

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

**ETA-11/0418**  
**of 14 December 2015**

English translation prepared by DIBt - Original version in German language

### General Part

Technical Assessment Body issuing the  
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Upat injection system UPM 55

Product family  
to which the construction product belongs

Bonded anchor for use in concrete

Manufacturer

fischerwerke GmbH & Co. KG  
Otto-Hahn-Straße 15  
79211 Denzlingen  
DEUTSCHLAND

Manufacturing plant

Upat

This European Technical Assessment  
contains

40 pages including 3 annexes which form an integral part  
of this assessment

This European Technical Assessment is  
issued in accordance with Regulation (EU)  
No 305/2011, on the basis of

Guideline for European technical approval of "Metal  
anchors for use in concrete", ETAG 001 Part 5:  
"Bonded anchors", April 2013,  
used as European Assessment Document (EAD)  
according to Article 66 Paragraph 3 of Regulation (EU)  
No 305/2011.

**European Technical Assessment**

**ETA-11/0418**

English translation prepared by DIBt

**Page 2 of 40 | 14 December 2015**

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## Specific Part

### 1 Technical description of the product

The Upat Injectino system UPM 55 Diamond is a bonded anchor consisting of a cartridge with injection mortar UPM 55 and a steel element. The steel element consist of

- an Upat threaded rod with washer and hexagon nut of sizes M8 to M30 or
- an Upat internal threaded anchor IST of sizes M8 to M20 or
- a reinforcing bar of sizes  $\phi = 8$  to 40 mm or
- an Upat rebar anchor of sizes M12 to M24

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 19  |
| Characteristic values for seismic performance categories C1 and C2 for design according to Technical Report TR 045, Displacements | See Annex C 20 to C 23 |

#### 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: [98/582/EC].

The system to be applied is: 1

**5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document**

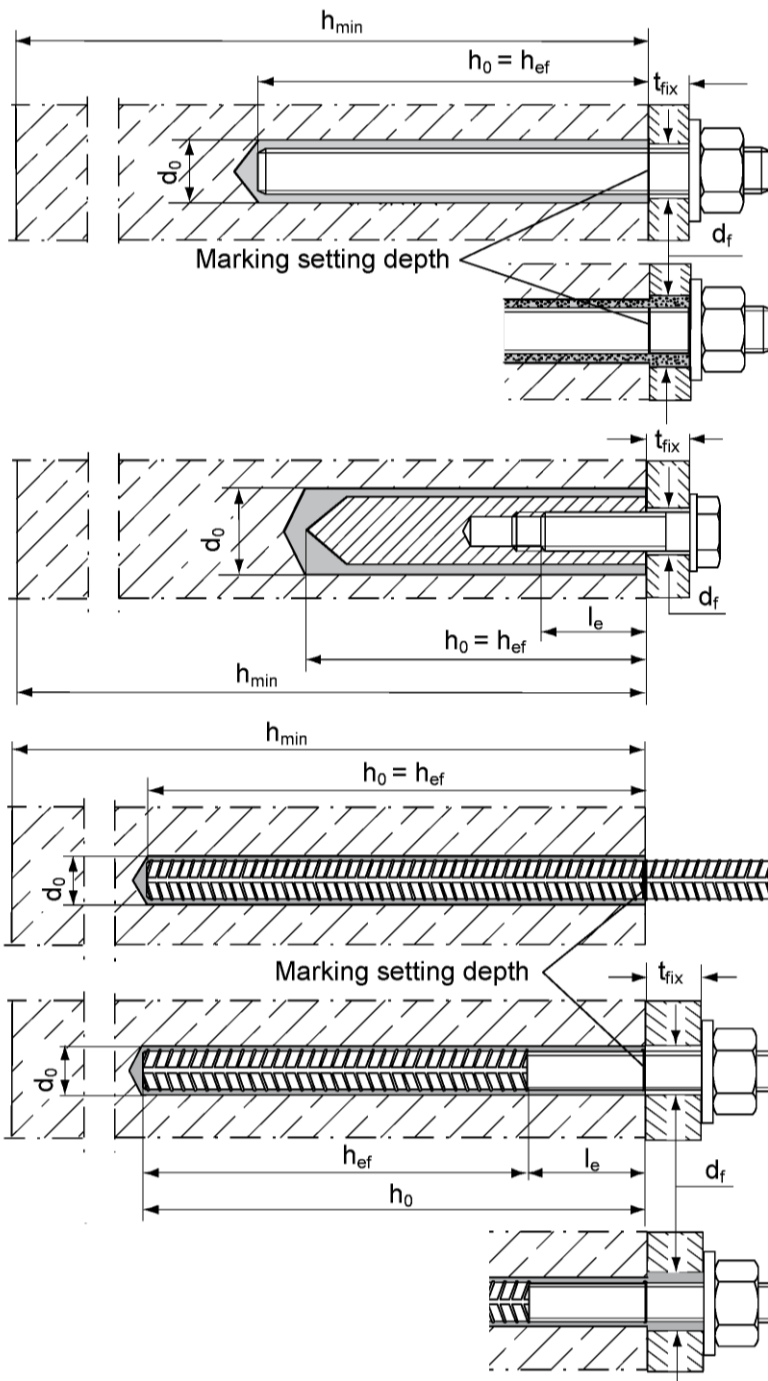
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 14 December 2015 by Deutsches Institut für Bautechnik

Uwe Bender  
Head of Department

*beglaubigt:*  
Müller

## Installation conditions



**Upat threaded rod**  
Pre-positioned anchorage

**Upat threaded rod**  
Push-through anchorage  
(annular gap filled with mortar)

**Upat internal threaded anchor IST**  
Only pre-positioned anchorage

**Reinforcing bar**

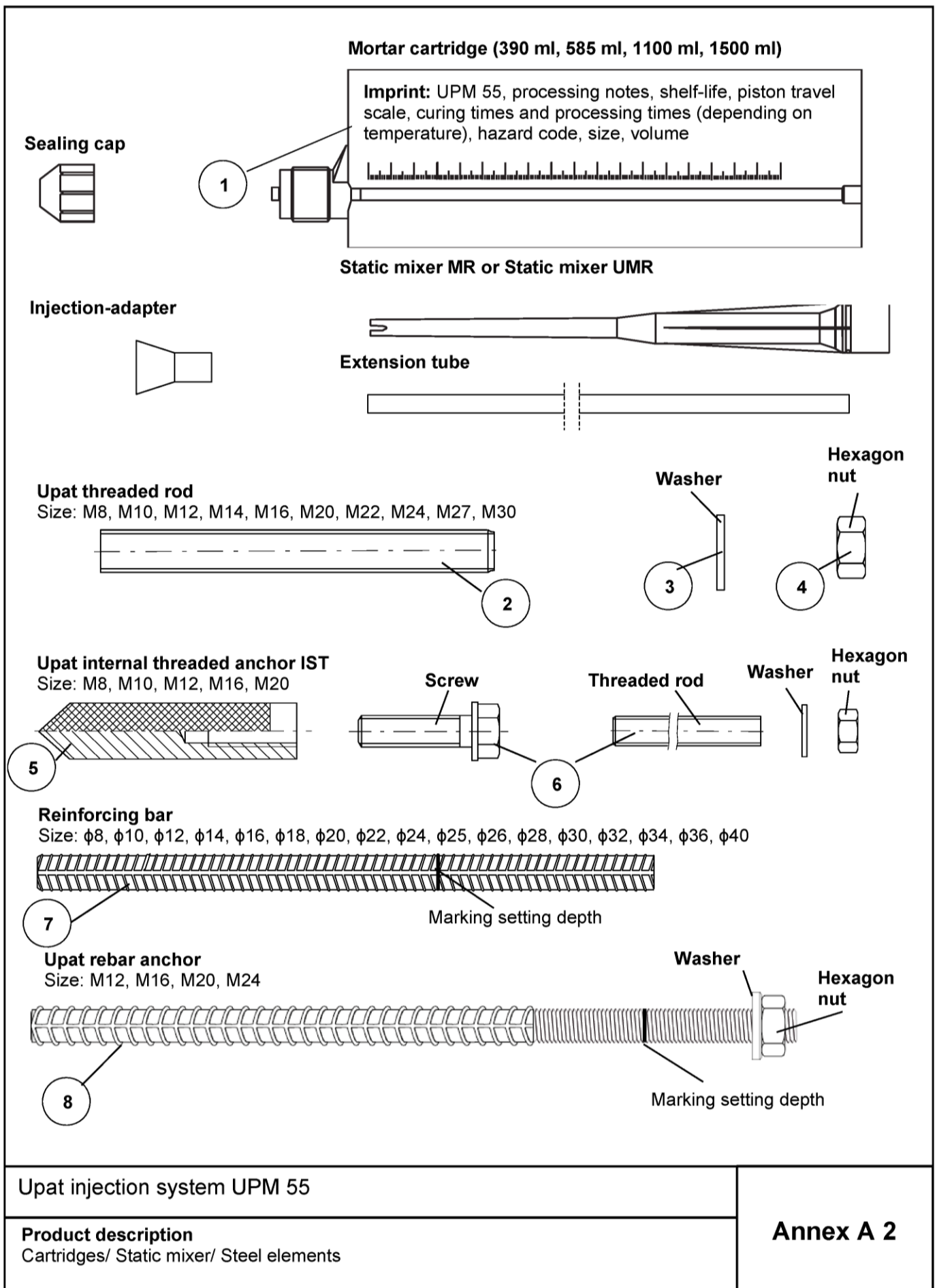
**Upat rebar anchor**  
Pre-positioned anchorage

**Upat rebar anchor**  
Push-through anchorage  
(annular gap filled with mortar)

Upat injection system UPM 55

**Product description**  
Installation conditions

**Annex A 1**



**Table A1: Materials**

| Part | Designation                                                  | Material                                                                                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                            |
|------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Mortar cartridge                                             | Mortar, hardener, filler                                                                                                                                                                                                                |                                                                                                                                                                                                                      |                                                                                                                                                                                                                            |
|      |                                                              | Steel, zinc plated                                                                                                                                                                                                                      | Stainless steel A4                                                                                                                                                                                                   | High corrosion-resistant steel C                                                                                                                                                                                           |
| 2    | Threaded 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>$A_5 > 12\%$ fracture<br>elongation | Property class 50, 70<br>or 80<br>EN ISO 3506:2009<br>1.4401; 1.4404;<br>1.4578; 1.4571;<br>1.4439; 1.4362;<br>1.4062<br>EN 10088-1:2014<br>$f_{uk} \leq 1000 \text{ N/mm}^2$<br>$A_5 > 12\%$ fracture<br>elongation | Property class 50 or 80<br>EN ISO 3506:2009<br>or property class 70<br>with $f_{yk} = 560 \text{ N/mm}^2$<br>1.4565; 1.4529<br>EN 10088-1:2014<br>$f_{uk} \leq 1000 \text{ N/mm}^2$<br>$A_5 > 12\%$ fracture<br>elongation |
| 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;<br>1.4439; 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 898-2:2013<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<br>or 80<br>EN ISO 3506:2009<br>1.4401; 1.4404;<br>1.4578; 1.4571;<br>1.4439; 1.4362<br>EN 10088-1:2014                                                                                        | Property class 50, 70 or<br>80<br>EN ISO 3506:2009<br>1.4565; 1.4529<br>EN 10088-1:2014                                                                                                                                    |
| 5    | Internal threaded anchor<br>IST                              | Property class 5.8 or 8.8;<br>ISO 898-1:2013<br>zinc plated $\geq 5\mu\text{m}$ ,<br>ISO 4042:1999 A2K                                                                                                                                  | Property class 70<br>EN ISO 3506:2009<br>1.4401; 1.4404;<br>1.4578; 1.4571;<br>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 threaded rod for<br>internal threaded anchor<br>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                                                                                                                               | Property class 70<br>EN ISO 3506:2009<br>1.4401; 1.4404;<br>1.4578; 1.4571;<br>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                                                                                                                                               |
| 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/NA:2013<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$                                                                                      |                                                                                                                                                                                                                      |                                                                                                                                                                                                                            |
| 8    | Upat rebar anchor                                            | Rebar part: Bars and de-coiled rods<br>class B or C with $f_{yk}$ and $k$ according to<br>NDP or NCL of EN 1992-1-1/NA:2013<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$                                                                       | Threaded part:<br>Property class 70<br>ISO 3506:2009<br>1.4565; 1.4529<br>EN 10088-1:2014                                                                                                                            |                                                                                                                                                                                                                            |

