

## DECLARAÇÃO DE DESEMPENHO

DoP N.o: MKT-2.1-200\_pt

- ✧ **Código de identificação único do produto-tipo:** Sistema de injeção VME para betão
- ✧ **Utilização(ões) prevista(s):** Sistema de injeção para ancoragem em concreto, veja o Anexo/Annex B
- ✧ **Fabricante:** MKT Metall-Kunststoff-Technik GmbH & Co.KG  
Auf dem Immel 2  
67685 Weilerbach
- ✧ **Sistema(s) de avaliação e verificação da regularidade do desempenho (AVCP):** 1
- ✧ **Documento de Avaliação Europeu** **ETAG 001-5**  
Avaliação Técnica Europeia : **ETA-09/0350, 12.12.2017**  
Organismo de Avaliação Técnica: DIBt, Berlin  
Organismo(s) notificado (s): NB 2873 – Technische Universität Darmstadt

✧ **Desempenho(s) declarado(s):**

| Características essenciais   | Desempenho  |
|--|---|
| <b>Resistência mecânica e estabilidade (BWR 1)</b>   |   |
| Resistências características para cargas estáticas e quase estáticas e resistências características para as categorias de desempenho sísmico C1 + C2 | Anexo/Annex C1 – C7   |
| Deslocamento   | Anexo/Annex C8 – C10  |
| <b>Segurança contra incêndio (BWR 2)</b>   |   |
| Comportamento do fogo  | Classe A1   |
| Resistência ao fogo  | NPD (No Performance Determined)<br>Desempenho Não Determinado |

O desempenho do produto identificado acima está em conformidade com o conjunto de desempenhos declarados. A presente declaração de desempenho é emitida, em conformidade com o Regulamento (UE) n.o 305/2011, sob a exclusiva responsabilidade do fabricante identificado acima.

Assinado por e em nome do fabricante por:



**Stefan Weustenhagen**  
(Diretor-gerente)  
**Weilerbach, 01.01.2021**

p.p. 

**Dipl.-Ing. Detlef Bigalke**  
(Director de Desenvolvimento de Produto)



O original desta declaração de desempenho foi escrito em alemão. Em caso de desvios na tradução, a versão alemã é válida.

## Specifications of intended use

| Injection system VME                   | Anchor rod  | Internally threaded anchor rod   | rebar    |
|--|---|--|----------|
|  | VMU-A, V-A, VM-A, commercial standard threaded rod                      | VMU-IG   |          |
| Static or quasi-static action          | M8 - M30<br>(zinc plated, A4, HCR)                                      | IG M6 - IG M20<br>(electroplated, A4, HCR)                             | Ø8 - Ø32 |
| Seismic action Performance Category C1 | M8 - M30<br>(zinc plated <sup>1)</sup> , A4, HCR)                       | -  | Ø8 - Ø32 |
| Seismic action Performance Category C2 | M12 and M16<br>(zinc plated <sup>1)</sup> (class 8.8), A4, HCR)         | -  | -        |
| Base material                          | Reinforced or unreinforced normal weight concrete acc. to EN 206-1:2000 |  |          |
|  | Strength classes C20/25 to C50/60 acc. to EN 206-1:2000                 |  |          |
|  | Cracked and uncracked concrete  |  |          |
| Temperature Range I                    | -40 °C to +40 °C  | max long term temperature +24 °C and max short term temperature +40 °C |          |
| Temperature Range II                   | -40 °C to +60 °C  | max long term temperature +43 °C and max short term temperature +60 °C |          |
| Temperature Range III                  | -40 °C to +72 °C  | max long term temperature +43 °C and max short term temperature +72 °C |          |

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

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc coated steel, stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel)

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

### Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Anchorages under static or quasi-static actions are designed in accordance with:
  - EOTA Technical Report TR 029 "Design of bonded anchors", Edition September 2010 or
  - CEN/TS 1992-4:2009
- Anchorages under seismic actions (cracked concrete) are designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure.
  - Fastenings in stand-off installation or with a grout layer are not allowed.

### Installation:

- Dry or wet concrete, flooded holes (not sea water)
- Hole drilling by hammer or compressed air drill mode or vacuum drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site
- Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod

## Injection System VME for concrete

Intended use  
Specifications

**Annex B1**

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

| Threaded rod  |                 |      | M8  | M10 | M12 | M16             | M20 | M24 | M27 | M30 |
|---|-----------------|------|---|-----|-----|-----------------|-----|-----|-----|-----|
| Nominal drill hole diameter                             | $d_0 =$         | [mm] | 10  | 12  | 14  | 18              | 24  | 28  | 32  | 35  |
| Effective anchorage depth                               | $h_{ef,min} =$  | [mm] | 60  | 60  | 70  | 80              | 90  | 96  | 108 | 120 |
|   | $h_{ef,max} =$  | [mm] | 96  | 120 | 144 | 192             | 240 | 288 | 324 | 360 |
| Diameter of clearance hole in the fixture <sup>1)</sup> | $d_f \leq$      | [mm] | 9   | 12  | 14  | 18              | 22  | 26  | 30  | 33  |
| Installation torque                                     | $T_{inst} \leq$ | [Nm] | 10  | 20  | 40  | 80              | 120 | 160 | 180 | 200 |
| Minimum thickness of member                             | $h_{min}$       | [mm] | $h_{ef} + 30 \text{ mm}$<br>$\geq 100 \text{ mm}$ |     |     | $h_{ef} + 2d_0$ |     |     |     |     |
| Minimum spacing   | $s_{min}$       | [mm] | 40  | 50  | 60  | 80              | 100 | 120 | 135 | 150 |
| Minimum edge distance                                   | $c_{min}$       | [mm] | 40  | 50  | 60  | 80              | 100 | 120 | 135 | 150 |

<sup>1)</sup> For larger clearance hole see TR029 section 1.1; for application under seismic loading the diameter of clearance hole in the fixture shall be at maximum  $d_{nom} + 1 \text{ mm}$  or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

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

| Internally threaded anchor rod                          |                 |      | IG-M 6  | IG-M 8 | IG-M 10 | IG-M 12         | IG-M 16 | IG-M 20 |
|---|-----------------|------|---|--------|---------|-----------------|---------|---------|
| Internal diameter of sleeve                             | $d_2 =$         | [mm] | 6   | 8      | 10      | 12              | 16      | 20      |
| Outer diameter of sleeve <sup>2)</sup>                  | $d_{nom} =$     | [mm] | 10  | 12     | 16      | 20              | 24      | 30      |
| Nominal drill hole diameter                             | $d_0 =$         | [mm] | 12  | 14     | 18      | 24              | 28      | 35      |
| Effective anchorage depth                               | $h_{ef,min} =$  | [mm] | 60  | 70     | 80      | 90              | 96      | 120     |
|   | $h_{ef,max} =$  | [mm] | 120   | 144    | 192     | 240             | 288     | 360     |
| Diameter of clearance hole in the fixture <sup>1)</sup> | $d_f \leq$      | [mm] | 7   | 9      | 12      | 14              | 18      | 22      |
| Installation torque                                     | $T_{inst} \leq$ | [Nm] | 10  | 10     | 20      | 40              | 60      | 100     |
| Minimum screw-in depth                                  | $l_{IG}$        | [mm] | 8   | 8      | 10      | 12              | 16      | 20      |
| Minimum thickness of member                             | $h_{min}$       | [mm] | $h_{ef} + 30 \text{ mm}$<br>$\geq 100 \text{ mm}$ |        |         | $h_{ef} + 2d_0$ |         |         |
| Minimum spacing   | $s_{min}$       | [mm] | 50  | 60     | 80      | 100             | 120     | 150     |
| Minimum edge distance                                   | $c_{min}$       | [mm] | 50  | 60     | 80      | 100             | 120     | 150     |

