

## TELJESÍTMÉNYNYILATKOZAT

DoP Száma: MKT-2.1-701\_hu

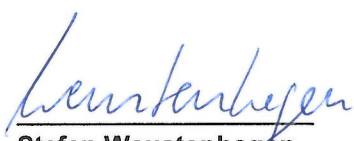
- ✧ **A terméktípus egyedi azonosító kódja:** **VME plus befecskendező rendszer betonhoz**
- ✧ **Felhasználás célja(i):** Befecskendező rendszer beton rögzítéséhez, lásd a B. Mellékletet / Annex B
- ✧ **Gyártó:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ✧ **A teljesítmény állandóságának értékelésére és ellenőrzésére szolgáló rendszer vagy rendszerek:** 1
- ✧ **Az európai értékelési dokumentum:** **EAD 330499-01-0601**  
Európai műszaki értékelés: **ETA-19/0483, 12.05.2021**  
A műszaki értékelést végző szerv: DIBt, Berlin  
Bejelentett szerv(ek): NB 2873 – Technische Universität Darmstadt

✧ **A nyilatkozatban szereplő teljesítmény(ek):**

| Alapvető tulajdonságok  | Teljesítmény                                     |
|---|--|
| <b>Mechanikai szilárdság és állékonyság (BWR 1)</b>                                     |  |
| Jellemző ellenállás húzóterhelés mellett (statikus és kvázi-staikus hatások)            | Melléklet / Annex B3, C1, C3-C6, C9-C11, C13-C15 |
| Jellemző ellenállás keresztirányú feszültség alatt (statikus és kvázi-staikus hatások)  | Melléklet / Annex C2, C7, C12, C16               |
| Eltolódásokat   | Melléklet / Annex C18 – C21                      |
| Jellemző ellenállás és elmozdulások a szeizmikus teljesítménykategória C1 + C2 esetében | Melléklet / Annex C8, C17-C19                    |
| <b>Higiénia, egészség és környezetvédelem (BWR 3)</b>                                   |  |
| Veszélyes anyagok tartalma, kibocsátása és / vagy kibocsátása                           | A teljesítmény nem lett besorolva                |

A fent azonosított termék teljesítménye megfelel a bejelentett teljesítmény(ek)nek. A 305/2011/EU rendeletnek megfelelően e teljesítménynyilatkozat kiadásáért kizárólag a fent meghatározott gyártó a felelős.

A gyártó nevében és részéről aláíró személy:



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(Vezérigazgató)  
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p.p.

  
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(A termékfejlesztés vezetője)

A teljesítménynyilatkozat eredeti példányát németül írták. A fordítás eltérése esetén a német változat érvényes.

## Specification of intended use

| Static and quasi-static action                          | working life 50 years   | working life 100 years                  |
|---|---|---|
| Threaded rod<br>Internally threaded anchor rod<br>Rebar | <b>M8 - M30</b><br><b>VMU-IG M6 - VMU-IG M20</b><br><b>Ø8 - Ø32</b>   |   |
| Base material   | cracked or uncracked concrete   |   |
|   | strength classes C20/25 to C50/60<br>compacted, reinforced or unreinforced normal weight concrete<br>(without fibers) acc. to EN 206:2013+A1:2016 |   |
| Hole drilling   | cracked concrete:<br>hammer drilling / compressed air drilling / vaccum drilling  |   |
|   | uncracked concrete:<br>hammer drilling / compressed air drilling / vaccum drilling /<br>diamond drilling  |   |
| Temperature range <sup>1)</sup>                         | I: -40°C to +40°C<br>II: -40°C to +72°C   | I: -40°C to +40°C<br>II: -40°C to +72°C |

| Seismic action  | performance category C1   | performance category C2                 |
|---|---|---|
| Threaded rod<br>Internally threaded anchor rod<br>Rebar | <b>M8 - M30</b><br><b>Ø8 - Ø32</b>  | <b>M12 - M24</b><br>---                 |
| Base material   | cracked or uncracked concrete   |   |
|   | strength classes C20/25 to C50/60<br>compacted, reinforced or unreinforced normal weight concrete<br>(without fibers) acc. to EN 206:2013+A1:2016 |   |
| Hole drilling   | hammer drilling / compressed air drilling / vaccum drilling   |   |
| Temperature range <sup>1)</sup>                         | I: -40°C to +40°C<br>II: -40°C to +72°C   | I: -40°C to +40°C<br>II: -40°C to +72°C |

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

### Injection System VME plus

Intended use  
Specifications

**Annex B1**

## Specification of intended use

### Use conditions (Environmental conditions):

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

### Design:

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

### Installation:

- Dry or wet concrete or waterfilled drillholes (not seawater)
- Hole drilling by hammer drill, compressed air drill, vacuum drill or diamond drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person responsible for technical matters of the site
- 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 VME plus**

**Annex B2**

**Intended use**  
Specifications

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

| Threaded rod                              |  |      | M8                             | M10 | M12                      | M16                               | M20 | M24 | M27 | M30 |
|---|--|------|--------------------------------|-----|--------------------------|-----------------------------------|-----|-----|-----|-----|
| Diameter of threaded rod                  | d=d <sub>nom</sub>                               | [mm] | 8                              | 10  | 12                       | 16                                | 20  | 24  | 27  | 30  |
| Nominal drill hole diameter               | d <sub>0</sub>                                   | [mm] | 10                             | 12  | 14                       | 18                                | 22  | 28  | 30  | 35  |
| Effective anchorage depth                 | h <sub>ef,min</sub>                              | [mm] | 60                             | 60  | 70                       | 80                                | 90  | 96  | 108 | 120 |
|   | h <sub>ef,max</sub>                              | [mm] | 160                            | 200 | 240                      | 320                               | 400 | 480 | 540 | 600 |
| Diameter of clearance hole in the fixture | Pre-setting installation<br>d <sub>f</sub> ≤     | [mm] | 9                              | 12  | 14                       | 18                                | 22  | 26  | 30  | 33  |
|   | Through setting installation<br>d <sub>f</sub> ≤ | [mm] | 12                             | 14  | 16                       | 20                                | 24  | 30  | 33  | 40  |
| Maximum installation torque               | max.T <sub>inst</sub> ≤                          | [Nm] | 10                             | 20  | 40<br>(35) <sup>1)</sup> | 60                                | 100 | 170 | 250 | 300 |
| Minimum thickness of member               | h <sub>min</sub>                                 | [mm] | h <sub>ef</sub> + 30mm ≥ 100mm |     |                          | h <sub>ef</sub> + 2d <sub>0</sub> |     |     |     |     |
| Minimum spacing                           | s <sub>min</sub>                                 | [mm] | 40                             | 50  | 60                       | 75                                | 95  | 115 | 125 | 140 |
| Minimum edge distance                     | c <sub>min</sub>                                 | [mm] | 35                             | 40  | 45                       | 50                                | 60  | 65  | 75  | 80  |

<sup>1)</sup> max. installation torque for property class 4.6

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

| Internally threaded anchor rod               |                         |      | IG-M 6                            | IG-M 8 | IG-M 10 | IG-M 12                           | IG-M 16 | IG-M 20 |
|--|-------------------------|------|-----------------------------------|--------|---------|-----------------------------------|---------|---------|
| Inner diameter of threaded rod               | d <sub>2</sub>          | [mm] | 6                                 | 8      | 10      | 12                                | 16      | 20      |
| Outer diameter of threaded rod <sup>1)</sup> | d=d <sub>nom</sub>      | [mm] | 10                                | 12     | 16      | 20                                | 24      | 30      |
| Nominal drill hole diameter                  | d <sub>0</sub>          | [mm] | 12                                | 14     | 18      | 22                                | 28      | 35      |
| Effective anchorage depth                    | h <sub>ef,min</sub>     | [mm] | 60                                | 70     | 80      | 90                                | 96      | 120     |
|  | h <sub>ef,max</sub>     | [mm] | 200                               | 240    | 320     | 400                               | 480     | 600     |
| Diameter of clearance hole in the fixture    | d <sub>f</sub> ≤        | [mm] | 7                                 | 9      | 12      | 14                                | 18      | 22      |
| Maximum installation torque                  | max.T <sub>inst</sub> ≤ | [Nm] | 10                                | 10     | 20      | 40                                | 60      | 100     |
| Minimum screw-in depth                       | l <sub>IG</sub>         | [mm] | 8                                 | 8      | 10      | 12                                | 16      | 20      |
| Minimum thickness of member                  | h <sub>min</sub>        | [mm] | h <sub>ef</sub> + 30mm<br>≥ 100mm |        |         | h <sub>ef</sub> + 2d <sub>0</sub> |         |         |
| Minimum spacing                              | s <sub>min</sub>        | [mm] | 50                                | 60     | 75      | 95                                | 115     | 140     |
| Minimum edge distance                        | c <sub>min</sub>        | [mm] | 40                                | 45     | 50      | 60                                | 65      | 80      |

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

**Table B3: Installation parameters for rebar**

| Rebar                                     |                     |      | Ø 8                                 | Ø 10    | Ø 12    | Ø 14 | Ø 16                              | Ø 20 | Ø 24    | Ø 25    | Ø 28 | Ø 32 |
|---|---------------------|------|-------------------------------------|---------|---------|------|-----------------------------------|------|---------|---------|------|------|
| Diameter of rebar                         | d=d <sub>nom</sub>  | [mm] | 8                                   | 10      | 12      | 14   | 16                                | 20   | 24      | 25      | 28   | 32   |
| Nominal drill hole diameter <sup>1)</sup> | d <sub>0</sub>      | [mm] | 10   12                             | 12   14 | 14   16 | 18   | 20                                | 25   | 30   32 | 30   32 | 35   | 40   |
| Effective anchorage depth                 | h <sub>ef,min</sub> | [mm] | 60                                  | 60      | 70      | 75   | 80                                | 90   | 96      | 100     | 112  | 128  |
|   | h <sub>ef,max</sub> | [mm] | 160                                 | 200     | 240     | 280  | 320                               | 400  | 480     | 500     | 560  | 640  |
| Minimum thickness of member               | h <sub>min</sub>    | [mm] | h <sub>ef</sub> + 30 mm<br>≥ 100 mm |         |         |      | h <sub>ef</sub> + 2d <sub>0</sub> |      |         |         |      |      |
| Minimum spacing                           | s <sub>min</sub>    | [mm] | 40                                  | 50      | 60      | 70   | 75                                | 95   | 120     | 120     | 130  | 150  |
| Minimum edge distance                     | c <sub>min</sub>    | [mm] | 35                                  | 40      | 45      | 50   | 50                                | 60   | 70      | 70      | 75   | 85   |






