

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

**ETA-23/0419**  
**of 31 July 2023**

English translation prepared by DIBt - Original version in German language

### General Part

Technical Assessment Body issuing the  
European Technical Assessment:

Trade name of the construction product

Product family  
to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment  
contains

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

Deutsches Institut für Bautechnik

Rotho Blaas Injection System EPO-FIX Injection system

Bonded fastener for use in concrete

Rotho Blaas s.r.l  
Via dell'Adige 2/1  
39040 CORTACCIA (BZ)  
ITALIEN

Plant C2

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

330499-01-0601; Edition 04/2020

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## Specific Part

### 1 Technical description of the product

The "Rotho Blaas Injection system EPO-FIX for concrete" is a bonded anchor consisting of a mortar cartridge with injection mortar EPO-FIX and a steel element according to Annex A 3.

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 fastener 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 fastener of at least 50 and/or 100 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 resistance to tension load (static and quasi-static loading)              | See Annex C 1 to C 6, C 8 to C 11, C 13 to C 16, B 3 |
| Characteristic resistance to shear load (static and quasi-static loading)                | See Annex C 1, C 7, C 12, C 17                       |
| Displacements under short-term and long-term loading                                     | See Annex C 18 to C 20                               |
| Characteristic resistance and displacements for seismic performance categories C1 and C2 | See Annex C 21 to C 28                               |

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

| Essential characteristic                                 | Performance             |
|----------------------------------------------------------|-------------------------|
| Content, emission and/or release of dangerous substances | No performance assessed |

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

In accordance with the European Assessment Document EAD 330499-01-0601 the applicable European legal act is: [96/582/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.

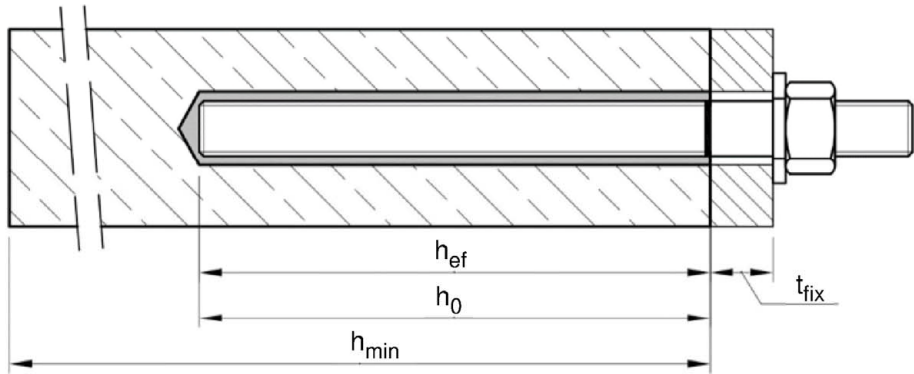
Issued in Berlin on 31 July 2023 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock  
Head of Section

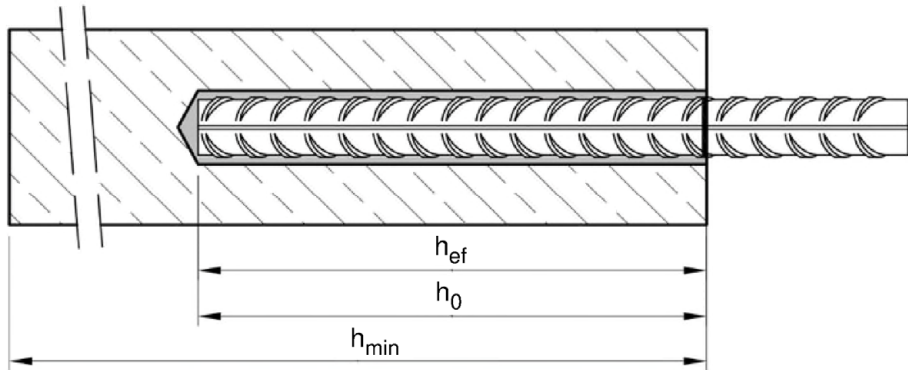
*beglaubigt:*  
Baderschneider

Installation threaded rod M8 up to M30

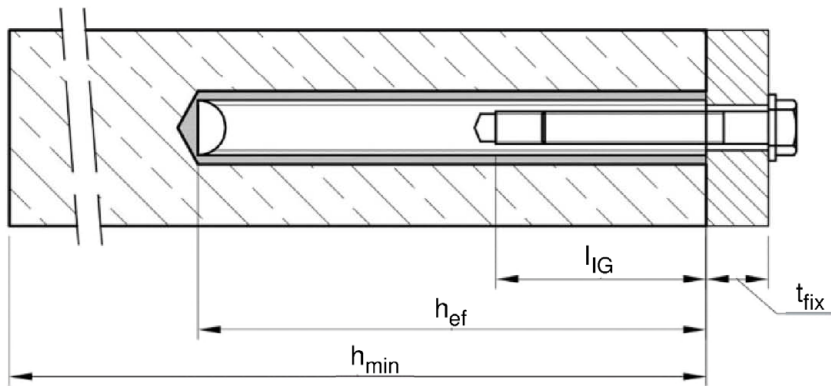
prepositioned installation or  
push through installation (annular gap filled with mortar)



Installation reinforcing bar Ø8 up to Ø32



Installation internal threaded anchor rod IR-M6 up to IR-M20



$T_{fix}$  = thickness of fixture  
 $h_{ef}$  = effective embedment depth  
 $h_{min}$  = minum thickness of member

$h_0$  = nominal drill hole diameter  
 $l_{IG}$  = thread engagement length

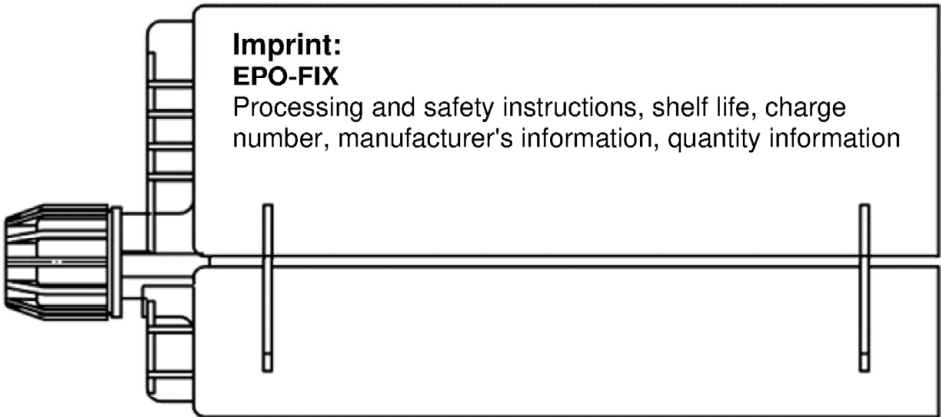
Rotho Blaas Injection System EPO-FIX Injection system

Product description  
Installed condition

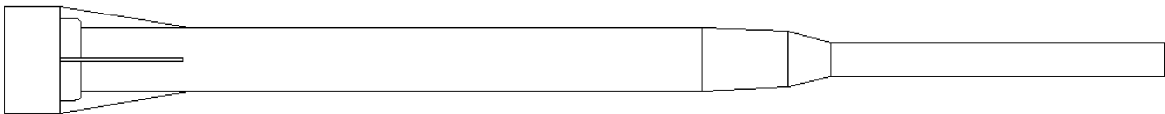
Annex A 1

Cartridge system

Side-by-Side Cartridge:  
440 ml, 585 ml and 1400 ml



Static mixer



Piston plug PL and mixer extension

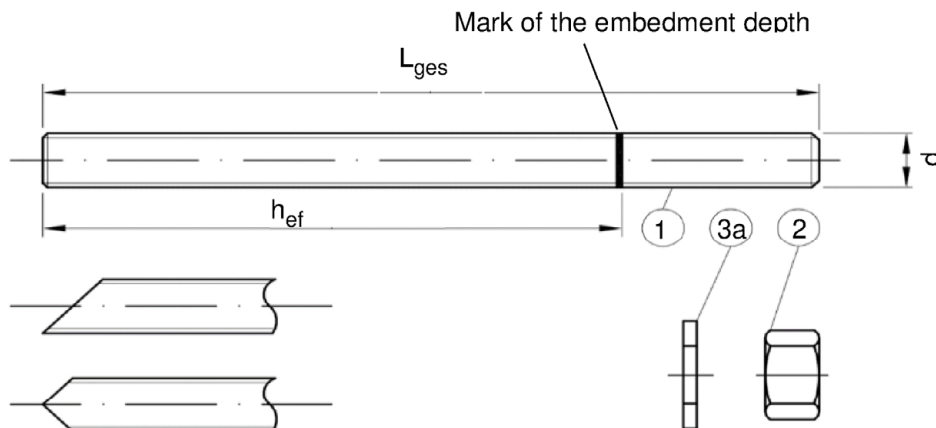


Rotho Blaas Injection System EPO-FIX Injection system

Product description  
Injection system

Annex A 2

## Threaded rod M8 up to M30 with washer and hexagon nut

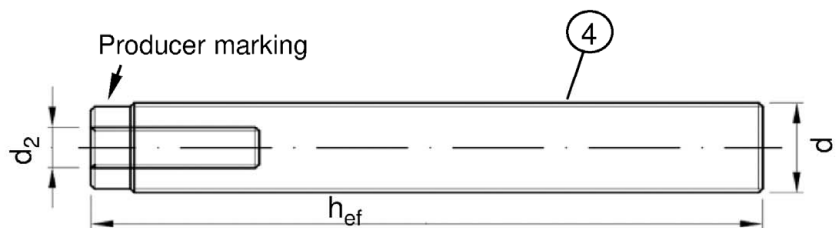
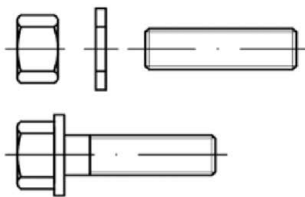


Commercial standard rod with:

- Materials, dimensions and mechanical properties acc. to Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004. The document shall be stored.
- Marking of embedment depth

## Internal threaded rod IR-M6 to IR-M10

Threaded rod or screw



Producer marking: e.g.  M8



Marking Internal thread

Mark

M8

Thread size (Internal thread)

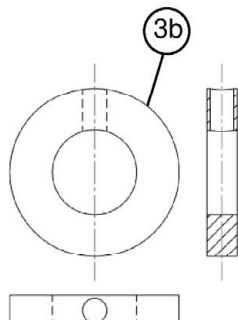
A4

additional mark for stainless steel

HCR

additional mark for high-corrosion resistance steel

## Filling washer



## Mixer reduction nozzle



## Rotho Blaas Injection System EPO-FIX Injection system

### Product description

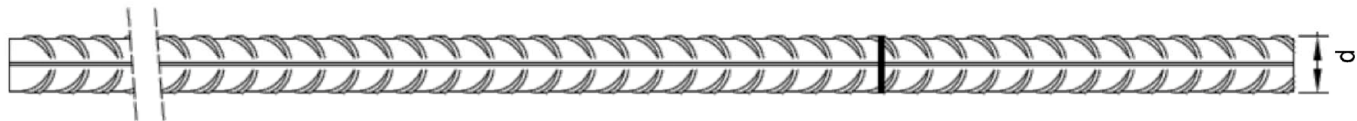
Threaded rod; Internal threaded rod  
Filling washer; Mixer reduction nozzle

## Annex A 3

**Table A1: Materials**

| Part                                                                                                                                                                                                                                                                                                         | Designation                                  | Material                                                                                                                                                                                                                                                                                                              |                                                |                                     |                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------|------------------------|
| <b>Steel, zinc plated</b> (Steel acc. to EN ISO 683-4:2018 or EN 10263:2017)<br>- zinc plated ≥ 5 µm acc. to EN ISO 4042:2022 or<br>- hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2022 and EN ISO 10684:2004+AC:2009 or<br>- sherardized ≥ 45 µm acc. to EN ISO 17668:2016                                |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |
| 1                                                                                                                                                                                                                                                                                                            | Threaded rod                                 | Property class                                                                                                                                                                                                                                                                                                        | Characteristic steel ultimate tensile strength | Characteristic steel yield strength | Elongation at fracture |
|                                                                                                                                                                                                                                                                                                              |                                              | acc. to EN ISO 898-1:2013                                                                                                                                                                                                                                                                                             | 4.6 $f_{uk} = 400 \text{ N/mm}^2$              | $f_{yk} = 240 \text{ N/mm}^2$       | $A_5 > 8\%$            |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 4.8 $f_{uk} = 400 \text{ N/mm}^2$              | $f_{yk} = 320 \text{ N/mm}^2$       | $A_5 > 8\%$            |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 5.6 $f_{uk} = 500 \text{ N/mm}^2$              | $f_{yk} = 300 \text{ N/mm}^2$       | $A_5 > 8\%$            |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 5.8 $f_{uk} = 500 \text{ N/mm}^2$              | $f_{yk} = 400 \text{ N/mm}^2$       | $A_5 > 8\%$            |
| 8.8 $f_{uk} = 800 \text{ N/mm}^2$                                                                                                                                                                                                                                                                            | $f_{yk} = 640 \text{ N/mm}^2$                | $A_5 \geq 12\%^{3)}$                                                                                                                                                                                                                                                                                                  |                                                |                                     |                        |
| 2                                                                                                                                                                                                                                                                                                            | Hexagon nut                                  | acc. to EN ISO 898-2:2012                                                                                                                                                                                                                                                                                             | 4                                              | for anchor rod class 4.6 or 4.8     |                        |
|                                                                                                                                                                                                                                                                                                              |                                              | 5                                                                                                                                                                                                                                                                                                                     | for anchor rod class 5.6 or 5.8                |                                     |                        |
|                                                                                                                                                                                                                                                                                                              |                                              | 8                                                                                                                                                                                                                                                                                                                     | for anchor rod class 8.8                       |                                     |                        |
| 3a                                                                                                                                                                                                                                                                                                           | Washer                                       | Steel, zinc plated, hot-dip galvanised or sherardized (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)                                                                                                                                                                                 |                                                |                                     |                        |
| 3b                                                                                                                                                                                                                                                                                                           | Filling washer                               | Steel, zinc plated, hot-dip galvanised or sherardized                                                                                                                                                                                                                                                                 |                                                |                                     |                        |
| 4                                                                                                                                                                                                                                                                                                            | Internal threaded anchor rod                 | Property class                                                                                                                                                                                                                                                                                                        | Characteristic steel ultimate tensile strength | Characteristic steel yield strength | Elongation at fracture |
|                                                                                                                                                                                                                                                                                                              |                                              | acc. to EN ISO 898-1:2013                                                                                                                                                                                                                                                                                             | 5.8 $f_{uk} = 500 \text{ N/mm}^2$              | $f_{yk} = 400 \text{ N/mm}^2$       | $A_5 > 8\%$            |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 8.8 $f_{uk} = 800 \text{ N/mm}^2$              | $f_{yk} = 640 \text{ N/mm}^2$       | $A_5 > 8\%$            |
| <b>Stainless steel A2</b> (Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014)                                                                                                                                                                                                    |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |
| <b>Stainless steel A4</b> (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014)                                                                                                                                                                                                    |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |
| <b>High corrosion resistance steel</b> (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)                                                                                                                                                                                                                 |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |
| 1                                                                                                                                                                                                                                                                                                            | Threaded rod <sup>1)4)</sup>                 | Property class                                                                                                                                                                                                                                                                                                        | Characteristic steel ultimate tensile strength | Characteristic steel yield strength | Elongation at fracture |
|                                                                                                                                                                                                                                                                                                              |                                              | acc. to EN ISO 3506-1:2020                                                                                                                                                                                                                                                                                            | 50 $f_{uk} = 500 \text{ N/mm}^2$               | $f_{yk} = 210 \text{ N/mm}^2$       | $A_5 \geq 8\%$         |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 70 $f_{uk} = 700 \text{ N/mm}^2$               | $f_{yk} = 450 \text{ N/mm}^2$       | $A_5 \geq 12\%^{3)}$   |
| 80 $f_{uk} = 800 \text{ N/mm}^2$                                                                                                                                                                                                                                                                             | $f_{yk} = 600 \text{ N/mm}^2$                | $A_5 \geq 12\%^{3)}$                                                                                                                                                                                                                                                                                                  |                                                |                                     |                        |
| 2                                                                                                                                                                                                                                                                                                            | Hexagon nut <sup>1)4)</sup>                  | acc. to EN ISO 3506-1:2020                                                                                                                                                                                                                                                                                            | 50                                             | for anchor rod class 50             |                        |
|                                                                                                                                                                                                                                                                                                              |                                              | 70                                                                                                                                                                                                                                                                                                                    | for anchor rod class 70                        |                                     |                        |
|                                                                                                                                                                                                                                                                                                              |                                              | 80                                                                                                                                                                                                                                                                                                                    | for anchor rod class 80                        |                                     |                        |
| 3a                                                                                                                                                                                                                                                                                                           | Washer                                       | A2: Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014<br>A4: Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014<br>HCR: Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014<br>(e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000) |                                                |                                     |                        |
| 3b                                                                                                                                                                                                                                                                                                           | Filling washer                               | Stainless steel A4, High corrosion resistance steel                                                                                                                                                                                                                                                                   |                                                |                                     |                        |
| 4                                                                                                                                                                                                                                                                                                            | Internal threaded anchor rod <sup>1)2)</sup> | Property class                                                                                                                                                                                                                                                                                                        | Characteristic steel ultimate tensile strength | Characteristic steel yield strength | Elongation at fracture |
|                                                                                                                                                                                                                                                                                                              |                                              | acc. to EN ISO 3506-1:2020                                                                                                                                                                                                                                                                                            | 50 $f_{uk} = 500 \text{ N/mm}^2$               | $f_{yk} = 210 \text{ N/mm}^2$       | $A_5 > 8\%$            |
|                                                                                                                                                                                                                                                                                                              |                                              |                                                                                                                                                                                                                                                                                                                       | 70 $f_{uk} = 700 \text{ N/mm}^2$               | $f_{yk} = 450 \text{ N/mm}^2$       | $A_5 > 8\%$            |
| 1) Property class 70 or 80 for anchor rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IR-M16<br>2) for IR-M20 only property class 50<br>3) $A_5 > 8\%$ fracture elongation if no use for seismic performance category C2<br>4) Property class 80 only for stainless steel A4 and HCR |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                                                                                                                        |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     | Annex A 4              |
| Product description<br>Materials threaded rod, Internal threaded anchor rod and filling washer                                                                                                                                                                                                               |                                              |                                                                                                                                                                                                                                                                                                                       |                                                |                                     |                        |

