...eine starke Verbindung

# DICHIARAZIONE DI PRESTAZIONE

DoP No. **MKT-342** - it

- **Codice di identificazione unico del prodotto-tipo:** **Sistema di iniezione VMH nel calcestruzzo**
- **Usi previsti:** Anchor composito per l'ancoraggio nel calcestruzzo, vedi allegato B /Annex B
- **Fabbricante:** MKT Metall-Kunststoff-Technik GmbH & Co.KG
Auf dem Immel 2
67685 Weilerbach
- **Sistema o sistemi di valutazione e verifica della costanza della prestazione:** 1
- **Documento per la valutazione europea:** **EAD 330499-01-0601**
  - Valutazione tecnica europea: **ETA-17/0716, 22.11.2019**
  - Organismo di valutazione tecnica: DIBt, Berlin
  - Organismi notificati: NB 1343 – MPA, Darmstadt
- **Prestazioni dichiarate:**

| Caratteristiche essenziali | Prestazione |
|---|---|
| **Resistenza meccanica e stabilità (BWR 1)** | |
| Resistenze caratteristiche sotto carico di trazione (effetti statici e quasi statici) | Allegato / Annex C1, C3, C6, C8 |
| Resistenze caratteristiche sotto stress trasversale (effetti statici e quasi statici) | Allegato / Annex C2, C4, C7, C9 |
| Turni (effetti statici e quasi statici) | Allegato / Annex C11 – C13 |
| Resistenza caratteristica e turni per la categoria di prestazioni sismiche C1 + C2 | Allegato / Annex C5, C10, C11 |
| Durabilità | Allegato / Annex B1 |
| **Igiene, salute e ambiente (BWR 3)** | |
| Contenuto, emissione e / o rilascio di sostanze pericolose | Nessuna prestazione determinata |

La prestazione del prodotto sopra identificato è conforme all'insieme delle prestazioni dichiarate. La presente dichiarazione di responsabilità viene emessa, in conformità al regolamento (EU) n. 305/2011, sotto la sola responsabilità del fabbricante sopra identificato.

Firmato a nome e per conto del fabbricante da:

**Stefan Weustenhagen**
(Direttore Generale)
**Weilerbach, 22.11.2019**

p.p.
**Dipl.-Ing. Detlef Bigalke**
(Direttore del Sviluppo del Prodotto)

L'originale di questa dichiarazione di prestazione è stata scritta in tedesco. In caso di deviazioni nella traduzione, la versione tedesca è valida.

## Specification of intended use

| Injection System VMH | | Threaded rod | Internally threaded anchor rod | Rebar |
|---|---|---|---|---|
| Static or quasi-static action | | M8 - M30<br>zinc plated, A2, A4, HCR | VMU-IG M6 -<br>VMU-IG M20<br>zinc plated[1], A4, HCR | Ø8 - Ø32 |
| Seismic action | performance category C1 | M8 - M30<br>zinc plated[1], A4, HCR | - | Ø8 - Ø32 |
| | performance category C2 | M12 – M24<br>zinc plated[1] (property class 8.8)<br>A4, HCR (poperty class ≥ 70) | - | - |
| Base materials | | compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013 | | |
| | | strength classes acc. to EN 206:2013: C20/25 to C50/60 | | |
| | | cracked or uncracked concrete | | |
| Temperature Range I | -40 °C to +80 °C | max. long term temperature +50 °C and max. short term temperature +80 °C | | |
| Temperature Range II | -40 °C to +120 °C | max. long term temperature +72 °C and max. short term temperature +120 °C | | |
| Temperature Range III | -40 °C to +160 °C | max. long term temperature +100 °C and max. short term temperature +160 °C | | |

[1] except hot-dip galvanised

**Use conditions (Environmental conditions):**

- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes:
  - Stainless steel A2 according to Annex A4, Table A1: CRC II
  - Stainless steel A4 according to Annex A4, Table A1: CRC III
  - High corrosion resistant steel HCR according to Annex A4, Table A1: CRC V

**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

**Installation:**

- Dry or wet concrete or waterfilled drill holes (not seawater)
- Hole drilling by hammer or compressed air drill or vacuum drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person competent for technical matters on site
- 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

## Table B1: Installation parameters for threaded rods

| Threaded rod | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of threaded rod | | $d = d_{nom}$ | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 27 | 30 |
| Nominal drill hole diameter | | $d_0$ | [mm] | 10 | 12 | 14 | 18 | 22 | 28 | 30 | 35 |
| Effective anchorage depth | | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 80 | 90 | 96 | 108 | 120 |
| | | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 320 | 400 | 480 | 540 | 600 |
| Diameter of clearance hole in the fixture[2] | Pre-setting installation | $d_f \leq$ | [mm] | 9 | 12 | 14 | 18 | 22 | 26 | 30 | 33 |
| | Through setting installation | $d_f \leq$ | [mm] | 12 | 14 | 16 | 20 | 24 | 30 | 33 | 40 |
| Installation torque | | $T_{inst} \leq$ | [Nm] | 10 | 20 | 40 (35)[1] | 60 | 100 | 170 | 250 | 300 |
| Minimum thickness of member | | $h_{min}$ | [mm] | $h_{ef}$ + 30 mm ≥ 100 mm | | | $h_{ef} + 2d_0$ | | | | |
| Minimum spacing | | $s_{min}$ | [mm] | 40 | 50 | 60 | 75 | 95 | 115 | 125 | 140 |
| Minimum edge distance | | $c_{min}$ | [mm] | 35 | 40 | 45 | 50 | 60 | 65 | 75 | 80 |

[1] Installation torque for M12 with steel grade 4.6

[2] For applications under seismic loading the diameter of clearance hole in the fixture shall be at maximum $d_{nom}$ + 1mm or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