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

**Injection System VME plus**


**Intended use**  
Installation parameters

**Annex B3**

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

| Threaded rod  | Internally threaded anchor rod  | Rebar   | Drill bit Ø   | Brush Ø   | min. Brush Ø            |
|---|---|---|---|---|-------------------------|
|  |  |  |  |  |                         |
| [-]   | [-]   | Ø [mm]  | d <sub>0</sub> [mm]   | d <sub>b</sub> [mm]   | d <sub>b,min</sub> [mm] |
| M8  |   | 8   | 10  | 11,5  | 10,5                    |
| M10   | VMU-IG M6   | 8 / 10  | 12  | 13,5  | 12,5                    |
| M12   | VMU-IG M8   | 10 / 12   | 14  | 15,5  | 14,5                    |
|   |   | 12  | 16  | 17,5  | 16,5                    |
| M16   | VMU-IG M10  | 14  | 18  | 20,0  | 18,5                    |
|   |   | 16  | 20  | 22,0  | 20,5                    |
| M20   | VMU-IG M12  |   | 22  | 24,0  | 22,5                    |
|   |   | 20  | 25  | 27,0  | 25,5                    |
| M24   | VMU-IG M16  |   | 28  | 30,0  | 28,5                    |
| M27   |   | 24 / 25   | 30  | 31,8  | 30,5                    |
|   |   | 24 / 25   | 32  | 34,0  | 32,5                    |
| M30   | VMU-IG M20  | 28  | 35  | 37,0  | 35,5                    |
|   |   | 32  | 40  | 43,5  | 40,5                    |

**Table B5: Retaining washer**

| Drill bit Ø         |  | Installation direction and use |                         |     |
|---------------------|---|--------------------------------|-------------------------|-----|
| d <sub>0</sub> [mm] | [-]   | ↓                              | →                       | ↑   |
| 10                  | No retaining washer required  |                                |                         |     |
| 12                  |   |                                |                         |     |
| 14                  |   |                                |                         |     |
| 16                  |   |                                |                         |     |
| 18                  | VM-IA 18  | h <sub>ef</sub> > 250mm        | h <sub>ef</sub> > 250mm | all |
| 20                  | VM-IA 20  |                                |                         |     |
| 22                  | VM-IA 22  |                                |                         |     |
| 25                  | VM-IA 25  |                                |                         |     |
| 28                  | VM-IA 28  |                                |                         |     |
| 30                  | VM-IA 30  |                                |                         |     |
| 32                  | VM-IA 32  |                                |                         |     |
| 35                  | VM-IA 35  |                                |                         |     |
| 40                  | VM-IA 40  |                                |                         |     |



**Vacuum drill bit**

Vacuum drill bit (MKT Hollow drill bit SB, Würth Hammer drill bit with suction or Heller Duster Expert hollow drill bit system) and a vacuum cleaner with minimum negative pressure of 253 hPa and flow rate of minimum 42 l/s (150 m³/h)



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

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

**Injection System VME plus**

**Intended use**  
Cleaning and setting tools

**Annex B4**

**Table B6: Working time and curing time**

| Concrete temperature         | Working time         | Minimum curing time |              |
|------------------------------|----------------------|---------------------|--------------|
|                              |                      | dry concrete        | wet concrete |
| 0°C to +4°C                  | 90 min               | 144 h               | 288 h        |
| +5°C to +9°C                 | 80 min               | 48 h                | 96 h         |
| +10°C to +14°C               | 60 min               | 28 h                | 56 h         |
| +15°C to +19°C               | 40 min               | 18 h                | 36 h         |
| +20°C to +24°C               | 30 min               | 12 h                | 24 h         |
| +25°C to +34°C               | 12 min               | 9 h                 | 18 h         |
| +35°C to +39°C               | 8 min                | 6 h                 | 12 h         |
| +40°C                        | 8 min                | 4 h                 | 8 h          |
| <b>Cartridge temperature</b> | <b>+5°C to +40°C</b> |                     |              |

**Injection System VME plus**

**Intended use**  
Working and curing time

**Annex B5**

# Installation instructions

## Drilling of the drill hole and cleaning: Hammer drilling, compressed air drilling and vacuum drilling

|   |  |  |
|---|--|--|
| 1 |  | <p><b>Hammer drilling or compressed air drilling:</b><br/>         Drill with hammer drill or compressed air drill a hole into the base material with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole depth. Continue with <u>step 2</u>.<br/>         In case of aborted drill hole, the drill hole shall be filled with mortar.</p> <p><b>Vacuum drilling:</b> see Annex B4<br/>         Drill drillhole with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole depth. This drilling method removes dust and cleans the drillhole during drilling. Continue with step 3.<br/>         In case of aborted drill hole, the drill hole shall be filled with mortar.</p> |
|---|--|--|

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

**Cleaning:** dry, wet and water-filled drill holes with all diameter in uncracked and cracked concrete (Cleaning not applicable when using vacuum drilling)

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

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

### Injection System VME plus

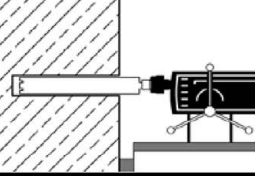

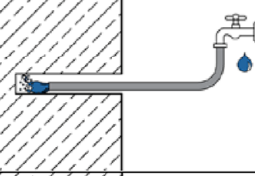
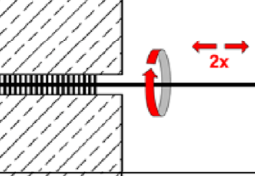
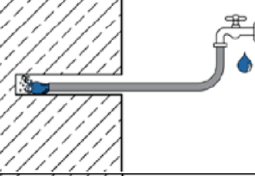
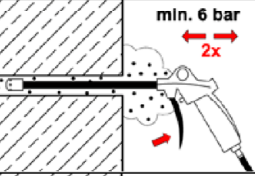
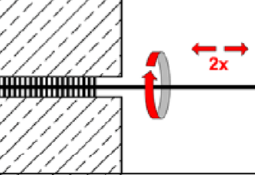
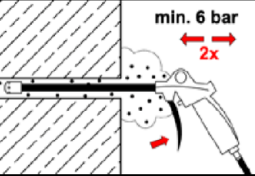
#### Intended use

Installation instructions – Drilling and cleaning: Hammer drilling, compressed air drilling and vacuum drilling

**Annex B6**

## Installation instructions (continuation)

### Drilling of the drill hole and cleaning: Diamond drilling

|   |   |   |
|---|---|---|
| 1   |    | <p>Drill a hole into the base material with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole depth. Continue with step 2.<br/>In case of aborted drill hole, the drill hole shall be filled with mortar.</p>                                  |
| <p><b>Cleaning:</b> dry, wet and water-filled drill holes with all diameter in uncracked concrete</p> |   |   |
| 2a  |    | <p>Remove drill core at least up to the nominal drill hole depth and check drill hole depth.</p>  |
| 2b  |    | <p>Flush drill hole with water, starting from the bottom until clear water gets out of the drill hole.</p>  |
| 2c  |    | <p>Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush <math>\geq d_{b,min}</math> (Table B4) a minimum of <b>two</b> times.<br/>If the drillhole ground is not reached with the brush, an appropriate brush extension must be used.</p>       |
| 2d  |   | <p>Flush drill hole again with water, starting from the bottom until clear water gets out of the drill hole.</p>  |
| 2e  |  | <p>Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of <b>two</b> times until return air stream is free of noticeable dust.<br/>If the drillhole ground is not reached, an extension must be used.</p>    |
| 2f  |  | <p>Check brush diameter (Table B4). Brush the hole again with an appropriate sized wire brush <math>\geq d_{b,min}</math> (Table B4) a minimum of <b>two</b> times.<br/>If the drillhole ground is not reached with the brush, an appropriate brush extension must be used.</p> |
| 2g  |  | <p>Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of <b>two</b> times until return air stream is free of noticeable dust.<br/>If the drillhole ground is not reached, an extension must be used.</p>    |

### Injection System VME plus

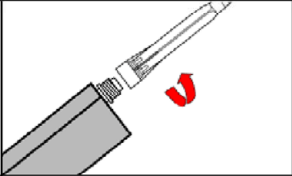
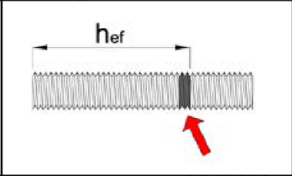
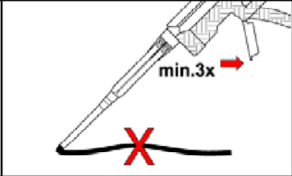
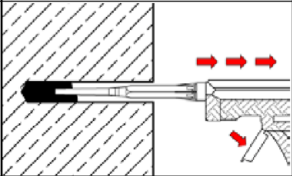
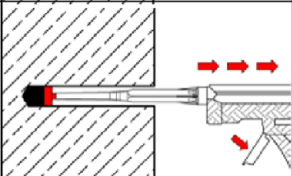
#### Intended use

Installation instructions – Drilling and cleaning: Diamond drilling

Annex B7



## Installation instructions (continuation)

| Injection |  |  |
|-----------|--|--|
| 3         |   | Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.<br>For every working interruption longer than the recommended working time (Table B6) as well as for new cartridges, a new static-mixer shall be used.  |
| 4         |   | Prior to inserting the rod into the filled drillhole, the position of the embedment depth shall be marked on the threaded rod or rebar.  |
| 5         |   | Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey or red colour.  |
| 6         |   | Starting from the bottom or back of the cleaned drill hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid air pockets. If the drill hole ground is not reached, an appropriate extension nozzle shall be used.<br>Observe temperature dependent working times given in Table B6.  |
| 7         |  | Retaining washer and mixer nozzle extensions shall be used according to Table B5 for the following applications: <ul style="list-style-type: none"> <li>• Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-<math>\varnothing</math> <math>d_0 \geq 18</math> mm and anchorage 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 VME plus