Reinforcing bar: ø8 up to ø32



Minimum value of related rip area  $f_{R,min}$  according to EN 1992-1-1:2004+AC:2010  
Rib height of the bar shall be in the range  $0,05d \leq h_{rib} \leq 0,07d$   
(d: Nominal diameter of the bar;  $h_{rib}$ : Rib height of the bar)

Table A2: Materials Reinforcing bar

| Part  | Designation                                                      | Material                                                                                                                                             |
|-------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rebar |                                                                  |                                                                                                                                                      |
| 1     | Reinforcing steel according to EN 1992 1 1:2004+AC:2010, Annex C | Bars and rebars from ring class B or C<br>$f_{yk}$ and $k$ according to NDP or NCI according to EN 1992-1-1/NA<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ |

Rotho Blaas Injection System EPO-FIX Injection system

Product description  
Materials reinforcing bar

Annex A 5

| Specification of the intended use                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                       |                         |                                                                       |                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-------------------------|-----------------------------------------------------------------------|-------------------------|
| Fasteners subject to (Static and quasi-static loads):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |                         |                                                                       |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Working life 50 years                                                 |                         | Working life 100 years                                                |                         |
| Base material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | uncracked concrete                                                    | cracked concrete        | uncracked concrete                                                    | cracked concrete        |
| HD: Hammer drilling<br>HDB: Hammer drilling with hollow drill bit<br>CD: Compressed air drilling                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | M8 to M30,<br>Ø8 to Ø32,<br>IR-M6 to IR-M20                           |                         | M8 to M30,<br>Ø8 to Ø32,<br>IR-M6 to IR-M20                           |                         |
| DD: Diamond drilling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | M8 to M30,<br>Ø8 to Ø32,<br>IR-M6 to IR-M20                           | No performance assessed | M8 to M30,<br>Ø8 to Ø32,<br>IR-M6 to IR-M20                           | No performance assessed |
| Temperature Range:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | I: - 40 C to +40 C <sup>1)</sup><br>II: - 40 C to +72 C <sup>2)</sup> |                         | I: - 40 C to +40 C <sup>1)</sup><br>II: - 40 C to +72 C <sup>2)</sup> |                         |
| Fasteners subject to (seismic action):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                       |                         |                                                                       |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Performance Category C1                                               |                         | Performance Category C2                                               |                         |
| Base material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Cracked and uncracked concrete                                        |                         | Cracked and uncracked concrete                                        |                         |
| HD: Hammer drilling<br>HDB: Hammer drilling with hollow drill bit<br>CD: Compressed air drilling                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | M8 to M30,<br>Ø8 to Ø32                                               |                         | M12 to M24                                                            |                         |
| DD: Diamond drilling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | No performance assessed                                               |                         | No performance assessed                                               |                         |
| Temperature Range:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | I: - 40 C to +40 C <sup>1)</sup><br>II: - 40 C to +72 C <sup>2)</sup> |                         | I: - 40 C to +40 C <sup>1)</sup><br>II: - 40 C to +72 C <sup>2)</sup> |                         |
| <div>1) (max. long-term temperature +24°C and max. short-term temperature +40°C)</div> <div>2) (max. long-term temperature +50°C and max. short-term temperature +72°C)</div>                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                       |                         |                                                                       |                         |
| <b>Base materials:</b> <ul style="list-style-type: none"><li>- Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016.</li><li>- Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016.</li></ul>                                                                                                                                                                                                                                                                                                       |                                                                       |                         |                                                                       |                         |
| <b>Use conditions (Environmental conditions):</b> <ul style="list-style-type: none"><li>- Structures subject to dry internal conditions (all materials).</li><li>- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance class:<ul style="list-style-type: none"><li>• Stainless steel Stahl A2 according to Annex A 4, Table A1: CRC II</li><li>• Stainless steel Stahl A4 according to Annex A 4, Table A1: CRC III</li><li>• High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V</li></ul></li></ul> |                                                                       |                         |                                                                       |                         |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |                         | Annex B 1                                                             |                         |
| Intended Use Specifications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                       |                         |                                                                       |                         |

#### Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work.
- The fasteners are designed in accordance to EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

#### Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB), compressed air (CD) or diamond drill mode (DD).
- Overhead installation allowed.
- Fastener installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

**Rotho Blaas Injection System EPO-FIX Injection system**

**Intended Use**  
Specifications (Continued)

**Annex B 2**

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

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

<sup>1)</sup> Maximum installation torque for M12 with steel Grade 4.6 is 35 Nm

**Table B2: Installation parameters for reinforcing bar**

| Reinforcing bar             |                      |      | Ø 8 <sup>1)</sup>                   | Ø 10 <sup>1)</sup> | Ø 12 <sup>1)</sup> | Ø 14                              | Ø 16 | Ø 20 | Ø 24 <sup>1)</sup> | Ø 25 <sup>1)</sup> | Ø 28 | Ø 32 |
|-----------------------------|----------------------|------|-------------------------------------|--------------------|--------------------|-----------------------------------|------|------|--------------------|--------------------|------|------|
| Diameter of element         | d = d <sub>nom</sub> | [mm] | 8                                   | 10                 | 12                 | 14                                | 16   | 20   | 24                 | 25                 | 28   | 32   |
| Nominal drill hole diameter | d <sub>0</sub>       | [mm] | 10   12                             | 12   14            | 14   16            | 18                                | 20   | 25   | 30   32            | 30   32            | 35   | 40   |
| Effective embedment depth   | h <sub>ef,min</sub>  | [mm] | 60                                  | 60                 | 70                 | 75                                | 80   | 90   | 96                 | 100                | 112  | 128  |
|                             | h <sub>ef,max</sub>  | [mm] | 160                                 | 200                | 240                | 280                               | 320  | 400  | 480                | 500                | 560  | 640  |
| Minimum thickness of member | h <sub>min</sub>     | [mm] | h <sub>ef</sub> + 30 mm ≥<br>100 mm |                    |                    | h <sub>ef</sub> + 2d <sub>0</sub> |      |      |                    |                    |      |      |
| Minimum spacing             | s <sub>min</sub>     | [mm] | 40                                  | 50                 | 60                 | 70                                | 75   | 95   | 120                | 120                | 130  | 150  |
| Minimum edge distance       | c <sub>min</sub>     | [mm] | 35                                  | 40                 | 45                 | 50                                | 50   | 60   | 70                 | 70                 | 75   | 85   |

<sup>1)</sup> both nominal drill hole diameter can be used

**Table B3: Installation parameters for Internal threaded anchor rod**

| Internal threaded anchor rod               |                 |      | IR-M6                                        | IR-M8 | IR-M10 | IR-M12          | IR-M16 | IR-M20 |
|--------------------------------------------|-----------------|------|----------------------------------------------|-------|--------|-----------------|--------|--------|
| Internal diameter of anchor rod            | $d_2$           | [mm] | 6                                            | 8     | 10     | 12              | 16     | 20     |
| Outer diameter of anchor rod <sup>1)</sup> | $d = d_{nom}$   | [mm] | 10                                           | 12    | 16     | 20              | 24     | 30     |
| Nominal drill hole diameter                | $d_0$           | [mm] | 12                                           | 14    | 18     | 22              | 28     | 35     |
| Effective embedment depth                  | $h_{ef,min}$    | [mm] | 60                                           | 70    | 80     | 90              | 96     | 120    |
|                                            | $h_{ef,max}$    | [mm] | 200                                          | 240   | 320    | 400             | 480    | 600    |
| Diameter of clearance hole in the fixture  | $d_f \leq$      | [mm] | 7                                            | 9     | 12     | 14              | 18     | 22     |
| Maximum installation torque                | $\max T_{inst}$ | [Nm] | 10                                           | 10    | 20     | 40              | 60     | 100    |
| Thread engagement length min/max           | $l_{IG}$        | [mm] | 8/20                                         | 8/20  | 10/25  | 12/30           | 16/32  | 20/40  |
| Minimum thickness of member                | $h_{min}$       | [mm] | $h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$ |       |        | $h_{ef} + 2d_0$ |        |        |
| Minimum spacing                            | $s_{min}$       | [mm] | 50                                           | 60    | 75     | 95              | 115    | 140    |
| Minimum edge distance                      | $c_{min}$       | [mm] | 40                                           | 45    | 50     | 60              | 65     | 80     |

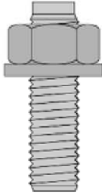
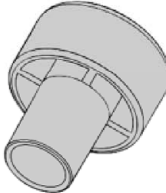
<sup>1)</sup> With metric threads according to EN 1993-1-8:2005+AC:2009

**Rotho Blaas Injection System EPO-FIX Injection system**

**Intended Use**  
Installation parameters

**Annex B 3**

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

|  |  |  |  |  |      |  |                  |                                                                                     |                                                                                     |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Threaded Rod                                                                      | Re-inforcing bar                                                                  | Internal threaded anchor rod                                                      | d <sub>0</sub><br>Drill bit - Ø<br>HD, HDB, CD, DD                                | d <sub>b</sub><br>Brush - Ø                                                       |      | d <sub>b,min</sub><br>min.<br>Brush - Ø                                             | Piston plug      | Installation direction and use of piston plug                                       |                                                                                     |                                                                                     |
| [mm]                                                                              | [mm]                                                                              | [mm]                                                                              | [mm]                                                                              | BRU                                                                               | [mm] | [mm]                                                                                |                  |  |  |  |
| M8                                                                                | 8                                                                                 |                                                                                   | 10                                                                                | H10                                                                               | 11,5 | 10,5                                                                                | No plug required |                                                                                     |                                                                                     |                                                                                     |
| M10                                                                               | 8 / 10                                                                            | IR-M6                                                                             | 12                                                                                | H12                                                                               | 13,5 | 12,5                                                                                |                  |                                                                                     |                                                                                     |                                                                                     |
| M12                                                                               | 10 / 12                                                                           | IR-M8                                                                             | 14                                                                                | H14                                                                               | 15,5 | 14,5                                                                                |                  |                                                                                     |                                                                                     |                                                                                     |
|                                                                                   | 12                                                                                |                                                                                   | 16                                                                                | H16                                                                               | 17,5 | 16,5                                                                                |                  |                                                                                     |                                                                                     |                                                                                     |
| M16                                                                               | 14                                                                                | IR-M10                                                                            | 18                                                                                | H18                                                                               | 20,0 | 18,5                                                                                | PL18             | h <sub>ef</sub> ><br>250 mm                                                         | h <sub>ef</sub> ><br>250 mm                                                         | all                                                                                 |
|                                                                                   | 16                                                                                |                                                                                   | 20                                                                                | H20                                                                               | 22,0 | 20,5                                                                                | PL20             |                                                                                     |                                                                                     |                                                                                     |
| M20                                                                               |                                                                                   | IR-M12                                                                            | 22                                                                                | H22                                                                               | 24,0 | 22,5                                                                                | PL22             |                                                                                     |                                                                                     |                                                                                     |
|                                                                                   | 20                                                                                |                                                                                   | 25                                                                                | H25                                                                               | 27,0 | 25,5                                                                                | PL25             |                                                                                     |                                                                                     |                                                                                     |
| M24                                                                               |                                                                                   | IR-M16                                                                            | 28                                                                                | H28                                                                               | 30,0 | 28,5                                                                                | PL28             |                                                                                     |                                                                                     |                                                                                     |
| M27                                                                               | 24 / 25                                                                           |                                                                                   | 30                                                                                | H30                                                                               | 31,8 | 30,5                                                                                | PL30             |                                                                                     |                                                                                     |                                                                                     |
|                                                                                   | 24 / 25                                                                           |                                                                                   | 32                                                                                | H32                                                                               | 34,0 | 32,5                                                                                | PL32             |                                                                                     |                                                                                     |                                                                                     |
| M30                                                                               | 28                                                                                | IR-M20                                                                            | 35                                                                                | H35                                                                               | 37,0 | 35,5                                                                                | PL35             |                                                                                     |                                                                                     |                                                                                     |
|                                                                                   | 32                                                                                |                                                                                   | 40                                                                                | H40                                                                               | 43,5 | 40,5                                                                                | PL40             |                                                                                     |                                                                                     |                                                                                     |

## Cleaning and installation tools

### HDB – Hollow drill bit system



The hollow drill system consists of Heller Duster Expert hollow drill bit and a class M Hoover with a minimum negative pressure of 253 hPa and a flow rate of minimum 150 m³/h (42 l/s).

### Compressed air tool

(min 6 bar)



### Brush BRUH



### Piston Plug PL



### Brush extension



## Rotho Blaas Injection System EPO-FIX Injection system

### Intended Use

Cleaning and installation tools

## Annex B 4

**Table B5: Working and curing time**

| Temperature in base material |    |         | Maximum working time | Minimum curing time <sup>1)</sup> |
|------------------------------|----|---------|----------------------|-----------------------------------|
| T                            |    |         | t <sub>work</sub>    | t <sub>cure</sub>                 |
| + 0 °C                       | to | + 4 °C  | 90 min               | 144 h                             |
| + 5 °C                       | to | + 9 °C  | 80 min               | 48 h                              |
| + 10 °C                      | to | + 14 °C | 60 min               | 28 h                              |
| + 15 °C                      | to | + 19 °C | 40 min               | 18 h                              |
| + 20 °C                      | to | + 24 °C | 30 min               | 12 h                              |
| + 25 °C                      | to | + 34 °C | 12 min               | 9 h                               |
| + 35 °C                      | to | + 39 °C | 8 min                | 6 h                               |
| + 40 °C                      |    |         | 8 min                | 4 h                               |
| Cartridge temperature        |    |         | +5 °C to +40 °C      |                                   |

<sup>1)</sup> The minimum curing time is only valid for dry base material.  
In wet base material the curing time must be doubled.

