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## YDEEVNEDEKLARATION


DoP Nr.: **MKT-340** - da

- ❖ **Varetypens unikke identifikationskode:** Injektionssystemet VMH til beton
- ❖ **Tilsligtet anvendelse:** Injektionssystem til forankring i beton, se bilag / Annex B
- ❖ **Fabrikant:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ❖ **System eller systemer til vurdering og kontrol af konstansen af ydeevnen:** 1
- ❖ **Europæisk vurderingsdokument:** **ETAG 001-5, 2013-04**  
Europæisk teknisk vurdering: **ETA-17/0716, 08.12.2017**  
Teknisk vurderingsorgan: DIBt, Berlin  
Notificeret organ/notificerede organer: NB 1343 – MPA, Darmstadt
- ❖ **Deklareret ydeevne/deklarerede ydeevner:**

Væsentlige funktioner	Ydeevne
<b>Mekanisk modstandsdygtighed og stabilitet (BWR1)</b>	
Karakteristiske værdier for statiske og kvasi-statiske handlinger og seismiske præstationskategorier C1 + C2	Bilag/Annex C1 – C7
Skift	Bilag/Annex C8 – C10
<b>Brandsikring (BWR2)</b>	
Brandegenskaber	Klasse A1
Brandsikkerhed	NPD (No Performance Determined) ingen ydeevne fastlagt

Ydeevnen for den vare, der er anført ovenfor, er i overensstemmelse med den deklarerede ydeevne. Denne ydeevnedeklaration er udarbejdet i overensstemmelse med forordning (EU) nr. 305/2011 på eneansvar af den fabrikant, der er anført ovenfor.

Underskrevet for fabrikanten og på dennes vegne af:

  
**Stefan Weustenhagen**  
(CEO)  
**Weilerbach, 08.12.2017**

p.p.   
**Dipl.-Ing. Detlef Bigalke**  
(Leder af produktudvikling)



Originalen af denne erklæringserklæring blev skrevet på tysk. I tilfælde af afvigelser i oversættelsen er den tyske udgave gyldig.

### Specification of intended use

Injection System VMH	Threaded rod	Internally threaded anchor rod	Rebar
	VMU-A, V-A, VM-A, commercial standard threaded rod	VMU-IG	
Static or quasi-static action	M8 - M30 zinc plated, A4, HCR	IG-M6 - 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 zinc plated <sup>1)</sup> (strength class 8.8) A4, HCR	-	-
Base materials	Reinforced or unreinforced normal weight concrete acc. to EN 206-1:2000		
	Strength classes acc. to EN 206-1:2000:C20/25 to C50/60		
	Cracked and 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 or high corrosion resistant steel)
  - 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 or high corrosion resistant steel)
  - Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel)
- Note: 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.)
- Anchorage are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Anchorage under static or quasi-static actions are designed in accordance with:
  - EOTA Technical Report TR 029 "Design of bonded anchors", Edition September 2010 or
  - CEN/TS 1992-4:2009
- Anchorage under seismic actions (cracked concrete) are designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition February 2013
  - Anchorage shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure
  - Fastenings in stand-off installation or with a grout layer are not allowed

#### Installation:

- Dry or wet concrete
- 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
- Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod

### 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	$d_{nom} =$ [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>	$d_f \leq$ [mm]	9	12	14	18	22	26	30	33
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 larger clearance hole see TR029 section 1.1; for application 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 rod**

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>2)</sup>	$d_{nom} =$ [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 <sup>1)</sup>	$d_f \leq$ [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> For larger clearance hole see TR029 section 1.1

<sup>2)</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 25	Ø 28	Ø 32
Diameter of rebar	$d = d_{nom} =$ [mm]	8	10	12	14	16	20	25	28	32
Nominal drill hole diameter	$d_0 =$ [mm]	12	14	16	18	20	25	32	35	40
Effective anchorage depth	$h_{ef,min} =$ [mm]	60	60	70	75	80	90	100	112	128
	$h_{ef,max} =$ [mm]	160	200	240	280	320	400	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	130	150
Minimum edge distance	$c_{min}$ [mm]	35	40	45	50	50	60	70	75	85

