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## PRESTANDEKLARATION

DoP Nr: **MKT-2.1-301\_sv**

- ✧ **Produkttypens unika identifikationskod:** **Insprutningssystem VMU plus för betong**
- ✧ **Avsedd användning/avsedda användningar:** Bundet ankare för förankring i betong, se bilaga/Annex B
- ✧ **Tillverkare:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ✧ **System för bedömning och fortlöpande kontroll av prestanda:** 1
- ✧ **Europeiskt bedömningsdokument:** **EAD 330499-01-0601**  
Europeisk teknisk bedömning: **ETA-11/0415, 01.06.2021**  
Tekniskt bedömningsorgan: DIBt, Berlin  
Anmält/anmälda organ: NB 2873 – Technische Universität Darmstadt
- ✧ **Angiven prestanda:**

| Väsentliga egenskaper   | Prestanda                           |
|---|-------------------------------------|
| <b>Bärförmåga, stadga och beständighet (BWR 1)</b>                                  |                                     |
| Karakteristiska motstånd under dragbelastning (statiska och kvasistatiska effekter) | Bilaga/Annex B2, C1, C3, C4, C7, C9 |
| Karakteristiska motstånd under tvärspänning (statiska och kvasistatiska effekter)   | Bilaga/Annex C2, C5, C8, C10        |
| Skift (statiska och kvasistatiska effekter)   | Bilaga/Annex C12, C13               |
| Karakteristisk motstånd och skift för seismisk prestanda kategori C1                | Bilaga/Annex C6, C11                |
| Karakteristisk motstånd och skift för seismisk prestanda kategori C2                | Prestanda inte betygsatt            |
| <b>Hygien, hälsa och miljö (BWR 3)</b>  |                                     |
| Innehåll, utsläpp och / eller utsläpp av farliga ämnen                              | Prestanda inte betygsatt            |

Prestandan för ovanstående produkt överensstämmer med den angivna prestandan. Denna prestandadeklaration har utfärdats i enlighet med förordning (EU) nr 305/2011 på eget ansvar av den tillverkare som anges ovan.

Undertecknad på tillverkarens vägnar av:

  
**Stefan Weustenhagen**  
(Verkställande direktör)  
**Weilerbach, 01.06.2021**

p.p.   
**Dipl.-Ing. Detlef Bigalke**  
(Produktutveckling direktör)



Originalen av denna deklareringsförklaring skrevs på tyska. Vid avvikelser i översättningen gäller den tyska versionen.

## Specification of intended use

| Injection System VMU plus               | Threaded rod  | Internally threaded anchor rod           | Rebar    |
|---|---|--|----------|
| Static and quasi-static action          | M8 - M30  | IG-M6 - IG-M20<br>(zinc plated, A4, HCR) | Ø8 - Ø32 |
| Seismic action, performance category C1 | M8 - M30  | -  | Ø8 - Ø32 |
| Base materials                          | compacted, reinforced or unreinforced normal weight concrete (without fibers), acc. to EN 206:2013 + A1:2016<br>strength classes C20/25 to C50/60 acc. to EN 206-1:2013+A1:2016<br>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  |  |          |

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions:  
Intended use of Material according to Annx 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: M8 to M30, IG-M6 to IG-M20, Rebar Ø8 to Ø32
- Waterfilled 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
- Installation direction D3: downwards, horizontally and upwards (overhead) installation
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site
- The injection mortar is assessed for installation at minimum concrete temperature of -10°C resp. -20°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 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 |
|---|--|------|----------------------------|-----|--------------------------|-----------------|-----|-----|-----|-----|
| Diameter 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              | 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 | Pre-setting installation<br>$d_f \leq$     | [mm] | 9                          | 12  | 14                       | 18              | 22  | 26  | 30  | 33  |
|   | Through setting installation<br>$d_f \leq$ | [mm] | 12                         | 14  | 16                       | 20              | 25  | 30  | 33  | 38  |
| Installation torque                       | $\max T_{inst} \leq$                       | [Nm] | 10                         | 20  | 40<br>(35) <sup>1)</sup> | 80              | 120 | 160 | 180 | 200 |
| Minimum thickness of member               | $h_{min}$                                  | [mm] | $h_{ef} + 30mm \geq 100mm$ |     |                          | $h_{ef} + 2d_0$ |     |     |     |     |
| 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> max. installation torque for property class 4.6

**Table B2: Installation parameters for internally threaded anchor rod**

| Internally threaded anchor rod               |                      |      | IG-M 6                                       | IG-M 8 | IG-M 10 | IG-M 12         | IG-M 16 | IG-M 20 |
|--|----------------------|------|--|--------|---------|-----------------|---------|---------|
| Inner diameter of threaded rod               | $d_2$                | [mm] | 6  | 8      | 10      | 12              | 16      | 20      |
| Outer diameter of threaded rod <sup>1)</sup> | $d=d_{nom}$          | [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    | $d_f \leq$           | [mm] | 7  | 9      | 12      | 14              | 18      | 22      |
| 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     | 80      | 100             | 120     | 150     |
| Minimum edge distance                        | $c_{min}$            | [mm] | 50   | 60     | 80      | 100             | 120     | 150     |

