

## DECLARATION OF PERFORMANCE

### DoP 0299

for UPAT injection system UPM 55 (Bonded fastener for use in concrete)

EN

1. Unique identification code of the product-type: DoP 0299
2. Intended use/es: Post-installed fastening for use in cracked or uncracked concrete, see appendix, especially annexes B1 - B11.
3. Manufacturer: fischerwerke GmbH & Co. KG, Otto-Hahn-Straße 15, 79211 Denzlingen, Germany
4. Authorised representative: -
5. System/s of AVCP: 1
6. European Assessment Document: ETAG 001, Part 5, April 2013, used as EAD  
 European Technical Assessment: ETA-11/0418; 2016-09-30  
 Technical Assessment Body: DIBt- Deutsches Institut für Bautechnik  
 Notified body/ies: 2873 TU Darmstadt
7. Declared performance/s:  
**Mechanical resistance and stability (BWR 1)**  
**Characteristic resistance to tension load (static and quasi-static loading):**  
 Resistance to steel failure: Annexes C1-C3  
 Resistance to combined pull- out and concrete cone failure: Annexes C5-C8  
 Resistance to concrete cone failure: Annex C4  
 Edge distance to prevent splitting under load: Annex C4  
 Robustness: Annexes C4-C8  
 Maximum installation torque: Annexes B3, B4, B6  
 Minimum edge distance and spacing: Annexes B3-B6  
 $\psi_{sus}^0 = \text{NPD}$   
**Characteristic resistance to shear load (static and quasi-static loading):**  
 Resistance to steel failure: Annexes C1-C3  
 Resistance to pry-out failure: Annex C4  
 Resistance to concrete edge failure: Annex C4  
 $(k_7=k_2)$   
 $(k_8=k_3)$   
**Displacements under short-term and long-term loading:**  
 Displacements under short-term and long-term loading: Annexes C9, C10  
**Characteristic resistance and displacements for seismic performance categories C1 and C2:**  
 Resistance to tension load, displacements, category C1: Annexes C11-C13  
 Resistance to tension load, displacements, category C2: Annexes C11, C14  
 Resistance to shear load, displacements, category C1: Annexes C11, C12  
 Resistance to shear load, displacements, category C2: Annexes C11, C14  
 Factor for annular gap: NPD  
**Hygiene, health and the environment (BWR 3)**  
 Content, emission and/or release of dangerous substances: NPD
8. Appropriate Technical Documentation and/or Specific Technical Documentation: -

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:



Dr.-Ing. Oliver Geibig, Managing Director Business Units & Engineering  
 Tümlingen, 2021-01-19



Jürgen Grün, Managing Director Chemistry & Quality

This DoP has been prepared in different languages. In case there is a dispute on the interpretation the English version shall always prevail.

The Appendix includes voluntary and complementary information in English language exceeding the (language-neutrally specified) legal requirements.

## Specific Part

### 1 Technical description of the product

The UPAT injection system UPM 55 is a bonded anchor consisting of a cartridge with injection mortar UPM 55 and a steel element.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

### 2 Specification of the intended use in accordance with the applicable European Assessment Document

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 verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, 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.

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

#### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic                                                                                                          | Performance            |
|-----------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Characteristic values under static and quasi-static action for design according to TR 029 or CEN/TS 1992-4:2009, Displacements    | See Annex C 1 to C 10  |
| Characteristic values for seismic performance categories C1 and C2 for design according to Technical Report TR 045, Displacements | See Annex C 11 to C 14 |

#### 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance                                 |
|--------------------------|---------------------------------------------|
| Reaction to fire         | Anchorage satisfy requirements for Class A1 |
| Resistance to fire       | No performance assessed                     |

#### 3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

#### 3.4 Safety in use (BWR 4)

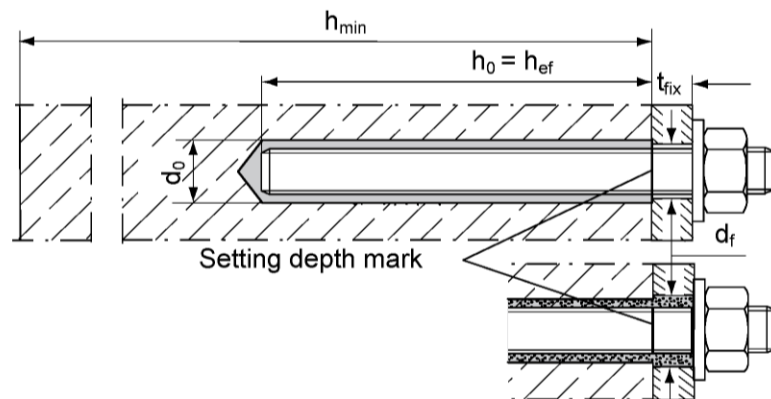
The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

#### **4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base**

In accordance with guideline for European technical approval ETAG 001, April 2013 used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

## Installation conditions

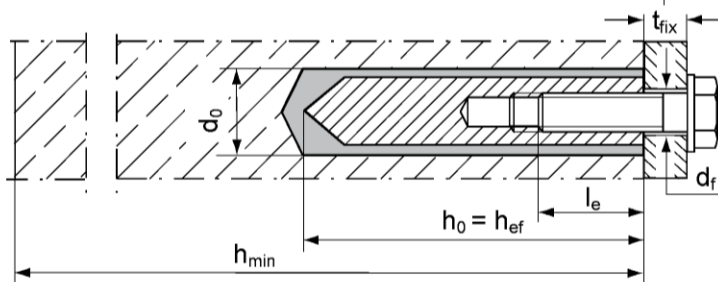


### Anchor rod

Pre-positioned anchor

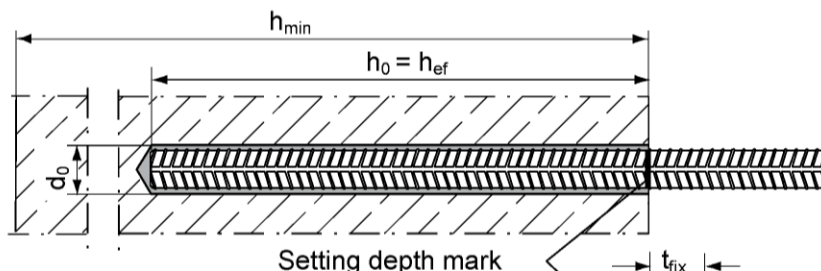
### Anchor rod

Push through anchor  
(annular gap filled with mortar)

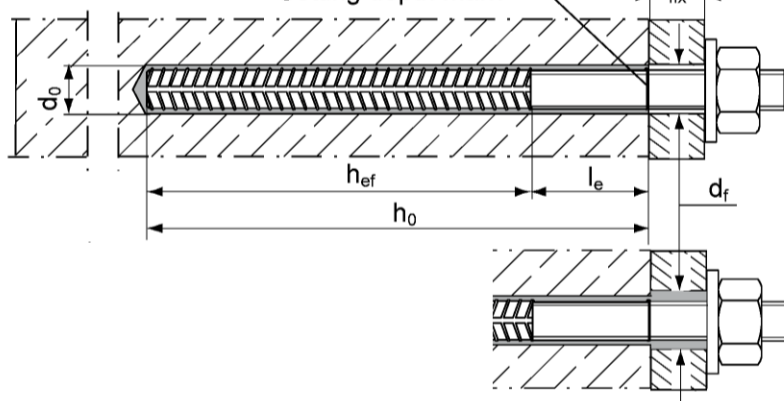


### Internal threaded anchor IST

Pre-positioned anchor only



### Reinforcing bar



### UPAT rebar anchor

Pre-positioned anchor

### UPAT rebar anchor

Push through anchor  
(annular gap filled with mortar)

UPAT injection system UPM 55

**Product description**  
Installation conditions

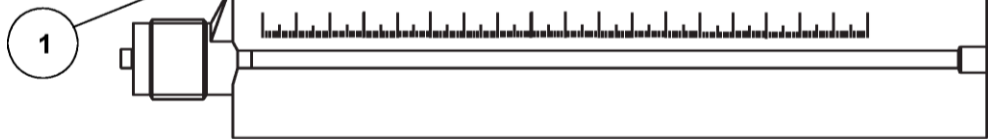
**Annex A 1**

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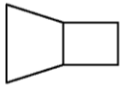
**Cartridge sizes (390 ml, 585 ml, 1100 ml, 1500 ml)**

**Imprint:** UPM 55, processing notes, shelf-life, piston travel scale, curing times and processing times (depending on temperature), hazard code, size, volume

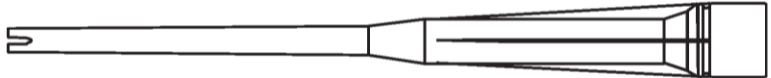
**Sealing cap**



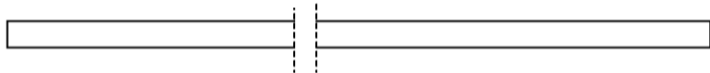
**Injection-adapter**



**Static mixer UPM**

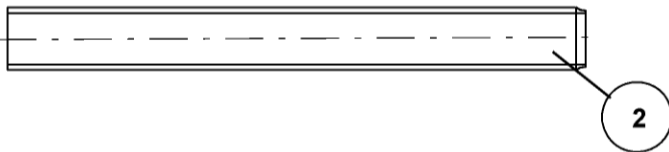


**Extension tube**

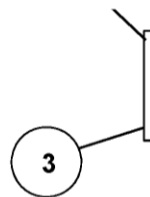


**Anchor rod**

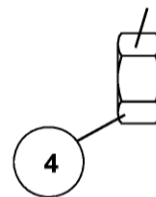
Size: M8, M10, M12, M14, M16, M20, M22, M24, M27, M30



**Washer**

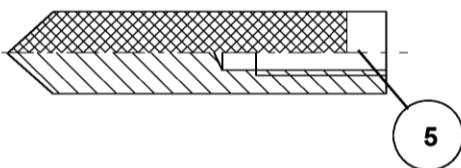


**Hexagon nut**

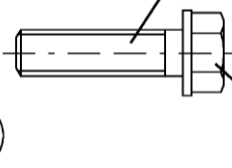


**Internal threaded anchor IST**

Size: M8, M10, M12, M16, M20



**Screw**



**Threaded rod**



**Washer**

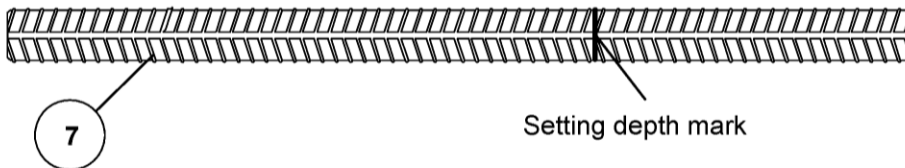


**Hexagon nut**



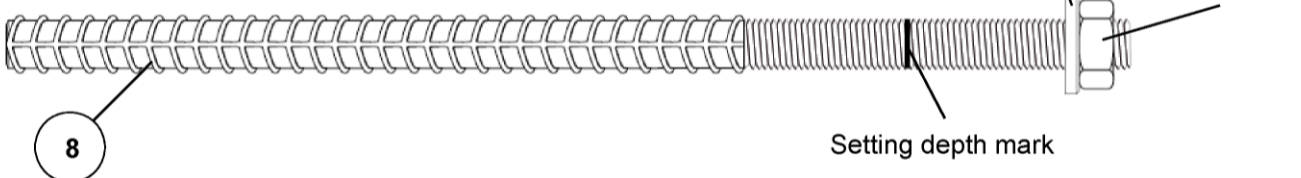
**Reinforcing bar**

Nominal diameter of the bar:  $\phi 8$ ,  $\phi 10$ ,  $\phi 12$ ,  $\phi 14$ ,  $\phi 16$ ,  $\phi 18$ ,  $\phi 20$ ,  $\phi 22$ ,  $\phi 24$ ,  $\phi 25$ ,  $\phi 26$ ,  $\phi 28$ ,  $\phi 30$ ,  $\phi 32$ ,  $\phi 34$ ,  $\phi 36$ ,  $\phi 40$