**Intended use**  
Installation instructions – Injection

**Annex B8**

## Installation instructions (continuation)

| Setting the fastening element |  |   |
|-------------------------------|--|---|
| 8                             |  | <p>Push the threaded rod or reinforcing bar into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.</p> <p>The anchor shall be free of dirt, grease, oil or other foreign material.</p>  |
| 9                             |  | <p>Make sure that excess mortar is visible at the top of the hole and in case of through-setting installation also in the fixture. If these requirements are not maintained, repeat application before end of working time! For overhead installation, the anchor should be fixed (e.g. by wedges).</p>     |
| 10                            |  | <p>Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B6).</p>   |
| 11                            |  | <p>Remove excess mortar.</p>  |
| 12                            |  | <p>The fixture can be mounted after curing time. Apply installation torque <math>T_{inst}</math> according to Table B1 or B2.</p>   |
| 13                            |  | <p>In case of pre-setting installation the annular gap between anchor rod and fixture can optionally be filled with mortar. Therefore, replace regular washer by washer with drill and plug on reducing adapter on static mixer.</p> <p>Annular gap is completely filled, when excess mortar seeps out.</p> |

### Injection System VME plus

#### Intended use

Installation instructions – Setting the fastening element

**Annex B9**

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

| Threaded rod  |                                     |                 |      | M8         | M10        | M12  | M16 | M20 | M24 | M27             | M30             |
|---|-------------------------------------|-----------------|------|------------|------------|------|-----|-----|-----|-----------------|-----------------|
| <b>Steel failure</b>  |                                     |                 |      |            |            |      |     |     |     |                 |                 |
| Cross sectional area $A_s$ [mm <sup>2</sup> ]                     |                                     |                 |      | 36,6       | 58,0       | 84,3 | 157 | 245 | 353 | 459             | 561             |
| <b>Characteristic resistance under tension load <sup>1)</sup></b> |                                     |                 |      |            |            |      |     |     |     |                 |                 |
| Steel,<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 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 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 VME plus**

**Performance**

Characteristic steel resistance for **threaded rods** under **tension load**

**Annex C1**

**Table C2: Characteristic steel resistance for threaded rods under shear load**

| Threaded rod  |                                   |                     | M8         | M10        | M12  | M16 | M20 | M24 | M27   | M30   |
|---|-----------------------------------|---------------------|------------|------------|------|-----|-----|-----|-------|-------|
| <b>Steel failure</b>  |                                   |                     |            |            |      |     |     |     |       |       |
| Cross sectional area $A_s$ [mm <sup>2</sup> ]                   |                                   |                     | 36,6       | 58,0       | 84,3 | 157 | 245 | 353 | 459   | 561   |
| <b>Characteristic 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 | -     | -     |
|   | A4 and HCR, property class 80     | $V^0_{Rk,s}$ [kN]   | 15         | 23         | 34   | 63  | 98  | 141 | -     | -     |
| <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)} |

<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 VME plus**

**Annex C2**

**Performance**

Characteristic **steel resistance** for **threaded rods** under **shear load**

**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                                |                        | $N^{0}_{RK,sp}$ | [kN]      | $\min ( N_{RK,p} ; N^{0}_{RK,c} )$  |
| Edge distance  | $h/h_{ef} \geq 2,0$    | $c_{cr,sp}$     | [mm]      | $1,0 \cdot h_{ef}$                  |
|  | $2,0 > h/h_{ef} > 1,3$ |                 |           | $2 \cdot h_{ef} (2,5 - h / h_{ef})$ |
|  | $h/h_{ef} \leq 1,3$    |                 |           | $2,4 \cdot h_{ef}$                  |
| Spacing  |                        | $s_{cr,sp}$     | [mm]      | $2 \cdot c_{cr,sp}$                 |

**Injection System VME plus**

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

**Annex C3**

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

| Threaded rod  |   |                 |                      | M8                                   | M10 | M12 | M16                      | M20 | M24 | M27 | M30 |
|---|---|-----------------|----------------------|--------------------------------------|-----|-----|--------------------------|-----|-----|-----|-----|
| <b>Steel failure</b>  |   |                 |                      |                                      |     |     |                          |     |     |     |     |
| Characteristic resistance   |   | $N_{Rk,s}$      | [kN]                 | $A_s \cdot f_{uk}$ (or see Table C1) |     |     |                          |     |     |     |     |
| Partial factor  |   | $\gamma_{Ms,N}$ | [-]                  | see Table C1                         |     |     |                          |     |     |     |     |
| <b>Combined pull-out and concrete failure</b>                             |   |                 |                      |                                      |     |     |                          |     |     |     |     |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |   |                 |                      |                                      |     |     |                          |     |     |     |     |
| Temperature range I:<br>40°C / 24°C                                       | hammer- or<br>compressed air<br>drilling            | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 20                                   | 20  | 19  | 19                       | 18  | 17  | 16  | 16  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                                   | 15  | 15  | 14                       | 13  | 13  | 12  | 12  |
| Temperature range I:<br>40°C / 24°C                                       | vacuum drilling                                     | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 17<br>(16) <sup>1)</sup>             | 16  | 16  | 16<br>(15) <sup>1)</sup> | 15  | 14  | 14  | 13  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 14                                   | 14  | 14  | 13                       | 13  | 12  | 12  | 11  |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |   |                 |                      |                                      |     |     |                          |     |     |     |     |
| Temperature range I:<br>40°C / 24°C                                       | hammer-,<br>compressed air<br>or vacuum<br>drilling | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7,0                                  | 7,0 | 8,5 | 8,5                      | 8,5 | 8,5 | 8,5 | 8,5 |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 6,0                                  | 6,0 | 7,0 | 7,0                      | 7,0 | 7,0 | 7,0 | 7,0 |
| <b>Reductionfactor <math>\psi_{sus}^0</math> in concrete C20/25</b>       |   |                 |                      |                                      |     |     |                          |     |     |     |     |
| Temperature range I:<br>40°C / 24°C                                       | hammer-,<br>compressed air<br>or vacuum<br>drilling | $\psi_{sus}^0$  | [-]                  | 0,80                                 |     |     |                          |     |     |     |     |
| Temperature range II:<br>72°C / 50°C                                      |   | $\psi_{sus}^0$  | [-]                  | 0,68                                 |     |     |                          |     |     |     |     |
| Increasing factors for<br>concrete  | C25/30  | $\psi_c$        | [-]                  | 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                                  |     |     |                          |     |     |     |     |
| waterfilled drill hole  |   | $\gamma_{inst}$ | [-]                  | 1,2                                  |     |     |                          |     |     |     |     |

<sup>1)</sup> value in brackets: characteristic bond resistance for waterfilled drill holes

**Injection System VME plus**

**Performance**

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

**Annex C4**

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

| Threaded rod  |   |                     |                      | M8                                   | M10 | M12 | M16                      | M20 | M24 | M27 | M30 |
|---|---|---------------------|----------------------|--------------------------------------|-----|-----|--------------------------|-----|-----|-----|-----|
| <b>Steel failure</b>  |   |                     |                      |                                      |     |     |                          |     |     |     |     |
| Characteristic resistance   |   | $N_{Rk,s}$          | [kN]                 | $A_s \cdot f_{uk}$ (or see Table C1) |     |     |                          |     |     |     |     |
| Partial factor  |   | $\gamma_{Ms,N}$     | [-]                  | see Table C1                         |     |     |                          |     |     |     |     |
| <b>Combined pull-out and concrete failure</b>                             |   |                     |                      |                                      |     |     |                          |     |     |     |     |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |   |                     |                      |                                      |     |     |                          |     |     |     |     |
| Temperature range I:<br>40°C / 24°C                                       | Hammer- or<br>compressed air<br>drilling            | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 20                                   | 20  | 19  | 19                       | 18  | 17  | 16  | 16  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 15                                   | 15  | 15  | 14                       | 13  | 13  | 12  | 12  |
| Temperature range I:<br>40°C / 24°C                                       | Vacuum drilling                                     | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 17<br>(16) <sup>1)</sup>             | 16  | 16  | 16<br>(15) <sup>1)</sup> | 15  | 14  | 14  | 13  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 14                                   | 14  | 14  | 13                       | 13  | 12  | 12  | 11  |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |   |                     |                      |                                      |     |     |                          |     |     |     |     |
| Temperature range I:<br>40°C / 24°C                                       | Hammer-,<br>compressed air<br>or vacuum<br>drilling | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ] | 6,5                                  | 6,5 | 7,5 | 7,5                      | 7,5 | 7,5 | 7,5 | 7,5 |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ] | 5,5                                  | 5,5 | 6,5 | 6,5                      | 6,5 | 6,5 | 6,5 | 6,5 |
| Increasing factors for<br>concrete  | C25/30  | $\psi_c$            | [-]                  | 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                                  |     |     |                          |     |     |     |     |
| waterfilled drill hole  |   | $\gamma_{inst}$     | [-]                  | 1,2                                  |     |     |                          |     |     |     |     |

<sup>1)</sup> Value in brackets: characteristic bond resistance for waterfilled drill holes

**Injection System VME plus**

**Performance**

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

**Annex C5**

**Table C6: Characteristic values of tension load for threaded rods, static and quasi-static action, working life 50 and 100 years, diamond drilling in uncracked concrete**

| 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 uncracked concrete C20/25</b> Working life 50 years  |                  |                     |                      |                                      |     |     |     |     |     |     |     |
| Temperature range I:<br>40°C / 24°C   | diamond drilling | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ] | 15                                   | 14  | 14  | 13  | 12  | 12  | 11  | 11  |
| Temperature range II:<br>72°C / 50°C  |                  | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ] | 12                                   | 12  | 11  | 10  | 9,5 | 9,5 | 9,0 | 9,0 |
| <b>Reduction factor <math>\psi^{0}_{sus}</math> in uncracked concrete C20/25</b>          |                  |                     |                      |                                      |     |     |     |     |     |     |     |
| Temperature range I:<br>40°C / 24°C   | diamond drilling | $\psi^{0}_{sus}$    | [-]                  | 0,77                                 |     |     |     |     |     |     |     |
| Temperature range II:<br>72°C / 50°C  |                  | $\psi^{0}_{sus}$    | [-]                  | 0,72                                 |     |     |     |     |     |     |     |
| <b>Characteristic bond resistance in uncracked concrete C20/25</b> Working life 100 years |                  |                     |                      |                                      |     |     |     |     |     |     |     |
| Temperature range I:<br>40°C / 24°C   | diamond drilling | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 15                                   | 14  | 14  | 13  | 12  | 12  | 11  | 11  |
| Temperature range II:<br>72°C / 50°C  |                  | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 11                                   | 11  | 10  | 10  | 9,5 | 9,0 | 8,5 | 8,5 |
| Increasing factors for concrete   | C25/30           | $\psi_c$            | [-]                  | 1,04                                 |     |     |     |     |     |     |     |
|   | C30/37           |                     | [-]                  | 1,08                                 |     |     |     |     |     |     |     |
|   | C35/45           |                     | [-]                  | 1,12                                 |     |     |     |     |     |     |     |
|   | C40/50           |                     | [-]                  | 1,15                                 |     |     |     |     |     |     |     |
|   | C45/55           |                     | [-]                  | 1,17                                 |     |     |     |     |     |     |     |
|   | C50/60           |                     | [-]                  | 1,19                                 |     |     |     |     |     |     |     |
| <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                                  |     |     |     |     |     |     |     |
| waterfilled drill hole  |                  | $\gamma_{inst}$     | [-]                  | 1,2                                  |     |     | 1,4 |     |     |     |     |