Upat injection system UPM 55

**Product description**  
Materials

**Annex A 3**

## Specifications of intended use (part 1)

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

| Anchorages subject to                               |                      | UPM 55 with ...                                                                                   |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
|-----------------------------------------------------|----------------------|---------------------------------------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------------------------|--------------------------|
|                                                     |                      | Threaded rod<br> |                         | Internal threaded anchor<br>IST<br> |                          | Reinforcing bar<br> |                          | Rebar anchor<br> |                          |
| Hammer drilling                                     |                      | all sizes                                                                                         |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
| Diamond drilling                                    |                      | all sizes                                                                                         |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
| Static and quasi static load, in                    | un-cracked concrete  | all sizes                                                                                         | Tables: C1, C2, C9, C10 | all sizes                                                                                                            | Tables: C3, C4, C11, C12 | all sizes                                                                                              | Tables: C5, C6, C13, C14 | all sizes                                                                                           | Tables: C7, C8, C15, C16 |
|                                                     | cracked concrete     |                                                                                                   |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
| Seismic performance category (only hammer drilling) | C1                   | M10 – M30                                                                                         | Table C17               | -----                                                                                                                |                          | φ10 - φ 32                                                                                             | Table C18                | -----                                                                                               |                          |
|                                                     | C2                   | M12, M16, M20, M24                                                                                | Table C19               |                                                                                                                      |                          | -----                                                                                                  | -----                    |                                                                                                     |                          |
| Use category                                        | Dry or wet concrete  | all sizes                                                                                         |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
|                                                     | Flooded hole         | all sizes                                                                                         |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
| Installation temperature                            |                      | +5°C to +40°C                                                                                     |                         |                                                                                                                      |                          |                                                                                                        |                          |                                                                                                     |                          |
| 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)                                             |                          |                                                                                                        |                          |                                                                                                     |                          |

### Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206:2013
- Strength classes C20/25 to C50/60 according to EN 206:2013

### Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc coated steel, stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel)  
Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used)

Upat injection system UPM 55

**Intended Use**  
Specifications (part 1)

**Annex B 1**

## Specifications of intended use (part 2)

### Design:

- Anchorages have to be designed under the responsibility of an engineer experienced in anchorages and concrete work
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages 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 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
- Marking and keeping the effective anchorage depth
- Overhead installation is allowed

Upat injection system UPM 55

**Intended Use**  
Specifications (part 2)

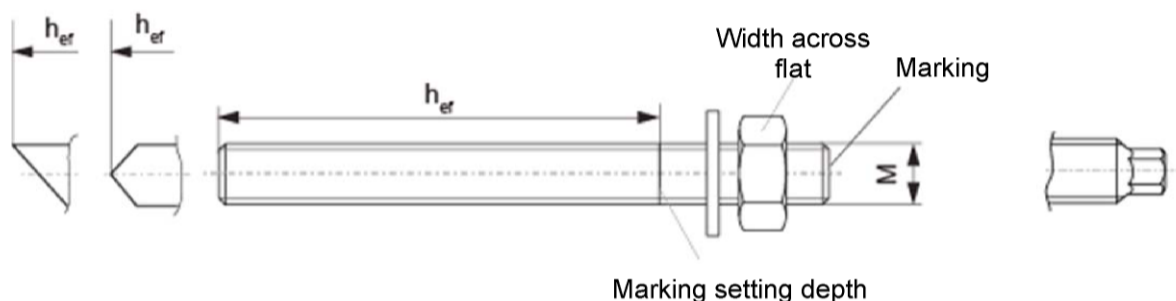
**Annex B 2**

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

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

### Upat threaded 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: ••

### 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 should be stored
- Marking of embedment depth

Upat injection system UPM 55

**Intended Use**  
Installation parameters anchor rods

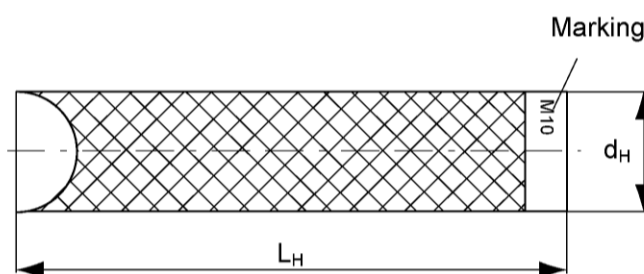
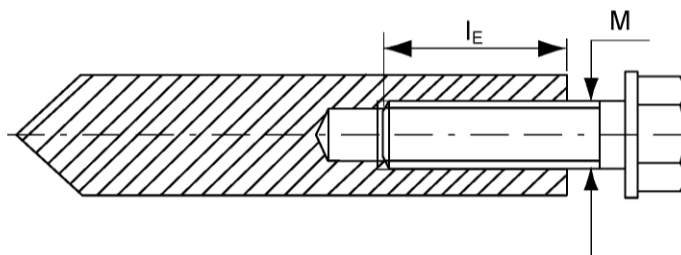
**Annex B 3**

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

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

<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

### Upat 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**

Fastening screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of Table A1

Upat injection system UPM 55

**Intended Use**

Installation parameters internal threaded anchors IST

**Annex B 4**

**Table B4: Installation parameters reinforcing bars**

| Reinforcing bar                           | $\phi$                   | 8                           | 10  | 12              | 14  | 16  | 18  | 20  | 22  | 24  |
|-------------------------------------------|--------------------------|-----------------------------|-----|-----------------|-----|-----|-----|-----|-----|-----|
| Nominal drill bit diameter                | $d_0$ [mm]               | 12                          | 14  | 16              | 18  | 20  | 25  | 25  | 30  | 30  |
| Drill hole depth                          | $h_0$ [mm]               | $h_0 = h_{ef}$              |     |                 |     |     |     |     |     |     |
| Effective anchorage depth                 | $h_{ef,min}$ [mm]        | 60                          | 60  | 70              | 75  | 80  | 85  | 90  | 94  | 98  |
|                                           | $h_{ef,max}$ [mm]        | 160                         | 200 | 240             | 280 | 320 | 360 | 400 | 440 | 480 |
| Minimum spacing and minimum edge distance | $s_{min} = c_{min}$ [mm] | 40                          | 45  | 55              | 60  | 65  | 75  | 85  | 95  | 105 |
| Minimum thickness of concrete member      | $h_{min}$ [mm]           | $h_{ef} + 30$<br>$\geq 100$ |     | $h_{ef} + 2d_0$ |     |     |     |     |     |     |

| Reinforcing bar                           | $\phi$                   | 25              | 26  | 28  | 30  | 32  | 34  | 36  | 40  |
|-------------------------------------------|--------------------------|-----------------|-----|-----|-----|-----|-----|-----|-----|
| Nominal drill bit diameter                | $d_0$ [mm]               | 30              | 35  | 35  | 40  | 40  | 40  | 45  | 55  |
| Drill hole depth                          | $h_0$ [mm]               | $h_0 = h_{ef}$  |     |     |     |     |     |     |     |
| Effective anchorage depth                 | $h_{ef,min}$ [mm]        | 100             | 104 | 112 | 120 | 128 | 136 | 144 | 160 |
|                                           | $h_{ef,max}$ [mm]        | 500             | 520 | 560 | 600 | 640 | 680 | 720 | 800 |
| Minimum spacing and minimum edge distance | $s_{min} = c_{min}$ [mm] | 110             | 120 | 130 | 140 | 160 | 170 | 180 | 200 |
| Minimum thickness of concrete member      | $h_{min}$ [mm]           | $h_{ef} + 2d_0$ |     |     |     |     |     |     |     |

**Reinforcing bar**



- The minimum value of related rip area  $f_{R,min}$  according to EN 1992-1-1:2004+AC:2010
- The maximum outer rebar diameter over the ribs shall be:
  - The nominal diameter of the rip  $\phi + 2 * h$  ( $h \leq 0,07 * \phi$ )
  - ( $\phi$ : Nominal diameter of the bar;  $h$ : rip height of the bar)

Upat injection system UPM 55

**Intended Use**

Installation parameters reinforcing bars

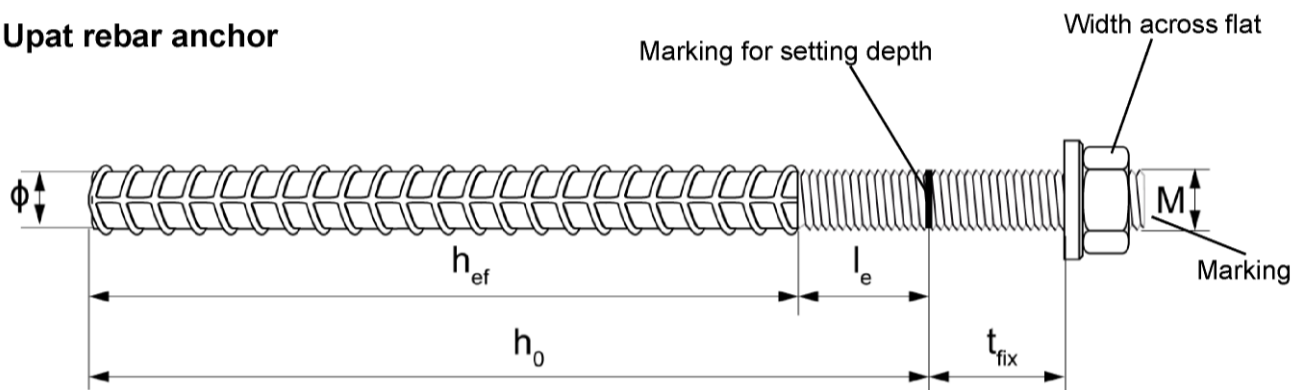
**Annex B 5**

**Table B5:** Installation parameters Upat rebar anchor

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

<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

**Upat rebar anchor**



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

Upat injection system UPM 55

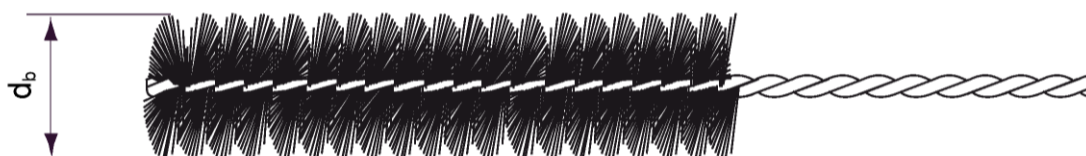
**Intended Use**

Installation parameters Upat rebar anchor

**Annex B 6**

**Table B6: Parameters of steel brush**

|                            |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------------------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Drill bit diameter         | [mm] | 12 | 14 | 16 | 18 | 20 | 24 | 25 | 28 | 30 | 32 | 35 | 40 | 45 | 55 |
| Steel brush diameter $d_b$ | [mm] | 14 | 16 | 20 |    | 25 | 26 | 27 | 30 | 40 |    |    | 42 | 47 | 58 |



**Table B7: Maximum processing time of the mortar and minimum curing time**

| System temperature<br>[°C] | Maximum processing time $t_{work}$<br>[minutes] | Minimum curing time <sup>1)</sup> $t_{cure}$<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 doublet.