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

| Internally threaded anchor rod | | | IG-M 6 | IG-M 8 | IG-M 10 | IG-M 12 | IG-M 16 | IG-M 20 |
|---|---|---|---|---|---|---|---|---|
| Inner diameter of threaded rod | $d_2$ | [mm] | 6 | 8 | 10 | 12 | 16 | 20 |
| Outer diameter of threaded rod[1] | $d = d_{nom}$ | [mm] | 10 | 12 | 16 | 20 | 24 | 30 |
| Nominal drill hole diameter | $d_0$ | [mm] | 12 | 14 | 18 | 22 | 28 | 35 |
| Effective anchorage depth | $h_{ef,min}$ | [mm] | 60 | 70 | 80 | 90 | 96 | 120 |
| | $h_{ef,max}$ | [mm] | 200 | 240 | 320 | 400 | 480 | 600 |
| Diameter of clearance hole in the fixture | $d_f \leq$ | [mm] | 7 | 9 | 12 | 14 | 18 | 22 |
| 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 mm ≥ 100 mm | | $h_{ef} + 2d_0$ | | | |
| Minimum spacing | $s_{min}$ | [mm] | 50 | 60 | 75 | 95 | 115 | 140 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 45 | 50 | 60 | 65 | 80 |

[1] With metric thread acc. to EN 1993-1-8:2005+AC:2009

## Table B3: Installation parameters for rebar

| Rebar | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of rebar | $d = d_{nom}$ | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 24 | 25 | 28 | 32 |
| Nominal drill hole diameter[1] | $d_0$ | [mm] | 10 \| 12 | 12 \| 14 | 14 \| 16 | 18 | 20 | 25 | 32 | 32 | 35 | 40 |
| Effective anchorage depth | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 75 | 80 | 90 | 96 | 100 | 112 | 128 |
| | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 280 | 320 | 400 | 480 | 500 | 560 | 640 |
| Minimum thickness of member | $h_{min}$ | [mm] | $h_{ef}$ + 30 mm ≥ 100 mm | | $h_{ef} + 2d_0$ | | | | | | | |
| Minimum spacing | $s_{min}$ | [mm] | 40 | 50 | 60 | 70 | 75 | 95 | 120 | 120 | 130 | 150 |
| Minimum edge distance | $c_{min}$ | [mm] | 35 | 40 | 45 | 50 | 50 | 60 | 70 | 70 | 75 | 85 |

[1] For diameter ∅8, ∅10 and ∅12 both nominal drill hole diameter can be used

## Table B4: Parameter cleaning and setting tools

| Threaded rod | Internally threaded anchor rod | Rebar | Drill bit Ø | Brush Ø | min. Brush Ø |
|---|---|---|---|---|---|
| [-] | [-] | Ø [mm] | $d_0$ [mm] | $d_b$ [mm] | $d_{b,min}$ [mm] |
| M8 | | 8 | 10 | 11,5 | 10,5 |
| M10 | VMU-IG M 6 | 8 / 10 | 12 | 13,5 | 12,5 |
| M12 | VMU-IG M 8 | 10 / 12 | 14 | 15,5 | 14,5 |
| | | 12 | 16 | 17,5 | 16,5 |
| M16 | VMU-IG M10 | 14 | 18 | 20,0 | 18,5 |
| | | 16 | 20 | 22,0 | 20,5 |
| M20 | VMU-IG M12 | | 22 | 24,0 | 22,5 |
| | | 20 | 25 | 27,0 | 25,5 |
| M24 | VMU-IG M16 | | 28 | 30,0 | 28,5 |
| M27 | | | 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

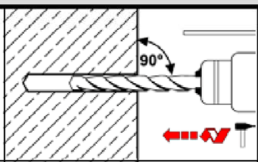
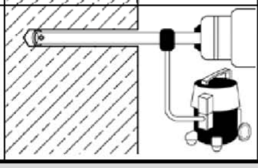
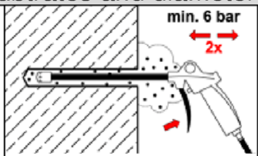
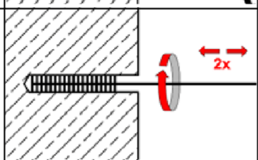
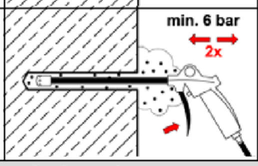
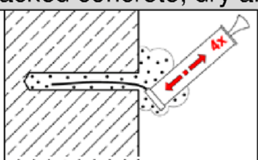
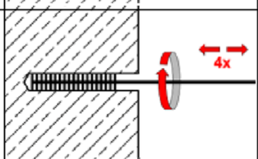
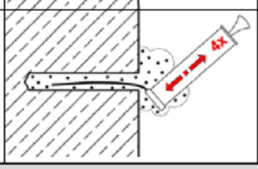
| Drill bit Ø | | Installation direction and use | | |
|---|---|---|---|---|
| $d_0$ [mm] | [-] | ⬇ | ➡ | ⬆ |
| 10 | No **retaining washer** required | | | |
| 12 | | | | |
| 14 | | | | |
| 16 | | | | |
| 18 | VM-IA 18 | $h_{ef}$ > 250mm | $h_{ef}$ > 250mm | all |
| 20 | VM-IA 20 | | | |
| 22 | VM-IA 22 | | | |
| 25 | VM-IA 25 | | | |
| 28 | VM-IA 28 | | | |
| 30 | VM-IA 30 | | | |
| 32 | VM-IA 32 | | | |
| 35 | VM-IA 35 | | | |
| 40 | VM-IA 40 | | | |

**Vacuum drill bit**
Drill bit diameter ($d_0$): all diameters
Vacuum drill bit (MKT Hollow drill bit SB, Würth Saugbohrer or Heller Duster Expert) and a class M vacuum with minimum negative pressure of 253 hPa and a flow rate of minimum 42 l/s

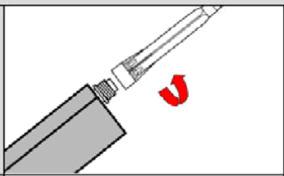
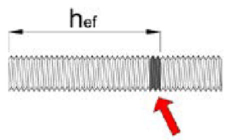
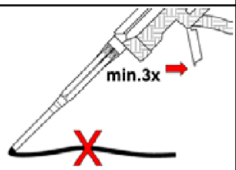
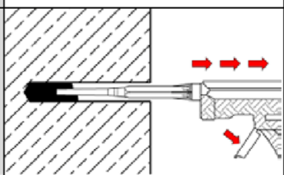
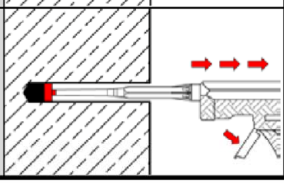
**Recommended compressed air tool (min 6 bar)**
Drill bit diameter ($d_0$): all diameters