**Injection System VME plus**

**Performance**

Characteristic values of tension loads for threaded rods, working life 50 and 100 years, diamond drilling

**Annex C6**



**Table C7: Characteristic values of shear loads for threaded rods, static and quasi-static action**

| Threaded rod   |                   |                    | M8   | M10 | M12 | M16 | M20 | M24 | M27                           | M30  |
|--|-------------------|--------------------|--|-----|-----|-----|-----|-----|-------------------------------|------|
| <b>Steel failure <u>without</u> lever arm</b>  |                   |                    |  |     |     |     |     |     |                               |      |
| Characteristic shear resistance<br>Steel, property class 4.6, 4.8, 5.6 and 5.8   | $V_{Rk,s}^0$      | [kN]               | 0,6 · A <sub>s</sub> · f <sub>uk</sub><br>or see Table C2  |     |     |     |     |     |                               |      |
| Characteristic shear resistance<br>Steel, property class 8.8<br>Stainless steel A2, A4 and HCR<br>(all property classes) | $V_{Rk,s}^0$      | [kN]               | 0,5 · A <sub>s</sub> · f <sub>uk</sub><br>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 <u>with</u> lever arm</b>   |                   |                    |  |     |     |     |     |     |                               |      |
| Characteristic bending resistance  | $M_{Rk,s}^0$      | [Nm]               | 1,2 · W <sub>el</sub> · f <sub>uk</sub><br>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 VME plus**

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

**Annex C7**

**Table C8: Characteristic values of tension load for threaded rods, seismic action (performance category C1 + C2), working life 50 and 100 years**

| Threaded rod   |  |                                     | M8                   | M10                  | M12 | M16 | M20 | M24 | M27             | M30             |
|--|--|-------------------------------------|----------------------|----------------------|-----|-----|-----|-----|-----------------|-----------------|
| <b>Tension loads</b>   |  |                                     |                      |                      |     |     |     |     |                 |                 |
| <b>Steel failure</b>   |  |                                     |                      |                      |     |     |     |     |                 |                 |
| Characteristic resistance <b>C1</b>  | $N_{Rk,s,C1}$  | [kN]                                | $1,0 \cdot N_{Rk,s}$ |                      |     |     |     |     |                 |                 |
| Characteristic resistance <b>C2</b><br>steel, zinc plated, property class 8.8<br>stainless steel A4 and HCR,<br>property class $\geq 70$ | $N_{Rk,s,C2}$  | [kN]                                | - <sup>1)</sup>      | $1,0 \cdot N_{Rk,s}$ |     |     |     |     |                 | - <sup>1)</sup> |
| Partial factor   | $\gamma_{Ms,N}$  | [-]                                 | see Table C1         |                      |     |     |     |     |                 |                 |
| <b>Combined pull-out and concrete failure</b>  |  |                                     |                      |                      |     |     |     |     |                 |                 |
| <b>Characteristic bond resistance in concrete C20/25 to C50/60</b>   |  |                                     |                      |                      |     |     |     |     |                 |                 |
| Temperature range I:<br>40°C / 24°C  | hammer-,<br>compressed<br>air or<br>vacuum<br>drilling | $\tau_{Rk,C1}$ [N/mm <sup>2</sup> ] | 7,0                  | 7,0                  | 8,5 | 8,5 | 8,5 | 8,5 | 8,5             | 8,5             |
|  |  | $\tau_{Rk,C2}$ [N/mm <sup>2</sup> ] | - <sup>1)</sup>      |                      | 5,8 | 4,8 | 5,0 | 5,1 | - <sup>1)</sup> |                 |
| Temperature range II:<br>72°C / 50°C   | hammer-,<br>compressed<br>air or<br>vacuum<br>drilling | $\tau_{Rk,C1}$ [N/mm <sup>2</sup> ] | 6,0                  | 6,0                  | 7,0 | 7,0 | 7,0 | 7,0 | 7,0             | 7,0             |
|  |  | $\tau_{Rk,C2}$ [N/mm <sup>2</sup> ] | - <sup>1)</sup>      |                      | 5,0 | 4,1 | 4,3 | 4,4 | - <sup>1)</sup> |                 |
| <b>Installation factor</b>   |  |                                     |                      |                      |     |     |     |     |                 |                 |
| Dry or wet concrete  | $\gamma_{inst}$  | [-]                                 | 1,0                  |                      |     |     |     |     |                 |                 |
| Waterfilled drill hole   | $\gamma_{inst}$  | [-]                                 | 1,2                  |                      |     |     |     |     |                 |                 |

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

**Table C9: Characteristic values of shear loads for threaded rods, seismic action (performance category C1 + C2)**

| Threaded rod   |   |                | M8                     | M10                    | M12 | M16 | M20 | M24 | M27 | M30             |
|--|---|----------------|------------------------|------------------------|-----|-----|-----|-----|-----|-----------------|
| <b>Shear loads</b>   |   |                |                        |                        |     |     |     |     |     |                 |
| <b>Steel failure <u>without</u> lever arm</b>  |   |                |                        |                        |     |     |     |     |     |                 |
| Characteristic resistance <b>C1</b>  | $V_{Rk,s,C1}$                                     | [kN]           | $0,7 \cdot V^0_{Rk,s}$ |                        |     |     |     |     |     |                 |
| Characteristic resistance <b>C2</b><br>steel, zinc plated, property class 8.8<br>stainless steel A4 and HCR,<br>property class $\geq 70$ | $V_{Rk,s,C2}$                                     | [kN]           | - <sup>1)</sup>        | $0,7 \cdot V^0_{Rk,s}$ |     |     |     |     |     | - <sup>1)</sup> |
| Partial factor   | $\gamma_{Ms,N}$                                   | [-]            | see Table C2           |                        |     |     |     |     |     |                 |
| Factor for anchorages  | without annular gap                               | $\alpha_{gap}$ | [-]                    | 1,0                    |     |     |     |     |     |                 |
|  | with annular gap between threaded rod and fixture |                |                        | 0,5                    |     |     |     |     |     |                 |

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

**Injection System VME plus**

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

**Annex C8**

**Table C10: Characteristic values of tension loads for internally threaded anchor rod, static and quasi-static action, working life 50 years**

| Internally threaded anchor rod  |  |                  |                      | VMU-IG<br>M 6 | VMU-IG<br>M 8 | VMU-IG<br>M 10        | VMU-IG<br>M 12 | VMU-IG<br>M 16 | VMU-IG<br>M 20    |
|---|--|------------------|----------------------|---------------|---------------|-----------------------|----------------|----------------|-------------------|
| <b>Steel failure <sup>1)</sup></b>  |  |                  |                      |               |               |                       |                |                |                   |
| Characteristic resistance, steel, zinc plated, property class             | 5.8  | $N_{Rk,s}$       | [kN]                 | 10            | 17            | 29                    | 42             | 76             | 123               |
|   | 8.8  | $N_{Rk,s}$       | [kN]                 | 16            | 27            | 46                    | 67             | 121            | 196               |
| Partial factor 5.8 and 8.8  |  | $\gamma_{Ms,N}$  | [-]                  | 1,5           |               |                       |                |                |                   |
| Characteristic resistance, Stainless steel A4 / HCR, property class 70    |  | $N_{Rk,s}$       | [kN]                 | 14            | 26            | 41                    | 59             | 110            | 124 <sup>2)</sup> |
| Partial factor  |  | $\gamma_{Ms,N}$  | [-]                  | 1,87          |               |                       |                |                |                   |
| <b>Combined pull-out and concrete failure</b>                             |  |                  |                      |               |               |                       |                |                |                   |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |  |                  |                      |               |               |                       |                |                |                   |
| Temperature range I: 40°C / 24°C  | hammer- or compressed air drilling         | $\tau_{Rk,ucr}$  | [N/mm <sup>2</sup> ] | 20            | 19            | 19                    | 18             | 17             | 16                |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,ucr}$  | [N/mm <sup>2</sup> ] | 15            | 15            | 14                    | 13             | 13             | 12                |
| Temperature range I: 40°C / 24°C  | vacuum drilling                            | $\tau_{Rk,ucr}$  | [N/mm <sup>2</sup> ] | 16            | 16            | 16 (15) <sup>3)</sup> | 15             | 14             | 13                |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,ucr}$  | [N/mm <sup>2</sup> ] | 14            | 14            | 13                    | 13             | 12             | 11                |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |  |                  |                      |               |               |                       |                |                |                   |
| Temperature range I: 40°C / 24°C  | hammer-, compressed air or vacuum drilling | $\tau_{Rk,cr}$   | [N/mm <sup>2</sup> ] | 7,0           | 8,5           | 8,5                   | 8,5            | 8,5            | 8,5               |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,cr}$   | [N/mm <sup>2</sup> ] | 6,0           | 7,0           | 7,0                   | 7,0            | 7,0            | 7,0               |
| <b>Reductionfactor <math>\psi^{0}_{sus}</math></b>                        |  |                  |                      |               |               |                       |                |                |                   |
| Temperature range I: 40°C / 24°C  | hammer-, compressed air or vacuum drilling | $\psi^{0}_{sus}$ | [-]                  | 0,80          |               |                       |                |                |                   |
| Temperature range II: 72°C / 50°C   |  | $\psi^{0}_{sus}$ | [-]                  | 0,68          |               |                       |                |                |                   |
| Increasing factor for concrete  |  | $\psi_c$         | C25/30               | 1,02          |               |                       |                |                |                   |
|   |  |                  | C30/37               | 1,04          |               |                       |                |                |                   |
|   |  |                  | C35/45               | 1,07          |               |                       |                |                |                   |
|   |  |                  | C40/50               | 1,08          |               |                       |                |                |                   |
|   |  |                  | C45/55               | 1,09          |               |                       |                |                |                   |
|   |  |                  | C50/60               | 1,10          |               |                       |                |                |                   |
| <b>Concrete cone failure</b>  |  |                  |                      |               |               |                       |                |                |                   |
| Relevant parameter  |  |                  |                      | see Table C3  |               |                       |                |                |                   |
| <b>Splitting failure</b>  |  |                  |                      |               |               |                       |                |                |                   |
| Relevant parameter  |  |                  |                      | see Table C3  |               |                       |                |                |                   |
| <b>Installation factor</b>  |  |                  |                      |               |               |                       |                |                |                   |
| dry or wet concrete   |  | $\gamma_{inst}$  | [-]                  | 1,0           |               |                       |                |                |                   |
| waterfilled drill hole  |  | $\gamma_{inst}$  | [-]                  | 1,2           |               |                       |                |                |                   |

