



...eine starke Verbindung

## IZJAVA O SVOJSTVIMA

DoP br. MKT-2.1-601\_hr

- ◇ **Jedinstvena identifikacijska oznaka vrste proizvoda:** Injekcijski sustav VMH za beton
- ◇ **Namjena/namjene:** Injekcijski sustav za sidrenje u betonu, vidi Prilog/Annex B
- ◇ **Proizvođač:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ◇ **Sustav ili sustavi ocjenjivanja i provjere stalnosti svojstava građevnog proizvoda:** 1
- ◇ **Europski dokument za ocjenjivanje:** EAD 330499-01-0601  
Europska tehnička ocjena: ETA-17/0716, 11.05.2021  
Tijelo za tehničko ocjenjivanje: DIBt, Berlin  
Prijavljeno tijelo/prijavljena tijela: NB 2873 – Technische Universität Darmstadt
- ◇ **Objavljena svojstva:**

Bitnih značajka	Svojstva
<b>Temeljni zahtjevi za građevine (BWR 1)</b>	
Karakteristični otpori pod vlačnim opterećenjem (statički i kvazi-statički efekti)	Prilog / Annex B3, C1, C3, C4, C5, C8, C9, C11, C12
Karakteristični otpori pod poprečnim naprezanjem (statički i kvazi-statički efekti)	Prilog / Annex C2, C6, C10, C13
Pomaci	Prilog / Annex C15 – C17
Karakteristični otpor i pomaci za seizmičke performanse kategorije C1 + C2	Prilog / Annex C7, C14, C15
<b>Higijena, zdravlje i okoliš (BWR 3)</b>	
Sadržaj, emisija i / ili oslobađanje opasnih tvari	Performanse nisu ocijenjene

Izvedba gore navedenog proizvoda je deklarirana izvedba / izvedba. Gore navedeni proizvođač jedini je odgovoran za sastavljanje izjave o učinkovitosti u skladu s Uredbom (EU) br. 305/2011.

Za proizvođača i u njegovo ime potpisao:

**Stefan Weustenhagen**  
(generalni direktor)  
Weilerbach, 11.05.2021

p.p.

**Dipl.-Ing. Detlef Bigalke**  
(Voditelj razvoja proizvoda)



Izvornik ove izjave o izvedbi pisan je na njemačkom jeziku. U slučaju odstupanja u prijevodu vrijedi njemačka verzija.

## Specification of intended use

Static and quasi-static action	working life 50 years	working life 100 years
Threaded rod Internally threaded anchor rod Rebar	<b>M8 - M30</b> <b>VMU-IG M6 - VMU-IG M20</b> <b>Ø8 - Ø32</b>	
Base material	cracked or uncracked concrete	
	strength classes C20/25 to C50/60 compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013+A1:2016	
Hole drilling	hammer drilling / compressed air drilling / vacuum drilling	
Temperature range <sup>1)</sup>	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C

Seismic action	performance category C1	performance category C2
Threaded rod Rebar	<b>M8 - M30</b> <b>Ø8 - Ø32</b>	<b>M12 - M24</b> ---
Base material	cracked or uncracked concrete	
	strength classes C20/25 to C50/60 compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013+A1:2016	
Hole drilling	hammer drilling / compressed air drilling / vacuum drilling	
Temperature range <sup>1)</sup>	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C

<sup>1)</sup> Temperature Range I: max. long term temperature +24°C and max. short term temperature +40°C  
 Temperature Range II: max. long term temperature +50°C and max. short term temperature +80°C  
 Temperature Range III: max. long term temperature +72°C and max. short term temperature +120°C  
 Temperature Range IV: max. long term temperature +100°C and max. short term temperature +160°C

Injection System VMH for concrete

Intended Use  
Specifications

Annex B1

## Specification of intended use

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions: all materials
- For all other conditions:  
Intended use of Materials according to Annex A4, Table A1 corresponding corrosion resistance classes CRC according to EN 1993-1-4:2006+A1:2015

### Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Anchorages are designed in accordance with EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