**Injection System VMH for concrete**

Intended use  
Installation parameters

**Annex B2**

**Table B4: Parameter cleaning and setting tools**

Threaded rod 	Rebar 	Internally threaded anchor rod 	Drill bit 	Brush 	min. Brush 		Retaining washer		
							Installation direction and use of retaining washer		
[-]	Ø [mm]	[-]	$d_0$ [mm]	$d_b$ [mm]	$d_{b,min}$ [mm]	[-]	↓	→	↑
M8			10	11,5	10,5	-	No retaining washer required		
M10	8	VMU-IG M 6	12	13,5	12,5	-			
M12	10	VMU-IG M 8	14	15,5	14,5	-			
	12		16	17,5	16,5	-			
M16	14	VMU-IG M10	18	20,0	18,5	VM-IA 18	$h_{ef} > 250\text{mm}$	$h_{ef} > 250\text{mm}$	all
	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			
	25		32	34,0	32,5	VM-IA 32			
M30	28	VMU-IG M20	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 for overhead or horizontal installation**  
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. |  | <p>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 Table B3). In case of aborted drill hole, the drill hole shall be filled with mortar.</p> |
|----|--|---|

### Cleaning

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

#### Cleaning with compressed air

Cracked and uncracked concrete: all diameters

- |     |  |   |
|-----|--|---|
| 2a. |  | <p>Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) a minimum of <b>two</b> times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.</p>       |
| 2b. |  | <p>Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush <math>\geq d_{b,min}</math> (Table B4) a minimum of <b>two</b> times. If the bore hole ground is not reached with the brush, a brush extension must be used.</p>                |
| 2c. |  | <p>Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) again a minimum of <b>two</b> times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.</p> |

#### 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. |  | <p>Starting from the bottom or back of the bore hole, blow out the hole with the blow-out pump a minimum of <b>four</b> times.</p>  |
| 2b. |  | <p>Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush <math>\geq d_{b,min}</math> (Table B4) a minimum of <b>four</b> times. If the bore hole ground is not reached with the brush, a brush extension must be used.</p> |
| 2c. |  | <p>Starting from the bottom or back of the bore hole blow out the hole again a minimum of <b>four</b> times.</p>  |

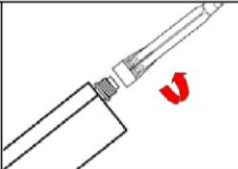
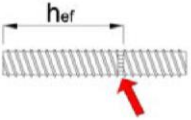
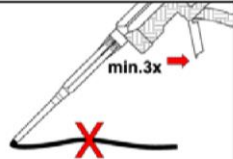
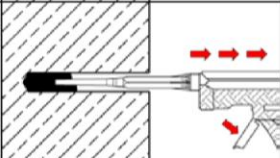
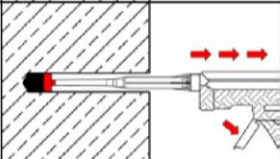
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

### Injection System VMH for concrete

Intended Use  
Installation instructions

Annex B4

## Installation instructions (continuation)

Injection	
3.	 <p>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.</p>
4.	 <p>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</p>
5.	 <p>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.</p>
6a.	 <p>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. For embedment larger than 190 mm, an extension nozzle shall be used. Observe working times given in Table B5.</p>
6b.	 <p>Retaining washer and mixer nozzle extensions shall be used according to Table B4 for the following applications:</p> <ul style="list-style-type: none"> <li>• Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-<math>\varnothing</math> <math>d_0 \geq 18</math> mm and embedment depth <math>h_{ef} &gt; 250</math>mm</li> <li>• Overhead installation: Drill bit-<math>\varnothing</math> <math>d_0 \geq 18</math> mm</li> </ul>

