6	γ _{Ms,V}	[-]				1,	67			
I, ited	Property class 4.8	γ _{Ms,V}	[-]				1,	25			
teel pla	Property class 4.8 Property class 5.6 Property class 5.8		[-]				1,	67			
S zinc			[-]				1,	25			
	Property class 8.8	γ _{Ms} ν	[-]				1,	25			
SS	A2, A4 and HCR, property class 50	γ _{Ms} v	[-]				2,	38			
Stainless steel	A2, A4 and HCR, property class 70	γ̃Ms,∀	[-]			1	,56			-	-
j Š	A4 and HCR, property class 80	γ _{Ms} ν	[-]			1	,33			-	-

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

Injection System	VMH for	concrete
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Performance

Characteristic values for threaded rods under shear loads

Table C3: Characteristic values of **tension loads** for **threaded rods** under static or quasi-static action

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Characteristic resistance	е	$N_{Rk,s}$	[kN]			(A _s or see T	• f _{uk} 「able C	1		
Partial factor		γ̃Ms,N	[-]				see Ta	able C1			
Combined pull-out and	d concrete failure										
Characteristic bond re	sistance in <u>uncrack</u>	<u>ed</u> cond	rete C20)/25							
Temperature range I:	80°C / 50°C	$\tau_{\text{Rk},\text{ucr}}$	[N/mm²]	17	17	16	15	14	13	13	13
Temperature range II:	120°C / 72°C	τ _{Rk,ucr}	[N/mm²]	15	14	14	13	12	12	11	11
Temperature range III:	160°C / 100°C	$ au_{Rk,ucr}$	[N/mm²]	12	11	11	10	9,5	9,0	9,0	9,0
Characteristic bond re	sistance in <u>cracked</u>	concre	te C20/2	5	•			'			
Temperature range I:	80°C / 50°C	$\tau_{\text{Rk,cr}}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
Temperature range II:	120°C / 72°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
Temperature range III:	160°C / 100°C	$\tau_{Rk,cr}$	[N/mm²]	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:	80°C / 50°C	ψ^0_{sus}	[-]				0,	79			
Temperature range II:	120°C / 72°C	ψ ⁰ sus	[-]				0,	75			
Temperature range III:	160°C / 100°C	$\psi^0_{ m sus}$	[-]				0,	66			
			C25/30 C30/37 C35/45				1,	02 04			
Increasing factors for co	ncrete	Ψο	C40/50				1,	07 08			
			C45/55 C50/60					09			
Concrete cone failure			C50/60				١,	10			
Concrete cone ianure	uncracked concrete	k _{ucr,N}	[-]				11	1,0			
Factor k ₁	cracked concrete	k _{cr,N}						,7			
Splitting failure		31,11									
-	h/h _{ef} ≥ 2,0						1,0	h _{ef}			
Edge distance	2,0> h/h _{ef} > 1,3	$C_{cr,sp}$	[mm]			2		5 – h / h	n _{ef})		
	h/h _{ef} ≤ 1,3						2,4	h _{ef}			
Spacing		S _{cr,sp}	[mm]				2 0	cr,sp			
Installation factor											
	Vacuum cleanii	ng γ _{inst}	[-]	1,2							
dry or wet concrete	Manual cleanii	ng γ _{inst}	[-]		1	,2			NF	PA	
	Compressed a		[-]					,0			
water filled drill hole	cleanir	ng γ _{inst}	[-]				1	,4			

Injection System	VMH for concrete
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Performance

Characteristic values of tension loads for threaded rods

Table C4: Characteristic values of **shear loads** for **threaded rods** under static or quasi-static action

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure without lever arm										
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V^0_{ {\sf Rk}, {\sf s}}$	[kN]					A _s • f _{uk} Table C2			
Characteristic resistance Steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR	V ⁰ _{Rk.s}	[kN]					A₅ • f _{uk} Table C2			
Ductility factor	k_7	[-]				1	,0			
Partial factor	$\gamma_{\text{Ms,V}}$	[-]				see Ta	able C2			
Steel failure with lever arm										
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]					V _{el} ∙ f _{uk} Γable C2			
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	γMs,V	[-]				see Ta	able C2			
Concrete pry-out failure										
Pry-out factor	k_8	[-]				2	,0			
Concrete edge failure										
Effective length of anchor	I _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	Yinst	[-]				1	,0			

