

## SUORITUSTASOILMOITUS

DoP Nro: **MKT-2.1-300\_fi**

- ◇ **Tuotetyypin yksilöllinen tunniste:** **Ruiskutusjärjestelmä VMU plus betoniin**
- ◇ **Aiottu käyttötarkoitus (aiotut käyttötarkoitukset):** Injektionestojärjestelmä ankkurointi betoniin, katso liite / Annex B
- ◇ **Valmistaja:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ◇ **Suoritustason pysyvyyden arvioinnissa ja varmentamisessa käytetty järjestelmä/käytetyt järjestelmät:** 1
- ◇ **Eurooppalainen arviointiasiakirja:** **ETAG 001-5**  
Eurooppalainen tekninen arviointi: **ETA-11/0415, 08.12.2017**  
Teknisestä arvioinnista vastaava laitos: DIBt, Berlin  
Ilmoitettu laitos/ilmoitetut laitokset: NB 2873 – Technische Universität Darmstadt

◇ **Ilmoitettu suoritustaso/ilmoitetut suoritustasot:**

Olennaiset ominaisuudet	Suoritustaso
<b>Mekaaninen lujuus ja vakaus (BWR 1)</b>	
Ominaisarvot veto- ja poikittaisjännitykselle	Liite / Annex C1 – C12
Vuorossa	Liite / Annex C13 – C14
<b>Paloturvallisuus (BWR 2)</b>	
Palokäyttäytyminen	Luokka A1
Palonkestävyys	NPD (No Performance Determined) Suoritustasoa ei ole määritely

Edellä yksilöidyn tuotteen suoritustaso on ilmoitettujen suoritustasojen joukon mukainen. Tämä suoritustasoilmoitus on asetuksen (EU) N:o 305/2011 mukaisesti annettu edellä ilmoitetun valmistajan yksinomaisella vastuulla.

Valmistajan puolesta allekirjoittanut:



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Tämän suoritustasoilmoituksen alkuperäinen teksti on kirjoitettu saksaksi. Jos käännökset poikkeavat toisistaan, saksankielinen versio on pätevä.

## Specification of intended use

Injection System VMU plus	Anchor 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
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 +40 °C	max long term temperature +24 °C and max short term temperature +40 °C	
Temperature Range II	-40 °C to +80 °C	max long term temperature +50 °C and max short term temperature +80 °C	
Temperature Range III	-40 °C to +120 °C	max long term temperature +72 °C and max short term temperature +120 °C	

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

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc coated 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: M8 to M30, IG-M6 to IG-M20, Rebar Ø8 to Ø32.
- Flooded holes (not sea water): M8 to M16, IG-M6 to IG-M10, Rebar Ø8 to Ø16.
- Hole drilling by hammer or compressed air drill mode 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.

## Injection system VMU plus for concrete

Intended Use  
Specifications

**Annex B1**

**Table B1: Installation parameters for threaded rod**

Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30
Nominal drill hole diameter	$d_0 =$ [mm]	10	12	14	18	24	28	32	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	80	120	160	180	200
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	80	100	120	135	150
Minimum edge distance	$c_{min}$ [mm]	40	50	60	80	100	120	135	150

<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

**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	24	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	80	100	120	150
Minimum edge distance	$c_{min}$ [mm]	50	60	80	100	120	150

<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
Nominal drill hole diameter	$d_0 =$ [mm]	12	14	16	18	20	24	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	80	100	125	140	160
Minimum edge distance	$c_{min}$ [mm]	40	50	60	70	80	100	125	140	160

**Injection system VMU plus for concrete**

**Intended Use**  
Installation parameters

**Annex B2**

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

Threaded rod 	Internally threaded anchor rod 	Rebar 	Drill bit $\varnothing$ 	Brush $\varnothing$ 	min. Brush $\varnothing$ 	Retaining washer 				
[-]	[-]	$\varnothing$ [mm]	$d_0$ [mm]	$d_b$ [mm]	$d_{b,min}$ [mm]	[-]				
M8			10	12	10,5	No retaining washer required				
M10	VMU-IG M 6	8	12	14	12,5					
M12	VMU-IG M 8	10	14	16	14,5					
		12	16	18	16,5					
M16	VMU-IG M10	14	18	20	18,5	VM-IA 18	$h_{ef} > 250\text{mm}$	$h_{ef} > 250\text{mm}$	all	
		16	20	22	20,5					VM-IA 20
M20	VMU-IG M12	20	24	26	24,5					VM-IA 24
M24	VMU-IG M16		28	30	28,5					VM-IA 28
M27		25	32	34	32,5					VM-IA 32
M30	VMU-IG M20	28	35	37	35,5					VM-IA 35
		32	40	41,5	40,5					VM-IA 40