<sup>1)</sup> For larger clearance hole see TR029 section 1.1

<sup>2)</sup> With metric thread according to EN 1993-1-8:2005+AC:2009

**Table B3: Installation parameters for rebar**





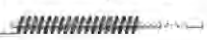
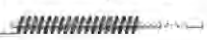




| Rebar                       |                |      | Ø 8   | Ø 10 | Ø 12 | Ø 14            | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|-----------------------------|----------------|------|---|------|------|-----------------|------|------|------|------|------|
| Nominal drill hole diameter | $d_0 =$        | [mm] | 12  | 14   | 16   | 18              | 20   | 24   | 32   | 35   | 40   |
| Effective anchorage depth   | $h_{ef,min} =$ | [mm] | 60  | 60   | 70   | 75              | 80   | 90   | 100  | 112  | 128  |
|                             | $h_{ef,max} =$ | [mm] | 96  | 120  | 144  | 168             | 192  | 240  | 300  | 336  | 384  |
| Minimum thickness of member | $h_{min}$      | [mm] | $h_{ef} + 30 \text{ mm}$<br>$\geq 100 \text{ mm}$ |      |      | $h_{ef} + 2d_0$ |      |      |      |      |      |
| Minimum spacing             | $s_{min}$      | [mm] | 40  | 50   | 60   | 70              | 80   | 100  | 125  | 140  | 160  |
| Minimum edge distance       | $c_{min}$      | [mm] | 40  | 50   | 60   | 70              | 80   | 100  | 125  | 140  | 160  |

**Injection System VME for concrete**

**Intended use**  
Installation parameters

**Annex B2**

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

| Threaded rod<br> | Rebar<br> | Internally threaded anchor rod<br> | Drill bit<br> | Brush<br> | min. Brush<br> |  | Retaining washer  |   |   |
|---|--|---|--|--|---|--|---|---|---|
|   |  |   |  |  |   |  | Installation direction and use of retaining washer                                  |   |   |
| [-]   | ∅ [mm]   | [-]   | $d_0$ [mm]   | $d_b$ [mm]   | $d_{b,min}$ [mm]  | [-]  |  |  |  |
| M8  |  |   | 10   | 12   | 10,5  | -  | No retaining washer required  |   |   |
| M10   | 8  | VMU-IG M6   | 12   | 14   | 12,5  | -  |   |   |   |
| M12   | 10   | VMU-IG M8   | 14   | 16   | 14,5  | -  |   |   |   |
|   | 12   |   | 16   | 18   | 16,5  | -  |   |   |   |
| M16   | 14   | VMU-IG M10  | 18   | 20   | 18,5  | VM-IA 18   | $h_{ef} > 250\text{mm}$   | $h_{ef} > 250\text{mm}$   | all   |
|   | 16   |   | 20   | 22   | 20,5  | VM-IA 20   |   |   |   |
| M 20  | 20   | VMU-IG M12  | 24   | 26   | 24,5  | VM-IA 24   |   |   |   |
| M 24  |  | VMU-IG M16  | 28   | 30   | 28,5  | VM-IA 28   |   |   |   |
| M 27  | 25   |   | 32   | 34   | 32,5  | VM-IA 32   |   |   |   |
| M 30  | 28   | VMU-IG M20  | 35   | 37   | 35,5  | VM-IA 35   |   |   |   |
|   | 32   |   | 40   | 41,5   | 40,5  | VM-IA 40   |   |   |   |



**Blow-out pump (volume 750ml)**  
 Drill bit diameter ( $d_0$ ): 10 mm to 20 mm  
 Bore hole depth  $h_0 \leq 10 d_{nom}$   
 see annex B4



**Recommended compressed air tool (min 6 bar)**  
 Drill bit diameter ( $d_0$ ): all diameters



**Retaining washer for overhead or horizontal installation**  
 Drill bit diameter ( $d_0$ ): 18 mm to 40 mm



**Injection System VME for concrete**

**Intended use**  
 Cleaning and setting tools

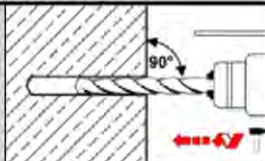
**Annex B3**



# Installation instructions

## Drilling of the hole

1.



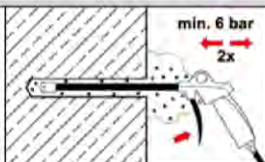
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Annex B2). In case of aborted drill hole: the drill hole shall be filled with mortar.

## Cleaning

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

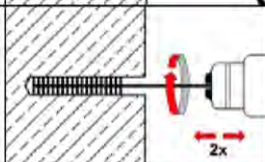
### Cleaning with compressed air cracked and uncracked concrete, all diameters

2a.



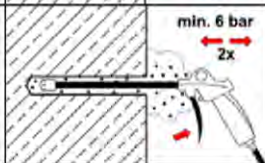
Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) a minimum of **two** times. If the bore hole ground is not reached an extension shall be used.

2b.



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

2c.



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

2.

### Manual cleaning

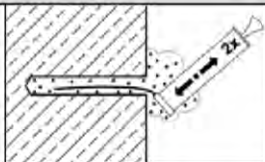
uncracked concrete:

Bore hole diameter  $d_0 \leq 20\text{mm}$  and bore hole depth  $h_0 \leq 10 d_{nom}$

cracked concrete:

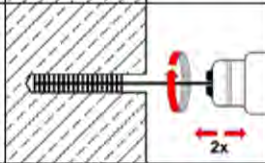
Bore hole diameter  $14\text{mm} \leq d_0 \leq 20\text{mm}$  and bore hole depth  $h_0 \leq 10 d_{nom}$

2a.



Starting from the bottom or back of the bore hole, blow the hole clean with the blow-out pump minimum of **two** times. If the bore hole ground is not reached an extension shall be used.

2b.



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

2c.



Finally blow the hole clean again with the blow-out pump a minimum of **two** times. If the bore hole ground is not reached an extension shall be used.

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


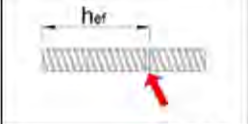

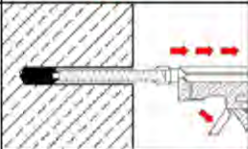
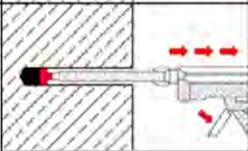
## Injection System VME for concrete

Intended use

Installation instruction

**Annex B4**

## Installation instructions (continuation)

| Injection |   |  |
|-----------|---|--|
| 3.        |  | Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.<br>For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used.  |
| 4.        |  | Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rod or rebar.   |
| 5.        |  | Prior to dispensing into the anchor 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.   |
| 6a.       |  | Starting from the bottom or back of the cleaned anchor hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. Observe the curing and working times given in Table B5. |
| 6b.       |  | For overhead and horizontal installation a retaining washer (Annex B 3) and extension nozzle shall be used. Observe the curing and working times given in Table B5.  |

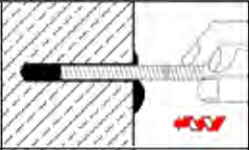

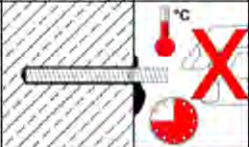
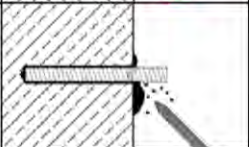
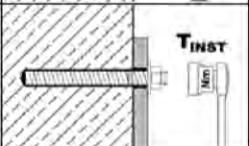
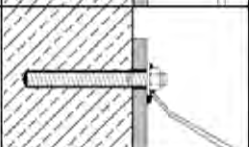
Injection System VME for concrete