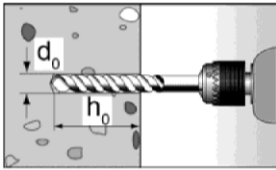
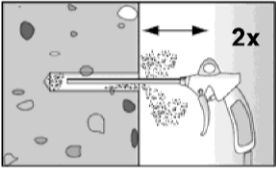
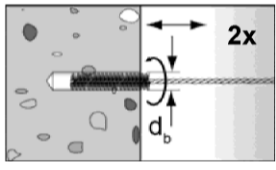
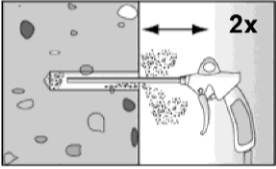
Upat injection system UPM 55

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

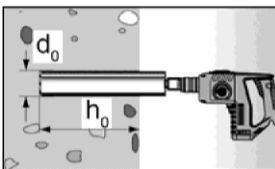
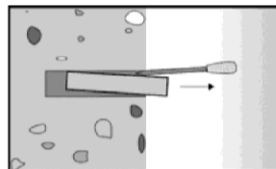
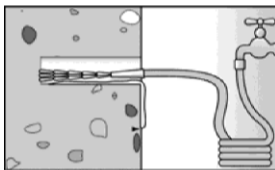
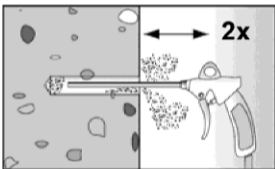
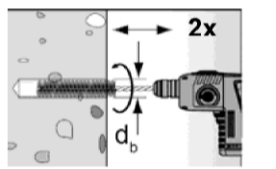
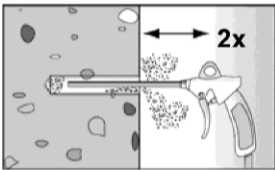
**Annex B 7**

## Installation instructions part 1

### Drilling and cleaning the hole (hammer drill)

|   |                                                                                    |                                                                                                                                                                    |                                                                                      |
|---|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 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 |   | Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air ( $p \geq 6$ bar)                                                           |   |
| 3 |   | Brush the drill hole two times. 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 |  | Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air ( $p \geq 6$ bar)                                                           |  |

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

|   |                                                                                     |                                                                                                              |                                                                                      |                                                                                      |                                                                                                        |
|---|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| 1 |  | Drill the hole.<br>Drill hole diameter $d_0$ and 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 until<br>the water comes clear.                                                         |                                                                                      |                                                                                      |                                                                                                        |
| 3 |  | Blow out the drill hole<br>two times, using oil-<br>free compressed air<br>( $p > 6$ bar)                    | 4                                                                                    |  | Brush the drill hole two<br>times using a power<br>drill. Corresponding<br>brushes see <b>Table B6</b> |
| 5 |  | Blow out the drill hole<br>two times, using oil-<br>free compressed air<br>( $p > 6$ bar)                    |                                                                                      |                                                                                      |                                                                                                        |

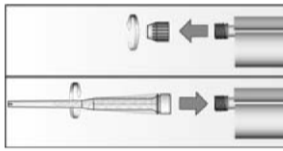
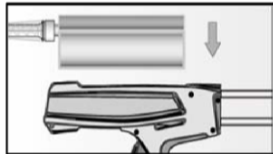
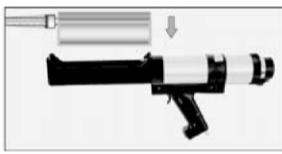
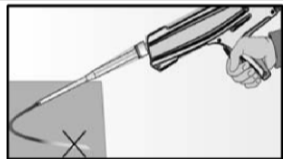
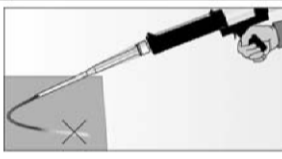
Upat injection system UPM 55

**Intended use**  
Installation instructions part 1

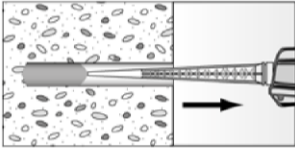
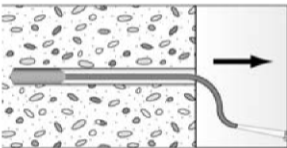
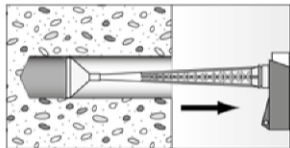
**Annex B 8**

## Installation instructions part 2

### Preparing the cartridge

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

### Injection of the mortar

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

Upat injection system UPM 55

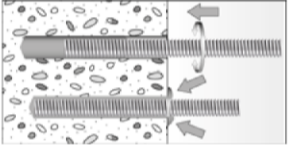
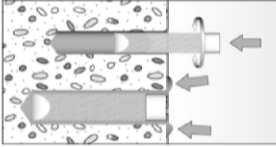
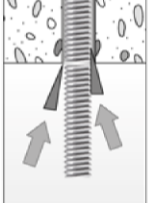
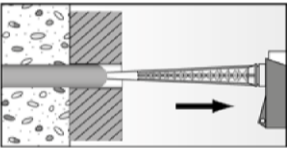
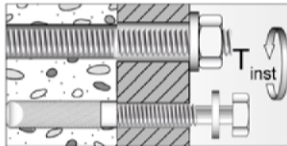
**Intended use**

Installation instructions part 2

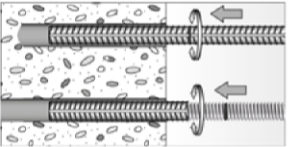
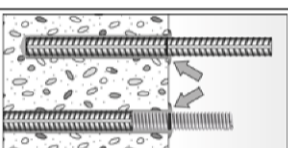
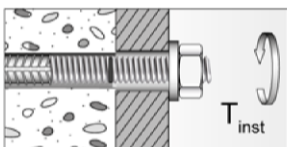
**Annex B 9**

### Installation instructions part 3

#### Installation threaded rods or Upat 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 anchor down to the bottom of the hole, turning it slightly while doing so. After inserting the anchor element, excess mortar must emerge around the anchor element.</p> |
|    |  <p>For overhead installation fasten the threaded rod with wedges until the mortar begins to harden</p> |  <p>For push-through installation fill the annular gap also with mortar</p>                                                                                                                                             |
| 11 |  <p>Wait for the specified curing time<br/><math>t_{\text{cure}}</math> see Table B7.</p>              |  <p>Mounting the fixture<br/><math>T_{\text{inst,max}}</math> see Tables B2 and B3.</p>                                                                                                                                |

#### Installation reinforcing bars and Upat rebar anchor

|    |                                                                                                                                                                              |                                                                                                                                                                                                                                         |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9  |                                                                                           | <p>Only use clean and oil-free reinforcing bars or Upat rebar anchor. Mark the setting depth. Using a turning movement, push the reinforcing bar or rebar anchor vigorously into the filled hole up to the insertion depth marking.</p> |
|    |                                                                                           | <p>When reaching the setting depth mark, excess mortar must emerge from the mouth of the drill hole.</p>                                                                                                                                |
| 10 |  <p>Wait for the specified curing time<br/><math>t_{\text{cure}}</math> see Table B7.</p> |  <p>Mounting the fixture<br/><math>T_{\text{inst,max}}</math> see Table B5.</p>                                                                     |

Upat injection system UPM 55

Intended use  
Installation instructions part 3

Annex B 10

**Table C1:** Characteristic values of resistance for threaded rods under tension load  
(un-cracked concrete)

| Size                                                         |                      |                          |                      | M8                   | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|--------------------------------------------------------------|----------------------|--------------------------|----------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation safety factor                                   | dry and wet concrete | $\gamma_2 =$             | [-]                  | 1,0                  |     |     |     |     |     | 1,2 |     |     |     |
|                                                              | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,4                  |     |     |     |     |     |     |     |     |     |
| Steel failure                                                |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Characteristic resistance                                    |                      | $N_{Rk,s}$               | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |     |     |     |     |     |     |
| Combined pullout and concrete cone failure                   |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Diameter of calculation                                      |                      | d                        | [mm]                 | 8                    | 10  | 12  | 14  | 16  | 20  | 22  | 24  | 27  | 30  |
| Characteristic bond resistance in un-cracked concrete C20/25 |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Hammer-drilling (dry and wet concrete)                       |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>(1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 16                   | 16  | 15  | 14  | 14  | 13  | 13  | 13  | 12  | 12  |
| Temperature range II <sup>(1)</sup>                          |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 14  | 13  | 13  | 12  | 12  | 12  | 11  | 11  |
| Hammer-drilling (flooded hole)                               |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>(1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 16                   | 16  | 15  | 13  | 13  | 11  | 11  | 10  | 10  | 9   |
| Temperature range II <sup>(1)</sup>                          |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 14  | 13  | 12  | 11  | 10  | 10  | 9   | 9   |
| Diamond-drilling (dry and wet concrete)                      |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>(1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 16                   | 15  | 13  | 12  | 12  | 10  | 10  | 10  | 9   | 9   |
| Temperature range II <sup>(1)</sup>                          |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 12  | 11  | 11  | 10  | 9   | 9   | 8   | 8   |
| Diamond-drilling (flooded hole)                              |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>(1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 16                   | 15  | 13  | 12  | 12  | 10  | 10  | 10  | 9   | 9   |
| Temperature range II <sup>(1)</sup>                          |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 12  | 11  | 11  | 10  | 9   | 9   | 8   | 8   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1               |                      | $k_{ucr}$                | [-]                  | 10,1                 |     |     |     |     |     |     |     |     |     |
| Increasing factor for $\tau_{Rk}$                            | $\Psi_c$             | C25/30                   | [-]                  | 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                                                | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                 | $1,0 h_{ef}$         |     |     |     |     |     |     |     |     |     |
|                                                              |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |     |     |     |     |     |     |
|                                                              |                      | $h / h_{ef} \leq 1,3$    | [mm]                 | $2,26 h_{ef}$        |     |     |     |     |     |     |     |     |     |
| Axial distance                                               | $s_{cr,sp}$          |                          | [mm]                 | $2 c_{cr,sp}$        |     |     |     |     |     |     |     |     |     |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values for static or quasi-static action under tension load for threaded rods (un-cracked concrete)

**Annex C 1**

**Table C1.1: Characteristic values of resistance for threaded rods under tension load  
(cracked concrete)**

| Size                                                        |                      |                          |                      | M8                   | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|-------------------------------------------------------------|----------------------|--------------------------|----------------------|----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation safety factor                                  | dry and wet concrete | $\gamma_2 =$             | [-]                  | 1,0                  |     |     |     |     |     | 1,2 |     |     |     |
|                                                             | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,2                  |     |     |     |     | 1,4 |     |     |     |     |
| Steel failure                                               |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Characteristic resistance                                   |                      | $N_{Rk,s}$               | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |     |     |     |     |     |     |
| Combined pullout and concrete cone failure                  |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Diameter of calculation                                     |                      | d                        | [mm]                 | 8                    | 10  | 12  | 14  | 16  | 20  | 22  | 24  | 27  | 30  |
| Characteristic bond resistance in cracked concrete C20/25   |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Hammer-drilling and diamond drilling (dry and wet concrete) |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                           |                      | $\tau_{Rk,cr}$           | [N/mm <sup>2</sup> ] | 7                    | 7   | 7   | 7   | 6   | 6   | 7   | 7   | 7   | 7   |
| Temperature range II <sup>1)</sup>                          |                      | $\tau_{Rk,cr}$           | [N/mm <sup>2</sup> ] | 7                    | 7   | 7   | 7   | 6   | 6   | 7   | 7   | 7   | 7   |
| Hammer-drilling and diamond drilling (flooded hole)         |                      |                          |                      |                      |     |     |     |     |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                           |                      | $\tau_{Rk,cr}$           | [N/mm <sup>2</sup> ] | 6                    | 7,5 | 7,5 | 7   | 6   | 6   | 6   | 6   | 6   | 6   |
| Temperature range II <sup>1)</sup>                          |                      | $\tau_{Rk,cr}$           | [N/mm <sup>2</sup> ] | 6                    | 7   | 7   | 7   | 6   | 6   | 6   | 6   | 6   | 6   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1              |                      | $k_{cr}$                 | [-]                  | 7,2                  |     |     |     |     |     |     |     |     |     |
| Increasing factor for $\tau_{Rk}$                           | $\Psi_c$             | C25/30                   | [-]                  | 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                                               | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                 | $1,0 h_{ef}$         |     |     |     |     |     |     |     |     |     |
|                                                             |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |     |     |     |     |     |     |
|                                                             |                      | $h / h_{ef} \leq 1,3$    | [mm]                 | $2,26 h_{ef}$        |     |     |     |     |     |     |     |     |     |
| Axial distance                                              | $s_{cr,sp}$          |                          | [mm]                 | $2 c_{cr,sp}$        |     |     |     |     |     |     |     |     |     |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values for static or quasi-static action under tension load for threaded rods (cracked concrete)