<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 25 | Ø 28 | Ø 32 |
|-----------------------------|--------------|------|--|------|------|-----------------|------|------|------|------|------|
| Diameter threaded rod       | $d=d_{nom}$  | [mm] | 8  | 10   | 12   | 14              | 16   | 20   | 24   | 28   | 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  |   |   |   |
|---|---|---|---|---|--|---|---|---|---|
|  |  |  |  |  |  | <b>Installation direction and use of retaining washer</b> |   |   |   |
| [-]   | [-]   | $\varnothing$ [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**

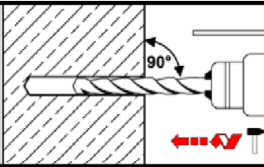
**Intended Use**  
 Cleaning and setting tools

**Annex B3**

# Installation instructions

## Drilling of the hole

1



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

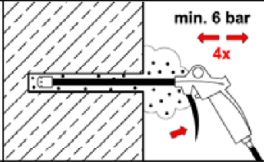
## Cleaning, all drilling methods

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

### Cleaning with compressed air

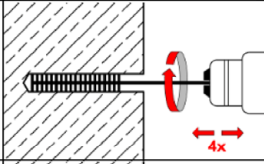
(all diameters, cracked and uncracked concrete)

2a



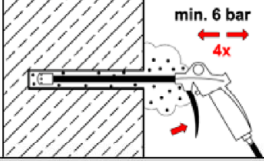
Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) **four** times, until return air stream is free of noticeable dust.  
If the drill hole ground is not reached, an extension must be used.

2b



Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) **four** times.  
If the drill 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, until the outgoing airstream is free of dust. If the drill hole ground is not reached an extension shall be used.

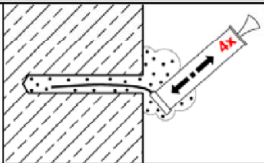
2

### Manual cleaning

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

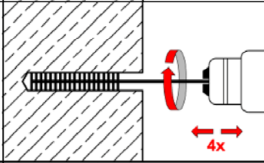
cracked concrete: Drill hole diameter:  $14\text{mm} \leq d_0 \leq 20\text{mm}$  and effective anchorage depth  $h_{ef} \leq 10 d_{nom}$

2a



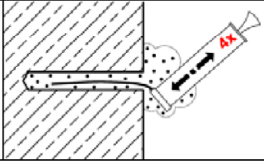
Starting from the bottom or back of the drill hole, blow the hole clean with the blow-out pump **four** times until return air stream is free of noticeable dust.

2b



Brush the hole **four** times with an appropriate sized wire brush  $> d_{b,min}$  (Table B4).  
If the drill 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 until return air stream is free of noticeable dust.

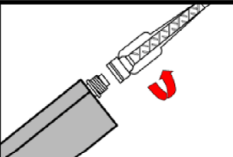
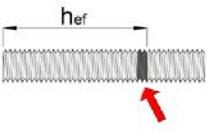
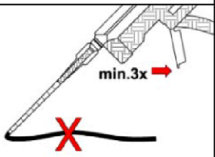
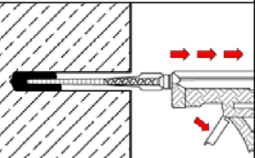
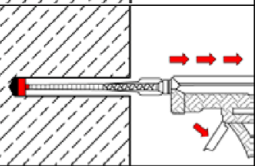
After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.

## Injection system 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> |

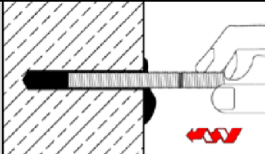
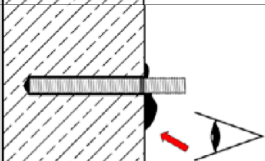
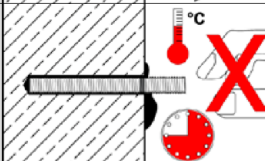
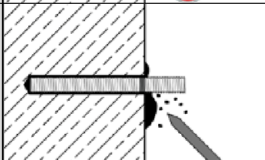
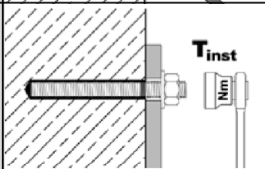
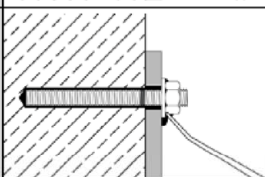
Injection system VMU plus for concrete

**Intended Use**  
Installation instructions (continuation)

**Annex B5**

## Installation instructions (continuation)

### Setting the fastening element

|    |   |  |
|----|---|--|
| 7  |    | <p>Push fastening element 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.</p>  |
| 8  |    | <p>Make sure that the fastening element is fully seated up to the full embedment depth and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed before the end of the working time. For overhead installation, the anchor should be fixed (e.g. by wedges).</p> |
| 9  |    | <p>Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (Table B5 or 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>Optionally, for pre-setting installation, the annular gap between anchor rod and attachment can be filled with mortar. Therefore replace the regular washer by washer with drill and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.</p>  |