Intended use  
Installation instructions (continuation)

Annex B5



## Installation instructions (continuation)

| Inserting the anchor |  |  |
|----------------------|--|--|
| 7.                   |   | Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The anchor shall be free of dirt, grease, oil or other foreign material.                          |
| 8.                   |   | Be sure that the rod is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod should be fixed (e.g. wedges). |
| 9.                   |   | Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the rod until it is fully cured (attend Table B5).  |
| 10.                  |   | Remove excess mortar.  |
| 11.                  |   | After full curing, the add-on part can be installed with up to the max. torque (Table B1 or B2) by using a calibrated torque wrench.   |
| 12.                  |  | Annular gap between anchor rod and attachment may optionally be filled with mortar. Therefore replace regular washer by washer with bore and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.                       |

**Table B5: Working and curing time**

| Bore hole temperature | Maximum working time | Minimum curing time |              |
|-----------------------|----------------------|---------------------|--------------|
|                       |                      | dry concrete        | wet concrete |
| +5°C to +9°C          | 120 min              | 50 h                | 100 h        |
| +10°C to +19°C        | 90 min               | 30 h                | 60 h         |
| +20°C to +29°C        | 30 min               | 10 h                | 20 h         |
| +30°C to +39°C        | 20 min               | 6 h                 | 12 h         |
| +40°C                 | 12 min               | 4 h                 | 8 h          |
| Cartridge temperature | + 5°C to + 40°C      |                     |              |

### Injection System VME for concrete

**Intended use**  
Installation instructions (continuation), Working and curing time

**Annex B6**

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

| Threaded rod                                  |   |                 |      | M 8  | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|-----------------|------|------|------|------|------|------|-----|------|------|
| <b>Steel failure</b>                          |   |                 |      |      |      |      |      |      |     |      |      |
| <b>Tension load</b>                           |   |                 |      |      |      |      |      |      |     |      |      |
| Characteristic tension resistance             | Steel, Property class 4.6 and 4.8             | $N_{Rk,s}$      | [kN] | 15   | 23   | 34   | 63   | 98   | 141 | 184  | 224  |
|   | Steel, Property class 5.6 and 5.8             | $N_{Rk,s}$      | [kN] | 18   | 29   | 42   | 78   | 122  | 176 | 230  | 280  |
|   | Steel, Property class 8.8                     | $N_{Rk,s}$      | [kN] | 29   | 46   | 67   | 125  | 196  | 282 | 368  | 449  |
|   | Stainless steel A4 and HCR, Property class 50 | $N_{Rk,s}$      | [kN] | 18   | 29   | 42   | 79   | 123  | 177 | 230  | 281  |
|   | Stainless steel A4 and HCR, Property class 70 | $N_{Rk,s}$      | [kN] | 26   | 41   | 59   | 110  | 171  | 247 | -    | -    |
| Partial factor                                | Steel, Property class 4.6                     | $\gamma_{Ms,N}$ | [-]  | 2,0  |      |      |      |      |     |      |      |
|   | Steel, Property class 4.8                     | $\gamma_{Ms,N}$ | [-]  | 1,5  |      |      |      |      |     |      |      |
|   | Steel, Property class 5.6                     | $\gamma_{Ms,N}$ | [-]  | 2,0  |      |      |      |      |     |      |      |
|   | Steel, Property class 5.8 and 8.8             | $\gamma_{Ms,N}$ | [-]  | 1,5  |      |      |      |      |     |      |      |
|   | Stainless steel A4 and HCR, Property class 50 | $\gamma_{Ms,N}$ | [-]  | 2,86 |      |      |      |      |     |      |      |
|   | Stainless steel A4 and HCR, Property class 70 | $\gamma_{Ms,N}$ | [-]  | 1,87 |      |      |      |      |     |      | -    |
| <b>Shear load</b>                             |   |                 |      |      |      |      |      |      |     |      |      |
| <b>Steel failure <u>without</u> lever arm</b> |   |                 |      |      |      |      |      |      |     |      |      |
| Characteristic shear resistance               | Steel, Property class 4.6 and 4.8             | $V_{Rk,s}$      | [kN] | 7    | 12   | 17   | 31   | 49   | 71  | 92   | 112  |
|   | Steel, Property class 5.6 and 5.8             | $V_{Rk,s}$      | [kN] | 9    | 15   | 21   | 39   | 61   | 88  | 115  | 140  |
|   | Steel, Property class 8.8                     | $V_{Rk,s}$      | [kN] | 15   | 23   | 34   | 63   | 98   | 141 | 184  | 224  |
|   | Stainless steel A4 and HCR, Property class 50 | $V_{Rk,s}$      | [kN] | 9    | 15   | 21   | 39   | 61   | 88  | 115  | 140  |
|   | Stainless steel A4 and HCR, Property class 70 | $V_{Rk,s}$      | [kN] | 13   | 20   | 30   | 55   | 86   | 124 | -    | -    |
| <b>Steel failure <u>with</u> lever arm</b>    |   |                 |      |      |      |      |      |      |     |      |      |
| Characteristic bending moment                 | Steel, Property class 4.6 and 4.8             | $M_{Rk,s}$      | [Nm] | 15   | 30   | 52   | 133  | 260  | 449 | 666  | 900  |
|   | Steel, Property class 5.6 and 5.8             | $M_{Rk,s}$      | [Nm] | 19   | 37   | 65   | 166  | 324  | 560 | 833  | 1123 |
|   | Steel, Property class 8.8                     | $M_{Rk,s}$      | [Nm] | 30   | 60   | 105  | 266  | 519  | 896 | 1333 | 1797 |
|   | Stainless steel A4 and HCR, Property class 50 | $M_{Rk,s}$      | [Nm] | 19   | 37   | 66   | 167  | 325  | 561 | 832  | 1125 |
|   | Stainless steel A4 and HCR, Property class 70 | $M_{Rk,s}$      | [Nm] | 26   | 52   | 92   | 232  | 454  | 784 | -    | -    |
| Partial factor                                | Steel, Property class 4.6                     | $\gamma_{Ms,V}$ | [-]  | 1,67 |      |      |      |      |     |      |      |
|   | Steel, Property class 4.8                     | $\gamma_{Ms,V}$ | [-]  | 1,25 |      |      |      |      |     |      |      |
|   | Steel, Property class 5.6                     | $\gamma_{Ms,V}$ | [-]  | 1,67 |      |      |      |      |     |      |      |
|   | Steel, Property class 5.8 and 8.8             | $\gamma_{Ms,V}$ | [-]  | 1,25 |      |      |      |      |     |      |      |
|   | Stainless steel A4 and HCR, Property class 50 | $\gamma_{Ms,V}$ | [-]  | 2,38 |      |      |      |      |     |      |      |
|   | Stainless steel A4 and HCR, Property class 70 | $\gamma_{Ms,V}$ | [-]  | 1,56 |      |      |      |      |     |      | -    |

