

DEKLARACJA WŁAŚCIWOŚCI UŻYTKOWYCH

DoP nr: MKT-2.1-600_pl

- ✧ **Niepowtarzalny kod identyfikacyjny typu wyrobu:** **System wtryskowy VMH do betonu**
- ✧ **Zamierzone zastosowanie lub zastosowania:** System wtryskowy do kotwienia w betonie, patrz załącznik B /Annex B
- ✧ **Producent:** MKT Metall-Kunststoff-Technik GmbH & Co.KG
Auf dem Immel 2
67685 Weilerbach
- ✧ **System lub systemy oceny i weryfikacji stałości właściwości użytkowych:** 1
- ✧ **Europejski dokument oceny:** **EAD 330499-01-0601**
 Europejska ocena techniczna: **ETA-17/0716, 22.11.2019**
 Jednostka ds. oceny technicznej: DIBt, Berlin
 Jednostka lub jednostki notyfikowane: NB 2873 – Technische Universität Darmstadt

✧ **Deklarowane właściwości użytkowe:**

Zasadnicze charakterystyki	Właściwości użytkowe
Nośność i stateczność (BWR 1)	
Odporności charakterystyczne pod obciążeniem rozciągającym (efekty statyczne i quasi-statyczne)	Załącznik/Annex C1, C3, C6, C8
Odporności charakterystyczne na naprężenia poprzeczne (efekty statyczne i quasi-statyczne)	Załącznik/Annex C2, C4, C7, C9
Przesunięcia (efekty statyczne i quasi-statyczne)	Załącznik/Annex C11 – C13
Wytrzymałość charakterystyczna i przemieszczenia dla kategorii wytrzymałości sejsmicznej C1 + C2	Załącznik/Annex C5, C10, C11
Trwałość	Załącznik/Annex B1
Higiena, zdrowie i środowisko (BWR 3)	
Zawartość, emisja i / lub uwalnianie substancji niebezpiecznych	Wydajność nie oceniono

Właściwości użytkowe określonego powyżej wyrobu są zgodne z zestawem deklarowanych właściwości użytkowych. Niniejsza deklaracja właściwości użytkowych wydana zostaje zgodnie z rozporządzeniem (EU) nr 305/2011 na wyłączną odpowiedzialność producenta określonego powyżej.

W imieniu producenta podpisał(-a):


Stefan Weustenhagen
 (Kierownik)

Weilerbach, 01.01.2021

p.p. 
Dipl.-Ing. Detlef Bigalke
 (Kierownik Rozwoju Produktu)



Oryginał tej deklaracji właściwości użytkowych został sporządzony w języku niemieckim. W przypadku odchyień w tłumaczeniu obowiązuje wersja niemiecka.

Specification of intended use

Injection System 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 action	performance category C1	M8 - M30 zinc plated ¹⁾ , A4, HCR	-	Ø8 - Ø32
	performance category C2	M12 – M24 zinc plated ¹⁾ (property class 8.8) A4, HCR (property class ≥ 70)	-	-
Base materials		compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013		
		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		M8	M10	M12	M16	M20	M24	M27	M30
Diameter of threaded rod	$d=d_{nom}$ [mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter	d_0 [mm]	10	12	14	18	22	28	30	35
Effective anchorage depth	$h_{ef,min}$ [mm]	60	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture ²⁾	Pre-setting installation $d_f \leq$ [mm]	9	12	14	18	22	26	30	33
	Through setting installation $d_f \leq$ [mm]	12	14	16	20	24	30	33	40
Installation torque	$T_{inst} \leq$ [Nm]	10	20	40 (35) ¹⁾	60	100	170	250	300
Minimum thickness of member	h_{min} [mm]	$h_{ef} + 30 \text{ mm}$ $\geq 100 \text{ mm}$			$h_{ef} + 2d_0$				
Minimum spacing	s_{min} [mm]	40	50	60	75	95	115	125	140
Minimum edge distance	c_{min} [mm]	35	40	45	50	60	65	75	80

¹⁾ 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 $d_{nom} + 1 \text{ mm}$ or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