Injection System VMH for concrete	
Performance Characteristic values of shear loads for threaded rods	Annex C4

Table C5: Characteristic values of tesion loads for threaded rods under seismic action, performance category C1 + C2 1)

Threaded roo	Ł					М8	M10	M12	M16	M20	M24	M27	M30		
Steel failure										<u>'</u>					
Characteristic	roois	tonoo	$N_{Rk,s,e}$	q,C1	[kN]				1,0 •	$N_{Rk,s}$					
Characteristic	aracteristic resistance rtial factor mbined pull-out and concrete failure aracteristic bond resistance 80°C / 50°C mperatur- nge II: 120°C / 72°C III: 160°C / 100°C rtallation factor mpressed air dry or wet co	$N_{Rk,s,e}$	q,C2	[kN]	N	PA		1,0 •	$N_{Rk,s}$		NF	PA			
Partial factor			γι	Ms,N	[-]	siehe Tabelle C1									
Combined pu	ıll-ou	t and concrete failure	•												
Characteristi	c bor	nd resistance													
l: 80°C :		90°C / 50°C	τ _{Rk.e}	o C1	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0		
	١.	00 07 00 0	τ _{Rk.e}	c C2	[N/mm²]	NI	PA	3,6	3,5	3,3	2,3	Ni	PA		
Temperatur-	114	120°C / 72°C	τ _{Rk.e}	o C1	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0		
range	111.		τ _{Rk,eq,C2}		[N/mm²]	NI	PA	3,1	3,0	2,8	2,0	N	PA		
	111.	160°C / 100°C	$ au_{Rk,e}$	q,C1	[N/mm²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5		
	1111	160°C / 100°C	$\tau_{Rk,e}$	q,C2	[N/mm²]	NPA		2,5	2,7	2,5	1,8	1,8 NF			
Installation fa															
Compressed air dry or we		dry or wet co			r 1				1	,0					
cleaning	water filled dri	ill hole	Yinst	[-]				1	,4						
Vacuum clear	ning	dry or wet co	ncrete	Yinsi	[-]				1	,2					

¹⁾ Materials and property classes according to Annex B1

Table C6: Characteristic values of **tesion loads** for **threaded rods** under **seismic action**, performance category **C1 + C2** 1)

Threaded ro	d			М8	M10	M12	M16	M20	M24	M27	M30
Steel failure	without lever arm										
Characteristic	o registance —	$V_{Rk,s,eq,C1}$ [kN] 0,7									
Characteristi		$V_{\text{Rk},\text{s},\text{eq},\text{C2}}$	[kN]	NPA 0,7 • V ⁰ _{Rk,s}						NF	PA
Partial factor		$\gamma_{\text{Ms},\text{N}}$	[-]	siehe Tabelle C2							
Steel failure	without lever arm										
Charactersiti	c bending resistance	M ⁰ _{Rk,s.eq}	[Nm]		N	o Perfo	mance	Assess	ed (NP	A)	
Installation fa	Installation factor		[-]				1	0,			
Factor for	without hole clearance	e α _{gaρ}	[-]				1	,0			
anchorages	with hole clearance between fastener and fixture	Ι α	[-]	0,5							

¹⁾ Materials and property classes according to Annex B1

Injection System VMH for concrete	
Performance Characteristic values under seismic action for threaded rods	Annex C5

Table C7: Characteristic values of **tension loads** for **internally threaded anchor rod** under static or quasi-static action