**UPAT rebar anchor**

Size: M12, M16, M20, M24



UPAT injection system UPM 55

**Product description**

Cartridges / Static mixer / Steel elements

**Annex A 2**

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**Table A1: Materials**

| Part | Designation                                                     | Material                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                             |
|------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Mortar cartridge                                                | Mortar, hardener, filler                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                             |
|      | Steel grade                                                     | Steel, zinc plated                                                                                                                                                                                                                                     | Stainless steel A4                                                                                                                                                                                                                              | High corrosion resistant steel C                                                                                                                                                                                                            |
| 2    | Anchor rod                                                      | Property class 5.8 or 8.8;<br>EN ISO 898-1:2013<br>zinc plated $\geq 5 \mu\text{m}$ ,<br>EN ISO 4042:1999 A2K<br>or hot-dip galvanised<br>EN ISO 10684:2004<br>$f_{uk} \leq 1000 \text{ N/mm}^2$<br>$A_5 > 12 \%$<br>fracture elongation <sup>1)</sup> | Property class 50, 70 or 80<br>EN ISO 3506-1:2009<br>1.4401; 1.4404; 1.4578;<br>1.4571; 1.4439; 1.4362;<br>1.4062, 1.4662, 1.4462<br>EN 10088-1:2014<br>$f_{uk} \leq 1000 \text{ N/mm}^2$<br>$A_5 > 12 \%$<br>fracture elongation <sup>1)</sup> | Property class 50 or 80<br>EN ISO 3506-1:2009<br>or property class 70 with<br>$f_{yk} = 560 \text{ N/mm}^2$<br>1.4565; 1.4529<br>EN 10088-1:2014<br>$f_{uk} \leq 1000 \text{ N/mm}^2$<br>$A_5 > 12 \%$<br>fracture elongation <sup>1)</sup> |
| 3    | Washer<br>ISO 7089:2000                                         | zinc plated $\geq 5 \mu\text{m}$ ,<br>EN ISO 4042:1999 A2K<br>or hot-dip galvanised<br>EN ISO 10684:2004                                                                                                                                               | 1.4401; 1.4404;<br>1.4578; 1.4571; 1.4439;<br>1.4362<br>EN 10088-1:2014                                                                                                                                                                         | 1.4565; 1.4529<br>EN 10088-1:2014                                                                                                                                                                                                           |
| 4    | Hexagon nut                                                     | Property class 5 or 8;<br>EN ISO 898-2:2012<br>zinc plated $\geq 5 \mu\text{m}$ ,<br>ISO 4042:1999 A2K<br>or hot-dip galvanised<br>EN ISO 10684:2004                                                                                                   | Property class 50, 70 or 80<br>EN ISO 3506-1:2009<br>1.4401; 1.4404; 1.4578;<br>1.4571; 1.4439; 1.4362<br>EN 10088-1:2014                                                                                                                       | Property class 50, 70 or 80<br>EN ISO 3506-1:2009<br>1.4565; 1.4529<br>EN 10088-1:2014                                                                                                                                                      |
| 5    | internal threaded anchor IST                                    | Property class 5.8<br>ISO 898-1:2013<br>zinc plated $\geq 5 \mu\text{m}$ ,<br>ISO 4042:1999 A2K                                                                                                                                                        | Property class 70<br>EN ISO 3506-1:2009<br>1.4401; 1.4404; 1.4578;<br>1.4571; 1.4439; 1.4362<br>EN 10088-1:2014                                                                                                                                 | Property class 70<br>EN ISO 3506-1:2009<br>1.4565; 1.4529<br>EN 10088-1:2014                                                                                                                                                                |
| 6    | Screw or anchor / threaded rod for internal threaded anchor IST | Property class 5.8 or 8.8;<br>EN ISO 898-1:2013<br>zinc plated $\geq 5 \mu\text{m}$ ,<br>ISO 4042:1999 A2K<br>fracture elongation<br>$A_5 > 8 \%$                                                                                                      | Property class 70<br>EN ISO 3506-1:2009<br>1.4401; 1.4404; 1.4578;<br>1.4571; 1.4439; 1.4362<br>EN 10088-1:2014<br>fracture elongation<br>$A_5 > 8 \%$                                                                                          | Property class 70<br>EN ISO 3506-1:2009<br>1.4565; 1.4529<br>EN 10088-1:2014<br>fracture elongation<br>$A_5 > 8 \%$                                                                                                                         |
| 7    | Reinforcing bar<br>EN 1992-1-1:2004 and<br>AC:2010, Annex C     | Bars and de-coiled rods, class B or C with<br>$f_{yk}$ and $k$ according to NDP or NCL of EN 1992-1-1:2004+AC:2010<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$                                                                                               |                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                             |
| 8    | UPAT rebar anchor                                               | Rebar part:<br>Bars and de-coiled rods class B or C<br>with $f_{yk}$ and $k$ according to NDP or NCL<br>of EN 1992-1-1:2004+AC:2010<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$                                                                              | Threaded part:<br>Property class 70 or 80<br>EN ISO 3506-1:2009<br>1.4565; 1.4529, 1.4401, 1.4404, 1.4571,<br>1.4578, 1.4439, 1.4362, 1.4062<br>EN 10088-1:2014                                                                                 |                                                                                                                                                                                                                                             |

<sup>1)</sup> Fracture elongation  $A_5 > 8 \%$  for applications without requirements for seismic performance

UPAT injection system UPM 55

**Product description**  
Materials

**Annex A 3**

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## Specifications of intended use (part 1)

**Table B1:** Overview use and performance categories

| Anchorages subject to                                                                                                                                                    |                      | UPM 55 with ...                                                                   |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------------------|-------------------------|------------------------------------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------|-------------------------|
|                                                                                                                                                                          |                      | Anchor rod                                                                        |                         | internal threaded anchor RG MI                                                    |                         | Reinforcing bar                                                                    |                         | UPAT rebar anchor                                                                   |                         |
|                                                                                                                                                                          |                      |  |                         |  |                         |  |                         |  |                         |
| Hammer drilling with standard drill bit                                                 |                      | all sizes                                                                         |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| Hammer drilling with hollow drill bit (Heller "Duster Expert" or Hilti "TE-CD, TE-YD")  |                      | Nominal drill bit diameter (d <sub>0</sub> ) 12 mm to 35 mm                       |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| Diamond drilling                                                                        |                      | all sizes                                                                         |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| Static and quasi static load, in                                                                                                                                         | uncracked concrete   | all sizes                                                                         | Tables: C1, C5, C6, C10 | all sizes                                                                         | Tables: C2, C5, C7, C11 | all sizes                                                                          | Tables: C3, C5, C8, C12 | all sizes                                                                           | Tables: C4, C5, C9, C13 |
|                                                                                                                                                                          | cracked concrete     |                                                                                   |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| Seismic performance category (only hammer drilling with Standard / hollow drill bits)                                                                                    | C1                   | M10 to M30                                                                        | Tables: C14, C16, C17   | ---                                                                               |                         | φ10 to φ32                                                                         | Tables: C15, C16, C18   | ---                                                                                 |                         |
|                                                                                                                                                                          | C2                   | M12, M16, M20, M24                                                                | Tables: C14, C16, C19   |                                                                                   |                         | ---                                                                                | ---                     |                                                                                     |                         |
| Use category                                                                                                                                                             | dry or wet concrete  | all sizes                                                                         |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
|                                                                                                                                                                          | flooded hole         | all sizes                                                                         |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| Installation temperature                                                                                                                                                 |                      | +5 °C to +40 °C                                                                   |                         |                                                                                   |                         |                                                                                    |                         |                                                                                     |                         |
| In-service temperature                                                                                                                                                   | Temperature range I  | -40 °C to +60 °C                                                                  |                         | (max. long term temperature +35 °C and max. short term temperature +60 °C)        |                         |                                                                                    |                         |                                                                                     |                         |
|                                                                                                                                                                          | Temperature range II | -40 °C to +72 °C                                                                  |                         | (max. long term temperature +50 °C and max. short term temperature +72 °C)        |                         |                                                                                    |                         |                                                                                     |                         |

UPAT injection system UPM 55

**Intended Use**  
Specifications (part 1)

**Annex B 1**

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## Specifications of intended use (part 2)

### Base materials:

- Reinforced or unreinforced normal weight concrete Strength classes C20/25 to C50/60 according to EN 206-1:2000

### Use conditions (Environmental conditions):

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

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

### Design:

- Anchorages have to be designed by a responsible engineer with experience of concrete anchor design
- Verifiable calculation notes and drawings are to be 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 under static or quasi-static actions are designed in accordance with EOTA Technical Report TR 029 "Design of bonded anchors" Edition September 2010 or CEN/TS 1992-4:2009
- Anchorages under seismic actions (cracked concrete) have to be designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure
  - Fastenings in stand-off installation or with a grout layer are not allowed

### Installation:

- Anchor installation is to be carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site
- In case of aborted hole: The hole shall be filled with mortar
- Anchorage depth should be marked and adhered to on installation
- Overhead installation is allowed

UPAT injection system UPM 55

**Intended Use**  
Specifications (part 2)

**Annex B 2**

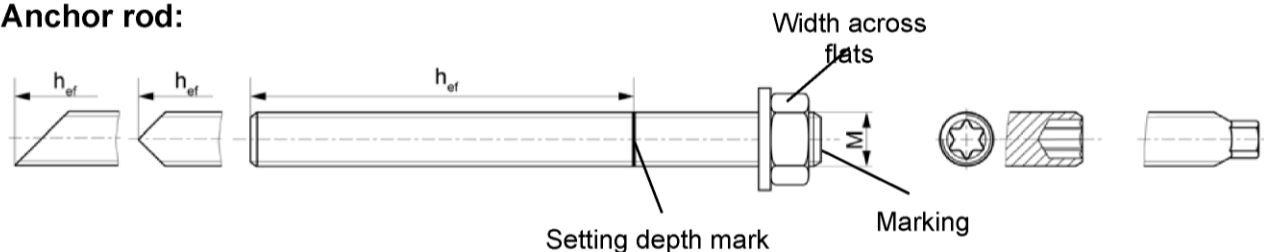
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**Table B2: Installation parameters for anchor rods**

| Size                                                    |                                | M8                              | M10 | M12 | M14             | M16 | M20 | M22 | M24 | M27 | M30 |
|---------------------------------------------------------|--------------------------------|---------------------------------|-----|-----|-----------------|-----|-----|-----|-----|-----|-----|
| Width across flats                                      | SW                             | 13                              | 17  | 19  | 22              | 24  | 30  | 32  | 36  | 41  | 46  |
| Nominal drill bit diameter                              | $d_0$                          | 12                              | 14  | 14  | 16              | 18  | 24  | 25  | 28  | 30  | 35  |
| Drill hole depth                                        | $h_0$                          | $h_0 = h_{ef}$                  |     |     |                 |     |     |     |     |     |     |
| Effective anchorage depth                               | $h_{ef,min}$                   | 60                              | 60  | 70  | 75              | 80  | 90  | 93  | 96  | 108 | 120 |
|                                                         | $h_{ef,max}$                   | 160                             | 200 | 240 | 280             | 320 | 400 | 440 | 480 | 540 | 600 |
| Minimum spacing and minimum edge distance               | $s_{min} = c_{min}$            | 40                              | 45  | 55  | 60              | 65  | 85  | 95  | 105 | 120 | 140 |
| Diameter of clearance hole in the fixture <sup>1)</sup> | pre-positioned anchorage $d_f$ | 9                               | 12  | 14  | 16              | 18  | 22  | 24  | 26  | 30  | 33  |
|                                                         | push through anchorage $d_f$   | 14                              | 16  | 16  | 18              | 20  | 26  | 28  | 30  | 33  | 40  |
| Minimum thickness of concrete member                    | $h_{min}$                      | $h_{ef} + 30$<br>( $\geq 100$ ) |     |     | $h_{ef} + 2d_0$ |     |     |     |     |     |     |
| Maximum installation torque                             | $T_{inst,max}$ [Nm]            | 10                              | 20  | 40  | 50              | 60  | 120 | 135 | 150 | 200 | 300 |