Table B2: Installation parameters for internally threaded anchor rods

Internally threaded anchor rod		IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Inner diameter of threaded rod	d_2 [mm]	6	8	10	12	16	20
Outer diameter of threaded rod ¹⁾	$d=d_{nom}$ [mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm]	12	14	18	22	28	35
Effective anchorage depth	$h_{ef,min}$ [mm]	60	70	80	90	96	120
	$h_{ef,max}$ [mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	$d_f \leq$ [mm]	7	9	12	14	18	22
Installation torque	$T_{inst} \leq$ [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]	$h_{ef} + 30 \text{ mm}$ $\geq 100 \text{ mm}$			$h_{ef} + 2d_0$		
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		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	32	32	35	40
Effective anchorage depth	$h_{ef,min}$ [mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$ [mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h_{min} [mm]	$h_{ef} + 30 \text{ mm}$ $\geq 100 \text{ mm}$			$h_{ef} + 2d_0$						
Minimum spacing	s_{min} [mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	c_{min} [mm]	35	40	45	50	50	60	70	70	75	85

¹⁾ For diameter Ø8, Ø10 and Ø12 both nominal drill hole diameter can be used

Injection System VMH for concrete

Intended use
Installation parameters

Annex B2

Table B4: Parameter cleaning and setting tools






Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
					
[-]	[-]	Ø [mm]	d ₀ [mm]	d _b [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]	[-]	↓	→	↑
10	No retaining washer required			
12				
14				
16				
18	VM-IA 18	h _{ef} > 250mm	h _{ef} > 250mm	all
20	VM-IA 20			
22	VM-IA 22			
25	VM-IA 25			
28	VM-IA 28			
30	VM-IA 30			
32	VM-IA 32			
35	VM-IA 35			
40	VM-IA 40			



Vacuum drill bit

Drill bit diameter (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

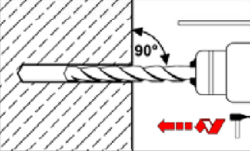
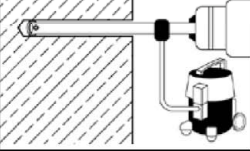
Injection System VMH for concrete

Intended Use
 Cleaning and setting tools

Annex B3

Installation Instructions

Drilling of the hole

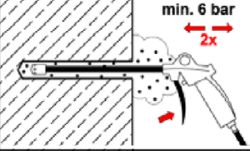
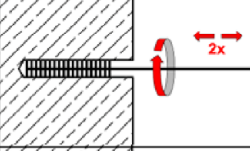
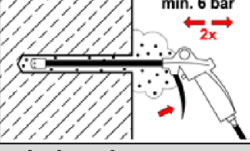
1	1a		Hammer drill oder compressed air drill Drill with hammer drill or compressed air drill a hole into the base material to the size required by the selected anchor (Table B1, B2 or B3). Continue with <u>step 2</u> . In case of aborted drill hole, the drill hole shall be filled with mortar.
	1b		Vacuum 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 <u>step 3</u> . 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!


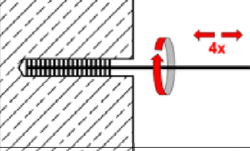
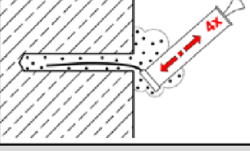
Cleaning with compressed air

all substrates and diameters according to Annex B1

2	2a		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of two times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
	2b		Check brush diameter (Table B4). Brush the hole with an 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.
	2c		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of two times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.

Manual cleaning

uncracked concrete, dry and wet drill holes; drill hole diameter $d_0 \leq 20\text{mm}$ and drill hole depth $h_0 \leq 10 d_{nom}$

2	2a		Starting from the bottom or back of the drill hole, blow out the hole with the blow-out pump a minimum of four times.
	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.
	2c		Starting from the bottom or back of the drill hole blow out the hole again a minimum of four times.

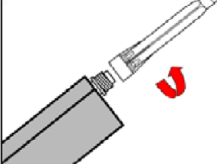
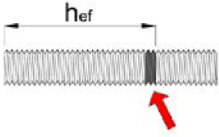
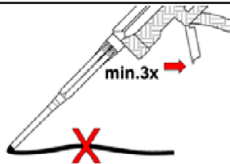
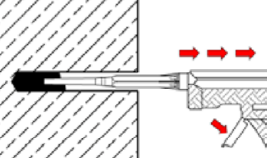
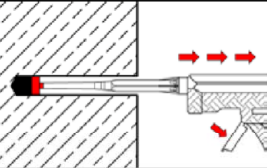
After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.