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
Steel failure 1)										
Characteristic resistan	ce,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123
steel, zinc plated, prop	c resistance, atted, property class c resistance, stainless CR, property class c resistance in uncracket concrete cracked			[kN]	16	27	46	67	121	196
Partial factor	teristic resistance, nc plated, property class actor teristic resistance, stainless defended pull-out and concrete failuteristic bond resistance in understance in understance in crass actor teristic bond resistance in understance in crass actor teristic bond resistance to concrete teristic bond resistance to concrete teristic bond resistance to concrete teristic bond resistance teristic bond resistance to concrete teristic bond resistance to concrete teristic bond resistance to concrete teristic bond resistance teristic bond resistance to concrete teristic bond resistance teristic bond resistan		γ _{Ms,N}	[-]			1,	5		
	,	/(1)	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 ²⁾
Partial factor			$\gamma_{Ms,N}$	[-]			1,87			2,86
Combined pull-out ar	nd con	crete failure								
Characteristic bond r	esista	nce in <u>uncrack</u>	<u>ed</u> cond	rete C20/	25					
	<u>l:</u>	80°C / 50°C	$\tau_{\mathbf{Rk},ucr}$	[N/mm²]	17	16	15	14	13	13
Temperature range	II:	120°C / 72°C	τ _{Rk,ucr}	[N/mm²]	14	14	13	12	12	11
	10:	160°C / 100°C	τ _{Rk,ucr}	[N/mm ²]	11	11	10	9,5	9,0	9,0
Characteristic bond r	esista	nce in <u>cracked</u>	concre	te C20/25						
	l:	80°C / 50°C	τ _{Rk.cr}	[N/mm²]	7,5	8,0	9,0	8,5	7,0	7,0
Temperature range	II:	120°C / 72°C	τ _{Rk cr}	[N/mm²]	6,5	7,0	7,5	7,0	6,0	6,0
	III:	160°C / 100°C	τ _{Rk cr}	[N/mm²]	5,5	6,0	6,5	6,0	5,5	5,5
Reduction factor ψ ⁰ su	_s in co	ncrete C20/25								
	l:	80°C / 50°C	$\psi^{0}_{ m sus}$	[-]			0,7	79		
Temperature range	II:	120°C / 72°C	ψ ⁰ sus	[-]			0,7	75		
	III:	160°C / 100°C	ψ^0_{sus}	[-]			0,€	36		
				C25/30			1,()2		
				C30/37			1,0)4		
Increasing factors for o	concret)16	C35/45			1,0)7		
mercasing factors for e	0110101		Ψc	C40/50			1,0	08		
				C45/55			1,0)9		
				C50/60			1,1	10		
Concrete cone failure										
Factor k ₁ -	uncr	acked concrete	k _{ucr,N}	[-]			11	·		
	cr	acked concrete	$k_{cr,N}$	[-]			7,	7		
Splitting failure										
_		h/h _{ef} ≥ 2,0					1,0			
Edge distance		$2.0 > h/h_{el} > 1.3$	C _{cr.sp}	[mm]			2 • h _{ef} (2,5			
		h/h _{ef} ≤ 1,3					2,4	_		
Spacing			S _{cr.sp}	[mm]			2 c	or,sp		
Installation factor										
_	Vä	accum cleaning	γ _{inst}	[-]			1,	2		
dry or wet concrete	<u>n</u>	nanual cleaning	Yınst	[-]		1,2			NPA	
_		compressed air	Yinst	[-]			1,	0		
waterfilled drill hole	,	cleaning	γ̈́ınst	[-]			1,	2		

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 are valid for the internally threaded anchor rod and the fastening element

Performance

Characteristic values of tension loads for internally threaded anchor rod

²⁾ For VMU-IG M20: property class 50

Table C8: Characteristic values of **shear loads** for **internally threaded anchor rod** under static or quasi-static action