<sup>1)</sup>Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

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

<sup>3)</sup> value in bracket is valid for waterfilled drill hole

**Injection System VME plus**

**Performance**

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

**Annex C9**

**Table C11: Characteristic values of tension loads for internally threaded anchor rod static and quasi-static action, working life 100 years**

| Internally threaded anchor rod  |  |                     |                      | VMU-IG<br>M 6 | VMU-IG<br>M 8 | VMU-IG<br>M 10        | VMU-IG<br>M 12 | VMU-IG<br>M 16 | VMU-IG<br>M 20    |
|---|--|---------------------|----------------------|---------------|---------------|-----------------------|----------------|----------------|-------------------|
| <b>Steel failure <sup>1)</sup></b>  |  |                     |                      |               |               |                       |                |                |                   |
| Characteristic resistance, steel, zinc plated, property class             | 5.8  | $N_{Rk,s}$          | [kN]                 | 10            | 17            | 29                    | 42             | 76             | 123               |
|   | 8.8  | $N_{Rk,s}$          | [kN]                 | 16            | 27            | 46                    | 67             | 121            | 196               |
| Partial factor 5.8 and 8.8  |  | $\gamma_{Ms,N}$     | [-]                  | 1,5           |               |                       |                |                |                   |
| Characteristic resistance, Stainless steel A4 / HCR, property class 70    |  | $N_{Rk,s}$          | [kN]                 | 14            | 26            | 41                    | 59             | 110            | 124 <sup>2)</sup> |
|   | Partial factor                             |                     | $\gamma_{Ms,N}$      | [-]           | 1,87          |                       |                |                |                   |
| <b>Combined pull-out and concrete failure</b>                             |  |                     |                      |               |               |                       |                |                |                   |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |  |                     |                      |               |               |                       |                |                |                   |
| Temperature range I: 40°C / 24°C  | hammer- or compressed air drilling         | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 20            | 19            | 19                    | 18             | 17             | 16                |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 15            | 15            | 14                    | 13             | 13             | 12                |
| Temperature range I: 40°C / 24°C  | vacuum drilling                            | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 16            | 16            | 16 (15) <sup>3)</sup> | 15             | 14             | 13                |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 14            | 14            | 13                    | 13             | 12             | 11                |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |  |                     |                      |               |               |                       |                |                |                   |
| Temperature range I: 40°C / 24°C  | hammer-, compressed air or vacuum drilling | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ] | 6,5           | 7,5           | 7,5                   | 7,5            | 7,5            | 7,5               |
| Temperature range II: 72°C / 50°C   |  | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ] | 5,5           | 6,5           | 6,5                   | 6,5            | 6,5            | 6,5               |
| Increasing factor for concrete  |  |                     | $\psi_c$             | C25/30        | 1,02          |                       |                |                |                   |
|   |  |                     |                      | C30/37        | 1,04          |                       |                |                |                   |
|   |  |                     |                      | C35/45        | 1,07          |                       |                |                |                   |
|   |  |                     |                      | C40/50        | 1,08          |                       |                |                |                   |
|   |  |                     |                      | C45/55        | 1,09          |                       |                |                |                   |
|   |  |                     |                      | C50/60        | 1,10          |                       |                |                |                   |
| <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           |               |                       |                |                |                   |
| waterfilled drill hole  |  | $\gamma_{inst}$     | [-]                  | 1,2           |               |                       |                |                |                   |

<sup>1)</sup> fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

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

<sup>3)</sup> value in bracket is valid for waterfilled drill hole

|   |  |                  |
|---|--|------------------|
| <b>Injection System VME plus</b>  |  | <b>Annex C10</b> |
| <b>Performance</b><br>Characteristic values of tension loads for internally threaded anchor rod, working life 100 years |  |                  |

**Table C12: Characteristic values of tension loads for internally threaded anchor rod, static and quasi-static action, working life 50 and 100 years, diamond drilling**

| Internally threaded anchor rod  |                  |                     |                      | VMU-IG<br>M 6 | VMU-IG<br>M 8 | VMU-IG<br>M 10 | VMU-IG<br>M 12 | VMU-IG<br>M 16                | VMU-IG<br>M 20    |
|---|------------------|---------------------|----------------------|---------------|---------------|----------------|----------------|-------------------------------|-------------------|
| <b>Steel failure <sup>1)</sup></b>  |                  |                     |                      |               |               |                |                |                               |                   |
| Characteristic resistance, steel, zinc plated, property class             | 5.8              | $N_{Rk,s}$          | [kN]                 | 10            | 17            | 29             | 42             | 76                            | 123               |
|   | 8.8              | $N_{Rk,s}$          | [kN]                 | 16            | 27            | 46             | 67             | 121                           | 196               |
| Partial factor 5.8 and 8.8  |                  | $\gamma_{Ms,N}$     | [-]                  | 1,5           |               |                |                |                               |                   |
| Characteristic resistance, stainless steel A4 / HCR, property class 70    |                  | $N_{Rk,s}$          | [kN]                 | 14            | 26            | 41             | 59             | 110                           | 124 <sup>2)</sup> |
|   | Partial factor   |                     | $\gamma_{Ms,N}$      | [-]           | 1,87          |                |                |                               |                   |
| <b>Combined pull-out and concrete failure</b>                             |                  |                     |                      |               |               |                |                |                               |                   |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |                  |                     |                      |               |               |                |                | <b>Working life 50 years</b>  |                   |
| Temperature range I:<br>40°C / 24°C                                       | diamond drilling | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ] | 14            | 14            | 13             | 12             | 12                            | 11                |
|   |                  | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ] | 12            | 11            | 10             | 9,5            | 9,5                           | 9,0               |
| <b>Reduktionsfaktor <math>\psi^0_{sus}</math></b>                         |                  |                     |                      |               |               |                |                |                               |                   |
| Temperature range I:<br>40°C / 24°C                                       | diamond drilling | $\psi^0_{sus}$      | [-]                  | 0,77          |               |                |                |                               |                   |
|   |                  | $\psi^0_{sus}$      | [-]                  | 0,72          |               |                |                |                               |                   |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |                  |                     |                      |               |               |                |                | <b>Working life 100 years</b> |                   |
| Temperature range I:<br>40°C / 24°C                                       | diamond drilling | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 14            | 14            | 13             | 12             | 12                            | 11                |
|   |                  | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ] | 11            | 10            | 10             | 9,5            | 9,0                           | 8,5               |
| Increasing factor for $\tau_{Rk,ucr}$                                     |                  | $\psi_c$            |                      | C25/30        | 1,04          |                |                |                               |                   |
|   |                  |                     |                      | C30/37        | 1,08          |                |                |                               |                   |
|   |                  |                     |                      | C35/45        | 1,12          |                |                |                               |                   |
|   |                  |                     |                      | C40/50        | 1,15          |                |                |                               |                   |
|   |                  |                     |                      | C45/55        | 1,17          |                |                |                               |                   |
|   |                  |                     |                      | C50/60        | 1,19          |                |                |                               |                   |
| <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           |               |                |                |                               |                   |
| waterfilled drill hole  |                  | $\gamma_{inst}$     | [-]                  | 1,2           |               |                | 1,4            |                               |                   |

<sup>1)</sup> fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

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

<sup>3)</sup> value in bracket is valid for waterfilled drill hole

### Injection System VME plus

#### Performance

Characteristic values of tension loads for internally threaded anchor rod, working life 50 and 100 years, diamond drilling

**Annex C11**

**Table C13: Characteristic values of shear loads for internally threaded anchor rod, static and quasi-static action**

| Internally threaded anchor rod                              |  |     |                   | VMU-IG<br>M 6                | VMU-IG<br>M 8 | VMU-IG<br>M 10 | VMU-IG<br>M 12 | VMU-IG<br>M 16 | VMU-IG<br>M 20    |                         |
|---|--|-----|-------------------|------------------------------|---------------|----------------|----------------|----------------|-------------------|-------------------------|
| <b>Steel failure <u>without</u> lever arm <sup>1)</sup></b> |  |     |                   |                              |               |                |                |                |                   |                         |
| Steel,<br>zinc plated                                       | Characteristic resistance,<br>property 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 5.8 and 8.8                                       |     | $\gamma_{Ms,V}$   | [-]                          | 1,25          |                |                |                |                   |                         |
| Stainless<br>steel  | Characteristic resistance,<br>A4 / HCR, property class 70        |     | $V_{Rk,s}^0$ [kN] | 7                            | 13            | 20             | 30             | 55             | 62 <sup>2)</sup>  |                         |
|   | Partial factor   |     | $\gamma_{Ms,V}$   | [-]                          | 1,56          |                |                |                |                   | 2,38                    |
| Ductility factor  |  |     | $k_7$             | [-]                          | 1,0           |                |                |                |                   |                         |
| <b>Steel failure <u>with</u> lever arm <sup>1)</sup></b>    |  |     |                   |                              |               |                |                |                |                   |                         |
| Steel,<br>zinc plated                                       | Characteristic bending<br>resistance,<br>property 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 5.8 and 8.8                                       |     | $\gamma_{Ms,V}$   | [-]                          | 1,25          |                |                |                |                   |                         |
| Stainless<br>steel  | Characteristic bending resistance<br>A4 / HCR, property class 70 |     | $M_{Rk,s}^0$ [Nm] | 11                           | 26            | 53             | 92             | 234            | 643 <sup>2)</sup> |                         |
|   | Partial factor   |     | $\gamma_{Ms,V}$   | [-]                          | 1,56          |                |                |                |                   | 2,38                    |
| <b>Concrete pry-out failure</b>                             |  |     |                   |                              |               |                |                |                |                   |                         |
| Pry-out factor  |  |     | $k_8$             | [-]                          | 2,0           |                |                |                |                   |                         |
| <b>Concrete edge failure</b>                                |  |     |                   |                              |               |                |                |                |                   |                         |
| Effective length of anchor                                  |  |     | $l_f$ [mm]        | min ( $h_{ef}; 12 d_{nom}$ ) |               |                |                |                |                   | min ( $h_{ef}; 300mm$ ) |
| Outside diameter of anchor                                  |  |     | $d_{nom}$ [mm]    | 10                           | 12            | 16             | 20             | 24             | 30                |                         |
| Installation factor   |  |     | $\gamma_{inst}$   | [-]                          | 1,0           |                |                |                |                   |                         |