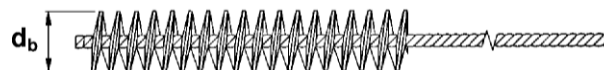
**Blow-out pump (volume 750ml)**  
 Drill bit diameter ( $d_0$ ): 10 mm to 20 mm  
 Anchorage depth ( $h_{ef}$ ):  $\leq 10 d_{nom}$   
 for uncracked concrete



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



**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 VMU plus for concrete**

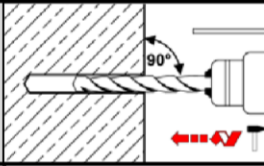
**Intended Use**  
 Cleaning and setting tools

**Annex B3**

# Installation instructions

## Drilling of the hole

1.



Drill the borehole by applying the drilling method acc. to Annex B1, the drill bit diameter (Table B4) and the selected borehole depth.  
In case of aborted drill hole, the drill hole shall be filled with mortar

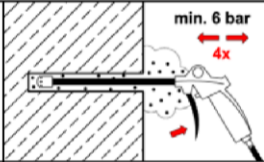
## Cleaning

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

### Cleaning with compressed air

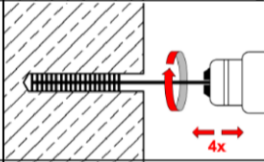
(all diameters, cracked and uncracked concrete)

2a.



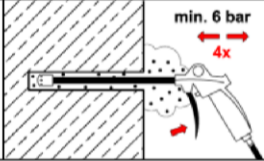
Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) **four** times.  
If the bore hole ground is not reached, an extension must be used.

2b.



Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) **four** times.  
If the bore hole ground is not reached, a brush extension shall be used.

2c.



Finally blow the hole clean again with compressed air (min. 6 bar) **four** times. If the bore hole ground is not reached an extension shall be used.

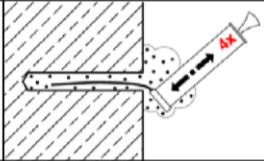
2.

### Manual cleaning

Uncracked concrete: Bore hole diameter  $d_0 \leq 20\text{mm}$  and effective anchorage depth  $h_{ef} \leq 10 d_{nom}$

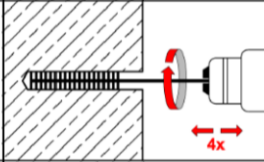
Cracked concrete: Bore hole diameter:  $14\text{mm} \leq d_0 \leq 20\text{mm}$  and effective anchorage depth  $h_{ef} \leq 10 d_{nom}$

2a.



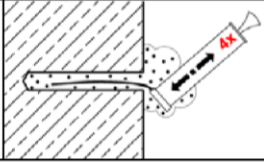
Starting from the bottom or back of the bore hole, blow the hole clean with the blow-out pump **four** times.

2b.



Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) **four** times.  
If the bore hole ground is not reached, a brush extension shall be used.

2c.



Finally blow the hole clean again with the blow-out pump **four** times.

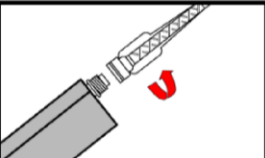
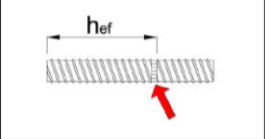

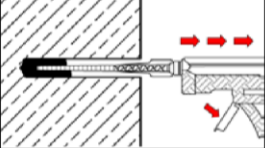
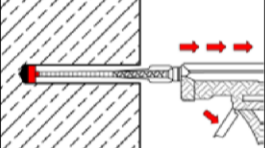
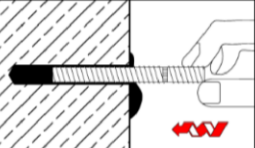
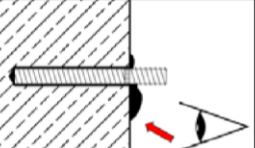
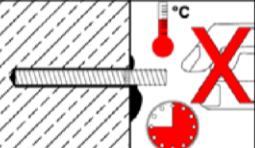
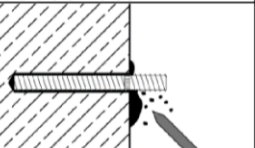
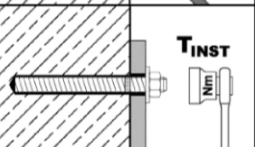
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.