**Injection System VME for concrete**

**Performance**

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

**Annex C1**



**Table C2:** Characteristic values of **tension loads** for **threaded rods** under static, quasi-static action and seismic action C1 + C2

| Threaded rod   |                            |                 | M8                   | M10                               | M12                  | M16 | M20                             | M24                             | M27 | M30 |     |
|--|----------------------------|-----------------|----------------------|-----------------------------------|----------------------|-----|---------------------------------|---------------------------------|-----|-----|-----|
| <b>Steel failure</b>   |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| Characteristic tension resistance                                  | $N_{Rk,s}$                 | [kN]            | see Table C1         |                                   |                      |     |                                 |                                 |     |     |     |
|  | $N_{Rk,s,C1}$              | [kN]            | $1,0 \cdot N_{Rk,s}$ |                                   |                      |     |                                 |                                 |     |     |     |
|  | $N_{Rk,s,C2}$              | [kN]            | NPD                  |                                   | $1,0 \cdot N_{Rk,s}$ |     | No Performance Determined (NPD) |                                 |     |     |     |
| Partial factor   | $\gamma_{Ms,N}$            | [-]             | see Table C1         |                                   |                      |     |                                 |                                 |     |     |     |
| <b>Combined pull-out and concrete failure</b>                      |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| <b>Characteristic bond resistance in uncracked concrete C20/25</b> |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| Temperature range I:<br>40°C / 24°C                                | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                                | 15                   | 15  | 14                              | 13                              | 12  | 12  | 12  |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                                | 14                   | 13  | 10                              | 9,5                             | 8,5 | 7,5 | 7,0 |
| Temperature range II:<br>60°C / 43°C                               | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 9,5                               | 9,5                  | 9,0 | 8,5                             | 8,0                             | 7,5 | 7,5 | 7,5 |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 9,5                               | 9,5                  | 9,0 | 8,5                             | 7,5                             | 7,0 | 6,5 | 6,0 |
| Temperature range III:<br>72°C / 43°C                              | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 8,5                               | 8,5                  | 8,0 | 7,5                             | 7,0                             | 7,0 | 6,5 | 6,5 |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 8,5                               | 8,5                  | 8,0 | 7,5                             | 7,0                             | 6,0 | 5,5 | 5,5 |
| <b>Characteristic bond resistance in cracked concrete C20/25</b>   |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| Temperature range I:<br>40°C / 24°C                                | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7,0                               | 7,0                  | 7,5 | 6,5                             | 6,0                             | 5,5 | 5,5 | 5,5 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 5,9                               | 7,0                  | 7,1 | 6,2                             | 5,7                             | 5,5 | 5,5 | 5,5 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 2,4 | 2,2                             | No Performance Determined (NPD) |     |     |     |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7,0                               | 7,0                  | 7,5 | 6,0                             | 5,0                             | 4,5 | 4,0 | 4,0 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 5,9                               | 7,0                  | 7,1 | 5,8                             | 4,8                             | 4,5 | 4,0 | 4,0 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 2,4 | 2,1                             | No Performance Determined (NPD) |     |     |     |
| Temperature range II:<br>60°C / 43°C                               | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,5                               | 4,5                  | 4,5 | 4,0                             | 3,5                             | 3,5 | 3,5 | 3,5 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 3,7                               | 4,5                  | 4,3 | 3,8                             | 3,4                             | 3,5 | 3,5 | 3,5 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 1,4 | 1,4                             | No Performance Determined (NPD) |     |     |     |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,5                               | 4,5                  | 4,5 | 4,0                             | 3,5                             | 3,5 | 3,5 | 3,5 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 3,7                               | 4,5                  | 4,3 | 3,8                             | 3,4                             | 3,5 | 3,5 | 3,5 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 1,4 | 1,4                             | No Performance Determined (NPD) |     |     |     |
| Temperature range III:<br>72°C / 43°C                              | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0                               | 4,0                  | 4,0 | 3,5                             | 3,0                             | 3,0 | 3,0 | 3,0 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 3,2                               | 4,0                  | 3,9 | 3,4                             | 3,0                             | 3,0 | 3,0 | 3,0 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 1,3 | 1,2                             | No Performance Determined (NPD) |     |     |     |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0                               | 4,0                  | 4,0 | 3,5                             | 3,0                             | 3,0 | 3,0 | 3,0 |
|  |                            | $\tau_{Rk,C1}$  | [N/mm <sup>2</sup> ] | 3,2                               | 4,0                  | 3,9 | 3,4                             | 3,0                             | 3,0 | 3,0 | 3,0 |
|  |                            | $\tau_{Rk,C2}$  | [N/mm <sup>2</sup> ] | NPD                               |                      | 1,3 | 1,2                             | No Performance Determined (NPD) |     |     |     |
| Increasing factor for concrete                                     | $\psi_c$                   | C25/30          |                      | 1,02                              |                      |     |                                 |                                 |     |     |     |
|  |                            | C30/37          |                      | 1,04                              |                      |     |                                 |                                 |     |     |     |
|  |                            | C35/45          |                      | 1,07                              |                      |     |                                 |                                 |     |     |     |
|  |                            | C40/50          |                      | 1,08                              |                      |     |                                 |                                 |     |     |     |
|  |                            | C45/55          |                      | 1,09                              |                      |     |                                 |                                 |     |     |     |
|  |                            | C50/60          |                      | 1,10                              |                      |     |                                 |                                 |     |     |     |
| Factor acc. CEN/TS1992-4-5 section 6.2.2.3                         | uncracked concrete         | $k_s$           | [-]                  | 10,1                              |                      |     |                                 |                                 |     |     |     |
|  | cracked concrete           |                 |                      | 7,2                               |                      |     |                                 |                                 |     |     |     |
| <b>Concrete cone failure</b>                                       |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| Factor acc. CEN/TS1992-4-5 section 6.2.3.1                         | uncracked concrete         | $k_{ucr}$       | [-]                  | 10,1                              |                      |     |                                 |                                 |     |     |     |
|  | cracked concrete           | $k_{cr}$        | [-]                  | 7,2                               |                      |     |                                 |                                 |     |     |     |
| Edge distance  |                            | $c_{cr,N}$      | [-]                  | $1,5 h_{ef}$                      |                      |     |                                 |                                 |     |     |     |
| Spacing  |                            | $s_{cr,N}$      | [-]                  | $3,0 h_{ef}$                      |                      |     |                                 |                                 |     |     |     |
| <b>Splitting failure</b>   |                            |                 |                      |                                   |                      |     |                                 |                                 |     |     |     |
| Edge distance  | $h/h_{ef} \geq 2,0$        | $c_{cr,sp}$     | [mm]                 | $1,0 h_{ef}$                      |                      |     |                                 |                                 |     |     |     |
|  | $2,0 > h/h_{ef} > 1,3$     |                 |                      | $2 \cdot h_{ef} (2,5 - h/h_{ef})$ |                      |     |                                 |                                 |     |     |     |
|  | $h/h_{ef} \leq 1,3$        |                 |                      | $2,4 h_{ef}$                      |                      |     |                                 |                                 |     |     |     |
| Spacing  |                            | $s_{cr,sp}$     | [mm]                 | $2 c_{cr,sp}$                     |                      |     |                                 |                                 |     |     |     |
| Installation factor (dry and wet concrete)                         | $\gamma_2 = \gamma_{inst}$ | [-]             | 1,2                  |                                   |                      |     | 1,4                             |                                 |     |     |     |
| Installation factor (flooded bore hole)                            | $\gamma_2 = \gamma_{inst}$ | [-]             | 1,4                  |                                   |                      |     |                                 |                                 |     |     |     |

**Injection System VME for concrete**

**Performance**  
Characteristic values of **tension loads** for **threaded rods** under static, quasi-static action and seismic action C1 + C2