**Blow-out pump (volume 750ml)**
Drill bit diameter ($d_0$): 10 mm to 20 mm
Drill hole depth ($h_0$): ≤ 10 $d_{nom}$
for uncracked concrete

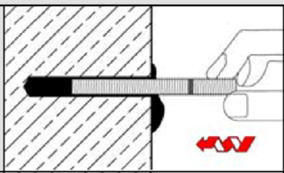
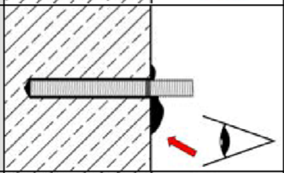
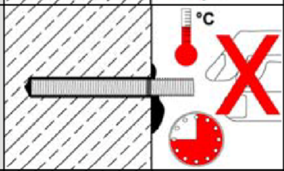
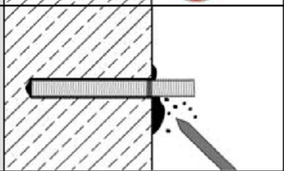
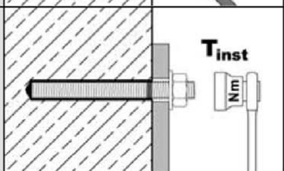
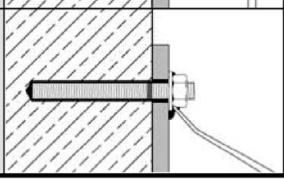
## Installation Instructions

| | | | |
|---|---|---|---|
| **Drilling of the hole** | | | |
| 1 | 1a |  | **Hammer drill oder compressed air drill**<br>Drill with hammer drill or compressed air drill a hole into the base material to the size required by the selected anchor (Table B1, B2 or B3). Continue with <u>step 2.</u><br>In case of aborted drill hole, the drill hole shall be filled with mortar. |
| | 1b |  | **Vacuum drill bit**: see Annex B3<br>Drill hole into the base material to the embedment size and embedment depth required by the selected anchor (table B1, B2 or B3). This drilling system removes dust and cleans the drill hole during drilling. Continue with <u>step 3</u>.<br>In case of aborted hole, the drill hole shall be filled with mortar. |
| **Cleaning** (not applicable when using a vacuum drill) | | | |
| 2 | **Attention! Standing water in the drill hole must be removed before cleaning!** | | |
| | **<u>Cleaning with compressed air</u>**<br>all subtrates and diameters according to Annex B1 | | |
| | 2a |  | Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust.<br>If the drill hole ground is not reached, an extension must be used. |
| | 2b |  | Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **two** times.<br>If the drill hole ground is not reached with the brush, an appropriate brush extension must be used. |
| | 2c |  | Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust.<br>If the drill hole ground is not reached, an extension must be used. |
| | **<u>Manual cleaning</u>**<br>uncracked concrete, dry and wet drill holes; drill hole diameter $d_0$ ≤ 20mm and drill hole depth $h_0$ ≤ 10 $d_{nom}$ | | |
| | 2a |  | Starting from the bottom or back of the drill hole, blow out the hole with the blow-out pump a minimum of **four** times. |
| | 2b |  | Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **four** times.<br>If the drill hole ground is not reached with the brush, an appropriate brush extension must be used. |
| | 2c |  | Starting from the bottom or back of the drill hole blow out the hole again a minimum of **four** times. |
| | After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again. | | |

## 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 drill hole, the position of the embedment depth shall be marked on the threaded rod or rebar |
| 5 |   | Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour. |
| 6a |  | Starting from the bottom or back of the cleaned drill hole fill the hole up to approximately<br>two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid air pockets. If the drill hole ground is not reached, an appropriate extension nozzle shall be used. Observe working times given in Table B6. |
| 6b |  | Retaining washer and mixer nozzle extensions shall be used according to Table B5 for the following applications:<br>• Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and anchorage depth $h_{ef} > 250$mm<br>• Overhead installation: Drill bit-Ø $d_0 \geq 18$ mm |

## Installation instructions (continuation)

| Inserting the anchor | | |
|---|---|---|
| 7 |  | Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.<br><br>The anchor shall be free of dirt, grease, oil or other foreign material. |
| 8 |  | After installation, the annular gap between anchor rod and concrete must be completely filled with mortar, in the case of push-through installation also in the fixture. If these requirements are not fulfilled, repeat application before end of working time!<br>For overhead installation, the anchor should be fixed (e.g. by wedges). |
| 9 |  | Allow the adhesive to cure to the specified time prior to applying any load or torque.<br>Do not move or load the anchor until it is fully cured (attend Table B6). |
| 10 |  | Remove excess mortar. |
| 11 |  | The fixture can be mounted after curing time. Apply installation torque $T_{inst}$ according to Table B1 or B2. |
| 12 |  | In case of pre-setting installation, the annular gap between anchor rod and fixture may optionally be filled with mortar. Therefore, replace regular washer by washer with bore and plug on reducing adapter on static mixer.<br>Annular gap is completely filled, when excess mortar seeps out. |

## Table B6: Working time and curing time

| Concrete temperature | Working time | Minimum curing time | |
|---|---|---|---|
| | | dry concrete | wet concrete |
| -5°C to -1°C | 50 min | 5 h | 10 h |
| 0°C to +4°C | 25 min | 3,5 h | 7 h |
| +5°C to +9°C | 15 min | 2 h | 4 h |
| +10°C to +14°C | 10 min | 1 h | 2 h |
| +15°C to +19°C | 6 min | 40 min | 80 min |
| +20°C to +29°C | 3 min | 30 min | 60 min |
| +30°C to +40°C | 2 min | 30 min | 60 min |
| **Cartridge temperature** | + 5°C to + 40°C | | |