### Installation:

- Dry or wet concrete or waterfilled drill holes (not seawater)
- Hole drilling by hammer or compressed air drill or vacuum drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person competent for technical matters on site
- The injection mortar is assessed for installation at minimum concrete temperature of -5°C, where subsequently the temperature in the concrete does not rise at a rapid rate, i.e. from the minimum installation temperature to 24°C within a 12-hour period.
- Internally threaded anchor rod: screws and threaded rods (incl. nut and washer) must at least correspond to the material and strength class of the internally threaded anchor rod used

**Injection System VMH for concrete**

**Intended Use**  
Specifications

**Annex B2**

**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>2)</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
Maximum installation torque	$max.T_{inst} \leq$	[Nm]	10	20	40 (35) <sup>1)</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> max. installation torque for M12 with steel grade 4.6

<sup>2)</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

**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
Maximum installation torque	$max.T_{inst} \leq$	[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 <sup>1)</sup>	$d_0$	[mm]	10   12	12   14	14   16	18	20	25	30   32	30   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






<sup>1)</sup> for diameter Ø8, Ø10, Ø12, Ø24 and Ø25 both nominal drill hole diameter can be used

**Injection System VMH for concrete**


**Intended use**  
Installation parameters

**Annex B3**

**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 <sub>0</sub> [mm]	d <sub>b</sub> [mm]	d <sub>b,min</sub> [mm]
M8		8	10	11,5	10,5
M10	VMU-IG M 6	8 / 10	12	13,5	12,5
M12	VMU-IG M 8	10 / 12	14	15,5	14,5
		12	16	17,5	16,5
M16	VMU-IG M10	14	18	20,0	18,5
		16	20	22,0	20,5
M20	VMU-IG M12		22	24,0	22,5
		20	25	27,0	25,5
M24	VMU-IG M16		28	30,0	28,5
M27		24 / 25	30	31,8	30,5
		24 / 25	32	34,0	32,5
M30	VMU-IG M20	28	35	37,0	35,5
		32	40	43,5	40,5

**Table B5: Retaining washer**

Drill bit Ø		Installation direction and use		
d <sub>0</sub> [mm]	[-]	↓	→	↑
10	No retaining washer required			
12				
14				
16				
18	VM-IA 18	h <sub>ef</sub> > 250mm	h <sub>ef</sub> > 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 (d<sub>0</sub>): all diameters  
 Vacuum drill bit (MKT Hollow drill bit SB, Würth Saugbohrer or Heller Duster Expert) and a class M vacuum with minimum negative pressure of 253 hPa and a flow rate of minimum 42 l/s (150 m³/h)



**Recommended compressed air tool (min 6 bar)**

Drill bit diameter (d<sub>0</sub>): all diameters



**Blow-out pump (volume 750ml)**

Drill bit diameter (d<sub>0</sub>): 10 mm to 20 mm  
 Drill hole depth (h<sub>0</sub>): ≤ 10 d<sub>nom</sub>  
 for uncracked concrete

**Injection System VMH for concrete**

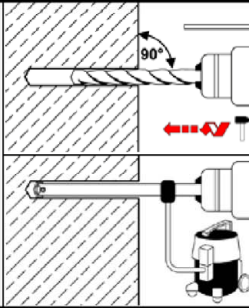
**Intended Use**  
 Cleaning and setting tools

**Annex B4**

# Installation Instructions

## Drilling of the hole

1



### Hammer drill or compressed air drill

Drill with hammer drill or compressed air drill a hole into the base material to the size required by the selected anchor (Table B1, B2 or B3). Continue with [step 2](#). In case of aborted drill hole, the drill hole shall be filled with mortar.

### Vacuum drill bit: see Annex B4

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

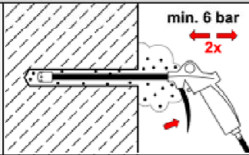
## Cleaning (not applicable when using a vacuum drill)

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

#### Cleaning with compressed air

all substrates and diameters according to Annex B1

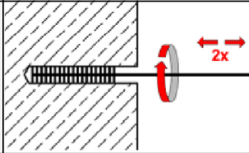
2a



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.