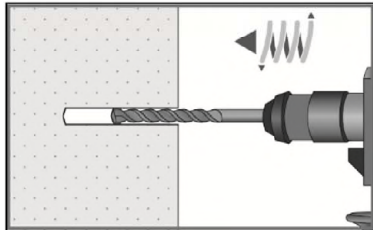
**Rotho Blaas Injection System EPO-FIX Injection system**

**Intended Use**  
Working time and curing time

**Annex B 5**

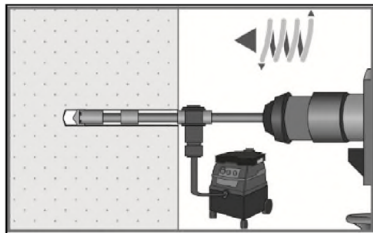
## Installation instructions

### Drilling of the bore hole (HD, HDB, CD)



#### 1a. Hammer drilling (HD) / Compressed air drilling (CD)

Drill a hole to the required embedment depth.  
Drill bit diameter according to Table B1, B2 or B3.  
Aborted drill holes shall be filled with mortar.  
Proceed with Step 2. Proceed with Step 2.



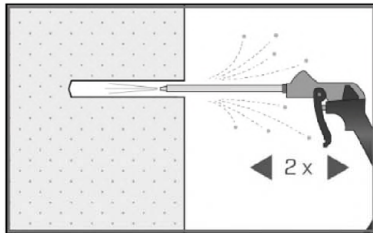
#### 1b. Hollow drill bit system (HDB) (see Annex B 4)

Drill a hole to the required embedment depth.  
Drill bit diameter according to Table B1, B2 or B3.  
The hollow drilling system removes the dust and cleans the bore hole.  
Proceed with Step 3.

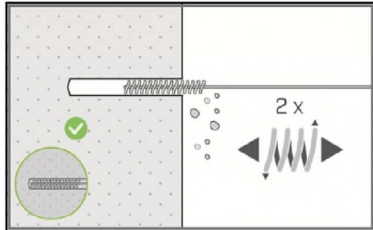
**Attention! Standing water in the bore hole must be removed before cleaning.**

### Compressed Air Cleaning (CAC):

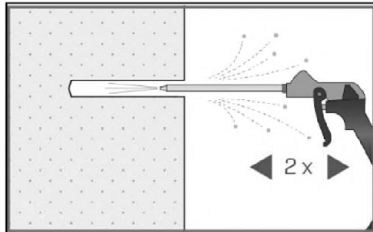
All diameter in cracked and uncracked concrete



2a. Blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)



2b. Brush the bore hole minimum 2x with brush BRUH according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)



2c. Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

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

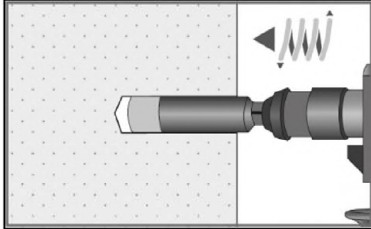
**Rotho Blaas Injection System EPO-FIX Injection system**

**Intended Use**  
Installation instructions

**Annex B 6**

## Installation instructions (continuation)

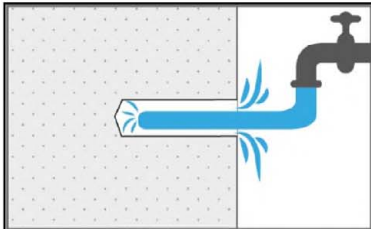
### Drilling of the bore hole (DD)



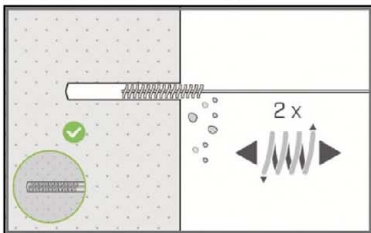
- 1a. Diamond drilling (DD)  
Drill a hole to the required embedment depth required  
Drill bit diameter according to Table B1, B2 or B3.  
Aborted drill holes shall be filled with mortar.  
Proceed with Step 2.

### Flush & Compressed Air Cleaning (SPCAC):

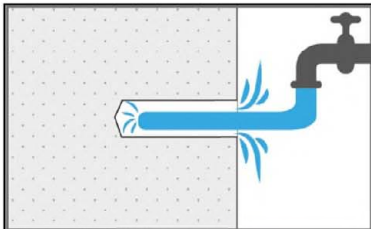
All diameter in uncracked concrete



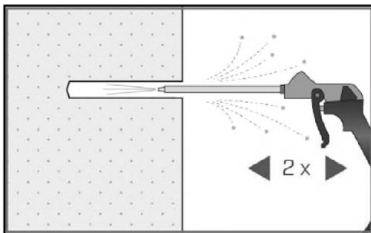
- 2a. Flushing with water until clear water comes out.



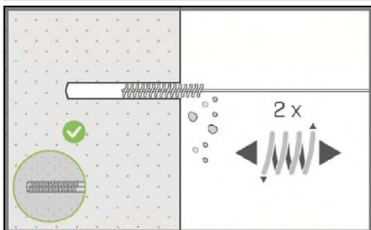
- 2b. Brush the bore hole minimum 2x with brush BRUH according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)



- 2c. Flushing again with water until clear water comes out.



- 2d. Blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)



- 2e. Brush the bore hole minimum 2x with brush BRUH according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used.)

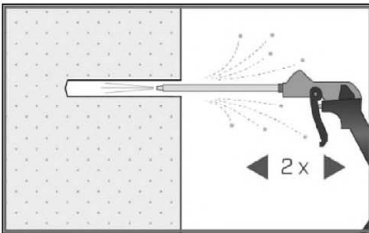
## Rotho Blaas Injection System EPO-FIX Injection system

### Intended Use

Installation instructions (continuation)

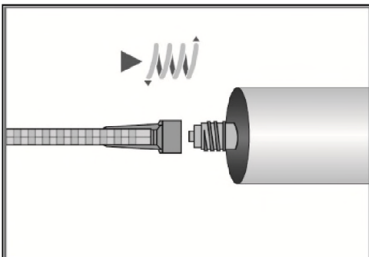
## Annex B 7

## Installation instructions (continuation)

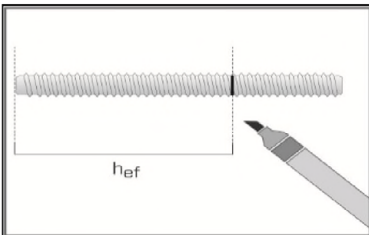


- 2f. Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

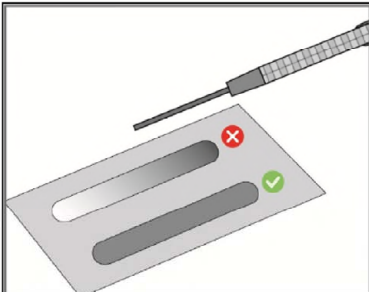
**Cleaned bore hole has to be protected against re-contamination in an appropriate way, If necessary, repeat cleaning process directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.**



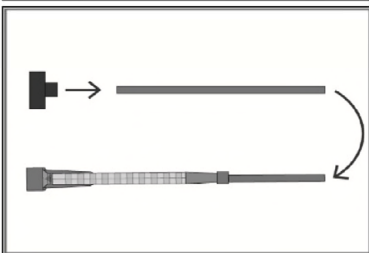
3. Screw on static-mixing nozzle and load the cartridge into an appropriate dispensing tool.  
For every working interruption longer than the maximum working time  $t_{work}$  (Annex B 5) as well as for new cartridges, a new static-mixer shall be used.



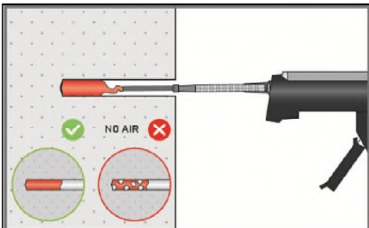
4. Mark embedment depth on the anchor rod.  
The anchor rod shall be free of dirt, grease, oil or other foreign material.



5. Not proper mixed mortar is not sufficient for fastening.  
Dispense and discard mortar until an uniform grey or red colour is shown (at least 3 full strokes).



6. Piston plugs PL and mixer nozzle extensions shall be used according to Table B4 for the following applications:
- Horizontal and vertical downwards direction: Drill bit- $\varnothing d_0 \geq 18$  mm and embedment depth  $h_{ef} > 250$ mm
  - Vertical upwards direction: Drill bit- $\varnothing d_0 \geq 18$  mm
- Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.



- 7a. **Injecting mortar without piston plug PL:**  
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.)  
Slowly withdraw of the static mixing nozzle avoid creating air pockets  
Observe the temperature related working time  $t_{work}$  (Annex B 5).

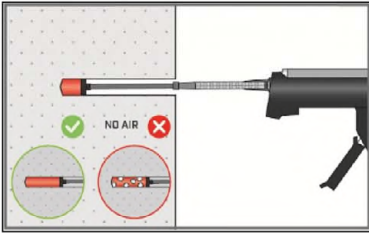
## Rotho Blaas Injection System EPO-FIX Injection system

### Intended Use

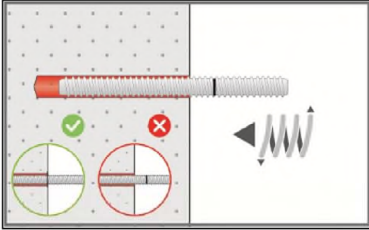
Installation instructions (continuation)

## Annex B 8

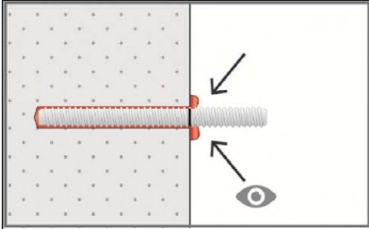
## Installation instructions (continuation)



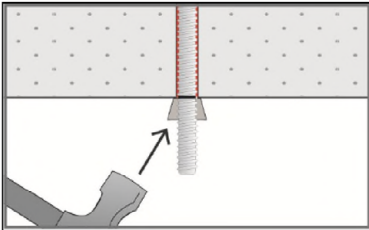
- 7b. Injecting mortar with piston plug PL:**  
Starting at bottom of the hole and fill the hole up to approximately two-thirds with adhesive. (If necessary, a mixer nozzle extension shall be used.) During injection the piston plug is pushed out of the bore hole by the back pressure of the mortar.  
Observe the temperature related working time  $t_{work}$  (Annex B 5).



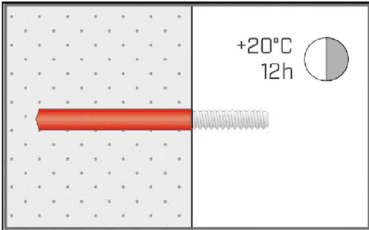
- 8.** Insert the anchor rod while turning slightly up to the embedment mark.



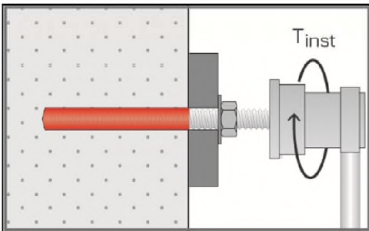
- 9.** Annular gap between anchor rod and base material must be completely filled with mortar. In case of push through installation the annular gap in the fixture must be filled with mortar also.  
Otherwise, the installation must be repeated starting from step 7 before the maximum working time  $t_{work}$  has expired.



- 10.** For application in vertical upwards direction the anchor rod shall be fixed (e.g. wedges).



- 11.** Temperature related curing time  $t_{cure}$  (Annex B 5) must be observed.  
Do not move or load the fastener during curing time.



- 12.** Install the fixture by using a calibrated torque wrench. Observe maximum installation torque (Table B1 or B3).  
In case of static requirements (e.g. seismic), fill the annular gap in the fixture with mortar (Annex A 2). Therefore replace the washer by the filling washer and use the mixer reduction nozzle.

## Rotho Blaas Injection System EPO-FIX Injection system

### Intended Use

Installation instructions (continuation)

## Annex B 9

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

| Threaded rod                                                                                                                                                                                                                                       |                                          |                                | M8    | M10     | M12     | M16  | M20 | M24       | M27 | M30  |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|--------------------------------|-------|---------|---------|------|-----|-----------|-----|------|------|
| Cross section area                                                                                                                                                                                                                                 |                                          | A <sub>s</sub>                 | [mm²] | 36,6    | 58      | 84,3 | 157 | 245       | 353 | 459  | 561  |
| Characteristic tension resistance, Steel failure 1)                                                                                                                                                                                                |                                          |                                |       |         |         |      |     |           |     |      |      |
| Steel, Property class 4.6 and 4.8                                                                                                                                                                                                                  |                                          | N <sub>Rk,s</sub>              | [kN]  | 15 (13) | 23 (21) | 34   | 63  | 98        | 141 | 184  | 224  |
| Steel, Property class 5.6 and 5.8                                                                                                                                                                                                                  |                                          | N <sub>Rk,s</sub>              | [kN]  | 18 (17) | 29 (27) | 42   | 78  | 122       | 176 | 230  | 280  |
| Steel, Property class 8.8                                                                                                                                                                                                                          |                                          | N <sub>Rk,s</sub>              | [kN]  | 29 (27) | 46 (43) | 67   | 125 | 196       | 282 | 368  | 449  |
| Stainless steel A2, A4 and HCR, class 50                                                                                                                                                                                                           |                                          | N <sub>Rk,s</sub>              | [kN]  | 18      | 29      | 42   | 79  | 123       | 177 | 230  | 281  |
| Stainless steel A2, A4 and HCR, class 70                                                                                                                                                                                                           |                                          | N <sub>Rk,s</sub>              | [kN]  | 26      | 41      | 59   | 110 | 171       | 247 | ..3) | ..3) |
| Stainless steel A4 and HCR, class 80                                                                                                                                                                                                               |                                          | N <sub>Rk,s</sub>              | [kN]  | 29      | 46      | 67   | 126 | 196       | 282 | ..3) | ..3) |
| Characteristic tension resistance, Partial factor 2)                                                                                                                                                                                               |                                          |                                |       |         |         |      |     |           |     |      |      |
| Steel, Property class 4.6 and 5.6                                                                                                                                                                                                                  |                                          | γ <sub>Ms,N</sub>              | [-]   | 2,0     |         |      |     |           |     |      |      |
| Steel, Property class 4.8, 5.8 and 8.8                                                                                                                                                                                                             |                                          | γ <sub>Ms,N</sub>              | [-]   | 1,5     |         |      |     |           |     |      |      |
| Stainless steel A2, A4 and HCR, class 50                                                                                                                                                                                                           |                                          | γ <sub>Ms,N</sub>              | [-]   | 2,86    |         |      |     |           |     |      |      |
| Stainless steel A2, A4 and HCR, class 70                                                                                                                                                                                                           |                                          | γ <sub>Ms,N</sub>              | [-]   | 1,87    |         |      |     |           |     |      |      |
| Stainless steel A4 and HCR, class 80                                                                                                                                                                                                               |                                          | γ <sub>Ms,N</sub>              | [-]   | 1,6     |         |      |     |           |     |      |      |
| Characteristic shear resistance, Steel failure 1)                                                                                                                                                                                                  |                                          |                                |       |         |         |      |     |           |     |      |      |
| Without lever arm                                                                                                                                                                                                                                  | Steel, Property class 4.6 and 4.8        | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 9 (8)   | 14 (13) | 20   | 38  | 59        | 85  | 110  | 135  |
|                                                                                                                                                                                                                                                    | Steel, Property class 5.6 and 5.8        | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 11 (10) | 17 (16) | 25   | 47  | 74        | 106 | 138  | 168  |
|                                                                                                                                                                                                                                                    | Steel, Property class 8.8                | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 15 (13) | 23 (21) | 34   | 63  | 98        | 141 | 184  | 224  |
|                                                                                                                                                                                                                                                    | Stainless steel A2, A4 and HCR, class 50 | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 9       | 15      | 21   | 39  | 61        | 88  | 115  | 140  |
|                                                                                                                                                                                                                                                    | Stainless steel A2, A4 and HCR, class 70 | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 13      | 20      | 30   | 55  | 86        | 124 | ..3) | ..3) |
|                                                                                                                                                                                                                                                    | Stainless steel A4 and HCR, class 80     | V <sup>0</sup> <sub>Rk,s</sub> | [kN]  | 15      | 23      | 34   | 63  | 98        | 141 | ..3) | ..3) |
| With lever arm                                                                                                                                                                                                                                     | Steel, Property class 4.6 and 4.8        | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 15 (13) | 30 (27) | 52   | 133 | 260       | 449 | 666  | 900  |
|                                                                                                                                                                                                                                                    | Steel, Property class 5.6 and 5.8        | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 19 (16) | 37 (33) | 65   | 166 | 324       | 560 | 833  | 1123 |
|                                                                                                                                                                                                                                                    | Steel, Property class 8.8                | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 30 (26) | 60 (53) | 105  | 266 | 519       | 896 | 1333 | 1797 |
|                                                                                                                                                                                                                                                    | Stainless steel A2, A4 and HCR, class 50 | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 19      | 37      | 66   | 167 | 325       | 561 | 832  | 1125 |
|                                                                                                                                                                                                                                                    | Stainless steel A2, A4 and HCR, class 70 | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 26      | 52      | 92   | 232 | 454       | 784 | ..3) | ..3) |
|                                                                                                                                                                                                                                                    | Stainless steel A4 and HCR, class 80     | M <sup>0</sup> <sub>Rk,s</sub> | [Nm]  | 30      | 59      | 105  | 266 | 519       | 896 | ..3) | ..3) |
| Characteristic shear resistance, Partial factor 2)                                                                                                                                                                                                 |                                          |                                |       |         |         |      |     |           |     |      |      |
| Steel, Property class 4.6 and 5.6                                                                                                                                                                                                                  |                                          | γ <sub>Ms,V</sub>              | [-]   | 1,67    |         |      |     |           |     |      |      |
| Steel, Property class 4.8, 5.8 and 8.8                                                                                                                                                                                                             |                                          | γ <sub>Ms,V</sub>              | [-]   | 1,25    |         |      |     |           |     |      |      |
| Stainless steel A2, A4 and HCR, class 50                                                                                                                                                                                                           |                                          | γ <sub>Ms,V</sub>              | [-]   | 2,38    |         |      |     |           |     |      |      |
| Stainless steel A2, A4 and HCR, class 70                                                                                                                                                                                                           |                                          | γ <sub>Ms,V</sub>              | [-]   | 1,56    |         |      |     |           |     |      |      |
| Stainless steel A4 and HCR, class 80                                                                                                                                                                                                               |                                          | γ <sub>Ms,V</sub>              | [-]   | 1,33    |         |      |     |           |     |      |      |
| 1) Values are only valid for the given stress area A <sub>s</sub> . Values in brackets are valid for undersized threaded rods with smaller stress area A <sub>s</sub> for hot-dip galvanised threaded rods according to EN ISO 10684:2004+AC:2009. |                                          |                                |       |         |         |      |     |           |     |      |      |
| 2) in absence of national regulation                                                                                                                                                                                                               |                                          |                                |       |         |         |      |     |           |     |      |      |
| 3) Fastener type not part of the ETA                                                                                                                                                                                                               |                                          |                                |       |         |         |      |     |           |     |      |      |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                                                              |                                          |                                |       |         |         |      |     | Annex C 1 |     |      |      |
| Performances<br>Characteristic values for steel tension resistance and steel shear resistance of threaded rods                                                                                                                                     |                                          |                                |       |         |         |      |     |           |     |      |      |