## Injection system VMU plus for concrete

Intended Use  
Installation instructions

Annex B4

## Installation instructions (continuation)

Injection		
3.		Attach a 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 or Table B6) as well as for new cartridges, a new static-mixer shall be used.
4.		Before injecting the mortar, mark the required anchorage depth on the fastening element.
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. For tubular film cartridges dismiss a minimum of six full strokes.
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. For embedment larger than 190mm an extension nozzle shall be used. Observe the gel-/ working times given in Table B5 or Table B6.
6b.		Retaining washer and mixer nozzle extensions shall be used according to Annex B3 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</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>
Inserting the anchor		
7.		Push the threaded rod into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached. The anchor shall be free of dirt, grease, oil or other foreign material.
8.		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, pull out the rod immediately and start again with step 6. For overhead installation, the anchor should be fixed (e.g. by wedges).
9.		Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (Table B5 or Table B6).
10.		Remove excess mortar.
11.		The fixture can be mounted after curing time. Apply installation torque $T_{INST}$ according to Table B1 or B2 by using a calibrated torque wrench. Optionally, the annular gap between anchor rod and attachment can be filled with mortar. Therefore replace the regular washer by washer with bore and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.

### Injection system VMU plus for concrete

**Intended Use**  
Installation instructions (continuation)

**Annex B5**

**Table B5: Maximum processing time and minimum curing time, VMU plus**

Concrete temperature	Maximum processing time	Minimum curing time in dry concrete <sup>1)</sup>
-10°C to -6°C	90 min <sup>2)</sup>	24 h <sup>2)</sup>
-5°C to -1°C	90 min	14 h
0°C to +4°C	45 min	7 h
+5°C to +9°C	25 min	2 h
+10°C to +19°C	15 min	80 min
+20°C to +29°C	6 min	45 min
+30°C to +34°C	4 min	25 min
+35°C to +39°C	2 min	20 min
+ 40°C	1,5 min	15 min
Cartridge temperature	+ 5°C to + 40°C	

<sup>1)</sup> In wet concrete the curing time must be doubled.

<sup>2)</sup> Cartridge temperature must be at min. + 15°C.

**Table B6: Maximum processing time and minimum curing time, VMU plus Polar**

Concrete temperature	Maximum processing time	Minimum curing time in dry concrete <sup>1)</sup>
- 20°C to -16°C	75 min	24 h
-15°C to -11°C	55 min	16 h
-10°C to -6°C	35 min	10 h
-5°C to -1°C	20 min	5 h
0°C to +4°C	10 min	2,5 h
+5°C to +9°C	6 min	80 min
+10°C	6 min	60 min
Cartridge temperature	- 20°C to + 10°C	

<sup>1)</sup> In wet concrete the curing time must be doubled.

**Injection system VMU plus for concrete**

**Intended Use**  
Processing time and curing time

**Annex B6**

**Table C1: Characteristic steel resistances for threaded rods under tension and shear loads**

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 VMU plus for concrete**

**Performance**  
 Characteristic steel resistances for **threaded rods** under **tension** and **shear loads**

**Annex C1**



**Table C2: Characteristic values for threaded rods under tension loads in cracked concrete**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</b>											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	see table C1							
<b>Combined pull-out and concrete cone failure</b>											
Characteristic bond resistance in cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	4,0	5,0	5,5	5,5	5,5	5,5	6,5	6,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	4,0	4,0	5,5	5,5	no performance determined (NPD)			
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,5	4,0	4,0	4,0	4,0	4,5	4,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,0	4,0	4,0	no performance determined (NPD)			
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,0	2,5	3,0	3,0	3,0	3,0	3,5	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,0	2,5	3,0	3,0	no performance determined (NPD)			
Increasing factor for $\tau_{Rk,cr}$			$\psi_c$	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/TS 1992-4-5		$k_B$	[-]	7,2							
<b>Concrete cone failure</b>											
Factor according to CEN/TS 1992-4-5		$k_{cr}$	[-]	7,2							
Edge distance		$c_{cr,N}$	[mm]	1,5 $h_{ef}$							
Axial distance		$s_{cr,N}$	[mm]	3,0 $h_{ef}$							
Installation factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2						
Installation factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4				no performance determined (NPD)			