**Annex C2**

**Table C3:** Characteristic values of **shear loads** for **threaded rods** under static, quasi-static action and seismic action C1 + C2

| Threaded rod  |                            |      | M8                              | M10 | M12                   | M16 | M20                             | M24                   | M27 | M30 |
|---|----------------------------|------|---------------------------------|-----|-----------------------|-----|---------------------------------|-----------------------|-----|-----|
| <b>Steel failure <u>without</u> lever arm</b>   |                            |      |                                 |     |                       |     |                                 |                       |     |     |
| Characteristic shear resistance   | $V_{Rk,s}$                 | [kN] | see Table C1                    |     |                       |     |                                 |                       |     |     |
|   | $V_{Rk,s,C1}$              | [kN] | $0,86 \cdot V_{Rk,s}$           |     | $0,88 \cdot V_{Rk,s}$ |     |                                 | $0,80 \cdot V_{Rk,s}$ |     |     |
|   | $V_{Rk,s,C2}$              | [kN] | NPD                             |     | $0,80 \cdot V_{Rk,s}$ |     | No Performance Determined (NPD) |                       |     |     |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | see Table C1                    |     |                       |     |                                 |                       |     |     |
| <b>Steel failure <u>with</u> lever arm</b>  |                            |      |                                 |     |                       |     |                                 |                       |     |     |
| Characteristic bending moment   | $M^0_{Rk,s}$               | [Nm] | see Table C1                    |     |                       |     |                                 |                       |     |     |
|   | $M^0_{Rk,s,C1}$            | [Nm] | No Performance Determined (NPD) |     |                       |     |                                 |                       |     |     |
|   | $M^0_{Rk,s,C2}$            | [Nm] |                                 |     |                       |     |                                 |                       |     |     |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | see Table C1                    |     |                       |     |                                 |                       |     |     |
| <b>Concrete pry-out failure</b>   |                            |      |                                 |     |                       |     |                                 |                       |     |     |
| Factor k in equation (5.7) acc. to Technical Report TR 029<br>Factor $k_3$ in equation (27) acc. to CEN/TS 1992-4-5 section 6.3.3 | $k_{(3)}$                  | [-]  | 2,0                             |     |                       |     |                                 |                       |     |     |
| <b>Concrete edge failure</b>  |                            |      |                                 |     |                       |     |                                 |                       |     |     |
| Effective length of anchor  | $l_f$                      | [mm] | $l_f = \min(h_{ef}; 8 d_{nom})$ |     |                       |     |                                 |                       |     |     |
| Outside diameter of anchor  | $d_{nom}$                  | [mm] | 8                               | 10  | 12                    | 16  | 20                              | 24                    | 27  | 30  |
| Installation factor   | $\gamma_2 = \gamma_{inst}$ | [-]  | 1,0                             |     |                       |     |                                 |                       |     |     |

**Injection System VME for concrete**

**Performance**  
Characteristic values of **shear loads** for **threaded rods** under static, quasi-static action and seismic action C1 + C2

**Annex C3**

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

| Internally threaded anchor rod   |                            |                 | IG-M 6               | IG-M 8                            | IG-M 10 | IG-M 12 | IG-M 16 | IG-M 20           |     |
|--|----------------------------|-----------------|----------------------|-----------------------------------|---------|---------|---------|-------------------|-----|
| <b>Steel failure<sup>1)</sup></b>  |                            |                 |                      |                                   |         |         |         |                   |     |
| Characteristic tension resistance, Steel, strength class 5.8                   | $N_{Rk,s}$                 | [kN]            | 10                   | 18                                | 29      | 42      | 79      | 123               |     |
| Partial factor   | $\gamma_{Ms,N}$            | [-]             | 1,5                  |                                   |         |         |         |                   |     |
| Characteristic tension resistance, Steel, strength class 8.8                   | $N_{Rk,s}$                 | [kN]            | 16                   | 27                                | 46      | 67      | 121     | 196               |     |
| Partial factor   | $\gamma_{Ms,N}$            | [-]             | 1,5                  |                                   |         |         |         |                   |     |
| Characteristic tension resistance, Stainless steel A4 / HCR, strength class 70 | $N_{Rk,s}$                 | [kN]            | 14                   | 26                                | 41      | 59      | 110     | 124 <sup>2)</sup> |     |
| Partial factor   | $\gamma_{Ms,N}$            | [-]             | 1,87                 |                                   |         |         |         |                   |     |
| <b>Combined pull-out and concrete failure</b>                                  |                            |                 |                      |                                   |         |         |         |                   |     |
| <b>Characteristic bond resistance in uncracked concrete C20/25</b>             |                            |                 |                      |                                   |         |         |         |                   |     |
| Temperature range I: 40°C / 24°C   | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                                | 15      | 14      | 13      | 12                | 12  |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 14                                | 13      | 10      | 9,5     | 8,5               | 7,0 |
| Temperature range II: 60°C / 43°C  | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 9,5                               | 9,0     | 8,5     | 8,0     | 7,5               | 7,5 |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 9,5                               | 9,0     | 8,5     | 7,5     | 7,0               | 6,0 |
| Temperature range III: 72°C / 43°C   | dry and wet concrete       | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 8,5                               | 8,0     | 7,5     | 7,0     | 7,0               | 6,5 |
|  | flooded bore hole          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 8,5                               | 8,0     | 7,5     | 7,0     | 6,0               | 5,5 |
| <b>Characteristic bond resistance in cracked concrete C20/25</b>               |                            |                 |                      |                                   |         |         |         |                   |     |
| Temperature range I: 40°C / 24°C   | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7,0                               | 7,5     | 6,5     | 6,0     | 5,5               | 5,5 |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7,0                               | 7,5     | 6,0     | 5,0     | 4,5               | 4,0 |
| Temperature range II: 60°C / 43°C  | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,5                               | 4,5     | 4,0     | 3,5     | 3,5               | 3,5 |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,5                               | 4,5     | 4,0     | 3,5     | 3,5               | 3,5 |
| Temperature range III: 72°C / 43°C   | dry and wet concrete       | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0                               | 4,0     | 3,5     | 3,0     | 3,0               | 3,0 |
|  | flooded bore hole          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 4,0                               | 4,0     | 3,5     | 3,0     | 3,0               | 3,0 |
| Increasing factor for concrete   |                            | $\psi_c$        | C25/30               | 1,02                              |         |         |         |                   |     |
|  |                            |                 | C30/37               | 1,04                              |         |         |         |                   |     |
|  |                            |                 | C35/45               | 1,07                              |         |         |         |                   |     |
|  |                            |                 | C40/50               | 1,08                              |         |         |         |                   |     |
|  |                            |                 | C45/55               | 1,09                              |         |         |         |                   |     |
|  |                            |                 | C50/60               | 1,10                              |         |         |         |                   |     |
| Factor acc. to CEN/TS1992-4-5 section 6.2.2.3                                  | uncracked concrete         | $k_B$           | [-]                  | 10,1                              |         |         |         |                   |     |
|  | cracked concrete           |                 |                      | 7,2                               |         |         |         |                   |     |
| <b>Concrete cone failure</b>   |                            |                 |                      |                                   |         |         |         |                   |     |
| Factor acc. to CEN/TS1992-4-5 section 6.2.3.1                                  | uncracked concrete         | $k_{ucr}$       | [-]                  | 10,1                              |         |         |         |                   |     |
|  | cracked concrete           | $k_{cr}$        | [-]                  | 7,2                               |         |         |         |                   |     |
| Edge distance  |                            | $c_{cr,N}$      | [mm]                 | 1,5 $h_{ef}$                      |         |         |         |                   |     |
| Spacing  |                            | $s_{cr,N}$      | [mm]                 | 3,0 $h_{ef}$                      |         |         |         |                   |     |
| <b>Splitting failure</b>   |                            |                 |                      |                                   |         |         |         |                   |     |
| Edge distance  | $h/h_{ef} \geq 2,0$        | $c_{cr,sp}$     | [mm]                 | 1,0 $h_{ef}$                      |         |         |         |                   |     |
|  | $2,0 > h/h_{ef} > 1,3$     |                 |                      | $2 \cdot h_{ef} (2,5 - h/h_{ef})$ |         |         |         |                   |     |
|  | $h/h_{ef} \leq 1,3$        |                 |                      | 2,4 $h_{ef}$                      |         |         |         |                   |     |
| Spacing  |                            | $s_{cr,sp}$     | [mm]                 | $2 c_{cr,sp}$                     |         |         |         |                   |     |
| Installation factor (dry and wet concrete)                                     | $\gamma_2 = \gamma_{inst}$ | [-]             |                      | 1,2                               |         |         | 1,4     |                   |     |
| Installation factor (flooded bore hole)  | $\gamma_2 = \gamma_{inst}$ | [-]             |                      | 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: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