Injection system VMU plus for concrete

**Intended Use**  
Installation instructions (continuation)

**Annex B6**

**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  |
| <b>Cartridge temperature</b> | <b>+ 5°C to + 40°C</b>  |   |

<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  |
| <b>Cartridge temperature</b> | <b>- 20°C to + 10°C</b> |   |

<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 B7**



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

| 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,<br>zinc plated   | Property class 4.6 and 4.8          | $N_{Rk,s}$      | [kN] | 15<br>(13) | 23<br>(21) | 34   | 63  | 98  | 141 | 184             | 224             |
|   | Property class 5.6 and 5.8          | $N_{Rk,s}$      | [kN] | 18<br>(17) | 29<br>(27) | 42   | 78  | 122 | 176 | 230             | 280             |
|   | Property class 8.8                  | $N_{Rk,s}$      | [kN] | 29<br>(27) | 46<br>(43) | 67   | 125 | 196 | 282 | 368             | 449             |
| Stainless<br>steel  | A2, A4 and HCR<br>Property class 50 | $N_{Rk,s}$      | [kN] | 18         | 29         | 42   | 79  | 123 | 177 | 230             | 281             |
|   | A2, A4 and HCR<br>Property class 70 | $N_{Rk,s}$      | [kN] | 26         | 41         | 59   | 110 | 171 | 247 | _ <sup>3)</sup> | _ <sup>3)</sup> |
|   | A4 and HCR<br>Property class 80     | $N_{Rk,s}$      | [kN] | 29         | 46         | 67   | 126 | 196 | 282 | _ <sup>3)</sup> | _ <sup>3)</sup> |
| <b>Partial factors <sup>2)</sup></b>                              |                                     |                 |      |            |            |      |     |     |     |                 |                 |
| Steel,<br>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<br>steel  | A2, A4 and HCR<br>Property class 50 | $\gamma_{Ms,N}$ | [-]  | 2,86       |            |      |     |     |     |                 |                 |
|   | A2, A4 and HCR<br>Property class 70 | $\gamma_{Ms,N}$ | [-]  | 1,87       |            |      |     |     |     | _ <sup>3)</sup> | _ <sup>3)</sup> |
|   | A4 and HCR<br>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 national regulation

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

**Injection system VMU plus for concrete**

**Performance**

Characteristic steel resistances for **threaded rods** under **tension loads**

**Annex C1**

**Table C2: Characteristic steel resistances for threaded rods under shear loads**

| 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 shear load <sup>1)</sup></b> |                                   |                 |      |            |            |      |     |     |      |      |      |  |
| <b>Steel failure <u>without</u> lever arm</b>                   |                                   |                 |      |            |            |      |     |     |      |      |      |  |
| Steel,<br>zinc plated   | Property class 4.6 and 4.8        | $V^{0}_{Rk,s}$  | [kN] | 9<br>(8)   | 14<br>(13) | 20   | 38  | 59  | 85   | 110  | 135  |  |
|   | Property class 5.6 and 5.8        | $V^{0}_{Rk,s}$  | [kN] | 11<br>(10) | 17<br>(16) | 25   | 47  | 74  | 106  | 138  | 168  |  |
|   | Property class 8.8                | $V^{0}_{Rk,s}$  | [kN] | 15<br>(13) | 23<br>(21) | 34   | 63  | 98  | 141  | 184  | 224  |  |
| Stainless<br>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  | _-3) | _-3) |  |
|   | A4 and HCR, property class 80     | $V^{0}_{Rk,s}$  | [kN] | 15         | 23         | 34   | 63  | 98  | 141  | _-3) | _-3) |  |
| <b>Steel failure <u>with</u> lever arm</b>                      |                                   |                 |      |            |            |      |     |     |      |      |      |  |
| Steel,<br>zinc plated   | Property class 4.6 and 4.8        | $M^{0}_{Rk,s}$  | [Nm] | 15<br>(13) | 30<br>(27) | 52   | 133 | 260 | 449  | 666  | 900  |  |
|   | Property class 5.6 and 5.8        | $M^{0}_{Rk,s}$  | [Nm] | 19<br>(16) | 37<br>(33) | 65   | 166 | 324 | 560  | 833  | 1123 |  |
|   | Property class 8.8                | $M^{0}_{Rk,s}$  | [Nm] | 30<br>(26) | 60<br>(53) | 105  | 266 | 519 | 896  | 1333 | 1797 |  |
| Stainless<br>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  | _-3) | _-3) |  |
|   | A4 and HCR, property class 80     | $M^{0}_{Rk,s}$  | [Nm] | 30         | 59         | 105  | 266 | 519 | 896  | _-3) | _-3) |  |
| <b>Partial factor <sup>2)</sup></b>                             |                                   |                 |      |            |            |      |     |     |      |      |      |  |
| Steel,<br>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<br>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       |            |      |     |     | _-3) | _-3) |      |  |
|   | A4 and HCR, property class 80     | $\gamma_{Ms,V}$ | [-]  | 1,33       |            |      |     |     | _-3) | _-3) |      |  |

1) the characteristic resistances apply for all anchor rods with the cross sectional area  $A_s$  specified here: VMU-A, V-A, VM-A  
For commercial standard threaded rods with a smaller cross sectional area (e.g. hot-dip galvanized threaded rods M8, M10 according to EN ISO 10684:2004 + AC:2009), the values in brackets are valid.

