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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

# European Technical Assessment ETA-23/0342 of 2023/04/24

I General Part

**Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011:** ETA-Danmark A/S

| | |
|---|---|
| **Trade name of the construction product:** | TIT PE-500 Bonded anchor |
| **Product family to which the above construction product belongs:** | Bonded anchor with anchor rod for use in concrete under static, quasi-static or seismic action (performance category C2) |
| **Manufacturer:** | TOO Energon Service<br>Uralsk, Chapaeva str., bld. 22<br>Kazakistan<br>Internet www.energon.asia |
| **Manufacturing plant:** | TOO Energon Service<br>Manufacturing Plant I |
| **This European Technical Assessment contains:** | 31 pages including 26 annexes which form an integral part of the document |
| **This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:** | EOTA EAD 330499-01-0601, “Bonded fasteners for use in concrete” |
| **This version replaces:** | |

# II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

## 1 Technical description of product

**Technical description of the product**

The TIT PE-500 is a bonded anchor (injection type) consisting of an injection mortar cartridge equipped with a special mixing nozzle and a steel element which is a commercial threaded rod size M8 to M30 with hexagon nut and washer or reinforcing bars (rebar) from Ø8 mm to Ø32 mm.

The steel element is placed into a drilled hole previously injected (using an applicator gun) with a mortar with a slow and slight twisting motion. The anchor rod is anchored by the bond between rod, mortar and concrete.

The anchor in the range of M8 to M30, Ø8 to Ø32 and the mortar cartridges corresponds to the drawings given in the Annex A

The characteristic material values, dimensions and tolerances of the anchors not indicated in Annexes shall correspond to the respective values laid down in the technical documentation[1] of this European Technical Assessment.

## 2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter EAD)

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the anchor of 50 years and 100 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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1 The technical documentation of this European Technical Assessment is deposited at ETA-Danmark and, as far as relevant for the tasks of the Notified bodies involved in the attestation of conformity procedure, is handed over to the notified bodies.

# 3 Performance of the product and references to the methods used for its assessment

## 3.1 Characteristics of product

**Mechanical resistance and stability (BWR 1):**
The essential characteristics are detailed in the Annex C.

**Safety in case of fire (BWR 2):**
No performance assessed.

**Hygiene, health and the environment (BWR3):**
No performance assessed

**Safety in use (BWR4):**
For basic requirement Safety in use the same criteria are valid for Basic Requirement Mechanical resistance and stability (BWR1).

Other Basic Requirements are not relevant.

## 3.2 Methods of assessment

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Basic Requirements 1 and 4 has been made in accordance with EOTA EAD 330499-01-0601, “Bonded fasteners for use in concrete”.

# 4 Attestation and verification of constancy of performance (AVCP)

## 4.1 AVCP system

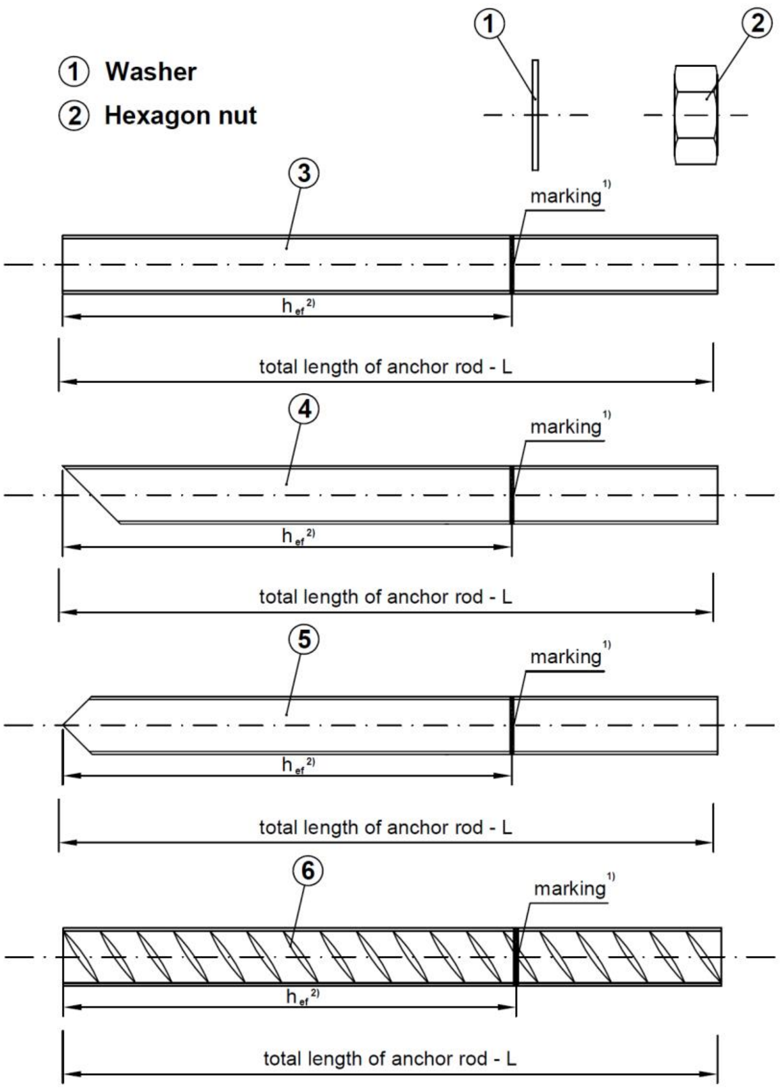
According to the decision 96/582/EC of the European Commission, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 1.

# 5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking

Issued in Copenhagen on 2023-04-04 by

Thomas Bruun
Manager, ETA-Danmark




③ **Version 1 - rod with flat end with marking on $h_{ef}$**

④ **Version 2 - rod with 45° cutted end with marking on $h_{ef}$**

⑤ **Version 3 - rod with V shape end with marking on $h_{ef}$**

⑥ **Rebar - Deformed reinforcing bar with marking on $h_{ef}$**

1) Marking according to clause 1.1 of EAD 330499-01-0601

2) Effective anchorage depth according to Table B1 and B2 (Annex B2 and B3)

| | |
|---|---|
| **TIT PE-500** | **Annex A1**<br>of European<br>Technical Assessment<br>ETA-23/0342 |
| **Product description**<br>Steel elements | |

**Table A1: Threaded rods**

| Designation | | Material | | | |
|---|---|---|---|---|---|
| **Steel, zinc plated**<br>**electroplated ≥ 5 µm acc. to EN ISO 4042**<br>**hot-dip galvanized ≥ 40 µm acc. to EN ISO 1461** | | | | | |
| Threaded rod | **Property class** | **Characteristic steel ultimate strength** | **Characteristic steel yield strength** | **Fracture elongation** | EN ISO 898-1 |
| | 4.8 | $f_{uk} \geq 400$ N/mm² | $f_{yk} \geq 320$ N/mm² | $A_5 > 8\%$[1)] | |
| | 5.8 | $f_{uk} \geq 500$ N/mm² | $f_{yk} \geq 400$ N/mm² | $A_5 > 8\%$[1)] | |
| | 8.8 | $f_{uk} \geq 800$ N/mm² | $f_{yk} \geq 640$ N/mm² | $A_5 \geq 12\%$[1)] | |
| | 10.9 | $f_{uk} \geq 1000$ N/mm² | $f_{yk} \geq 900$ N/mm² | $A_5 > 9\%$ | |
| Hexagon nut | 4 | for class 4.8 rods | | | EN 898-2 |
| | 5 | for class 5.8 rods | | | |
| | 8 | for class 8.8 rods | | | |
| | 10 | for class 10.9 rods | | | |
| Washer | Steel, according to EN ISO 7089; corresponding to anchor rod material | | | | |
| **Stainless steel A2**<br>**Stainless steel A4**<br>**High corrosion resistance stainless steel (HCR)** | | **(Materials) 1.4301, 1.4307, 1.4567, 1.4541**<br>**(Materials) 1.4401, 1.4404, 1.4571, 1.4362,1.4578**<br>**(Materials) 1.4529, 1.4565** | | | |
| Threaded rod | **Property class** | **Characteristic steel ultimate strength** | **Characteristic steel yield strength** | **Fracture elongation** | EN 10088<br>EN ISO 3506 |
| | 50 | $f_{uk} \geq 500$ N/mm² | $f_{yk} \geq 210$ N/mm² | $A_5 > 8\%$[1)] | |
| | 70 | $f_{uk} \geq 700$ N/mm² | $f_{yk} \geq 450$ N/mm² | $A_5 \geq 12\%$[1)] | |
| | 80 | $f_{uk} \geq 800$ N/mm² | $f_{yk} \geq 600$ N/mm² | $A_5 \geq 12\%$[1)] | |
| Hexagon nut | 50 | for class 50 rods | | | EN 10088<br>EN ISO 3506 |
| | 70 | for class 70 rods | | | |
| | 80 | for class 80 rods | | | |
| Washer | Steel, according to EN 10088; corresponding to anchor rod material | | | | |

[1)] For seismic performance category C2, $A_5 > 12\%$

Commercial standard threaded rods may be used, with:

- material and mechanical properties according to Table A3,
- confirmation of material and mechanical properties by inspection certificate 3.1 according to EN-10204:2004,
- marking of the threaded rod with the embedment depth.

