



...eine starke Verbindung

## DECLARAȚIA DE PERFORMANȚĂ

DoP Nr.: **MKT-341** - ro


- ❖ **Cod unic de identificare al produsului-tip:**      **Sistem de injecție VMH pentru beton**
- ❖ **Utilizare (utilizări) preconizată (preconizate):**      Sistem de injectare pentru ancorarea în beton, a se vedea anexa / Annex B
- ❖ **Fabricant:**      MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ❖ **Sistemul (sistemele) de evaluare și de verificare a constanței performanței:**      1
- ❖ **Documentul de evaluare european:**      **EAD 330499-01-0601**  
Evaluarea tehnică europeană:      **ETA-17/0716, 06.12.2018**  
Organismul de evaluare tehnică:      DIBt, Berlin  
Organism (organisme) notificat(e):      NB 1343 – MPA, Darmstadt

❖ **Performanța (performanțe) declarată (declarate):**

Caracteristici esențiale	Performanță
<b>Rezistență mecanică și stabilitate (BWR1)</b>	
Rezistență caracteristică la solicitări de tracțiune (efecte statice și cvasi-stactice)	Anexa/Annex C1, C3, C5, C7
Rezistență caracteristică sub stres lateral (efecte statice și cvasi-stactice)	Anexa/Annex C2, C4, C6, C8
Schimbare (efecte statice și cvasi-stactice)	Anexa/Annex C9 – C11
Rezistență caracteristică pentru performanța seismică categoria C1	Anexa/Annex C3, C4, C7, C8
Rezistența și deplasările caracteristice pentru performanța seismică categoria C2	Anexa/Annex C3, C4, C9
<b>Igienă, sănătate și mediu înconjurător (BWR3)</b>	
Conținutul, emisia și / sau eliberarea de substanțe periculoase	NPD (No Performance Determined) nicio performanță determinată

Performanța produsului identificat mai sus este în conformitate cu setul de performanțe declarate. Această declarație de performanță este eliberată în conformitate cu Regulamentul (UE) nr. 305/2011, pe răspunderea exclusivă a fabricantului identificat mai sus.

Semnată pentru și în numele fabricantului de către:

  
**Stefan Weustenhagen**  
(Director general)  
**Weilerbach, 06.12.2018**

p.p.   
**Dipl.-Ing. Detlef Bigalke**  
(Sef de dezvoltare a produselor)



Originalul acestei declarații de performanță a fost scris în limba germană. În cazul abaterilor în traducere, versiunea germană este validă.

## 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 electroplated, A4, HCR	Ø8 - Ø32
Seismic action, category C1	M8 - M30 zinc plated <sup>1)</sup> , A4, HCR	-	Ø8 - Ø32
Seismic action, category C2	M12 - M24 zinc plated <sup>1)</sup> (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	

<sup>1)</sup> except hot-dip galvanised

### Use conditions (Environmental conditions):

Structures subject to dry internal conditions	zinc plated steel, stainless steel A2 or A4 high corrosion resistant steel HCR
Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist	stainless steel A4 high corrosion resistant steel HCR
Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist <sup>2)</sup>	high corrosion resistant steel HCR

<sup>2)</sup> Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used)

### 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 boreholes (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 supervision of the person responsible for technical matters of the site
- 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 <sup>1)</sup>	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) <sup>2)</sup>	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

<sup>1)</sup> 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

<sup>2)</sup> 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 <sup>1)</sup>	$d=d_{nom}$ [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

<sup>1)</sup> With metric thread acc. to EN 1993-1-8:2005+AC:2009

**Table B3: Installation parameters for rebar**






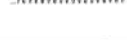




Rebar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Diameter of rebar	$d=d_{nom}$ [mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	$d_0$ [mm]	12	14	16	18	20	25	32	32	35	40
Effective anchorage depth	$h_{ef,min}$ [mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$ [mm]	160	200	240	280	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