**Table C2: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years**

| Fastener              |                        |             | All Fastener type and sizes |                                                        |
|-----------------------|------------------------|-------------|-----------------------------|--------------------------------------------------------|
| Concrete cone failure |                        |             |                             |                                                        |
| Uncracked concrete    | $k_{ucr,N}$            | [-]         | 11,0                        |                                                        |
| Cracked concrete      | $k_{cr,N}$             | [-]         | 7,7                         |                                                        |
| Edge distance         | $c_{cr,N}$             | [mm]        | 1,5 $h_{ef}$                |                                                        |
| Axial distance        | $s_{cr,N}$             | [mm]        | 2 $c_{cr,N}$                |                                                        |
| Splitting             |                        |             |                             |                                                        |
| Edge distance         | $h/h_{ef} \geq 2,0$    | $c_{cr,sp}$ | [mm]                        | 1,0 $h_{ef}$                                           |
|                       | $2,0 > h/h_{ef} > 1,3$ |             |                             | $2 \cdot h_{ef} \left( 2,5 - \frac{h}{h_{ef}} \right)$ |
|                       | $h/h_{ef} \leq 1,3$    |             |                             | 2,4 $h_{ef}$                                           |
| Axial distance        | $s_{cr,sp}$            | [mm]        | 2 $c_{cr,sp}$               |                                                        |

**Rotho Blaas Injection System EPO-FIX Injection system**

**Annex C 2**

**Performances**

Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years

| Table C3: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years                                                                             |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-----------------|--------------------------------------|---------------------------------------|-----|-----|-----|-----|-----------|-----|-----|
| Threaded rod                                                                                                                                                                                     |               |                                         |                 |                                      | M8                                    | M10 | M12 | M16 | M20 | M24       | M27 | M30 |
| Steel failure                                                                                                                                                                                    |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Characteristic tension resistance                                                                                                                                                                |               | $N_{Rk,s}$                              | [kN]            | $A_s \cdot f_{uk}$ (or see Table C1) |                                       |     |     |     |     |           |     |     |
| Partial factor                                                                                                                                                                                   |               | $\gamma_{Ms,N}$                         | [-]             | see Table C1                         |                                       |     |     |     |     |           |     |     |
| Combined pull-out and concrete failure                                                                                                                                                           |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                                   |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Temperature range                                                                                                                                                                                | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²]                              | 20                                    | 20  | 19  | 19  | 18  | 17        | 16  | 16  |
|                                                                                                                                                                                                  | II: 72°C/50°C |                                         |                 |                                      | 15                                    | 15  | 15  | 14  | 13  | 13        | 12  | 12  |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                                  |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Temperature range                                                                                                                                                                                | I: 40°C/24°C  | Dry, wet concrete                       | $\tau_{Rk,ucr}$ | [N/mm²]                              | 17                                    | 16  | 16  | 16  | 15  | 14        | 14  | 13  |
|                                                                                                                                                                                                  | II: 72°C/50°C |                                         |                 |                                      | 14                                    | 14  | 14  | 13  | 13  | 12        | 12  | 11  |
|                                                                                                                                                                                                  | I: 40°C/24°C  | flooded bore hole                       |                 |                                      | 16                                    | 16  | 16  | 15  | 15  | 14        | 14  | 13  |
|                                                                                                                                                                                                  | II: 72°C/50°C |                                         |                 |                                      | 14                                    | 14  | 14  | 13  | 13  | 12        | 12  | 11  |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)               |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Temperature range                                                                                                                                                                                | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,cr}$  | [N/mm²]                              | 7,0                                   | 7,0 | 8,5 | 8,5 | 8,5 | 8,5       | 8,5 | 8,5 |
|                                                                                                                                                                                                  | II: 72°C/50°C |                                         |                 |                                      | 6,0                                   | 6,0 | 7,0 | 7,0 | 7,0 | 7,0       | 7,0 | 7,0 |
| Reduction factor $\psi_{sus}^0$ in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Temperature range                                                                                                                                                                                | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\psi_{sus}^0$  | [-]                                  | 0,80                                  |     |     |     |     |           |     |     |
|                                                                                                                                                                                                  | II: 72°C/50°C |                                         |                 |                                      | 0,68                                  |     |     |     |     |           |     |     |
| Increasing factors for concrete                                                                                                                                                                  |               | $\psi_c$                                | [-]             | $(f_{ck} / 20)^{0,1}$                |                                       |     |     |     |     |           |     |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                          |               | $\tau_{Rk,ucr} =$                       |                 |                                      | $\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$ |     |     |     |     |           |     |     |
|                                                                                                                                                                                                  |               | $\tau_{Rk,cr} =$                        |                 |                                      | $\psi_c \cdot \tau_{Rk,cr,(C20/25)}$  |     |     |     |     |           |     |     |
| Concrete cone failure                                                                                                                                                                            |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Relevant parameter                                                                                                                                                                               |               |                                         |                 |                                      | see Table C2                          |     |     |     |     |           |     |     |
| Splitting                                                                                                                                                                                        |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Relevant parameter                                                                                                                                                                               |               |                                         |                 |                                      | see Table C2                          |     |     |     |     |           |     |     |
| Installation factor                                                                                                                                                                              |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                           |               | $\gamma_{inst}$                         | [-]             | 1,0                                  |                                       |     |     |     |     |           |     |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                              |               |                                         |                 | 1,2                                  |                                       |     |     |     |     |           |     |     |
|                                                                                                                                                                                                  |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                            |               |                                         |                 |                                      |                                       |     |     |     |     | Annex C 3 |     |     |
| Performances<br>Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (threaded rod)                                                        |               |                                         |                 |                                      |                                       |     |     |     |     |           |     |     |

| Table C4: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years                                                              |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|---------------------|-------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Threaded rod                                                                                                                                                                       |               |                                         |                     | M8                                        | M10 | M12 | M16 | M20 | M24 | M27 | M30 |     |
| Steel failure                                                                                                                                                                      |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Characteristic tension resistance                                                                                                                                                  |               | $N_{Rk,s}$                              | [kN]                | $A_s \cdot f_{uk}$ (or see Table C1)      |     |     |     |     |     |     |     |     |
| Partial factor                                                                                                                                                                     |               | $\gamma_{Ms,N}$                         | [-]                 | see Table C1                              |     |     |     |     |     |     |     |     |
| Combined pull-out and concrete failure                                                                                                                                             |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                     |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Temperature range                                                                                                                                                                  | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,ucr,100}$ | [N/mm²]                                   | 20  | 20  | 19  | 19  | 18  | 17  | 16  | 16  |
|                                                                                                                                                                                    | II: 72°C/50°C |                                         |                     |                                           | 15  | 15  | 15  | 14  | 13  | 13  | 12  | 12  |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                    |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Temperature range                                                                                                                                                                  | I: 40°C/24°C  | Dry, wet concrete                       | $\tau_{Rk,ucr,100}$ | [N/mm²]                                   | 17  | 16  | 16  | 16  | 15  | 14  | 14  | 13  |
|                                                                                                                                                                                    | II: 72°C/50°C |                                         |                     |                                           | 14  | 14  | 14  | 13  | 13  | 12  | 12  | 11  |
|                                                                                                                                                                                    | I: 40°C/24°C  | flooded bore hole                       |                     |                                           | 16  | 16  | 16  | 15  | 15  | 14  | 14  | 13  |
|                                                                                                                                                                                    | II: 72°C/50°C |                                         |                     |                                           | 14  | 14  | 14  | 13  | 13  | 12  | 12  | 11  |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Temperature range                                                                                                                                                                  | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,cr,100}$  | [N/mm²]                                   | 6,5 | 6,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
|                                                                                                                                                                                    | II: 72°C/50°C |                                         |                     |                                           | 5,5 | 5,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| Increasing factors for concrete                                                                                                                                                    |               | $\psi_c$                                | [-]                 | $(f_{ck} / 20)^{0,1}$                     |     |     |     |     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                            |               | $\tau_{Rk,ucr,100} =$                   |                     | $\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$ |     |     |     |     |     |     |     |     |
|                                                                                                                                                                                    |               | $\tau_{Rk,cr,100} =$                    |                     | $\psi_c \cdot \tau_{Rk,cr,100,(C20/25)}$  |     |     |     |     |     |     |     |     |
| Concrete cone failure                                                                                                                                                              |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Relevant parameter                                                                                                                                                                 |               |                                         |                     | see Table C2                              |     |     |     |     |     |     |     |     |
| Splitting                                                                                                                                                                          |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| Relevant parameter                                                                                                                                                                 |               |                                         |                     | see Table C2                              |     |     |     |     |     |     |     |     |
| Installation factor                                                                                                                                                                |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                             |               | $\gamma_{inst}$                         | [-]                 | 1,0                                       |     |     |     |     |     |     |     |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                |               |                                         |                     | 1,2                                       |     |     |     |     |     |     |     |     |
|                                                                                                                                                                                    |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
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|                                                                                                                                                                                    |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
|                                                                                                                                                                                    |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
|                                                                                                                                                                                    |               |                                         |                     |                                           |     |     |     |     |     |     |     |     |
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| Table C5: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
|----------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------|---------|---------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Threaded rod                                                                                                         |               |                                         |                   |         | M8                                    | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| Steel failure                                                                                                        |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Characteristic tension resistance                                                                                    |               |                                         | $N_{Rk,s}$        | [kN]    | $A_s \cdot f_{uk}$ (or see Table C1)  |     |     |     |     |     |     |     |
| Partial factor                                                                                                       |               |                                         | $\gamma_{Ms,N}$   | [-]     | see Table C1                          |     |     |     |     |     |     |     |
| Combined pull-out and concrete failure                                                                               |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)                            |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Temperature range                                                                                                    | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,ucr}$   | [N/mm²] | 15                                    | 14  | 14  | 13  | 12  | 12  | 11  | 11  |
|                                                                                                                      | II: 72°C/50°C |                                         |                   |         | 12                                    | 12  | 11  | 10  | 9,5 | 9,5 | 9,0 | 9,0 |
| Reduction factor $\psi^0_{sus}$ in uncracked concrete C20/25 in diamond drilled holes (DD)                           |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Temperature range                                                                                                    | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\psi^0_{sus}$    | [-]     | 0,77                                  |     |     |     |     |     |     |     |
|                                                                                                                      | II: 72°C/50°C |                                         |                   |         | 0,72                                  |     |     |     |     |     |     |     |
| Increasing factors for concrete                                                                                      |               |                                         | $\psi_c$          | [-]     | $(f_{ck} / 20)^{0,2}$                 |     |     |     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                                              |               |                                         | $\tau_{Rk,ucr} =$ |         | $\psi_c \cdot \tau_{Rk,ucr,(C20/25)}$ |     |     |     |     |     |     |     |
| Concrete cone failure                                                                                                |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Relevant parameter                                                                                                   |               |                                         |                   |         | see Table C2                          |     |     |     |     |     |     |     |
| Splitting                                                                                                            |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| Relevant parameter                                                                                                   |               |                                         |                   |         | see Table C2                          |     |     |     |     |     |     |     |
| Installation factor                                                                                                  |               |                                         |                   |         |                                       |     |     |     |     |     |     |     |
| for dry and wet concrete (DD)                                                                                        |               |                                         | $\gamma_{inst}$   | [-]     | 1,0                                   |     |     |     |     |     |     |     |
| for flooded bore hole (DD)                                                                                           |               |                                         |                   |         | 1,2                                   |     |     |     | 1,4 |     |     |     |
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**Table C6: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years**

| Threaded rod                                                                              |               |                                         |                                           | M8                                   | M10 | M12 | M16 | M20 | M24 | M27 | M30 |     |
|-------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------------------------|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Steel failure                                                                             |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| Characteristic tension resistance                                                         |               | $N_{Rk,s}$                              | [kN]                                      | $A_s \cdot f_{uk}$ (or see Table C1) |     |     |     |     |     |     |     |     |
| Partial factor                                                                            |               | $\gamma_{Ms,N}$                         | [-]                                       | see Table C1                         |     |     |     |     |     |     |     |     |
| Combined pull-out and concrete failure                                                    |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD) |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| Temperature range                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,ucr,100}$                       | [N/mm <sup>2</sup> ]                 | 15  | 14  | 14  | 13  | 12  | 12  | 11  | 11  |
|                                                                                           | II: 72°C/50°C |                                         |                                           |                                      | 11  | 11  | 10  | 10  | 9,5 | 9,0 | 8,5 | 8,5 |
| Increasing factors for concrete                                                           |               | $\psi_c$                                | [-]                                       | $(f_{ck} / 20)^{0,2}$                |     |     |     |     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                   |               | $\tau_{Rk,ucr,100} =$                   | $\psi_c \cdot \tau_{Rk,ucr,100,(C20/25)}$ |                                      |     |     |     |     |     |     |     |     |
| Concrete cone failure                                                                     |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| Relevant parameter                                                                        |               |                                         |                                           | see Table C2                         |     |     |     |     |     |     |     |     |
| Splitting                                                                                 |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| Relevant parameter                                                                        |               |                                         |                                           | see Table C2                         |     |     |     |     |     |     |     |     |
| Installation factor                                                                       |               |                                         |                                           |                                      |     |     |     |     |     |     |     |     |
| for dry and wet concrete (DD)                                                             |               | $\gamma_{inst}$                         | [-]                                       | 1,0                                  |     |     |     |     |     |     |     |     |
| for flooded bore hole (DD)                                                                |               |                                         |                                           | 1,2                                  |     |     |     | 1,4 |     |     |     |     |