Note: Commercial standard threaded rods made of galvanized steel with property class above 8.8 are not permitted in some Member States.

Filling Washer for filling annular gap

| | |
|---|---|
| **TIT PE-500** | **Annex A2**<br>of European<br>Technical Assessment<br>ETA-23/0342 |
| **Product description**<br>Materials (1) | |

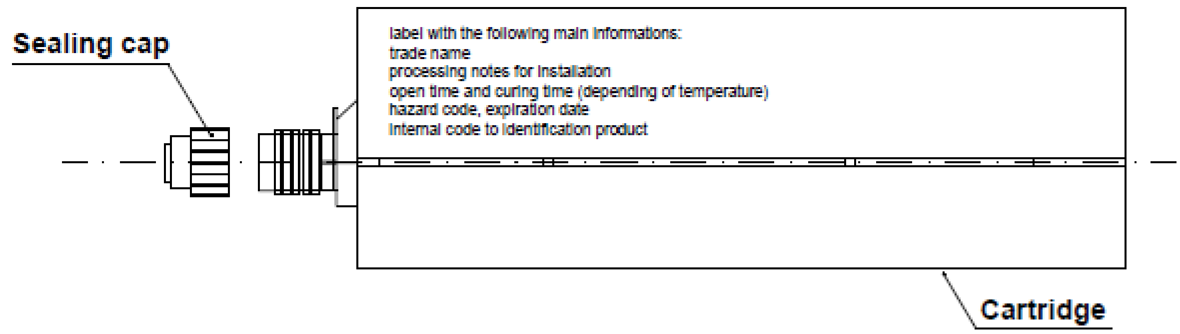
**Table A2: Reinforcing bars (Rebar)**

| Designation | Material |
|---|---|
| Rebar according to<br>EN 1992-1-1:2004+AC:2010, Annex C | Bars and de-coiled rods Class B or C<br>With $f_{yk}$ and k according to NDP or NCL or EN 1992-1-1:2004/NA<br>$f_{uk} = f_{tk} = k \times f_{yk}$<br>Rib height of the bar (h) in the range $0{,}05d \leq h \leq 0{,}07d$ |

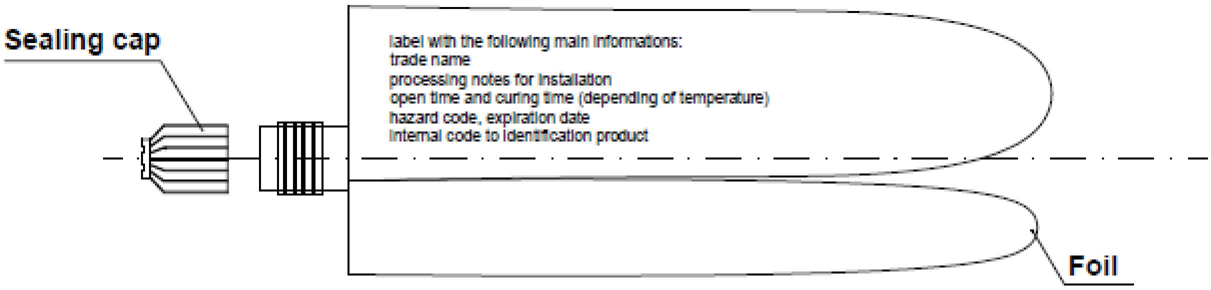
**Table A3: Injection mortars**

| Product | Composition |
|---|---|
| TIT PE-500<br>two component injection mortars | Additive: quartz<br>Bonding agent: epoxy resin |

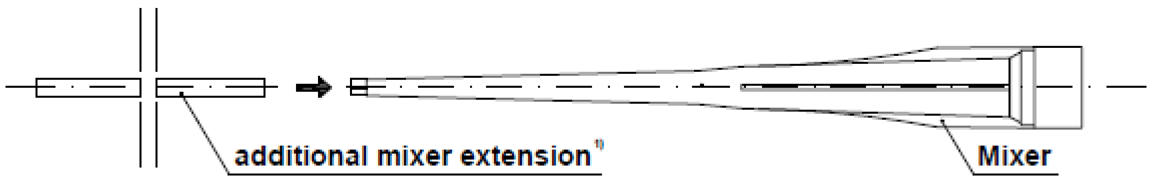
### from 385 to 1400 ml cartridge - side by side cartridge




### 600 ml - foil system




### MIXER - the mixer is suitable for each type of cartridge




1) Variable length from 380 mm up to 1000 mm

| TIT PE-500 | **Annex A4**<br>of European Technical Assessment ETA-23/0342 |
|---|---|
| **Product description**<br>Cartridge types and sizes | |

**Specifications of intended use**

**Use:**

The anchors are intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Basic Requirement 1 (EU) 305/2011 shall be fulfilled and failure of anchorages made with these products would compromise the stability of the works, cause risk to human life and/or lead to considerable economic consequences

**Anchors subject to:**

Static and quasi-static loads: sizes from M8 to M30 and from ϕ8 to ϕ32.

Seismic performance category C2: sizes M12 to M24, rods with $f_{uk} \leq 800$ N/mm² and $A_5 \geq 12\%$

Working life of 50 and 100 years

**Base material:**

- Reinforced or unreinforced normal weight concrete of strength class C20/25 at minimum to C50/60 at maximum according to EN 206-1.
- Non-cracked concrete: sizes from M8 to M30 and from ϕ8 to ϕ32.
- Cracked concrete: sizes from M12 to M30.

**Temperature range:**

The anchors may be used in the following temperature range:

- -40°C to +40°C (max. short term temperature +40°C and max. long term temperature +24°C).
- -40°C to +55°C (max. short term temperature +55°C and max. long term temperature +43°C).
- -40°C to +80°C (max. short term temperature +80°C and max. long term temperature +50°C).

**Use conditions (environmental conditions):**

- Structures subject to dry internal conditions: all materials according to Table A1.
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance class:

  Stainless steel A2 according to Annex A4, Table A1: CRC II

  Stainless steel A4 according to Annex A4, Table A1: CRC III

  High corrosion resistance steel HCR according to Annex A4, Table A1: CRC V

**Installation:**

- Dry or wet concrete (use category I1): sizes from M8 to M30 and from ϕ8 to ϕ32.
- Flooded holes with the exception of seawater (use category I2): sizes from M8 to M30 and from ϕ8 to ϕ32.
- Installation direction D3 (downward and horizontal and upwards installation): sizes from M8 to M30 and from ϕ8 to ϕ32.
- The anchors are suitable for hammer drilled holes (HD), for hollow drill bit (HDB) and for compressed air drill (CA): sizes from M8 to M30 and from ϕ8 to ϕ32. Diamond drilled holes (DD) for sizes from M16 to M30.

**Design methods:**

- 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 loads are designed in accordance to EN 1992-4 and Technical Report TR055.
- Anchorages under seismic actions are designed in accordance to EN 1992-4 and Technical Report TR045.