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

| Threaded rod | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Cross sectional area | | $A_s$ | [mm²] | 36,6 | 58,0 | 84,3 | 157 | 245 | 353 | 459 | 561 |
| **Characteristic resistance under tension load**[1] | | | | | | | | | | | |
| Steel, zinc plated | Property class 4.6 and 4.8 | $N_{Rk,s}$ | [kN] | 15 (13) | 23 (21) | 34 | 63 | 98 | 141 | 184 | 224 |
| | Property class 5.6 and 5.8 | $N_{Rk,s}$ | [kN] | 18 (17) | 29 (27) | 42 | 78 | 122 | 176 | 230 | 280 |
| | Property class 8.8 | $N_{Rk,s}$ | [kN] | 29 (27) | 46 (43) | 67 | 125 | 196 | 282 | 368 | 449 |
| Stainless steel | A2, A4 and HCR Property class 50 | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 79 | 123 | 177 | 230 | 281 |
| | A2, A4 and HCR Property class 70 | $N_{Rk,s}$ | [kN] | 26 | 41 | 59 | 110 | 171 | 247 | - | - |
| | A4 and HCR Property class 80 | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 126 | 196 | 282 | - | - |
| **Partial factor**[2] | | | | | | | | | | | |
| Steel, zinc plated | Property class 4.6 | $\gamma_{Ms,N}$ | [-] | 2,0 | | | | | | | |
| | Property class 4.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| | Property class 5.6 | $\gamma_{Ms,N}$ | [-] | 2,0 | | | | | | | |
| | Property class 5.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| | Property class 8.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| Stainless steel | A2, A4 and HCR Property class 50 | $\gamma_{Ms,N}$ | [-] | 2,86 | | | | | | | |
| | A2, A4 and HCR Property class 70 | $\gamma_{Ms,N}$ | [-] | 1,87 | | | | | | - | - |
| | A4 and HCR Property class 80 | $\gamma_{Ms,N}$ | [-] | 1,6 | | | | | | - | - |

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

[2] In absence of other national regulations

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

| Threaded rod | | | | M 8 | M 10 | M 12 | M 16 | M 20 | M 24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Cross sectional area | | $A_s$ | [mm²] | 36,5 | 58,0 | 84,3 | 157 | 245 | 353 | 459 | 561 |
| **Characteristic resistances under shear load**[1] | | | | | | | | | | | |
| **Steel failure <u>without</u> lever arm** | | | | | | | | | | | |
| Steel, zinc plated | Property class 4.6 and 4.8 | $V^0_{Rk,s}$ | [kN] | 9 (8) | 14 (13) | 20 | 38 | 59 | 85 | 110 | 135 |
| | Property class 5.6 and 5.8 | $V^0_{Rk,s}$ | [kN] | 11 (10) | 17 (16) | 25 | 47 | 74 | 106 | 138 | 168 |
| | Property class 8.8 | $V^0_{Rk,s}$ | [kN] | 15 (13) | 23 (21) | 34 | 63 | 98 | 141 | 184 | 224 |
| Stainless steel | A2, A4 and HCR, property class 50 | $V^0_{Rk,s}$ | [kN] | 9 | 15 | 21 | 39 | 61 | 88 | 115 | 140 |
| | A2, A4 and HCR, property class 70 | $V^0_{Rk,s}$ | [kN] | 13 | 20 | 30 | 55 | 86 | 124 | - | - |
| | A4 and HCR, property class 80 | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | - | - |
| **Steel failure <u>with</u> lever arm** | | | | | | | | | | | |
| Steel, zinc plated | Property class 4.6 and 4.8 | $M^0_{Rk,s}$ | [Nm] | 15 (13) | 30 (27) | 52 | 133 | 260 | 449 | 666 | 900 |
| | Property class 5.6 and 5.8 | $M^0_{Rk,s}$ | [Nm] | 19 (16) | 37 (33) | 65 | 166 | 324 | 560 | 833 | 1123 |
| | Property class 8.8 | $M^0_{Rk,s}$ | [Nm] | 30 (26) | 60 (53) | 105 | 266 | 519 | 896 | 1333 | 1797 |
| Stainless steel | A2, A4 and HCR, property class 50 | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 66 | 167 | 325 | 561 | 832 | 1125 |
| | A2, A4 and HCR, property class 70 | $M^0_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 232 | 454 | 784 | - | - |
| | A4 and HCR, property class 80 | $M^0_{Rk,s}$ | [Nm] | 30 | 59 | 105 | 266 | 519 | 896 | - | - |
| **Partial factor** [2] | | | | | | | | | | | |
| Steel, zinc plated | Property class 4.6 | $\gamma_{Ms,V}$ | [-] | 1,67 | | | | | | | |
| | Property class 4.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| | Property class 5.6 | $\gamma_{Ms,V}$ | [-] | 1,67 | | | | | | | |
| | Property class 5.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| | Property class 8.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| Stainless steel | A2, A4 and HCR, property class 50 | $\gamma_{Ms,V}$ | [-] | 2,38 | | | | | | | |
| | A2, A4 and HCR, property class 70 | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | | - | - |
| | A4 and HCR, property class 80 | $\gamma_{Ms,V}$ | [-] | 1,33 | | | | | | - | - |