2) in absence of national regulation

3) Anchor type not part of the ETA

**Injection system VMU plus for concrete**

**Performance**

Characteristic steel resistances for **threaded rods** under **tension loads**

**Annex C2**

**Table C3: Characteristic values for concrete cone 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] | $2 \cdot c_{Cr,N}$                  |
| <b>Splitting failure</b>                                 |                        |               |      |                                     |
| Characteristic resistance                                |                        | $N_{Rk,sp}^0$ | [kN] | $\min ( N_{Rk,p} ; N_{Rk,c}^0 )$    |
| 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] | $2 \cdot c_{Cr,sp}$                 |

**Injection system VMU plus for concrete**

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

**Annex C3**

**Table C4: Characteristic values for threaded rods under tension loads**

| 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    | dry or wet concrete                         | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 10                                   | 12   | 12  | 12                      | 12                      | 11  | 10  | 9   |
|   | II: 80°C/50°C   |   |                 |                      | 7,5                                  | 9    | 9   | 9                       | 9                       | 8,5 | 7,5 | 6,5 |
|   | III: 120°C/72°C |   |                 |                      | 5,5                                  | 6,5  | 6,5 | 6,5                     | 6,5                     | 6,5 | 5,5 | 5,0 |
|   | I: 40°C/24°C    | waterfilled drill hole                      | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 7,5                                  | 8,5  | 8,5 | 8,5                     | no performance assessed |     |     |     |
|   | II: 80°C/50°C   |   |                 |                      | 5,5                                  | 6,5  | 6,5 | 6,5                     |                         |     |     |     |
|   | III: 120°C/72°C |   |                 |                      | 4,0                                  | 5,0  | 5,0 | 5,0                     |                         |     |     |     |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |                 |   |                 |                      |                                      |      |     |                         |                         |     |     |     |
| Temperature range   | I: 40°C/24°C    | dry or 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 |
|   | II: 80°C/50°C   |   |                 |                      | 2,5                                  | 3,5  | 4,0 | 4,0                     | 4,0                     | 4,0 | 4,5 | 4,5 |
|   | III: 120°C/72°C |   |                 |                      | 2,0                                  | 2,5  | 3,0 | 3,0                     | 3,0                     | 3,0 | 3,5 | 3,5 |
|   | I: 40°C/24°C    | waterfilled drill hole                      | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0                                  | 4,0  | 5,5 | 5,5                     | no performance assessed |     |     |     |
|   | II: 80°C/50°C   |   |                 |                      | 2,5                                  | 3,0  | 4,0 | 4,0                     |                         |     |     |     |
|   | III: 120°C/72°C |   |                 |                      | 2,0                                  | 2,5  | 3,0 | 3,0                     |                         |     |     |     |
| <b>Reduction factor <math>\psi^0_{sus}</math> in concrete C20/25</b>      |                 |   |                 |                      |                                      |      |     |                         |                         |     |     |     |
| Temperature range   | I: 40°C/24°C    | dry or wet concrete; waterfilled drill hole | $\psi^0_{sus}$  | [-]                  | 0,73                                 |      |     |                         |                         |     |     |     |
|   | II: 80°C/50°C   |   |                 |                      | 0,65                                 |      |     |                         |                         |     |     |     |
|   | III: 120°C/72°C |   |                 |                      | 0,57                                 |      |     |                         |                         |     |     |     |
| Increasing factors for $\tau_{Rk}$  |                 |   | $\psi_c$        | [-]                  | 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   |                 |   | $\gamma_{inst}$ | [-]                  | 1,0                                  | 1,2  |     |                         |                         |     |     |     |
| waterfilled drill hole  |                 |   | $\gamma_{inst}$ | [-]                  | 1,4                                  |      |     | no performance assessed |                         |     |     |     |

**Injection system VMU plus for concrete**

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

**Annex C4**

**Table C5: Characteristic values for threaded rods under shear loads**

| Threaded rod  |                   |                    | M8  | M10 | M12 | M16 | M20 | M24 | M27                          | M30  |  |
|---|-------------------|--------------------|---|-----|-----|-----|-----|-----|------------------------------|------|--|
| <b>Steel failure without lever arm</b>  |                   |                    |   |     |     |     |     |     |                              |      |  |
| Characteristic resistance, steel zinc plated, property class 4.6, 4.8, 5.6, 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, property class 8.8, stainless steel A2 / A4 / HCR, all property classes | $V_{Rk,s}^0$      | [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>Ms,V</sub> | [-]                | see Table C2  |     |     |     |     |     |                              |      |  |
| <b>Steel failure with lever arm</b>   |                   |                    |   |     |     |     |     |     |                              |      |  |
| Characteristic bending moment   | $M_{Rk,s}^0$      | [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>Ms,V</sub> | [-]                | see table C2  |     |     |     |     |     |                              |      |  |
| <b>Concrete pry-out failure</b>   |                   |                    |   |     |     |     |     |     |                              |      |  |
| Pry-out Factor  | k <sub>8</sub>    | [-]                | 2,0   |     |     |     |     |     |                              |      |  |
| <b>Concrete edge failure</b>  |                   |                    |   |     |     |     |     |     |                              |      |  |
| Effective length of anchor  | l <sub>f</sub>    | [mm]               | min(h <sub>ef</sub> ; 12 d <sub>nom</sub> )               |     |     |     |     |     | min(h <sub>ef</sub> ; 300mm) |      |  |
| Outside diameter of anchor  | d <sub>nom</sub>  | [mm]               | 8   | 10  | 12  | 16  | 20  | 24  | 27                           | 30   |  |
| Installation factor   | γ <sub>inst</sub> | [-]                | 1,0   |     |     |     |     |     |                              |      |  |