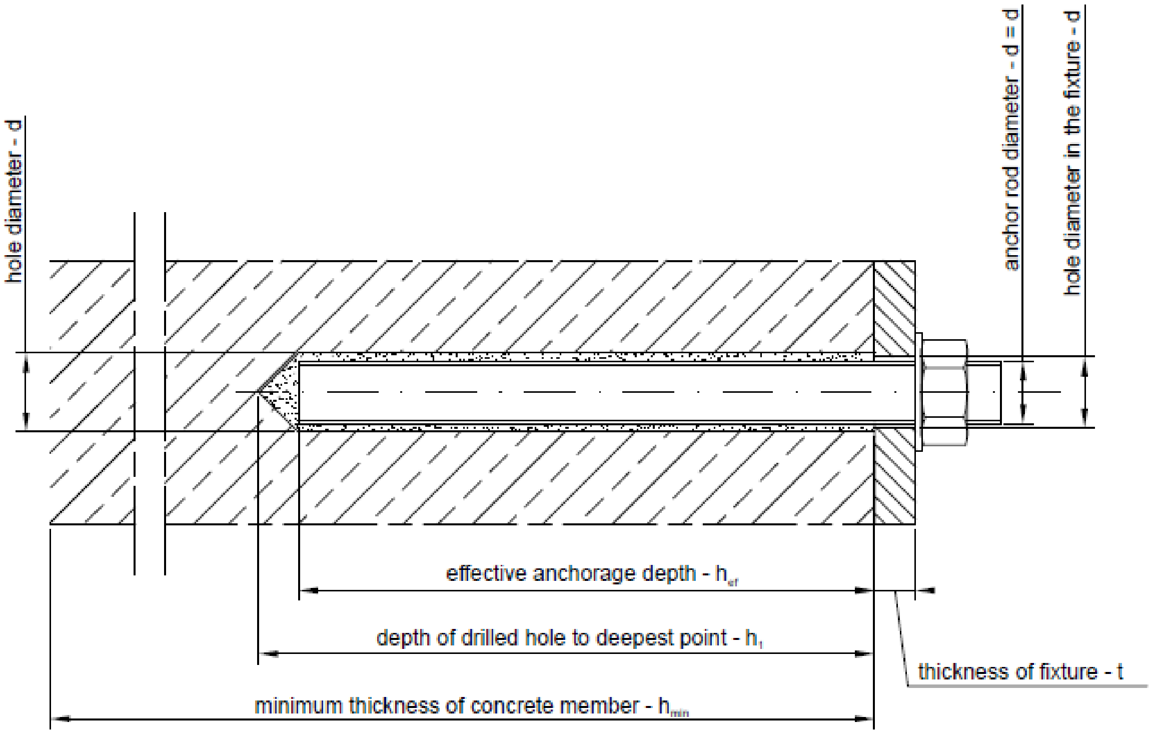



**Table B1: Installation data for threaded rods**

| Size | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| Nominal drilling diameter | $d_0$ [mm] | 10 | 12 | 14 | 18 | 22-24 | 28 | 30 | 35 |
| Maximum diameter hole in the fixture | $d_{fix}$ [mm] | 9 | 12 | 14 | 18 | 22 | 26 | 30 | 33 |
| Effective embedment depth | $h_{ef,min}$ [mm] | 60 | 60 | 70 | 80 | 90 | 96 | 110 | 120 |
| | $h_{ef,max}$ [mm] | 160 | 200 | 240 | 320 | 400 | 480 | 540 | 600 |
| Depth of the drilling hole | $h_1$ [mm] | $h_{ef}$ + 5 mm | | | | | | | |
| Minimum thickness of the concrete slab | $h_{min}$ [mm] | $h_{ef}$ + 30 mm; ≥ 100 mm | | | $h_{ef}$ + 2$d_0$ | | | | |
| Maximum setting torque moment | $T_{fix}$ [Nm] | 10 | 20 | 40 | 80 | 130 | 200 | 270 | 300 |
| Minimum spacing | $s_{min}$ [mm] | 40 | 50 | 60 | 75 | 90 | 115 | 120 | 140 |
| Minimum edge distance | $c_{min}$ [mm] | 35 | 40 | 45 | 50 | 55 | 60 | 75 | 80 |

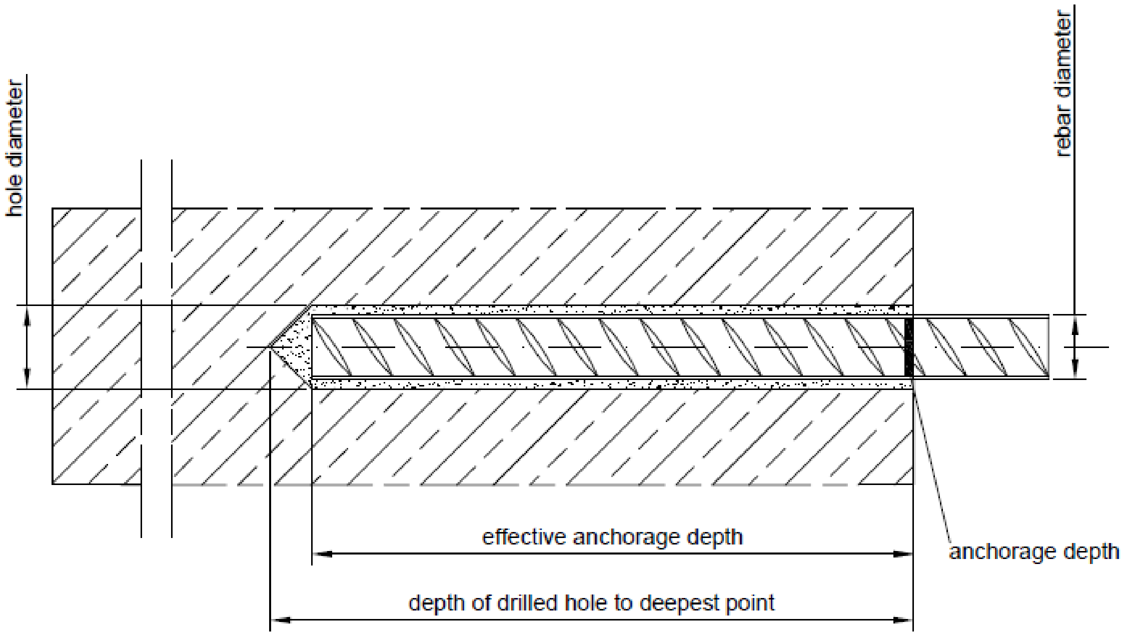



**Table B2: Installation data for rebars**

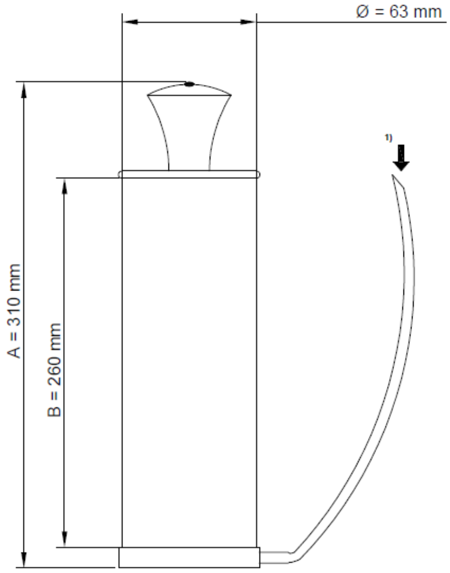
| **Size** | | **Ø8** | **Ø10** | **Ø12** | **Ø14** | **Ø16** | **Ø20** | **Ø22** | **Ø25** | **Ø28** | **Ø30** | **Ø32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drilling diameter | $d_0$ [mm] | 10-12 | 12-14 | 14-16 | 18 | 20 | 25 | 26 | 30-32 | 35 | 35 | 40 |
| Effective embedment depth | $h_{ef,min}$ [mm] | 60 | 70 | 80 | 80 | 100 | 120 | 120 | 150 | 180 | 180 | 200 |
| | $h_{ef,max}$ [mm] | 160 | 200 | 240 | 280 | 320 | 400 | 440 | 500 | 560 | 600 | 640 |
| Depth of the drilling hole | $h_1$ [mm] | $h_{ef}$ + 5 mm | | | | | | | | | | |
| Minimum thickness of the concrete slab | $h_{min}$ [mm] | $h_{ef}$ + 30 mm; ≥ 100 mm | | $h_{ef} + 2d_0$ | | | | | | | | |
| Minimum spacing | $s_{min}$ [mm] | 40 | 50 | 60 | 70 | 80 | 100 | 105 | 125 | 140 | 150 | 160 |
| Minimum edge distance | $c_{min}$ [mm] | 40 | 45 | 45 | 50 | 50 | 65 | 65 | 70 | 75 | 80 | 80 |

**Table B3: Maximum processing time and minimum curing time**

| TIT PE-500 | | | |
|---|---|---|---|
| **Concrete T° [C°]** | **Working time** | **Torque time[3)]** | **Minimum curing time[3)]** |
| 0°C[2)] | 2 h | 48 h | 96 h |
| 5°C[2)] | 1 h 15 min | 24 h | 48 h |
| 10°C | 1 h | 12 h | 24 h |
| 15°C | 45 min | 6 h | 18 h |
| 20°C | 30 min | 4 h | 12 h |
| 25°C | 20 min | 4 h | 10 h |
| 30°C | 15 min | 3 h | 5 h |
| 35°C | 12 min | 3 h | 5 h |
| 40°C | 8 min | 3 h | 5 h |

1) The minimum time from the end of the mixing to the time when the anchor is loaded
2) Minimum resin temperature recommended, for injection between 5°C and 0°C, equal to 10°C.
3) In presence of water the curing time must be doubled
4) Max resin temperature of 24°C for installation at maximum setting depth

## Manual Blower pump: nominal dimensions




**It is possible to use the mixer extension (see Annex 6) with the manual blower pump.**

**However it is possible to blow the hole using the mechanical air system (compressed air) also with the mixer estension**


**Suitable min pressure 6 bar at 6 m³/h**
**Oil-free compressed air**
**Recommended air gun with an orifice opening of minimum 3.5 mm in diameter**