Injection System VMH for concrete

Intended Use
Installation instructions

Annex B4

Installation instructions (continuation)

Injection		
3		Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B6) as well as for new cartridges, a new static-mixer shall be used.
4		Prior to inserting the rod into the filled drill hole, the position of the embedment depth shall be marked on the threaded rod or rebar
5		Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey 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: <ul style="list-style-type: none"> • Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-\varnothing $d_0 \geq 18$ mm and anchorage depth $h_{ef} > 250$mm • Overhead installation: Drill bit-\varnothing $d_0 \geq 18$ mm

Injection System VMH for concrete

Intended Use
Installation instructions (continuation)

Annex B5

Installation instructions (continuation)

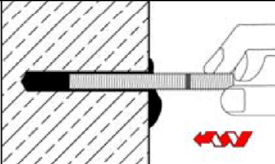
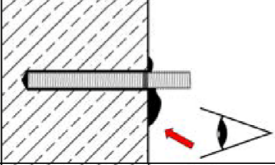
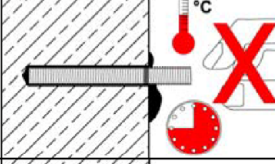
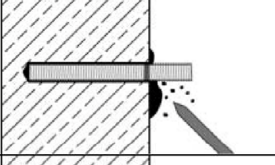
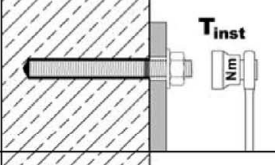
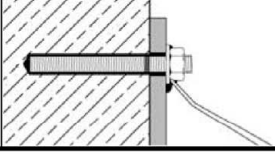
Inserting the anchor		
7		<p>Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.</p> <p>The anchor shall be free of dirt, grease, oil or other foreign material.</p>
8		<p>After installation, the annular gap 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).</p>
9		<p>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).</p>
10		<p>Remove excess mortar.</p>
11		<p>The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B1 or B2.</p>
12		<p>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.</p>

Table B6: Working time and curing time

Concrete temperature	Working time	Minimum curing 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				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Cross sectional area A_s [mm ²]				36,6	58,0	84,3	157	245	353	459	561
Characteristic resistance under tension load¹⁾											
Steel, zinc plated	Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280
	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449
Stainless steel	A2, A4 and HCR Property class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
	A2, A4 and HCR Property class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-	-
	A4 and HCR Property class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-
Partial factor²⁾											
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,N}$	[-]	2,0							
	Property class 4.8	$\gamma_{Ms,N}$	[-]	1,5							
	Property class 5.6	$\gamma_{Ms,N}$	[-]	2,0							
	Property class 5.8	$\gamma_{Ms,N}$	[-]	1,5							
	Property class 8.8	$\gamma_{Ms,N}$	[-]	1,5							
Stainless steel	A2, A4 and HCR Property class 50	$\gamma_{Ms,N}$	[-]	2,86							
	A2, A4 and HCR Property class 70	$\gamma_{Ms,N}$	[-]	1,87						-	-
	A4 and HCR Property class 80	$\gamma_{Ms,N}$	[-]	1,6						-	-