**Annex C 2**

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

| Size                                                                                                           |                            | M8                 | M10 | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |    |
|----------------------------------------------------------------------------------------------------------------|----------------------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Installation safety factor                                                                                     | $\gamma_2 = \gamma_{inst}$ | [-]                |     |     |     |     |     |     |     |     |     |    |
| 1,0                                                                                                            |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Steel failure without lever arm                                                                                |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Characteristic steel resistance                                                                                | $V_{Rk,s}$                 | [kN]               |     |     |     |     |     |     |     |     |     |    |
| $0,5 \cdot A_s \cdot f_{uk}$                                                                                   |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1                                                  | $k_2$                      | [-]                |     |     |     |     |     |     |     |     |     |    |
| 0,8                                                                                                            |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Steel failure with lever arm                                                                                   |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Characteristic bending moment <sup>1)</sup>                                                                    | $M^0_{Rk,s}$               | [Nm]               |     |     |     |     |     |     |     |     |     |    |
| $1,2 \cdot W_{el} \cdot f_{uk}$                                                                                |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Concrete pryout failure                                                                                        |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Factor k acc. to TR029 Section 5.2.3.3 resp. $k_3$ acc. to CEN/TS 1992-4-5:2009 Section 6.3.3                  | $k_{(3)}$                  | [-]                |     |     |     |     |     |     |     |     |     |    |
| 2,0                                                                                                            |                            |                    |     |     |     |     |     |     |     |     |     |    |
| Concrete edge failure                                                                                          |                            |                    |     |     |     |     |     |     |     |     |     |    |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: |                            | $\min(h_{ef}; 8d)$ |     |     |     |     |     |     |     |     |     |    |
| Diameter of calculation                                                                                        | d                          | [mm]               | 8   | 10  | 12  | 14  | 16  | 20  | 22  | 24  | 27  | 30 |

Upat injection system UPM 55

**Performances**

Characteristic values for static or quasi-static action under shear load for threaded rods

**Annex C 3**

**Table C3:** Characteristic values of resistance for internal threaded anchors IST under tension load (un-cracked concrete)

| Size                                                         |                      |                          |                      | M8                   | M10 | M12 | M16 | M20 |
|--------------------------------------------------------------|----------------------|--------------------------|----------------------|----------------------|-----|-----|-----|-----|
| Installation safety factor                                   | dry and wet concrete | $\gamma_2 =$             | [-]                  | 1,0                  |     |     | 1,2 |     |
|                                                              | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,2                  |     |     | 1,4 |     |
| Steel failure                                                |                      |                          |                      |                      |     |     |     |     |
| Characteristic resistance with screw                         |                      | $N_{Rk,s}$               | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |     |
| Combined pullout and concrete cone failure                   |                      |                          |                      |                      |     |     |     |     |
| Diameter of calculation                                      |                      | d                        | [mm]                 | 12                   | 16  | 18  | 22  | 28  |
| Characteristic bond resistance in un-cracked concrete C20/25 |                      |                          |                      |                      |     |     |     |     |
| Hammer-drilling (dry and wet concrete)                       |                      |                          |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 14  | 13  | 12  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 14                   | 13  | 13  | 12  | 11  |
| Hammer-drilling (flooded hole)                               |                      |                          |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 14                   | 12  | 12  | 11  | 10  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 13                   | 12  | 11  | 10  | 9   |
| Diamond-drilling (dry and wet concrete)                      |                      |                          |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 13                   | 12  | 11  | 10  | 9   |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 12                   | 11  | 10  | 9   | 8   |
| Diamond-drilling (flooded hole)                              |                      |                          |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 13                   | 12  | 11  | 10  | 9   |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 12                   | 11  | 10  | 9   | 8   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1               |                      | $k_{ucr}$                | [-]                  | 10,1                 |     |     |     |     |
| Increasing factor for $\tau_{Rk}$                            | $\Psi_c$             | C25/30                   | [-]                  | 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                                                | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                 | $1,0 h_{ef}$         |     |     |     |     |
|                                                              |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |     |
|                                                              |                      | $h / h_{ef} \leq 1,3$    | [mm]                 | $2,26 h_{ef}$        |     |     |     |     |
| Axial distance                                               | $s_{cr,sp}$          |                          | [mm]                 | $2 c_{cr,sp}$        |     |     |     |     |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

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

**Annex C 4**

**Table C3.1:** Characteristic values of resistance for internal threaded anchors IST under tension load (cracked concrete)

| Size                                                        |                      |                            |                      | M8                   | M10 | M12 | M16 | M20 |
|-------------------------------------------------------------|----------------------|----------------------------|----------------------|----------------------|-----|-----|-----|-----|
| Installation safety factor                                  | dry and wet concrete | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0                  |     |     | 1,2 |     |
|                                                             | flooded hole         |                            | [-]                  | 1,2                  |     |     | 1,4 |     |
| Steel failure                                               |                      |                            |                      |                      |     |     |     |     |
| Characteristic resistance with screw                        |                      | $N_{Rk,s}$                 | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |     |
| Combined pullout and concrete cone failure                  |                      |                            |                      |                      |     |     |     |     |
| Diameter of calculation                                     |                      | $d_H$                      | [mm]                 | 12                   | 16  | 18  | 22  | 28  |
| Characteristic bond resistance in cracked concrete C20/25   |                      |                            |                      |                      |     |     |     |     |
| Hammer-drilling and diamond drilling (dry and wet concrete) |                      |                            |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                           |                      | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 7   | 7   |
| Temperature range II <sup>1)</sup>                          |                      | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 7   | 7   |
| Hammer-drilling and diamond drilling (flooded hole)         |                      |                            |                      |                      |     |     |     |     |
| Temperature range I <sup>1)</sup>                           |                      | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7                    | 6,5 | 6   | 6   | 6   |
| Temperature range II <sup>1)</sup>                          |                      | $\tau_{Rk,cr}$             | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 6   | 6   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1              |                      | $k_{cr}$                   | [-]                  | 7,2                  |     |     |     |     |
| Increasing factor for $\tau_{Rk}$                           | $\Psi_c$             | C25/30                     | [-]                  | 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                                               | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$      | [mm]                 | $1,0 h_{ef}$         |     |     |     |     |
|                                                             |                      | $2,0 > h / h_{ef} > 1,3$   | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |     |
|                                                             |                      | $h / h_{ef} \leq 1,3$      | [mm]                 | $2,26 h_{ef}$        |     |     |     |     |
| Axial distance                                              | $s_{cr,sp}$          |                            | [mm]                 | $2 c_{cr,sp}$        |     |     |     |     |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

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

**Annex C 5**

**Table C4:** Characteristic values of resistance for internal threaded anchors IST under shear load

| Size                                                                                                           |                            |      | M8                              | M10 | M12 | M16 | M20 |
|----------------------------------------------------------------------------------------------------------------|----------------------------|------|---------------------------------|-----|-----|-----|-----|
| Installation safety factor                                                                                     | $\gamma_2 = \gamma_{inst}$ | [-]  | 1,0                             |     |     |     |     |
| Steel failure without lever arm                                                                                |                            |      |                                 |     |     |     |     |
| Characteristic resistance with screw                                                                           | $V_{Rk,s}$                 | [-]  | $0,5 \cdot A_s \cdot f_{uk}$    |     |     |     |     |
| Ductility factor acc. to CEN/TS 1992-4-5: 2009 Section 6.3.2.1                                                 | $k_2$                      | [-]  | 0,8                             |     |     |     |     |
| Steel failure with lever arm                                                                                   |                            |      |                                 |     |     |     |     |
| Characteristic bending moment with screw                                                                       | $M^0_{Rk,s}$               | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}$ |     |     |     |     |
| Concrete pryout failure                                                                                        |                            |      |                                 |     |     |     |     |
| Factor k acc. to TR029 Section 5.2.3.3 resp. $k_3$ acc. to CEN/TS 1992-4-5:2009 Section 6.3.3                  | $k_{(3)}$                  | [-]  | 2,0                             |     |     |     |     |
| Concrete edge failure                                                                                          |                            |      |                                 |     |     |     |     |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: |                            |      | $\min(h_{ef}, 8d)$              |     |     |     |     |
| Diameter of calculation                                                                                        | d                          | [mm] | 12                              | 16  | 18  | 22  | 28  |

Upat injection system UPM 55

**Performances**

Characteristic values for static or quasi-static action under shear load for internal threaded anchors IST

**Annex C 6**

**Table C5:** Characteristic values of resistance for reinforcing bars under tension loads  
(hammer-drilling; un-cracked concrete;  $\phi$  8-  $\phi$  24)

| Reinforcing bar                                       |                      |                          |                 | $\phi$               | 8                  | 10 | 12 | 14 | 16 | 18 | 20 | 22  | 24 |
|-------------------------------------------------------|----------------------|--------------------------|-----------------|----------------------|--------------------|----|----|----|----|----|----|-----|----|
| Installation safety factor                            | dry and wet concrete | $\gamma_2 =$             | [-]             | 1,0                  |                    |    |    |    |    |    |    | 1,2 |    |
|                                                       | flooded hole         | $\gamma_{inst}$          | [-]             | 1,4                  |                    |    |    |    |    |    |    |     |    |
| Steel failure                                         |                      |                          |                 |                      |                    |    |    |    |    |    |    |     |    |
| Characteristic resistance                             |                      |                          | $N_{Rk,s}$      | [kN]                 | $A_s \cdot f_{uk}$ |    |    |    |    |    |    |     |    |
| Combined pullout and concrete cone failure            |                      |                          |                 |                      |                    |    |    |    |    |    |    |     |    |
| Diameter of calculation                               |                      |                          | d               | [mm]                 | 8                  | 10 | 12 | 14 | 16 | 18 | 20 | 22  | 24 |
| Characteristic bond resistance in un-cracked concrete |                      |                          |                 |                      |                    |    |    |    |    |    |    |     |    |
| Hammer-drilling (dry and wet concrete)                |                      |                          |                 |                      |                    |    |    |    |    |    |    |     |    |
| Temperature range I <sup>1)</sup>                     |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 16                 | 16 | 15 | 14 | 14 | 14 | 13 | 13  | 13 |
| Temperature range II <sup>1)</sup>                    |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                 | 14 | 14 | 13 | 13 | 13 | 12 | 12  | 12 |
| Hammer-drilling (flooded hole)                        |                      |                          |                 |                      |                    |    |    |    |    |    |    |     |    |
| Temperature range I <sup>1)</sup>                     |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 16                 | 16 | 14 | 13 | 12 | 12 | 11 | 11  | 10 |
| Temperature range II <sup>1)</sup>                    |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 15                 | 14 | 13 | 12 | 11 | 12 | 11 | 10  | 10 |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1        |                      |                          | $k_{ucr}$       | [-]                  | 10,1               |    |    |    |    |    |    |     |    |
| Increasing factor for $\tau_{Rk}$                     | $\Psi_c$             | C25/30                   | [-]             | 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                                         | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]            | $1,0 h_{ef}$         |                    |    |    |    |    |    |    |     |    |
|                                                       |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]            | $4,6 h_{ef} - 1,8 h$ |                    |    |    |    |    |    |    |     |    |
|                                                       |                      | $h / h_{ef} \leq 1,3$    | [mm]            | $2,26 h_{ef}$        |                    |    |    |    |    |    |    |     |    |
| Axial distance                                        | $s_{cr,sp}$          |                          | [mm]            | $2 c_{cr,sp}$        |                    |    |    |    |    |    |    |     |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars  
(hammer-drilling; un-cracked concrete;  $\phi$  8-  $\phi$  24)