**1) Position to insert the mixer extension**

Mixer extension (from 380 mm to 1000 mm) with nominal diameter 10 mm

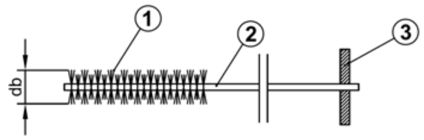
| | |
|---|---|
| **TIT PE-500** | **Annex B5**<br>of European Technical Assessment ETA-23/0342 |
| **Intended use**<br>Cleaning tools (1) | |

**Table B4: Standard brush diameter for threaded rods**

| Threaded rod diameter | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 10 | 12 | 14 | 18 | 22-24 | 28 | 30 | 35 |
| $d_b$ | Brush diameter [mm] | 12 | 14 | 16 | 20 | 26 | 30 | 35 | 37 |

**Table B5: Standard brush diameter for rebars**

| Rebar diameter | | Ø8 | | Ø10 | | Ø12 | | Ø14 |
|---|---|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 10 | 12 | 12 | 14 | 14 | 16 | 18 |
| $d_b$ | Brush diameter [mm] | 12 | 14 | 14 | 16 | 16 | 18 | 20 |



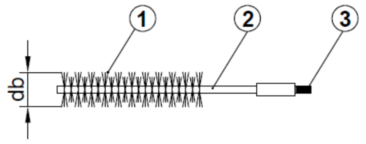

① Steel bristles
② Steel stem
③ Wood handle

**Table B6: Special brush diameter (mechanical brush) for threaded rods**

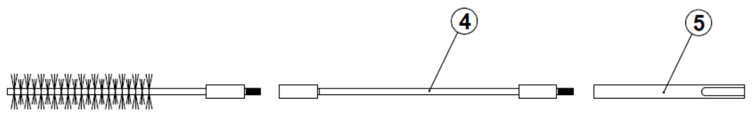
| Threaded rod diameter | | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 18 | 22-24 | 28 | 30 | 35 |
| $d_b$ | Brush diameter [mm] | 20 | 26 | 30 | 32 | 37 |

**Table B7: Special brush diameter (mechanical brush) for rebars**

| Threaded rod diameter | | Ø8 | | Ø10 | | Ø12 | | Ø14 | Ø16 | Ø20 | Ø25 | Ø22 | Ø28 | Ø30 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 10 | 12 | 12 | 14 | 14 | 16 | 18 | 20 | 25 | 30-32 | 26 | 35 | 35 | 40 |
| $d_b$ | Brush diameter [mm] | 12 | 14 | 14 | 16 | 16 | 18 | 20 | 22 | 27 | 32 | 27 | 37 | 37 | 42 |




① Steel bristles
② Steel stem
③ Threaded connection for drilling tool extension
④ Extension special brush
⑤ Drilling tool connection (SDS connection)

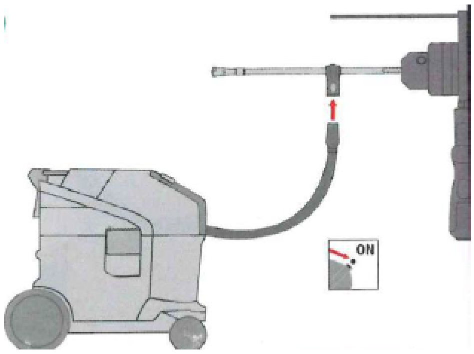


**Hollow Drill Bit (HDB)**

This drilling method is a hammer drilling method.

This drilling system removes the dust and cleans the bore hole during the drilling operation when used in accordance with the user's manual.

This drilling system include a vacuum cleaner. A suitable dust extraction system must be used.
e.g. Bosch GAS 35 M AFC or a comparable dust extraction system with equivalent performance data.




**Switch-on the vacuum cleaner before to dril....**

**Table B8: HDB perforation diameter for threaded rods**

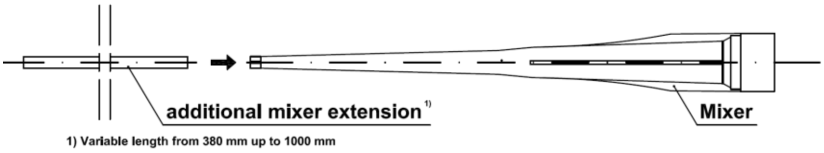
| Threaded rod diameter | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 10 | 12 | 14 | 18 | 22-24 | 28 | 30 | 35 |

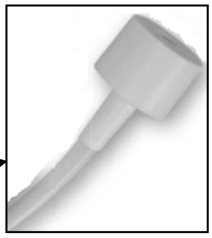
**Table B9: HDB perforation diameter for rebars**

| Rebar diameter | | ϕ8 | ϕ10 | ϕ12 | ϕ14 | ϕ16 | ϕ20 | ϕ22 | ϕ25 | ϕ28 | ϕ30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $d_0$ | Nominal drill hole [mm] | 10-12 | 12-14 | 14-16 | 18 | 20 | 25 | 26 | 30-32 | 35 | 35 |

| TIT PE-500 | **Annex B7**<br>of European Technical Assessment ETA-23/0342 |
|---|---|
| **Intended use**<br>Hollow drill bit (HDB) specification | |

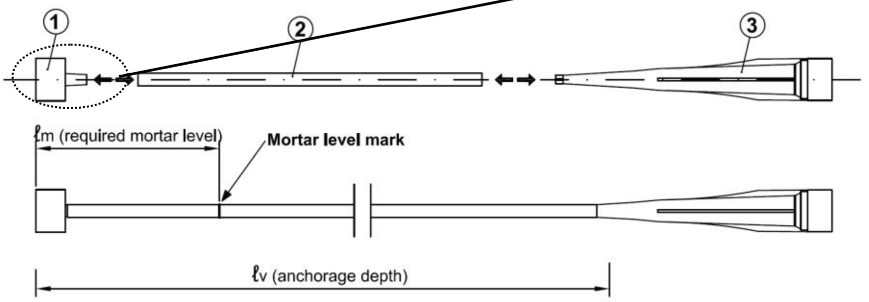
**<u>Use the mixer extension (assembled on the standard mixer) for the injection up to 300 mm if necessary.</u>**



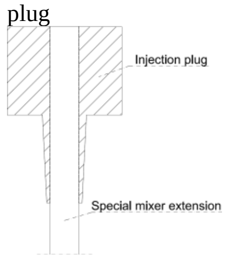



**<u>Use this system for special conditions.</u>**

**Tools for installation in special condition**




Insert the special mixer extension in the inner diameter of the injection plug up to reach the top of the plug

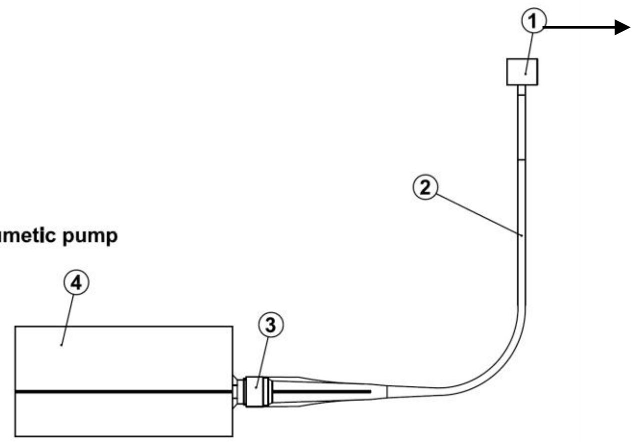



1. **Injection plug (nominal diameter according to the nominal diameter of drilled hole)**
2. **Special mixer extension (variable length with nominal diameter 10 mm)**
   **Mark the required mortar level $\ell_m$ and embedment depth $\ell_v$ with tape or marker on the injection extension. Quick estimation: $\ell_m = 1/3 \cdot \ell_v$**
   **Continue injection until the mortar level mark $\ell_m$ becomes visible.**
3. **Standard mixer (suitable for all size of cartirge)**

**These tools allow the application in special conditions:**
**- installation with anchorage depth greater than 300 mm**
**- overhead installation.**
**For these applications is recommanded the use of the injection pneumatic pump.**

**System assembled**

1. **Injection plug**
2. **Special mixer extension**
3. **Standard mixer**
4. **Cartridge**
5. **Sample of injection pneumetic pump**

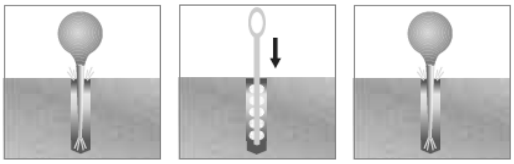
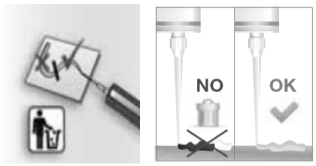
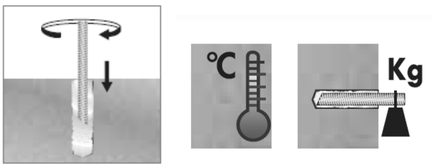

| | |
|---|---|
| **TIT PE-500** | **Annex B8**<br>of European Technical Assessment ETA-23/0342 |
| **Intended use**<br>Tools for installation (1) | |