<sup>1)</sup> For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

### Anchor rod:



### Marking (on random place):

Property class 8.8, stainless steel, property class 80 or high corrosion resistant steel, property class 80: •  
 Stainless steel A4, property class 50 and high corrosion resistant steel, property class 50: ••  
 Or colour coding according to DIN 976-1

### Commercial standard threaded rods, washers and hexagon nuts may also be used if the following requirements are fulfilled:

- Materials, dimensions and mechanical properties according Annex A 3, Table A1
- Inspection certificate 3.1 according to EN 10204:2004, the documents have to be stored
- Setting depth is marked

UPAT injection system UPM 55

### Intended Use

Installation parameters anchor rods

## Annex B 3

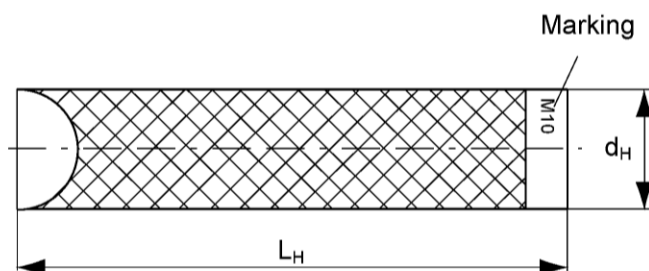
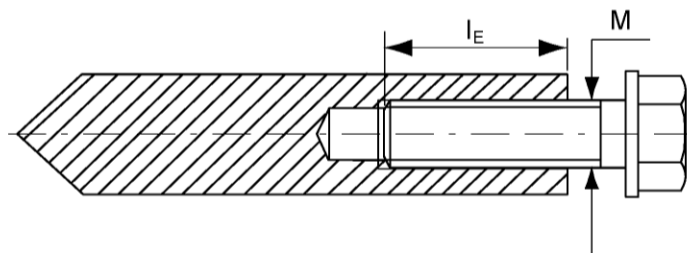
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**Table B3:** Installation parameters for internal threaded anchors IST

| Size                                                       |                     | M8             | M10 | M12 | M16 | M20 |
|------------------------------------------------------------|---------------------|----------------|-----|-----|-----|-----|
| Diameter of anchor                                         | $d_H$               | 12             | 16  | 18  | 22  | 28  |
| Nominal drill bit diameter                                 | $d_0$               | 14             | 18  | 20  | 24  | 32  |
| Drill hole depth                                           | $h_0$               | $h_0 = h_{ef}$ |     |     |     |     |
| Effective anchorage depth<br>( $h_{ef} = L_H$ )            | $h_{ef}$            | 90             | 90  | 125 | 160 | 200 |
| Minimum spacing and<br>minimum edge distance               | $s_{min} = c_{min}$ | 55             | 65  | 75  | 95  | 125 |
| Diameter of clearance hole in<br>the fixture <sup>1)</sup> | $d_f$               | 9              | 12  | 14  | 18  | 22  |
| Minimum thickness<br>of concrete member                    | $h_{min}$           | 120            | 125 | 165 | 205 | 260 |
| Maximum screw-in depth                                     | $l_{E,max}$         | 18             | 23  | 26  | 35  | 45  |
| Minimum screw-in depth                                     | $l_{E,min}$         | 8              | 10  | 12  | 16  | 20  |
| Maximum installation torque                                | $T_{inst,max}$ [Nm] | 10             | 20  | 40  | 80  | 120 |

<sup>1)</sup> For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

### Internal threaded anchor IST



**Marking:** Anchor size

e.g.: **M10**

Stainless steel additional **A4**

e.g.: **M10 A4**

High corrosion resistant steel

additional **C**

e.g.: **M10 C**

Retaining bolt or threaded rods (including nut and washer) must comply with the appropriate material and strength class of Annex A 3, Table A1

UPAT injection system UPM 55

#### Intended Use

Installation parameters internal threaded anchors IST

**Annex B 4**

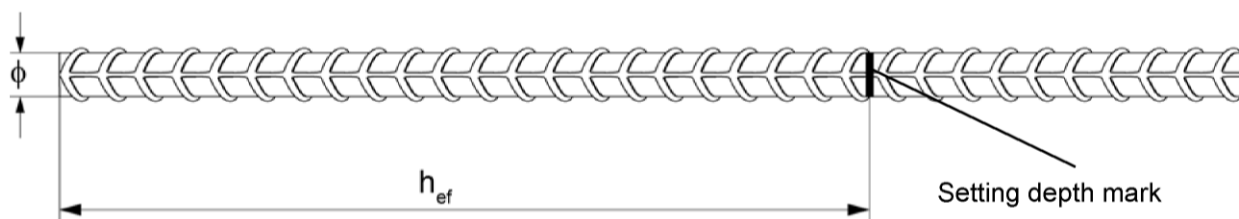
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**Table B4:** Installation parameters for reinforcing bars

| Nominal diameter of the bar               |                     | $\phi$                            | 8 <sup>1)</sup>                  |     | 10 <sup>1)</sup> |                                   | 12 <sup>1)</sup> |     | 14  | 16  | 18  | 20  | 22  | 24 |
|-------------------------------------------|---------------------|-----------------------------------|----------------------------------|-----|------------------|-----------------------------------|------------------|-----|-----|-----|-----|-----|-----|----|
| Nominal drill bit diameter                | d <sub>0</sub>      | [mm]                              | 10                               | 12  | 12               | 14                                | 14               | 16  | 18  | 20  | 25  | 25  | 30  | 30 |
| Drill hole depth                          | h <sub>0</sub>      |                                   | h <sub>0</sub> = h <sub>ef</sub> |     |                  |                                   |                  |     |     |     |     |     |     |    |
| Effective anchorage depth                 | h <sub>ef,min</sub> |                                   | 60                               | 60  |                  | 70                                |                  | 75  | 80  | 85  | 90  | 94  | 98  |    |
|                                           | h <sub>ef,max</sub> |                                   | 160                              | 200 |                  | 240                               |                  | 280 | 320 | 360 | 400 | 440 | 480 |    |
| Minimum spacing and minimum edge distance | s <sub>min</sub>    |                                   | 40                               | 45  | 55               | 60                                | 65               | 75  | 85  | 95  | 105 |     |     |    |
|                                           | c <sub>min</sub>    |                                   |                                  |     |                  |                                   |                  |     |     |     |     |     |     |    |
| Minimum thickness of concrete member      | h <sub>min</sub>    | h <sub>ef</sub> + 30<br>(≥ 100)   |                                  |     |                  | h <sub>ef</sub> + 2d <sub>0</sub> |                  |     |     |     |     |     |     |    |
|                                           |                     |                                   |                                  |     |                  |                                   |                  |     |     |     |     |     |     |    |
| Nominal diameter of the bar               |                     | $\phi$                            | 25                               | 26  | 28               | 30                                | 32               | 34  | 36  | 40  | --- |     |     |    |
| Nominal drill bit diameter                | d <sub>0</sub>      | [mm]                              | 30                               | 35  | 35               | 40                                | 40               | 40  | 45  | 55  | --- |     |     |    |
| Drill hole depth                          | h <sub>0</sub>      |                                   | h <sub>0</sub> = h <sub>ef</sub> |     |                  |                                   |                  |     |     |     |     |     |     |    |
| Effective anchorage depth                 | h <sub>ef,min</sub> |                                   | 100                              | 104 | 112              | 120                               | 128              | 136 | 144 | 160 | --- |     |     |    |
|                                           | h <sub>ef,max</sub> |                                   | 500                              | 520 | 560              | 600                               | 640              | 680 | 720 | 800 | --- |     |     |    |
| Minimum spacing and minimum edge distance | s <sub>min</sub>    |                                   | 110                              | 120 | 130              | 140                               | 160              | 170 | 180 | 200 | --- |     |     |    |
|                                           | c <sub>min</sub>    |                                   |                                  |     |                  |                                   |                  |     |     |     |     |     |     |    |
| Minimum thickness of concrete member      | h <sub>min</sub>    | h <sub>ef</sub> + 2d <sub>0</sub> |                                  |     |                  |                                   |                  |     |     |     |     |     |     |    |

<sup>1)</sup> Both drill bit diameters can be used

### Reinforcing bar



- The minimum value of related rib area  $f_{R,min}$  must fulfil the requirements of EN 1992-1-1:2004+AC:2010
- The rib height must be within the range:  $0,05 \cdot \phi \leq h_{rib} \leq 0,07 \cdot \phi$   
( $\phi$  = Nominal diameter of the bar ,  $h_{rib}$  = rib height)

UPAT injection system UPM 55

**Intended Use**  
Installation parameters reinforcing bars

**Annex B 5**

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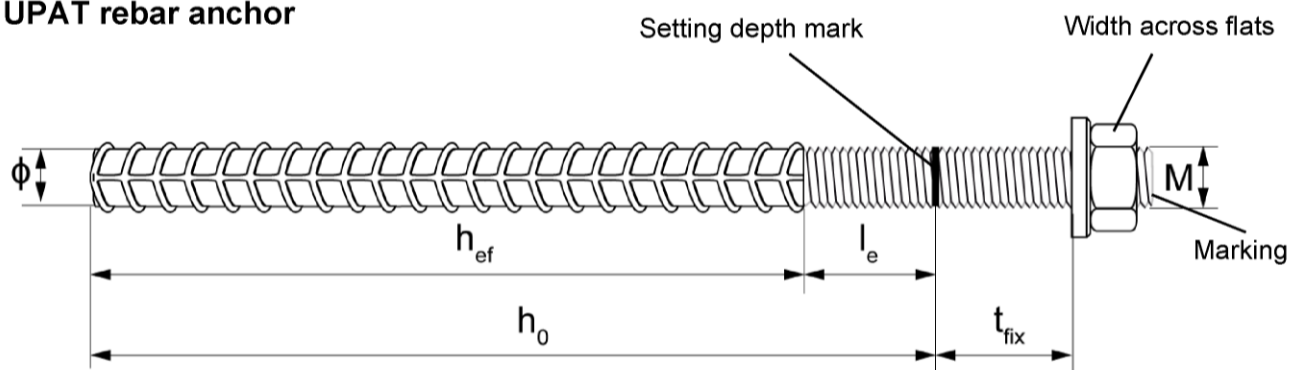
**Table B5: Installation parameters for UPAT rebar anchor**

| Size                                                    |                                     | M12 <sup>1)</sup>            |    | M16          | M20 | M24 |
|---------------------------------------------------------|-------------------------------------|------------------------------|----|--------------|-----|-----|
| Nominal diameter of the bar                             | $\phi$                              | 12                           |    | 16           | 20  | 25  |
| Width across flats                                      | SW                                  | 19                           |    | 24           | 30  | 36  |
| Nominal drill bit diameter                              | $d_0$                               | 14                           | 16 | 20           | 25  | 30  |
| Drill hole depth                                        | $h_0$                               | $h_{ef} + l_e$               |    |              |     |     |
| Effective anchorage depth                               | $h_{ef,min}$                        | 70                           |    | 80           | 90  | 96  |
|                                                         | $h_{ef,max}$                        | 140                          |    | 220          | 300 | 380 |
| Distance concrete surface to welded join                | $l_e$                               | 100                          |    |              |     |     |
|                                                         |                                     | [mm]                         |    |              |     |     |
| Minimum spacing and minimum edge distance               | $s_{min} = c_{min}$                 | 55                           |    | 65           | 85  | 105 |
| Diameter of clearance hole in the fixture <sup>2)</sup> | pre-positioned anchorage $\leq d_f$ | 14                           |    | 18           | 22  | 26  |
|                                                         | push through anchorage $\leq d_f$   | 18                           |    | 22           | 26  | 32  |
| Minimum thickness of concrete member                    | $h_{min}$                           | $h_0 + 30$<br>( $\geq 100$ ) |    | $h_0 + 2d_0$ |     |     |
| Maximum installation torque                             | $T_{inst,max}$                      | 40                           |    | 60           | 120 | 150 |
|                                                         |                                     | [Nm]                         |    |              |     |     |