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for **threaded rods** under **tension loads** in **cracked concrete**

**Annex C2**

**Table C3:** Characteristic values for **threaded rods** under **tension loads** in **uncracked concrete**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure</b>											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	see table C1							
<b>Combined pull-out and concrete cone failure</b>											
Characteristic bond resistance in uncracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	10	12	12	12	12	11	10	9
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	7,5	8,5	8,5	8,5	no performance determined (NPD)			
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	7,5	9	9	9	9	8,5	7,5	6,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5	no performance determined (NPD)			
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	4,0	5,0	5,0	5,0	no performance determined (NPD)			
Increasing factor for $\tau_{Rk,ucr}$		$\psi_c$	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/TS 1992-4-5		$k_8$	[-]	10,1							
<b>Concrete cone failure</b>											
Factor according to CEN/TS 1992-4-5		$k_{ucr}$	[-]	10,1							
Edge distance		$c_{Cr,N}$	[mm]	1,5 $h_{ef}$							
Axial distance		$s_{Cr,N}$	[mm]	3,0 $h_{ef}$							
<b>Splitting failure</b>											
Edge distance for		$c_{Cr,sp}$	[mm]	$1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left( 2,5 - \frac{h}{h_{ef}} \right) \leq 2,4 \cdot h_{ef}$							
Axial distance		$s_{Cr,sp}$	[mm]	2 $c_{Cr,sp}$							
Installation factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2						
Installation factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4				no performance determined (NPD)			

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for **threaded rods** under **tension loads** in **uncracked concrete**

**Annex C3**

**Table C4:** Characteristic values for **threaded rods** under **shear loads** in **cracked and uncracked concrete**

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Steel failure without lever arm</b>										
Characteristic shear resistance	$V_{Rk,s}$	[kN]	see table C1							
Ductility factor acc. to CEN/TS 1992-4-5	$k_2$	[-]	0,8							
<b>Steel failure with lever arm</b>										
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	see table C1							
<b>Concrete pry-out failure</b>										
Factor k acc. to TR 029 or $k_3$ 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]	8	10	12	16	20	24	27	30
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0							

**Injection system VMU plus for concrete**

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

**Annex C4**

**Table C5:** Characteristic values for **threaded rods** under **seismic action**, category **C1**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30	
<b>Tension load</b>												
<b>Steel failure</b>												
Characteristic tension resistance	$N_{Rk,s,seis}$	[kN]	$1,0 \cdot N_{Rk,s}$ (see table C1)									
<b>Combined pull-out and concrete cone failure</b>												
Characteristic bond resistance in concrete C20/25 to C50/60												
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	2,5	3,1	3,7	3,7	3,7	3,8	4,5	4,5	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	2,5	2,5	3,7	3,7	no performance determined (NPD)				
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,6	2,2	2,7	2,7	2,7	2,8	3,1	3,1	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,6	1,9	2,7	2,7	no performance determined (NPD)				
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,3	1,6	2,0	2,0	2,0	2,1	2,4	2,4	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,3	1,6	2,0	2,0	no performance determined (NPD)				
Increasing factor for $\tau_{Rk,seis}$	$\psi_c$	[-]	1,0									
Installation factor (dry and wet concrete)	$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2								
Installation factor (flooded bore hole)	$\gamma_2 = \gamma_{inst}$	[-]	1,4					no performance determined (NPD)				
<b>Shear load</b>												
<b>Steel failure without lever arm</b>												
Characteristic shear resistance	$V_{Rk,s,seis}$	[kN]	$0,7 \cdot V_{Rk,s}$ (see table C1)									
<b>Steel failure with lever arm</b>												
Characteristic bending moment	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)									

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for **threaded rods** under **seismic action**, category **C1**