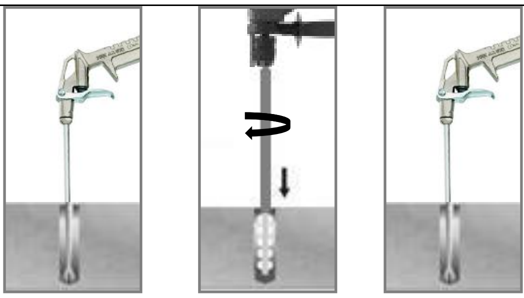
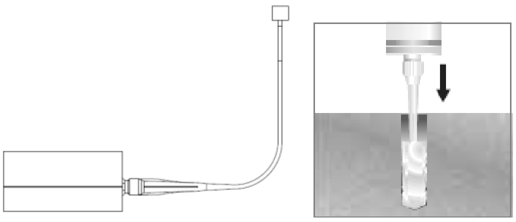
**Table B10: Mortar injection dispensers**

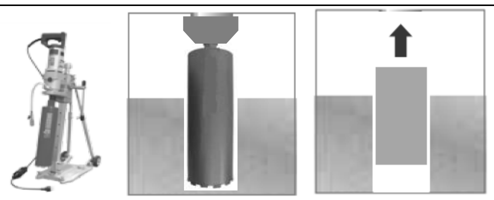
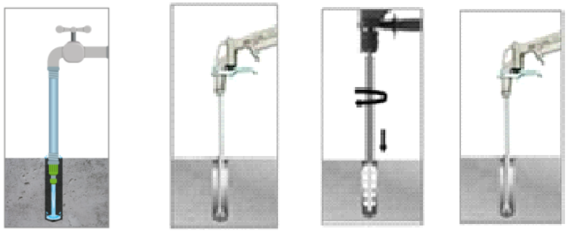
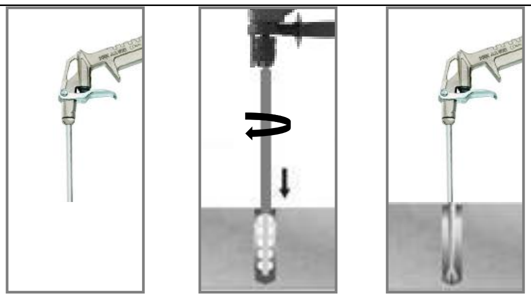
| Injection dispensers | Cartridges | Clean hole tools | Maximum depth of the drill hole |
|---|---|---|---|
|  *Manual* | 385 ml<br>585 ml | Blower pump or compressed air and standard brush or special brush or HDB | 300 mm* |
|  *Manual+ Cartridge Adaptor* | 600 ml<br>Foil system | Blower pump or compressed air and standard brush or special brush or HDB | 300 mm* |
|  *Battery* | 385 ml<br>585 ml | Compressed air and special brush or HDB | 300 mm to 640 mm* |
|  *Pneumatic* | 385 ml<br>585 ml<br>1000 ml<br>1400 ml | Compressed air and special brush or HDB | 300 mm to 640 mm* |

* Note: use the mixer extension described in Annex B8 for the injection of the mortar

| | |
|---|---|
| **TIT PE-500** | **Annex B9**<br>of European Technical Assessment ETA-23/0342 |
| **Intended use**<br>Tools for installation (2) | |

| | | |
|---|---|---|
| **1** |  | Drill the hole with the correct diameter and depth using a rotary percussive machine. Check the perpendicularity of the hole during the drilling operation. In case of use of hollow drill bit (Annex B7) proceed directly to the point 3 |
| **2** | <br>**4x Blower Manual Pump** **4x Standard Brush** **4x Blower Manual Pump**<br>**if necessary use a mixer extension for the blower operation (see Annex B5)** | Clean the hole from drilling dust:<br>the hole shall be cleaned by at least 4 blowing operations, by at least 4 brushing operations followed again by at least 4 blowing operations; before brushing clean the brush and check (see Annex B6, standard brush) if the brush diameter is sufficient. For the blower tools see Annex B5. |
| **3** |  | Unscrew the front cup, screw on the mixer and insert the cartridge in the gun. |
| **4** |  | Before starting to use the cartridge, eject a first part of the product, being sure that the two components are completely mixed. The complete mixing is reached only after that the product, obtained by mixing the two components, comes out from the mixer with a uniform color. |
| **5** |  **if necessary, use a mixer extension for the injection (see Annex B8)** | Fill the drilled hole uniformly starting from the drilled hole bottom, in order to avoid entrapment of the air; remove the mixer slowly bit by bit during pressing-out; filling the drill hole with a quantity of the injection mortar corresponding to 2/3 of the drill hole depth. |
| **6** | <br>**ATTENTION: Use the rods dry and free oil and other contaminants** | Insert immediately the rod, marked according to the proper anchorage depth, slowly and with a slight twisting motion, removing excess of injection mortar around the rod. Observe the working time according Annex B4. Wait the curing time according Annex B4. It can be optionally filled the annular gap between anchor and fixture with mortar. |

| | | |
|---|---|---|
| **1** | See point 1 Annex B10. In case of use of hollow drill bit (HDB) proceed directly to the point 3. | |
| **2** | <br>**4 x 5 seconds 4x 4 x 5 seconds**<br>**ATTENTION: compressed air free oil** | Clean the hole from drilling dust:<br>the hole shall be cleaned by at least 4 blowing operations (5 seconds for single operation) with compressed air, by at least 4 brushing operations with special brush followed again by at least 4 blowing operations (5 seconds for single operation) with compressed air. Before brushing clean the brush and check (see Annex B6, special brush) if the brush diameter is sufficient. For the blower tools see the Annex B5. |
| **3** | See point 3 Annex B10 | |
| **4** | See point 4 Annex B10 | |
| **5** |  | Before starting the injection, assemble the system according to Annex B8. After that, fill the drilled hole uniformly from the drilled hole bottom, in order to avoid entrapment of the air; remove the special mixer extension with injection plug slowly bit by bit during pressing-out; filling the drill hole with a quantity of the injection mortar corresponding to 2/3 of the drill hole depth.<br>Procedure for overhead application is detailed in Annex B13. |
| **6** | See point 6 Annex B10 | |

| | | |
|---|---|---|
| **1** |  | Drill the hole with the correct diameter and depth using a core drill machine. Check the perpendicularity of the hole during the drilling operation. Remove completely the core from the hole. |
| **2** | <br>**flush hole until water runs clear** / **4x blower with compressed air** / **4x special brush** / **4x blower with compressed air** | After operation 1, if the diamond drilling machine used has a dry cutting system proceed with the installation procedure according to the point 3.<br>Instead, if it is used a wet cutting system before go to the point 4 the following operation must be done:<br>- flush hole 2 times by inserting a water hose to the back of the hole until water runs clear;<br>- brush 2 times with the proper special brush. Before brushing clean the brush and check (see Annex B6, special brush) if the brush diameter is sufficient;<br>- flush again 2 times until water runs clear;<br>- remove all standing water completely (using for example vacuum system or compressed air free oil). |
| **3** | <br>**4 x 5 seconds** / **6x** / **4 x 5 seconds**<br><br>**ATTENTION: compressed air free oil** | Clean the hole from drilling dust:<br>the hole shall be cleaned by at least<br>- 4 blowing operations (5 seconds for single operation) with compressed air<br>- 4 brushing operations with special brush<br>- 4 blowing operations (5 seconds for single operation) with compressed air.<br><br>Before brushing clean the brush and check (see Annex B6, special brush) if the brush diameter is sufficient. For the blower tools see the Annex B5. |
| **4** | After the operation above, to follow the operations from 4 to 6 on the previous Annex B9 and B10 in function of the depth of the hole. | |