**Injection System VME for concrete**

**Performance**

Characteristic values of **tension loads** for internally threaded anchor rods under static and quasi-static action

**Annex C4**

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

| Internally threaded anchor rod  |                            |      | IG-M 6                          | IG-M 8 | IG-M 10 | IG-M 12 | IG-M 16 | IG-M 20           |
|---|----------------------------|------|---------------------------------|--------|---------|---------|---------|-------------------|
| <b>Steel failure <u>without</u> lever arm<sup>1)</sup></b>  |                            |      |                                 |        |         |         |         |                   |
| Characteristic shear resistance<br>Steel, strength class 5.8  | $V_{Rk,s}$                 | [kN] | 5                               | 9      | 15      | 21      | 39      | 61                |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,25                            |        |         |         |         |                   |
| Characteristic shear resistance<br>Steel, strength class 8.8  | $V_{Rk,s}$                 | [kN] | 8                               | 14     | 23      | 34      | 60      | 98                |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,25                            |        |         |         |         |                   |
| Characteristic shear resistance<br>Stainless steel A4 / HCR<br>strength class 70  | $V_{Rk,s}$                 | [kN] | 7                               | 13     | 20      | 30      | 55      | 62 <sup>2)</sup>  |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,56                            |        |         |         |         |                   |
| <b>Steel failure <u>with</u> lever arm<sup>1)</sup></b>   |                            |      |                                 |        |         |         |         |                   |
| Characteristic bending moment,<br>Steel, strength class 5.8   | $M_{Rk,s}^0$               | [Nm] | 8                               | 19     | 37      | 66      | 167     | 325               |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,25                            |        |         |         |         |                   |
| Characteristic bending moment,<br>Steel, strength class 8.8   | $M_{Rk,s}^0$               | [Nm] | 12                              | 30     | 60      | 105     | 267     | 519               |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,25                            |        |         |         |         |                   |
| Characteristic bending moment,<br>Stainless steel A4 / HCR<br>strength class 70   | $M_{Rk,s}^0$               | [Nm] | 11                              | 26     | 53      | 92      | 234     | 643 <sup>2)</sup> |
| Partial factor  | $\gamma_{Ms,v}$            | [-]  | 1,56                            |        |         |         |         |                   |
| <b>Concrete pry-out failure</b>   |                            |      |                                 |        |         |         |         |                   |
| Factor k in equation (5.7) of<br>Technical Report TR 029<br>Factor $k_3$ in equation (27) of<br>CEN/TS 1992-4-5 section 6.3.3 | $k_{(3)}$                  | [-]  | 2,0                             |        |         |         |         |                   |
| <b>Concrete edge failure</b>  |                            |      |                                 |        |         |         |         |                   |
| Effective length of anchor  | $l_f$                      | [mm] | $l_f = \min(h_{ef}; 8 d_{nom})$ |        |         |         |         |                   |
| Outside diameter of anchor  | $d_{nom}$                  | [mm] | 10                              | 12     | 16      | 20      | 24      | 30                |
| Installation factor   | $\gamma_2 = \gamma_{inst}$ | [-]  | 1,0                             |        |         |         |         |                   |

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

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

**Injection System VME for concrete**

**Performance**

Characteristic values of **shear loads** for internally threaded anchor rods under static and quasi-static action

**Annex C5**



**Table C6: Characteristic values of tension loads for rebar under static, quasi-static action and seismic action C1**

| Reinforcing bar   |                            |                    | Ø 8                     | Ø 10                              | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |     |
|---|----------------------------|--------------------|-------------------------|-----------------------------------|------|------|------|------|------|------|------|-----|
| <b>Steel failure</b>  |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| Characteristic tension resistance   | $N_{Rk,s}$                 | [kN]               | $A_s \cdot f_{uk}^{1)}$ |                                   |      |      |      |      |      |      |      |     |
|   | $N_{Rk,s,C1}$              | [kN]               | $1,0 \cdot N_{Rk,s}$    |                                   |      |      |      |      |      |      |      |     |
| Cross section area  | $A_s$                      | [mm <sup>2</sup> ] | 50                      | 79                                | 113  | 154  | 201  | 314  | 491  | 616  | 804  |     |
| Partial factor  | $\gamma_{Ms,N}$            | [-]                | 1,4 <sup>2)</sup>       |                                   |      |      |      |      |      |      |      |     |
| <b>Combined pull-out and concrete failure</b>                             |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| <b>Characteristic bond resistance in <u>uncracked</u> concrete C20/25</b> |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| Temperature range I:<br>40°C / 24°C                                       | dry and wet concrete       | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 14                                | 14   | 13   | 13   | 12   | 12   | 11   | 11   | 11  |
|   | flooded bore hole          | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 14                                | 13   | 11   | 10   | 9,5  | 8,5  | 7,5  | 7,0  | 6,0 |
| Temperature range II:<br>60°C / 43°C                                      | dry and wet concrete       | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 8,5                               | 8,5  | 8,0  | 8,0  | 7,5  | 7,0  | 7,0  | 6,5  | 6,5 |
|   | flooded bore hole          | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 8,5                               | 8,5  | 8,0  | 8,0  | 7,5  | 7,0  | 6,0  | 5,5  | 5,0 |
| Temperature range III:<br>72°C / 43°C                                     | dry and wet concrete       | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 7,5                               | 7,5  | 7,5  | 7,0  | 7,0  | 6,5  | 6,0  | 6,0  | 6,0 |
|   | flooded bore hole          | $\tau_{Rk,ucr}$    | [N/mm <sup>2</sup> ]    | 7,5                               | 7,5  | 7,5  | 7,0  | 7,0  | 6,0  | 5,5  | 5,0  | 4,5 |
| <b>Characteristic bond resistance in <u>cracked</u> concrete C20/25</b>   |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| Temperature range I:<br>40°C / 24°C                                       | dry and wet concrete       | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 7,0                               | 7,0  | 7,5  | 7,0  | 6,5  | 6,0  | 5,5  | 5,5  | 5,5 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 5,9                               | 7,0  | 7,1  | 6,4  | 6,2  | 5,7  | 5,5  | 5,5  | 5,5 |
|   | flooded bore hole          | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 7,0                               | 7,0  | 7,5  | 6,5  | 6,0  | 5,0  | 4,5  | 4,0  | 4,0 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 5,9                               | 7,0  | 7,1  | 6,0  | 5,7  | 4,8  | 4,5  | 4,0  | 4,0 |
| Temperature range II:<br>60°C / 43°C                                      | dry and wet concrete       | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 4,5                               | 4,5  | 4,5  | 4,0  | 4,0  | 3,5  | 3,5  | 3,5  | 3,5 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 3,7                               | 4,5  | 4,3  | 3,7  | 3,8  | 3,3  | 3,5  | 3,5  | 3,5 |
|   | flooded bore hole          | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 4,5                               | 4,5  | 4,5  | 4,0  | 4,0  | 3,5  | 3,5  | 3,5  | 3,0 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 3,7                               | 4,5  | 4,3  | 3,7  | 3,8  | 3,3  | 3,5  | 3,5  | 3,0 |
| Temperature range III:<br>72°C / 43°C                                     | dry and wet concrete       | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 4,0                               | 4,0  | 4,0  | 3,5  | 3,5  | 3,0  | 3,0  | 3,0  | 3,0 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 3,2                               | 4,0  | 3,9  | 3,2  | 3,3  | 2,9  | 3,0  | 3,0  | 3,0 |
|   | flooded bore hole          | $\tau_{Rk,cr}$     | [N/mm <sup>2</sup> ]    | 4,0                               | 4,0  | 4,0  | 3,5  | 3,5  | 3,0  | 3,0  | 3,0  | 3,0 |
|   |                            | $\tau_{Rk,C1}$     | [N/mm <sup>2</sup> ]    | 3,2                               | 4,0  | 3,9  | 3,2  | 3,3  | 2,9  | 3,0  | 3,0  | 3,0 |
| Increasing factor for concrete  |                            | $\psi_c$           | C25/30                  | 1,02                              |      |      |      |      |      |      |      |     |
|   |                            |                    | C30/37                  | 1,04                              |      |      |      |      |      |      |      |     |
|   |                            |                    | C35/45                  | 1,07                              |      |      |      |      |      |      |      |     |
|   |                            |                    | C40/50                  | 1,08                              |      |      |      |      |      |      |      |     |
|   |                            |                    | C45/55                  | 1,09                              |      |      |      |      |      |      |      |     |
|   |                            |                    | C50/60                  | 1,10                              |      |      |      |      |      |      |      |     |
| Factor acc.CEN/TS1992-4-5<br>section 6.2.2.3                              | uncracked concrete         | $k_B$              | [-]                     | 10,1                              |      |      |      |      |      |      |      |     |
|   | cracked concrete           |                    | [-]                     | 7,2                               |      |      |      |      |      |      |      |     |
| <b>Concrete cone failure</b>  |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| Factor acc. CEN/TS1992-4-5<br>section 6.2.3.1                             | uncracked concrete         | $k_{ucr}$          | [-]                     | 10,1                              |      |      |      |      |      |      |      |     |
|   | cracked concrete           | $k_{cr}$           | [-]                     | 7,2                               |      |      |      |      |      |      |      |     |
| Edge distance   |                            | $c_{cr,N}$         | [mm]                    | 1,5 $h_{ef}$                      |      |      |      |      |      |      |      |     |
| Spacing   |                            | $s_{cr,N}$         | [mm]                    | 3,0 $h_{ef}$                      |      |      |      |      |      |      |      |     |
| <b>Splitting failure</b>  |                            |                    |                         |                                   |      |      |      |      |      |      |      |     |
| Edge distance   | $h/h_{ef} \geq 2,0$        | $c_{cr,sp}$        | [mm]                    | 1,0 $h_{ef}$                      |      |      |      |      |      |      |      |     |
|   | $2,0 > h/h_{ef} > 1,3$     |                    |                         | $2 \cdot h_{ef} (2,5 - h/h_{ef})$ |      |      |      |      |      |      |      |     |
|   | $h/h_{ef} \leq 1,3$        |                    |                         | 2,4 $h_{ef}$                      |      |      |      |      |      |      |      |     |
| Spacing   |                            | $s_{cr,sp}$        | [mm]                    | $2 c_{cr,sp}$                     |      |      |      |      |      |      |      |     |
| Installation factor<br>(dry and wet concrete)                             | $\gamma_2 = \gamma_{inst}$ | [-]                | 1,2                     |                                   |      |      |      | 1,4  |      |      |      |     |
| Installation factor<br>(flooded bore hole)                                | $\gamma_2 = \gamma_{inst}$ | [-]                | 1,4                     |                                   |      |      |      |      |      |      |      |     |