**Annex C5**

**Table C6: Characteristic values of tension loads for internally threaded anchor rods in cracked concrete**

Internally threaded anchor rod				IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M20
<b>Steel failure <sup>1)</sup></b>									
Characteristic shear resistance Steel, strength class 5.8	$N_{Rk,s}$	[kN]		10	18	29	42	79	123
Partial factor	$\gamma_{Ms,N}$	[-]		1,5					
Characteristic shear resistance Steel, strength class 8.8	$N_{Rk,s}$	[kN]		16	27	46	67	121	196
Partial factor	$\gamma_{Ms,N}$	[-]		1,5					
Characteristic shear resistance Stainless steel A4 / HCR, strength 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 cone failure</b>									
Characteristic bond resistance in <b>cracked</b> concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	5,0	5,5	5,5	5,5	5,5	6,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	4,0	5,5	5,5	no performance determined (NPD)		
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	3,5	4,0	4,0	4,0	4,0	4,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	3,0	4,0	4,0	no performance determined (NPD)		
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,0	3,0	3,0	3,0	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,0	3,0	no performance determined (NPD)		
Increasing factor for $\tau_{Rk,cr}$		$\psi_c$	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/TS 1992-4-5	$k_g$	[-]		7,2					
<b>Concrete cone failure</b>									
Factor according to CEN/TS 1992-4-5	$k_{cr}$	[-]		7,2					
Edge distance	$c_{cr,N}$	[mm]		1,5 $h_{ef}$					
Spacing	$s_{cr,N}$	[mm]		3,0 $h_{ef}$					
Installation factor (dry and wet concrete)	$\gamma_2 = \gamma_{inst}$	[-]		1,2					
Installation factor (flooded bore hole)	$\gamma_2 = \gamma_{inst}$	[-]		1,4			no performance determined (NPD)		

<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: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for **internally threaded anchor rods** under **tension loads** in **cracked concrete**

**Annex C6**

**Table C7: Characteristic values of tension loads for internally threaded anchor rods in uncracked concrete**

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 shear resistance Steel, strength class 5.8	$N_{Rk,s}$	[kN]	10	18	29	42	79	123	
Partial factor	$\gamma_{Ms,N}$	[-]	1,5						
Characteristic shear resistance Steel, strength class 8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196	
Partial factor	$\gamma_{Ms,N}$	[-]	1,5						
Characteristic shear resistance Stainless steel A4 / HCR, strength 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 cone failure</b>									
Characteristic bond resistance in <b>uncracked</b> concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	12	12	12	12	11	9,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	8,5	8,5	8,5	no performance determined		
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	9,0	9,0	9,0	9,0	8,5	6,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	6,5	6,5	6,5	no performance determined		
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	6,5	6,5	6,5	6,5	6,5	5,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	5,0	5,0	5,0	no performance determined		
Increasing factor for $\tau_{Rk,ucr}$	$\psi_c$	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/TS 1992-4-5	$k_g$	[-]	10,1						
<b>Concrete cone failure</b>									
Factor according to CEN/TS 1992-4-5	$k_{ucr}$	[-]	10,1						
Edge distance	$c_{cr,N}$	[mm]	1,5 $h_{ef}$						
Spacing	$s_{cr,N}$	[mm]	3,0 $h_{ef}$						
<b>Splitting failure</b>									
Edge distance	$c_{cr,sp}$	[mm]	$h/h_{ef} \geq 2,0$	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 (dry and wet concrete)	$\gamma_2 = \gamma_{inst}$	[-]	1,2						
Installation factor (flooded bore hole)	$\gamma_2 = \gamma_{inst}$	[-]	1,4			no performance determined			

<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: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for **internally threaded anchor rods** under **tension loads** in **uncracked concrete**

**Annex C7**

**Table C8: Characteristic values for internally threaded anchor rods under shear loads in cracked and uncracked concrete**

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					
Ductility factor according to CEN/TS 1992-4-5	$k_2$	[-]	0,8					
<b>Steel failure <u>with</u> lever arm<sup>1)</sup></b>								
Characteristic bending moment, Steel, strength class 5.8	$M_{Rk,s}^0$	[Nm]	8	19	37	66	167	325
Partial factor	$\gamma_{Ms,v}$	[-]	1,25					
Characteristic bending moment, Steel, strength class 8.8	$M_{Rk,s}^0$	[Nm]	12	30	60	105	267	519
Partial factor	$\gamma_{Ms,v}$	[-]	1,25					
Characteristic bending moment, Stainless steel A4 / HCR, strength class 70	$M_{Rk,s}^0$	[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 or $k_3$ 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 VMU plus for concrete**