Intern	nally threaded anchor i	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			
Steel	failure without lever a	rm ¹⁾											
pel	Characteristic pr resistance cla	operty ass 5.8	V ⁰ _{Rk,s}	[kN]	5	9	15	21	38	61			
Steel, zinc plated		operty ass 8.8	V ⁰ _{Rk,s}	[kN]	8	14	23	34	60	98			
zi	Partial factor		γ _{Ms,V}	[-]			1,:	25					
Stainless steel	Characteristic presistance cla	operty ass 70	V ⁰ Rk,s	[kN]	7	13	20	30	55	62 ²⁾			
1S	Partial factor	γ _{Ms,V}	[-]			1,56			2,38				
Ductil	ity factor		k ₇	[-]			1,	,0					
Steel	steel failure with lever arm1)												
, ted	Characteristic pr bending resistance cla	operty ass 5.8	M ⁰ _{Rk,s}	[Nm]	8	19	37	66	167	325			
Steel, zinc plated	Characteristic pr bending resistance cla	operty ass 8.8	M ⁰ _{Rk.s}	[Nm]	12	30	60	105	267	519			
įΖ	Partial factor		γ̃Ms,V	[-]		1,25							
Stainless steel		roperty ass 70	M ^o _{Rk,s}	[Nm]	11	26	53	92	234	643 ²⁾			
Sta	Partial factor		γ _{Ms,V}	[-]			1,56			2,38			
Conc	rete pry-out failure												
Pry-o	ut factor		k ₈	[-]			2,	,0					
Conc	rete edge failure												
Effect	ive length of anchor		I _f	[mm]		mi	n (h _{ef} ;12 d _{no}	om)		min (h _{ef} ; 300mm)			
Outsid	de diameter of anchor		d _{nom}	[mm]	10	12	16	20	24	30			
Install	ation factor		γ _{inst}	[-]	1,0								

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: VMU-IG M20). The characteristic shear resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element

Injection System VMH for concrete
Performance Characteristic values of shear loads for internally threaded anchor rod

²⁾ For VMU-IG M20: Internally threaded rod: property class 50; Fastening screws or threaded rods (incl. nut and washer); property class 70

Reinforcing bar					Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure														
Characteristic res	istanc	е	$N_{Rk,s}$	[kN]					A_s •	$f_{uk}^{ 1)}$				
Cross sectional a	rea		A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			$\gamma_{\text{Ms},\text{N}}$	[-]					1,	4 ²⁾				
Combined pull-o	ut an	d concrete failur	е											
Characteristic be	ond re	esistance in <u>uncr</u>	acked o	oncrete (220/25	5								
Tamparatura	l:	80°C / 50°C	$\tau_{\text{Rk},\text{ucr}}$		14	14	14	14	13	13	13	13	13	13
Temperature range	II:	120°C / 72°C	$\tau_{\text{Rk},\text{ucr}}$	[N/mm ²]	13	12	12	12	12	11	11	11	11	11
	HI:	160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
Characteristic be	ond re	esistance in <u>crac</u>	<u>ked</u> cor	crete C20	1/25									
Temperature	1:_	80°C / 50°C	$\tau_{Rk,cr}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
range	II:	120°C / 72°C	$\tau_{Rk,\mathrm{cr}}$	· ·	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	111:	160°C / 100°C	$\tau_{\mathrm{Rk,cr}}$	[N/mm²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Reduction factor														
Tamanaratura	[-]					0,	79							
Temperature range	II:	120°C / 72°C	$\psi^0_{{ m sus}}$	[-]					0,	75				
	III:	160°C / 100°C	ψ^0_{sus}	[-]					0,	66				
				C25/30	1,02									
				C30/37					1,	04				
Increasing factor	for co	acroto		C35/45					1,5	07				
increasing factor	ioi coi	iciete	Ψε	C40/50					1,	80				
				C45/55	1,09									
				C50/60					1,	10				
Concrete cone fa	ailure													
Factor k ₁	unc	racked concrete	k _{ucr,N}	[-]					11	,0				
Tactor K ₁	(cracked concrete	$k_{\text{cr},N}$	[-]					7	,7				
Splitting failure														
		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 c	cr,sp				
Installation facto														
vacuum cleaning				[-]					1	,2				
dry or wet concre	te _	manual cleaning	γ_{inst}	[-]	1,2 NPA									
		compressed air	γ _{inst}	[-]					1	,0				
waterfilled drill ho	le	cleaning	γ _{inst}	[-]					1	,4				
f _{uk} shall be taken fro in absence of nation	m the s	specifications of reinfo	.	'S										