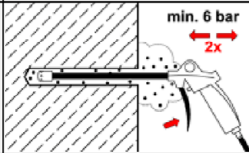
2b



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.

2

#### Manual cleaning

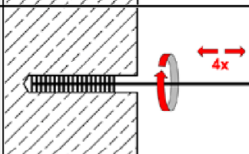
uncracked concrete, dry and wet drill holes; drill hole diameter  $d_0 \leq 20\text{mm}$  and drill hole depth  $h_0 \leq 10 d_{nom}$

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 until return air stream is free of noticeable dust.

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 until return air stream is free of noticeable dust.

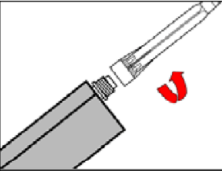
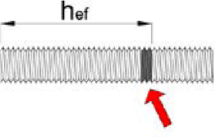
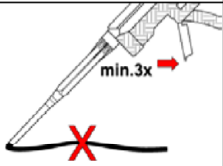
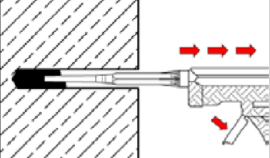
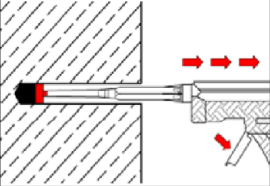
After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.

## Injection System VMH for concrete

Intended Use  
Installation instructions

Annex B5

## Installation instructions (continuation)

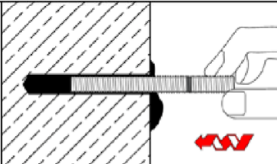
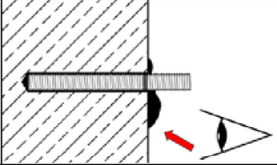
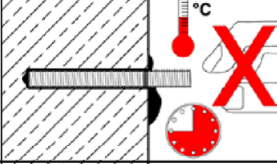
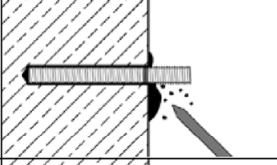
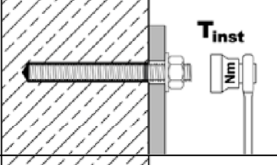
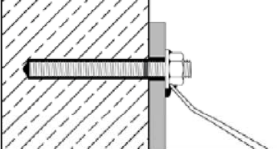
Injection		
3		Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B6) as well as for new cartridges, a new static-mixer shall be used.
4		Prior to inserting the 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"> <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 B6

## Installation instructions (continuation)

Setting the fastening element		
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!</p> <p>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 <math>\leq T_{inst}</math> 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
<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 B7**



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

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</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 <sup>1)</sup></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	_ <sup>3)</sup>	_ <sup>3)</sup>
	A4 and HCR Property class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	_ <sup>3)</sup>	_ <sup>3)</sup>
<b>Partial factor <sup>2)</sup></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						_ <sup>3)</sup>	_ <sup>3)</sup>
	A4 and HCR Property class 80	$\gamma_{Ms,N}$	[-]	1,6						_ <sup>3)</sup>	_ <sup>3)</sup>

<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.

<sup>2)</sup> in absence of other national regulations

<sup>3)</sup> Anchor type not part of the ETA

**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				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</b>											
Cross sectional area $A_s$ [mm <sup>2</sup> ]				36,6	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	$V^{0}_{Rk,s}$ [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	.. <sup>3)</sup>	.. <sup>3)</sup>	
	A4 and HCR, property class 80	$V^{0}_{Rk,s}$ [kN]	15	23	34	63	98	141	.. <sup>3)</sup>	.. <sup>3)</sup>	
<b>Steel failure <u>with</u> lever arm</b>											
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	.. <sup>3)</sup>	.. <sup>3)</sup>	
	A4 and HCR, property class 80	$M^{0}_{Rk,s}$ [Nm]	30	59	105	266	519	896	.. <sup>3)</sup>	.. <sup>3)</sup>	
<b>Partial factor <sup>2)</sup></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						.. <sup>3)</sup>	.. <sup>3)</sup>	
	A4 and HCR, property class 80	$\gamma_{Ms,V}$ [-]	1,33						.. <sup>3)</sup>	.. <sup>3)</sup>	