<sup>1)</sup> fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod (exception: VMU-IG M20). The characteristic shear resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

<sup>2)</sup> for VMU-IG M20: Internally threaded rod: property class 50;  
Fastening screws or threaded rods (incl. nut and washer): property class 70

**Injection System VME plus**

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

**Annex C12**

**Table C14: Characteristic values of tension loads for rebar, static and quasi-static action, working life 50 years**

| Reinforcing bar  |   |                    |                         | Ø 8                      | Ø 10                     | Ø 12                     | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|--|---|--------------------|-------------------------|--------------------------|--------------------------|--------------------------|------|------|------|------|------|------|------|
| <b>Steel failure</b>   |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Characteristic tension resistance                                  | $N_{Rk,s}$  | [kN]               | $A_s \cdot f_{uk}^{1)}$ |                          |                          |                          |      |      |      |      |      |      |      |
| Cross sectional area   | $A_s$   | [mm <sup>2</sup> ] | 50                      | 79                       | 113                      | 154                      | 201  | 314  | 452  | 491  | 616  | 804  |      |
| Partial factor   | $\gamma_{Ms,N}$                                     | [-]                | 1,4 <sup>2)</sup>       |                          |                          |                          |      |      |      |      |      |      |      |
| <b>Combined pull-out and concrete failure</b>                      |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| <b>Characteristic bond resistance in uncracked concrete C20/25</b> |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Temperature range I:<br>40°C / 24°C                                | hammer- and<br>compressed air<br>drilling           | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 16                       | 16                       | 16                       | 16   | 16   | 16   | 15   | 15   | 15   | 15   |
| Temperature range II:<br>72°C / 50°C                               |   | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 12                       | 12                       | 12                       | 12   | 12   | 12   | 12   | 12   | 11   | 11   |
| Temperature range I:<br>40°C / 24°C                                | vacuum drilling                                     | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 14<br>(13) <sup>3)</sup> | 14<br>(13) <sup>3)</sup> | 13                       | 13   | 13   | 13   | 13   | 13   | 13   | 13   |
| Temperature range II:<br>72°C / 50°C                               |   | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 12<br>(11) <sup>3)</sup> | 12<br>(11) <sup>3)</sup> | 12<br>(11) <sup>3)</sup> | 11   | 11   | 11   | 11   | 11   | 11   | 11   |
| <b>Characteristic bond resistance in cracked concrete C20/25</b>   |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Temperature range I:<br>40°C / 24°C                                | hammer-,<br>compressed air<br>or vacuum<br>drilling | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 7,0                      | 7,0                      | 8,5                      | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  |
| Temperature range II:<br>72°C / 50°C                               |   | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 6,0                      | 6,0                      | 7,0                      | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  |
| <b>Reductionfactor <math>\psi_{sus}^0</math></b>                   |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Temperature range I:<br>40°C / 24°C                                | hammer-,<br>compressed air<br>or vacuum<br>drilling | $\psi_{sus}^0$     | [-]                     | 0,80                     |                          |                          |      |      |      |      |      |      |      |
| Temperature range II:<br>72°C / 50°C                               |   | $\psi_{sus}^0$     | [-]                     | 0,68                     |                          |                          |      |      |      |      |      |      |      |
| Increasing factor for concrete                                     |   | $\psi_c$           | C25/30                  | 1,02                     |                          |                          |      |      |      |      |      |      |      |
|  |   |                    | C30/37                  | 1,04                     |                          |                          |      |      |      |      |      |      |      |
|  |   |                    | C35/45                  | 1,07                     |                          |                          |      |      |      |      |      |      |      |
|  |   |                    | C40/50                  | 1,08                     |                          |                          |      |      |      |      |      |      |      |
|  |   |                    | C45/55                  | 1,09                     |                          |                          |      |      |      |      |      |      |      |
|  |   |                    | C50/60                  | 1,10                     |                          |                          |      |      |      |      |      |      |      |
| <b>Concrete cone failure</b>                                       |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Relevant parameter   |   |                    |                         | see Table C3             |                          |                          |      |      |      |      |      |      |      |
| <b>Splitting failure</b>   |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| Relevant parameter   |   |                    |                         | see Table C3             |                          |                          |      |      |      |      |      |      |      |
| <b>Installation factor</b>   |   |                    |                         |                          |                          |                          |      |      |      |      |      |      |      |
| dry or wet concrete  |   | $\gamma_{inst}$    | [-]                     | 1,0                      |                          |                          |      |      |      |      |      |      |      |
| waterfilled drill hole   |   | $\gamma_{inst}$    | [-]                     | 1,2                      |                          |                          |      |      |      |      |      |      |      |

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

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

<sup>3)</sup> value in brackets: characteristic bond resistance for waterfilled drill holes

**Injection System VME plus**

**Performance**

Characteristic values of tension loads for rebar, working life 50 years

**Annex C13**

**Table C15: Characteristic values of tension loads for rebar, static and quasi-static action, working life 100 years**

| Reinforcing bar   |   |                     | Ø 8                     | Ø 10                     | Ø 12                     | Ø 14                     | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |     |
|---|---|---------------------|-------------------------|--------------------------|--------------------------|--------------------------|------|------|------|------|------|------|-----|
| <b>Steel failure</b>  |   |                     |                         |                          |                          |                          |      |      |      |      |      |      |     |
| Characteristic tension resistance   | $N_{Rk,s}$  | [kN]                | $A_s \cdot f_{uk}^{1)}$ |                          |                          |                          |      |      |      |      |      |      |     |
| Cross sectional area  | $A_s$   | [mm <sup>2</sup> ]  | 50                      | 79                       | 113                      | 154                      | 201  | 314  | 452  | 491  | 616  | 804  |     |
| Partial factor  | $\gamma_{Ms,N}$                                     | [-]                 | 1,4 <sup>2)</sup>       |                          |                          |                          |      |      |      |      |      |      |     |
| <b>Combined pull-out and concrete failure</b>                             |   |                     |                         |                          |                          |                          |      |      |      |      |      |      |     |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |   |                     |                         |                          |                          |                          |      |      |      |      |      |      |     |
| Temperature range I:<br>40°C / 24°C                                       | hammer- and<br>compressed<br>air drilling           | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 16                       | 16                       | 16                       | 16   | 16   | 16   | 15   | 15   | 15   | 15  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 12                       | 12                       | 12                       | 12   | 12   | 12   | 12   | 12   | 11   | 11  |
| Temperature range I:<br>40°C / 24°C                                       | vacuum drilling                                     | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 14<br>(13) <sup>3)</sup> | 14<br>(13) <sup>3)</sup> | 13                       | 13   | 13   | 13   | 13   | 13   | 13   | 13  |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 12<br>(11) <sup>3)</sup> | 12<br>(11) <sup>3)</sup> | 12<br>(11) <sup>3)</sup> | 11   | 11   | 11   | 11   | 11   | 11   | 11  |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |   |                     |                         |                          |                          |                          |      |      |      |      |      |      |     |
| Temperature range I:<br>40°C / 24°C                                       | hammer-,<br>compressed<br>air or vacuum<br>drilling | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ]    | 6,5                      | 6,5                      | 7,5                      | 7,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5 |
| Temperature range II:<br>72°C / 50°C                                      |   | $\tau_{Rk,cr,100}$  | [N/mm <sup>2</sup> ]    | 5,5                      | 5,5                      | 6,5                      | 6,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5 |
| Increasing factor for concrete  |   |                     | $\psi_c$                | C25/30                   | 1,02                     |                          |      |      |      |      |      |      |     |
|   |   |                     |                         | C30/37                   | 1,04                     |                          |      |      |      |      |      |      |     |
|   |   |                     |                         | C35/45                   | 1,07                     |                          |      |      |      |      |      |      |     |
|   |   |                     |                         | C40/50                   | 1,08                     |                          |      |      |      |      |      |      |     |
|   |   |                     |                         | C45/55                   | 1,09                     |                          |      |      |      |      |      |      |     |
|   |   |                     |                         | C50/60                   | 1,10                     |                          |      |      |      |      |      |      |     |
| <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                     |                          |                          |                          |      |      |      |      |      |      |     |
| waterfilled drill hole  | $\gamma_{inst}$                                     | [-]                 | 1,2                     |                          |                          |                          |      |      |      |      |      |      |     |

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

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

<sup>3)</sup> value in brackets: characteristic bond resistance for waterfilled drill holes