## Overhead installation procedure

### In addition to standard procedure, for overhead installation, following the below procedure

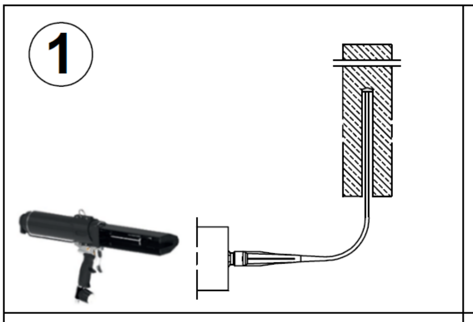
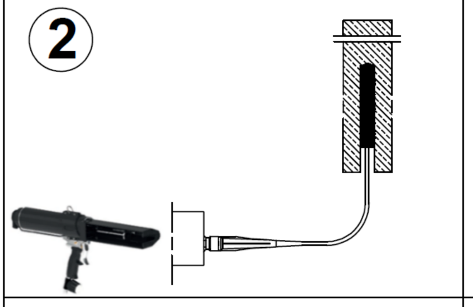
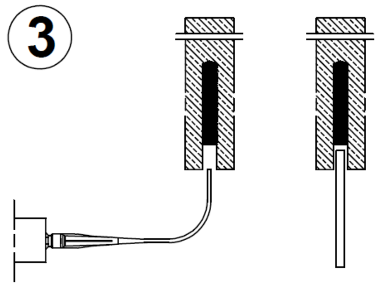
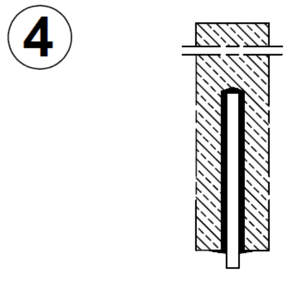
| | |
|---|---|
|  | **1 - Start injection**<br><br>**Inject from the bottom of the hole. Use battery or pneumatic dispenser if the anchorage depth is grater than 200 mm.** |
|  | **2 - Injection phase**<br><br>**Inject the product about 2/3 of the hole depth. Remove the mixer extension slowly bit by bit during pressing-out.** |
|  | **3 - End injection**<br><br>**Remove the mixer extension. Insert immediately the steel element (turn the steel element during the insertion).** |
|  | **4 - End installation**<br><br>**To avoid the slipping of the steel element during the open time of the product (due to the steel element own weigth) use a temporary interlocking element (for ex. wedge of wood)** |

**Table C1: Characteristic values for steel tension resistance and steel shear resistance – threaded rods.**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure – characteristic tension resistance** | | | | | | | | | | |
| Steel class 4.8 | $N_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 183 | 224 |
| Steel class 5.8 | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 229 | 280 |
| Steel class 8.8 | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 126 | 196 | 282 | 367 | 449 |
| Steel class 10.9 | $N_{Rk,s}$ | [kN] | 37 | 58 | 84 | 157 | 245 | 353 | 459 | 561 |
| Stainless steel A2, A4, HCR class 50 | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 229 | 280 |
| Stainless steel A2, A4, HCR class 70 | $N_{Rk,s}$ | [kN] | 26 | 41 | 59 | 110 | 171 | 247 | 321 | 392 |
| Stainless steel A4, HCR class 80 | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 126 | 196 | 282 | 367 | 449 |
| **Steel failure – characteristic tension resistance – partial factor** | | | | | | | | | | |
| Steel class 4.8 | $\gamma_{Ms,N}$ [1)] | [-] | 1,50 | | | | | | | |
| Steel class 5.8 | $\gamma_{Ms,N}$ [1)] | [-] | 1,50 | | | | | | | |
| Steel class 8.8 | $\gamma_{Ms,N}$ [1)] | [-] | 1,50 | | | | | | | |
| Steel class 10.9 | $\gamma_{Ms,N}$ [1)] | [-] | 1,40 | | | | | | | |
| Stainless steel A2, A4, HCR class 50 | $\gamma_{Ms,N}$ [1)] | [-] | 2,86 | | | | | | | |
| Stainless steel A2, A4, HCR class 70 | $\gamma_{Ms,N}$ [1)] | [-] | 1,87 | | | | | | | |
| Stainless steel A4, HCR class 80 | $\gamma_{Ms,N}$ [1)] | [-] | 1,60 | | | | | | | |
| **Steel failure – characteristic shear resistance without lever arm** | | | | | | | | | | |
| Steel class 4.8 | $V^0_{Rk,s}$ | [kN] | 7 | 12 | 17 | 31 | 49 | 71 | 92 | 112 |
| Steel class 5.8 | $V^0_{Rk,s}$ | [kN] | 9 | 14 | 21 | 39 | 61 | 88 | 115 | 140 |
| Steel class 8.8 | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| Steel class 10.9 | $V^0_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 230 | 280 |
| Stainless steel A2, A4, HCR class 50 | $V^0_{Rk,s}$ | [kN] | 9 | 14 | 21 | 39 | 61 | 88 | 115 | 140 |
| Stainless steel A2, A4, HCR class 70 | $V^0_{Rk,s}$ | [kN] | 13 | 20 | 29 | 55 | 86 | 124 | 160 | 196 |
| Stainless steel A4, HCR class 80 | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| **Steel failure – characteristic shear resistance with lever arm** | | | | | | | | | | |
| Steel class 4.8 | $M^0_{Rk,s}$ | [Nm] | 15 | 30 | 52 | 133 | 260 | 449 | 666 | 900 |
| Steel class 5.8 | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 65 | 166 | 324 | 561 | 832 | 1125 |
| Steel class 8.8 | $M^0_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 | 898 | 1331 | 1799 |
| Steel class 10.9 | $M^0_{Rk,s}$ | [Nm] | 37 | 75 | 131 | 333 | 649 | 1123 | 1664 | 2249 |
| Stainless steel A2, A4, HCR class 50 | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 66 | 166 | 324 | 561 | 832 | 1124 |
| Stainless steel A2, A4, HCR class 70 | $M^0_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 233 | 454 | 786 | 1165 | 1574 |
| Stainless steel A4, HCR class 80 | $M^0_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 | 898 | 1331 | 1799 |
| **Steel failure – characteristic shear resistance – partial factor** | | | | | | | | | | |
| Steel class 4.8 | $\gamma_{Ms,V}$ [1)] | [-] | 1,25 | | | | | | | |
| Steel class 5.8 | $\gamma_{Ms,V}$ [1)] | [-] | 1,25 | | | | | | | |
| Steel class 8.8 | $\gamma_{Ms,V}$ [1)] | [-] | 1,25 | | | | | | | |
| Steel class 10.9 | $\gamma_{Ms,V}$ [1)] | [-] | 1,50 | | | | | | | |
| Stainless steel A2, A4, HCR class 50 | $\gamma_{Ms,V}$ [1)] | [-] | 2,38 | | | | | | | |
| Stainless steel A2, A4, HCR class 70 | $\gamma_{Ms,V}$ [1)] | [-] | 1,56 | | | | | | | |
| Stainless steel A4, HCR class 80 | $\gamma_{Ms,V}$ [1)] | [-] | 1,33 | | | | | | | |

**Fracture elongation threaded rod for seismic C2 must be $A_5 \geq 12\%$.**
**Steel classes 10.9 are not covered for seismic application.**

[1)] In the absence of national regulation

**Table C2: Characteristic values tension resistance load in non-cracked concrete for threaded rod under static and quasi-static loads for 50 and 100 years**

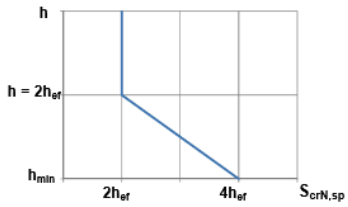
| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | See Annex C1 – Table C1 | | | | | | | |
| Partial factor | $\gamma_{Ms,N}$ | [-] | See Annex C1 – Table C1 | | | | | | | |
| **Combined pull-out and concrete cone failure in non-cracked concrete C20/25 for HD – HBD and CA** | | | | | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,ucr}$ | [N/mm²] | 16,0 | 16,0 | 16,0 | 16,0 | 16,0 | 16,0 | 15,0 | 14,0 |
| Characteristic bond resistance temperature range -40°C / +55°C | $\tau_{Rk,ucr}$ | [N/mm²] | 15,0 | 15,0 | 15,0 | 15,0 | 15,0 | 15,0 | 14,0 | 14,0 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,ucr}$ | [N/mm²] | 11,0 | 11,0 | 11,0 | 10,0 | 10,0 | 10,0 | 10,0 | 10,0 |
| **Combined pull-out and concrete cone failure in non-cracked concrete C20/25 for DD** | | | | | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,ucr}$ | [N/mm²] | - | - | - | 14,0 | 14,0 | 14,0 | 13,0 | 13,0 |
| Characteristic bond resistance temperature range -40°C / +55°C | $\tau_{Rk,ucr}$ | [N/mm²] | - | - | - | 13,0 | 13,0 | 13,0 | 12,0 | 12,0 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,ucr}$ | [N/mm²] | - | - | - | 10,0 | 10,0 | 10,0 | 9,0 | 9,0 |
| **Reduction factor $\psi^0_{sus}$ for non-cracked concrete valid for all drilling method** | | | | | | | | | | |
| Sustained load factor temperature range -40°C / +40°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | | | |
| Sustained load factor temperature range -40°C / +55°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | | | |
| Sustained load factor temperature range -40°C / +80°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | | | |
| Increasing factor for non-cracked concrete related to strength $f_{ck}$ | $\psi_c$ | [-] | $(f_{ck}/20)^{0,2}$ | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | |
| Factor for non-cracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | |
| Edge distance | $C_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | | | |
| Spacing | $S_{cr,N}$ | [mm] | $3{,}0 \cdot h_{ef}$ | | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Spacing | $S_{cr,Nsp}$ | [mm] | If $h = h_{min}$<br>$S_{cr,Nsp} = 4{,}0 \cdot h_{ef}$<br>If $h_{min} < h < 2 h_{ef}$<br><br>$S_{cr,Nsp}$ = interpolate values<br>if $h \geq 2 h_{ef}$<br>$S_{cr,Nsp} = 2 h_{ef}$ | | | | | | | |
| Edge distance | $C_{cr,Nsp}$ | [mm] | $0{,}5 \cdot S_{cr,sp}$ | | | | | | | |
| **Installation factor for combined pull-out, concrete cone and splitting failure** | | | | | | | | | | |
| Installation factors for category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| Installation factors for category I2 | | | 1,2 | | | | | | | |