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (threaded rod)

**Annex C 6**

**Table C7: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years**

| Threaded rod                                                                                                                                    |                 |       | M8                                                | M10 | M12 | M16 | M20 | M24       | M27                          | M30  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------|---------------------------------------------------|-----|-----|-----|-----|-----------|------------------------------|------|--|
| Steel failure without lever arm                                                                                                                 |                 |       |                                                   |     |     |     |     |           |                              |      |  |
| Characteristic shear resistance<br>Steel, strength class 4.6, 4.8 and 5.6, 5.8                                                                  | $V_{Rk,s}^0$    | [kN]  | $0,6 \cdot A_s \cdot f_{uk}$ (or see Table C1)    |     |     |     |     |           |                              |      |  |
| Characteristic shear resistance<br>Steel, strength class 8.8<br>Stainless Steel A2, A4 and HCR, all strength classes                            | $V_{Rk,s}^0$    | [kN]  | $0,5 \cdot A_s \cdot f_{uk}$ (or see Table C1)    |     |     |     |     |           |                              |      |  |
| Partial factor                                                                                                                                  | $\gamma_{Ms,V}$ | [-]   | see Table C1                                      |     |     |     |     |           |                              |      |  |
| Ductility factor                                                                                                                                | $k_7$           | [-]   | 1,0                                               |     |     |     |     |           |                              |      |  |
| Steel failure with lever arm                                                                                                                    |                 |       |                                                   |     |     |     |     |           |                              |      |  |
| Characteristic bending moment                                                                                                                   | $M_{Rk,s}^0$    | [Nm]  | $1,2 \cdot W_{el} \cdot f_{uk}$ (or see Table C1) |     |     |     |     |           |                              |      |  |
| Elastic section modulus                                                                                                                         | $W_{el}$        | [mm³] | 31                                                | 62  | 109 | 277 | 541 | 935       | 1387                         | 1874 |  |
| Partial factor                                                                                                                                  | $\gamma_{Ms,V}$ | [-]   | see Table C1                                      |     |     |     |     |           |                              |      |  |
| Concrete pry-out failure                                                                                                                        |                 |       |                                                   |     |     |     |     |           |                              |      |  |
| Factor                                                                                                                                          | $k_8$           | [-]   | 2,0                                               |     |     |     |     |           |                              |      |  |
| Installation factor                                                                                                                             | $\gamma_{inst}$ | [-]   | 1,0                                               |     |     |     |     |           |                              |      |  |
| Concrete edge failure                                                                                                                           |                 |       |                                                   |     |     |     |     |           |                              |      |  |
| Effective length of fastener                                                                                                                    | $l_f$           | [mm]  | $\min(h_{ef}; 12 \cdot d_{nom})$                  |     |     |     |     |           | $\min(h_{ef}; 300\text{mm})$ |      |  |
| Outside diameter of fastener                                                                                                                    | $d_{nom}$       | [mm]  | 8                                                 | 10  | 12  | 16  | 20  | 24        | 27                           | 30   |  |
| Installation factor                                                                                                                             | $\gamma_{inst}$ | [-]   | 1,0                                               |     |     |     |     |           |                              |      |  |
|                                                                                                                                                 |                 |       |                                                   |     |     |     |     |           |                              |      |  |
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| Rotho Blaas Injection System EPO-FIX Injection system                                                                                           |                 |       |                                                   |     |     |     |     | Annex C 7 |                              |      |  |
| Performances<br>Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (threaded rod) |                 |       |                                                   |     |     |     |     |           |                              |      |  |

**Table C8: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years**

| Internal threaded anchor rods                                                                                                                                                                                                                             |               |                                         |                               | IR-M6        | IR-M8                                         | IR-M10 | IR-M12 | IR-M16 | IR-M20 |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------------|--------------|-----------------------------------------------|--------|--------|--------|--------|-----|
| Steel failure <sup>1)</sup>                                                                                                                                                                                                                               |               |                                         |                               |              |                                               |        |        |        |        |     |
| Characteristic tension resistance,                                                                                                                                                                                                                        | 5.8           | N <sub>Rk,s</sub>                       | [kN]                          | 10           | 17                                            | 29     | 42     | 76     | 123    |     |
| Steel, strength class                                                                                                                                                                                                                                     | 8.8           | N <sub>Rk,s</sub>                       | [kN]                          | 16           | 27                                            | 46     | 67     | 121    | 196    |     |
| Partial factor, strength class 5.8 and 8.8                                                                                                                                                                                                                |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,5          |                                               |        |        |        |        |     |
| Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup>                                                                                                                                                            |               | N <sub>Rk,s</sub>                       | [kN]                          | 14           | 26                                            | 41     | 59     | 110    | 124    |     |
| Partial factor                                                                                                                                                                                                                                            |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,87         |                                               |        |        |        | 2,86   |     |
| Combined pull-out and concrete cone failure                                                                                                                                                                                                               |               |                                         |                               |              |                                               |        |        |        |        |     |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                                                                                            |               |                                         |                               |              |                                               |        |        |        |        |     |
| Temperature range                                                                                                                                                                                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr</sub>           | [N/mm²]      | 20                                            | 19     | 19     | 18     | 17     | 16  |
|                                                                                                                                                                                                                                                           | II: 72°C/50°C |                                         |                               |              | 15                                            | 15     | 14     | 13     | 13     | 12  |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                                                                                           |               |                                         |                               |              |                                               |        |        |        |        |     |
| Temperature range                                                                                                                                                                                                                                         | I: 40°C/24°C  | Dry, wet concrete                       | τ <sub>Rk,ucr</sub>           | [N/mm²]      | 16                                            | 16     | 16     | 15     | 14     | 13  |
|                                                                                                                                                                                                                                                           | II: 72°C/50°C |                                         |                               |              | 14                                            | 14     | 13     | 13     | 12     | 11  |
|                                                                                                                                                                                                                                                           | I: 40°C/24°C  | flooded bore hole                       |                               |              | 16                                            | 16     | 15     | 15     | 14     | 13  |
|                                                                                                                                                                                                                                                           | II: 72°C/50°C |                                         |                               |              | 14                                            | 14     | 13     | 13     | 12     | 11  |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)                                                                         |               |                                         |                               |              |                                               |        |        |        |        |     |
| Temperature range                                                                                                                                                                                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,cr</sub>            | [N/mm²]      | 7,0                                           | 8,5    | 8,5    | 8,5    | 8,5    | 8,5 |
|                                                                                                                                                                                                                                                           | II: 72°C/50°C |                                         |                               |              | 6,0                                           | 7,0    | 7,0    | 7,0    | 7,0    | 7,0 |
| Reduction factor ψ <sup>0</sup> <sub>sus</sub> in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)                                           |               |                                         |                               |              |                                               |        |        |        |        |     |
| Temperature range                                                                                                                                                                                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | ψ <sup>0</sup> <sub>sus</sub> | [-]          | 0,80                                          |        |        |        |        |     |
|                                                                                                                                                                                                                                                           | II: 72°C/50°C |                                         |                               |              | 0,68                                          |        |        |        |        |     |
| Increasing factors for concrete                                                                                                                                                                                                                           |               |                                         | ψ <sub>C</sub>                | [-]          | (f <sub>ck</sub> / 20) <sup>0,1</sup>         |        |        |        |        |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                                                                                   |               |                                         | τ <sub>Rk,ucr</sub> =         |              | ψ <sub>C</sub> • τ <sub>Rk,ucr,(C20/25)</sub> |        |        |        |        |     |
|                                                                                                                                                                                                                                                           |               |                                         | τ <sub>Rk,cr</sub> =          |              | ψ <sub>C</sub> • τ <sub>Rk,cr,(C20/25)</sub>  |        |        |        |        |     |
| Concrete cone failure                                                                                                                                                                                                                                     |               |                                         |                               |              |                                               |        |        |        |        |     |
| Relevant parameter                                                                                                                                                                                                                                        |               |                                         |                               | see Table C2 |                                               |        |        |        |        |     |
| Splitting failure                                                                                                                                                                                                                                         |               |                                         |                               |              |                                               |        |        |        |        |     |
| Relevant parameter                                                                                                                                                                                                                                        |               |                                         |                               | see Table C2 |                                               |        |        |        |        |     |
| Installation factor                                                                                                                                                                                                                                       |               |                                         |                               |              |                                               |        |        |        |        |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                                                                                    |               | γ <sub>inst</sub>                       | [-]                           | 1,0          |                                               |        |        |        |        |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                                                                                       |               |                                         |                               | 1,2          |                                               |        |        |        |        |     |
| 1) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element. |               |                                         |                               |              |                                               |        |        |        |        |     |
| 2) For IR-M20 strength class 50 is valid                                                                                                                                                                                                                  |               |                                         |                               |              |                                               |        |        |        |        |     |

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (Internal threaded anchor rod)

**Annex C 8**

**Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years**

| Internal threaded anchor rods                                                                                                                                                     |               |                                         |                         | IR-M6                                             | IR-M8 | IR-M10 | IR-M12 | IR-M16 | IR-M20 |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------|---------------------------------------------------|-------|--------|--------|--------|--------|-----|
| Steel failure <sup>1)</sup>                                                                                                                                                       |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Characteristic tension resistance,                                                                                                                                                | 5.8           | N <sub>Rk,s</sub>                       | [kN]                    | 10                                                | 17    | 29     | 42     | 76     | 123    |     |
| Steel, strength class                                                                                                                                                             | 8.8           | N <sub>Rk,s</sub>                       | [kN]                    | 16                                                | 27    | 46     | 67     | 121    | 196    |     |
| Partial factor, strength class 5.8 and 8.8                                                                                                                                        |               | γ <sub>Ms,N</sub>                       | [-]                     | [-]                                               |       |        |        |        |        |     |
| Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup>                                                                                    |               | N <sub>Rk,s</sub>                       | [kN]                    | [kN]                                              | 26    | 41     | 59     | 110    | 124    |     |
| Partial factor                                                                                                                                                                    |               | γ <sub>Ms,N</sub>                       | [-]                     | [-]                                               |       |        |        |        |        |     |
| 2,86                                                                                                                                                                              |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Combined pull-out and concrete cone failure                                                                                                                                       |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                    |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr,100</sub> | [N/mm <sup>2</sup> ]                              | 20    | 19     | 19     | 18     | 17     | 16  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 15    | 15     | 14     | 13     | 13     | 12  |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                   |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete                       | τ <sub>Rk,ucr,100</sub> | [N/mm <sup>2</sup> ]                              | 16    | 16     | 16     | 15     | 14     | 13  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 14    | 14     | 13     | 13     | 12     | 11  |
|                                                                                                                                                                                   | I: 40°C/24°C  | flooded bore hole                       |                         |                                                   | 16    | 16     | 15     | 15     | 14     | 13  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 14    | 14     | 13     | 13     | 12     | 11  |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,cr,100</sub>  | [N/mm <sup>2</sup> ]                              | 6,5   | 7,5    | 7,5    | 7,5    | 7,5    | 7,5 |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 5,5   | 6,5    | 6,5    | 6,5    | 6,5    | 6,5 |
| Increasing factors for concrete                                                                                                                                                   |               | ψ <sub>c</sub>                          | [-]                     | (f <sub>ck</sub> / 20) <sup>0,1</sup>             |       |        |        |        |        |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                           |               | τ <sub>Rk,ucr,100</sub> =               |                         | ψ <sub>c</sub> • τ <sub>Rk,ucr,100,(C20/25)</sub> |       |        |        |        |        |     |
|                                                                                                                                                                                   |               | τ <sub>Rk,cr,100</sub> =                |                         | ψ <sub>c</sub> • τ <sub>Rk,cr,100,(C20/25)</sub>  |       |        |        |        |        |     |
| Concrete cone failure                                                                                                                                                             |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Relevant parameter                                                                                                                                                                |               |                                         |                         | see Table C2                                      |       |        |        |        |        |     |
| Splitting failure                                                                                                                                                                 |               |                                         |                         |                                                   |       |        |        |        |        |     |
| Relevant parameter                                                                                                                                                                |               |                                         |                         | see Table C2                                      |       |        |        |        |        |     |
| Installation factor                                                                                                                                                               |               |                                         |                         |                                                   |       |        |        |        |        |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                            |               | γ <sub>inst</sub>                       | [-]                     | 1,0                                               |       |        |        |        |        |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                               |               |                                         |                         | 1,2                                               |       |        |        |        |        |     |

- 1) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.  
2) For IR-M20 strength class 50 is valid

## Rotho Blaas Injection System EPO-FIX Injection system

### Performances

Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (Internal threaded anchor rod)

## Annex C 9

**Table C10: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years**

| Internal threaded anchor rods                                                                             |               |                                         |                               | IR-M6                | IR-M8                                         | IR-M10 | IR-M12 | IR-M16 | IR-M20 |     |
|-----------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------------|----------------------|-----------------------------------------------|--------|--------|--------|--------|-----|
| Steel failure <sup>1)</sup>                                                                               |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Characteristic tension resistance,                                                                        | 5.8           | N <sub>Rk,s</sub>                       | [kN]                          | 10                   | 17                                            | 29     | 42     | 76     | 123    |     |
| Steel, strength class                                                                                     | 8.8           | N <sub>Rk,s</sub>                       | [kN]                          | 16                   | 27                                            | 46     | 67     | 121    | 196    |     |
| Partial factor, strength class 5.8 and 8.8                                                                |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,5                  |                                               |        |        |        |        |     |
| Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup>            |               | N <sub>Rk,s</sub>                       | [kN]                          | 14                   | 26                                            | 41     | 59     | 110    | 124    |     |
| Partial factor                                                                                            |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,87                 |                                               |        |        |        | 2,86   |     |
| Combined pull-out and concrete cone failure                                                               |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)                 |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Temperature range                                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr</sub>           | [N/mm <sup>2</sup> ] | 14                                            | 14     | 13     | 12     | 12     | 11  |
|                                                                                                           | II: 72°C/50°C |                                         |                               |                      | 12                                            | 11     | 10     | 9,5    | 9,5    | 9,0 |
| Reduction factor ψ <sup>0</sup> <sub>SUS</sub> in uncracked concrete C20/25 in diamond drilled holes (DD) |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Temperature range                                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | ψ <sup>0</sup> <sub>SUS</sub> | [-]                  | 0,77                                          |        |        |        |        |     |
|                                                                                                           | II: 72°C/50°C |                                         |                               |                      | 0,72                                          |        |        |        |        |     |
| Increasing factors for concrete                                                                           |               |                                         | ψ <sub>c</sub>                | [-]                  | (f <sub>ck</sub> / 20) <sup>0,2</sup>         |        |        |        |        |     |
| Characteristic bond resistance depending on the concrete strength class                                   |               |                                         | τ <sub>Rk,ucr</sub> =         |                      | ψ <sub>c</sub> • τ <sub>Rk,ucr,(C20/25)</sub> |        |        |        |        |     |
| Concrete cone failure                                                                                     |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Relevant parameter                                                                                        |               |                                         |                               | see Table C2         |                                               |        |        |        |        |     |
| Splitting failure                                                                                         |               |                                         |                               |                      |                                               |        |        |        |        |     |
| Relevant parameter                                                                                        |               |                                         |                               | see Table C2         |                                               |        |        |        |        |     |
| Installation factor                                                                                       |               |                                         |                               |                      |                                               |        |        |        |        |     |
| for dry and wet concrete (DD)                                                                             |               | γ <sub>inst</sub>                       | [-]                           | 1,0                  |                                               |        |        |        |        |     |
| for flooded bore hole (DD)                                                                                |               |                                         |                               | 1,2                  |                                               | 1,4    |        |        |        |     |