<sup>1)</sup> Both drill bit diameters can be used

<sup>2)</sup> For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

### UPAT rebar anchor



Marking frontal e.g.: FRA (for stainless steel);  
FRA C (for high corrosion resistant steel)

UPAT injection system UPM 55

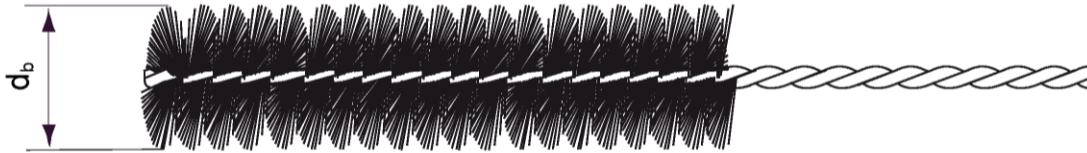
**Intended Use**  
Installation parameters UPAT rebar anchor

**Annex B 6**

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**Table B6: Parameters of steel brush BS / BSB Ø**

|                      |                | BS   |    |    |    |    |    |    |    |    |    |    | BSB |    |    |    |
|----------------------|----------------|------|----|----|----|----|----|----|----|----|----|----|-----|----|----|----|
| Drill bit diameter   | d <sub>0</sub> | [mm] | 12 | 14 | 16 | 18 | 20 | 24 | 25 | 28 | 30 | 32 | 35  | 40 | 45 | 55 |
| Steel brush diameter | d <sub>b</sub> |      | 14 | 16 | 20 |    | 25 | 26 | 27 | 30 | 40 |    |     | 42 | 47 | 58 |



**Table B7: Maximum processing time of the mortar and minimum curing time**  
 (During the curing time of the mortar the concrete temperature may not fall below the listed minimum temperature)

| System temperature<br>[°C] | Maximum processing time<br>$t_{work}$<br>[minutes] | Minimum curing time <sup>1)</sup><br>$t_{cure}$<br>[hours] |
|----------------------------|----------------------------------------------------|------------------------------------------------------------|
| +5 to +10                  | 120                                                | 40                                                         |
| ≥ +10 to +20               | 30                                                 | 18                                                         |
| ≥ +20 to +30               | 14                                                 | 10                                                         |
| ≥ +30 to +40               | 7                                                  | 5                                                          |

<sup>1)</sup> In wet concrete or flooded holes the curing times must be doubled

UPAT injection system UPM 55

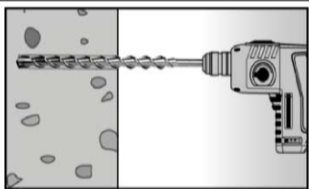
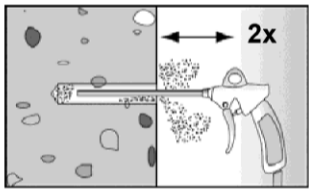
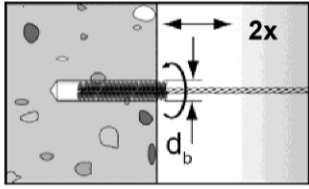
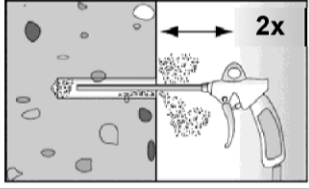
**Intended Use**  
 Cleaning tools  
 Processing times and curing times

**Annex B 7**

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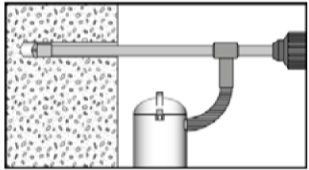
## Installation instructions part 1

### Drilling and cleaning the hole (hammer drilling with standard drill bit)

|   |                                                                                   |                                                                                                                                                                |                                                                                     |
|---|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1 |  | Drill the hole.<br>Drill hole diameter $d_0$ and drill hole depth $h_0$ see <b>Tables B2, B3, B4, B5</b>                                                       |                                                                                     |
| 2 |  | Blow out the drill hole twice, with oil-free compressed air ( $p \geq 6$ bar)                                                                                  |  |
| 3 |  | Brush the drill hole twice. For drill hole diameter $\geq 30$ mm use a power drill. For deep holes use an extension. Corresponding brushes see <b>Table B6</b> |                                                                                     |
| 4 |  | Blow out the drill hole twice, with oil-free compressed air ( $p \geq 6$ bar)                                                                                  |  |

Go to step 6

### Drilling and cleaning the hole (hammer drilling with hollow drill bit)

|   |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                            |  |
|---|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1 |  | Check a suitable hollow drill (see <b>Table B1</b> ) for correct operation of the dust extraction                                                                                                                                                                                                                                                                          |  |
| 2 |  | Use a suitable dust extraction system, e.g. Bosch GAS 35 M AFC or a comparable dust extraction system with equivalent performance data<br><br>Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process. Diameter of drill hole $d_0$ and drill hole depth $h_0$ see <b>Tables B2, B3, B4, B5</b> |  |

Go to step 6

UPAT injection system UPM 55

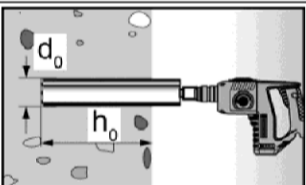
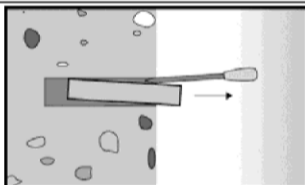
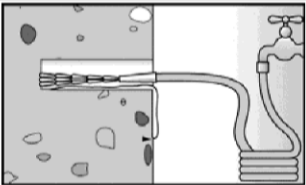
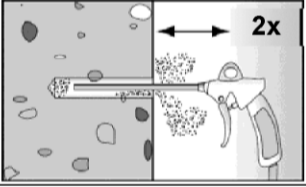
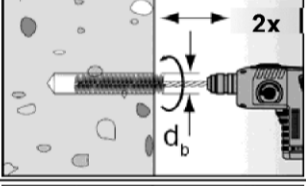
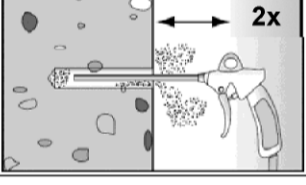
**Intended use**  
Installation instructions part 1

**Annex B 8**

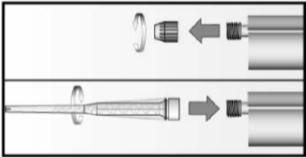
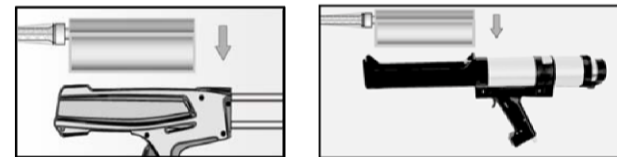
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## Installation instructions part 2

### Drilling and cleaning the hole (wet drilling with diamond drill bit)

|   |                                                                                    |                                                                                                                |                                                                                    |                                         |
|---|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------|
| 1 |   | Drill the hole.<br>Drill hole diameter $d_0$ and<br>drill hole depth $h_0$ see<br><b>Tables B2, B3, B4, B5</b> |  | Break the drill core<br>and draw it out |
| 2 |   | Flush the drill hole with clean water until it flows clear                                                     |                                                                                    |                                         |
| 3 |   | Blow out the drill hole twice, using oil-free compressed air ( $p > 6$ bar)                                    |                                                                                    |                                         |
| 4 |   | Brush the drill hole twice using a power drill. Corresponding brushes see<br><b>Table B6</b>                   |                                                                                    |                                         |
| 5 |  | Blow out the drill hole twice, using oil-free compressed air ( $p > 6$ bar)                                    |                                                                                    |                                         |

### Preparing the cartridge

|   |                                                                                     |                                                                                                                                          |
|---|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 6 |  | Remove the sealing cap<br><br>Screw on the static mixer<br>(the spiral in the static mixer must be clearly visible)                      |
| 7 |  | Place the cartridge into the dispenser                                                                                                   |
| 8 |  | Extrude approximately 10 cm of material out until<br>the resin is evenly grey in colour. Do not use mortar<br>that is not uniformly grey |

UPAT injection system UPM 55

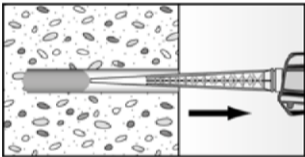
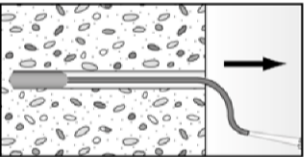
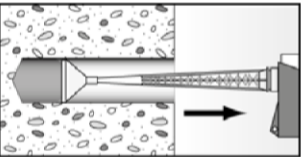
**Intended use**  
Installation instructions part 2

**Annex B 9**

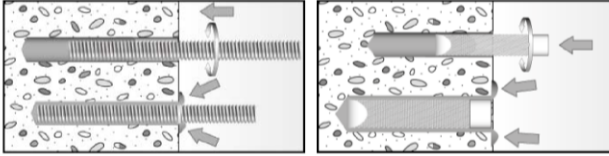
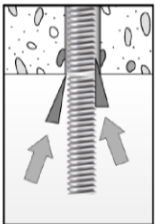
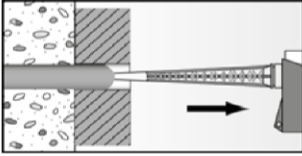
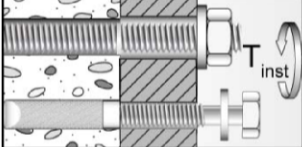
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## Installation instructions part 3

### Injection of the mortar

|   |                                                                                                                                                                                                           |                                                                                                                                                              |                                                                                                                                                                                                                                          |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9 |  <p>Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles</p> |  <p>For drill hole depth <math>\geq 150</math> mm use an extension tube</p> |  <p>For overhead installation, deep holes <math>h_0 &gt; 250</math> mm or drill hole diameter <math>d_0 \geq 40</math> mm use an injection-adaptor</p> |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Installation of anchor rods or internal threaded anchors IST

|    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                  |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 |                                                                                               | <p>Only use clean and oil-free anchor elements. Mark the setting depth of the anchor. Press the threaded rod or internal threaded IST anchor down to the bottom of the hole, turning it slightly while doing so. After inserting the anchor element, excess mortar must be emerged around the anchor element</p> |
|    |  <p>For overhead installations support the anchor rod with wedges</p>                        |  <p>For push through installation fill the annular gap with mortar</p>                                                                                                                                                         |
| 11 |  <p>Wait for the specified curing time <math>t_{\text{cure}}</math> see <b>Table B7</b></p> | <p>12</p>  <p>Mounting the fixture<br/><math>T_{\text{inst, max}}</math> see <b>Tables B2 and B3</b></p>                                                                                                                     |

UPAT injection system UPM 55

#### Intended use

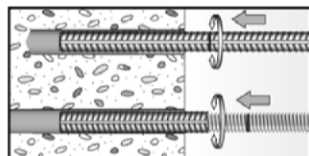
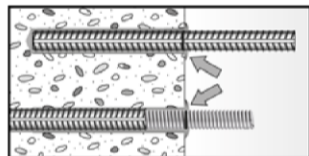
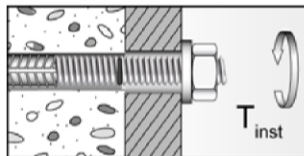
Installation instructions part 3