**Injection System VME plus**

**Performance**

Characteristic values of tension loads for rebar, working life 100 years

**Annex C14**



**Table C16: Characteristic values of tension loads for rebar, static and quasi-static action, working life 50 and 100 years, diamond drilling**

| Reinforcing bar  |                     |                     |                         | Ø 8          | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |  |  |
|--|---------------------|---------------------|-------------------------|--------------|------|------|------|------|------|------|------|------|------|--|--|
| <b>Steel failure</b>   |                     |                     |                         |              |      |      |      |      |      |      |      |      |      |  |  |
| Characteristic tension resistance  | $N_{Rk,s}$          | [kN]                | $A_s \cdot f_{uk}^{1)}$ |              |      |      |      |      |      |      |      |      |      |  |  |
| Cross sectional area   | $A_s$               | [mm <sup>2</sup> ]  | 50                      | 79           | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |      |  |  |
| Partial factor   | $\gamma_{Ms,N}$     | [-]                 | 1,4 <sup>2)</sup>       |              |      |      |      |      |      |      |      |      |      |  |  |
| <b>Combined pull-out and concrete failure</b>  |                     |                     |                         |              |      |      |      |      |      |      |      |      |      |  |  |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25 Working life 50 years</b>  |                     |                     |                         |              |      |      |      |      |      |      |      |      |      |  |  |
| Temperature range I:<br>40°C / 24°C  | diamond<br>drilling | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ]    | 14           | 13   | 13   | 13   | 12   | 12   | 11   | 11   | 11   | 11   |  |  |
| Temperature range II:<br>72°C / 50°C   |                     | $\tau_{Rk,ucr}$     | [N/mm <sup>2</sup> ]    | 11           | 11   | 10   | 10   | 10   | 9,5  | 9,5  | 9,5  | 9,0  | 9,0  |  |  |
| <b>Reductionfactor <math>\psi^{0}_{sus}</math></b>   |                     |                     |                         |              |      |      |      |      |      |      |      |      |      |  |  |
| Temperature range I:<br>40°C / 24°C  | diamond<br>drilling | $\psi^{0}_{sus}$    | [-]                     | 0,77         |      |      |      |      |      |      |      |      |      |  |  |
| Temperature range II:<br>72°C / 50°C   |                     | $\psi^{0}_{sus}$    | [-]                     | 0,72         |      |      |      |      |      |      |      |      |      |  |  |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25 Working life 100 years</b> |                     |                     |                         |              |      |      |      |      |      |      |      |      |      |  |  |
| Temperature range I:<br>40°C / 24°C  | diamond<br>drilling | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 14           | 13   | 13   | 13   | 12   | 12   | 11   | 11   | 11   | 11   |  |  |
| Temperature range II:<br>72°C / 50°C   |                     | $\tau_{Rk,ucr,100}$ | [N/mm <sup>2</sup> ]    | 11           | 10   | 10   | 10   | 9,5  | 9,0  | 9,0  | 9,0  | 8,5  | 8,5  |  |  |
| Increasing factor for concrete   |                     | $\psi_c$            | C25/30                  | 1,04         |      |      |      |      |      |      |      |      |      |  |  |
|  |                     |                     | C30/37                  | 1,08         |      |      |      |      |      |      |      |      |      |  |  |
|  |                     |                     | C35/45                  | 1,12         |      |      |      |      |      |      |      |      |      |  |  |
|  |                     |                     | C40/50                  | 1,15         |      |      |      |      |      |      |      |      |      |  |  |
|  |                     |                     | C45/55                  | 1,17         |      |      |      |      |      |      |      |      |      |  |  |
|  |                     |                     | C50/60                  | 1,19         |      |      |      |      |      |      |      |      |      |  |  |
| <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                     |              |      |      |      |      |      |      |      |      |      |  |  |
| waterfilled drill hole   | $\gamma_{inst}$     | [-]                 | 1,2                     |              |      |      |      | 1,4  |      |      |      |      |      |  |  |

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

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

### Injection System VME plus

#### Performance

Characteristic values of **tension loads for rebar**, working life **50 and 100 years**, **diamond drilling**

**Annex C15**

**Table C17: Characteristic values of shear loads for rebar, static and quasi-static action**

| Reinforcing bar                               |                             | Ø 8                                  | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25                    | Ø 28 | Ø 32 |  |
|---|-----------------------------|--------------------------------------|------|------|------|------|------|------|-------------------------|------|------|--|
| <b>Steel failure <u>without</u> lever arm</b> |                             |                                      |      |      |      |      |      |      |                         |      |      |  |
| Characteristic shear resistance               | $V^0_{Rk,s}$ [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  | 452  | 491                     | 616  | 804  |  |
| Partial factor                                | $\gamma_{Ms,V}$ [-]         | 1,5 <sup>2)</sup>                    |      |      |      |      |      |      |                         |      |      |  |
| Ductility factor                              | $k_7$ [-]                   | 1,0                                  |      |      |      |      |      |      |                         |      |      |  |
| <b>Steel failure <u>with</u> lever arm</b>    |                             |                                      |      |      |      |      |      |      |                         |      |      |  |
| Characteristic bending resistance             | $M^0_{Rk,s}$ [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  | 1357 | 1534                    | 2155 | 3217 |  |
| Partial factor                                | $\gamma_{Ms,V}$ [-]         | 1,5 <sup>2)</sup>                    |      |      |      |      |      |      |                         |      |      |  |
| <b>Concrete pry-out failure</b>               |                             |                                      |      |      |      |      |      |      |                         |      |      |  |
| Pry-out factor                                | $k_8$ [-]                   | 2,0                                  |      |      |      |      |      |      |                         |      |      |  |
| <b>Concrete edge failure</b>                  |                             |                                      |      |      |      |      |      |      |                         |      |      |  |
| Effective length of rebar                     | $l_f$ [mm]                  | min ( $h_{ef}$ ; 12 $d_{nom}$ )      |      |      |      |      |      |      | min ( $h_{ef}$ ; 300mm) |      |      |  |
| Outside diameter of rebar                     | $d_{nom}$ [mm]              | 8                                    | 10   | 12   | 14   | 16   | 20   | 24   | 25                      | 28   | 32   |  |
| Installation factor                           | $\gamma_{inst}$ [-]         | 1,0                                  |      |      |      |      |      |      |                         |      |      |  |

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

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

**Injection System VME plus**

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

**Annex C16**

**Table C18: Characteristic values of tension load for rebar, seismic action (performance category C1), working life 50 and 100 years**

| Reinforcing bar  |   |                    | Ø 8                     | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|--|---|--------------------|-------------------------|------|------|------|------|------|------|------|------|------|
| <b>Steel failure</b>   |   |                    |                         |      |      |      |      |      |      |      |      |      |
| Characteristic resistance  | $N_{Rk,s,C1}$                                       | [kN]               | $A_s \cdot f_{uk}^{1)}$ |      |      |      |      |      |      |      |      |      |
| Cross sectional area   | $A_s$   | [mm <sup>2</sup> ] | 50                      | 79   | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |
| Partial factor   | $\gamma_{Ms,N}$                                     | [-]                | 1,4 <sup>2)</sup>       |      |      |      |      |      |      |      |      |      |
| <b>Combined pull-out and concrete failure</b>                      |   |                    |                         |      |      |      |      |      |      |      |      |      |
| <b>Characteristic bond resistance in concrete C20/25 to C50/60</b> |   |                    |                         |      |      |      |      |      |      |      |      |      |
| Temperature range I:<br>40°C / 24°C                                | hammer-,<br>compressed air<br>or vacuum<br>drilling | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 7,0  | 7,0  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  |
| Temperature range II:<br>72°C / 50°C                               |   | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 6,0  | 6,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  |
| <b>Installation factor</b>   |   |                    |                         |      |      |      |      |      |      |      |      |      |
| dry or wet concrete  | $\gamma_{inst}$                                     | [-]                | 1,0                     |      |      |      |      |      |      |      |      |      |
| waterfilled drill hole   | $\gamma_{inst}$                                     | [-]                | 1,2                     |      |      |      |      |      |      |      |      |      |

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

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

**Table C19: Characteristic values of shear loads for rebar, seismic action (performance category C1)**

| Reinforcing bar                               |                 |                    | Ø 8                                | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|---|-----------------|--------------------|------------------------------------|------|------|------|------|------|------|------|------|------|
| <b>Steel failure <u>without</u> lever arm</b> |                 |                    |                                    |      |      |      |      |      |      |      |      |      |
| Characteristic resistance                     | $V_{Rk,s,C1}$   | [kN]               | $0,35 \cdot A_s \cdot f_{uk}^{1)}$ |      |      |      |      |      |      |      |      |      |
| Cross sectional area                          | $A_s$           | [mm <sup>2</sup> ] | 50                                 | 79   | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |
| Partial factor                                | $\gamma_{Ms,V}$ | [-]                | 1,5 <sup>2)</sup>                  |      |      |      |      |      |      |      |      |      |
| Ductility factor                              | $k_7$           | [-]                | 1,0                                |      |      |      |      |      |      |      |      |      |

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

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

**Injection System VME plus**

**Performance**

Characteristic values for rebar under seismic action

**Annex C17**

**Table C20: Displacements under tension load, threaded rod**

| Threaded rod   |                             | M8                         | M10   | M12   | M16   | M20   | M24   | M27   | M30   |       |
|--|-----------------------------|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Hammer-, compressed air or vacuum drilling</b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Displacement factor<sup>1)</sup></b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 and 100 years</b> |                             |                            |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[ $\frac{N}{mm^2}$ ] | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
|  | $\delta_{N\infty}$ - factor |                            | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,038 | 0,039 | 0,040 | 0,044 | 0,047 | 0,051 | 0,052 | 0,055 |
|  | $\delta_{N\infty}$ - factor |                            | 0,047 | 0,049 | 0,051 | 0,055 | 0,059 | 0,064 | 0,067 | 0,070 |
| <b>Displacement factor<sup>1)</sup></b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Cracked concrete, static and quasi-static action, working life 50 and 100 years</b>   |                             |                            |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[ $\frac{N}{mm^2}$ ] | 0,069 | 0,071 | 0,072 | 0,074 | 0,076 | 0,079 | 0,081 | 0,082 |
|  | $\delta_{N\infty}$ - factor |                            | 0,100 | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,092 | 0,095 | 0,096 | 0,099 | 0,102 | 0,106 | 0,109 | 0,110 |
|  | $\delta_{N\infty}$ - factor |                            | 0,134 | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 |
| <b>Displacement</b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Uncracked and cracked concrete, seismic action (C2)</b>                               |                             |                            |       |       |       |       |       |       |       |       |
| All temperature ranges   | $\delta_{N,C2}$ (DLS)       | [mm]                       | _2)   | 0,21  | 0,24  | 0,27  | 0,36  | _2)   |       |       |
|  | $\delta_{N,C2}$ (ULS)       |                            |       | 0,54  | 0,51  | 0,54  | 0,63  |       |       |       |
| <b>Diamond drilling</b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Displacement factor<sup>1)</sup></b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 years</b>         |                             |                            |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[ $\frac{N}{mm^2}$ ] | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
|  | $\delta_{N\infty}$ - factor |                            | 0,018 | 0,019 | 0,019 | 0,020 | 0,022 | 0,023 | 0,024 | 0,025 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
|  | $\delta_{N\infty}$ - factor |                            | 0,052 | 0,053 | 0,055 | 0,058 | 0,062 | 0,065 | 0,068 | 0,070 |
| <b>Displacement factor<sup>1)</sup></b>  |                             |                            |       |       |       |       |       |       |       |       |
| <b>Uncracked concrete, static and quasi-static action, working life 100 years</b>        |                             |                            |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[ $\frac{N}{mm^2}$ ] | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
|  | $\delta_{N\infty}$ - factor |                            | 0,020 | 0,021 | 0,021 | 0,023 | 0,024 | 0,025 | 0,026 | 0,027 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
|  | $\delta_{N\infty}$ - factor |                            | 0,038 | 0,039 | 0,040 | 0,043 | 0,045 | 0,047 | 0,049 | 0,051 |