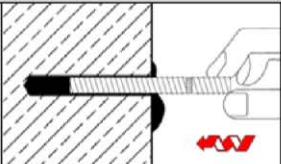
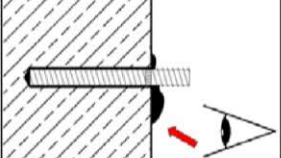
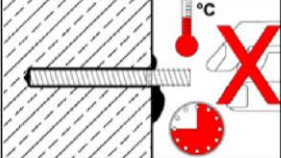
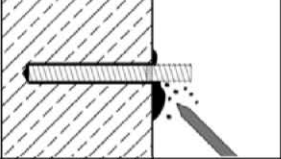
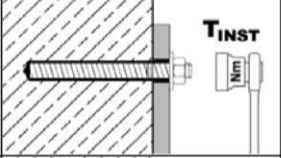
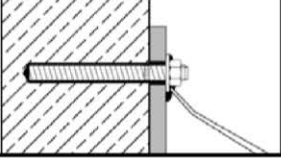
Injection System VMH for concrete

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 the anchor is fully seated up to the full embedment depth and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. 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 by using a calibrated torque wrench.</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>

**Tabelle B1: Working time and curing time**

Concrete temperature	Maximum 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>	+ 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 and shear resistance

Threaded rod				M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
<b>Steel failure</b>											
<b>Tension load</b>											
Characteristic tension resistance	Steel, Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
	Steel, Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
	Steel, Property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
	Stainless steel A4 and HCR, Property class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
	Stainless steel A4 and HCR, Property class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-	-
Partial factor	Steel, Property class 4.6	$\gamma_{Ms,N}$	[-]	2,0							
	Steel, Property class 4.8	$\gamma_{Ms,N}$	[-]	1,5							
	Steel, Property class 5.6	$\gamma_{Ms,N}$	[-]	2,0							
	Steel, Property class 5.8	$\gamma_{Ms,N}$	[-]	1,5							
	Steel, Property class 8.8	$\gamma_{Ms,N}$	[-]	1,5							
	Stainless steel A4 and HCR, Property class 50	$\gamma_{Ms,N}$	[-]	2,86							
	Stainless steel A4 and HCR, Property class 70	$\gamma_{Ms,N}$	[-]	1,87							-
<b>Shear load</b>											
<b>Steel failure <u>without</u> lever arm</b>											
Characteristic shear resistance	Steel, Property class 4.6 and 4.8	$V_{Rk,s}$	[kN]	7	12	17	31	49	71	92	112
	Steel, Property class 5.6 and 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Steel, Property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
	Stainless steel A4 and HCR, Property class 50	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Stainless steel A4 and HCR, Property class 70	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	-	-
<b>Steel failure <u>with</u> lever arm</b>											
Characteristic bending moment	Steel, Property class 4.6 and 4.8	$M_{Rk,s}$	[Nm]	15	30	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	$M_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
	Steel, Property class 8.8	$M_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
	Stainless steel A4 and HCR, Property class 50	$M_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
	Stainless steel A4 and HCR, Property class 70	$M_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
Partial factor	Steel, Property class 4.6	$\gamma_{Ms,V}$	[-]	1,67							
	Steel, Property class 4.8	$\gamma_{Ms,V}$	[-]	1,25							
	Steel, Property class 5.6	$\gamma_{Ms,V}$	[-]	1,67							
	Steel, Property class 5.8	$\gamma_{Ms,V}$	[-]	1,25							
	Steel, Property class 8.8	$\gamma_{Ms,V}$	[-]	1,25							
	Stainless steel A4 and HCR, Property class 50	$\gamma_{Ms,V}$	[-]	2,38							
	Stainless steel A4 and HCR, Property class 70	$\gamma_{Ms,V}$	[-]	1,56							-

**Injection System VMH for concrete**

**Performance**

Characteristic values for **threaded rods** under **tension** and **shear loads**