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

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

**Injection System VME for concrete**

**Performance**

Characteristic values of tension loads for rebar under static, quasi-static action and seismic action C1

**Annex C6**

**Table C7:** Characteristic values of **shear loads** for **rebar**  
under static, quasi-static action and seismic action C1

| Reinforcing bar   |                            | Ø 8                | Ø 10                                 | Ø 12 | Ø 14                  | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |      |
|---|----------------------------|--------------------|--------------------------------------|------|-----------------------|------|------|------|------|------|------|
| <b>Steel failure <u>without</u> lever arm</b>   |                            |                    |                                      |      |                       |      |      |      |      |      |      |
| Characteristic shear resistance   | $V_{RK,s}$                 | [kN]               | $0,50 \cdot A_s \cdot f_{uk}^{1)}$   |      |                       |      |      |      |      |      |      |
|   | $V_{RK,s,C1}$              | [kN]               | $0,80 \cdot V_{RK,s}$                |      | $0,88 \cdot V_{RK,s}$ |      |      |      |      |      |      |
| Cross section area  | $A_s$                      | [mm <sup>2</sup> ] | 50                                   | 79   | 113                   | 154  | 201  | 314  | 491  | 616  | 804  |
| Partial factor  | $\gamma_{Ms,v}$            | [-]                | $1,5^{2)}$                           |      |                       |      |      |      |      |      |      |
| <b>Steel failure <u>with</u> lever arm</b>  |                            |                    |                                      |      |                       |      |      |      |      |      |      |
| Characteristic bending moment   | $M^0_{RK,s}$               | [Nm]               | $1.2 \cdot W_{el} \cdot f_{uk}^{1)}$ |      |                       |      |      |      |      |      |      |
|   | $M^0_{RK,s,C1}$            | [Nm]               | No Performance Determined (NPD)      |      |                       |      |      |      |      |      |      |
| Elastic section modulus   | $W_{el}$                   | [mm <sup>3</sup> ] | 50                                   | 98   | 170                   | 269  | 402  | 785  | 1534 | 2155 | 3217 |
| Partial factor  | $\gamma_{Ms,v}$            | [-]                | $1,5^{2)}$                           |      |                       |      |      |      |      |      |      |
| <b>Concrete pry-out failure</b>   |                            |                    |                                      |      |                       |      |      |      |      |      |      |
| Factor k in equation (5.7) of Technical Report TR 029<br>Factor $k_3$ in equation (27) of CEN/TS 1992-4-5 section 6.3.3 | $k_{(3)}$                  | [-]                | 2,0                                  |      |                       |      |      |      |      |      |      |
| <b>Concrete edge failure</b>  |                            |                    |                                      |      |                       |      |      |      |      |      |      |
| Effective length of anchor  | $l_f$                      | [mm]               | $l_f = \min(h_{ef}; 8 d_{nom})$      |      |                       |      |      |      |      |      |      |
| Outside diameter of rebar   | $d_{nom}$                  | [mm]               | 8                                    | 10   | 12                    | 14   | 16   | 20   | 25   | 28   | 32   |
| Installation factor   | $\gamma_2 = \gamma_{inst}$ | [-]                | 1,0                                  |      |                       |      |      |      |      |      |      |

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

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

**Injection System VME for concrete**

**Performance**

Characteristic values of **shear loads** for **rebar**  
under static, quasi-static action and seismic action C1