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

**Annex C8**

**Table C9: Characteristic values for rebar under tension loads in cracked concrete**

Rebar			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	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$										
<b>Combined pull-out and concrete cone failure</b>													
Characteristic bond resistance in cracked concrete C20/25													
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	4,0	5,0	5,5	5,5	5,5	5,5	5,5	6,5	6,5	
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	4,0	4,0	5,5	5,5	5,5	no performance determined (NPD)				
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,5	4,0	4,0	4,0	4,0	4,0	4,5	4,5	
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,5	3,0	4,0	4,0	4,0	no performance determined (NPD)				
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,0	2,5	3,0	3,0	3,0	3,0	3,0	3,5	3,5	
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	2,0	2,5	3,0	3,0	3,0	no performance determined (NPD)				
Increasing factors for $\tau_{Rk,cr}$		$\psi_c$	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 acc. to CEN/TS 1992-4-5	$k_B$	[-]	7,2										
<b>Concrete cone failure</b>													
Factor acc. to CEN/TS 1992-4-5	$k_{cr}$	[-]	7,2										
Edge distance	$c_{cr,N}$	[mm]	1,5 $h_{ef}$										
Axial distance	$s_{cr,N}$	[mm]	3,0 $h_{ef}$										
Installation factor (dry and wet concrete)	$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2									
Installation factor (flooded bore hole)	$\gamma_2 = \gamma_{inst}$	[-]	1,4						no performance determined (NPD)				

<sup>1)</sup>  $f_{uk} = f_{tk} = k \cdot f_{yk}$

**Injection system VMU plus for concrete**

**Performance**  
Characteristic values for rebar under tension loads in cracked concrete

**Annex C9**



**Table C10: Characteristic values for rebar under tension loads in uncracked concrete**

Rebar			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	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$										
<b>Combined pull-out and concrete cone failure</b>													
Characteristic bond resistance in uncracked concrete C20/25													
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	10	12	12	12	12	12	11	10	8,5	
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	7,5	8,5	8,5	8,5	8,5	no performance determined (NPD)				
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	7,5	9,0	9,0	9,0	9,0	9,0	8,0	7,0	6,0	
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5	6,5	no performance determined (NPD)				
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5	
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	4,0	5,0	5,0	5,0	5,0	no performance determined (NPD)				
Increasing factors for $\tau_{Rk,ucr}$		$\psi_c$	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 acc. to CEN/TS 1992-4-5	$k_8$	[-]	10,1										
<b>Concrete cone failure</b>													
Factor acc. to CEN/TS 1992-4-5	$k_{ucr}$	[-]	10,1										
Edge distance	$c_{cr,N}$	[mm]	1,5 $h_{ef}$										
Axial distance	$s_{cr,N}$	[mm]	3,0 $h_{ef}$										
<b>Splitting failure</b>													
Edge distance for	$c_{cr,sp}$	[mm]	$1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left( 2,5 - \frac{h}{h_{ef}} \right) \leq 2,4 \cdot h_{ef}$										
Axial distance	$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$										
Installation factor (dry and wet concrete)	$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2									
Installation factor (flooded bore hole)	$\gamma_2 = \gamma_{inst}$	[-]	1,4						no performance determined (NPD)				

<sup>1)</sup>  $f_{uk} = f_{tk} = k \cdot f_{yk}$

**Injection system VMU plus for concrete**

**Performance**  
Characteristic values for rebar under tension loads in uncracked concrete

**Annex C10**

**Table C11: Characteristic values for rebar under shear loads in cracked and uncracked concrete**

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
<b>Steel failure without lever arm</b>											
Characteristic shear resistance	$V_{Rk,s}$	[kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$								
Ductility factor according to CEN/TS 1992-4-5	$k_2$	[-]	0,8								
<b>Steel failure with lever arm</b>											
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$								
<b>Concrete pry-out failure</b>											
Factor k acc. to TR 029 or $k_3$ 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]	8	10	12	14	16	20	25	28	32
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0								

<sup>1)</sup>  $f_{uk} = f_{tk} = k \cdot f_{yk}$

**Injection system VMU plus for concrete**

**Performance**

Characteristic values for rebar under shear loads in cracked and uncracked concrete