**Annex B 10**

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Installation instructions part 4

Installation reinforcing bars and UPAT rebar anchor

|    |                                                                                   |                                                                                                                                                                                                                            |    |                                                                                    |                                                                   |
|----|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| 10 |  | Only use clean and oil-free reinforcing bars or UPAT rebar anchor. Mark the setting depth. Turn while using force to push the reinforcement bar or the UPAT rebar anchor into the filled hole up to the setting depth mark |    |                                                                                    |                                                                   |
|    |  | When the setting depth mark is reached, excess mortar must be emerged from the mouth of the drill hole                                                                                                                     |    |                                                                                    |                                                                   |
| 11 |  | Wait for the specified curing time<br>$t_{\text{cure}}$ see <b>Table B7</b>                                                                                                                                                | 12 |  | Mounting the fixture<br>$T_{\text{inst,max}}$ see <b>Table B5</b> |

UPAT injection system UPM 55

Intended use  
Installation instructions part 4

**Table C1: Characteristic values for the steel bearing capacity under tensile / shear load of UPAT anchor rods and standard threaded rods**

| Size                                                          |                                                         |       |      | M8                        | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27  | M30  |
|---------------------------------------------------------------|---------------------------------------------------------|-------|------|---------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|
| Bearing capacity under tensile load, steel failure            |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| Charact. bearing capacity $N_{Rk}$                            | Steel zinc plated                                       | 5.8   | [kN] | 19                        | 29  | 43  | 58  | 79  | 123 | 152 | 177 | 230  | 281  |
|                                                               |                                                         | 8.8   |      | 29                        | 47  | 68  | 92  | 126 | 196 | 243 | 282 | 368  | 449  |
|                                                               | Stainless steel A4 and High corrosion resistant steel C | 50    |      | 19                        | 29  | 43  | 58  | 79  | 123 | 152 | 177 | 230  | 281  |
|                                                               |                                                         | 70    |      | 26                        | 41  | 59  | 81  | 110 | 172 | 212 | 247 | 322  | 393  |
|                                                               |                                                         | 80    |      | 30                        | 47  | 68  | 92  | 126 | 196 | 243 | 282 | 368  | 449  |
| Partial safety factors <sup>1)</sup>                          |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| Partial safety factor $\gamma_{Ms,N}$                         | Steel zinc plated                                       | 5.8   | [-]  | 1,50                      |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 8.8   |      | 1,50                      |     |     |     |     |     |     |     |      |      |
|                                                               | Stainless steel A4 and High corrosion resistant steel C | 50    |      | 2,86                      |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 70    |      | 1,50 <sup>2)</sup> / 1,87 |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 80    |      | 1,60                      |     |     |     |     |     |     |     |      |      |
| Bearing capacity under shear load, steel failure              |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| without lever arm                                             |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| Charact. bearing capacity $V_{Rk}$                            | Steel zinc plated                                       | 5.8   | [kN] | 9                         | 15  | 21  | 29  | 39  | 61  | 76  | 89  | 115  | 141  |
|                                                               |                                                         | 8.8   |      | 15                        | 23  | 34  | 46  | 63  | 98  | 122 | 141 | 184  | 225  |
|                                                               | Stainless steel A4 and High corrosion resistant steel C | 50    |      | 9                         | 15  | 21  | 29  | 39  | 61  | 76  | 89  | 115  | 141  |
|                                                               |                                                         | 70    |      | 13                        | 20  | 30  | 40  | 55  | 86  | 107 | 124 | 161  | 197  |
|                                                               |                                                         | 80    |      | 15                        | 23  | 34  | 46  | 63  | 98  | 122 | 141 | 184  | 225  |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1 |                                                         | $k_2$ | [-]  | 1,0                       |     |     |     |     |     |     |     |      |      |
| with lever arm                                                |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| Charact. bending moment $M_{Rk}$                              | Steel zinc plated                                       | 5.8   | [Nm] | 19                        | 37  | 65  | 104 | 166 | 324 | 447 | 560 | 833  | 1123 |
|                                                               |                                                         | 8.8   |      | 30                        | 60  | 105 | 167 | 266 | 519 | 716 | 896 | 1333 | 1797 |
|                                                               | Stainless steel A4 and High corrosion resistant steel C | 50    |      | 19                        | 37  | 65  | 104 | 166 | 324 | 447 | 560 | 833  | 1123 |
|                                                               |                                                         | 70    |      | 26                        | 52  | 92  | 146 | 232 | 454 | 626 | 784 | 1167 | 1573 |
|                                                               |                                                         | 80    |      | 30                        | 60  | 105 | 167 | 266 | 519 | 716 | 896 | 1333 | 1797 |
| Partial safety factors <sup>1)</sup>                          |                                                         |       |      |                           |     |     |     |     |     |     |     |      |      |
| Partial safety factor $\gamma_{Ms,V}$                         | Steel zinc plated                                       | 5.8   | [-]  | 1,25                      |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 8.8   |      | 1,25                      |     |     |     |     |     |     |     |      |      |
|                                                               | Stainless steel A4 and High corrosion resistant steel C | 50    |      | 2,38                      |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 70    |      | 1,25 <sup>2)</sup> / 1,56 |     |     |     |     |     |     |     |      |      |
|                                                               |                                                         | 80    |      | 1,33                      |     |     |     |     |     |     |     |      |      |

<sup>1)</sup> In absence of other national regulations

<sup>2)</sup> Only admissible for steel C, with  $f_{yk} / f_{uk} \geq 0,8$  and  $A_5 > 12 \%$  (e.g. UPAT anchor rods)

UPAT injection system UPM 55

#### Performances

Characteristic steel bearing capacity of UPAT anchor rods and standard threaded rods

**Annex C 1**

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**Table C2: Characteristic values for the steel bearing capacity under tensile / shear load of internal threaded anchors IST**

| Size                                                          |                                |                   |                | M8   | M10                       | M12  | M16  | M20  |      |
|---------------------------------------------------------------|--------------------------------|-------------------|----------------|------|---------------------------|------|------|------|------|
| Bearing capacity under tensile load, steel failure            |                                |                   |                |      |                           |      |      |      |      |
| Characteristic bearing capacity with screw                    | N <sub>Rk,s</sub>              | Property class    | 5.8            | [kN] | 19                        | 29   | 43   | 79   | 123  |
|                                                               |                                |                   | 8.8            |      | 29                        | 47   | 68   | 108  | 179  |
|                                                               |                                | Property class 70 | A4             |      | 26                        | 41   | 59   | 110  | 172  |
|                                                               |                                |                   | C              |      | 26                        | 41   | 59   | 110  | 172  |
| Partial safety factors <sup>1)</sup>                          |                                |                   |                |      |                           |      |      |      |      |
| Partial safety factor                                         | γ <sub>Ms,N</sub>              | Property class    | 5.8            | [-]  | 1,50                      |      |      |      |      |
|                                                               |                                |                   | 8.8            |      | 1,50                      |      |      |      |      |
|                                                               |                                | Property class 70 | A4             |      | 1,87                      |      |      |      |      |
|                                                               |                                |                   | C              |      | 1,87                      |      |      |      |      |
| Bearing capacity under shear load, steel failure              |                                |                   |                |      |                           |      |      |      |      |
| without lever arm                                             |                                |                   |                |      |                           |      |      |      |      |
| Characteristic bearing capacity with screw                    | V <sub>Rk,s</sub>              | Property class    | 5.8            | [kN] | 9,2                       | 14,5 | 21,1 | 39,2 | 62,0 |
|                                                               |                                |                   | 8.8            |      | 14,6                      | 23,2 | 33,7 | 54,0 | 90,0 |
|                                                               |                                | Property class 70 | A4             |      | 12,8                      | 20,3 | 29,5 | 54,8 | 86,0 |
|                                                               |                                |                   | C              |      | 12,8                      | 20,3 | 29,5 | 54,8 | 86,0 |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1 |                                |                   | k <sub>2</sub> | [-]  | 1,0                       |      |      |      |      |
| with lever arm                                                |                                |                   |                |      |                           |      |      |      |      |
| Characteristic bending moment with screw                      | M <sup>0</sup> <sub>Rk,s</sub> | Property class    | 5.8            | [Nm] | 20                        | 39   | 68   | 173  | 337  |
|                                                               |                                |                   | 8.8            |      | 30                        | 60   | 105  | 266  | 519  |
|                                                               |                                | Property class 70 | A4             |      | 26                        | 52   | 92   | 232  | 454  |
|                                                               |                                |                   | C              |      | 26                        | 52   | 92   | 232  | 454  |
| Partial safety factors <sup>1)</sup>                          |                                |                   |                |      |                           |      |      |      |      |
| Partial safety factor                                         | γ <sub>Ms,V</sub>              | Property class    | 5.8            | [-]  | 1,25                      |      |      |      |      |
|                                                               |                                |                   | 8.8            |      | 1,25                      |      |      |      |      |
|                                                               |                                | Property class 70 | A4             |      | 1,56                      |      |      |      |      |
|                                                               |                                |                   | C              |      | 1,56                      |      |      |      |      |
|                                                               |                                |                   |                |      | 1,25 / 1,50 <sup>2)</sup> |      |      |      |      |

<sup>1)</sup> In absence of other national regulations

<sup>2)</sup> Only for steel failure without lever arm

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#### Performances

Characteristic steel bearing capacity of internal threaded anchors IST

## Annex C 2

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**Table C3: Characteristic values for the steel bearing capacity under tensile / shear load of reinforcing bars**

| Nominal diameter of the bar                                   | $\phi$       | 8    | 10                                   | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
|---------------------------------------------------------------|--------------|------|--------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Bearing capacity under tensile load, steel failure            |              |      |                                      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Characteristic bearing capacity                               | $N_{Rk,s}$   | [kN] | $A_s \cdot f_{uk}^{1)}$              |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Bearing capacity under shear load, steel failure              |              |      |                                      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| without lever arm                                             |              |      |                                      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Characteristic bearing capacity                               | $V_{Rk,s}$   | [kN] | $0,5 \cdot A_s \cdot f_{uk}^{1)}$    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1 | $k_2$        | [-]  | 0,8                                  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| with lever arm                                                |              |      |                                      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Characteristic bending moment                                 | $M^0_{Rk,s}$ | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}^{1)}$ |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

<sup>1)</sup>  $f_{uk}$  or  $f_{yk}$  respectively must be taken from the specifications of the reinforcing bar

**Table C4: Characteristic values for the steel bearing capacity under tensile / shear load of UPAT rebar anchors**

| Size                                                          |                                |      | M12  | M16 | M20 | M24 |
|---------------------------------------------------------------|--------------------------------|------|------|-----|-----|-----|
| Bearing capacity under tensile load, steel failure            |                                |      |      |     |     |     |
| Characteristic bearing capacity                               | N <sub>RK,s</sub>              | [kN] | 63   | 111 | 173 | 270 |
| Partial safety factors <sup>1)</sup>                          |                                |      |      |     |     |     |
| Partial safety factor                                         | γ <sub>Ms,N</sub>              | [-]  | 1,4  |     |     |     |
| Bearing capacity under shear load, steel failure              |                                |      |      |     |     |     |
| without lever arm                                             |                                |      |      |     |     |     |
| Characteristic bearing capacity                               | V <sub>RK,s</sub>              | [kN] | 30   | 55  | 86  | 124 |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1 | k <sub>2</sub>                 | [-]  | 1,0  |     |     |     |
| with lever arm                                                |                                |      |      |     |     |     |
| Characteristic bearing capacity                               | M <sup>0</sup> <sub>RK,s</sub> | [Nm] | 92   | 233 | 454 | 785 |
| Partial safety factors <sup>1)</sup>                          |                                |      |      |     |     |     |
| Partial safety factor                                         | γ <sub>Ms,V</sub>              | [-]  | 1,56 |     |     |     |