<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

<sup>2)</sup> in absence of other national regulations

<sup>3)</sup> Anchor type not part of the ETA

**Injection System VMH for concrete**

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

**Annex C2**

**Table C3: Characteristic values of concrete cone failure and splitting failure**

Threaded rods / Internally threaded anchor rods / Rebars			all sizes	
<b>Concrete cone failure</b>				
Factor $k_1$	uncracked concrete	$k_{ucr,N}$	[-]	11,0
	cracked concrete	$k_{cr,N}$	[-]	7,7
Edge distance		$C_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$
Spacing		$S_{cr,N}$	[mm]	$2,0 \cdot C_{cr,N}$
<b>Splitting failure</b>				
Characteristic resistance		$N^0_{Rk,sp}$	[kN]	$\min ( N_{Rk,p} ; N^0_{Rk,c} )$
Edge distance	$h/h_{ef} \geq 2,0$	$C_{cr,sp}$	[mm]	$1,0 \cdot h_{ef}$
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} (2,5 - h / h_{ef})$
	$h/h_{ef} \leq 1,3$			$2,4 \cdot h_{ef}$
Spacing		$S_{cr,sp}$	[mm]	$2,0 \cdot C_{cr,sp}$

**Injection System VMH for concrete**

**Performance**  
 Characteristic values of **concrete cone failure** and **splitting failure**

**Annex C3**

**Table C4: Characteristic values of tension loads for threaded rods, static and quasi-static action, working life 50 years**

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								
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	40°C / 24°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	17	17	16	15	14	13	13	13
	II	80°C / 50°C			17	17	16	15	14	13	13	13
	III	120°C / 72°C			15	14	14	13	12	12	11	11
	VI	160°C / 100°C			12	11	11	10	9,5	9,0	9,0	9,0
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>												
Temperature range	I	40°C / 24°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	II	80°C / 50°C			7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	III	120°C / 72°C			6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	VI	160°C / 100°C			5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
<b>Reduction factor <math>\psi^0_{sus}</math> in concrete C20/25</b>												
Temperature range	I	40°C / 24°C	$\psi^0_{sus}$	[-]	0,90							
	II	80°C / 50°C			0,87							
	III	120°C / 72°C			0,75							
	VI	160°C / 100°C			0,66							
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>												
Relevant parameter				see Table C3								
<b>Splitting failure</b>												
Relevant parameter				see Table C3								
<b>Installation factor</b>												
dry or wet concrete	vacuum cleaning		$\gamma_{inst}$	[-]	1,2							
	manual cleaning				1,2	No performance assessed						
	compressed air cleaning				1,0							
water filled drill hole	compressed air cleaning		$\gamma_{inst}$	[-]	1,4							

**Injection System VMH for concrete**

**Performance**  
Characteristic values of **tension loads** for **threaded rods**, working life **50 years**

**Annex C4**

**Table C5: Characteristic values of tension loads for threaded rods, static and quasi-static action, working life 100 years**

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										
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	40°C / 24°C	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	17	17	16	15	14	13	13	13	
	II	80°C / 50°C			17	17	16	15	14	13	13	13	
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>													
Temperature range	I	40°C / 24°C	$\tau_{Rk,cr,100}$	[N/mm <sup>2</sup> ]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5	
	II	80°C / 50°C			5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5	
Increasing factors for concrete			$\psi_c$	[N/mm <sup>2</sup> ]	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>													
Relevant parameter				see Table C3									
<b>Splitting failure</b>													
Relevant parameter				see Table C3									
<b>Installation factor</b>													
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2									
	manual cleaning			1,2				No performance assessed					
	compressed air cleaning			1,0									
water filled drill hole	compressed air cleaning	$\gamma_{inst}$	[-]	1,4									