**Annex C 7**

**Table C5.1:** Characteristic values of resistance for reinforcing bars under tension loads (hammer-drilling; un-cracked concrete  $\phi$  25-  $\phi$  40)

| Reinforcing bar                                       |                      |                          |                 | $\phi$               | 25                 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
|-------------------------------------------------------|----------------------|--------------------------|-----------------|----------------------|--------------------|----|----|----|----|----|----|----|
| Installation safety factor                            | dry and wet concrete | $\gamma_2 =$             | [-]             | 1,2                  |                    |    |    |    |    |    |    |    |
|                                                       | flooded hole         | $\gamma_{inst}$          | [-]             | 1,4                  |                    |    |    |    |    |    |    |    |
| Steel failure                                         |                      |                          |                 |                      |                    |    |    |    |    |    |    |    |
| Characteristic resistance                             |                      |                          | $N_{Rk,s}$      | [kN]                 | $A_s \cdot f_{uk}$ |    |    |    |    |    |    |    |
| Combined pullout and concrete cone failure            |                      |                          |                 |                      |                    |    |    |    |    |    |    |    |
| Diameter of calculation                               |                      |                          | d               | [mm]                 | 25                 | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
| Characteristic bond resistance in un-cracked concrete |                      |                          |                 |                      |                    |    |    |    |    |    |    |    |
| Hammer-drilling (dry and wet concrete)                |                      |                          |                 |                      |                    |    |    |    |    |    |    |    |
| Temperature range I <sup>1)</sup>                     |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 13                 | 13 | 13 | 12 | 12 | 12 | 12 | 12 |
| Temperature range II <sup>1)</sup>                    |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 12                 | 11 | 11 | 11 | 11 | 11 | 11 | 10 |
| Hammer-drilling (flooded hole)                        |                      |                          |                 |                      |                    |    |    |    |    |    |    |    |
| Temperature range I <sup>1)</sup>                     |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 10                 | 10 | 10 | 9  | 9  | 9  | 8  | 8  |
| Temperature range II <sup>1)</sup>                    |                      |                          | $\tau_{Rk,ucr}$ | [N/mm <sup>2</sup> ] | 9                  | 9  | 9  | 9  | 8  | 8  | 8  | 8  |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1        |                      |                          | $k_{ucr}$       | [-]                  | 10,1               |    |    |    |    |    |    |    |
| Increasing factor for $\tau_{Rk}$                     | $\Psi_c$             | C25/30                   | [-]             | 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                                         | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]            | 1,0 $h_{ef}$         |                    |    |    |    |    |    |    |    |
|                                                       |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]            | $4,6 h_{ef} - 1,8 h$ |                    |    |    |    |    |    |    |    |
|                                                       |                      | $h / h_{ef} \leq 1,3$    | [mm]            | 2,26 $h_{ef}$        |                    |    |    |    |    |    |    |    |
| Axial distance                                        | $s_{cr,sp}$          |                          | [mm]            | 2 $c_{cr,sp}$        |                    |    |    |    |    |    |    |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars (hammer-drilling; un-cracked concrete;  $\phi$  25-  $\phi$  40)

**Annex C 8**

**Table C5.2:** Characteristic values of resistance for reinforcing bars under tension loads  
(diamond-drilling; un-cracked concrete  $\phi$  8-  $\phi$  24)

| Reinforcing bar                                       |                      |                                 |                     | φ                           | 8                                | 10 | 12 | 14 | 16 | 18 | 20 | 22  | 24 |
|-------------------------------------------------------|----------------------|---------------------------------|---------------------|-----------------------------|----------------------------------|----|----|----|----|----|----|-----|----|
| Installation safety factor                            | dry and wet concrete | γ <sub>2</sub> =                | [-]                 | 1,0                         |                                  |    |    |    |    |    |    | 1,2 |    |
|                                                       | flooded hole         | γ <sub>inst</sub>               | [-]                 | 1,4                         |                                  |    |    |    |    |    |    |     |    |
| Steel failure                                         |                      |                                 |                     |                             |                                  |    |    |    |    |    |    |     |    |
| Characteristic resistance                             |                      |                                 | N <sub>Rk,s</sub>   | [kN]                        | A <sub>s</sub> • f <sub>uk</sub> |    |    |    |    |    |    |     |    |
| Combined pullout and concrete cone failure            |                      |                                 |                     |                             |                                  |    |    |    |    |    |    |     |    |
| Diameter of calculation                               |                      |                                 | d                   | [mm]                        | 8                                | 10 | 12 | 14 | 16 | 18 | 20 | 22  | 24 |
| Characteristic bond resistance in un-cracked concrete |                      |                                 |                     |                             |                                  |    |    |    |    |    |    |     |    |
| Diamond-drilling (dry and wet concrete)               |                      |                                 |                     |                             |                                  |    |    |    |    |    |    |     |    |
| Temperature range I <sup>1)</sup>                     |                      |                                 | τ <sub>Rk,ucr</sub> | [N/mm²]                     | 16                               | 15 | 13 | 12 | 12 | 11 | 10 | 10  | 10 |
| Temperature range II <sup>1)</sup>                    |                      |                                 | τ <sub>Rk,ucr</sub> | [N/mm²]                     | 15                               | 14 | 12 | 11 | 11 | 10 | 10 | 9   | 9  |
| Diamond-drilling (flooded hole)                       |                      |                                 |                     |                             |                                  |    |    |    |    |    |    |     |    |
| Temperature range I <sup>1)</sup>                     |                      |                                 | τ <sub>Rk,ucr</sub> | [N/mm²]                     | 16                               | 15 | 13 | 12 | 12 | 11 | 10 | 10  | 10 |
| Temperature range II <sup>1)</sup>                    |                      |                                 | τ <sub>Rk,ucr</sub> | [N/mm²]                     | 15                               | 14 | 12 | 11 | 11 | 10 | 10 | 9   | 9  |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1        |                      |                                 | k <sub>ucr</sub>    | [-]                         | 10,1                             |    |    |    |    |    |    |     |    |
| Increasing factor for τ <sub>Rk</sub>                 | Ψ <sub>c</sub>       | C25/30                          | [-]                 | 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                                         | c <sub>cr,sp</sub>   | h / h <sub>ef</sub> ≥ 2,0       | [mm]                | 1,0 h <sub>ef</sub>         |                                  |    |    |    |    |    |    |     |    |
|                                                       |                      | 2,0 > h / h <sub>ef</sub> > 1,3 | [mm]                | 4,6 h <sub>ef</sub> – 1,8 h |                                  |    |    |    |    |    |    |     |    |
|                                                       |                      | h / h <sub>ef</sub> ≤ 1,3       | [mm]                | 2,26 h <sub>ef</sub>        |                                  |    |    |    |    |    |    |     |    |
| Axial distance                                        | s <sub>cr,sp</sub>   |                                 | [mm]                | 2 c <sub>cr,sp</sub>        |                                  |    |    |    |    |    |    |     |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars  
(diamond-drilling; un-cracked concrete;  $\phi$  8-  $\phi$  24)

**Annex C 9**

**Table C5.3:** Characteristic values of resistance for reinforcing bars under tension loads  
(diamond-drilling; un-cracked concrete  $\phi$  25-  $\phi$  40)

| Reinforcing bar                                              |                      |                          | $\phi$               | 25                   | 26   | 28 | 30 | 32 | 34 | 36 | 40 |
|--------------------------------------------------------------|----------------------|--------------------------|----------------------|----------------------|------|----|----|----|----|----|----|
| Installation safety factor                                   | dry and wet concrete | $\gamma_2 =$             | [-]                  | 1,2                  |      |    |    |    |    |    |    |
|                                                              | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,4                  |      |    |    |    |    |    |    |
| Steel failure                                                |                      |                          |                      |                      |      |    |    |    |    |    |    |
| Characteristic resistance                                    |                      | $N_{Rk,s}$               | [kN]                 | $A_s \cdot f_{uk}$   |      |    |    |    |    |    |    |
| Combined pullout and concrete cone failure                   |                      |                          |                      |                      |      |    |    |    |    |    |    |
| Diameter of calculation                                      |                      | d                        | [mm]                 | 25                   | 26   | 28 | 30 | 32 | 34 | 36 | 40 |
| Characteristic bond resistance in un-cracked concrete C20/25 |                      |                          |                      |                      |      |    |    |    |    |    |    |
| Diamond-drilling (dry and wet concrete)                      |                      |                          |                      |                      |      |    |    |    |    |    |    |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 9                    | 9    | 9  | 9  | 8  | 8  | 8  | 7  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 9                    | 8    | 8  | 8  | 8  | 7  | 7  | 7  |
| Diamond-drilling (flooded hole)                              |                      |                          |                      |                      |      |    |    |    |    |    |    |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 9                    | 9    | 9  | 9  | 8  | 8  | 8  | 7  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 9                    | 8    | 8  | 8  | 8  | 7  | 7  | 7  |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1               |                      |                          | $k_{ucr}$            | [-]                  | 10,1 |    |    |    |    |    |    |
| Increasing factor for $\tau_{Rk}$                            | $\Psi_c$             | C25/30                   | [-]                  | 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                                                | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                 | 1,0 $h_{ef}$         |      |    |    |    |    |    |    |
|                                                              |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |      |    |    |    |    |    |    |
|                                                              |                      | $h / h_{ef} \leq 1,3$    | [mm]                 | 2,26 $h_{ef}$        |      |    |    |    |    |    |    |
| Axial distance                                               | $s_{cr,sp}$          |                          | [mm]                 | 2 $c_{cr,sp}$        |      |    |    |    |    |    |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars  
(diamond-drilling; un-cracked concrete;  $\phi$  25-  $\phi$  40)

**Annex C 10**

**Table C5.4:** Characteristic values of resistance for reinforcing bars under tension loads  
(cracked concrete  $\phi$  8-  $\phi$  24)

| Reinforcing bar                                             |                      |                          | $\phi$                               | 8                    | 10  | 12  | 14  | 16  | 18 | 20  | 22  | 24 |
|-------------------------------------------------------------|----------------------|--------------------------|--------------------------------------|----------------------|-----|-----|-----|-----|----|-----|-----|----|
| Installation safety factor                                  | dry and wet concrete | $\gamma_2 =$             | [-]                                  | 1,0                  |     |     |     |     |    |     | 1,2 |    |
|                                                             | flooded hole         | $\gamma_{inst}$          | [-]                                  | 1,2                  |     |     |     |     |    | 1,4 |     |    |
| Steel failure                                               |                      |                          |                                      |                      |     |     |     |     |    |     |     |    |
| Characteristic resistance                                   |                      |                          | $N_{Rk,s}$ [kN]                      | $A_s \cdot f_{uk}$   |     |     |     |     |    |     |     |    |
| Combined pullout and concrete cone failure                  |                      |                          |                                      |                      |     |     |     |     |    |     |     |    |
| Diameter of calculation                                     |                      |                          | d [mm]                               | 8                    | 10  | 12  | 14  | 16  | 18 | 20  | 22  | 24 |
| Characteristic bond resistance in cracked concrete          |                      |                          |                                      |                      |     |     |     |     |    |     |     |    |
| Hammer-drilling and diamond-drilling (dry and wet concrete) |                      |                          |                                      |                      |     |     |     |     |    |     |     |    |
| Temperature range I <sup>1)</sup>                           |                      |                          | $\tau_{Rk,ucr}$ [N/mm <sup>2</sup> ] | 7                    | 7   | 7   | 7   | 6   | 6  | 6   | 7   | 7  |
| Temperature range II <sup>1)</sup>                          |                      |                          | $\tau_{Rk,ucr}$ [N/mm <sup>2</sup> ] | 7                    | 7   | 7   | 7   | 6   | 6  | 6   | 7   | 7  |
| Hammer-drilling and diamond-drilling (flooded hole)         |                      |                          |                                      |                      |     |     |     |     |    |     |     |    |
| Temperature range I <sup>1)</sup>                           |                      |                          | $\tau_{Rk,ucr}$ [N/mm <sup>2</sup> ] | 6                    | 7,5 | 6,5 | 6,5 | 6,5 | 6  | 6   | 6   | 6  |
| Temperature range II <sup>1)</sup>                          |                      |                          | $\tau_{Rk,ucr}$ [N/mm <sup>2</sup> ] | 6                    | 6,5 | 6,5 | 6   | 6   | 6  | 6   | 6   | 6  |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1              |                      |                          | $k_{cr}$ [-]                         | 7,2                  |     |     |     |     |    |     |     |    |
| Increasing factor for $\tau_{Rk}$                           | $\Psi_c$             | C25/30                   | [-]                                  | 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                                               | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                                 | $1,0 h_{ef}$         |     |     |     |     |    |     |     |    |
|                                                             |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |     |    |     |     |    |
|                                                             |                      | $h / h_{ef} \leq 1,3$    | [mm]                                 | $2,26 h_{ef}$        |     |     |     |     |    |     |     |    |
| Axial distance                                              | $s_{cr,sp}$          |                          | [mm]                                 | $2 c_{cr,sp}$        |     |     |     |     |    |     |     |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars  
(cracked concrete;  $\phi$  8-  $\phi$  24)