Performance

Characteristic values of tension loads for rebar

Table C10: Characteristic values of shear loads for rebar under static or quasi-static action

Reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever arm												
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]					0,50 • /	A _s • f _{uk} 1)				
Cross sectional area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γ̃Ms,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	γ _{Ms,V}	[-]					1,	5 ²⁾				
Concrete pry-out failure												
Pry-out Factor	k ₈	[-]					2	,0				
Concrete edge failure												
Effective length of rebar	I _f	[mm]	m] 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				

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

Characteristic values of shear loads for rebar

Table C11: Characteristic values of tension loads for rebar under seismic action, performance category C1

Reinforcing bar					Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 2 5	Ø 28	Ø 32
Steel failure														
Characteristic resi	istan	ce N	I _{Rk,s,eq,C1}	[kN]	$A_s \cdot f_{uk}^{(1)}$									
Cross sectional ar	ea		A_s	[mm²]									804	
Partial factor	[-]					1,4	4 ²⁾							
Combined pull-o	ut ar	nd concrete failur												
Characteristic bo	ond r	esistance in con	crete C2	0/25										
	I:	80°C / 50°C	τ _{Rk,eq,C1}	[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Temperature range	II:	120°C / 72°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	III:	160°C / 100°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Installation facto	r													
dry or wat concret	[-]					1,	2							
dry or wet concrete compressed air		γinst	[-]	1,0										
waterfilled drill hole cleaning γ_{inst} [-]					1,4									

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

Table C12: Characteristic values of shear loads for rebar under seismic action, performance category C1

				_								
Reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever	arm				•							
Characteristic resistance	$V^0_{\text{Rk},s,\text{eq},\text{C1}}$	[kN]					0,35 • 1	$A_s \cdot f_{uk}^{1}$				
Cross sectional area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γ _{Ms,V}	[-]					1,	5 ²⁾				
Ductility factor	k_7	[-]					1	,0				
Steel failure with lever arn	n											
Characteristic bending resistance	M ⁰ Rk.s eq.C1	[Nm]	n] No Performance Assessd (NPA)									
Installation factor	γ _{inst}	i _{nst} [-] 1,0										

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

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Performance Characteristic values under seismic action for rebar	Annex C10

Table C13: Displacements under tension load (threaded rod)

Threaded rod				M10	M12	M16	M20	M24	M27	M30
Displacement factor) for uncrac	ked concrete	under st	atic and	quasi-st	atic actio	n			
Temperature range	δ_{N0} -factor	[mm/(N/mm ²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range	δ _{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
II: 120°C / 72°C	$\delta_{N \infty}\text{-factor}$	[mm/(N/mm²)]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range	δ_{No} -factor	[mm/(N/mm²)]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Displacement factor	or cracke	d concrete und	der statio	c and qu	asi-statio	action				
Temperature range	$\delta_{\text{No}}\text{-factor}$	[mm/(N/mm²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
II: 120°C / 72°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
Cracked concrete under seismic action (C2)		action (C2)								
All temperature	$\delta_{\text{N,eq (DLS)}}$	[mm]	NIC.	PA	0,24	0,27	0,29	0,27	l kit	PA
ranges	$\delta_{\text{N.eq (ULS)}}$	[mm]	INI		0,55	0,51	0,50	0,58	INI	

¹⁾ Calculation of the displacement

 $\delta_{\text{NO}} = \delta_{\text{NO}^-} \text{ factor } \cdot \tau;$

τ: acting bond stress for tension

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

Table C14: Displacements under shear load (threaded rod)