**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 $\varnothing$ 	Brush $\varnothing$ 	min. Brush $\varnothing$ 	Retaining washer 			
						Installation direction and use			
[-]	[-]	$\varnothing$ [mm]	$d_0$ [mm]	$d_b$ [mm]	$d_{b,min}$ [mm]	[-]			
M8			10	11,5	10,5	No retaining washer required			
M10	VMU-IG M 6	8	12	13,5	12,5				
M12	VMU-IG M 8	10	14	15,5	14,5				
		12	16	17,5	16,5				
M16	VMU-IG M10	14	18	20,0	18,5	$h_{ef} > 250\text{mm}$	$h_{ef} > 250\text{mm}$	all	VM-IA 18
		16	20	22,0	20,5				VM-IA 20
M20	VMU-IG M12		22	24,0	22,5				VM-IA 22
		20	25	27,0	25,5				VM-IA 25
M24	VMU-IG M16		28	30,0	28,5				VM-IA 28
M27			30	31,8	30,5				VM-IA 30
		24/25	32	34,0	32,5				VM-IA 32
M30	VMU-IG M20	28	35	37,0	35,5				VM-IA 35
		32	40	43,5	40,5				VM-IA 40



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



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



**Retaining washer**  
 Drill bit diameter ( $d_0$ ):  
 18 mm to 40 mm



**Steel brush**  
 Drill bit diameter ( $d_0$ ): all diameters

**Injection System VMH for concrete**

**Intended Use**  
 Cleaning and setting tools

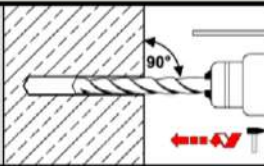
**Annex B3**



# Installation Instructions

## Drilling of the hole

1.



Drill with hammer drill or compressed air drill or vacuum drill a hole into the base material to the size required by the selected anchor (Table B1, B2 or B3). In case of aborted drill hole, the drill hole shall be filled with mortar.

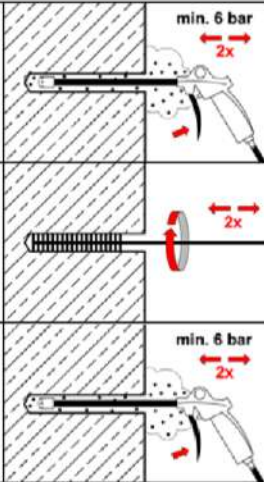
## Cleaning

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

### Cleaning with compressed air

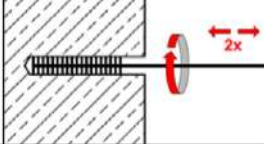
Cracked and uncracked concrete, all diameters

2a.



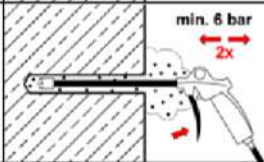
Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.

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 bore hole ground is not reached with the brush, an appropriate brush extension must be used.

2c.



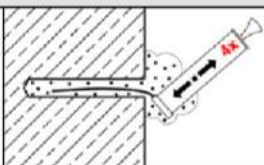
Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.

2.

### Manual cleaning

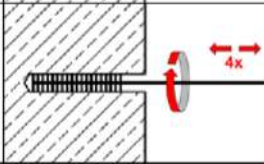
Drill hole diameter  $d_0 \leq 20\text{mm}$  and drill hole depth  $h_0 \leq 10 d_{nom}$  (uncracked concrete only)

2a.



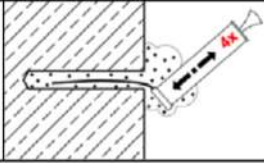
Starting from the bottom or back of the bore hole, blow out the hole with the blow-out pump a minimum of **four** times.

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 bore hole ground is not reached with the brush, an appropriate brush extension must be used.

2c.



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


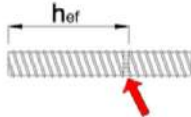
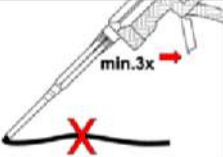
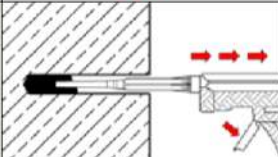
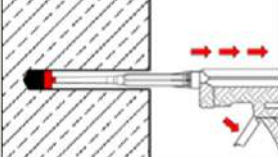
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

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 B5) as well as for new cartridges, a new static-mixer shall be used.
4.		Prior to inserting the rod into the filled bore 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 bore hole ground is not reached, an appropriate extension nozzle shall be used. Observe working times given in Table B5.
6b.		Retaining washer and mixer nozzle extensions shall be used according to Table B4 for the following applications: <ul style="list-style-type: none"> <li>• Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-<math>\varnothing d_0 \geq 18</math> mm and anchorage depth <math>h_{ef} &gt; 250</math>mm</li> <li>• Overhead installation: Drill bit-<math>\varnothing d_0 \geq 18</math> mm</li> </ul>