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 **tension loads**

Annex C1

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

Threaded rod				M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30	
Steel failure												
Cross sectional area				A_s [mm ²]	36,5	58,0	84,3	157	245	353	459	561
Characteristic resistances under shear load¹⁾												
Steel failure <u>without</u> lever arm												
Steel, zinc plated	Property class 4.6 and 4.8	$V^0_{Rk,s}$ [kN]	9 (8)	14 (13)	20	38	59	85	110	135		
	Property class 5.6 and 5.8	$V^0_{Rk,s}$ [kN]	11 (10)	17 (16)	25	47	74	106	138	168		
	Property class 8.8	$V^0_{Rk,s}$ [kN]	15 (13)	23 (21)	34	63	98	141	184	224		
Stainless steel	A2, A4 and HCR, property class 50	$V^0_{Rk,s}$ [kN]	9	15	21	39	61	88	115	140		
	A2, A4 and HCR, property class 70	$V^0_{Rk,s}$ [kN]	13	20	30	55	86	124	-	-		
	A4 and HCR, property class 80	$V^0_{Rk,s}$ [kN]	15	23	34	63	98	141	-	-		
Steel failure <u>with</u> lever arm												
Steel, zinc plated	Property class 4.6 and 4.8	$M^0_{Rk,s}$ [Nm]	15 (13)	30 (27)	52	133	260	449	666	900		
	Property class 5.6 and 5.8	$M^0_{Rk,s}$ [Nm]	19 (16)	37 (33)	65	166	324	560	833	1123		
	Property class 8.8	$M^0_{Rk,s}$ [Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797		
Stainless steel	A2, A4 and HCR, property class 50	$M^0_{Rk,s}$ [Nm]	19	37	66	167	325	561	832	1125		
	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$ [Nm]	26	52	92	232	454	784	-	-		
	A4 and HCR, property class 80	$M^0_{Rk,s}$ [Nm]	30	59	105	266	519	896	-	-		
Partial factor ²⁾												
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,V}$ [-]	1,67									
	Property class 4.8	$\gamma_{Ms,V}$ [-]	1,25									
	Property class 5.6	$\gamma_{Ms,V}$ [-]	1,67									
	Property class 5.8	$\gamma_{Ms,V}$ [-]	1,25									
	Property class 8.8	$\gamma_{Ms,V}$ [-]	1,25									
Stainless steel	A2, A4 and HCR, property class 50	$\gamma_{Ms,V}$ [-]	2,38									
	A2, A4 and HCR, property class 70	$\gamma_{Ms,V}$ [-]	1,56						-	-		
	A4 and HCR, property class 80	$\gamma_{Ms,V}$ [-]	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**

Annex C2

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	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ or see Table C1								
Partial factor	$\gamma_{Ms,N}$	[-]	see Table C1								
Combined pull-out and concrete failure											
Characteristic bond resistance in <u>uncracked</u> concrete C20/25											
Temperature range I:	80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm ²]	17	17	16	15	14	13	13	13
Temperature range II:	120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm ²]	15	14	14	13	12	12	11	11
Temperature range III:	160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm ²]	12	11	11	10	9,5	9,0	9,0	9,0
Characteristic bond resistance in <u>cracked</u> concrete C20/25											
Temperature range I:	80°C / 50°C	$\tau_{Rk,cr}$	[N/mm ²]	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/mm ²]	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/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Reduction factor ψ_{sus}^0 in concrete C20/25											
Temperature range I:	80°C / 50°C	ψ_{sus}^0	[-]	0,79							
Temperature range II:	120°C / 72°C	ψ_{sus}^0	[-]	0,75							
Temperature range III:	160°C / 100°C	ψ_{sus}^0	[-]	0,66							
Increasing factors for concrete	ψ_c	C25/30		1,02							
		C30/37		1,04							
		C35/45		1,07							
		C40/50		1,08							
		C45/55		1,09							
		C50/60		1,10							
Concrete cone failure											
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0							
	cracked concrete	$k_{cr,N}$	[-]	7,7							
Splitting failure											
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$							
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} (2,5 - h / h_{ef})$							
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$							
Spacing		$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$							
Installation factor											
dry or wet concrete	Vacuum cleaning	γ_{inst}	[-]	1,2							
	Manual cleaning	γ_{inst}	[-]	1,2				NPA			
	Compressed air	γ_{inst}	[-]	1,0							
water filled drill hole	cleaning	γ_{inst}	[-]	1,4							

Injection System VMH for concrete

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

Annex C3

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 <u>without</u> lever arm											
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V_{Rk,s}^0$	[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	$V_{Rk,s}^0$	[kN]	0,5 · A _s · f _{uk} or see Table C2								
Ductility factor	k ₇	[-]	1,0								
Partial factor	γ _{Ms,v}	[-]	see Table C2								
Steel failure <u>with</u> lever arm											
Characteristic bending resistance	$M_{Rk,s}^0$	[Nm]	1,2 · W _{el} · f _{uk} or see Table C2								
Elastic section modulus	W _{el}	[mm ³]	31	62	109	277	541	935	1387	1874	
Partial factor	γ _{Ms,v}	[-]	see Table C2								
Concrete pry-out failure											
Pry-out factor	k ₈	[-]	2,0								
Concrete edge failure											
Effective length of anchor	l _f	[mm]	min (h _{ef} ; 12 d _{nom})							min (h _{ef} ; 300mm)	
Outside diameter of anchor	d _{nom}	[mm]	8	10	12	16	20	24	27	30	
Installation factor	γ _{inst}	[-]	1,0								