**Table C3: Characteristic values tension resistance load in cracked concrete for threaded rod under static and quasi-static loads for 50 and 100 years**

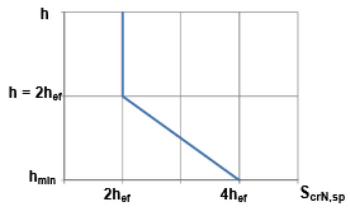
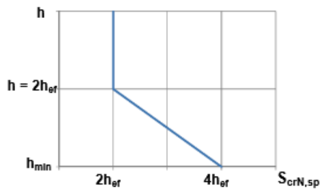
| **Size** | | | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | See Annex C1 – Table C1 | | | | | |
| Partial factor | $\gamma_{Ms,N}$ | [-] | See Annex C1 – Table C1 | | | | | |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 for HD – HBD and CA** | | | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,5 | 7,0 | 8,0 | - | - |
| Characteristic bond resistance temperature range -40°C / +55°C | $\tau_{Rk,cr}$ | [N/mm²] | 7,0 | 7,5 | 7,0 | 8,0 | - | - |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,cr}$ | [N/mm²] | 5,5 | 5,5 | 5,5 | 5,5 | - | - |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 for DD** | | | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 7,5 | 7,0 | 7,0 | 7,0 | 6,5 |
| Characteristic bond resistance temperature range -40°C / +55°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 7,5 | 7,0 | 7,0 | 7,0 | 6,5 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,cr}$ | [N/mm²] | - | 5,5 | 5,0 | 5,0 | 5,0 | 4,5 |
| **Reduction factor $\psi^0_{sus}$ for cracked concrete valid for all drilling method** | | | | | | | | |
| Sustained load factor temperature range -40°C / +40°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | |
| Sustained load factor temperature range -40°C / +55°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | |
| Sustained load factor temperature range -40°C / +80°C | $\psi^0_{sus}$ | [-] | 0,73 | | | | | |
| Increasing factor for cracked concrete related to strength $f_{ck}$ | $\psi_c$ | [-] | 1,00 | | | | | |
| **Concrete cone failure** | | | | | | | | |
| Factor for cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | |
| Edge distance | $C_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | |
| Spacing | $S_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | |
| **Splitting failure** | | | | | | | | |
| Spacing | $S_{cr,Nsp}$ | [mm] | If $h = h_{min}$<br>$S_{cr,Nsp} = 4{,}0 \cdot h_{ef}$<br>If $h_{min} < h < 2\ h_{ef}$<br><br>$S_{cr,Nsp}$ = interpolate values<br>if $h \geq 2\ h_{ef}$<br>$S_{cr,Nsp} = 2\ h_{ef}$ | | | | | |
| Edge distance | $C_{cr,Nsp}$ | [mm] | $0{,}5 \cdot S_{cr,sp}$ | | | | | |
| **Installation factor for combined pull-out, concrete cone and splitting failure** | | | | | | | | |
| Installation factors for category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | | | |
| Installation factors for category I2 | | | 1,2 | | | | | |

**Table C4: Characteristic values shear resistance load – non-cracked and cracked concrete for threaded rod under static and quasi-static loads for 50 and 100 years**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | See Annex C1 – Table C1 | | | | | | | |
| Partial factor | $\gamma_{Ms,V}$ | [-] | See Annex C1 – Table C1 | | | | | | | |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [kN] | See Annex C1 – Table C1 | | | | | | | |
| Partial factor | $\gamma_{Ms,V}$ | [-] | See Annex C1 – Table C1 | | | | | | | |
| **Concrete pry out failure** | | | | | | | | | | |
| Factor | $k_8$ | [-] | 2,0 | | | | | | | |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | |
| Effective length of anchor under shear loading | $l_f$ | [-] | $l_f = h_{ef}$ and $\leq 12\ d_{nom}$ | | | | | | $l_f = h_{ef}$ and $\leq$ max (8 $d_{nom}$; 300 mm) | |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |

**Table C5: Characteristic values tension resistance load in non-cracked concrete for rebar under static and quasi-static loads for 50 and 100 years**

| **Size** | | | **Ø8** | **Ø10** | **Ø12** | **Ø14** | **Ø16** | **Ø20** | **Ø22** | **Ø25** | **Ø28** | **Ø30** | **Ø32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s$ x $f_{uk}$ 2) | | | | | | | | | | |
| Cross section area | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 380 | 491 | 616 | 707 | 804 |
| Partial factor | $\gamma_{Ms,N}$ 1) | [-] | 1,4 | | | | | | | | | | |
| **Combined pull-out and concrete cone failure in non-cracked concrete C20/25 for HD – HBD and CA** | | | | | | | | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,ucr}$ | [N/mm²] | 15,0 | 15,0 | 15,0 | 14,0 | 14,0 | 13,0 | 13,0 | 12,0 | 12,0 | 12,0 | 10,0 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,ucr}$ | [N/mm²] | 15,0 | 15,0 | 15,0 | 14,0 | 14,0 | 13,0 | 13,0 | 12,0 | 12,0 | 12,0 | 10,0 |
| Characteristic bond resistance temperature range -40°C / +120°C | $\tau_{Rk,ucr}$ | [N/mm²] | 10,0 | 10,0 | 10,0 | 10,0 | 10,0 | 9,5 | 9,0 | 9,0 | 9,0 | 9,0 | 7,5 |
| **Reduction factor $\psi^0_{sus}$ for cracked concrete valid for all drilling method** | | | | | | | | | | | | | |
| Sustained load factor temperature range -40°C / +40°C | $\psi^0_{sus}$ | | 0,73 | | | | | | | | | | |
| Sustained load factor temperature range -40°C / +55°C | $\psi^0_{sus}$ | | 0,73 | | | | | | | | | | |
| Sustained load factor temperature range -40°C / +80°C | $\psi^0_{sus}$ | | 0,73 | | | | | | | | | | |
| Increasing factor for non-cracked concrete related to strength $f_{ck}$ | $\psi_c$ | [-] | $(f_{ck}/20)^{0,2}$ | | | | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | | | |
| Factor for non-cracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | | | | |
| Edge distance | $C_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | | | | | | |
| Spacing | $S_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | | | | | | |
| **Splitting failure** | | | | | | | | | | | | | |
| Spacing | $S_{cr,Nsp}$ | [mm] | If h = $h_{min}$ | | | | | | | | | | |
| | | | $S_{cr,Nsp}$ = 4,0·$h_{ef}$ | | | | | | | | | | |
| | | | If $h_{min}$ < h < 2 $h_{ef}$ | | | | | | | | | | |
| | | |   $S_{cr,Nsp}$ = interpolate values | | | | | | | | | | |
| | | | if h ≥ 2 $h_{ef}$ | | | | | | | | | | |
| | | | $S_{cr,Nsp}$ = 2 $h_{ef}$ | | | | | | | | | | |
| Edge distance | $C_{cr,Nsp}$ | [mm] | 0,5 · $S_{cr,sp}$ | | | | | | | | | | |
| **Installation factor for combined pull-out, concrete cone and splitting failure** | | | | | | | | | | | | | |
| Installation factors for category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | | |
| Installation factors for category I2 | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | | | | |