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

[2] In absence of other national regulations

**Table C3:** Characteristic values of **tension loads** for **threaded rods** under static or quasi-static action

| Threaded rod | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Characteristic resistance | | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ or see Table C1 | | | | | | | |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | see Table C1 | | | | | | | |
| **Combined pull-out and concrete failure** | | | | | | | | | | | |
| **Characteristic bond resistance in <u>uncracked</u> concrete C20/25** | | | | | | | | | | | |
| Temperature range I: | 80°C / 50°C | $\tau_{Rk,ucr}$ | [N/mm²] | 17 | 17 | 16 | 15 | 14 | 13 | 13 | 13 |
| Temperature range II: | 120°C / 72°C | $\tau_{Rk,ucr}$ | [N/mm²] | 15 | 14 | 14 | 13 | 12 | 12 | 11 | 11 |
| Temperature range III: | 160°C / 100°C | $\tau_{Rk,ucr}$ | [N/mm²] | 12 | 11 | 11 | 10 | 9,5 | 9,0 | 9,0 | 9,0 |
| **Characteristic bond resistance in <u>cracked</u> concrete C20/25** | | | | | | | | | | | |
| Temperature range I: | 80°C / 50°C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,5 | 8,0 | 9,0 | 8,5 | 7,0 | 7,0 | 7,0 |
| Temperature range II: | 120°C / 72°C | $\tau_{Rk,cr}$ | [N/mm²] | 6,0 | 6,5 | 7,0 | 7,5 | 7,0 | 6,0 | 6,0 | 6,0 |
| Temperature range III: | 160°C / 100°C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,5 | 6,0 | 5,5 | 5,5 | 5,5 |
| **Reduction factor $\psi^0_{sus}$ in concrete C20/25** | | | | | | | | | | | |
| Temperature range I: | 80°C / 50°C | $\psi^0_{sus}$ | [-] | 0,79 | | | | | | | |
| Temperature range II: | 120°C / 72°C | $\psi^0_{sus}$ | [-] | 0,75 | | | | | | | |
| Temperature range III: | 160°C / 100°C | $\psi^0_{sus}$ | [-] | 0,66 | | | | | | | |
| Increasing factors for concrete | | $\psi_c$ | C25/30 | 1,02 | | | | | | | |
| | | | C30/37 | 1,04 | | | | | | | |
| | | | C35/45 | 1,07 | | | | | | | |
| | | | C40/50 | 1,08 | | | | | | | |
| | | | C45/55 | 1,09 | | | | | | | |
| | | | C50/60 | 1,10 | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | |
| Factor $k_1$ | uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | |
| | cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | | | |
| **Splitting failure** | | | | | | | | | | | |
| 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 or wet concrete | Vacuum cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | |
| | Manual cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | NPA | | | |
| | Compressed air cleaning | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| water filled drill hole | | $\gamma_{inst}$ | [-] | 1,4 | | | | | | | |

**Table C4:** Characteristic values of **shear loads** for **threaded rods** under static or quasi-static action

| Threaded rod | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | |
| Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8 | $V^0_{Rk,s}$ | [kN] | $0{,}6 \cdot A_s \cdot f_{uk}$ or see Table C2 | | | | | | | |
| Characteristic resistance Steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR | $V^0_{Rk,s}$ | [kN] | $0{,}5 \cdot A_s \cdot f_{uk}$ or see Table C2 | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | |
| Partial factor | $\gamma_{Ms,V}$ | [-] | see Table C2 | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | |
| Characteristic bending resistance | $M^0_{Rk,s}$ | [Nm] | $1{,}2 \cdot W_{el} \cdot f_{uk}$ or see Table C2 | | | | | | | |
| Elastic section modulus | $W_{el}$ | [mm³] | 31 | 62 | 109 | 277 | 541 | 935 | 1387 | 1874 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | see Table C2 | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | |
| Pry-out factor | $k_8$ | [-] | 2,0 | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | |
| Effective length of anchor | $l_f$ | [mm] | min ($h_{ef}$;12 $d_{nom}$) | | | | | | min ($h_{ef}$;300mm) | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 27 | 30 |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |

**Table C5:** Characteristic values of **tesion loads** for **threaded rods** under **seismic action**, performance category **C1 + C2** [1)]

| **Threaded rod** | | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Characteristic resistance | | $N_{Rk,s,eq,C1}$ | [kN] | $1{,}0 \cdot N_{Rk,s}$ | | | | | | | |
| | | $N_{Rk,s,eq,C2}$ | [kN] | NPA | | $1{,}0 \cdot N_{Rk,s}$ | | | | NPA | |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | siehe Tabelle C1 | | | | | | | |
| **Combined pull-out and concrete failure** | | | | | | | | | | | |
| **Characteristic bond resistance** | | | | | | | | | | | |
| Temperatur-range | I: 80°C / 50°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 7,0 | 7,5 | 8,0 | 9,0 | 8,5 | 7,0 | 7,0 | 7,0 |
| | | $\tau_{Rk,eq,C2}$ | [N/mm²] | NPA | | 3,6 | 3,5 | 3,3 | 2,3 | NPA | |
| | II: 120°C / 72°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 6,0 | 6,5 | 7,0 | 7,5 | 7,0 | 6,0 | 6,0 | 6,0 |
| | | $\tau_{Rk,eq,C2}$ | [N/mm²] | NPA | | 3,1 | 3,0 | 2,8 | 2,0 | NPA | |
| | III: 160°C / 100°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,5 | 6,0 | 5,5 | 5,5 | 5,5 |
| | | $\tau_{Rk,eq,C2}$ | [N/mm²] | NPA | | 2,5 | 2,7 | 2,5 | 1,8 | NPA | |
| **Installation factor** | | | | | | | | | | | |
| Compressed air cleaning | dry or wet concrete | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| | water filled drill hole | | | 1,4 | | | | | | | |
| Vacuum cleaning | dry or wet concrete | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | |

[1)] Materials and property classes according to Annex B1

**Table C6:** Characteristic values of **tesion loads** for **threaded rods** under **seismic action**, performance category **C1 + C2** [1)]

| **Threaded rod** | | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | |
| Characteristic resistance | | $V_{Rk,s,eq,C1}$ | [kN] | $0{,}7 \cdot V^0_{Rk,s}$ | | | | | | | |
| | | $V_{Rk,s,eq,C2}$ | [kN] | NPA | | $0{,}7 \cdot V^0_{Rk,s}$ | | | | NPA | |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | siehe Tabelle C2 | | | | | | | |
| **Steel failure without lever arm** | | | | | | | | | | | |
| Charactersitic bending resistance | | $M^0_{Rk,s,eq}$ | [Nm] | No Performance Assessed (NPA) | | | | | | | |
| Installation factor | | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Factor for anchorages | without hole clearance | $\alpha_{gap}$ | [-] | 1,0 | | | | | | | |
| | with hole clearance between fastener and fixture | $\alpha_{gap}$ | [-] | 0,5 | | | | | | | |