<sup>1)</sup> In absence of other national regulations

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**Performances**

Characteristic steel bearing capacity of reinforcing bars and UPAT rebar anchors

**Annex C 3**

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**Table C5: General design factors for the bearing capacity under tensile / shear load; uncracked or cracked concrete**

| Size                                                                                                   |                          |                            | All Sizes   |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|--------------------------------------------------------------------------------------------------------|--------------------------|----------------------------|-------------|----------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|
| Bearing capacity under tensile load                                                                    |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Factors acc. to CEN/TS 1992-4:2009 Section 6.2.2.3                                                     |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Uncracked concrete                                                                                     |                          | $k_{ucr}$                  | [-]         | 10,1                 |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Cracked concrete                                                                                       |                          | $k_{cr}$                   |             | 7,2                  |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Factors for the compressive strength of concrete > C20/25                                              |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Increasing factor<br>for $\tau_{RK}$                                                                   | C25/30                   |                            | $\Psi_c$    | [-]                  | 1,02                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | C30/37                   |                            |             |                      | 1,04                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | C35/45                   |                            |             |                      | 1,06                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | C40/50                   |                            |             |                      | 1,07                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | C45/55                   |                            |             |                      | 1,08                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | C50/60                   |                            |             |                      | 1,09                 |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Splitting failure                                                                                      |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Edge distance                                                                                          | $h / h_{ef} \geq 2,0$    |                            | $c_{cr,sp}$ | [mm]                 | 1,0 $h_{ef}$         |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | $2,0 > h / h_{ef} > 1,3$ |                            |             |                      | 4,6 $h_{ef}$ - 1,8 h |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
|                                                                                                        | $h / h_{ef} \leq 1,3$    |                            |             |                      | 2,26 $h_{ef}$        |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Spacing                                                                                                |                          | $s_{cr,sp}$                |             |                      | 2 $c_{cr,sp}$        |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Concrete cone failure acc. to CEN/TS 1992-4-5:2009 Section 6.2.3.2                                     |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Edge distance                                                                                          |                          | $c_{cr,N}$                 | [mm]        | 1,5 $h_{ef}$         |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Spacing                                                                                                |                          | $s_{cr,N}$                 |             | 2 $c_{cr,N}$         |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Bearing capacity under shear load                                                                      |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Installation safety factors                                                                            |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| All installation conditions                                                                            |                          | $\gamma_2 = \gamma_{inst}$ | [-]         | 1,0                  |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Concrete pry-out failure                                                                               |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Factor k acc. to TR029<br>Section 5.2.3.3 resp. $k_3$ acc. to<br>CEN/TS 1992-4-5:2009<br>Section 6.3.3 |                          | $k_{(3)}$                  | [-]         | 2,0                  |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Concrete edge failure                                                                                  |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| The value of $h_{ef}$ (= $l_f$ )<br>under shear load                                                   |                          |                            | [mm]        | min ( $h_{ef}$ ; 8d) |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Calculation diameters                                                                                  |                          |                            |             |                      |                      |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |
| Size                                                                                                   |                          |                            |             | M8                   | M10                  | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |    |    |    |    |    |    |    |    |    |
| UPAT anchor rods and<br>standard threaded rods                                                         |                          | d                          | [mm]        | 8                    | 10                   | 12  | 14  | 16  | 20  | 22  | 24  | 27  | 30  |    |    |    |    |    |    |    |    |    |
| internal threaded anchors IST                                                                          |                          | d                          |             | 12                   | 16                   | 18  | -   | 22  | 28  | -   | -   | -   | -   |    |    |    |    |    |    |    |    |    |
| UPAT rebar anchors                                                                                     |                          | d                          |             | -                    | -                    | 12  | -   | 16  | 20  | -   | 25  | -   | -   |    |    |    |    |    |    |    |    |    |
| Nominal diameter of the bar                                                                            |                          |                            |             | $\phi$               | 8                    | 10  | 12  | 14  | 16  | 18  | 20  | 22  | 24  | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |    |
| Reinforcing bar                                                                                        |                          |                            |             | d                    | [mm]                 | 8   | 10  | 12  | 14  | 16  | 18  | 20  | 22  | 24 | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |

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**Performances**

General design factors relating to the characteristic bearing capacity under tensile / shear load

**Annex C 4**

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**Table C6: Characteristic values of resistance for UPAT anchor rods and standard threaded rods in hammer or diamond drilled holes; uncracked or cracked concrete**

| Size                                                                                                    |                   |                            | M8                   | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |    |
|---------------------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Combined pullout and concrete cone failure                                                              |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Calculation diameter                                                                                    |                   | d                          | [mm]                 | 8   | 10  | 12  | 14  | 16  | 20  | 22  | 24  | 27  | 30 |
| Uncracked concrete                                                                                      |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Characteristic bond resistance in uncracked concrete C20/25                                             |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete)                      |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 16  | 15  | 14  | 14  | 13  | 13  | 13  | 12  | 12 |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 14  | 13  | 13  | 12  | 12  | 12  | 11  | 11 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)                              |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 16  | 15  | 13  | 13  | 11  | 11  | 10  | 10  | 9  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 14  | 13  | 12  | 11  | 10  | 10  | 9   | 9  |
| Diamond-drilling (dry and wet concrete as well as flooded hole)                                         |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 15  | 13  | 12  | 12  | 10  | 10  | 10  | 9   | 9  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 12  | 11  | 11  | 10  | 9   | 9   | 8   | 8  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     | 1,2 |     |     |     |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,4 |     |     |     |     |     |     |     |     |    |
| Cracked concrete                                                                                        |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Characteristic bond resistance in cracked concrete C20/25                                               |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (dry and wet concrete) |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 7   | 7   | 7   | 6   | 6   | 7   | 7   | 7   | 7  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 7   | 7   | 7   | 6   | 6   | 7   | 7   | 7   | 7  |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (flooded hole)         |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 6   | 7,5 | 7,5 | 7   | 6   | 6   | 6   | 6   | 6   | 6  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 6   | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6   | 6  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |     |     |     |     |     |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     | 1,2 |     |     |     |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,2 |     |     |     |     | 1,4 |     |     |     |    |

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**Performances**

Characteristic values for static or quasi-static action under tensile load for UPAT anchor rods and standard threaded rods (uncracked or cracked concrete)

**Annex C 5**

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**Table C7: Characteristic values of resistance for internal threaded anchors IST in hammer or diamond drilled holes; uncracked or cracked concrete**

| Size                                                                                                    |                   |                            | M8                   | M10 | M12 | M16 | M20 |    |
|---------------------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|----|
| Combined pullout and concrete cone failure                                                              |                   |                            |                      |     |     |     |     |    |
| Calculation diameter                                                                                    |                   | d                          | [mm]                 | 12  | 16  | 18  | 22  | 28 |
| Uncracked concrete                                                                                      |                   |                            |                      |     |     |     |     |    |
| Characteristic bond resistance in uncracked concrete C20/25                                             |                   |                            |                      |     |     |     |     |    |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete)                      |                   |                            |                      |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 15  | 14  | 14  | 13  | 12 |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 14  | 13  | 13  | 12  | 11 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)                              |                   |                            |                      |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 14  | 12  | 12  | 11  | 10 |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 13  | 12  | 11  | 10  | 9  |
| Diamond-drilling (dry and wet concrete as well as flooded hole)                                         |                   |                            |                      |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 13  | 12  | 11  | 10  | 9  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 12  | 11  | 10  | 9   | 8  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     | 1,2 |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,4 |     |     |     |    |
| Cracked concrete                                                                                        |                   |                            |                      |     |     |     |     |    |
| Characteristic bond resistance in cracked concrete C20/25                                               |                   |                            |                      |     |     |     |     |    |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (dry and wet concrete) |                   |                            |                      |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 6   | 6   | 7   | 7  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 6   | 6   | 7   | 7  |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (flooded hole)         |                   |                            |                      |     |     |     |     |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 6,5 | 6   | 6   | 6  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 6   | 6   | 6   | 6  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     | 1,2 |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,2 |     |     |     |    |

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**Performances**

Characteristic values for static or quasi-static action under tensile load for internal threaded anchors IST (uncracked or cracked concrete)

**Annex C 6**

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**Table C8: Characteristic values of resistance for reinforcing bars**  
in hammer or diamond drilled holes; **uncracked or cracked concrete**

| Nominal diameter of the bar $\phi$                                                                      |                   |                            | 8                    | 10  | 12  | 14  | 16  | 18  | 20 | 22 | 24 | 25  | 26 | 28 | 30 | 32 | 34 | 36 | 40 |    |
|---------------------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|-----|----|----|----|-----|----|----|----|----|----|----|----|----|
| Combined pullout and concrete cone failure                                                              |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Calculation diameter                                                                                    |                   | d                          | [mm]                 | 8   | 10  | 12  | 14  | 16  | 18 | 20 | 22 | 24  | 25 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| Uncracked concrete                                                                                      |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Characteristic bond resistance in uncracked concrete C20/25                                             |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete)                      |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 16  | 15  | 14  | 14  | 14 | 13 | 13 | 13  | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 11 |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 14  | 13  | 13  | 13 | 12 | 12 | 12  | 12 | 11 | 11 | 11 | 11 | 11 | 11 | 10 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)                              |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 16  | 14  | 13  | 12  | 12 | 11 | 11 | 10  | 10 | 10 | 10 | 9  | 9  | 9  | 8  | 8  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 13  | 12  | 12  | 11 | 11 | 10 | 10  | 9  | 9  | 9  | 9  | 8  | 8  | 8  | 8  |
| Diamond-drilling (dry and wet concrete as well as flooded hole)                                         |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 16  | 15  | 13  | 12  | 12  | 11 | 10 | 10 | 10  | 9  | 9  | 9  | 9  | 8  | 8  | 8  | 7  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 15  | 14  | 12  | 11  | 11  | 10 | 10 | 9  | 9   | 9  | 8  | 8  | 8  | 8  | 7  | 7  | 7  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |    |    |    | 1,2 |    |    |    |    |    |    |    |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,4 |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Cracked concrete                                                                                        |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Characteristic bond resistance in cracked concrete C20/25                                               |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (dry and wet concrete) |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 7   | 7   | 7   | 6   | 6  | 6  | 7  | 7   | 7  | 7  | 7  | 7  | 5  | 5  | 5  | 5  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 7   | 7   | 7   | 6   | 6  | 6  | 7  | 7   | 7  | 7  | 7  | 7  | 7  | 5  | 5  | 5  |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (flooded hole)         |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 6   | 7,5 | 6,5 | 6,5 | 6,5 | 6  | 6  | 6  | 6   | 6  | 6  | 6  | 6  | 5  | 5  | 5  | 5  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 6   | 6,5 | 6,5 | 6   | 6   | 6  | 6  | 6  | 6   | 6  | 6  | 6  | 6  | 5  | 5  | 5  | 5  |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |     |    |    |    |     |    |    |    |    |    |    |    |    |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |    |    |    | 1,2 |    |    |    |    |    |    |    |    |
| Flooded hole                                                                                            |                   |                            |                      | 1,2 |     |     |     |     |    |    |    | 1,4 |    |    |    |    |    |    |    |    |

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**Performances**

Characteristic values for static or quasi-static action under tensile load for reinforcing bars (uncracked or cracked concrete)