**Injection system VMU plus for concrete**

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

**Annex C5**

**Table C6: Characteristic values for threaded rods under tension load, seismic action, performance category C1**

| Threaded rod   |                 |                        |                | M8                   | M10 | M12 | M16 | M20 | M24                     | M27 | M30 |     |
|--|-----------------|------------------------|----------------|----------------------|-----|-----|-----|-----|-------------------------|-----|-----|-----|
| <b>Steel failure</b>   |                 |                        |                |                      |     |     |     |     |                         |     |     |     |
| Characteristic resistance  |                 | $N_{Rk,s,C1}$          | [kN]           | $1,0 \cdot N_{Rk,s}$ |     |     |     |     |                         |     |     |     |
| Partial factor   |                 | $\gamma_{Ms,V}$        | [-]            | 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    | dry or wet concrete    | $\tau_{Rk,C1}$ | [N/mm <sup>2</sup> ] | 2,5 | 3,1 | 3,7 | 3,7 | 3,7                     | 3,8 | 4,5 | 4,5 |
|  | II: 80°C/50°C   |                        |                |                      | 1,6 | 2,2 | 2,7 | 2,7 | 2,7                     | 2,8 | 3,1 | 3,1 |
|  | III: 120°C/72°C |                        |                |                      | 1,3 | 1,6 | 2,0 | 2,0 | 2,0                     | 2,1 | 2,4 | 2,4 |
|  | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,C1}$ | [N/mm <sup>2</sup> ] | 2,5 | 2,5 | 3,7 | 3,7 | no performance assessed |     |     |     |
|  | II: 80°C/50°C   |                        |                |                      | 1,6 | 1,9 | 2,7 | 2,7 |                         |     |     |     |
|  | III: 120°C/72°C |                        |                |                      | 1,3 | 1,6 | 2,0 | 2,0 |                         |     |     |     |
| <b>Installation factor</b>   |                 |                        |                |                      |     |     |     |     |                         |     |     |     |
| Dry or wet concrete  |                 | $\gamma_{inst}$        | [-]            | 1,0                  | 1,2 |     |     |     |                         |     |     |     |
| Waterfilled drill hole   |                 | $\gamma_{inst}$        | [-]            | 1,4                  |     |     |     |     | no performance assessed |     |     |     |

**Table C7: Characteristic values for threaded rods under shear load, seismic action, performance category C1**

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

**Injection system VMU plus for concrete**

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

**Annex C6**

**Table C8: Characteristic values of tension loads 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           |     |
|---|-----------------|------------------------|-----------------|----------------------|--------|---------|---------------------------|-------------------------|-------------------|-----|
| <b>Steel failure <sup>1)</sup></b>  |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| Characteristic resistance, steel zinc plated, strength 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, strength class 70    |                 | $N_{Rk,s}$             | [kN]            | 14                   | 26     | 41      | 59                        | 110                     | 124 <sup>2)</sup> |     |
| Partial factor  |                 | $\gamma_{Ms,N}$        | [-]             | 1,87                 |        |         |                           |                         | 2,86              |     |
| <b>Combined pull-out and concrete cone failure</b>                        |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| 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 |
|   | II: 80°C/50°C   |                        |                 | [N/mm <sup>2</sup> ] | 9,0    | 9,0     | 9,0                       | 9,0                     | 8,5               | 6,5 |
|   | III: 120°C/72°C |                        |                 | [N/mm <sup>2</sup> ] | 6,5    | 6,5     | 6,5                       | 6,5                     | 6,5               | 5,0 |
|   | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 8,5    | 8,5     | 8,5                       | no performance assessed |                   |     |
|   | II: 80°C/50°C   |                        |                 | [N/mm <sup>2</sup> ] | 6,5    | 6,5     | 6,5                       |                         |                   |     |
|   | III: 120°C/72°C |                        |                 | [N/mm <sup>2</sup> ] | 5,0    | 5,0     | 5,0                       |                         |                   |     |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| 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 |
|   | II: 80°C/50°C   |                        |                 | [N/mm <sup>2</sup> ] | 3,5    | 4,0     | 4,0                       | 4,0                     | 4,0               | 4,5 |
|   | III: 120°C/72°C |                        |                 | [N/mm <sup>2</sup> ] | 2,5    | 3,0     | 3,0                       | 3,0                     | 3,0               | 3,5 |
|   | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0    | 5,5     | 5,5                       | no performance assessed |                   |     |
|   | II: 80°C/50°C   |                        |                 | [N/mm <sup>2</sup> ] | 3,0    | 4,0     | 4,0                       |                         |                   |     |
|   | III: 120°C/72°C |                        |                 | [N/mm <sup>2</sup> ] | 2,5    | 3,0     | 3,0                       |                         |                   |     |
| <b>Reductionfactor <math>\psi^0_{sus}</math> in concrete C20/25</b>       |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| Temperature range   | I: 40°C/24°C    | dry and wet concrete   | $\psi^0_{sus}$  | [-]                  | 0,73   |         |                           |                         |                   |     |
|   | II: 80°C/50°C   |                        |                 |                      | 0,65   |         |                           |                         |                   |     |
|   | III: 120°C/72°C |                        |                 |                      | 0,57   |         |                           |                         |                   |     |
| Increasing factors for $\tau_{Rk}$  |                 |                        |                 | $\psi_c$             | 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 and splitting failure</b>                        |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| Relevant parameter  |                 |                        |                 | see Table C3         |        |         |                           |                         |                   |     |
| <b>Installation factor</b>  |                 |                        |                 |                      |        |         |                           |                         |                   |     |
| dry and wet concrete  |                 | $\gamma_{inst}$        | [-]             | 1,2                  |        |         |                           |                         |                   |     |
| waterfilled drill hole  |                 | $\gamma_{inst}$        | [-]             | 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**