- 1) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
- 2) For IR-M20 strength class 50 is valid

## Rotho Blaas Injection System EPO-FIX Injection system

### Performances

Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (Internal threaded anchor rod)

## Annex C 10

**Table C11: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years**

| Internal threaded anchor rods                                                                  |               |                                         |                           | IR-M6                | IR-M8                                             | IR-M10 | IR-M12 | IR-M16 | IR-M20 |      |
|------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|---------------------------|----------------------|---------------------------------------------------|--------|--------|--------|--------|------|
| Steel failure <sup>1)</sup>                                                                    |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| Characteristic tension resistance,                                                             | 5.8           | N <sub>Rk,s</sub>                       | [kN]                      | 10                   | 17                                                | 29     | 42     | 76     | 123    |      |
| Steel, strength class                                                                          | 8.8           | N <sub>Rk,s</sub>                       | [kN]                      | 16                   | 27                                                | 46     | 67     | 121    | 196    |      |
| Partial factor, strength class 5.8 and 8.8                                                     |               | γ <sub>Ms,N</sub>                       | [-]                       | 1,5                  |                                                   |        |        |        |        |      |
| Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup> |               | N <sub>Rk,s</sub>                       | [kN]                      | 14                   | 26                                                | 41     | 59     | 110    | 124    |      |
| Partial factor                                                                                 |               | γ <sub>Ms,N</sub>                       | [-]                       | 1,87                 |                                                   |        |        |        |        | 2,86 |
| Combined pull-out and concrete cone failure                                                    |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)      |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| Temperature range                                                                              | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr,100</sub>   | [N/mm <sup>2</sup> ] | 14                                                | 14     | 13     | 12     | 12     | 11   |
|                                                                                                | II: 72°C/50°C |                                         |                           |                      | 11                                                | 10     | 10     | 9,5    | 9,0    | 8,5  |
| Increasing factors for concrete                                                                |               |                                         | ψ <sub>C</sub>            | [-]                  | (f <sub>ck</sub> / 20) <sup>0,2</sup>             |        |        |        |        |      |
| Characteristic bond resistance depending on the concrete strength class                        |               |                                         | τ <sub>Rk,ucr,100</sub> = |                      | ψ <sub>C</sub> * τ <sub>Rk,ucr,100,(C20/25)</sub> |        |        |        |        |      |
| Concrete cone failure                                                                          |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| Relevant parameter                                                                             |               |                                         |                           | see Table C2         |                                                   |        |        |        |        |      |
| Splitting failure                                                                              |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| Relevant parameter                                                                             |               |                                         |                           | see Table C2         |                                                   |        |        |        |        |      |
| Installation factor                                                                            |               |                                         |                           |                      |                                                   |        |        |        |        |      |
| for dry and wet concrete (DD)                                                                  |               | γ <sub>inst</sub>                       | [-]                       | 1,0                  |                                                   |        |        |        |        |      |
| for flooded bore hole (DD)                                                                     |               |                                         |                           | 1,2                  |                                                   | 1,4    |        |        |        |      |

<sup>1)</sup> Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.

<sup>2)</sup> For IR-M20 strength class 50 is valid

## Rotho Blaas Injection System EPO-FIX Injection system

### Performances

Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (Internal threaded anchor rod)

## Annex C 11

**Table C12: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years**

| Internal threaded anchor rods                                                                                                                                                                                                                                                                                                |     |                 |      | IR-M6                            | IR-M8 | IR-M10 | IR-M12 | IR-M16     | IR-M20                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------|------|----------------------------------|-------|--------|--------|------------|------------------------------|
| Steel failure without lever arm <sup>1)</sup>                                                                                                                                                                                                                                                                                |     |                 |      |                                  |       |        |        |            |                              |
| Characteristic shear resistance, Steel, strength class                                                                                                                                                                                                                                                                       | 5.8 | $V_{Rk,s}^0$    | [kN] | 5                                | 9     | 15     | 21     | 38         | 61                           |
|                                                                                                                                                                                                                                                                                                                              | 8.8 | $V_{Rk,s}^0$    | [kN] | 8                                | 14    | 23     | 34     | 60         | 98                           |
| Partial factor, strength class 5.8 and 8.8                                                                                                                                                                                                                                                                                   |     | $\gamma_{Ms,V}$ | [-]  | 1,25                             |       |        |        |            |                              |
| Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup>                                                                                                                                                                                                                                 |     | $V_{Rk,s}^0$    | [kN] | 7                                | 13    | 20     | 30     | 55         | 40                           |
| Partial factor                                                                                                                                                                                                                                                                                                               |     | $\gamma_{Ms,V}$ | [-]  | 1,56                             |       |        |        |            | 2,38                         |
| Ductility factor                                                                                                                                                                                                                                                                                                             |     | $k_7$           | [-]  | 1,0                              |       |        |        |            |                              |
| Steel failure with lever arm <sup>1)</sup>                                                                                                                                                                                                                                                                                   |     |                 |      |                                  |       |        |        |            |                              |
| Characteristic bending moment, Steel, strength class                                                                                                                                                                                                                                                                         | 5.8 | $M_{Rk,s}^0$    | [Nm] | 8                                | 19    | 37     | 66     | 167        | 325                          |
|                                                                                                                                                                                                                                                                                                                              | 8.8 | $M_{Rk,s}^0$    | [Nm] | 12                               | 30    | 60     | 105    | 267        | 519                          |
| Partial factor, strength class 5.8 and 8.8                                                                                                                                                                                                                                                                                   |     | $\gamma_{Ms,V}$ | [-]  | 1,25                             |       |        |        |            |                              |
| Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70 <sup>2)</sup>                                                                                                                                                                                                                                   |     | $M_{Rk,s}^0$    | [Nm] | 11                               | 26    | 52     | 92     | 233        | 456                          |
| Partial factor                                                                                                                                                                                                                                                                                                               |     | $\gamma_{Ms,V}$ | [-]  | 1,56                             |       |        |        |            | 2,38                         |
| Concrete pry-out failure                                                                                                                                                                                                                                                                                                     |     |                 |      |                                  |       |        |        |            |                              |
| Factor                                                                                                                                                                                                                                                                                                                       |     | $k_8$           | [-]  | 2,0                              |       |        |        |            |                              |
| Installation factor                                                                                                                                                                                                                                                                                                          |     | $\gamma_{inst}$ | [-]  | 1,0                              |       |        |        |            |                              |
| Concrete edge failure                                                                                                                                                                                                                                                                                                        |     |                 |      |                                  |       |        |        |            |                              |
| Effective length of fastener                                                                                                                                                                                                                                                                                                 |     | $l_f$           | [mm] | $\min(h_{ef}; 12 \cdot d_{nom})$ |       |        |        |            | $\min(h_{ef}; 300\text{mm})$ |
| Outside diameter of fastener                                                                                                                                                                                                                                                                                                 |     | $d_{nom}$       | [mm] | 10                               | 12    | 16     | 20     | 24         | 30                           |
| Installation factor                                                                                                                                                                                                                                                                                                          |     | $\gamma_{inst}$ | [-]  | 1,0                              |       |        |        |            |                              |
| <div>1) Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod.<br/>The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.</div> <div>2) For IR-M20 strength class 50 is valid</div> |     |                 |      |                                  |       |        |        |            |                              |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                                                                                                                                        |     |                 |      |                                  |       |        |        | Annex C 12 |                              |
| <div>Performances</div> <div>Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (Internal threaded anchor rod)</div>                                                                                                                                           |     |                 |      |                                  |       |        |        |            |                              |

**Table C13: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years**

| Reinforcing bar                                                                                                                                                                                                 |               |                                         |                               | Ø 8                                            | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24       | Ø 25 | Ø 28 | Ø 32 |     |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------------|------------------------------------------------|------|------|------|------|------|------------|------|------|------|-----|----|
| Steel failure                                                                                                                                                                                                   |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Characteristic tension resistance                                                                                                                                                                               |               | N <sub>Rk,s</sub>                       | [kN]                          | A <sub>s</sub> • f <sub>uk</sub> <sup>1)</sup> |      |      |      |      |      |            |      |      |      |     |    |
| Cross section area                                                                                                                                                                                              |               | A <sub>s</sub>                          | [mm²]                         | 50                                             | 79   | 113  | 154  | 201  | 314  | 452        | 491  | 616  | 804  |     |    |
| Partial factor                                                                                                                                                                                                  |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,4 <sup>2)</sup>                              |      |      |      |      |      |            |      |      |      |     |    |
| Combined pull-out and concrete failure                                                                                                                                                                          |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                                                  |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Temperature range                                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr</sub>           | [N/mm²]                                        | 16   | 16   | 16   | 16   | 16   | 16         | 15   | 15   | 15   | 15  |    |
|                                                                                                                                                                                                                 | II: 72°C/50°C |                                         |                               |                                                | 12   | 12   | 12   | 12   | 12   | 12         | 12   | 12   | 11   | 11  |    |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                                                 |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Temperature range                                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete                       | τ <sub>Rk,ucr</sub>           | [N/mm²]                                        | 14   | 14   | 13   | 13   | 13   | 13         | 13   | 13   | 13   | 13  |    |
|                                                                                                                                                                                                                 | II: 72°C/50°C |                                         |                               |                                                | 12   | 12   | 12   | 11   | 11   | 11         | 11   | 11   | 11   | 11  |    |
|                                                                                                                                                                                                                 | I: 40°C/24°C  | flooded bore hole                       |                               |                                                | 13   | 13   | 13   | 13   | 13   | 13         | 13   | 13   | 13   | 13  | 13 |
|                                                                                                                                                                                                                 | II: 72°C/50°C |                                         |                               |                                                | 11   | 11   | 11   | 11   | 11   | 11         | 11   | 11   | 11   | 11  |    |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)                               |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Temperature range                                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,cr</sub>            | [N/mm²]                                        | 7,0  | 7,0  | 8,5  | 8,5  | 8,5  | 8,5        | 8,5  | 8,5  | 8,5  | 8,5 |    |
|                                                                                                                                                                                                                 | II: 72°C/50°C |                                         |                               |                                                | 6,0  | 6,0  | 7,0  | 7,0  | 7,0  | 7,0        | 7,0  | 7,0  | 7,0  | 7,0 |    |
| Reduction factor ψ <sup>0</sup> <sub>sus</sub> in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Temperature range                                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | ψ <sup>0</sup> <sub>sus</sub> | [-]                                            | 0,80 |      |      |      |      |            |      |      |      |     |    |
|                                                                                                                                                                                                                 | II: 72°C/50°C |                                         |                               |                                                | 0,68 |      |      |      |      |            |      |      |      |     |    |
| Increasing factors for concrete                                                                                                                                                                                 |               | ψ <sub>c</sub>                          | [-]                           | (f <sub>ck</sub> / 20) <sup>0,1</sup>          |      |      |      |      |      |            |      |      |      |     |    |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                                         |               | τ <sub>Rk,ucr</sub> =                   |                               | ψ <sub>c</sub> • τ <sub>Rk,ucr,(C20/25)</sub>  |      |      |      |      |      |            |      |      |      |     |    |
|                                                                                                                                                                                                                 |               | τ <sub>Rk,cr</sub> =                    |                               | ψ <sub>c</sub> • τ <sub>Rk,ucr,(C20/25)</sub>  |      |      |      |      |      |            |      |      |      |     |    |
| Concrete cone failure                                                                                                                                                                                           |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Relevant parameter                                                                                                                                                                                              |               |                                         |                               | see Table C2                                   |      |      |      |      |      |            |      |      |      |     |    |
| Splitting                                                                                                                                                                                                       |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Relevant parameter                                                                                                                                                                                              |               |                                         |                               | see Table C2                                   |      |      |      |      |      |            |      |      |      |     |    |
| Installation factor                                                                                                                                                                                             |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                                          |               | γ <sub>inst</sub>                       | [-]                           | 1,0                                            |      |      |      |      |      |            |      |      |      |     |    |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                                             |               |                                         |                               | 1,2                                            |      |      |      |      |      |            |      |      |      |     |    |
| 1) f <sub>uk</sub> shall be taken from the specifications of reinforcing bars                                                                                                                                   |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| 2) in absence of national regulation                                                                                                                                                                            |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                           |               |                                         |                               |                                                |      |      |      |      |      | Annex C 13 |      |      |      |     |    |
| Performances                                                                                                                                                                                                    |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |
| Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (reinforcing bar)                                                                                    |               |                                         |                               |                                                |      |      |      |      |      |            |      |      |      |     |    |

**Table C14: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years**

| Reinforcing bar                                                                                                                                                                   |               |                                         |                         | Ø 8                                               | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------|---------------------------------------------------|------|------|------|------|------|------|------|------|------|-----|
| Steel failure                                                                                                                                                                     |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Characteristic tension resistance                                                                                                                                                 |               | N <sub>Rk,s</sub>                       | [kN]                    | A <sub>s</sub> · f <sub>uk</sub> <sup>1)</sup>    |      |      |      |      |      |      |      |      |      |     |
| Cross section area                                                                                                                                                                |               | A <sub>s</sub>                          | [mm <sup>2</sup> ]      | 50                                                | 79   | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |     |
| Partial factor                                                                                                                                                                    |               | γ <sub>Ms,N</sub>                       | [-]                     | 1,4 <sup>2)</sup>                                 |      |      |      |      |      |      |      |      |      |     |
| Combined pull-out and concrete failure                                                                                                                                            |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)                                                    |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr,100</sub> | [N/mm <sup>2</sup> ]                              | 16   | 16   | 16   | 16   | 16   | 16   | 15   | 15   | 15   | 15  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 12   | 12   | 12   | 12   | 12   | 12   | 12   | 12   | 11   | 11  |
| Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)                                                                   |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete                       | τ <sub>Rk,ucr,100</sub> | [N/mm <sup>2</sup> ]                              | 14   | 14   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 12   | 12   | 12   | 11   | 11   | 11   | 11   | 11   | 11   | 11  |
|                                                                                                                                                                                   | I: 40°C/24°C  | flooded bore hole                       |                         |                                                   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13  |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 11   | 11   | 11   | 11   | 11   | 11   | 11   | 11   | 11   |     |
| Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Temperature range                                                                                                                                                                 | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,cr,100</sub>  | [N/mm <sup>2</sup> ]                              | 6,5  | 6,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5  | 7,5 |
|                                                                                                                                                                                   | II: 72°C/50°C |                                         |                         |                                                   | 5,5  | 5,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5  | 6,5 |
| Increasing factors for concrete                                                                                                                                                   |               | ψ <sub>c</sub>                          | [-]                     | (f <sub>ck</sub> / 20) <sup>0,1</sup>             |      |      |      |      |      |      |      |      |      |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                           |               | τ <sub>Rk,ucr,100</sub> =               |                         | ψ <sub>c</sub> · τ <sub>Rk,ucr,100,(C20/25)</sub> |      |      |      |      |      |      |      |      |      |     |
|                                                                                                                                                                                   |               | τ <sub>Rk,cr,100</sub> =                |                         | ψ <sub>c</sub> · τ <sub>Rk,cr,100,(C20/25)</sub>  |      |      |      |      |      |      |      |      |      |     |
| Concrete cone failure                                                                                                                                                             |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Relevant parameter                                                                                                                                                                |               |                                         |                         | see Table C2                                      |      |      |      |      |      |      |      |      |      |     |
| Splitting                                                                                                                                                                         |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Relevant parameter                                                                                                                                                                |               |                                         |                         | see Table C2                                      |      |      |      |      |      |      |      |      |      |     |
| Installation factor                                                                                                                                                               |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                            |               | γ <sub>inst</sub>                       | [-]                     | 1,0                                               |      |      |      |      |      |      |      |      |      |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                               |               |                                         |                         | 1,2                                               |      |      |      |      |      |      |      |      |      |     |