**Annex C 7**

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**Table C9: Characteristic values of resistance for UPAT rebar anchors  
in hammer or diamond drilled holes; uncracked or cracked concrete**

| Size                                                                                                    |                   |                            | M12                  | M16 | M20 | M24 |     |
|---------------------------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|
| Combined pullout and concrete cone failure                                                              |                   |                            |                      |     |     |     |     |
| Calculation diameter                                                                                    |                   | d                          | [mm]                 | 12  | 16  | 20  | 25  |
| Uncracked concrete                                                                                      |                   |                            |                      |     |     |     |     |
| Characteristic bond resistance in uncracked concrete C20/25                                             |                   |                            |                      |     |     |     |     |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete)                      |                   |                            |                      |     |     |     |     |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 15  | 14  | 13  | 13  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 14  | 13  | 12  | 12  |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)                              |                   |                            |                      |     |     |     |     |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 14  | 12  | 11  | 10  |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 13  | 12  | 11  | 9   |
| Diamond-drilling (dry and wet concrete as well as flooded hole)                                         |                   |                            |                      |     |     |     |     |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 13  | 12  | 10  | 9   |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 12  | 11  | 10  | 9   |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     | 1,2 |
| Flooded hole                                                                                            |                   |                            |                      | 1,4 |     |     |     |
| Cracked concrete                                                                                        |                   |                            |                      |     |     |     |     |
| Characteristic bond resistance in cracked concrete C20/25                                               |                   |                            |                      |     |     |     |     |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (dry and wet concrete) |                   |                            |                      |     |     |     |     |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 6   | 6   | 7   |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 6   | 6   | 7   |
| Hammer-drilling with standard drill bit or hollow drill bit and diamond-drilling (flooded hole)         |                   |                            |                      |     |     |     |     |
| Temperature range                                                                                       | I: 35 °C / 60 °C  | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7   | 6   | 6   | 6   |
|                                                                                                         | II: 50 °C / 72 °C |                            |                      | 7   | 6   | 6   | 6   |
| Installation safety factors                                                                             |                   |                            |                      |     |     |     |     |
| Dry and wet concrete                                                                                    |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     | 1,2 |
| Flooded hole                                                                                            |                   |                            |                      | 1,2 |     |     | 1,4 |

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**Performances**

Characteristic values for static or quasi-static action under tensile load for UPAT rebar anchors (uncracked or cracked concrete)

**Annex C 8**

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**Table C10: Displacements for anchor rods**

| Size                                                   |                           | M8   | M10  | M12  | M14  | M16  | M20  | M22  | M24  | M27  | M30  |
|--------------------------------------------------------|---------------------------|------|------|------|------|------|------|------|------|------|------|
| Displacement-Factors for tensile load <sup>1)</sup>    |                           |      |      |      |      |      |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |      |      |      |      |      |
| $\delta_{N0}$ -Factor                                  | [mm/(N/mm <sup>2</sup> )] | 0,07 | 0,08 | 0,09 | 0,09 | 0,10 | 0,11 | 0,11 | 0,12 | 0,12 | 0,13 |
| $\delta_{N\infty}$ -Factor                             |                           | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 | 0,17 | 0,18 | 0,19 | 0,19 |
| Displacement-Factors for shear load <sup>2)</sup>      |                           |      |      |      |      |      |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |      |      |      |      |      |
| $\delta_{V0}$ -Factor                                  | [mm/kN]                   | 0,18 | 0,15 | 0,12 | 0,10 | 0,09 | 0,07 | 0,07 | 0,06 | 0,05 | 0,05 |
| $\delta_{V\infty}$ -Factor                             |                           | 0,27 | 0,22 | 0,18 | 0,16 | 0,14 | 0,11 | 0,10 | 0,09 | 0,08 | 0,07 |

1) Calculation of effective displacement:

$$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau_{Ed}$$

$$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau_{Ed}$$

( $\tau_{Ed}$ : Design value of the applied tensile stress)

2) Calculation of effective displacement:

$$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V_{Ed}$$

$$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V_{Ed}$$

( $V_{Ed}$ : Design value of the applied shear force)

**Table C11: Displacements for internal threaded anchors IST**

| Size                                                   |                           | M8   | M10  | M12  | M16  | M20  |
|--------------------------------------------------------|---------------------------|------|------|------|------|------|
| Displacement-Factors for tensile load <sup>1)</sup>    |                           |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |
| $\delta_{N0}$ -Factor                                  | [mm/(N/mm <sup>2</sup> )] | 0,09 | 0,10 | 0,10 | 0,11 | 0,13 |
| $\delta_{N\infty}$ -Factor                             |                           | 0,13 | 0,15 | 0,16 | 0,17 | 0,19 |
| Displacement-Factors for shear load <sup>2)</sup>      |                           |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |
| $\delta_{V0}$ -Factor                                  | [mm/kN]                   | 0,12 | 0,09 | 0,08 | 0,07 | 0,05 |
| $\delta_{V\infty}$ -Factor                             |                           | 0,18 | 0,14 | 0,12 | 0,10 | 0,08 |

1) Calculation of effective displacement:

$$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau_{Ed}$$

$$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau_{Ed}$$

( $\tau_{Ed}$ : Design value of the applied tensile stress)

2) Calculation of effective displacement:

$$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V_{Ed}$$

$$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V_{Ed}$$

( $V_{Ed}$ : Design value of the applied shear force)

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#### Performances

Displacements for anchor rods and internal threaded anchors IST

## Annex C 9

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**Table C12: Displacements for reinforcing bars**

| Nominal diameter of the bar $\phi$                     |                           | 8    | 10   | 12   | 14   | 16   | 18   | 20   | 22   | 24   | 25   | 26   | 28   | 30   | 32   | 34   | 36   | 40   |
|--------------------------------------------------------|---------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Displacement-Factors for tensile load <sup>1)</sup>    |                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| $\delta_{N0}$ -Factor                                  | [mm/(N/mm <sup>2</sup> )] | 0,07 | 0,08 | 0,09 | 0,09 | 0,10 | 0,10 | 0,11 | 0,11 | 0,12 | 0,12 | 0,12 | 0,13 | 0,13 | 0,13 | 0,14 | 0,14 | 0,15 |
| $\delta_{N\infty}$ -Factor                             |                           | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 | 0,16 | 0,17 | 0,18 | 0,18 | 0,18 | 0,19 | 0,19 | 0,20 | 0,20 | 0,21 | 0,22 |
| Displacement-Factors for shear load <sup>2)</sup>      |                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| $\delta_{V0}$ -Factor                                  | [mm/kN]                   | 0,18 | 0,15 | 0,12 | 0,10 | 0,09 | 0,08 | 0,07 | 0,07 | 0,06 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 |
| $\delta_{V\infty}$ -Factor                             |                           | 0,27 | 0,22 | 0,18 | 0,16 | 0,14 | 0,12 | 0,11 | 0,10 | 0,09 | 0,09 | 0,08 | 0,08 | 0,07 | 0,07 | 0,06 | 0,06 | 0,05 |

1) Calculation of effective displacement:

$$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau_{Ed}$$

$$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau_{Ed}$$

( $\tau_{Ed}$ : Design value of the applied tensile stress)

2) Calculation of effective displacement:

$$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V_{Ed}$$

$$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V_{Ed}$$

( $V_{Ed}$ : Design value of the applied shear force)

**Table C13: Displacements for UPAT rebar anchors**

| Size                                                   |                           | M12  | M16  | M20  | M24  |
|--------------------------------------------------------|---------------------------|------|------|------|------|
| Displacement-Factors for tensile load <sup>1)</sup>    |                           |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |
| $\delta_{N0}$ -Factor                                  | [mm/(N/mm <sup>2</sup> )] | 0,09 | 0,10 | 0,11 | 0,12 |
| $\delta_{N\infty}$ -Factor                             |                           | 0,13 | 0,15 | 0,16 | 0,18 |
| Displacement-Factors for shear load <sup>2)</sup>      |                           |      |      |      |      |
| Uncracked or cracked concrete; Temperature range I, II |                           |      |      |      |      |
| $\delta_{V0}$ -Factor                                  | [mm/kN]                   | 0,12 | 0,09 | 0,07 | 0,06 |
| $\delta_{V\infty}$ -Factor                             |                           | 0,18 | 0,14 | 0,11 | 0,09 |

1) Calculation of effective displacement:

$$\delta_{N0} = \delta_{N0\text{-Factor}} \cdot \tau_{Ed}$$

$$\delta_{N\infty} = \delta_{N\infty\text{-Factor}} \cdot \tau_{Ed}$$

( $\tau_{Ed}$ : Design value of the applied tensile stress)

2) Calculation of effective displacement:

$$\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V_{Ed}$$

$$\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V_{Ed}$$

( $V_{Ed}$ : Design value of the applied shear force)

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**Performances**

Displacements for reinforcing bars and UPAT rebar anchors

**Annex C 10**

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**Table C14: Characteristic values for the steel bearing capacity under tensile / shear load of UPAT anchor rods and standard threaded rods under seismic action performance category C1 or C2**

| Size                                                                             |                                                         |     |      | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|----------------------------------------------------------------------------------|---------------------------------------------------------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Bearing capacity under tensile load, steel failure <sup>1)</sup>                 |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| UPAT anchor rods and standard threaded rods, performance category C1             |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| Charact.bearing capacity $N_{Rk,s,C1}$                                           | Steel zinc plated                                       | 5.8 | [kN] | 29  | 43  | 58  | 79  | 123 | 152 | 177 | 230 | 281 |
|                                                                                  |                                                         | 8.8 |      | 47  | 68  | 92  | 126 | 196 | 243 | 282 | 368 | 449 |
|                                                                                  | Stainless steel A4 and High corrosion resistant steel C | 50  |      | 29  | 43  | 58  | 79  | 123 | 152 | 177 | 230 | 281 |
|                                                                                  |                                                         | 70  |      | 41  | 59  | 81  | 110 | 172 | 212 | 247 | 322 | 393 |
|                                                                                  |                                                         | 80  |      | 47  | 68  | 92  | 126 | 196 | 243 | 282 | 368 | 449 |
| UPAT anchor rods and standard threaded rods, performance category C2             |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| Charact.bearing capacity $N_{Rk,s,C2}$                                           | Steel zinc plated                                       | 5.8 | [kN] | --- | 39  | --- | 72  | 108 | --- | 177 | --- | --- |
|                                                                                  |                                                         | 8.8 |      | --- | 61  | --- | 116 | 173 | --- | 282 | --- | --- |
|                                                                                  | Stainless steel A4 and High corrosion resistant steel C | 50  |      | --- | 39  | --- | 72  | 108 | --- | 177 | --- | --- |
|                                                                                  |                                                         | 70  |      | --- | 53  | --- | 101 | 152 | --- | 247 | --- | --- |
|                                                                                  |                                                         | 80  |      | --- | 61  | --- | 116 | 173 | --- | 282 | --- | --- |
| Bearing capacity under shear load, steel failure without lever arm <sup>1)</sup> |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| UPAT anchor rods, performance category C1                                        |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| Charact.bearing capacity $V_{Rk,s,C1}$                                           | Steel zinc plated                                       | 5.8 | [kN] | 15  | 21  | 29  | 39  | 61  | 76  | 89  | 115 | 141 |
|                                                                                  |                                                         | 8.8 |      | 23  | 34  | 46  | 63  | 98  | 122 | 141 | 184 | 225 |
|                                                                                  | Stainless steel A4 and High corrosion resistant steel C | 50  |      | 15  | 21  | 29  | 39  | 61  | 76  | 89  | 115 | 141 |
|                                                                                  |                                                         | 70  |      | 20  | 30  | 40  | 55  | 86  | 107 | 124 | 161 | 197 |
|                                                                                  |                                                         | 80  |      | 23  | 34  | 46  | 63  | 98  | 122 | 141 | 184 | 225 |
| Standard threaded rods, performance category C1                                  |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| Charact.bearing capacity $V_{Rk,s,C1}$                                           | Steel zinc plated                                       | 5.8 | [kN] | 11  | 15  | 20  | 27  | 43  | 53  | 62  | 81  | 99  |
|                                                                                  |                                                         | 8.8 |      | 16  | 24  | 32  | 44  | 69  | 85  | 99  | 129 | 158 |
|                                                                                  | Stainless steel A4 and High corrosion resistant steel C | 50  |      | 11  | 15  | 20  | 27  | 43  | 53  | 62  | 81  | 99  |
|                                                                                  |                                                         | 70  |      | 14  | 21  | 28  | 39  | 60  | 75  | 87  | 113 | 138 |
|                                                                                  |                                                         | 80  |      | 16  | 24  | 32  | 44  | 69  | 85  | 99  | 129 | 158 |
| UPAT anchor rods and standard threaded rods, performance category C2             |                                                         |     |      |     |     |     |     |     |     |     |     |     |
| Charact.bearing capacity $V_{Rk,s,C2}$                                           | Steel zinc plated                                       | 5.8 | [kN] | --- | 14  | --- | 27  | 43  | --- | 62  | --- | --- |
|                                                                                  |                                                         | 8.8 |      | --- | 22  | --- | 44  | 69  | --- | 99  | --- | --- |
|                                                                                  | Stainless steel A4 and High corrosion resistant steel C | 50  |      | --- | 14  | --- | 27  | 43  | --- | 62  | --- | --- |
|                                                                                  |                                                         | 70  |      | --- | 20  | --- | 39  | 60  | --- | 87  | --- | --- |
|                                                                                  |                                                         | 80  |      | --- | 22  | --- | 44  | 69  | --- | 99  | --- | --- |