[1)] Materials and property classes according to Annex B1

**Table C7:** Characteristic values of **tension loads** for **internally threaded anchor rod** under static or quasi-static action

| **Internally threaded anchor rod** | | | | **VMU-IG M 6** | **VMU-IG M 8** | **VMU-IG M 10** | **VMU-IG M 12** | **VMU-IG M 16** | **VMU-IG M 20** |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** [1)] | | | | | | | | | |
| Characteristic resistance, steel, zinc plated, property class | 5.8 | $N_{Rk,s}$ | [kN] | 10 | 17 | 29 | 42 | 76 | 123 |
| | 8.8 | $N_{Rk,s}$ | [kN] | 16 | 27 | 46 | 67 | 121 | 196 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | |
| Characteristic resistance, stainless steel A4 / HCR, property class | 70 | $N_{Rk,s}$ | [kN] | 14 | 26 | 41 | 59 | 110 | 124 [2)] |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,87 | | | | | 2,86 |
| **Combined pull-out and concrete failure** | | | | | | | | | |
| **Characteristic bond resistance in <u>uncracked</u> concrete C20/25** | | | | | | | | | |
| Temperature range | I: 80°C / 50°C | $\tau_{Rk,ucr}$ | [N/mm²] | 17 | 16 | 15 | 14 | 13 | 13 |
| | II: 120°C / 72°C | $\tau_{Rk,ucr}$ | [N/mm²] | 14 | 14 | 13 | 12 | 12 | 11 |
| | III: 160°C / 100°C | $\tau_{Rk,ucr}$ | [N/mm²] | 11 | 11 | 10 | 9,5 | 9,0 | 9,0 |
| **Characteristic bond resistance in <u>cracked</u> concrete C20/25** | | | | | | | | | |
| Temperature range | I: 80°C / 50°C | $\tau_{Rk,cr}$ | [N/mm²] | 7,5 | 8,0 | 9,0 | 8,5 | 7,0 | 7,0 |
| | II: 120°C / 72°C | $\tau_{Rk,cr}$ | [N/mm²] | 6,5 | 7,0 | 7,5 | 7,0 | 6,0 | 6,0 |
| | III: 160°C / 100°C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | 6,0 | 6,5 | 6,0 | 5,5 | 5,5 |
| **Reduction factor $\psi^0_{sus}$ in concrete C20/25** | | | | | | | | | |
| Temperature range | I: 80°C / 50°C | $\psi^0_{sus}$ | [-] | 0,79 | | | | | |
| | II: 120°C / 72°C | $\psi^0_{sus}$ | [-] | 0,75 | | | | | |
| | III: 160°C / 100°C | $\psi^0_{sus}$ | [-] | 0,66 | | | | | |
| Increasing factors for concrete | | $\psi_c$ | C25/30 | 1,02 | | | | | |
| | | | C30/37 | 1,04 | | | | | |
| | | | C35/45 | 1,07 | | | | | |
| | | | C40/50 | 1,08 | | | | | |
| | | | C45/55 | 1,09 | | | | | |
| | | | C50/60 | 1,10 | | | | | |
| **Concrete cone failure** | | | | | | | | | |
| Factor $k_1$ | uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | |
| | cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | |
| **Splitting failure** | | | | | | | | | |
| 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 or wet concrete | vaccum cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | | |
| | manual cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | NPA | | |
| | compressed air cleaning | $\gamma_{inst}$ | [-] | 1,0 | | | | | |
| waterfilled drill hole | | $\gamma_{inst}$ | [-] | 1,2 | | | | | |

1) 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

2) For VMU-IG M20: property class 50

**Table C8:** Characteristic values of **shear loads** for **internally threaded anchor rod** under static or quasi-static action

| Internally threaded anchor rod | | | | VMU-IG M 6 | VMU-IG M 8 | VMU-IG M 10 | VMU-IG M 12 | VMU-IG M 16 | VMU-IG M 20 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm**[1] | | | | | | | | | |
| Steel, zinc plated | Characteristic resistance, property class 5.8 | $V^0_{Rk,s}$ | [kN] | 5 | 9 | 15 | 21 | 38 | 61 |
| Steel, zinc plated | Characteristic resistance, property class 8.8 | $V^0_{Rk,s}$ | [kN] | 8 | 14 | 23 | 34 | 60 | 98 |
| Steel, zinc plated | Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Stainless steel | Characteristic resistance A4 / HCR, property class 70 | $V^0_{Rk,s}$ | [kN] | 7 | 13 | 20 | 30 | 55 | 62 [2] |
| Stainless steel | Partial factor | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | 2,38 |
| Ductility factor | | $k_7$ | [-] | 1,0 | | | | | |
| **Steel failure with lever arm**[1] | | | | | | | | | |
| Steel, zinc plated | Characteristic bending resistance, property class 5.8 | $M^0_{Rk,s}$ | [Nm] | 8 | 19 | 37 | 66 | 167 | 325 |
| Steel, zinc plated | Characteristic bending resistance, property class 8.8 | $M^0_{Rk,s}$ | [Nm] | 12 | 30 | 60 | 105 | 267 | 519 |
| Steel, zinc plated | Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Stainless steel | Characteristic bending resistance A4 / HCR, property class 70 | $M^0_{Rk,s}$ | [Nm] | 11 | 26 | 53 | 92 | 234 | 643 [2] |
| Stainless steel | Partial factor | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | 2,38 |
| **Concrete pry-out failure** | | | | | | | | | |
| Pry-out factor | | $k_8$ | [-] | 2,0 | | | | | |
| **Concrete edge failure** | | | | | | | | | |
| 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 | | | | | |

[1] 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

[2] For VMU-IG M20: Internally threaded rod: property class 50;
Fastening screws or threaded rods (incl. nut and washer): property class 70