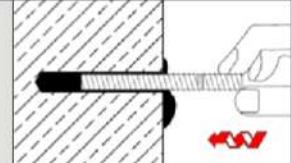
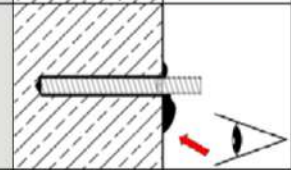
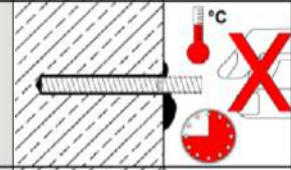
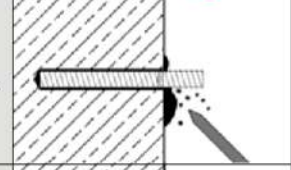
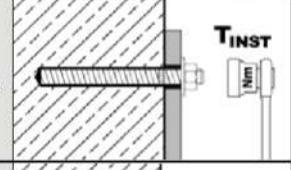
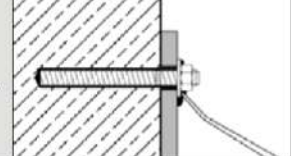
Injection System VMH for concrete

**Intended Use**  
Installation instructions (continuation)

**Annex B5**

## Installation instructions (continuation)

### Inserting the anchor

7.		<p>Push the threaded rod or reinforcing bar 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>Make sure that excess mortar is visible at the top of the hole. If these requirements are not maintained, 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 B5).</p>
10.		<p>Remove excess mortar.</p>
11.		<p>The fixture can be mounted after curing time. Apply installation torque <math>T_{inst}</math> according to Table B1 or B2.</p>
12.		<p>Annular gap between anchor rod and attachment 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 B5: 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
<b>Cartridge temperature</b>	<b>+ 5°C to + 40°C</b>		

### 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
<b>Steel failure <sup>1)</sup></b>											
Cross sectional area $A_s$ [mm <sup>2</sup> ]				36,6	58,0	84,3	157	245	353	459	561
<b>Characteristic resistance under tension load</b>											
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	-	-	
<b>Partial factor</b>											
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.

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

<sup>1)</sup> 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 **shear loads**

**Annex C2**

**Table C3: Characteristic values of tension loads for threaded rods**  
under static, quasi-static action and seismic action C1 + C2

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</b>										
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ or see Table C1							
	$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$							
	$N_{Rk,s,eq,C2}$	[kN]	NPA		$1,0 \cdot N_{Rk,s}$				NPA	
Partial factor	$\gamma_{Ms,N}$	[-]	see Table C1							
<b>Combined pull-out and concrete failure</b>										
<b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b>										
Temperature range I: 80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	17	17	16	15	14	13	13	13
Temperature range II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	15	14	14	13	12	12	11	11
Temperature range III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	12	11	11	10	9,5	9,0	9,0	9,0
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>										
Temperature range I: 80°C / 50°C	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	$\tau_{Rk,eq,C2}$	[N/mm <sup>2</sup> ]	NPA		3,6	3,5	3,3	2,3	NPA	
Temperature range II: 120°C / 72°C	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	$\tau_{Rk,eq,C2}$	[N/mm <sup>2</sup> ]	NPA		3,1	3,0	2,8	2,0	NPA	
Temperature range III: 160°C / 100°C	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
	$\tau_{Rk,eq,C2}$	[N/mm <sup>2</sup> ]	NPA		2,5	2,7	2,5	1,8	NPA	
Increasing factors for concrete	$\psi_c$	C25/30	1,02							
		C30/37	1,04							
		C35/45	1,07							
		C40/50	1,08							
		C45/55	1,09							
		C50/60	1,10							
<b>Concrete cone failure</b>										
Factor $k_1$	uncracked concrete	$k_{ucr,N}$	[-]	11,0						
	cracked concrete	$k_{cr,N}$	[-]	7,7						
<b>Splitting failure</b>										
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]	$2 c_{cr,sp}$						
<b>Installation factor</b>										
Compressed air cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,0						
	water filled bore hole	$\gamma_{inst}$	[-]	1,4						
Manual cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,2			NPA			