**Annex C 11**

**Table C5.5:** Characteristic values of resistance for reinforcing bars under tension loads  
(cracked concrete  $\phi$  25-  $\phi$  40)

| Reinforcing bar                                             |                          |                 |                      | $\phi$               | 25  | 26 | 28 | 30 | 32 | 34 | 36 | 40 |
|-------------------------------------------------------------|--------------------------|-----------------|----------------------|----------------------|-----|----|----|----|----|----|----|----|
| Installation safety factor                                  | dry and wet concrete     | $\gamma_2 =$    | [-]                  | 1,2                  |     |    |    |    |    |    |    |    |
|                                                             | flooded hole             | $\gamma_{inst}$ | [-]                  | 1,4                  |     |    |    |    |    |    |    |    |
| Steel failure                                               |                          |                 |                      |                      |     |    |    |    |    |    |    |    |
| Characteristic steel resistance                             |                          | $N_{Rk,s}$      | [kN]                 | $A_s \cdot f_{uk}$   |     |    |    |    |    |    |    |    |
| Combined pullout and concrete cone failure                  |                          |                 |                      |                      |     |    |    |    |    |    |    |    |
| Diameter of calculation                                     |                          | d               | [mm]                 | 25                   | 26  | 28 | 30 | 32 | 34 | 36 | 40 |    |
| Characteristic bond resistance in cracked concrete C20/25   |                          |                 |                      |                      |     |    |    |    |    |    |    |    |
| Hammer-drilling and diamond drilling (dry and wet concrete) |                          |                 |                      |                      |     |    |    |    |    |    |    |    |
| Temperature range I <sup>(1)</sup>                          |                          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7                    | 7   | 7  | 7  | 5  | 5  | 5  | 5  |    |
| Temperature range II <sup>(1)</sup>                         |                          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 7                    | 7   | 7  | 7  | 5  | 5  | 5  | 5  |    |
| Hammer-drilling and diamond drilling (flooded hole)         |                          |                 |                      |                      |     |    |    |    |    |    |    |    |
| Temperature range I <sup>(1)</sup>                          |                          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 6                    | 6   | 6  | 6  | 5  | 5  | 5  | 5  |    |
| Temperature range II <sup>(1)</sup>                         |                          | $\tau_{Rk,cr}$  | [N/mm <sup>2</sup> ] | 6                    | 6   | 6  | 6  | 5  | 5  | 5  | 5  |    |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1              |                          |                 | $k_{cr}$             | [-]                  | 7,2 |    |    |    |    |    |    |    |
| Increasing factor for $\tau_{Rk}$                           | $\Psi_c$                 | C25/30          | [-]                  | 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 $c_{cr,sp}$                                   | $h / h_{ef} \geq 2,0$    |                 | [mm]                 | $1,0 h_{ef}$         |     |    |    |    |    |    |    |    |
|                                                             | $2,0 > h / h_{ef} > 1,3$ |                 | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |    |    |    |    |    |    |    |
|                                                             | $h / h_{ef} \leq 1,3$    |                 | [mm]                 | $2,26 h_{ef}$        |     |    |    |    |    |    |    |    |
| Axial distance                                              |                          | $s_{cr,sp}$     | [mm]                 | $2 c_{cr,sp}$        |     |    |    |    |    |    |    |    |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for rebars  
(cracked concrete;  $\phi$  25-  $\phi$  40)

**Annex C 12**

**Table C6:** Characteristic values of resistance for reinforcing bars under shear load ( $\phi$  8-  $\phi$  24)

| Reinforcing bar                                                                                                       | $\phi$                     | 8                          | 10 | 12                                      | 14 | 16 | 18 | 20 | 22 | 24 |     |    |  |  |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------|----|-----------------------------------------|----|----|----|----|----|----|-----|----|--|--|
| Installation safety factor                                                                                            | $\gamma_2 = \gamma_{inst}$ | [-]                        |    |                                         |    |    |    |    |    |    | 1,0 |    |  |  |
| Steel failure without lever arm                                                                                       |                            |                            |    |                                         |    |    |    |    |    |    |     |    |  |  |
| Characteristic steel resistance                                                                                       | $V_{Rk,s}$                 | [kN]                       |    | 0,5 • A <sub>s</sub> • f <sub>uk</sub>  |    |    |    |    |    |    |     |    |  |  |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1                                                         | k <sub>2</sub>             | [-]                        |    | 0,8                                     |    |    |    |    |    |    |     |    |  |  |
| Steel failure with lever arm                                                                                          |                            |                            |    |                                         |    |    |    |    |    |    |     |    |  |  |
| Characteristic bending moment                                                                                         | $M^0_{Rk,s}$               | [kN]                       |    | 1,2 • W <sub>el</sub> • f <sub>uk</sub> |    |    |    |    |    |    |     |    |  |  |
| Concrete pryout failure                                                                                               |                            |                            |    |                                         |    |    |    |    |    |    |     |    |  |  |
| Factor k acc. to TR029 Section 5.2.3.3 resp. k <sub>3</sub> acc. to CEN/TS 1992-4-5:2009 Section 6.3.3                | k <sub>(3)</sub>           | [-]                        |    | 2,0                                     |    |    |    |    |    |    |     |    |  |  |
| Concrete edge failure                                                                                                 |                            |                            |    |                                         |    |    |    |    |    |    |     |    |  |  |
| The value of h <sub>ef</sub> for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: |                            | min (h <sub>ef</sub> ; 8d) |    |                                         |    |    |    |    |    |    |     |    |  |  |
| Diameter of calculation                                                                                               | d                          | [mm]                       |    | 8                                       | 10 | 12 | 14 | 16 | 18 | 20 | 22  | 24 |  |  |

**Table C6.1:** Characteristic values of resistance for reinforcing bars under shear load ( $\phi$  25-  $\phi$  40)

| Reinforcing bar                                                                                                | $\phi$            | 25                              | 26 | 28 | 30 | 32 | 34 | 26 | 40 |
|----------------------------------------------------------------------------------------------------------------|-------------------|---------------------------------|----|----|----|----|----|----|----|
| Installation safety factor                                                                                     | $\gamma_2$ [-]    | 1,0                             |    |    |    |    |    |    |    |
| Steel failure without lever arm                                                                                |                   |                                 |    |    |    |    |    |    |    |
| Characteristic steel resistance                                                                                | $V_{Rk,s}$ [kN]   | $0,5 \cdot A_s \cdot f_{uk}$    |    |    |    |    |    |    |    |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1                                                  | $K_2$ [-]         | 0,8                             |    |    |    |    |    |    |    |
| Steel failure with lever arm                                                                                   |                   |                                 |    |    |    |    |    |    |    |
| Characteristic bending moment                                                                                  | $M^0_{Rk,s}$ [kN] | $1,2 \cdot W_{el} \cdot f_{uk}$ |    |    |    |    |    |    |    |
| Concrete pryout failure                                                                                        |                   |                                 |    |    |    |    |    |    |    |
| Factor k acc. to TR029 Section 5.2.3.3 resp. $k_3$ acc. to CEN/TS 1992-4-5:2009 Section 6.3.3                  | $k_{(3)}$ [-]     | 2,0                             |    |    |    |    |    |    |    |
| Concrete edge failure                                                                                          |                   |                                 |    |    |    |    |    |    |    |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: |                   | $\min(h_{ef}; 8d)$              |    |    |    |    |    |    |    |
| Diameter of calculation                                                                                        | d [mm]            | 25                              | 26 | 28 | 30 | 32 | 34 | 26 | 40 |

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action of rebars under shear loads

**Annex C 13**

**Table C7:** Characteristic values of resistance for Upat rebar anchors under tension loads (un-cracked concrete)

| Size                                                         |                      |                          |                      | M12                  | M16 | M20 | M24 |
|--------------------------------------------------------------|----------------------|--------------------------|----------------------|----------------------|-----|-----|-----|
| Installation safety factor                                   | dry and wet concrete | $\gamma_2 =$             | [-]                  | 1,0                  |     |     | 1,2 |
|                                                              | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,2                  |     |     | 1,4 |
| Steel failure                                                |                      |                          |                      |                      |     |     |     |
| Characteristic steel resistance                              |                      | $N_{Rk,s}$               | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |
| Partial safety factor                                        |                      | $\gamma_{Ms,N}^{2)}$     | [-]                  | 1,4                  |     |     |     |
| Combined pullout and concrete cone failure                   |                      |                          |                      |                      |     |     |     |
| Diameter of calculation                                      |                      | d                        | [mm]                 | 12                   | 16  | 20  | 25  |
| Characteristic bond resistance in un-cracked concrete C20/25 |                      |                          |                      |                      |     |     |     |
| Hammer-drilling (dry and wet concrete)                       |                      |                          |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 14  | 13  | 13  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 14                   | 13  | 12  | 12  |
| Hammer-drilling (flooded hole)                               |                      |                          |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 15                   | 13  | 11  | 10  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 14                   | 12  | 11  | 10  |
| Diamond-drilling (dry and wet concrete)                      |                      |                          |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 13                   | 12  | 10  | 10  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 12                   | 11  | 10  | 9   |
| Diamond-drilling (flooded hole)                              |                      |                          |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 13                   | 12  | 10  | 10  |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$          | [N/mm <sup>2</sup> ] | 12                   | 11  | 10  | 9   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1               |                      | $k_{ucr}$                | [-]                  | 10,1                 |     |     |     |
| Increasing factor for $\tau_{Rk}$                            | $\Psi_c$             | C25/30                   | [-]                  | 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                                                | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$    | [mm]                 | $1,0 h_{ef}$         |     |     |     |
|                                                              |                      | $2,0 > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |
|                                                              |                      | $h / h_{ef} \leq 1,3$    | [mm]                 | $2,26 h_{ef}$        |     |     |     |
| Axial distance                                               |                      | $s_{cr,sp}$              | [mm]                 | $2 c_{cr,sp}$        |     |     |     |

<sup>1)</sup> See Annex B 1

<sup>2)</sup> In absence of other national regulations

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for Upat rebar anchors (un-cracked concrete)

**Annex C 14**

**Table C7.1:** Characteristic values of resistance for Upat rebar anchors under tension load (hammer and diamond-drilling; cracked concrete)

| Size                                                         |                      |                            |                      | M12                  | M16 | M20 | M24 |
|--------------------------------------------------------------|----------------------|----------------------------|----------------------|----------------------|-----|-----|-----|
| Installation safety factor                                   | dry and wet concrete | $\gamma_2 =$               | [-]                  | 1,0                  |     |     | 1,2 |
|                                                              | flooded hole         | $\gamma_{inst}$            | [-]                  | 1,2                  |     |     | 1,4 |
| Steel failure                                                |                      |                            |                      |                      |     |     |     |
| Characteristic steel resistance                              |                      | $N_{Rk,s}$                 | [kN]                 | $A_s \cdot f_{uk}$   |     |     |     |
| Partial safety factor                                        |                      | $\gamma_{Ms,N}^{2)}$       | [-]                  | 1,4                  |     |     |     |
| Combined pullout and concrete cone failure                   |                      |                            |                      |                      |     |     |     |
| Diameter of calculation                                      |                      | d                          | [mm]                 | 12                   | 16  | 20  | 25  |
| Characteristic bond resistance in un-cracked concrete C20/25 |                      |                            |                      |                      |     |     |     |
| Hammer-drilling and diamond-drilling (dry and wet concrete)  |                      |                            |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 7   |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 7   |
| Hammer-drilling diamond-drilling (flooded hole)              |                      |                            |                      |                      |     |     |     |
| Temperature range I <sup>1)</sup>                            |                      | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 6   |
| Temperature range II <sup>1)</sup>                           |                      | $\tau_{Rk,ucr}$            | [N/mm <sup>2</sup> ] | 7                    | 6   | 6   | 6   |
| Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1               |                      | $k_{cr}$                   | [-]                  | 7,2                  |     |     |     |
| Increasing factor for $\tau_{Rk}$                            | $\Psi_c$             | C25/30                     | [-]                  | 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                                                | $c_{cr,sp}$          | $h / h_{ef} \geq 2,0$      | [mm]                 | $1,0 h_{ef}$         |     |     |     |
|                                                              |                      | $2,0 h > h / h_{ef} > 1,3$ | [mm]                 | $4,6 h_{ef} - 1,8 h$ |     |     |     |
|                                                              |                      | $h / h_{ef} \leq 1,3$      | [mm]                 | $2,26 h_{ef}$        |     |     |     |
| Axial distance                                               |                      | $s_{cr,sp}$                | [mm]                 | $2 c_{cr,sp}$        |     |     |     |

<sup>1)</sup> See Annex B 1

<sup>2)</sup> In absence of other national regulations.