**Annex C1**



**Table C2:** 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 tension resistance	$N_{Rk,s}$	[kN]	see Table C1							
	$N_{Rk,s,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$							
	$N_{Rk,s,C2}$	[kN]	NPD	$1,0 \cdot N_{Rk,s}$	No Performance Determined (NPD)					
Partial factor	$\gamma_{Ms,N}$	[-]	see Table C1							
<b>Combined pull-out and concrete failure</b>										
<b>Characteristic bond resistance in uncracked 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	12	11	10	9,5	9,0	9,0	9,0
<b>Characteristic bond resistance in cracked concrete C20/25</b>										
Temperature range I: 80°C / 50°C	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	6,5	7,0	7,5	8,5	8,5	8,5	8,5	8,5
	$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	NPD		3,6	No Performance Determined (NPD)				
Temperature range II: 120°C / 72°C	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	5,5	6,0	6,5	7,5	7,5	7,5	7,5	7,5
	$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	NPD		3,1	No Performance Determined (NPD)				
Temperature range III: 160°C / 100°C	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	5,0	5,5	6,0	6,5	6,5	6,5	6,5	6,5
	$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	NPD		2,5	No Performance Determined (NPD)				
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							
Factor according to CEN/TS1992-4-5	uncracked concrete	$k_B$	[-]	10,1						
	cracked concrete			7,2						
<b>Concrete cone failure</b>										
Factor according to CEN/TS1992-4-5	uncracked concrete	$k_{ucr}$	[-]	10,1						
	cracked concrete	$k_{cr}$		7,2						
<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]	$2 c_{cr,sp}$						
Installation factor <b>Compressed air cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,0 (1,2) <sup>1)</sup>				1,2			
Installation factor <b>Manual cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,2				-			

<sup>1)</sup> Value in brackets for cracked concrete

**Injection System VMH for concrete**

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

**Annex C2**

**Table C3:** 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	$V_{Rk,s}$ [kN]	see Table C1							
	$V_{Rk,s,C1}$ [kN]	$0,70 \cdot V_{Rk,s}$							
	$V_{Rk,s,C2}$ [kN]	NPD		$0,80 \cdot V_{Rk,s}$	No Performance Determined (NPD)				
Partial factor	$\gamma_{Ms,v}$ [-]	see Table C1							
<b>Steel failure <u>with</u> lever arm</b>									
Characteristic bending moment	$M^0_{Rk,s}$ [Nm]	see Table C1							
	$M^0_{Rk,s,C1}$ [Nm]	No Performance Determined (NPD)							
	$M^0_{Rk,s,C2}$ [Nm]								
Partial factor	$\gamma_{Ms,v}$ [-]	see Table C1							
<b>Concrete pry-out failure</b>									
Factor k acc. to TR 029 Factor $k_3$ acc. to CEN/TS 1992-4-5	$k_{(3)}$ [-]	2,0							
Installation factor	$\gamma_2 = \gamma_{inst}$ [-]	1,0							
<b>Concrete edge failure</b>									
Effective length of anchor	$l_f$ [mm]	$l_f = \min(h_{ef}; 8 d_{nom})$							
Outside diameter of anchor	$d_{nom}$ [mm]	8	10	12	16	20	24	27	30
Installation factor	$\gamma_2 = \gamma_{inst}$ [-]	1,0							

**Injection System VMH for concrete**

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

**Annex C3**

**Table C4:** Characteristic values of **tension loads** for **internally threaded anchor rod** under static, quasi-static action