**Table C9:** Characteristic values of **tension loads** for **rebar** under static or 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ 1) | | | | | | | | | |
| Cross sectional area | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 452 | 491 | 616 | 804 |
| Partial factor | $\gamma_{Ms,N}$ | [-] | 1,4 2) | | | | | | | | | |
| **Combined pull-out and concrete failure** | | | | | | | | | | | | |
| **Characteristic bond resistance in <u>uncracked</u> concrete C20/25** | | | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\tau_{Rk,ucr}$ | [N/mm²] | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 13 | 13 |
| Temperature range II: 120°C / 72°C | $\tau_{Rk,ucr}$ | [N/mm²] | 13 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 11 |
| Temperature range III: 160°C / 100°C | $\tau_{Rk,ucr}$ | [N/mm²] | 9,5 | 9,5 | 9,5 | 9,0 | 9,0 | 9,0 | 9,0 | 9,0 | 8,5 | 8,5 |
| **Characteristic bond resistance in <u>cracked</u> concrete C20/25** | | | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,5 | 6,5 | 6,5 | 6,5 | 7,0 | 7,0 | 7,0 |
| Temperature range II: 120°C / 72°C | $\tau_{Rk,cr}$ | [N/mm²] | 4,5 | 5,0 | 5,0 | 5,5 | 5,5 | 5,5 | 5,5 | 6,0 | 6,0 | 6,0 |
| Temperature range III: 160°C / 100°C | $\tau_{Rk,cr}$ | [N/mm²] | 4,0 | 4,5 | 4,5 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| **Reduction factor $\psi^0_{sus}$ in concrete C20/25** | | | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\psi^0_{sus}$ | [-] | 0,79 | | | | | | | | | |
| Temperature range II: 120°C / 72°C | $\psi^0_{sus}$ | [-] | 0,75 | | | | | | | | | |
| Temperature range III: 160°C / 100°C | $\psi^0_{sus}$ | [-] | 0,66 | | | | | | | | | |
| Increasing factor for concrete | $\psi_c$ | C25/30 | 1,02 | | | | | | | | | |
| | | C30/37 | 1,04 | | | | | | | | | |
| | | C35/45 | 1,07 | | | | | | | | | |
| | | C40/50 | 1,08 | | | | | | | | | |
| | | C45/55 | 1,09 | | | | | | | | | |
| | | C50/60 | 1,10 | | | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | | |
| Factor $k_1$ uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | | | |
| Factor $k_1$ cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | | | | | |
| **Splitting failure** | | | | | | | | | | | | |
| Edge distance $h/h_{ef} \geq 2{,}0$ | $c_{cr,sp}$ | [mm] | $1{,}0\ h_{ef}$ | | | | | | | | | |
| Edge distance $2{,}0 > h/h_{ef} > 1{,}3$ | $c_{cr,sp}$ | [mm] | $2 \cdot h_{ef}\ (2{,}5 - h / h_{ef})$ | | | | | | | | | |
| Edge distance $h/h_{ef} \leq 1{,}3$ | $c_{cr,sp}$ | [mm] | $2{,}4\ h_{ef}$ | | | | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2\ c_{cr,sp}$ | | | | | | | | | |
| **Installation factor** | | | | | | | | | | | | |
| dry or wet concrete, vacuum cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | | | |
| dry or wet concrete, manual cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | | NPA | | | | |
| dry or wet concrete, compressed air cleaning | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| waterfilled drill hole, compressed air cleaning | $\gamma_{inst}$ | [-] | 1,4 | | | | | | | | | |

1) $f_{uk}$ shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

**Table C10:** Characteristic values of **shear loads** for **rebar** under static or 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** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | | |
| Characteristic shear resistance | $V^0_{Rk,s}$ | [kN] | $0{,}50 \cdot A_s \cdot f_{uk}$ [1] | | | | | | | | | |
| Cross sectional area | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 452 | 491 | 616 | 804 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,5 [2] | | | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | | |
| Characteristic bending resistance | $M^0_{Rk,s}$ | [Nm] | $1{,}2 \cdot W_{el} \cdot f_{uk}$ [1] | | | | | | | | | |
| Elastic section modulus | $W_{el}$ | [mm³] | 50 | 98 | 170 | 269 | 402 | 785 | 1357 | 1534 | 2155 | 3217 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,5 [2] | | | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | | | |
| Pry-out Factor | $k_8$ | [-] | 2,0 | | | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | | | |
| 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 | | | | | | | | | |

[1] $f_{uk}$ shall be taken from the specifications of reinforcing bars
[2] in absence of national regulation

**Table C11:** Characteristic values of **tension loads** for **rebar** under **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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | | |
| Characteristic resistance | | $N_{Rk,s,eq,C1}$ | [kN] | $A_s \cdot f_{uk}$ 1) | | | | | | | | | |
| Cross sectional area | | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 452 | 491 | 616 | 804 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,4 2) | | | | | | | | | |
| **Combined pull-out and concrete failure** | | | | | | | | | | | | | |
| **Characteristic bond resistance in concrete C20/25** | | | | | | | | | | | | | |
| Temperature range | I: 80°C / 50°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,5 | 6,5 | 6,5 | 6,5 | 7,0 | 7,0 | 7,0 |
| | II: 120°C / 72°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 4,5 | 5,0 | 5,0 | 5,5 | 5,5 | 5,5 | 5,5 | 6,0 | 6,0 | 6,0 |
| | III: 160°C / 100°C | $\tau_{Rk,eq,C1}$ | [N/mm²] | 4,0 | 4,5 | 4,5 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| **Installation factor** | | | | | | | | | | | | | |
| dry or wet concrete | vacuum cleaning | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | | | |
| | compressed air cleaning | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |
| waterfilled drill hole | | $\gamma_{inst}$ | [-] | 1,4 | | | | | | | | | |

1) $f_{uk}$ shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

**Table C12:** Characteristic values of **shear loads** for **rebar** under **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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s,eq,C1}$ | [kN] | $0,35 \cdot A_s \cdot f_{uk}$ 1) | | | | | | | | | |
| Cross sectional area | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 452 | 491 | 616 | 804 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,5 2) | | | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | | |
| Characteristic bending resistance | $M^0_{Rk,s,eq,C1}$ | [Nm] | No Performance Assessd (NPA) | | | | | | | | | |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | |

1) $f_{uk}$ shall be taken from the specifications of reinforcing bars
2) in absence of national regulation