**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, quasi-static action and seismic action C1 + C2

Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure <u>without</u> lever arm</b>									
Characteristic shear resistance	$V_{RK,s}^0$ <sup>1)</sup> [kN]	0,5 · A <sub>s</sub> · f <sub>uk</sub> or see Table C2							
	$V_{RK,s,eq,C1}$ [kN]	0,70 · V <sub>RK,s</sub> <sup>0</sup>							
	$V_{RK,s,eq,C2}$ [kN]	NPA			0,70 · V <sub>RK,s</sub> <sup>0</sup>				NPA
Ductility factor	k <sub>7</sub> [-]	1,0							
Partial factor	γ <sub>Ms,V</sub> [-]	see Table C2							
<b>Steel failure <u>with</u> lever arm</b>									
Characteristic bending resistance	$M_{RK,s}^0$ [Nm]	1,2 · W <sub>el</sub> · f <sub>uk</sub> or see Table C2							
	$M_{RK,s,eq,C1}^0$ [Nm]	No Performance Assessed (NPA)							
	$M_{RK,s,eq,C2}^0$ [Nm]								
Partial factor	γ <sub>Ms,V</sub> [-]	see Table C2							
<b>Concrete pry-out failure</b>									
Pry-out factor	k <sub>8</sub> [-]	2,0							
<b>Concrete edge failure</b>									
Effective length of anchor	l <sub>f</sub> [mm]	min (h <sub>ef</sub> ; 12 d <sub>nom</sub> )						min (h <sub>ef</sub> ; 300mm)	
Outside diameter of anchor	d <sub>nom</sub> [mm]	8	10	12	16	20	24	27	30
Factor for annular gap	<b>without</b> annular gap filling	α <sub>gap</sub> [-]	0,5						
	<b>with</b> annular gap filling	α <sub>gap</sub> [-]	1,0						
Installation factor	γ <sub>inst</sub> [-]	1,0							

<sup>1)</sup> For property class 4.6 and 4.8:  $V_{RK,s}^0 = 0,6 \cdot A_s \cdot f_{uk}$

Injection System VMH for concrete

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

**Annex C4**

**Table C5: Characteristic values of tension loads for internally threaded anchor rod under static, 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	
<b>Steel failure <sup>1)</sup></b>									
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	10	18	29	42	79	123	
Partial factor	$\gamma_{Ms,N}$	[-]	1,5						
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196	
Partial factor	$\gamma_{Ms,N}$	[-]	1,5						
Characteristic tension resistance, Stainless steel A4 / HCR, property class 70	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 <sup>2)</sup>	
Partial factor	$\gamma_{Ms,N}$	[-]	1,87						
<b>Combined pull-out and concrete failure</b>									
<b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b>									
Temperature range	I: 80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	17	16	15	14	13	13
	II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	13	12	12	11
	III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	11	11	10	9,5	9,0	9,0
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>									
Temperature range	I: 80°C / 50°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,5	8,0	9,0	8,5	7,0	7,0
	II: 120°C / 72°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	6,5	7,0	7,5	7,0	6,0	6,0
	III: 160°C / 100°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	5,5	6,0	6,5	6,0	5,5	5,5
Increasing factors for concrete		$\psi_c$	C25/30	1,02					
			C30/37	1,04					
			C35/45	1,07					
			C40/50	1,08					
			C45/55	1,09					
			C50/60	1,10					
<b>Concrete cone failure</b>									
Factor $k_1$	uncracked concrete	$k_{ucr,N}$	[-]	11,0					
	cracked concrete	$k_{cr,N}$	[-]	7,7					
<b>Splitting failure</b>									
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 $c_{cr,sp}$					
<b>Installation factor</b>									
Compressed air cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,0					
	waterfilled borehole	$\gamma_{inst}$	[-]	1,4					
Manual cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,2			NPA		