**Injection System VMH for concrete**

**Performance**

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

**Annex C5**

**Table C6: Characteristic values of shear loads for threaded rods, static and quasi-static action**

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30	
<b>Steel failure <u>without</u> lever arm</b>											
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	$V_{Rk,s}^0$	[kN]	0,6 · A <sub>s</sub> · f <sub>uk</sub> 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 <sub>s</sub> · f <sub>uk</sub> or see Table C2								
Ductility factor	k <sub>7</sub>	[-]	1,0								
Partial factor	γ <sub>M<sub>s</sub>,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								
Elastic section modulus	W <sub>el</sub>	[mm <sup>3</sup> ]	31	62	109	277	541	935	1387	1874	
Partial factor	γ <sub>M<sub>s</sub>,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	
Installation factor	γ <sub>inst</sub>	[-]	1,0								

**Injection System VMH for concrete**

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

**Annex C6**

**Table C7: Characteristic values of tension loads for threaded rods, seismic action (performance category C1 + C2), working life 50 and 100 years**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</b>											
Characteristic resistance		$N_{Rk,s,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$							
		$N_{Rk,s,C2}$	[kN]	- <sup>1)</sup>				$1,0 \cdot N_{Rk,s}$			
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
<b>Combined pull-out and concrete failure</b>											
<b>Characteristic bond resistance in concrete C20/25 to C50/60</b>											
Temperature range	I: 40°C / 24°C	$\tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
		$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	- <sup>1)</sup>		3,6	3,5	3,3	2,3	- <sup>1)</sup>	
	II: 80°C / 50°C	$\tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
		$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	- <sup>1)</sup>		3,6	3,5	3,3	2,3	- <sup>1)</sup>	
	III: 120°C / 72°C	$\tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
		$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	- <sup>1)</sup>		3,1	3,0	2,8	2,0	- <sup>1)</sup>	
VI: 160°C / 100°C	$\tau_{Rk,C1}$	[N/mm <sup>2</sup> ]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5	
	$\tau_{Rk,C2}$	[N/mm <sup>2</sup> ]	- <sup>1)</sup>		2,5	2,7	2,5	1,8	- <sup>1)</sup>		
<b>Installation factor</b>											
Compressed air cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,0							
	water filled drill hole			1,4							
Vacuum cleaning	dry or wet concrete	$\gamma_{inst}$	[-]	1,2							

<sup>1)</sup> No performance assessed

**Table C8: Characteristic values of shear loads for threaded rods, seismic action (performance category C1 + C2)**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure <u>without</u> lever arm</b>											
Characteristic resistance		$V_{Rk,s,C1}$	[kN]	$0,7 \cdot V^0_{Rk,s}$							
		$V_{Rk,s,C2}$	[kN]	- <sup>1)</sup>				$0,7 \cdot V^0_{Rk,s}$			
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C2							
Factor for anchorages	without hole clearance	$\alpha_{gap}$	[-]	1,0							
	with hole clearance between fastener and fixture	$\alpha_{gap}$	[-]	0,5							

<sup>1)</sup> No performance assessed

**Injection System VMH for concrete**

**Performance**  
Characteristic values for **threaded rods** under **seismic action**

**Annex C7**

**Table C9: Characteristic values of tension loads for internally threaded anchor rod, static and quasi-static action, working life 50 years**