Internally threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
<b>Steel failure <sup>1)</sup></b>								
Characteristic tension resistance, Steel, strength class 5.8	$N_{Rk,s}$	[kN]	10	18	29	42	79	123
Partial factor	$\gamma_{Ms,N}$	[-]	1,5					
Characteristic tension resistance, Steel, strength 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, strength class 70	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 <sup>3)</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
Temperature range II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	13	12	12	11
Temperature range III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	12	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> ]	7,0	7,5	8,5	8,5	8,5	8,5
Temperature range II: 120°C / 72°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	6,0	6,5	7,5	7,5	7,5	7,5
Temperature range III: 160°C / 100°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	5,5	6,0	6,5	6,5	6,5	6,5
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					
Factor according to CEN/TS1992-4-5	$k_8$	uncracked concrete	10,1					
		cracked concrete	7,2					
<b>Concrete cone failure</b>								
Factor according to CEN/TS1992-4-5	$k_{ucr}$	uncracked concrete	10,1					
		cracked concrete	7,2					
<b>Splitting failure</b>								
Edge distance	$c_{cr,sp}$	$h/h_{ef} \geq 2,0$	1,0 $h_{ef}$					
		$2,0 > h/h_{ef} > 1,3$	$2 * h_{ef} (2,5 - h / h_{ef})$					
		$h/h_{ef} \leq 1,3$	2,4 $h_{ef}$					
Spacing	$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$					
Installation factor <b>Compressed air cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,0 (1,2) <sup>2)</sup>				1,2	
Installation factor <b>Manual cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,2				-	

<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> Value in brackets for cracked concrete

<sup>3)</sup> For VMU-IG M20: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

**Injection System VMH for concrete**

**Performance**

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

**Annex C4**

**Table C5:** Characteristic values of **shear loads** for **internally threaded anchor rod** under static and quasi-static action

Internally threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
<b>Steel failure <u>without</u> lever arm<sup>1)</sup></b>								
Characteristic shear resistance Steel, strength class 5.8	$V_{Rk,s}$	[kN]	5	9	15	21	39	61
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance Steel, strength class 8.8	$V_{Rk,s}$	[kN]	8	14	23	34	60	98
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance Stainless steel A4 / HCR, strength class 70	$V_{Rk,s}$	[kN]	7	13	20	30	55	62 <sup>2)</sup>
Partial factor	$\gamma_{Ms,V}$	[-]	1,56					
<b>Steel failure <u>with</u> lever arm<sup>1)</sup></b>								
Characteristic bending moment, Steel, strength class 5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Steel, strength class 8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
Partial factor	$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Stainless steel A4 / HCR, strength class 70	$M^0_{Rk,s}$	[Nm]	11	26	53	92	234	643 <sup>2)</sup>
Partial factor	$\gamma_{Ms,V}$	[-]	1,56					
<b>Concrete pry-out failure</b>								
Factor k acc. to TR 029 Factor $k_3$ acc. to CEN/TS 1992-4-5	$k_{(3)}$	[-]	2,0					
<b>Concrete edge failure</b>								
Effective length of anchor	$l_f$	[mm]	$l_f = \min(h_{ef}; 8 d_{nom})$					
Outside diameter of anchor	$d_{nom}$	[mm]	10	12	16	20	24	30
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	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. 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: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

**Injection System VMH for concrete**

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

**Annex C5**

**Table C6:** 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 25	Ø 28	Ø 32	
<b>Steel failure</b>											
Characteristic tension resistance	$N_{Rk,s} = N_{Rk,s,C1}$	[kN]	$A_s \cdot f_{uk}^{1)}$								
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	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
Temperature range II: 120°C / 72°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	13	12	12	12	12	11	11	11	11
Temperature range III: 160°C / 100°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	10	10	9,5	9,5	9,5	9,0	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	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	5,0	5,5	6,0	6,0	7,5	7,5	7,5	7,5	8,0
Temperature range II: 120°C / 72°C	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	4,5	5,0	5,0	5,5	6,5	6,5	6,5	6,5	7,0
Temperature range III: 160°C / 100°C	$\tau_{Rk,cr} = \tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	4,0	4,5	4,5	5,0	5,5	6,0	6,0	5,5	6,5
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								
Factor according to CEN/TS1992-4-5	uncracked concrete	$k_8$	[-]	10,1							
	cracked concrete			7,2							
<b>Concrete cone failure</b>											
Factor according to CEN/TS1992-4-5	uncracked concrete	$k_{ucr}$	[-]	10,1							
	cracked concrete	$k_{cr}$		7,2							
<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 $C_{cr,sp}$							
Installation factor <b>Compressed air cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,0 (1,2) <sup>3)</sup>				1,2				
Installation factor <b>Manual cleaning</b>	$\gamma_2 = \gamma_{inst}$	[-]	1,2				-				