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under tension load for Upat rebar anchors (hammer and diamond-drilling; cracked concrete)

**Annex C 15**

**Table C8:** Characteristic values of resistance for Upat rebar anchors under shear load

| Size                                                                                                           |                            |      | M12                             | M16 | M20 | M24 |
|----------------------------------------------------------------------------------------------------------------|----------------------------|------|---------------------------------|-----|-----|-----|
| Installation safety factor                                                                                     | $\gamma_2 = \gamma_{inst}$ | [-]  | 1,0                             |     |     |     |
| Steel failure without lever arm                                                                                |                            |      |                                 |     |     |     |
| Characteristic steel resistance                                                                                | $V_{Rk,s}$                 | [kN] | $0,5 \cdot A_s \cdot f_{uk}$    |     |     |     |
| Partial safety factor                                                                                          | $\gamma_{Ms,V}^{1)}$       | [-]  | 1,56                            |     |     |     |
| Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1                                                  | $k_2$                      | [-]  | 0,8                             |     |     |     |
| Steel failure with lever arm                                                                                   |                            |      |                                 |     |     |     |
| Characteristic bending moment                                                                                  | $M^0_{Rk,s}$               | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}$ |     |     |     |
| Partial safety factor                                                                                          | $\gamma_{Ms,V}^{1)}$       | [-]  | 1,56                            |     |     |     |
| Concrete pryout failure                                                                                        |                            |      |                                 |     |     |     |
| Factor k acc. to TR029 Section 5.2.3.3<br>resp. $k_3$ acc. to CEN/TS 1992-4-5:2009<br>Section 6.3.3            | $k_{(3)}$                  | [-]  | 2,0                             |     |     |     |
| Concrete edge failure                                                                                          |                            |      |                                 |     |     |     |
| The value of $h_{ef}$ for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by: |                            |      | $\min(h_{ef}; 8d)$              |     |     |     |
| Diameter of calculation                                                                                        | d                          | [mm] | 12                              | 16  | 20  | 25  |

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

Upat injection system UPM 55

**Performances**

Characteristic values in static or quasi-static action under shear load for Upat rebar anchors

**Annex C 16**

**Table C9: Displacements under tension load for threaded rods<sup>1)</sup>**

| Size                                                            |                             | M8                        | M10  | M12  | M16  | M20  | M24  | M27  | M30  |
|-----------------------------------------------------------------|-----------------------------|---------------------------|------|------|------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                             |                           |      |      |      |      |      |      |      |
| Displacement                                                    | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,07 | 0,08 | 0,09 | 0,10 | 0,11 | 0,12 | 0,13 |
| Displacement                                                    | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,13 | 0,14 | 0,15 | 0,17 | 0,17 | 0,18 | 0,19 |

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

$$\delta_{N0} = \delta_{N0} - \text{factor} \cdot \tau$$

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

( $\tau$ : design bond strength)

**Table C10: Displacements under shear load for threaded rods<sup>1)</sup>**

| Size                                                            |                             | M8      | M10  | M12  | M16  | M20  | M24  | M27  | M30  |
|-----------------------------------------------------------------|-----------------------------|---------|------|------|------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                             |         |      |      |      |      |      |      |      |
| Displacement                                                    | $\delta_{V0}$ - factor      | [mm/kN] | 0,18 | 0,15 | 0,12 | 0,09 | 0,07 | 0,06 | 0,05 |
| Displacement                                                    | $\delta_{V\infty}$ - factor | [mm/kN] | 0,27 | 0,22 | 0,18 | 0,14 | 0,11 | 0,09 | 0,07 |

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

$$\delta_{V0} = \delta_{V0} - \text{factor} \cdot V$$

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

(V: design shear resistance)

**Table C11: Displacements under tension load for internal threaded anchors IST<sup>1)</sup>**

| Size                                                            |                             | M8                        | M10  | M12  | M16  | M20  |
|-----------------------------------------------------------------|-----------------------------|---------------------------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                             |                           |      |      |      |      |
| Displacement                                                    | $\delta_{N0}$ - factor      | [mm/(N/mm <sup>2</sup> )] | 0,09 | 0,10 | 0,10 | 0,11 |
| Displacement                                                    | $\delta_{N\infty}$ - factor | [mm/(N/mm <sup>2</sup> )] | 0,13 | 0,15 | 0,15 | 0,17 |

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

$$\delta_{N0} = \delta_{N0} - \text{factor} \cdot \tau$$

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

( $\tau$ : design bond strength)

**Table C12: Displacements under shear load for internal threaded anchors IST<sup>1)</sup>**

| Size                                                            |                             | M8      | M10  | M12  | M16  | M20  |
|-----------------------------------------------------------------|-----------------------------|---------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                             |         |      |      |      |      |
| Displacement                                                    | $\delta_{V0}$ - factor      | [mm/kN] | 0,12 | 0,09 | 0,08 | 0,07 |
| Displacement                                                    | $\delta_{V\infty}$ - factor | [mm/kN] | 0,18 | 0,14 | 0,12 | 0,10 |

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

$$\delta_{V0} = \delta_{V0} - \text{factor} \cdot V$$

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

(V: design shear resistance)

Upat injection system UPM 55

**Performances**

Displacements threaded rods and internal threaded anchor IST

**Annex C 17**

**Table C13:** Displacements under tension load for reinforcing bars <sup>1)</sup>

| Size                                                            | $\phi$                    | 8    | 10   | 12   | 14   | 16   | 18   | 20   | 22   | 24   |
|-----------------------------------------------------------------|---------------------------|------|------|------|------|------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                           |      |      |      |      |      |      |      |      |      |
| Displacement $\delta_{N0}$ - 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 |
| Displacement $\delta_{N\infty}$ - factor                        | [mm/(N/mm <sup>2</sup> )] | 0,11 | 0,12 | 0,13 | 0,14 | 0,15 | 0,16 | 0,16 | 0,17 | 0,18 |
| Size                                                            | $\phi$                    | 25   | 26   | 28   | 30   | 32   | 34   | 36   | 40   |      |
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                           |      |      |      |      |      |      |      |      |      |
| Displacement $\delta_{N0}$ - factor                             | [mm/(N/mm <sup>2</sup> )] | 0,12 | 0,12 | 0,13 | 0,13 | 0,13 | 0,14 | 0,14 | 0,15 |      |
| Displacement $\delta_{N\infty}$ - factor                        | [mm/(N/mm <sup>2</sup> )] | 0,18 | 0,18 | 0,19 | 0,19 | 0,20 | 0,20 | 0,21 | 0,22 |      |

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

$$\delta_{N0} = \delta_{N0} - \text{factor} \cdot \tau$$

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

( $\tau$ : design bond strength)

**Table C14:** Displacements under shear load for reinforcing bars <sup>1)</sup>

| Size                                                            | $\phi$  | 8    | 10   | 12   | 14   | 16   | 18   | 20   | 22   | 24   |
|-----------------------------------------------------------------|---------|------|------|------|------|------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |         |      |      |      |      |      |      |      |      |      |
| Displacement $\delta_{V0}$ - factor                             | [mm/kN] | 0,18 | 0,15 | 0,12 | 0,10 | 0,09 | 0,08 | 0,07 | 0,07 | 0,06 |
| Displacement $\delta_{V\infty}$ - factor                        | [mm/kN] | 0,27 | 0,22 | 0,18 | 0,16 | 0,14 | 0,12 | 0,11 | 0,10 | 0,09 |
| Size                                                            | $\phi$  | 25   | 26   | 28   | 30   | 32   | 34   | 36   | 40   |      |
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |         |      |      |      |      |      |      |      |      |      |
| Displacement $\delta_{V0}$ - factor                             | [mm/kN] | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,04 |      |
| Displacement $\delta_{V\infty}$ - factor                        | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,07 | 0,07 | 0,06 | 0,06 | 0,05 |      |

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

$$\delta_{V0} = \delta_{V0} - \text{factor} \cdot V$$

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

(V: design shear resistance)

Upat injection system UPM 55

**Performances**

Displacements reinforcing bars

**Annex C 18**

**Table C15:** Displacements under tension load for Upat rebar anchors <sup>1)</sup>

| Size                                                            | $\phi$                    | 12   | 16   | 20   | 24   |
|-----------------------------------------------------------------|---------------------------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |                           |      |      |      |      |
| Displacement $\delta_{N0}$ - factor                             | [mm/(N/mm <sup>2</sup> )] | 0,09 | 0,10 | 0,11 | 0,12 |
| Displacement $\delta_{N\infty}$ - factor                        | [mm/(N/mm <sup>2</sup> )] | 0,13 | 0,16 | 0,16 | 0,18 |

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

$$\delta_{N0} = \delta_{N0} - \text{factor} \cdot \tau$$

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

( $\tau$ : design bond strength)

**Table C16:** Displacements under shear load for Upat rebar anchors <sup>1)</sup>

| Size                                                            | $\phi$  | 12   | 16   | 20   | 24   |
|-----------------------------------------------------------------|---------|------|------|------|------|
| <b>Un-cracked and cracked concrete; temperature range I, II</b> |         |      |      |      |      |
| Displacement $\delta_{V0}$ - factor                             | [mm/kN] | 0,12 | 0,09 | 0,07 | 0,06 |
| Displacement $\delta_{V\infty}$ - factor                        | [mm/kN] | 0,18 | 0,14 | 0,11 | 0,09 |

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

$$\delta_{V0} = \delta_{V0} - \text{factor} \cdot V$$

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

(V: design shear resistance)

Upat injection system UPM 55

**Performances**

Displacements Upat rebar anchor

**Annex C 19**

**Table C17A:** Characteristic values of resistance for Upat threaded rods  
under seismic action performance category C1 in  
hammer drilled hole

| Size                                                                       |                                |                            |     | M10                       | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |
|----------------------------------------------------------------------------|--------------------------------|----------------------------|-----|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation safety factor                                                 | dry and wet concrete           | $\gamma_2 =$               | [-] | 1,0                       |     |     |     |     | 1,2 |     |     |     |
|                                                                            | flooded hole                   | $\gamma_{inst}$            | [-] | 1,4                       |     |     |     |     |     |     |     |     |
| Characteristic resistance tension load, steel failure                      |                                |                            |     |                           |     |     |     |     |     |     |     |     |
| $N_{Rk,s,C1}$                                                              | Zinc plated steel              | Property class             | 5.8 | 29                        | 43  | 58  | 79  | 123 | 152 | 177 | 230 | 281 |
|                                                                            |                                |                            | 8.8 | 47                        | 68  | 92  | 126 | 196 | 243 | 282 | 368 | 449 |
| [kN]                                                                       | Stainless steel A4 and steel C | Property class             | 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 |
| $\gamma_{M,s,C1}^{1)}$                                                     | Zinc plated steel              | Property class             | 5.8 | 1,50                      |     |     |     |     |     |     |     |     |
|                                                                            |                                |                            | 8.8 | 1,50                      |     |     |     |     |     |     |     |     |
| [-]                                                                        | Stainless steel A4 and steel C | Property class             | 50  | 2,86                      |     |     |     |     |     |     |     |     |
|                                                                            |                                |                            | 70  | 1,50 <sup>2)</sup> / 1,87 |     |     |     |     |     |     |     |     |
|                                                                            |                                |                            | 80  | 1,6                       |     |     |     |     |     |     |     |     |
| Characteristic bond resistance, combined pullout and concrete cone failure |                                |                            |     |                           |     |     |     |     |     |     |     |     |
| (dry and wet concrete)                                                     |                                |                            |     |                           |     |     |     |     |     |     |     |     |
| Temperature range I <sup>3)</sup>                                          | $\tau_{Rk,C1}$                 | [N/mm <sup>2</sup> ]       | 7,0 | 7,0                       | 6,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 |
| Temperature range II <sup>3)</sup>                                         | $\tau_{Rk,C1}$                 | [N/mm <sup>2</sup> ]       | 7,0 | 7,0                       | 6,7 | 5,7 | 5,7 | 6,7 | 6,7 | 6,7 | 6,7 | 6,7 |
| (flooded hole)                                                             |                                |                            |     |                           |     |     |     |     |     |     |     |     |
| Temperature range I <sup>3)</sup>                                          | $\tau_{Rk,C1}$                 | [N/mm <sup>2</sup> ]       | 7,5 | 7,5                       | 6,5 | 6,5 | 5,7 | 6,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| Temperature range II <sup>3)</sup>                                         | $\tau_{Rk,C1}$                 | [N/mm <sup>2</sup> ]       | 6,8 | 6,8                       | 6,5 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| Characteristic resistance shear load, steel failure without lever arm      |                                |                            |     |                           |     |     |     |     |     |     |     |     |
| $V_{Rk,s,C1}$                                                              | Zinc plated steel              | Property class             | 5.8 | 15                        | 21  | 29  | 39  | 61  | 76  | 89  | 115 | 141 |
|                                                                            |                                |                            | 8.8 | 23                        | 34  | 46  | 63  | 98  | 122 | 141 | 184 | 225 |
| [kN]                                                                       | Stainless steel A4 and steel C | Property class             | 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 |
| Installation safety factor                                                 |                                | $\gamma_2 = \gamma_{inst}$ | [-] | 1,0                       |     |     |     |     |     |     |     |     |