Internally threaded anchor rod				VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
<b>Steel failure <sup>1)</sup></b>									
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 <sup>2)</sup>
Partial factor		$\gamma_{Ms,N}$	[-]	1,87					
<b>Combined pull-out and concrete failure</b>									
<b>Characteristic bond resistance in uncracked concrete C20/25</b>									
Temperature range	I: 40°C / 24°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	17	16	15	14	13	13
	II: 80°C / 50°C			17	16	15	14	13	13
	III: 120°C / 72°C			14	14	13	12	12	11
	VI: 160°C / 100°C			11	11	10	9,5	9,0	9,0
<b>Characteristic bond resistance in cracked concrete C20/25</b>									
Temperature range	I: 40°C / 24°C	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,5	8,0	9,0	8,5	7,0	7,0
	II: 80°C / 50°C			7,5	8,0	9,0	8,5	7,0	7,0
	III: 120°C / 72°C			6,5	7,0	7,5	7,0	6,0	6,0
	VI: 160°C / 100°C			5,5	6,0	6,5	6,0	5,5	5,5
<b>Reduction factor <math>\psi_{sus}^0</math> in concrete C20/25</b>									
Temperature range	I: 40°C / 24°C	$\psi_{sus}^0$	[-]	0,90					
	II: 80°C / 50°C			0,87					
	III: 120°C / 72°C			0,75					
	VI: 160°C / 100°C			0,66					
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>									
Relevant parameter				see Table C3					
<b>Splitting failure</b>									
Relevant parameter				see Table C3					
<b>Installation factor</b>									
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2					
	manual cleaning			1,2	No performance assessed				
	compressed air cleaning			1,0					
waterfilled drill hole	compressed air cleaning	$\gamma_{inst}$	[-]	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> for VMU-IG M20: property class 50

**Injection System VMH for concrete**

**Performance**

Characteristic values of **tension loads** for **internally threaded anchor rod**, working life **50 years**

**Annex C8**



**Table C10: Characteristic values of tension loads for internally threaded anchor rod, static and quasi-static action, working life 100 years**

Internally threaded anchor rod				VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
<b>Steel failure <sup>1)</sup></b>									
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 <sup>2)</sup>
		$\gamma_{Ms,N}$	[-]	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: 40°C / 24°C	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	17	16	15	14	13	13
	II: 80°C / 50°C			17	16	15	14	13	13
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>									
Temperature range	I: 40°C / 24°C	$\tau_{Rk,cr,100}$	[N/mm <sup>2</sup> ]	6,0	6,5	6,5	6,5	6,5	6,5
	II: 80°C / 50°C			6,0	6,5	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				
<b>Concrete cone failure</b>									
Relevant parameter				see Table C3					
<b>Splitting failure</b>									
Relevant parameter				see Table C3					
<b>Installation factor</b>									
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2					
	manual cleaning			1,2	No performance assessed				
	compressed air cleaning			1,0					
waterfilled drill hole	compressed air cleaning	$\gamma_{inst}$	[-]	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> for VMU-IG M20: property class 50

**Injection System VMH for concrete**

**Performance**

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

**Annex C9**

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

Internally threaded anchor rod				VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
<b>Steel failure <u>without</u> lever arm <sup>1)</sup></b>									
Steel, zinc plated	Characteristic resistance	property class 5.8	$V^0_{Rk,s}$ [kN]	6	10	17	25	45	74
	Characteristic resistance	property class 8.8	$V^0_{Rk,s}$ [kN]	8	14	23	34	60	98
	Partial factor		$\gamma_{Ms,V}$	[-]	1,25				
Stainless steel	Characteristic resistance A4 / HCR	property class 70	$V^0_{Rk,s}$ [kN]	7	13	20	30	55	62 <sup>2)</sup>
	Partial factor		$\gamma_{Ms,V}$	[-]	1,56				
Ductility factor			$k_7$	[-]	1,0				
<b>Steel failure <u>with</u> lever arm <sup>1)</sup></b>									
Steel, zinc plated	Characteristic bending resistance	property class 5.8	$M^0_{Rk,s}$ [Nm]	8	19	37	66	167	325
	Characteristic bending resistance	property class 8.8	$M^0_{Rk,s}$ [Nm]	12	30	60	105	267	519
	Partial factor		$\gamma_{Ms,V}$	[-]	1,25				
Stainless steel	Characteristic bending resistance A4 / HCR	property class 70	$M^0_{Rk,s}$ [Nm]	11	26	53	92	234	643 <sup>2)</sup>
	Partial factor		$\gamma_{Ms,V}$	[-]	1,56				
<b>Concrete pry-out failure</b>									
Pry-out factor			$k_8$	[-]	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 C10**