<sup>1)</sup> 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

<sup>2)</sup> For VMU-IG M20: property class 50

**Injection System VMH for concrete**

**Performance**

Characteristic values of tension loads for internally threaded anchor rod

**Annex C5**



**Table C6: Characteristic values of shear loads for internally threaded anchor rod under static and 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	
<b>Steel failure <u>without</u> lever arm<sup>1)</sup></b>										
Steel, zinc plated	Characteristic resistance, property class 5.8	$V_{RK,s}^0$	[kN]	5	9	15	21	39	61	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,25						
	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 A4 / HCR, property class 70	$V_{RK,s}^0$	[kN]	7	13	20	30	55	62 <sup>2)</sup>	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56					2,38	
Ductility factor			$k_7$	[-]						1,0
<b>Steel failure <u>with</u> lever arm<sup>1)</sup></b>										
Steel, zinc plated	Characteristic bending moment, property class 5.8	$M_{RK,s}^0$	[Nm]	8	19	37	66	167	325	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,25						
	Characteristic bending moment, 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 moment, A4 / HCR, property class 70	$M_{RK,s}^0$	[Nm]	11	26	53	92	234	643 <sup>2)</sup>	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56					2,38	
<b>Concrete pry-out failure</b>										
Pry-out factor			$k_B$	[-]						2,0
<b>Concrete edge failure</b>										
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			$\gamma_{inst}$	[-]						1,0

<sup>1)</sup> 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

<sup>2)</sup> 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 C6**

**Table C7: Characteristic values of tension loads for rebar under static, quasi-static action and seismic action C1**

Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Steel failure</b>													
Characteristic tension resistance		$N_{Rk,s} = N_{Rk,s,eq,C1}$	[kN]	$A_s \cdot f_{uk}^{1)}$									
Cross sectional area		$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 <sup>2)</sup>									
<b>Combined pull-out and concrete failure</b>													
<b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b>													
Temperature range	I: 80°C / 50°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	14	14	13	13	13	13	13	13
	II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	13	12	12	12	12	11	11	11	11	11
	III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>													
Temperature range	I: 80°C / 50°C	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	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	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	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	$\tau_{Rk,cr} = \tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Increasing factor for concrete		$\psi_c$	C25/30	1,02									
			C30/37	1,04									
			C35/45	1,07									
			C40/50	1,08									
			C45/55	1,09									
			C50/60	1,10									
<b>Concrete cone failure</b>													
Factor $k_1$	uncracked concrete	$k_{ucr,N}$	[-]	11,0									
	cracked concrete	$k_{cr,N}$	[-]	7,7									
<b>Splitting failure</b>													
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]	$2 c_{cr,sp}$									
<b>Installation factor</b>													
Compressed air cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,0									
	waterfilled borehole	$\gamma_{inst}$	[-]	1,4									
Manual cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,2					NPA				

<sup>1)</sup>  $f_{uk}$  shall be taken from the specifications of reinforcing bars

<sup>2)</sup> in absence of national regulation

**Injection System VMH for concrete**

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

**Annex C7**

**Table C8: Characteristic values of shear loads for rebar under static, quasi-static action and seismic action C1**

Reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
<b>Steel failure <u>without</u> lever arm</b>												
Characteristic shear resistance	$V_{Rk,s}^0$ [kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$										
	$V_{Rk,s,eq,C1}$ [kN]	$0,37 \cdot A_s \cdot f_{uk}^{1)}$										
Cross sectional area	$A_s$ [mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804	
Partial factor	$\gamma_{Ms,V}$ [-]	1,5 <sup>2)</sup>										
Ductility factor	$k_7$ [-]	1,0										
<b>Steel failure <u>with</u> lever arm</b>												
Characteristic bending resistance	$M_{Rk,s}^0$ [Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$										
	$M_{Rk,s,eq,C1}^0$ [Nm]	No Performance Assessed (NPA)										
Elastic section modulus	$W_{el}$ [mm <sup>3</sup> ]	50	98	170	269	402	785	896	1534	2155	3217	
Partial factor	$\gamma_{Ms,V}$ [-]	1,5 <sup>2)</sup>										
<b>Concrete pry-out failure</b>												
Pry-out Factor	$k_8$ [-]	2,0										
<b>Concrete edge failure</b>												
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	
Factor for annular gap	<b>without</b> annular gap filling $\alpha_{gap}$ [-]	0,5										
	<b>with</b> annular gap filling $\alpha_{gap}$ [-]	1,0										
Installation factor	$\gamma_{inst}$ [-]	1,0										

<sup>1)</sup>  $f_{uk}$  shall be taken from the specifications of reinforcing bars