Injection System VMH for concrete

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

Annex C4

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

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure											
Characteristic resistance		$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$							
		$N_{Rk,s,eq,C2}$	[kN]	NPA			$1,0 \cdot N_{Rk,s}$			NPA	
Partial factor		$\gamma_{Ms,N}$	[-]	siehe Tabelle C1							
Combined pull-out and concrete failure											
Characteristic bond resistance											
Temperatur- range	I: 80°C / 50°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
		$\tau_{Rk,eq,C2}$	[N/mm ²]	NPA		3,6	3,5	3,3	2,3	NPA	
	II: 120°C / 72°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
		$\tau_{Rk,eq,C2}$	[N/mm ²]	NPA		3,1	3,0	2,8	2,0	NPA	
	III: 160°C / 100°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
		$\tau_{Rk,eq,C2}$	[N/mm ²]	NPA		2,5	2,7	2,5	1,8	NPA	
Installation factor											
Compressed air cleaning	dry or wet concrete	γ_{inst}	[-]	1,0							
	water filled drill hole			1,4							
Vacuum cleaning	dry or wet concrete	γ_{inst}	[-]	1,2							

¹⁾ 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 rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure <u>without</u> lever arm										
Characteristic resistance		$V_{Rk,s,eq,C1}$	[kN]	$0,7 \cdot V_{Rk,s}^0$						
		$V_{Rk,s,eq,C2}$	[kN]	NPA			$0,7 \cdot V_{Rk,s}^0$			NPA
Partial factor		$\gamma_{Ms,N}$	[-]	siehe Tabelle C2						
Steel failure <u>without</u> lever arm										
Charactersitic bending resistance		$M_{Rk,s,eq}^0$	[Nm]	No Performance Assessed (NPA)						
Installation factor		γ_{inst}	[-]	1,0						
Factor for anchorages	without hole clearance	α_{gap}	[-]	1,0						
	with hole clearance between fastener and fixture	α_{gap}	[-]	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 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
Steel failure ¹⁾									
Characteristic resistance, steel, zinc plated, property class	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123
	8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic resistance, stainless steel A4 / HCR, property class	70	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 ²⁾
Partial factor		$\gamma_{Ms,N}$	[-]	1,87					2,86
Combined pull-out and concrete failure									
Characteristic bond resistance in <u>uncracked</u> concrete C20/25									
Temperature range	I: 80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm ²]	17	16	15	14	13	13
	II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm ²]	14	14	13	12	12	11
	III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm ²]	11	11	10	9,5	9,0	9,0
Characteristic bond resistance in <u>cracked</u> concrete C20/25									
Temperature range	I: 80°C / 50°C	$\tau_{Rk,cr}$	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0
	II: 120°C / 72°C	$\tau_{Rk,cr}$	[N/mm ²]	6,5	7,0	7,5	7,0	6,0	6,0
	III: 160°C / 100°C	$\tau_{Rk,cr}$	[N/mm ²]	5,5	6,0	6,5	6,0	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					
	II: 120°C / 72°C	ψ^0_{sus}	[-]	0,75					
	III: 160°C / 100°C	ψ^0_{sus}	[-]	0,66					
Increasing factors for concrete		ψ_c	C25/30	1,02					
			C30/37	1,04					
			C35/45	1,07					
			C40/50	1,08					
			C45/55	1,09					
			C50/60	1,10					
Concrete cone failure									
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0					
	cracked concrete	$k_{cr,N}$	[-]	7,7					
Splitting failure									
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}					
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} (2,5 - h/h_{ef})$					
	$h/h_{ef} \leq 1,3$			2,4 h_{ef}					
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$					
Installation factor									
dry or wet concrete	vaccum cleaning	γ_{inst}	[-]	1,2					
	manual cleaning	γ_{inst}	[-]	1,2			NPA		
	compressed air	γ_{inst}	[-]	1,0					
waterfilled drill hole	cleaning	γ_{inst}	[-]	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