## Table C13: **Displacements** under **tension load** (threaded rod)

| Threaded rod | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1)] for uncracked concrete under static and quasi-static action** | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,031 | 0,032 | 0,034 | 0,037 | 0,039 | 0,042 | 0,044 | 0,046 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,040 | 0,042 | 0,044 | 0,047 | 0,051 | 0,054 | 0,057 | 0,060 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,032 | 0,034 | 0,035 | 0,038 | 0,041 | 0,044 | 0,046 | 0,048 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,042 | 0,044 | 0,045 | 0,049 | 0,053 | 0,056 | 0,059 | 0,062 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,121 | 0,126 | 0,131 | 0,142 | 0,153 | 0,163 | 0,171 | 0,179 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,124 | 0,129 | 0,135 | 0,146 | 0,157 | 0,168 | 0,176 | 0,184 |
| **Displacement factor[1)] for cracked concrete under static and quasi-static action** | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,081 | 0,083 | 0,085 | 0,090 | 0,095 | 0,099 | 0,103 | 0,106 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,104 | 0,107 | 0,110 | 0,116 | 0,122 | 0,128 | 0,133 | 0,137 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,084 | 0,086 | 0,088 | 0,093 | 0,098 | 0,103 | 0,107 | 0,110 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,108 | 0,111 | 0,114 | 0,121 | 0,127 | 0,133 | 0,138 | 0,143 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,312 | 0,321 | 0,330 | 0,349 | 0,367 | 0,385 | 0,399 | 0,412 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,321 | 0,330 | 0,340 | 0,358 | 0,377 | 0,396 | 0,410 | 0,424 |
| **Cracked concrete under seismic action (C2)** | | | | | | | | | | |
| All temperature ranges | $\delta_{N,eq\,(DLS)}$ | [mm] | NPA | | 0,24 | 0,27 | 0,29 | 0,27 | NPA | |
| | $\delta_{N,eq\,(ULS)}$ | [mm] | | | 0,55 | 0,51 | 0,50 | 0,58 | | |

[1)] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$- factor $\cdot \tau$;  $\tau$: acting bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}$- factor $\cdot \tau$;

## Table C14: **Displacements** under **shear load** (threaded rod)

| Threaded rod | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1)] for concrete under static and quasi-static action** | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-Faktor | [mm/(kN)] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$-Faktor | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |
| **Cracked concrete under seismic action (C2)** | | | | | | | | | | |
| All temperature ranges | $\delta_{V,eq(DLS)}$ | [mm] | NPA | | 3,6 | 3,0 | 3,1 | 3,5 | NPA | |
| | $\delta_{V,eq(ULS)}$ | [mm] | | | 7,0 | 6,6 | 7,0 | 9,3 | | |

[1)]Calculation of the displacement
$\delta_{V0} = \delta_{V0}$-factor $\cdot$ V;  V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}$-factor $\cdot$ V;

## Table C15: **Displacements** under **tension load** (internally threaded anchor rod)

| **Internally threaded anchor rod** | | | **VMU-IG M 6** | **VMU-IG M 8** | **VMU-IG M 10** | **VMU-IG M 12** | **VMU-IG M 16** | **VMU-IG M 20** |
|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1] for uncracked concrete under static and quasi-static action** | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,032 | 0,034 | 0,037 | 0,039 | 0,042 | 0,046 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,042 | 0,044 | 0,047 | 0,051 | 0,054 | 0,060 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,034 | 0,035 | 0,038 | 0,041 | 0,044 | 0,048 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,044 | 0,045 | 0,049 | 0,053 | 0,056 | 0,062 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,126 | 0,131 | 0,142 | 0,153 | 0,163 | 0,179 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,129 | 0,135 | 0,146 | 0,157 | 0,168 | 0,184 |
| **Displacement factor[1] for cracked concrete under static and quasi-static action** | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,083 | 0,085 | 0,090 | 0,095 | 0,099 | 0,106 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,107 | 0,110 | 0,116 | 0,122 | 0,128 | 0,137 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,086 | 0,088 | 0,093 | 0,098 | 0,103 | 0,110 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,111 | 0,114 | 0,121 | 0,127 | 0,133 | 0,143 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,321 | 0,330 | 0,349 | 0,367 | 0,385 | 0,412 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,330 | 0,340 | 0,358 | 0,377 | 0,396 | 0,424 |

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: acting bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

## Table C16: **Displacements** under **shear load** (internally threaded anchor rod)

| **Internally threaded anchor rod** | | | **VMU-IG M 6** | **VMU-IG M 8** | **VMU-IG M 10** | **VMU-IG M 12** | **VMU-IG M 16** | **VMU-IG M 20** |
|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1] under static and quasi-static action** | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,07 | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,10 | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 |

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

## Table C17: **Displacements** under **tension load** (rebar)

| **Rebar** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 24** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1] for uncracked concrete under static and quasi-static action** | | | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,031 | 0,032 | 0,034 | 0,035 | 0,037 | 0,039 | 0,042 | 0,043 | 0,045 | 0,048 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,040 | 0,042 | 0,044 | 0,045 | 0,047 | 0,051 | 0,054 | 0,055 | 0,058 | 0,063 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,032 | 0,034 | 0,035 | 0,036 | 0,038 | 0,041 | 0,044 | 0,045 | 0,047 | 0,050 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,042 | 0,044 | 0,045 | 0,047 | 0,049 | 0,053 | 0,056 | 0,057 | 0,060 | 0,065 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,121 | 0,126 | 0,131 | 0,137 | 0,142 | 0,153 | 0,163 | 0,164 | 0,172 | 0,186 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,124 | 0,129 | 0,135 | 0,141 | 0,146 | 0,157 | 0,168 | 0,169 | 0,177 | 0,192 |
| **Displacement factor[1] for cracked concrete under static and quasi-static action** | | | | | | | | | | | | |
| Temperature range I: 80°C / 50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,081 | 0,083 | 0,085 | 0,087 | 0,090 | 0,095 | 0,099 | 0,099 | 0,103 | 0,108 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,104 | 0,107 | 0,110 | 0,113 | 0,116 | 0,122 | 0,128 | 0,128 | 0,133 | 0,141 |
| Temperature range II: 120°C / 72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,084 | 0,086 | 0,088 | 0,090 | 0,093 | 0,098 | 0,103 | 0,103 | 0,107 | 0,113 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,108 | 0,111 | 0,114 | 0,118 | 0,121 | 0,127 | 0,133 | 0,133 | 0,138 | 0,148 |
| Temperature range III: 160°C / 100°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,312 | 0,321 | 0,330 | 0,340 | 0,349 | 0,367 | 0,385 | 0,385 | 0,399 | 0,425 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,321 | 0,330 | 0,340 | 0,349 | 0,358 | 0,377 | 0,396 | 0,396 | 0,410 | 0,449 |

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: acting bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{- factor} \cdot \tau$;

## Table C18: **Displacements** under **shear load** (rebar)

| **Rebar** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 24** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Displacement factor[1] under static and quasi-static action** | | | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 |

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;