**Table C12: Characteristic values of tension loads for rebar, static and quasi-static action, 50 years working life**

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 resistance		$N_{Rk,s}$	[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: 40°C / 24°C	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	14	14	13	13	13	13	13	13	
	II: 80°C / 50°C			14	14	14	14	13	13	13	13	13	13	
	III: 120°C / 72°C			13	12	12	12	12	11	11	11	11	11	
	VI: 160°C / 100°C			9,5	9,5	9,5	9,0	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: 40°C / 24°C	$\tau_{Rk,cr}$	[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: 80°C / 50°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0	
	III: 120°C / 72°C			4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0	
	VI: 160°C / 100°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0	
<b>Reduction factor <math>\psi_{sus}^0</math> in concrete C20/25</b>														
Temperature range	I: 40°C / 24°C	$\psi_{sus}^0$	[-]	0,90										
	II: 80°C / 50°C			0,87										
	III: 120°C / 72°C			0,75										
	VI: 160°C / 100°C			0,66										
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>														
Relevant parameter				see Table C3										
<b>Splitting failure</b>														
Relevant parameter				see Table C3										
<b>Installation factor</b>														
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2										
	manual cleaning			1,2	No performance assessed									
	compressed air cleaning			1,0										
waterfilled drill hole	compressed air cleaning	$\gamma_{inst}$	[-]	1,4										

<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, 50 years working life

**Annex C11**

**Table C13: Characteristic values of tension loads for rebar, static and quasi-static action, 100 years working life**

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 resistance	$N_{Rk,s}$	[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: 40°C / 24°C	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	14	14	14	14	13	13	13	13	13	13
	II: 80°C / 50°C			14	14	14	14	13	13	13	13	13	13
<b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>													
Temperature range	I: 40°C / 24°C	$\tau_{Rk,cr,100}$	[N/mm <sup>2</sup> ]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
	II: 80°C / 50°C			4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
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>													
Relevant parameter			see Table C3										
<b>Splitting failure</b>													
Relevant parameter			see Table C3										
<b>Installation factor</b>													
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2									
	manual cleaning			1,2					No performance assessed				
	compressed air cleaning			1,0									
waterfilled drill hole	compressed air cleaning	$\gamma_{inst}$	[-]	1,4									

<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, 100 years working life

**Annex C12**

**Table C14: Characteristic values of shear loads for rebar, static and 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	
<b>Steel failure <u>without</u> lever arm</b>												
Characteristic shear resistance	$V_{Rk,s}^0$ [kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$										
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]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$										
Elastic section modulus	$W_{el}$ [mm <sup>3</sup> ]	50	98	170	269	402	785	1357	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	$d_{no_m}$ [mm]	8	10	12	14	16	20	24	25	28	32	
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 C13**

**Table C15: Characteristic values of tension loads for rebar, seismic action**  
(performance category C1), 50 and 100 years working life

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 resistance	$N_{Rk,s,C1}$	[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</b> in concrete C20/25 to C50/60													
Temperature range	I: 40°C / 24°C	$\tau_{Rk,C1}$	[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: 80°C / 50°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	III: 120°C / 72°C			4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	VI: 160°C / 100°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
<b>Installation factor</b>													
dry or wet concrete	vacuum cleaning	$\gamma_{inst}$	[-]	1,2									
	compressed air cleaning	$\gamma_{inst}$	[-]	1,0									
waterfilled drill hole		$\gamma_{inst}$	[-]	1,4									

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

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

**Table C16: Characteristic values of shear loads for rebar, 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
<b>Steel failure <u>without</u> lever arm</b>												
Characteristic resistance	$V^0_{Rk,s,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$									
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									

<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 for rebar under seismic action