**Annex C7**

**Table C8: Displacements under tension load<sup>1)</sup> (threaded rod)**

| Threaded rod  |                                  |                           | M8    | M10   | M12   | M16   | M20                             | M24   | M27   | M30   |
|---|----------------------------------|---------------------------|-------|-------|-------|-------|---------------------------------|-------|-------|-------|
| <b>Uncracked concrete C20/25 under static and quasi-static action</b> |                                  |                           |       |       |       |       |                                 |       |       |       |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,011 | 0,013 | 0,015 | 0,020 | 0,024                           | 0,029 | 0,032 | 0,035 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,044 | 0,052 | 0,061 | 0,079 | 0,096                           | 0,114 | 0,127 | 0,140 |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,015 | 0,018 | 0,023 | 0,028                           | 0,033 | 0,037 | 0,043 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,050 | 0,060 | 0,070 | 0,091 | 0,111                           | 0,131 | 0,146 | 0,161 |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,015 | 0,018 | 0,023 | 0,028                           | 0,033 | 0,037 | 0,043 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,050 | 0,060 | 0,070 | 0,091 | 0,111                           | 0,131 | 0,146 | 0,161 |
| <b>Cracked concrete C20/25 under static and quasi-static action</b>   |                                  |                           |       |       |       |       |                                 |       |       |       |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,032 | 0,037 | 0,042                           | 0,048 | 0,053 | 0,058 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,210 | 0,210 | 0,210 | 0,210 | 0,210                           | 0,210 | 0,210 | 0,210 |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,037 | 0,043 | 0,049                           | 0,055 | 0,061 | 0,067 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240 | 0,240 | 0,240                           | 0,240 | 0,240 | 0,240 |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor           | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,037 | 0,043 | 0,049                           | 0,055 | 0,061 | 0,067 |
|   | $\delta_{N\infty}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240 | 0,240 | 0,240                           | 0,240 | 0,240 | 0,240 |
| <b>Cracked concrete C20/25 under seismic action (C2)</b>              |                                  |                           |       |       |       |       |                                 |       |       |       |
| All temperature ranges  | $\delta_{N,seis}$ (DLS) - factor | [mm/(N/mm <sup>2</sup> )] | NPD   |       | 0,03  | 0,05  | No Performance Determined (NPD) |       |       |       |
|   | $\delta_{N,seis}$ (ULS) - factor | [mm/(N/mm <sup>2</sup> )] |       |       | 0,06  | 0,09  |                                 |       |       |       |

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

$$\delta_{N0} = \delta_{N0}\text{- factor} \cdot \tau; \quad \delta_{N,seis}(DLS) = \delta_{N,seis}(DLS)\text{- factor} \cdot \tau; \quad \tau: \text{action bond stress for tension}$$

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

**Table C9: Displacements under shear load<sup>1)</sup> (threaded rod)**

| Threaded rod  |                                 |           | M 8  | M 10 | M 12 | M 16 | M 20                            | M 24 | M 27 | M 30 |
|---|---------------------------------|-----------|------|------|------|------|---------------------------------|------|------|------|
| <b>Uncracked and cracked concrete C20/25 under static and quasi-static action</b> |                                 |           |      |      |      |      |                                 |      |      |      |
| All temperature ranges  | $\delta_{V0}$ - factor          | [mm/(kN)] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04                            | 0,03 | 0,03 | 0,03 |
|   | $\delta_{V\infty}$ - factor     | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06                            | 0,05 | 0,05 | 0,05 |
| <b>Cracked concrete C20/25 under seismic action (C2)</b>                          |                                 |           |      |      |      |      |                                 |      |      |      |
| All temperature ranges  | $\delta_{V,seis}(DLS)$ - factor | [mm/(kN)] | NPD  |      | 0,2  | 0,1  | No Performance Determined (NPD) |      |      |      |
|   | $\delta_{V,seis}(ULS)$ - factor | [mm/(kN)] |      |      | 0,2  | 0,1  |                                 |      |      |      |

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

$$\delta_{V0} = \delta_{V0}\text{- factor} \cdot V; \quad \delta_{V,seis}(DLS) = \delta_{V,seis}(DLS)\text{- factor} \cdot V; \quad V: \text{action shear load}$$

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

**Injection System VME for concrete**

**Performance**  
Displacements (threaded rod)

**Annex C8**

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

| Internally threaded anchor rod  |                             |                           | IG-M6 | IG-M8 | IG-M10 | IG-M12 | IG-M16 | IG-M20 |
|---|-----------------------------|---------------------------|-------|-------|--------|--------|--------|--------|
| <b>Uncracked concrete C20/25 under static and quasi-static action</b> |                             |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ -factor       | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,015 | 0,020  | 0,024  | 0,029  | 0,035  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,052 | 0,061 | 0,079  | 0,096  | 0,114  | 0,140  |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,015 | 0,018 | 0,023  | 0,028  | 0,033  | 0,043  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,060 | 0,070 | 0,091  | 0,111  | 0,131  | 0,161  |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,015 | 0,018 | 0,023  | 0,028  | 0,033  | 0,043  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,060 | 0,070 | 0,091  | 0,111  | 0,131  | 0,161  |
| <b>Cracked concrete C20/25 under static and quasi-static action</b>   |                             |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,037  | 0,042  | 0,048  | 0,058  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,210 | 0,210 | 0,210  | 0,210  | 0,210  | 0,210  |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,037 | 0,043  | 0,049  | 0,055  | 0,067  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240  | 0,240  | 0,240  | 0,240  |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,037 | 0,043  | 0,049  | 0,055  | 0,067  |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240  | 0,240  | 0,240  | 0,240  |

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

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

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

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

| Internally threaded anchor rod  |                             |           | IG-M6 | IG-M8 | IG-M10 | IG-M12 | IG-M16 | IG-M20 |
|---|-----------------------------|-----------|-------|-------|--------|--------|--------|--------|
| <b>Uncracked and cracked concrete C20/25 under static and quasi-static action</b> |                             |           |       |       |        |        |        |        |
| All temperature ranges  | $\delta_{V0}$ - factor      | [mm/(kN)] | 0,07  | 0,06  | 0,06   | 0,05   | 0,04   | 0,04   |
|   | $\delta_{V\infty}$ - factor | [mm/(kN)] | 0,10  | 0,09  | 0,08   | 0,08   | 0,06   | 0,06   |

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

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

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

**Injection System VME for concrete**

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

**Annex C9**



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

| Reinforcing bar   |                             |                           | Ø 8   | Ø 10  | Ø 12  | Ø 14  | Ø 16  | Ø 20  | Ø 25  | Ø 28  | Ø 32  |
|---|-----------------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Uncracked concrete C20/25 under static and quasi-static action</b> |                             |                           |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,011 | 0,013 | 0,015 | 0,018 | 0,020 | 0,024 | 0,030 | 0,033 | 0,037 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,044 | 0,052 | 0,061 | 0,070 | 0,079 | 0,096 | 0,118 | 0,132 | 0,149 |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,015 | 0,018 | 0,020 | 0,023 | 0,028 | 0,034 | 0,038 | 0,043 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,050 | 0,060 | 0,070 | 0,081 | 0,091 | 0,111 | 0,136 | 0,151 | 0,172 |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,015 | 0,018 | 0,020 | 0,023 | 0,028 | 0,034 | 0,038 | 0,043 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,050 | 0,060 | 0,070 | 0,081 | 0,091 | 0,111 | 0,136 | 0,151 | 0,172 |
| <b>Cracked concrete C20/25 under static and quasi-static action</b>   |                             |                           |       |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C / 24°C                                   | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,032 | 0,035 | 0,037 | 0,042 | 0,049 | 0,055 | 0,061 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,210 | 0,210 | 0,210 | 0,210 | 0,210 | 0,210 | 0,210 | 0,210 | 0,210 |
| Temperature range II:<br>60°C / 43°C                                  | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,037 | 0,040 | 0,043 | 0,049 | 0,056 | 0,063 | 0,070 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 |
| Temperature range III:<br>72°C / 43°C                                 | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,032 | 0,032 | 0,037 | 0,040 | 0,043 | 0,049 | 0,056 | 0,063 | 0,070 |
|   | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 | 0,240 |

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

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

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

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

| Reinforcing bar   |                             |           | Ø 8  | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|-----------------------------|-----------|------|------|------|------|------|------|------|------|------|
| <b>For concrete C20/25 under static and quasi-static action</b> |                             |           |      |      |      |      |      |      |      |      |      |
| All temperature ranges  | $\delta_{V0}$ - factor      | [mm/(kN)] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
|   | $\delta_{V\infty}$ - factor | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 |

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

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

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

**Injection System VME for concrete**

**Performance**  
Displacements (rebar)

**Annex C10**