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

**Table C6: Characteristic values shear resistance load – non-cracked concrete for rebar under static and quasi-static loads for 50 and 100 years**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø22 | Ø25 | Ø28 | Ø30 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | $0,5 \times A_s \times f_{uk}$ 2) | | | | | | | | | | |
| Partial factor | $\gamma_{Ms,V}$ 1) | [-] | 1,5 | | | | | | | | | | |
| Cross section area | $A_s$ | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 380 | 491 | 616 | 707 | 804 |
| Ductility factor | $k_7$ | [-] | 1,0 | | | | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [kN] | $1,2 \times W_{el} \times f_{uk}$ 2) | | | | | | | | | | |
| Elastic section modulus | $W_{el}$ | [mm³] | 50 | 98 | 170 | 269 | 402 | 785 | 1045 | 1534 | 2155 | 2650 | 3217 |
| Partial factor | $\gamma_{Ms,V}$ 1) | [-] | 1,5 | | | | | | | | | | |
| **Concrete pry out failure** | | | | | | | | | | | | | |
| Factor | $k_8$ | [-] | 2,0 | | | | | | | | | | |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | | | | |
| Effective length of anchor under shear loading | $l_f$ | [-] | $l_f = h_{ef}$ and $\leq 12\ d_{nom}$ | | | | | | | $l_f = h_{ef}$ and $\leq \max (8\ d_{nom}; 300\ mm)$ | | | |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | | | |

**Table C7. Displacement under tension loads for non-cracked concrete – threaded rods under static and quasi-static loads for hammer drilling (HD), hollow drill bit (HDB) and compressed air drilling (CA)**

| **Size** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in non-cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | | |
| Temperature range -40°C / +40°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,01 | 0,02 | 0,03 | 0,03 | 0,03 | 0,03 | 0,04 | 0,05 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,05 | 0,05 |
| Temperature range -40°C / +55°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,01 | 0,02 | 0,03 | 0,03 | 0,03 | 0,03 | 0,04 | 0,05 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Temperature range -40°C / +80°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,02 | 0,03 | 0,04 | 0,04 | 0,04 | 0,05 | 0,06 | 0,07 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,06 | 0,06 | 0,06 | 0,07 | 0,07 | 0,07 | 0,07 | 0,07 |

**Table C8: Displacement under tension loads for -cracked concrete – threaded rods under static and quasi-static loads for hammer drilling (HD), hollow drill bit (HDB) and compressed air drilling (CA)**

| **Size** | | | **M12** | **M16** | **M20** | **M24** |
|---|---|---|---|---|---|---|
| **Characteristic displacement in -cracked concrete C20/25 to C50/60 under tension loads** | | | | | | |
| Temperature range -40°C / +40°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,06 | 0,06 | 0,06 | 0,07 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,26 | 0,24 | 0,26 | 0,23 |
| Temperature range -40°C / +55°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,06 | 0,06 | 0,06 | 0,07 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,26 | 0,24 | 0,26 | 0,23 |
| Temperature range -40°C / +80°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,07 | 0,08 | 0,08 | 0,09 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,33 | 0,33 | 0,33 | 0,33 |

**Table C9. Displacement under tension loads for non-cracked concrete – threaded rods under static and quasi-static loads for diamond drilling (DD)**

| **Size** | | | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|
| **Characteristic displacement in non-cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | |
| Temperature range -40°C / +40°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,02 | 0,03 | 0,03 | 0,03 | 0,04 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Temperature range -40°C / +55°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,02 | 0,03 | 0,03 | 0,04 | 0,04 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 |
| Temperature range -40°C / +80°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,03 | 0,04 | 0,04 | 0,05 | 0,05 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,07 | 0,07 | 0,07 | 0,08 | 0,08 |

**Table C10. Displacement under tension loads for -cracked concrete – threaded rods under static and quasi-static loads for diamond drilling (DD)**

| Size | | | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|
| **Characteristic displacement in -cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | |
| Temperature range -40°C / +40°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,07 | 0,07 | 0,08 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,25 | 0,26 | 0,26 | 0,26 | 0,028 |
| Temperature range -40°C / +55°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,07 | 0,07 | 0,08 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,25 | 0,26 | 0,26 | 0,26 | 0,28 |
| Temperature range -40°C / +80°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,07 | 0,08 | 0,09 | 0,10 | 0,11 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,34 | 0,37 | 0,37 | 0,37 | 0,41 |

**Table C11: Displacement under shear loads for non-cracked and cracked concrete – threaded rods under static and quasi-static loads for all drilling method.**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in cracked and non-cracked concrete C20/25 to C50/60 under shear loads** | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$ factor | [mm/kN] | 0,024 | 0,020 | 0,019 | 0,011 | 0,007 | 0,006 | 0,005 | 0,005 |
| | $\delta_{V\infty}$ factor | [mm/kN] | 0,036 | 0,030 | 0,030 | 0,017 | 0,011 | 0,009 | 0,007 | 0,008 |

**Table C12: Displacement under tension loads for non-cracked concrete – rebar under static and quasi-static loads.**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø22 | Ø25 | Ø28 | Ø30 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in non-cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | | | | | |
| Temperature range -40°C / +40°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,04 | 0,04 | 0,05 | 0,06 | 0,06 | 0,07 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 | 0,06 | 0,06 |
| Temperature range -40°C / +55°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,02 | 0,02 | 0,03 | 0,03 | 0,03 | 0,04 | 0,04 | 0,05 | 0,06 | 0,06 | 0,07 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,06 | 0,06 | 0,06 | 0,06 |
| Temperature range -40°C / +80°C | $\delta_{N0}$ | [mm/(N/mm$^2$)] | 0,03 | 0,00 | 0,04 | 0,04 | 0,04 | 0,06 | 0,06 | 0,06 | 0,08 | 0,09 | 0,09 |
| | $\delta_{N\infty}$ | [mm/(N/mm$^2$)] | 0,07 | 0,07 | 0,07 | 0,07 | 0,07 | 0,08 | 0,08 | 0,08 | 0,09 | 0,09 | 0,09 |

**Table C13: Displacement under shear loads for non-cracked concrete – rebar under static and quasi-static loads.**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø22 | Ø25 | Ø28 | Ø30 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in non-cracked concrete C20/25 to C50/60 under shear loads** | | | | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$ factor | [mm/kN] | 0,018 | 0,014 | 0,013 | 0,009 | 0,008 | 0,006 | 0,005 | 0,004 | 0,004 | 0,004 | 0,003 |
| | $\delta_{V\infty}$ factor | [mm/kN] | 0,027 | 0,022 | 0,019 | 0,014 | 0,012 | 0,009 | 0,008 | 0,006 | 0,006 | 0,005 | 0,005 |

**Table C14: Characteristic values tension resistance load for threaded rod for seismic performance category C2 for 50 and 100 years**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Characteristic resistance | $N_{Rk,s,eq,C2}$ | [kN] | 1,0 x $N_{Rk,s}$ | | | |
| Partial factor | $\gamma_{Ms,N}$ | [-] | See Annex C1 – Table C1 | | | |
| **Combined pull-out and concrete cone failure** | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,C2}$ | [N/mm²] | 5,4 | 5,3 | 5,5 | 5,4 |
| Characteristic bond resistance temperature range -40°C / +55°C | $\tau_{Rk,C2}$ | [N/mm²] | 5,4 | 5,2 | 5,5 | 5,4 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,C2}$ | [N/mm²] | 3,9 | 3,8 | 3,9 | 3,9 |
| Increasing factor related to concrete strength $f_{ck}$ | $\psi_c$ | [-] | 1,0 | | | |
| Installation factors for category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | |
| Installation factors for category I2 | | | 1,2 | | | |

**Table C15: Characteristic values shear resistance load for threaded rod for seismic performance category C2 for 50 and 100 years**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Characteristic resistance | $V_{Rk,s,eq,C2}$ | [kN] | 0,54 x $V^0_{Rk,s}$ | 0,55 x $V^0_{Rk,s}$ | 0,68 x $V^0_{Rk,s}$ | 0,59 x $V^0_{Rk,s}$ |
| Partial factor [1)] | $\gamma_{Ms,V}$ | [-] | See Annex C1 – Table C1 | | | |

**Table C16: Reduction factor for annular gap.**

| **Reduction factor for annular gap** | | | |
|---|---|---|---|
| Without annular gap filling | $\alpha_{gap}$ | [-] | 0,5 |
| With annular gap filling | $\alpha_{gap}$ | [-] | 1,0 |

**Table C17: Displacements for tensile and shear load for seismic performance category C2 - threaded rod.**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Displacements for tensile and shear load for seismic performance category C2** | | | | | | |
| Displacement in tensile at damage limitation states | $\delta_{N,eq,seis (DLS)}$ | [mm] | 0,22 | 0,27 | 0,92 | 0,54 |
| Displacement in tensile at ultimate limit state | $\delta_{N,eq,seis (ULS)}$ | [mm] | 0,28 | 0,66 | 1,70 | 0,93 |
| Displacement in shear at damage limitation states | $\delta_{V,eq,seis (DLS)}$ | [mm] | 4,60 | 4,57 | 2,39 | 2,21 |
| Displacement in shear at ultimate limit state | $\delta_{V,eq,seis (ULS)}$ | [mm] | 8,27 | 9,26 | 7,29 | 7,42 |