²⁾ For VMU-IG M20: property class 50

Injection System VMH for concrete

Performance

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

Annex C6

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

Internally threaded 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	
Steel failure <u>without</u> lever arm¹⁾											
Steel, zinc plated	Characteristic resistance	property class 5.8	$V_{Rk,s}^0$	[kN]	5	9	15	21	38	61	
	Characteristic resistance	property class 8.8	$V_{Rk,s}^0$	[kN]	8	14	23	34	60	98	
	Partial factor		$\gamma_{Ms,v}$	[-]	1,25						
Stainless steel	Characteristic resistance	property class 70	$V_{Rk,s}^0$	[kN]	7	13	20	30	55	62 ²⁾	
	Partial factor		$\gamma_{Ms,v}$	[-]	1,56					2,38	
Ductility factor				k_7	[-]	1,0					
Steel failure <u>with</u> lever arm¹⁾											
Steel, zinc plated	Characteristic bending resistance	property class 5.8	$M_{Rk,s}^0$	[Nm]	8	19	37	66	167	325	
	Characteristic bending resistance	property class 8.8	$M_{Rk,s}^0$	[Nm]	12	30	60	105	267	519	
	Partial factor		$\gamma_{Ms,v}$	[-]	1,25						
Stainless steel	Characteristic bending resistance	property class 70	$M_{Rk,s}^0$	[Nm]	11	26	53	92	234	643 ²⁾	
	Partial factor		$\gamma_{Ms,v}$	[-]	1,56					2,38	
Concrete pry-out failure											
Pry-out factor				k_8	[-]	2,0					
Concrete edge failure											
Effective length of anchor				l_f	[mm]	min (h_{ef} ; 12 d_{nom})					min (h_{ef} ; 300mm)
Outside diameter of anchor				d_{nom}	[mm]	10	12	16	20	24	30
Installation 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

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 C7

Table C9: Characteristic values of **tension 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													
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$									
Cross sectional area		A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 ²⁾									
Combined pull-out and concrete failure													
Characteristic bond resistance in <u>uncracked</u> concrete C20/25													
Temperature range	I: 80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm ²]	14	14	14	14	13	13	13	13	13	13
	II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm ²]	13	12	12	12	12	11	11	11	11	11
	III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm ²]	9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
Characteristic bond resistance in <u>cracked</u> concrete C20/25													
Temperature range	I: 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
	II: 120°C / 72°C	$\tau_{Rk,cr}$	[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	$\tau_{Rk,cr}$	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Reduction factor ψ_{sus}^0 in concrete C20/25													
Temperature range	I: 80°C / 50°C	ψ_{sus}^0	[-]	0,79									
	II: 120°C / 72°C	ψ_{sus}^0	[-]	0,75									
	III: 160°C / 100°C	ψ_{sus}^0	[-]	0,66									
Increasing factor for concrete	ψ_c	C25/30		1,02									
		C30/37		1,04									
		C35/45		1,07									
		C40/50		1,08									
		C45/55		1,09									
		C50/60		1,10									
Concrete cone failure													
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0									
	cracked concrete	$k_{cr,N}$	[-]	7,7									
Splitting failure													
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$									
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} (2,5 - h / h_{ef})$									
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$									
Spacing		$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$									
Installation factor													
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	1,2									
	manual cleaning	γ_{inst}	[-]	1,2					NPA				
waterfilled drill hole	compressed air	γ_{inst}	[-]	1,0									
	cleaning	γ_{inst}	[-]	1,4									