<sup>1)</sup> Partial safety factors for performance category C1 or C2 see Table C16, for UPAT anchor rods the factor for steel ductility is 1,0

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#### Performances

Characteristic steel bearing capacity of UPAT anchor rods and standard threaded rods under seismic action (performance category C1 or C2)

**Annex C 11**

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**Table C15: Characteristic values for the steel bearing capacity under tensile / shear load of reinforcing bars (B500B) under seismic action performance category C1**

| Nominal diameter of the bar                                                      |               |      | $\phi$ | 10 | 12 | 14  | 16  | 18  | 20  | 22  | 24  | 25  | 26  | 28  | 30  | 32 |
|----------------------------------------------------------------------------------|---------------|------|--------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Bearing capacity under tensile load, steel failure <sup>1)</sup>                 |               |      |        |    |    |     |     |     |     |     |     |     |     |     |     |    |
| Reinforcing bar B500B acc. to DIN 488-2:2009-08, performance category C1         |               |      |        |    |    |     |     |     |     |     |     |     |     |     |     |    |
| Characteristic bearing capacity                                                  | $N_{Rk,s,C1}$ | [kN] | 44     | 63 | 85 | 111 | 140 | 173 | 209 | 249 | 270 | 292 | 339 | 389 | 443 |    |
| Bearing capacity under shear load, steel failure without lever arm <sup>1)</sup> |               |      |        |    |    |     |     |     |     |     |     |     |     |     |     |    |
| Reinforcing bar B500B acc. to DIN 488-2:2009-08, performance category C1         |               |      |        |    |    |     |     |     |     |     |     |     |     |     |     |    |
| Characteristic bearing capacity                                                  | $V_{Rk,s,C1}$ | [kN] | 15     | 22 | 30 | 39  | 49  | 61  | 74  | 88  | 95  | 102 | 119 | 137 | 155 |    |

<sup>1)</sup> Partial safety factors for performance category C1 see Table C16

**Table C16: Partial safety factors of UPAT anchor rods, standard threaded rods and reinforcing bars (B500B) under seismic action performance category C1 or C2**

| Size                                                             |                                                         |                |       | M10 | M12                       | M14 | M16 | M20 | M22 | M24 | M27 | M30 |    |    |    |    |
|------------------------------------------------------------------|---------------------------------------------------------|----------------|-------|-----|---------------------------|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|
| Nominal diameter of the bar $\phi$                               |                                                         |                |       | 10  | 12                        | 14  | 16  | 18  | 20  | 22  | 24  | 25  | 26 | 28 | 30 | 32 |
| Bearing capacity under tensile load, steel failure <sup>1)</sup> |                                                         |                |       |     |                           |     |     |     |     |     |     |     |    |    |    |    |
| Partial safety factor<br>$\gamma_{Ms,N}$                         | Steel zinc plated                                       | Property class | 5.8   | [-] | 1,50                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 8.8   |     | 1,50                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  | Stainless steel A4 and High corrosion resistant steel C |                | 50    |     | 2,86                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 70    |     | 1,50 <sup>2)</sup> / 1,87 |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 80    |     | 1,60                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  | Reinforcing bar                                         |                | B500B |     | 1,40                      |     |     |     |     |     |     |     |    |    |    |    |
| Bearing capacity under shear load, steel failure <sup>1)</sup>   |                                                         |                |       |     |                           |     |     |     |     |     |     |     |    |    |    |    |
| Partial safety factor<br>$\gamma_{Ms,V}$                         | Steel zinc plated                                       | Property class | 5.8   | [-] | 1,25                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 8.8   |     | 1,25                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  | Stainless steel A4 and High corrosion resistant steel C |                | 50    |     | 2,38                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 70    |     | 1,25 <sup>2)</sup> / 1,56 |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  |                                                         |                | 80    |     | 1,33                      |     |     |     |     |     |     |     |    |    |    |    |
|                                                                  | Reinforcing bar                                         |                | B500B |     | 1,50                      |     |     |     |     |     |     |     |    |    |    |    |

<sup>1)</sup> In absence of other national regulations

<sup>2)</sup> Only admissible for steel C, with  $f_{yk} / f_{uk} \geq 0,8$  and  $A_5 > 12 \%$  (e.g. UPAT anchor rods)

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#### Performances

Characteristic steel bearing capacity of reinforcing bars under seismic action (performance category C1); partial safety factors (performance category C1 or C2)

**Annex C 12**

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**Table C17: Characteristic values of resistance for UPAT anchor rods and standard threaded rods in hammer drilled holes under seismic action performance category C1**

| Size                                                                               |                   |                            | M10                  | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Characteristic bond resistance, combined pullout and concrete cone failure         |                   |                            |                      |     |     |     |     |     |     |     |     |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete) |                   |                            |                      |     |     |     |     |     |     |     |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C1}$             | [N/mm <sup>2</sup> ] | 7,0 | 7,0 | 6,7 | 6,0 | 5,7 | 6,7 | 6,7 | 6,7 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)         |                   |                            |                      |     |     |     |     |     |     |     |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C1}$             | [N/mm <sup>2</sup> ] | 7,5 | 7,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 6,8 | 6,8 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| Installation safety factors                                                        |                   |                            |                      |     |     |     |     |     |     |     |     |
| Bearing capacity under tensile load                                                |                   |                            |                      |     |     |     |     |     |     |     |     |
| Dry and wet concrete                                                               |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     | 1,2 |     |     |     |
| Flooded hole                                                                       |                   |                            |                      | 1,2 |     |     |     | 1,4 |     |     |     |
| Bearing capacity under shear load                                                  |                   |                            |                      |     |     |     |     |     |     |     |     |
| All installation conditions                                                        |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |     |     |     |

**Table C18: Characteristic values of resistance for reinforcing bars in hammer drilled holes under seismic action performance category C1**

| Nominal diameter of the bar                                                        |                   | $\phi$                     | 10                   | 12  | 14  | 16  | 18  | 20  | 22  | 24  | 25  | 26  | 28  | 30  | 32  |
|------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Characteristic bond resistance, combined pullout and concrete cone failure         |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete) |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C1}$             | [N/mm <sup>2</sup> ] | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 7,0 | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)         |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C1}$             | [N/mm <sup>2</sup> ] | 7,5 | 6,5 | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 6,5 | 6,5 | 5,8 | 5,8 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
| Installation safety factors                                                        |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| Bearing capacity under tensile load                                                |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| Dry and wet concrete                                                               |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |     | 1,2 |     |     |     |     |     |
| Flooded hole                                                                       |                   |                            |                      | 1,2 |     |     |     |     |     | 1,4 |     |     |     |     |     |
| Bearing capacity under shear load                                                  |                   |                            |                      |     |     |     |     |     |     |     |     |     |     |     |     |
| All installation conditions                                                        |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |     |     |     |     |     |     |     |

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**Performances**

Characteristic values under seismic action (performance category C1) for UPAT anchor rods, standard threaded rods and reinforcing bars

**Annex C 13**

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**Table C19: Characteristic values of resistance for UPAT anchor rods and standard threaded rods in hammer drilled holes under seismic action performance category C2**

| Size                                                                               |                   |                            | M12                  | M16  | M20  | M24  |     |
|------------------------------------------------------------------------------------|-------------------|----------------------------|----------------------|------|------|------|-----|
| Characteristic bond resistance, combined pullout and concrete cone failure         |                   |                            |                      |      |      |      |     |
| Hammer-drilling with standard drill bit or hollow drill bit (dry and wet concrete) |                   |                            |                      |      |      |      |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C2}$             | [N/mm <sup>2</sup> ] | 2,2  | 3,5  | 1,8  | 2,4 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 2,2  | 3,5  | 1,8  | 2,4 |
| Hammer-drilling with standard drill bit or hollow drill bit (flooded hole)         |                   |                            |                      |      |      |      |     |
| Temperature range                                                                  | I: 35 °C / 60 °C  | $\tau_{Rk,C2}$             | [N/mm <sup>2</sup> ] | 2,3  | 3,5  | 1,8  | 2,1 |
|                                                                                    | II: 50 °C / 72 °C |                            |                      | 2,3  | 3,5  | 1,8  | 2,1 |
| Installation safety factors                                                        |                   |                            |                      |      |      |      |     |
| Bearing capacity under tensile load                                                |                   |                            |                      |      |      |      |     |
| Dry and wet concrete                                                               |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0  |      | 1,2  |     |
| Flooded hole                                                                       |                   |                            |                      | 1,2  |      | 1,4  |     |
| Bearing capacity under shear load                                                  |                   |                            |                      |      |      |      |     |
| All installation conditions                                                        |                   | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0  |      |      |     |
| Displacement-Factors for tensile load <sup>1)</sup>                                |                   |                            |                      |      |      |      |     |
| $\delta_{N,(DLS)}\text{-Factor}$                                                   |                   | [mm/(N/mm <sup>2</sup> )]  | 0,09                 | 0,10 | 0,11 | 0,12 |     |
| $\delta_{N,(ULS)}\text{-Factor}$                                                   |                   |                            | 0,15                 | 0,17 | 0,17 | 0,18 |     |
| Displacement-Factors for shear load <sup>2)</sup>                                  |                   |                            |                      |      |      |      |     |
| $\delta_{V,(DLS)}\text{-Factor}$                                                   |                   | [mm/kN]                    | 0,18                 | 0,10 | 0,07 | 0,06 |     |
| $\delta_{V,(ULS)}\text{-Factor}$                                                   |                   |                            | 0,25                 | 0,14 | 0,11 | 0,09 |     |

1) Calculation of effective displacement:

$$\delta_{N,(DLS)} = \delta_{N,(DLS)\text{-Factor}} \cdot \tau_{Ed}$$

$$\delta_{N,(ULS)} = \delta_{N,(ULS)\text{-Factor}} \cdot \tau_{Ed}$$

( $\tau_{Ed}$ : Design value of the applied tensile stress)

2) Calculation of effective displacement:

$$\delta_{V,(DLS)} = \delta_{V,(DLS)\text{-Factor}} \cdot V_{Ed}$$

$$\delta_{V,(ULS)} = \delta_{V,(ULS)\text{-Factor}} \cdot V_{Ed}$$

( $V_{Ed}$ : Design value of the applied shear force)

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#### Performances

Characteristic values under seismic action (performance category C2) for UPAT anchor rods and standard threaded rods

**Annex C 14**

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