**Annex C7**

**Table C9: Characteristic values for internally threaded anchor rods under shear loads**

| 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 resistance, steel zinc plated, strength class                | 5.8 | $V_{Rk,s}^0$    | [kN] | 6                              | 10     | 17      | 25      | 45      | 74                      |
|   | 8.8 | $V_{Rk,s}^0$    | [kN] | 8                              | 14     | 23      | 34      | 60      | 98                      |
| Partial factor  |     | $\gamma_{Ms,V}$ | [-]  | 1,25                           |        |         |         |         |                         |
| Characteristic resistance, stainless steel A4 / HCR, strength class         | 70  | $V_{Rk,s}^0$    | [kN] | 7                              | 13     | 20      | 30      | 55      | 62 <sup>2)</sup>        |
|   |     | $\gamma_{Ms,V}$ | [-]  | 1,56                           |        |         |         |         | 2,38                    |
| Ductility factor  |     | $k_7$           | [-]  | 1,0                            |        |         |         |         |                         |
| <b>Steel failure <u>with</u> lever arm<sup>1)</sup></b>                     |     |                 |      |                                |        |         |         |         |                         |
| Characteristic bending moment, steel zinc plated, strength class            | 5.8 | $M_{Rk,s}^0$    | [Nm] | 8                              | 19     | 37      | 66      | 167     | 325                     |
|   | 8.8 | $M_{Rk,s}^0$    | [Nm] | 12                             | 30     | 60      | 105     | 267     | 519                     |
| Partial factor  |     | $\gamma_{Ms,V}$ | [-]  | 1,25                           |        |         |         |         |                         |
| Characteristic bending resistance, stainless steel A4 / HCR, strength class | 70  | $M_{Rk,s}^0$    | [Nm] | 11                             | 26     | 53      | 92      | 234     | 643 <sup>2)</sup>       |
|   |     | $\gamma_{Ms,V}$ | [-]  | 1,56                           |        |         |         |         | 2,38                    |
| <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. 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 C10: Characteristic values for rebar under tension loads**