**Annex C11**

**Table C12: Characteristic values for rebar under seismic action, category C1**

Rebar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32	
<b>Tension load</b>													
<b>Steel failure</b>													
Characteristic tension resistance	$N_{Rk,s,seis}$	[kN]	$A_s \cdot f_{uk}^{1)}$										
<b>Combined pull-out and concrete cone failure</b>													
Characteristic bond resistance in concrete C20/25 to C50/60													
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	2,5	3,1	3,7	3,7	3,7	3,7	3,8	4,5	4,5	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	2,5	2,5	3,7	3,7	3,7	no performance determined (NPD)				
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,6	2,2	2,7	2,7	2,7	2,7	2,8	3,1	3,1	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,6	1,9	2,7	2,7	2,7	no performance determined (NPD)				
Temperature range III: 120°C/72°C	dry and wet concrete	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,3	1,6	2,0	2,0	2,0	2,0	2,1	2,4	2,4	
	flooded bore hole	$\tau_{Rk,seis}$	[N/mm <sup>2</sup> ]	1,3	1,6	2,0	2,0	2,0	no performance determined (NPD)				
Increasing factor for $\tau_{Rk,seis}$		$\psi_c$	[-]	1,0									
Installation factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,0	1,2								
Installation factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4						no performance determined (NPD)			
<b>Shear load</b>													
<b>Steel failure without lever arm</b>													
Characteristic shear resistance	$V_{Rk,s,seis}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$										
<b>Steel failure with lever arm</b>													
Characteristic bending moment	$M_{Rk,s,seis}^0$	[Nm]	no performance determined (NPD)										

<sup>1)</sup>  $f_{uk} = f_{tk} = k \cdot f_{yk}$

**Injection system VMU plus for concrete**

**Performance**  
Characteristic values for rebar under seismic action, category C1

**Annex C12**

**Table C13: Displacements under tension loads<sup>1)</sup>**  
(threaded rod and internally threaded anchor rod)

Threaded rod			M8	M10 IG-M6	M12 IG-M8	M16 IG- M10	M20 IG-M12	M24 IG-M16	M27	M30 IG-M20
<b>Uncracked concrete C20/25</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,030	0,033	0,037	0,045	0,052	0,060	0,065	0,071
Temperature range II: 80°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Temperature range III: 120°C/72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
<b>Cracked concrete C20/25</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,090		0,070					
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,105		0,105					
Temperature range II: 80°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,219		0,170					
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,255		0,245					
Temperature range III: 120°C/72°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,219		0,170					
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,255		0,245					

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

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

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

**Table C14: Displacements under shear load<sup>1)</sup>**  
(threaded rod and internally threaded anchor rod)

Threaded rod			M8	M10 IG-M6	M12 IG-M8	M16 IG- M10	M20 IG-M12	M24 IG-M16	M27	M30 IG-M20
<b>Uncracked concrete C20/25</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</b>										
All temperature ranges	$\delta_{V0}$ -factor	[mm/(kN)]	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07
	$\delta_{V\infty}$ -factor	[mm/(kN)]	0,18	0,18	0,17	0,15	0,14	0,13	0,12	0,10

<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 VMU plus for concrete**

**Performance**

Displacements (threaded rod and internally threaded anchor rod)

**Annex C13**

**Table C15: 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</b>											
Temperature range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,030	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
Temperature range II: 80°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Temperature range III: 120°C/72°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
<b>Cracked concrete C20/25</b>											
Temperature range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,090				0,070				
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,105				0,105				
Temperature range II: 80°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,219				0,170				
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,255				0,245				
Temperature range III: 120°C/72°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,219				0,170				
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,255				0,245				

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

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

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

**Table C16: 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>Uncracked concrete C20/25</b>											
All temperature ranges	δ <sub>V0</sub> -factor	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
	δ <sub>V∞</sub> -factor	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
<b>Cracked concrete C20/25</b>											
All temperature ranges	δ <sub>V0</sub> -factor	[mm/(kN)]	0,12	0,12	0,11	0,11	0,10	0,09	0,08	0,07	0,06
	δ <sub>V∞</sub> -factor	[mm/(kN)]	0,18	0,18	0,17	0,16	0,15	0,14	0,12	0,11	0,10

<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 VMU plus for concrete**

**Performance**  
Displacements (rebar)

**Annex C14**