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

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

## Rotho Blaas Injection System EPO-FIX Injection system

### Performances

Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (reinforcing bar)

## Annex C 14

**Table C15: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years**

| Reinforcing bar                                                                                                                              |               |                                         |                               | Ø 8                                            | Ø 10                                          | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24       | Ø 25 | Ø 28 | Ø 32 |     |
|----------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------------|------------------------------------------------|-----------------------------------------------|------|------|------|------|------------|------|------|------|-----|
| Steel failure                                                                                                                                |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Characteristic tension resistance                                                                                                            |               | N <sub>Rk,s</sub>                       | [kN]                          | A <sub>s</sub> · f <sub>uk</sub> <sup>1)</sup> |                                               |      |      |      |      |            |      |      |      |     |
| Cross section area                                                                                                                           |               | A <sub>s</sub>                          | [mm²]                         | 50                                             | 79                                            | 113  | 154  | 201  | 314  | 452        | 491  | 616  | 804  |     |
| Partial factor                                                                                                                               |               | γ <sub>Ms,N</sub>                       | [-]                           | 1,4 <sup>2)</sup>                              |                                               |      |      |      |      |            |      |      |      |     |
| Combined pull-out and concrete failure                                                                                                       |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)                                                    |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Temperature range                                                                                                                            | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr</sub>           | [N/mm²]                                        | 14                                            | 13   | 13   | 13   | 12   | 12         | 11   | 11   | 11   | 11  |
|                                                                                                                                              | II: 72°C/50°C |                                         |                               |                                                | 11                                            | 11   | 10   | 10   | 10   | 9,5        | 9,5  | 9,5  | 9,0  | 9,0 |
| Reduction factor ψ <sup>0</sup> <sub>sus</sub> in uncracked concrete C20/25 in diamond drilled holes (DD)                                    |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Temperature range                                                                                                                            | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | ψ <sup>0</sup> <sub>sus</sub> | [-]                                            | 0,77                                          |      |      |      |      |            |      |      |      |     |
|                                                                                                                                              | II: 72°C/50°C |                                         |                               |                                                | 0,72                                          |      |      |      |      |            |      |      |      |     |
| Increasing factors for concrete                                                                                                              |               | ψ <sub>c</sub>                          | [-]                           | (f <sub>ck</sub> / 20) <sup>0,2</sup>          |                                               |      |      |      |      |            |      |      |      |     |
| Characteristic bond resistance depending on the concrete strength class                                                                      |               | τ <sub>Rk,ucr</sub> =                   |                               |                                                | ψ <sub>c</sub> · τ <sub>Rk,ucr,(C20/25)</sub> |      |      |      |      |            |      |      |      |     |
| Concrete cone failure                                                                                                                        |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Relevant parameter                                                                                                                           |               |                                         |                               | see Table C2                                   |                                               |      |      |      |      |            |      |      |      |     |
| Splitting                                                                                                                                    |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Relevant parameter                                                                                                                           |               |                                         |                               | see Table C2                                   |                                               |      |      |      |      |            |      |      |      |     |
| Installation factor                                                                                                                          |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| for dry and wet concrete (DD)                                                                                                                |               | γ <sub>inst</sub>                       | [-]                           | 1,0                                            |                                               |      |      |      |      |            |      |      |      |     |
| for flooded bore hole (DD)                                                                                                                   |               |                                         |                               | 1,2                                            |                                               |      |      | 1,4  |      |            |      |      |      |     |
| 1) f <sub>uk</sub> shall be taken from the specifications of reinforcing bars<br>2) in absence of national regulation                        |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                        |               |                                         |                               |                                                |                                               |      |      |      |      | Annex C 15 |      |      |      |     |
| Performances<br>Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (reinforcing bar) |               |                                         |                               |                                                |                                               |      |      |      |      |            |      |      |      |     |

**Table C16: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years**

| Reinforcing bar                                                                           |               |                                         |                         | Ø 8                                               | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |     |
|-------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------------|---------------------------------------------------|------|------|------|------|------|------|------|------|------|-----|
| Steel failure                                                                             |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Characteristic tension resistance                                                         |               | N <sub>Rk,s</sub>                       | [kN]                    | A <sub>s</sub> • f <sub>uk</sub> <sup>1)</sup>    |      |      |      |      |      |      |      |      |      |     |
| Cross section area                                                                        |               | A <sub>s</sub>                          | [mm²]                   | 50                                                | 79   | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |     |
| Partial factor                                                                            |               | γ <sub>Ms,N</sub>                       | [-]                     | 1,4 <sup>2)</sup>                                 |      |      |      |      |      |      |      |      |      |     |
| Combined pull-out and concrete failure                                                    |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD) |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Temperature range                                                                         | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,ucr,100</sub> | [N/mm²]                                           | 14   | 13   | 13   | 13   | 12   | 12   | 11   | 11   | 11   | 11  |
|                                                                                           | II: 72°C/50°C |                                         |                         |                                                   | 11   | 10   | 10   | 10   | 9,5  | 9,0  | 9,0  | 9,0  | 8,5  | 8,5 |
| Increasing factors for concrete                                                           |               | ψ <sub>c</sub>                          | [-]                     | (f <sub>ck</sub> / 20) <sup>0,2</sup>             |      |      |      |      |      |      |      |      |      |     |
| Characteristic bond resistance depending on the concrete strength class                   |               | τ <sub>Rk,ucr,100</sub> =               |                         | ψ <sub>c</sub> • τ <sub>Rk,ucr,100,(C20/25)</sub> |      |      |      |      |      |      |      |      |      |     |
| Concrete cone failure                                                                     |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Relevant parameter                                                                        |               |                                         |                         | see Table C2                                      |      |      |      |      |      |      |      |      |      |     |
| Splitting                                                                                 |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| Relevant parameter                                                                        |               |                                         |                         | see Table C2                                      |      |      |      |      |      |      |      |      |      |     |
| Installation factor                                                                       |               |                                         |                         |                                                   |      |      |      |      |      |      |      |      |      |     |
| for dry and wet concrete (DD)                                                             |               | γ <sub>inst</sub>                       | [-]                     | 1,0                                               |      |      |      |      |      |      |      |      |      |     |
| for flooded bore hole (DD)                                                                |               |                                         |                         | 1,2                                               |      |      |      | 1,4  |      |      |      |      |      |     |

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

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

## Rotho Blaas Injection System EPO-FIX Injection system

### Performances

Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (reinforcing bar)

## Annex C 16

**Table C17: Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years**

| Reinforcing bar                 |                 |       | Ø 8                                  | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25                         | Ø 28 | Ø 32 |
|---------------------------------|-----------------|-------|--------------------------------------|------|------|------|------|------|------|------------------------------|------|------|
| Steel failure without lever arm |                 |       |                                      |      |      |      |      |      |      |                              |      |      |
| Characteristic shear resistance | $V^0_{Rk,s}$    | [kN]  | $0,5 \cdot A_s \cdot f_{uk}^{1)}$    |      |      |      |      |      |      |                              |      |      |
| Cross section area              | $A_\sigma$      | [mm²] | 50                                   | 79   | 113  | 154  | 201  | 314  | 452  | 491                          | 616  | 804  |
| Partial factor                  | $\gamma_{Ms,V}$ | [-]   | 1,5 <sup>2)</sup>                    |      |      |      |      |      |      |                              |      |      |
| Ductility factor                | $k_7$           | [-]   | 1,0                                  |      |      |      |      |      |      |                              |      |      |
| Steel failure with lever arm    |                 |       |                                      |      |      |      |      |      |      |                              |      |      |
| Characteristic bending moment   | $M^0_{Rk,s}$    | [Nm]  | $1,2 \cdot W_{el} \cdot f_{uk}^{1)}$ |      |      |      |      |      |      |                              |      |      |
| Elastic section modulus         | $W_{el}$        | [mm³] | 50                                   | 98   | 170  | 269  | 402  | 785  | 1357 | 1534                         | 2155 | 3217 |
| Partial factor                  | $\gamma_{Ms,V}$ | [-]   | 1,5 <sup>2)</sup>                    |      |      |      |      |      |      |                              |      |      |
| Concrete pry-out failure        |                 |       |                                      |      |      |      |      |      |      |                              |      |      |
| Factor                          | $k_8$           | [-]   | 2,0                                  |      |      |      |      |      |      |                              |      |      |
| Installation factor             | $\gamma_{inst}$ | [-]   | 1,0                                  |      |      |      |      |      |      |                              |      |      |
| Concrete edge failure           |                 |       |                                      |      |      |      |      |      |      |                              |      |      |
| Effective length of fastener    | $l_f$           | [mm]  | $\min(h_{ef}; 12 \cdot d_{nom})$     |      |      |      |      |      |      | $\min(h_{ef}; 300\text{mm})$ |      |      |
| Outside diameter of fastener    | $d_{nom}$       | [mm]  | 8                                    | 10   | 12   | 14   | 16   | 20   | 24   | 25                           | 28   | 32   |
| Installation factor             | $\gamma_{inst}$ | [-]   | 1,0                                  |      |      |      |      |      |      |                              |      |      |

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

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

#### Rotho Blaas Injection System EPO-FIX Injection system

##### Performances

Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (reinforcing bar)

#### Annex C 17

**Table C18: Displacements under tension load<sup>1)</sup>  
in hammer drilled holes (HD), compressed air drilled holes (CD) and in  
hammer drilled holes with hollow drill bit (HDB)**

| Threaded rod                                                                                          |                            |                           | M8    | M10   | M12   | M16   | M20   | M24   | M27   | M30   |
|-------------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |                           |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                                                     | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
| Temperature range II:<br>72°C/50°C                                                                    | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,038 | 0,039 | 0,040 | 0,044 | 0,047 | 0,051 | 0,052 | 0,055 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,047 | 0,049 | 0,051 | 0,055 | 0,059 | 0,064 | 0,067 | 0,070 |
| <b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>   |                            |                           |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                                                     | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,069 | 0,071 | 0,072 | 0,074 | 0,076 | 0,079 | 0,081 | 0,082 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,100 | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 |
| Temperature range II:<br>72°C/50°C                                                                    | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,092 | 0,095 | 0,096 | 0,099 | 0,102 | 0,106 | 0,109 | 0,110 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,134 | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 |

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

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

$\tau$ : action bond stress for tension

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

**Table C19: Displacements under tension load<sup>1)</sup>  
in diamond drilled holes (DD)**

| Threaded rod                                                                                   |                            |                           | M8    | M10   | M12   | M16   | M20   | M24   | M27   | M30   |
|------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 years</b>  |                            |                           |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                                              | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,018 | 0,019 | 0,019 | 0,020 | 0,022 | 0,023 | 0,024 | 0,025 |
| Temperature range II:<br>72°C/50°C                                                             | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,052 | 0,053 | 0,055 | 0,058 | 0,062 | 0,065 | 0,068 | 0,070 |
| <b>Uncracked concrete under static and quasi-static action for a working life of 100 years</b> |                            |                           |       |       |       |       |       |       |       |       |
| Temperature range I:<br>40°C/24°C                                                              | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,020 | 0,021 | 0,021 | 0,023 | 0,024 | 0,025 | 0,026 | 0,027 |
| Temperature range II:<br>72°C/50°C                                                             | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,038 | 0,039 | 0,040 | 0,043 | 0,045 | 0,047 | 0,049 | 0,051 |

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

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

$\tau$ : action bond stress for tension

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

**Table C20: Displacements under shear load<sup>1)</sup>  
for all drilling methods**

| Threaded rod                                                                                                      |                            |         | M8   | M10  | M12  | M16  | M20  | M24  | M27  | M30  |
|-------------------------------------------------------------------------------------------------------------------|----------------------------|---------|------|------|------|------|------|------|------|------|
| <b>Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |         |      |      |      |      |      |      |      |      |
| All temperature<br>ranges                                                                                         | $\delta_{V0}$ -factor      | [mm/kN] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
|                                                                                                                   | $\delta_{V\infty}$ -factor | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |

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

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

V: action shear load

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

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Displacements under static and quasi-static action  
for a working life of 50 and 100 years (threaded rod)

**Annex C 18**

**Table C21: Displacements under tension load<sup>1)</sup>  
in hammer drilled holes (HD), compressed air drilled holes (CD) and  
in hammer drilled holes with hollow drill bit (HDB)**

| Internal threaded anchor rods                                                                         |                            |                           | IR-M6 | IR-M8 | IR-M10 | IR-M12 | IR-M16 | IR-M20 |
|-------------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|--------|--------|--------|--------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C/24°C                                                                     | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,029 | 0,030 | 0,033  | 0,035  | 0,038  | 0,041  |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,029 | 0,030 | 0,033  | 0,035  | 0,038  | 0,041  |
| Temperature range II:<br>72°C/50°C                                                                    | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,039 | 0,040 | 0,044  | 0,047  | 0,051  | 0,055  |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,049 | 0,051 | 0,055  | 0,059  | 0,064  | 0,070  |
| <b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>   |                            |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C/24°C                                                                     | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,071 | 0,072 | 0,074  | 0,076  | 0,079  | 0,082  |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,115 | 0,122 | 0,128  | 0,135  | 0,142  | 0,171  |
| Temperature range II:<br>72°C/50°C                                                                    | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,095 | 0,096 | 0,099  | 0,102  | 0,106  | 0,110  |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,154 | 0,163 | 0,172  | 0,181  | 0,189  | 0,229  |

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

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

$\tau$ : action bond stress for tension

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

**Table C22: Displacements under tension load<sup>1)</sup>  
in diamond drilled holes (DD)**

| Internal threaded anchor rods                                                                  |                            |                           | IR-M6 | IR-M8 | IR-M10 | IR-M12 | IR-M16 | IR-M20 |
|------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|--------|--------|--------|--------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 years</b>  |                            |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C/24°C                                                              | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,012 | 0,012 | 0,013  | 0,014  | 0,014  | 0,015  |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,019 | 0,019 | 0,020  | 0,022  | 0,023  | 0,025  |
| Temperature range II:<br>72°C/50°C                                                             | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,014 | 0,014 | 0,015  | 0,016  | 0,016  | 0,018  |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,053 | 0,055 | 0,058  | 0,062  | 0,065  | 0,070  |
| <b>Uncracked concrete under static and quasi-static action for a working life of 100 years</b> |                            |                           |       |       |        |        |        |        |
| Temperature range I:<br>40°C/24°C                                                              | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,012 | 0,012 | 0,013  | 0,014  | 0,014  | 0,015  |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,021 | 0,021 | 0,023  | 0,024  | 0,025  | 0,027  |
| Temperature range II:<br>72°C/50°C                                                             | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,014 | 0,014 | 0,015  | 0,016  | 0,016  | 0,018  |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,039 | 0,040 | 0,043  | 0,045  | 0,047  | 0,051  |

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

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

$\tau$ : action bond stress for tension

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

**Table C23: Displacements under shear load<sup>1)</sup>  
for all drilling methods**

| Internal threaded anchor rods                                                                                     |                            |         | IR-M6 | IR-M8 | IR-M10 | IR-M12 | IR-M16 | IR-M20 |
|-------------------------------------------------------------------------------------------------------------------|----------------------------|---------|-------|-------|--------|--------|--------|--------|
| <b>Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |         |       |       |        |        |        |        |
| All temperature ranges                                                                                            | $\delta_{V0}$ -factor      | [mm/kN] | 0,07  | 0,06  | 0,06   | 0,05   | 0,04   | 0,04   |
|                                                                                                                   | $\delta_{V\infty}$ -factor | [mm/kN] | 0,10  | 0,09  | 0,08   | 0,08   | 0,06   | 0,06   |

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

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

V: action shear load

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

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Displacements under static and quasi-static action  
for a working life of 50 and 100 years (Internal threaded anchor rod)