<sup>1)</sup> For Upat anchor rods the factor for steel ductility is 1,0

<sup>2)</sup>  $f_{uk} = 700 \text{ N/mm}^2$  ;  $f_{yk} = 560 \text{ N/mm}^2$

<sup>3)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values under seismic action (performances C1) for Upat threaded rods

**Annex C 20**

**Table C17B:** Characteristic values of resistance for standard threaded rods under seismic action performance category C1 in hammer drilled hole

| Size                                                                       |                                |                |     | M10                      | M12 | M14 | M16 | M20 | M22 | M24 | M27 | M30 |     |
|----------------------------------------------------------------------------|--------------------------------|----------------|-----|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation safety factor                                                 |                                |                |     | See Table C17A           |     |     |     |     |     |     |     |     |     |
| Characteristic resistance tension load, steel failure                      |                                |                |     | See Table C17A           |     |     |     |     |     |     |     |     |     |
| Characteristic bond resistance, combined pullout and concrete cone failure |                                |                |     | See Table C17A           |     |     |     |     |     |     |     |     |     |
| Characteristic resistance shear load, steel failure without lever arm      |                                |                |     |                          |     |     |     |     |     |     |     |     |     |
| V <sub>Rk,s,C1</sub>                                                       | Zinc plated steel              | Property class | 5.8 | 11                       | 15  | 20  | 27  | 43  | 53  | 62  | 81  | 99  |     |
|                                                                            |                                |                | 8.8 | 16                       | 24  | 32  | 44  | 69  | 85  | 99  | 129 | 158 |     |
| [kN]                                                                       | Stainless steel A4 and steel C | Property class | 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 |     |
| Installation safety factor                                                 |                                |                |     | $\gamma_2=\gamma_{inst}$ | [-] |     |     |     |     |     |     |     | 1,0 |

Upat injection system UPM 55

**Performances**

Characteristic values under seismic action (performances C1) for standard threaded rods

**Annex C 21**

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

| Reinforcing bar                                                            |                      |                            | $\phi$  | 10   | 12  | 14  | 16  | 18  | 20  | 22  | 24  |     |
|----------------------------------------------------------------------------|----------------------|----------------------------|---------|------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation safety factor                                                 | dry and wet concrete | $\gamma_2 =$               | [-]     | 1,0  |     |     |     |     |     | 1,2 |     |     |
|                                                                            | flooded hole         | $\gamma_{inst}$            | [-]     | 1,2  |     |     |     |     |     | 1,4 |     |     |
| Characteristic resistance tension load, steel failure                      |                      |                            |         |      |     |     |     |     |     |     |     |     |
| $N_{Rk,s, C1}$                                                             |                      |                            |         | [kN] | 44  | 63  | 85  | 111 | 140 | 173 | 209 | 249 |
| Characteristic bond resistance, combined pullout and concrete cone failure |                      |                            |         |      |     |     |     |     |     |     |     |     |
| (dry and wet concrete)                                                     |                      |                            |         |      |     |     |     |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                                          |                      | $\tau_{Rk, C1}$            | [N/mm²] | 7,0  | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 |     |
| Temperature range II <sup>1)</sup>                                         |                      | $\tau_{Rk, C1}$            | [N/mm²] | 7,0  | 7,0 | 6,7 | 5,7 | 5,7 | 5,7 | 6,7 | 6,7 |     |
| (flooded hole)                                                             |                      |                            |         |      |     |     |     |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                                          |                      | $\tau_{Rk, C1}$            | [N/mm²] | 7,5  | 7,0 | 6,5 | 5,7 | 5,7 | 5,7 | 6,7 | 5,7 |     |
| Temperature range II <sup>1)</sup>                                         |                      | $\tau_{Rk, C1}$            | [N/mm²] | 6,8  | 6,8 | 5,8 | 5,8 | 5,7 | 5,7 | 5,7 | 5,7 |     |
| Characteristic resistance shear load, steel failure without lever arm      |                      |                            |         |      |     |     |     |     |     |     |     |     |
| $V_{Rk,s, C1}$                                                             |                      |                            |         | [kN] | 15  | 22  | 30  | 39  | 49  | 61  | 74  | 88  |
| Installation safety factor                                                 |                      | $\gamma_2 = \gamma_{inst}$ | [-]     | 1,0  |     |     |     |     |     |     |     |     |

| Reinforcing bar                                                            |                      |                          | $\phi$               | 25  | 26  | 28  | 30  | 32  |
|----------------------------------------------------------------------------|----------------------|--------------------------|----------------------|-----|-----|-----|-----|-----|
| Installation safety factor                                                 | dry and wet concrete | $\gamma_2$               | [-]                  | 1,2 |     |     |     |     |
|                                                                            | flooded hole         | $\gamma_{inst}$          | [-]                  | 1,4 |     |     |     |     |
| Characteristic resistance tension load, steel failure                      |                      |                          |                      |     |     |     |     |     |
| $N_{Rk,s,C1}$                                                              |                      |                          | [kN]                 | 270 | 292 | 339 | 389 | 443 |
| Characteristic bond resistance, combined pullout and concrete cone failure |                      |                          |                      |     |     |     |     |     |
| (dry and wet concrete)                                                     |                      |                          |                      |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                                          |                      | $\tau_{Rk,s,C1}$         | [N/mm <sup>2</sup> ] | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| Temperature range II <sup>1)</sup>                                         |                      | $\tau_{Rk,s,C1}$         | [N/mm <sup>2</sup> ] | 6,7 | 6,7 | 6,7 | 6,7 | 4,8 |
| (flooded hole)                                                             |                      |                          |                      |     |     |     |     |     |
| Temperature range I <sup>1)</sup>                                          |                      | $\tau_{Rk,s,C1}$         | [N/mm <sup>2</sup> ] | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| Temperature range II <sup>1)</sup>                                         |                      | $\tau_{Rk,s,C1}$         | [N/mm <sup>2</sup> ] | 5,7 | 5,7 | 5,7 | 5,7 | 4,8 |
| Characteristic resistance shear load, steel failure without lever arm      |                      |                          |                      |     |     |     |     |     |
| $V_{Rk,s,C1}$                                                              |                      |                          | [kN]                 | 95  | 102 | 119 | 137 | 155 |
| Installation safety factor                                                 |                      | $\gamma_2=\gamma_{inst}$ | [-]                  | 1,0 |     |     |     |     |

<sup>1)</sup> See Annex B 1

Upat injection system UPM 55

**Performances**

Characteristic values under seismic action (performances C1) for rebars

**Annex C 22**

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

| Size                                                                                              |                                |                            |                      | M12  | M16  | M20  | M24  |
|---------------------------------------------------------------------------------------------------|--------------------------------|----------------------------|----------------------|------|------|------|------|
| Installation safety factor                                                                        | dry and wet concrete           | $\gamma_2 =$               | [-]                  | 1,0  |      |      | 1,2  |
|                                                                                                   | flooded hole                   | $\gamma_{inst}$            | [-]                  | 1,2  |      | 1,4  |      |
| Characteristic resistance tension load, steel failure                                             |                                |                            |                      |      |      |      |      |
| $N_{Rk,s, C2}$                                                                                    | Zinc plated steel              | Property class             | 5.8                  | 39   | 72   | 108  | 177  |
|                                                                                                   |                                |                            | 8.8                  | 61   | 116  | 173  | 282  |
| [kN]                                                                                              | Stainless steel A4 and steel C | Property class             | 50                   | 39   | 72   | 108  | 177  |
|                                                                                                   |                                |                            | 70                   | 53   | 101  | 152  | 247  |
|                                                                                                   |                                |                            | 80                   | 61   | 116  | 173  | 282  |
| Characteristic bond resistance, combined pullout and concrete cone failure (dry and wet concrete) |                                |                            |                      |      |      |      |      |
| Temperature range I <sup>1)</sup>                                                                 |                                | $\tau_{Rk, C2}$            | [N/mm <sup>2</sup> ] | 2,2  | 3,5  | 1,8  | 2,4  |
| Temperature range II <sup>1)</sup>                                                                |                                | $\tau_{Rk, C2}$            | [N/mm <sup>2</sup> ] | 2,2  | 3,5  | 1,8  | 2,4  |
| Characteristic bond resistance, combined pullout and concrete cone failure (flooded hole)         |                                |                            |                      |      |      |      |      |
| Temperature range I <sup>1)</sup>                                                                 |                                | $\tau_{Rk, C2}$            | [N/mm <sup>2</sup> ] | 2,3  | 3,5  | 1,8  | 2,1  |
| Temperature range II <sup>1)</sup>                                                                |                                | $\tau_{Rk, C2}$            | [N/mm <sup>2</sup> ] | 2,3  | 3,5  | 1,8  | 2,1  |
| Displacements                                                                                     |                                |                            |                      |      |      |      |      |
| $\delta_{N,(DLS)} - \text{factor}^{3)}$                                                           |                                | [mm/(N/mm <sup>2</sup> )]  |                      | 0,09 | 0,10 | 0,11 | 0,12 |
| $\delta_{N,(ULS)} - \text{factor}^{3)}$                                                           |                                | [mm/(N/mm <sup>2</sup> )]  |                      | 0,15 | 0,17 | 0,17 | 0,18 |
| Characteristic resistance shear load, steel failure without lever arm                             |                                |                            |                      |      |      |      |      |
| $V_{Rk,s, C2}^{2)}$                                                                               | Zinc plated steel              | Property class             | 5.8                  | 14   | 27   | 43   | 62   |
|                                                                                                   |                                |                            | 8.8                  | 22   | 44   | 69   | 99   |
| [kN]                                                                                              | Stainless steel A4 and steel C | Property class             | 50                   | 14   | 27   | 43   | 62   |
|                                                                                                   |                                |                            | 70                   | 20   | 39   | 60   | 87   |
|                                                                                                   |                                |                            | 80                   | 22   | 44   | 69   | 99   |
| Installation safety factor                                                                        |                                | $\gamma_2 = \gamma_{inst}$ | [-]                  | 1,0  |      |      |      |
| Displacements                                                                                     |                                |                            |                      |      |      |      |      |
| $\delta_{V,(DLS)} - \text{factor}^{4)}$                                                           |                                | [mm/kN]                    |                      | 0,18 | 0,10 | 0,07 | 0,06 |
| $\delta_{V,(ULS)} - \text{factor}^{4)}$                                                           |                                | [mm/kN]                    |                      | 0,25 | 0,14 | 0,11 | 0,09 |

<sup>1)</sup> See Annex B 1

<sup>2)</sup> For Upat anchor rods the factor for steel ductility is 1,0

<sup>3)</sup> Calculation for displacement

$$\delta_{N,(DLS)} = \delta_{N,(DLS)} - \text{Factor} \cdot \tau;$$

$$\delta_{N,(ULS)} = \delta_{N,(ULS)} - \text{Factor} \cdot \tau;$$

( $\tau$ : design bond strength)

<sup>4)</sup> Calculation for displacement

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

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

( $V$ : design shear resistance)

Upat injection system UPM 55

**Performances**

Characteristic values under seismic action (performances C2) for Upat threaded rods and standard threaded rods

**Annex C 23**