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

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

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

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

**Injection System VME plus**

**Performance**  
Displacements (threaded rod under tension load)

**Annex C18**

**Table C21: Displacements** under **shear load**, threaded rod

| Threaded rod  |                             | M8        | M10  | M12  | M16  | M20  | M24  | M27  | M30  |      |
|---|-----------------------------|-----------|------|------|------|------|------|------|------|------|
| <b>All drilling methods</b>   |                             |           |      |      |      |      |      |      |      |      |
| <b>Displacement factor<sup>1)</sup></b>                               |                             |           |      |      |      |      |      |      |      |      |
| <b>Uncracked and cracked concrete, static and quasi-static action</b> |                             |           |      |      |      |      |      |      |      |      |
| All temperature ranges  | $\delta_{v0}$ - factor      | [mm/(kN)] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
|   | $\delta_{v\infty}$ - factor |           | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |
| <b>Displacement</b>   |                             |           |      |      |      |      |      |      |      |      |
| <b>Uncracked and cracked concrete, seismic action (C2)</b>            |                             |           |      |      |      |      |      |      |      |      |
| All temperature ranges  | $\delta_{v,C2}$ (DLS)       | [mm]      | _2)  | 3,1  | 3,4  | 3,5  | 4,2  | _2)  |      |      |
|   | $\delta_{v,C2}$ (ULS)       |           |      | 6,0  | 7,6  | 7,3  | 10,9 |      |      |      |

1) Calculation of the displacement

$$\delta_{v0} = \delta_{v0}\text{- factor} \cdot V; \quad V: \text{acting shear load}$$

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

2) No Performance assessed

**Injection System VME plus**

**Performance**  
Displacements (threaded rod under shear load)

**Annex C19**

**Table C22: Displacement factors<sup>1)</sup> under tension load, internally threaded anchor rod**

| Internally threaded anchor rod   |                             | VMU-IG<br>M 6              | VMU-IG<br>M 8              | VMU-IG<br>M 10 | VMU-IG<br>M 12 | VMU-IG<br>M 16 | VMU-IG<br>M 20 |       |
|--|-----------------------------|----------------------------|----------------------------|----------------|----------------|----------------|----------------|-------|
| <b>Hammer-, compressed air or vacuum drilling</b>  |                             |                            |                            |                |                |                |                |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 and 100 years</b> |                             |                            |                            |                |                |                |                |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,029                      | 0,030          | 0,033          | 0,035          | 0,038          | 0,041 |
|  | $\delta_{N\infty}$ - factor |                            | 0,029                      | 0,030          | 0,033          | 0,035          | 0,038          | 0,041 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,039                      | 0,040          | 0,044          | 0,047          | 0,051          | 0,055 |
|  | $\delta_{N\infty}$ - factor |                            | 0,049                      | 0,051          | 0,055          | 0,059          | 0,064          | 0,070 |
| <b>Cracked concrete, static and quasi-static action, working life 50 and 100 years</b>   |                             |                            |                            |                |                |                |                |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      |                            | mm<br>[N/mm <sup>2</sup> ] | 0,071          | 0,072          | 0,074          | 0,076          | 0,079 |
|  | $\delta_{N\infty}$ - factor | 0,115                      |                            | 0,122          | 0,128          | 0,135          | 0,142          | 0,171 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      | 0,095                      |                            | 0,096          | 0,099          | 0,102          | 0,106          | 0,110 |
|  | $\delta_{N\infty}$ - factor | 0,154                      |                            | 0,163          | 0,172          | 0,181          | 0,189          | 0,229 |
| <b>Diamond drilling</b>  |                             |                            |                            |                |                |                |                |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 years</b>         |                             |                            |                            |                |                |                |                |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,012                      | 0,012          | 0,013          | 0,014          | 0,014          | 0,015 |
|  | $\delta_{N\infty}$ - factor |                            | 0,019                      | 0,019          | 0,020          | 0,022          | 0,023          | 0,025 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,014                      | 0,014          | 0,015          | 0,016          | 0,016          | 0,018 |
|  | $\delta_{N\infty}$ - factor |                            | 0,053                      | 0,055          | 0,058          | 0,062          | 0,065          | 0,070 |
| <b>Cracked concrete, static and quasi-static action, working life 100 years</b>          |                             |                            |                            |                |                |                |                |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      |                            | mm<br>[N/mm <sup>2</sup> ] | 0,012          | 0,012          | 0,013          | 0,014          | 0,014 |
|  | $\delta_{N\infty}$ - factor | 0,021                      |                            | 0,021          | 0,023          | 0,024          | 0,025          | 0,027 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      | 0,014                      |                            | 0,014          | 0,015          | 0,016          | 0,016          | 0,018 |
|  | $\delta_{N\infty}$ - factor | 0,039                      |                            | 0,040          | 0,043          | 0,045          | 0,047          | 0,051 |

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

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

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

**Table C23: Displacement factors<sup>1)</sup> under shear load: internally threaded anchor rod**

| Internally threaded anchor rod  |                             | VMU-IG<br>M 6 | VMU-IG<br>M 8 | VMU-IG<br>M 10 | VMU-IG<br>M 12 | VMU-IG<br>M 16 | VMU-IG<br>M 20 |      |
|---|-----------------------------|---------------|---------------|----------------|----------------|----------------|----------------|------|
| <b>Uncracked and cracked concrete, static and quasi-static action</b> |                             |               |               |                |                |                |                |      |
| All temperature ranges  | $\delta_{V0}$ - factor      | [mm/(kN)]     | 0,07          | 0,06           | 0,06           | 0,05           | 0,04           | 0,04 |
|   | $\delta_{V\infty}$ - factor |               | 0,10          | 0,09           | 0,08           | 0,08           | 0,06           | 0,06 |

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

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

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

**Injection System VME plus**

**Performance**

Displacements (internally threaded anchor rod)

**Annex C20**

**Table C24: Displacement factors<sup>1)</sup> under tension load (rebar)**

| Reinforcing bar  |                             | Ø 8                        | Ø 10  | Ø 12  | Ø 14  | Ø 16  | Ø 20  | Ø 24  | Ø 25  | Ø 28  | Ø 32  |       |
|--|-----------------------------|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Hammer-, compressed air or vaccum drilling</b>  |                             |                            |       |       |       |       |       |       |       |       |       |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 and 100 years</b> |                             |                            |       |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,028 | 0,029 | 0,030 | 0,031 | 0,033 | 0,035 | 0,038 | 0,038 | 0,040 | 0,043 |
|  | $\delta_{N\infty}$ - factor |                            | 0,015 | 0,015 | 0,016 | 0,017 | 0,017 | 0,019 | 0,020 | 0,020 | 0,021 | 0,023 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,038 | 0,039 | 0,040 | 0,042 | 0,044 | 0,047 | 0,051 | 0,051 | 0,054 | 0,058 |
|  | $\delta_{N\infty}$ - factor |                            | 0,047 | 0,049 | 0,051 | 0,053 | 0,055 | 0,059 | 0,065 | 0,065 | 0,068 | 0,072 |
| <b>Cracked concrete, static and quasi-static action, working life 50 and 100 years</b>   |                             |                            |       |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,069 | 0,071 | 0,072 | 0,073 | 0,074 | 0,076 | 0,079 | 0,079 | 0,081 | 0,084 |
|  | $\delta_{N\infty}$ - factor |                            | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 | 0,171 | 0,181 | 0,194 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,092 | 0,095 | 0,096 | 0,098 | 0,099 | 0,102 | 0,106 | 0,106 | 0,109 | 0,113 |
|  | $\delta_{N\infty}$ - factor |                            | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 | 0,229 | 0,242 | 0,260 |
| <b>Diamond drilling</b>  |                             |                            |       |       |       |       |       |       |       |       |       |       |
| <b>Uncracked concrete, static and quasi-static action, working life 50 years</b>         |                             |                            |       |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,008 | 0,009 | 0,009 | 0,010 | 0,011 | 0,012 | 0,013 | 0,013 | 0,014 | 0,015 |
|  | $\delta_{N\infty}$ - factor |                            | 0,018 | 0,018 | 0,019 | 0,020 | 0,021 | 0,024 | 0,027 | 0,027 | 0,028 | 0,031 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,009 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,015 | 0,016 | 0,018 |
|  | $\delta_{N\infty}$ - factor |                            | 0,048 | 0,051 | 0,054 | 0,058 | 0,061 | 0,068 | 0,076 | 0,076 | 0,081 | 0,088 |
| <b>Uncracked concrete, static and quasi-static action, working life 100 years</b>        |                             |                            |       |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C  | $\delta_{N0}$ - factor      | mm<br>[N/mm <sup>2</sup> ] | 0,008 | 0,009 | 0,009 | 0,010 | 0,011 | 0,012 | 0,013 | 0,013 | 0,014 | 0,015 |
|  | $\delta_{N\infty}$ - factor |                            | 0,018 | 0,020 | 0,021 | 0,022 | 0,024 | 0,026 | 0,029 | 0,029 | 0,031 | 0,034 |
| Temperature range II:<br>72°C / 50°C   | $\delta_{N0}$ - factor      |                            | 0,009 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,015 | 0,016 | 0,018 |
|  | $\delta_{N\infty}$ - factor |                            | 0,035 | 0,037 | 0,040 | 0,042 | 0,045 | 0,049 | 0,055 | 0,055 | 0,059 | 0,064 |

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

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

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

**Table C25: Displacement factors<sup>1)</sup> under shear load (rebar)**

| Reinforcing bar   |                             | Ø 8       | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |      |
|---|-----------------------------|-----------|------|------|------|------|------|------|------|------|------|------|
| <b>Uncracked and cracked concrete, static and quasi-static action</b> |                             |           |      |      |      |      |      |      |      |      |      |      |
| All temperature ranges  | $\delta_{V0}$ - factor      | [mm/(kN)] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 | 0,03 |
|   | $\delta_{V\infty}$ - factor |           | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 |

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

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

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

**Injection System VME plus**

**Performance**  
Displacements (rebar)

**Annex C21**