**Annex C14**

**Table C17: Displacements under tension load (threaded rod)**

Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30	
<b>Displacement factor <sup>1)</sup></b>										
uncracked concrete, static and quasi-static action, working life 50 and 100 years										
Temperature range I: 40°C / 24°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		0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor		0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$ -factor		0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor		0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
	$\delta_{N\infty}$ -factor		0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
<b>Displacement factor <sup>1)</sup></b>										
cracked concrete, static and quasi-static action, working life 50 and 100 years										
Temperature range I: 40°C / 24°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		0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor		0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
	$\delta_{N\infty}$ -factor		0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor		0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
	$\delta_{N\infty}$ -factor		0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424
<b>Displacement, seismic action (C2)</b>										
All temperature ranges	$\delta_{N,C2}$ (DLS)		[mm]	-2)	0,24	0,27	0,29	0,27	-2)	
	$\delta_{N,C2}$ (ULS)	0,55			0,51	0,50	0,58			

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

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

$\tau$ : acting bond stress for tension

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

<sup>2)</sup> No performance assessed

**Table C18: Displacements under shear load (threaded rod)**

Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30	
<b>Displacement factor<sup>1)</sup></b>										
cracked and uncracked concrete, static and quasi-static action										
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		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
<b>Displacement, seismic action (C2)</b>										
All temperature ranges	$\delta_{V,C2}$ (DLS)	[mm]	-2)	3,6	3,0	3,1	3,5	-2)		
	$\delta_{V,C2}$ (ULS)			7,0	6,6	7,0	9,3			

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

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

V: acting shear load

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

<sup>2)</sup> No performance assessed

**Injection System VMH for concrete**

**Performance**  
Displacements (threaded rod)

**Annex C15**

**Table C19: 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
<b>Displacement factor<sup>1)</sup></b> uncracked concrete, static and quasi-static action, working life 50 and 100 years								
Temperature range I: 40°C / 24°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		0,042	0,044	0,047	0,051	0,054	0,060
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor		0,034	0,035	0,038	0,041	0,044	0,048
	$\delta_{N\infty}$ -factor		0,044	0,045	0,049	0,053	0,056	0,062
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor		0,126	0,131	0,142	0,153	0,163	0,179
	$\delta_{N\infty}$ -factor		0,129	0,135	0,146	0,157	0,168	0,184
<b>Displacement factor<sup>1)</sup></b> cracked concrete, static and quasi-static action, working life 50 and 100 years								
Temperature range I: 40°C / 24°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		0,107	0,110	0,116	0,122	0,128	0,137
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor		0,086	0,088	0,093	0,098	0,103	0,110
	$\delta_{N\infty}$ -factor		0,111	0,114	0,121	0,127	0,133	0,143
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor		0,321	0,330	0,349	0,367	0,385	0,412
	$\delta_{N\infty}$ -factor		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 C20: 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
<b>Displacement factor<sup>1)</sup></b> cracked and uncracked concrete, static and quasi-static action								
All temperature ranges	$\delta_{V0}$ -factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$ -factor		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 C16**



**Table C21: 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	
<b>Displacement factor<sup>1)</sup></b> uncracked concrete, static and quasi-static action, working life 50 and 100 years												
Temperature range I: 40°C / 24°C II: 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		0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor		0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
	$\delta_{N\infty}$ -factor		0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor		0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
	$\delta_{N\infty}$ -factor		0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
<b>Displacement factor<sup>1)</sup></b> cracked concrete, static and quasi-static action, working life 50 and 100 years												
Temperature range I: 40°C / 24°C II: 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
	$\delta_{N\infty}$ -factor	0,104		0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range III: 120°C / 72°C	$\delta_{N0}$ -factor	0,084		0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
	$\delta_{N\infty}$ -factor	0,108		0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range VI: 160°C / 100°C	$\delta_{N0}$ -factor	0,312		0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
	$\delta_{N\infty}$ -factor	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

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

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

**Table C22: 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	
<b>Displacement factor<sup>1)</sup></b> cracked and uncracked concrete, static and quasi-static action												
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		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

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

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

**Injection System VMH for concrete**

**Performance**  
Displacements (rebar)

**Annex C17**