<sup>2)</sup> in absence of national regulation

**Injection System VMH for concrete**

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

**Annex C8**



**Table C9: Displacements under tension load<sup>1)</sup> (threaded rod)**

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Uncracked concrete C20/25 under static and quasi-static action</b>										
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range II: 120°C / 72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range III: 160°C / 100°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
<b>Cracked concrete C20/25 under static and quasi-static action</b>										
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range II: 120°C / 72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range III: 160°C / 100°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
<b>Cracked concrete C20/25 under seismic action (C2)</b>										
All temperature ranges	$\delta_{N,eq(DLS)}$ -factor	[mm/(N/mm <sup>2</sup> )]	NPA		0,120	0,100	0,100	0,120		NPA
	$\delta_{N,eq(ULS)}$ -factor	[mm/(N/mm <sup>2</sup> )]			0,140	0,150	0,110	0,150		

<sup>1)</sup> Calculation of the displacement

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

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

$$\delta_{N,eq(DLS)} = \delta_{N,eq(DLS)}\text{-factor} \cdot \tau_{Ed};$$

$$\delta_{N,eq(ULS)} = \delta_{N,eq(ULS)}\text{-factor} \cdot \tau_{Ed};$$

$\tau_{Ed}$ : acting bond stress for tension

**Table C10: Displacements under shear load<sup>1)</sup> (threaded rod)**

Threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
<b>Uncracked and cracked concrete C20/25 under static and quasi-static action</b>										
All temperature ranges	$\delta_{V0}$ -factor	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
<b>Cracked concrete C20/25 under seismic action (C2)</b>										
All temperature ranges	$\delta_{V,eq(DLS)}$ -factor	[mm/(kN)]	NPA		0,27	0,13	0,09	0,06		NPA
	$\delta_{V,eq(ULS)}$ -factor	[mm/(kN)]			0,27	0,14	0,10	0,08		

<sup>1)</sup> Calculation of the displacement

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

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

$$\delta_{V,eq(DLS)} = \delta_{V,eq(DLS)}\text{-factor} \cdot V_{Ed};$$

$$\delta_{V,eq(ULS)} = \delta_{V,eq(ULS)}\text{-factor} \cdot V_{Ed};$$

$V_{Ed}$ : acting shear load

**Injection System VMH for concrete**

**Performance**  
Displacements (threaded rod)

**Annex C9**



**Table C11: Displacements under tension load<sup>1)</sup>** (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
<b>Uncracked concrete C20/25 under static and quasi-static action</b>								
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,032	0,034	0,037	0,039	0,042	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,042	0,044	0,047	0,051	0,054	0,060
Temperature range II: 120°C / 72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,034	0,035	0,038	0,041	0,044	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range III: 160°C / 100°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,126	0,131	0,142	0,153	0,163	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,129	0,135	0,146	0,157	0,168	0,184
<b>Cracked concrete C20/25 under static and quasi-static action</b>								
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,083	0,085	0,090	0,095	0,099	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,107	0,110	0,116	0,122	0,128	0,137
Temperature range II: 120°C / 72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,086	0,088	0,093	0,098	0,103	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range III: 160°C / 100°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,321	0,330	0,349	0,367	0,385	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,330	0,340	0,358	0,377	0,396	0,424

<sup>1)</sup> Calculation of the displacement

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

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

**Table C12: Displacements under shear load<sup>1)</sup>** (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
<b>Uncracked and cracked concrete C20/25 under static and quasi-static action</b>								
All temperature ranges	$\delta_{V0}$ -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

<sup>1)</sup> Calculation of the displacement

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

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

**Injection System VMH for concrete**

**Performance**  
Displacements (internally threaded anchor rod)

**Annex C10**

**Table C13: Displacements under tension load<sup>1)</sup> (rebar)**

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Uncracked concrete C20/25 under static and quasi-static action</b>												
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	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	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	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	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
<b>Cracked concrete C20/25 under static and quasi-static action</b>												
Temperature range I: 80°C / 50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	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	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	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	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	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 <sup>2</sup> )]	0,321	0,330	0,340	0,349	0,358	0,377	0,396	0,396	0,410	0,449

<sup>1)</sup> Calculation of the displacement

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

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

**Table C14: Displacements under shear load<sup>1)</sup> (rebar)**

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Cracked and uncracked concrete C20/25 under static and quasi-static action</b>												
All temperature ranges	$\delta_{V0}$ -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

<sup>1)</sup> Calculation of the displacement

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

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

**Injection System VMH for concrete**

**Performance**  
Displacements (rebar)

**Annex C11**