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

²⁾ in absence of national regulation

Injection System VMH for concrete

Performance

Characteristic values of **tension loads** for rebar

Annex C8

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 <u>without</u> lever arm												
Characteristic shear resistance	$V_{Rk,s}^0$ [kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$										
Cross sectional area	A_s [mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor	$\gamma_{Ms,v}$ [-]	$1,5^{2)}$										
Ductility factor	k_7 [-]	1,0										
Steel failure <u>with</u> lever arm												
Characteristic bending resistance	$M_{Rk,s}^0$ [Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$										
Elastic section modulus	W_{el} [mm ³]	50	98	170	269	402	785	1357	1534	2155	3217	
Partial factor	$\gamma_{Ms,v}$ [-]	$1,5^{2)}$										
Concrete pry-out failure												
Pry-out Factor	k_8 [-]	2,0										
Concrete edge failure												
Effective length of rebar	l_f [mm]	min (h_{ef} ; 12 d_{nom})							min (h_{ef} ; 300mm)			
Outside diameter of rebar	d_{nom} [mm]	8	10	12	14	16	20	24	25	28	32	
Installation factor	γ_{inst} [-]	1,0										

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

²⁾ in absence of national regulation

Injection System VMH for concrete

Performance
Characteristic values of **shear loads** for rebar

Annex C9

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

Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic resistance	$N_{Rk,s,eq,C1}$	[kN]	$A_s \cdot f_{uk}^{1)}$										
Cross sectional area	A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor	$\gamma_{Ms,N}$	[-]	1,4 ²⁾										
Combined pull-out and concrete failure													
Characteristic bond resistance in concrete C20/25													
Temperature range	I: 80°C / 50°C	$\tau_{Rk,eq,C1}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	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 factor													
dry or wet concrete	vacuum cleaning	γ_{inst}	[-]	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

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

Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure <u>without</u> lever arm													
Characteristic resistance	$V^0_{Rk,s,eq,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$										
Cross sectional area	A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾										
Ductility factor	k_7	[-]	1,0										
Steel failure <u>with</u> lever arm													
Characteristic bending resistance	$M^0_{Rk,s,eq,C1}$	[Nm]	No Performance Assesd (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			M8	M10	M12	M16	M20	M24	M27	M30
Displacement factor¹⁾ for uncracked concrete under static and quasi-static action										
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Displacement factor¹⁾ for cracked concrete under static and quasi-static action										
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
Cracked concrete under seismic action (C2)										
All temperature ranges	$\delta_{N,eq}$ (DLS)	[mm]	NPA	0,24	0,27	0,29	0,27	NPA		
	$\delta_{N,eq}$ (ULS)	[mm]		0,55	0,51	0,50	0,58			

¹⁾ Calculation of the displacement

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

τ : acting bond stress for tension

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

Table C14: Displacements under shear load (threaded rod)

Threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Displacement factor¹⁾ for concrete under static and quasi-static action										
All temperature ranges	δ_{V0} -Faktor	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$ -Faktor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Cracked concrete under seismic action (C2)										
All temperature ranges	$\delta_{V,eq}$ (DLS)	[mm]	NPA	3,6	3,0	3,1	3,5	NPA		
	$\delta_{V,eq}$ (ULS)	[mm]		7,0	6,6	7,0	9,3			

¹⁾ Calculation of the displacement

$$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V;$$

V: acting shear load

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

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

Internally threaded 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 factor¹⁾ for uncracked concrete under static and quasi-static action								
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,037	0,039	0,042	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,047	0,051	0,054	0,060
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,034	0,035	0,038	0,041	0,044	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,126	0,131	0,142	0,153	0,163	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor¹⁾ for cracked concrete under static and quasi-static action								
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,083	0,085	0,090	0,095	0,099	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,107	0,110	0,116	0,122	0,128	0,137
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,086	0,088	0,093	0,098	0,103	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,321	0,330	0,349	0,367	0,385	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,330	0,340	0,358	0,377	0,396	0,424

¹⁾ Calculation of the displacement

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

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

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

Internally threaded 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 factor¹⁾ under static and quasi-static action								
All temperature ranges	δ_{V0} -factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,10	0,09	0,08	0,08	0,06	0,06

¹⁾ Calculation of the displacement

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

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

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Performance
Displacements (internally threaded anchor rod)

Annex C12

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 factor¹⁾ for uncracked concrete under static and quasi-static action												
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Displacement factor¹⁾ for cracked concrete under static and quasi-static action												
Temperature range I: 80°C / 50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,108
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range II: 120°C / 72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range III: 160°C / 100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	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

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

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

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 factor¹⁾ under static and quasi-static action												
All temperature ranges	δ_{V0} -factor	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

¹⁾ Calculation of the displacement

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

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

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Performance
Displacements (rebar)

Annex C13