Threaded rod			М 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Displacement factor	¹⁾ for concre	te under statio	and qua	asi-statio	action					
All temperature	$\delta_{\text{Vo}}\text{-Faktor}$	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
ranges	$\delta_{V\infty}$ -Faktor	[mm/(kN)]	0,09	0,08	0,08	0,06	 	0,05		
Cracked concrete u	nder seismic	action (C2)								
All temperature	$\delta_{\text{V,eq(DLS)}}$	[mm]	NIC.	٥٨	3,6	3,0	3,1	3,5	NE	٥٨
ranges	$\delta_{\text{V,eq(ULS)}}$	[mm]	- NPA		7,0	6,6	7,0	9,3	INI	- A

¹⁾Calculation of the displacement

 $\delta_{V0} = \delta_{V0}$ -factor · V;

V: acting shear load

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

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Displacements (threaded rod)

Table C15: Displacements under tension load (internally threaded anchor rod)

Internally threaded and	hor 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⁾ f	or uncrack	ed concrete un	der static	and quasi-	static actio	on		
Temperature range I:	δ_{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,037	0,039	0,042	0,046
80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,042	0,044	0,047	0,051	0,054	0,060
Temperature range II:	δ_{N0} -factor	[mm/(N/mm²)]	0,034	0,035	0,038	0,041	0,044	0,048
120°C / 72°C	δ _{ν∞} -factor	[mm/(N/mm²)]	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range III:	δ _{N0} -factor	[mm/(N/mm²)]	0,126	0,131	0,142	0,153	0,163	0,179
160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor ¹⁾ f	or cracked	concrete unde	r static an	d quasi-sta	tic action			
Temperature range I:	$\delta_{\text{N0}}\text{-factor}$	[mm/(N/mm²)]	0,083	0,085	0,090	0,095	0,099	0,106
80°C / 50°C	$\delta_{\mbox{\tiny N_{∞}}}\mbox{-} \mbox{factor}$	[mm/(N/mm²)]	0,107	0,110	0,116	0,122	0,128	0,137
Temperature range II:	δ _{N0} -factor	[mm/(N/mm²)]	0,086	0,088	0,093	0,098	0,103	0,110
120°C / 72°C	δ _{ν∞} -factor	[mm/(N/mm²)]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range III:	δ _{N0} -factor	[mm/(N/mm²)]	0,321	0,330	0,349	0,367	0,385	0,412
60°C / 100°C	δ _{ν∞} -factor	[mm/(N/mm²)]	0,330	0,340	0,358	0,377	0,396	0,424

¹⁾ Calculation of the displacement

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

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

Table C16: Displacements under shear load (internally threaded anchor rod)

Internally threaded and	hor 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⁾ under static and quasi-static action												
All to proper sections are proper	δ _{vo} -factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04				
All temperature ranges	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,10	0,09	0,08	0,08	0,06	0,06				

¹⁾ Calculation of the displacement

 $\delta_{V0} = \delta_{V0} \text{-factor } \cdot V; \qquad \qquad V: \text{acting shear load}$

 $\delta_{V_{oc}} = \delta_{V_{oc}}$ -factor $\cdot V$;

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Displacements (internally threaded anchor rod)

Table C17: 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⁾ for uncra	cked concret	e unde	r static	and qu	ıasi-sta	tic act	ion				
Temperature range	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
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range	δ _{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
II: 120°C / 72°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
III: 160°C / 100°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Displacement factor	¹⁾ for crack	ed concrete u	ınder s	tatic ar	d quas	i-statio	action					
Temperature range	$\delta_{\text{N0}}\text{-factor}$	[mm/(N/mm²)]	0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,108
I: 80°C / 50°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
II: 120°C / 72°C	δ _{N∞} -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
III: 160°C / 100°Č	δ _{No} factor	[mm/(N/mm²)]	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

 $\begin{array}{ll} \delta_{N0} = \delta_{N0} \text{-factor} + \tau; & \tau \text{: acting bond stress for tension} \\ \delta_{N\omega} = \delta_{N\omega} \text{- factor} + \tau; & \end{array}$

Table C18: 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⁾ under static and quasi-static action												
All temperature ranges	δ _{vo} -factor	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
	δ _{ν∞} -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

¹⁾ Calculation of the displacement

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

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

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Performance

Displacements (rebar)