| Rebar   |                 |                        | Ø 8                     | Ø 10                 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | 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  | 491                     | 616                     | 804  |     |     |
| Partial factor  | $\gamma_{Ms,N}$ | [-]                    | 1,4 <sup>2)</sup>       |                      |      |      |      |      |                         |                         |      |     |     |
| <b>Combined pull-out and concrete cone failure</b>                  |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| <b>Characteristic bond resistance in uncracked concrete C20/25</b>  |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| 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 |
|   | II: 80°C/50°C   |                        |                         |                      | 7,5  | 9,0  | 9,0  | 9,0  | 9,0                     | 9,0                     | 8,0  | 7,0 | 6,0 |
|   | III: 120°C/72°C |                        |                         |                      | 5,5  | 6,5  | 6,5  | 6,5  | 6,5                     | 6,5                     | 6,0  | 5,0 | 4,5 |
|   | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,ucr}$         | [N/mm <sup>2</sup> ] | 7,5  | 8,5  | 8,5  | 8,5  | 8,5                     | no performance assessed |      |     |     |
|   | II: 80°C/50°C   |                        |                         |                      | 5,5  | 6,5  | 6,5  | 6,5  | 6,5                     |                         |      |     |     |
|   | III: 120°C/72°C |                        |                         |                      | 4,0  | 5,0  | 5,0  | 5,0  | 5,0                     |                         |      |     |     |
| <b>Characteristic bond resistance in cracked concrete C20/25</b>    |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| 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 |
|   | II: 80°C/50°C   |                        |                         |                      | 2,5  | 3,5  | 4,0  | 4,0  | 4,0                     | 4,0                     | 4,0  | 4,5 | 4,5 |
|   | III: 120°C/72°C |                        |                         |                      | 2,0  | 2,5  | 3,0  | 3,0  | 3,0                     | 3,0                     | 3,0  | 3,5 | 3,5 |
|   | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,cr}$          | [N/mm <sup>2</sup> ] | 4,0  | 4,0  | 5,5  | 5,5  | 5,5                     | no performance assessed |      |     |     |
|   | II: 80°C/50°C   |                        |                         |                      | 2,5  | 3,0  | 4,0  | 4,0  | 4,0                     |                         |      |     |     |
|   | III: 120°C/72°C |                        |                         |                      | 2,0  | 2,5  | 3,0  | 3,0  | 3,0                     |                         |      |     |     |
| <b>Reductionfactor <math>\psi_{sus}^0</math> in concrete C20/25</b> |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| Temperature range   | I: 40°C/24°C    | dry and wet concrete   | $\psi_{sus}^0$          | [-]                  | 0,73 |      |      |      |                         |                         |      |     |     |
|   | II: 80°C/50°C   |                        |                         |                      | 0,65 |      |      |      |                         |                         |      |     |     |
|   | III: 120°C/72°C |                        |                         |                      | 0,57 |      |      |      |                         |                         |      |     |     |
| Increasing factors for $\tau_{Rk}$                                  |                 |                        | $\psi_c$                | 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 and splitting failure</b>                  |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| Relevant parameter  |                 |                        | see Table C3            |                      |      |      |      |      |                         |                         |      |     |     |
| <b>Installation factor</b>  |                 |                        |                         |                      |      |      |      |      |                         |                         |      |     |     |
| dry and wet concrete  |                 | $\gamma_{inst}$        | [-]                     | 1,0                  | 1,2  |      |      |      |                         |                         |      |     |     |
| waterfilled drill hole  |                 | $\gamma_{inst}$        | [-]                     | 1,4                  |      |      |      |      | no performance assessed |                         |      |     |     |

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

2) in absence of national regulation

**Injection system VMU plus for concrete**

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

**Annex C9**

**Table C11: Characteristic values for rebar under shear load**

| 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 resistance              | $V^0_{Rk,s}$    | [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  | 491                    | 616  | 804  |  |
| Partial factor                         | $\gamma_{Ms,V}$ | [-]                | 1,5 <sup>2)</sup>                    |      |      |      |      |      |                        |      |      |  |
| Ductility factor                       | $k_7$           | [-]                | 1,0                                  |      |      |      |      |      |                        |      |      |  |
| <b>Steel failure with lever arm</b>    |                 |                    |                                      |      |      |      |      |      |                        |      |      |  |
| Characteristic bending moment          | $M^0_{Rk,s}$    | [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  | 1534                   | 2155 | 3217 |  |
| Partial factor                         | $\gamma_{Ms,V}$ | [-]                | 1,5 <sup>2)</sup>                    |      |      |      |      |      |                        |      |      |  |
| <b>Concrete pry-out failure</b>        |                 |                    |                                      |      |      |      |      |      |                        |      |      |  |
| 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]               | 8                                    | 10   | 12   | 14   | 16   | 20   | 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 VMU plus for concrete**

**Performance**  
Characteristic values for rebar under shear load

**Annex C10**

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

| Rebar  |                 |                        |                    | Ø 8                     | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20                    | 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                     | 491                     | 616  | 804  |     |
| Partial factor   |                 | $\gamma_{Ms,N}$        | [-]                | 1,4 <sup>2)</sup>       |      |      |      |      |                         |                         |      |      |     |
| <b>Combined pull-out and concrete cone failure</b>                 |                 |                        |                    |                         |      |      |      |      |                         |                         |      |      |     |
| <b>Characteristic bond resistance in concrete C20/25 to C50/60</b> |                 |                        |                    |                         |      |      |      |      |                         |                         |      |      |     |
| Temperature range  | I: 40°C/24°C    | dry and wet concrete   | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 2,5  | 3,1  | 3,7  | 3,7  | 3,7                     | 3,7                     | 3,8  | 4,5  | 4,5 |
|  | II: 80°C/50°C   |                        |                    |                         | 1,6  | 2,2  | 2,7  | 2,7  | 2,7                     | 2,7                     | 2,8  | 3,1  | 3,1 |
|  | III: 120°C/72°C |                        |                    |                         | 1,3  | 1,6  | 2,0  | 2,0  | 2,0                     | 2,0                     | 2,1  | 2,4  | 2,4 |
|  | I: 40°C/24°C    | waterfilled drill hole | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 2,5  | 2,5  | 3,7  | 3,7  | 3,7                     | no performance assessed |      |      |     |
|  | II: 80°C/50°C   |                        |                    |                         | 1,6  | 1,9  | 2,7  | 2,7  | 2,7                     |                         |      |      |     |
|  | III: 120°C/72°C |                        |                    |                         | 1,3  | 1,6  | 2,0  | 2,0  | 2,0                     |                         |      |      |     |
| <b>Installation factor</b>   |                 |                        |                    |                         |      |      |      |      |                         |                         |      |      |     |
| dry and wet concrete   |                 | $\gamma_{inst}$        | [-]                | 1,0                     | 1,2  |      |      |      |                         |                         |      |      |     |
| waterfilled drill hole   |                 | $\gamma_{inst}$        | [-]                | 1,4                     |      |      |      |      | no performance assessed |                         |      |      |     |