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

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

<sup>3)</sup> Value in brackets for cracked concrete

**Injection System VMH for concrete**

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

**Annex C6**

**Table C7:** 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 25	Ø 28	Ø 32
<b>Steel failure <u>without</u> lever arm</b>										
Characteristic shear resistance	$V_{Rk,s}$ [kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$								
	$V_{Rk,s,C1}$ [kN]	$0,37 \cdot A_s \cdot f_{uk}^{1)}$								
Cross section area	$A_s$ [mm <sup>2</sup> ]	50	79	113	154	201	314	491	616	804
Partial factor	$\gamma_{Ms,v}$ [-]	1,5 <sup>2)</sup>								
Ductility factor according to CEN/TS 1992-4-5	$k_2$ [-]	0,8								
<b>Steel failure <u>with</u> lever arm</b>										
Characteristic bending moment	$M^0_{Rk,s}$ [Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$								
	$M^0_{Rk,s,C1}$ [Nm]	No Performance Determined (NPD)								
Elastic section modulus	$W_{el}$ [mm <sup>3</sup> ]	50	98	170	269	402	785	1534	2155	3217
Partial factor	$\gamma_{Ms,v}$ [-]	1,5 <sup>2)</sup>								
<b>Concrete pry-out failure</b>										
Factor k acc. to TR 029 Factor $k_3$ acc. to CEN/TS 1992-4-5	$k_{(3)}$ [-]	2,0								
Installation factor	$\gamma_2 = \gamma_{inst}$ [-]	1,0								
<b>Concrete edge failure</b>										
Effective length of rebar	$l_f$ [mm]	$l_f = \min(h_{ef}; 8 d_{nom})$								
Outside diameter of rebar	$d_{nom}$ [mm]	8	10	12	14	16	20	25	28	32
Installation factor	$\gamma_2 = \gamma_{inst}$ [-]	1,0								

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

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

**Injection System VMH for concrete**

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

**Annex C7**

**Table C8: Displacements under tension loads<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	$\delta_{N,seis}$ (DLS) -factor	[mm/(N/mm <sup>2</sup> )]	(NPD)		0,120	No Performance Determined (NPD)				
	$\delta_{N,seis}$ (ULS) -factor	[mm/(N/mm <sup>2</sup> )]			0,140					

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

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

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

$$\delta_{N,seis}(DLS) = \delta_{N,seis}(DLS)\text{-factor} \cdot \tau;$$

$$\delta_{N,seis}(ULS) = \delta_{N,seis}(ULS)\text{-factor} \cdot \tau;$$

$\tau$ : acting bond stress for tension

**Table C9: 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	$\delta_{V,seis}$ (DLS) -factor	[mm/(kN)]	(NPD)		0,27	No Performance Determined (NPD)				
	$\delta_{V,seis}$ (ULS) -factor	[mm/(kN)]			0,27					

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

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

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

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

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

V: acting shear load

**Injection System VMH for concrete**

**Performance**  
Displacements (threaded rod)

**Annex C8**

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

Internally threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
<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

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

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

**Table C11: Displacements under shear load<sup>1)</sup>** (internally threaded anchor rod)

Internally threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
<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

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

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

**Injection System VMH for concrete**

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

**Annex C9**



**Table C12: Displacements under tension load<sup>1)</sup> (rebar)**

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	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	0,043	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	0,055	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	0,045	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	0,057	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	0,164	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	0,169	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	0,103	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	0,133	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	0,107	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	0,138	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	0,399	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	0,410	0,449

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

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	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
	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04

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

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

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

**Injection System VMH for concrete**

**Performance**  
Displacements (rebar)

**Annex C10**