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

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

**Table C13: Characteristic values for rebar under seismic action, shear load, performance category C1**

| Rebar   |  |                 |                    | Ø 8                                | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|--|-----------------|--------------------|------------------------------------|------|------|------|------|------|------|------|------|
| <b>Steel failure <u>without</u> lever arm</b> |  |                 |                    |                                    |      |      |      |      |      |      |      |      |
| Characteristic resistance                     |  | $V_{Rk,s,C1}$   | [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  | 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 VMU plus for concrete**

**Performance**

Characteristic values for rebar under seismic action, category C1

**Annex C11**

**Table C14: Displacement factor under tension loads<sup>1)</sup>**  
(threaded rod and internally threaded anchor rod)

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

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

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

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

**Table C15: Displacement factor under shear load<sup>1)</sup>**  
(threaded rod and internally threaded anchor rod)

| Threaded rod   |                            |  | M8   | M10<br>IG-M6 | M12<br>IG-M8 | M16<br>IG- M10 | M20<br>IG-M12 | M24<br>IG-M16 | M27  | M30<br>IG-M20 |
|--|----------------------------|--|------|--------------|--------------|----------------|---------------|---------------|------|---------------|
| <b>Uncracked concrete C20/25, static and quasi-static action</b> |                            |  |      |              |              |                |               |               |      |               |
| All temperature ranges   | $\delta_{V0}$ -factor      | $\left[ \frac{\text{mm}}{\text{N/mm}^2} \right]$ | 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>Cracked concrete C20/25, static and quasi-static action</b>   |                            |  |      |              |              |                |               |               |      |               |
| All temperature ranges   | $\delta_{V0}$ -factor      | $\left[ \frac{\text{mm}}{\text{N/mm}^2} \right]$ | 0,12 | 0,12         | 0,11         | 0,10           | 0,09          | 0,08          | 0,08 | 0,07          |
|  | $\delta_{V\infty}$ -factor |  | 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 C12**

**Table C16: Displacement factor 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, static and quasi-static action</b> |                         |                            |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                | δ <sub>N0</sub> -factor | mm<br>[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 |                            | 0,030 | 0,033 | 0,037 | 0,041 | 0,045 | 0,052 | 0,061 | 0,071 | 0,075 |
| Temperature range II:<br>80°C/50°C                               | δ <sub>N0</sub> -factor |                            | 0,050 | 0,056 | 0,063 | 0,069 | 0,075 | 0,088 | 0,104 | 0,113 | 0,126 |
|  | δ <sub>N∞</sub> -factor |                            | 0,072 | 0,081 | 0,090 | 0,099 | 0,108 | 0,127 | 0,149 | 0,163 | 0,181 |
| Temperature range III:<br>120°C/72°C                             | δ <sub>N0</sub> -factor |                            | 0,050 | 0,056 | 0,063 | 0,069 | 0,075 | 0,088 | 0,104 | 0,113 | 0,126 |
|  | δ <sub>N∞</sub> -factor |                            | 0,072 | 0,081 | 0,090 | 0,099 | 0,108 | 0,127 | 0,149 | 0,163 | 0,181 |
| <b>Cracked concrete C20/25, static and quasi-static action</b>   |                         |                            |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                | δ <sub>N0</sub> -factor | mm<br>[N/mm <sup>2</sup> ] | 0,090 |       |       |       | 0,070 |       |       |       |       |
|  | δ <sub>N∞</sub> -factor |                            | 0,105 |       |       |       | 0,105 |       |       |       |       |
| Temperature range II:<br>80°C/50°C                               | δ <sub>N0</sub> -factor |                            | 0,219 |       |       |       | 0,170 |       |       |       |       |
|  | δ <sub>N∞</sub> -factor |                            | 0,255 |       |       |       | 0,245 |       |       |       |       |
| Temperature range III:<br>120°C/72°C                             | δ <sub>N0</sub> -factor |                            | 0,219 |       |       |       | 0,170 |       |       |       |       |
|  | δ <sub>N∞</sub> -factor |                            | 0,255 |       |       |       | 0,245 |       |       |       |       |

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

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

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

**Table C17: Displacement factor 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, static and quasi-static action</b> |                         |                            |      |      |      |      |      |      |      |      |      |
| All temperature ranges   | δ <sub>V0</sub> -factor | mm<br>[N/mm <sup>2</sup> ] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
|  | δ <sub>V∞</sub> -factor |                            | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 |
| <b>Cracked concrete C20/25, static and quasi-static action</b>   |                         |                            |      |      |      |      |      |      |      |      |      |
| All temperature ranges   | δ <sub>V0</sub> -factor | mm<br>[N/mm <sup>2</sup> ] | 0,12 | 0,12 | 0,11 | 0,11 | 0,10 | 0,09 | 0,08 | 0,07 | 0,06 |
|  | δ <sub>V∞</sub> -factor |                            | 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 C13**