**Annex C 19**

**Table C24: Displacements under tension load<sup>1)</sup>  
in hammer drilled holes (HD), compressed air drilled holes (CD) and in  
hammer drilled holes with hollow drill bit (HDB)**

| Reinforcing bar                                                                                       |                            |                           | Ø 8   | Ø 10  | Ø 12  | Ø 14  | Ø 16  | Ø 20  | Ø 24  | Ø 25  | Ø 28  | Ø 32  |
|-------------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |                           |       |       |       |       |       |       |       |       |       |       |
| Temp.- range I:<br>40°C/24°C                                                                          | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,028 | 0,029 | 0,030 | 0,031 | 0,033 | 0,035 | 0,038 | 0,038 | 0,040 | 0,043 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,028 | 0,029 | 0,030 | 0,031 | 0,033 | 0,035 | 0,038 | 0,038 | 0,040 | 0,043 |
| Temp.- range II:<br>72°C/50°C                                                                         | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,038 | 0,039 | 0,040 | 0,042 | 0,044 | 0,047 | 0,051 | 0,051 | 0,054 | 0,058 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,047 | 0,049 | 0,051 | 0,053 | 0,055 | 0,059 | 0,065 | 0,065 | 0,068 | 0,072 |
| <b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>   |                            |                           |       |       |       |       |       |       |       |       |       |       |
| Temp.- range I:<br>40°C/24°C                                                                          | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,069 | 0,071 | 0,072 | 0,073 | 0,074 | 0,076 | 0,079 | 0,079 | 0,081 | 0,084 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 | 0,171 | 0,181 | 0,194 |
| Temp.- range II:<br>72°C/50°C                                                                         | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,092 | 0,095 | 0,096 | 0,098 | 0,099 | 0,102 | 0,106 | 0,106 | 0,109 | 0,113 |
|                                                                                                       | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 | 0,229 | 0,242 | 0,260 |

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

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

$\tau$ : action bond stress for tension

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

**Table C25: Displacements under tension load<sup>1)</sup>  
in diamond drilled holes (DD)**

| Reinforcing bar                                                                                |                            |                           | Ø 8   | Ø 10  | Ø 12  | Ø 14  | Ø 16  | Ø 20  | Ø 24  | Ø 25  | Ø 28  | Ø 32  |
|------------------------------------------------------------------------------------------------|----------------------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Uncracked concrete under static and quasi-static action for a working life of 50 years</b>  |                            |                           |       |       |       |       |       |       |       |       |       |       |
| Temp.- range I:<br>40°C/24°C                                                                   | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,008 | 0,009 | 0,009 | 0,01  | 0,011 | 0,012 | 0,013 | 0,013 | 0,014 | 0,015 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,018 | 0,018 | 0,019 | 0,020 | 0,021 | 0,024 | 0,027 | 0,027 | 0,028 | 0,031 |
| Temp.- range II:<br>72°C/50°C                                                                  | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,009 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,015 | 0,016 | 0,018 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,048 | 0,051 | 0,054 | 0,058 | 0,061 | 0,068 | 0,076 | 0,076 | 0,081 | 0,088 |
| <b>Uncracked concrete under static and quasi-static action for a working life of 100 years</b> |                            |                           |       |       |       |       |       |       |       |       |       |       |
| Temp.- range I:<br>40°C/24°C                                                                   | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,008 | 0,009 | 0,009 | 0,010 | 0,011 | 0,012 | 0,013 | 0,013 | 0,014 | 0,015 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,018 | 0,020 | 0,021 | 0,022 | 0,024 | 0,026 | 0,029 | 0,029 | 0,031 | 0,034 |
| Temp.- range II:<br>72°C/50°C                                                                  | $\delta_{N0}$ -factor      | [mm/(N/mm <sup>2</sup> )] | 0,009 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,015 | 0,016 | 0,018 |
|                                                                                                | $\delta_{N\infty}$ -factor | [mm/(N/mm <sup>2</sup> )] | 0,035 | 0,037 | 0,040 | 0,042 | 0,045 | 0,049 | 0,055 | 0,055 | 0,059 | 0,064 |

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

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

$\tau$ : action bond stress for tension

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

**Table C26: Displacements under shear load<sup>1)</sup>  
for all drilling methods**

| Reinforcing bar                                                                                                   |                            |         | Ø 8  | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|-------------------------------------------------------------------------------------------------------------------|----------------------------|---------|------|------|------|------|------|------|------|------|------|------|
| <b>Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b> |                            |         |      |      |      |      |      |      |      |      |      |      |
| All temperature<br>ranges                                                                                         | $\delta_{V0}$ -factor      | [mm/kN] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 | 0,03 |
|                                                                                                                   | $\delta_{V\infty}$ -factor | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,04 | 0,04 |

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

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

V: action shear load

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

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Displacements under static and quasi-static action  
for a working life of 50 and 100 years (reinforcing bar)

**Annex C 20**

**Table C27: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years**

| Threaded rod                                                                                                                                                                                    |               |                                         |                   | M8                                      | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------|-----------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Steel failure                                                                                                                                                                                   |               |                                         |                   |                                         |     |     |     |     |     |     |     |
| Characteristic tension resistance                                                                                                                                                               |               | $N_{Rk,s,eq,C1}$                        | [kN]              | $1,0 \cdot N_{Rk,s}$                    |     |     |     |     |     |     |     |
| Partial factor                                                                                                                                                                                  |               | $\gamma_{Ms,N}$                         | [-]               | see Table C1                            |     |     |     |     |     |     |     |
| Combined pull-out and concrete failure                                                                                                                                                          |               |                                         |                   |                                         |     |     |     |     |     |     |     |
| Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                   |                                         |     |     |     |     |     |     |     |
| Temperature range                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,eq,C1}$ | [N/mm²]                                 | 7,0 | 7,0 | 8,5 | 8,5 | 8,5 | 8,5 | 8,5 |
|                                                                                                                                                                                                 | II: 72°C/50°C |                                         | $\tau_{Rk,eq,C1}$ | [N/mm²]                                 | 6,0 | 6,0 | 7,0 | 7,0 | 7,0 | 7,0 | 7,0 |
| Increasing factors for concrete                                                                                                                                                                 |               | $\psi_c$                                | [-]               | 1,0                                     |     |     |     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                         |               | $\tau_{Rk,eq,C1} =$                     |                   | $\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$ |     |     |     |     |     |     |     |
| Installation factor                                                                                                                                                                             |               |                                         |                   |                                         |     |     |     |     |     |     |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                          |               | $\gamma_{inst}$                         | [-]               | 1,0                                     |     |     |     |     |     |     |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                             |               |                                         |                   | 1,2                                     |     |     |     |     |     |     |     |
|                                                                                                                                                                                                 |               |                                         |                   |                                         |     |     |     |     |     |     |     |
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| Table C28: Characteristic values of tension loads under seismic action<br>(performance category C1) for a working life of 100 years                                                             |               |                                         |                   |                                         |     |     |     |     |     |     |     |     |
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| Threaded rod                                                                                                                                                                                    |               |                                         |                   | M8                                      | M10 | M12 | M16 | M20 | M24 | M27 | M30 |     |
| Steel failure                                                                                                                                                                                   |               |                                         |                   |                                         |     |     |     |     |     |     |     |     |
| Characteristic tension resistance                                                                                                                                                               |               | $N_{Rk,s,eq,C1}$                        | [kN]              | $1,0 \cdot N_{Rk,s}$                    |     |     |     |     |     |     |     |     |
| Partial factor                                                                                                                                                                                  |               | $\gamma_{Ms,N}$                         | [-]               | see Table C1                            |     |     |     |     |     |     |     |     |
| Combined pull-out and concrete failure                                                                                                                                                          |               |                                         |                   |                                         |     |     |     |     |     |     |     |     |
| Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                   |                                         |     |     |     |     |     |     |     |     |
| Temperature range                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,eq,C1}$ | [N/mm²]                                 | 6,5 | 6,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 | 7,5 |
|                                                                                                                                                                                                 | II: 72°C/50°C |                                         | $\tau_{Rk,eq,C1}$ | [N/mm²]                                 | 5,5 | 5,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 |
| Increasing factors for concrete                                                                                                                                                                 |               | $\psi_c$                                | [-]               | 1,0                                     |     |     |     |     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                         |               | $\tau_{Rk,eq,C1} =$                     |                   | $\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$ |     |     |     |     |     |     |     |     |
| Installation factor                                                                                                                                                                             |               |                                         |                   |                                         |     |     |     |     |     |     |     |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                          |               | $\gamma_{inst}$                         | [-]               | 1,0                                     |     |     |     |     |     |     |     |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                             |               |                                         |                   | 1,2                                     |     |     |     |     |     |     |     |     |
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**Table C29: Characteristic values of shear loads under seismic action  
(performance category C1) for a working life of 50 and 100 years**

| Threaded rod                                    |                  |      | M8                      | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|-------------------------------------------------|------------------|------|-------------------------|-----|-----|-----|-----|-----|-----|-----|
| <b>Steel failure</b>                            |                  |      |                         |     |     |     |     |     |     |     |
| Characteristic shear resistance<br>(Seismic C1) | $V_{Rk,s,eq,C1}$ | [kN] | $0,70 \cdot V_{Rk,s}^0$ |     |     |     |     |     |     |     |
| Partial factor                                  | $\gamma_{Ms,V}$  | [-]  | see Table C1            |     |     |     |     |     |     |     |
| <b>Factor for annular gap</b>                   | $\alpha_{gap}$   | [-]  | 0,5 (1,0) <sup>1)</sup> |     |     |     |     |     |     |     |

<sup>1)</sup> Value in brackets valid for filled annular gap between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Characteristic values of shear loads under seismic action (performance category C1)  
for a working life of 50 and 100 years (threaded rod)

**Annex C 23**

**Table C30: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years**

| Reinforcing bar                                                                                                                                                                                 |               |                                         |                       | Ø 8                                                  | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24 | Ø 25 | Ø 28 | Ø 32 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-----------------------|------------------------------------------------------|------|------|------|------|------|------|------|------|------|
| Steel failure                                                                                                                                                                                   |               |                                         |                       |                                                      |      |      |      |      |      |      |      |      |      |
| Characteristic tension resistance                                                                                                                                                               |               | N <sub>Rk,s,eq,C1</sub>                 | [kN]                  | 1,0 · A <sub>s</sub> · f <sub>uk</sub> <sup>1)</sup> |      |      |      |      |      |      |      |      |      |
| Cross section area                                                                                                                                                                              |               | A <sub>s</sub>                          | [mm²]                 | 50                                                   | 79   | 113  | 154  | 201  | 314  | 452  | 491  | 616  | 804  |
| Partial factor                                                                                                                                                                                  |               | γ <sub>Ms,N</sub>                       | [-]                   | 1,4 <sup>2)</sup>                                    |      |      |      |      |      |      |      |      |      |
| Combined pull-out and concrete failure                                                                                                                                                          |               |                                         |                       |                                                      |      |      |      |      |      |      |      |      |      |
| Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                       |                                                      |      |      |      |      |      |      |      |      |      |
| Temperature range                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | τ <sub>Rk,eq,C1</sub> | [N/mm²]                                              | 7,0  | 7,0  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  | 8,5  |
|                                                                                                                                                                                                 | II: 72°C/50°C |                                         | τ <sub>Rk,eq,C1</sub> | [N/mm²]                                              | 6,0  | 6,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  | 7,0  |
| Increasing factors for concrete                                                                                                                                                                 |               | ψ <sub>c</sub>                          | [-]                   | 1,0                                                  |      |      |      |      |      |      |      |      |      |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                         |               | τ <sub>Rk,eq,C1</sub> =                 |                       | ψ <sub>c</sub> · τ <sub>Rk,eq,C1</sub> , (C20/25)    |      |      |      |      |      |      |      |      |      |
| Installation factor                                                                                                                                                                             |               |                                         |                       |                                                      |      |      |      |      |      |      |      |      |      |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                          |               | γ <sub>inst</sub>                       | [-]                   | 1,0                                                  |      |      |      |      |      |      |      |      |      |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                             |               |                                         |                       | 1,2                                                  |      |      |      |      |      |      |      |      |      |

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

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

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years (reinforcing bar)

**Annex C 24**

**Table C31: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years**

| Reinforcing bar                                                                                                                                                                                 |               |                                         |                   | Ø 8                               | Ø 10                                    | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24       | Ø 25 | Ø 28 | Ø 32 |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------|-----------------------------------|-----------------------------------------|------|------|------|------|------------|------|------|------|-----|
| Steel failure                                                                                                                                                                                   |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |
| Characteristic tension resistance                                                                                                                                                               |               | $N_{Rk,s,eq,C1}$                        | [kN]              | $1,0 \cdot A_s \cdot f_{uk}^{1)}$ |                                         |      |      |      |      |            |      |      |      |     |
| Cross section area                                                                                                                                                                              |               | $A_s$                                   | [mm²]             | 50                                | 79                                      | 113  | 154  | 201  | 314  | 452        | 491  | 616  | 804  |     |
| Partial factor                                                                                                                                                                                  |               | $\gamma_{Ms,N}$                         | [-]               | $1,4^{2)}$                        |                                         |      |      |      |      |            |      |      |      |     |
| Combined pull-out and concrete failure                                                                                                                                                          |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |
| Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |
| Temperature range                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,eq,C1}$ | [N/mm²]                           | 6,5                                     | 6,5  | 7,5  | 7,5  | 7,5  | 7,5        | 7,5  | 7,5  | 7,5  | 7,5 |
|                                                                                                                                                                                                 | II: 72°C/50°C |                                         | $\tau_{Rk,eq,C1}$ | [N/mm²]                           | 5,5                                     | 5,5  | 6,5  | 6,5  | 6,5  | 6,5        | 6,5  | 6,5  | 6,5  | 6,5 |
| Increasing factors for concrete                                                                                                                                                                 |               | $\psi_c$                                | [-]               | $1,0$                             |                                         |      |      |      |      |            |      |      |      |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                         |               | $\tau_{Rk,eq,C1} =$                     |                   |                                   | $\psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$ |      |      |      |      |            |      |      |      |     |
| Installation factor                                                                                                                                                                             |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                          |               | $\gamma_{inst}$                         | [-]               | $1,0$                             |                                         |      |      |      |      |            |      |      |      |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                             |               |                                         |                   | $1,2$                             |                                         |      |      |      |      |            |      |      |      |     |
| <div>1) <math>f_{uk}</math> shall be taken from the specifications of reinforcing bars</div> <div>2) in absence of national regulation</div>                                                    |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                           |               |                                         |                   |                                   |                                         |      |      |      |      | Annex C 25 |      |      |      |     |
| Performances<br>Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years (reinforcing bar)                                         |               |                                         |                   |                                   |                                         |      |      |      |      |            |      |      |      |     |

**Table C32: Characteristic values of shear loads under seismic action  
(performance category C1) for a working life of 50 and 100 years**

| Reinforcing bar                                                                                                                                                                                                                                                                                                       |                  |       | Ø 8                                | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 24       | Ø 25 | Ø 28 | Ø 32 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------|------------------------------------|------|------|------|------|------|------------|------|------|------|
| Steel failure                                                                                                                                                                                                                                                                                                         |                  |       |                                    |      |      |      |      |      |            |      |      |      |
| Characteristic shear resistance                                                                                                                                                                                                                                                                                       | $V_{Rk,s,eq,C1}$ | [kN]  | $0,35 \cdot A_s \cdot f_{uk}^{1)}$ |      |      |      |      |      |            |      |      |      |
| Cross section area                                                                                                                                                                                                                                                                                                    | $A_s$            | [mm²] | 50                                 | 79   | 113  | 154  | 201  | 314  | 452        | 491  | 616  | 804  |
| Partial factor                                                                                                                                                                                                                                                                                                        | $\gamma_{Ms,V}$  | [-]   | $1,5^{2)}$                         |      |      |      |      |      |            |      |      |      |
| Factor for annular gap                                                                                                                                                                                                                                                                                                | $\alpha_{gap}$   | [-]   | $0,5 (1,0)^{3)}$                   |      |      |      |      |      |            |      |      |      |
| <div>1) <math>f_{uk}</math> shall be taken from the specifications of reinforcing bars</div> <div>2) in absence of national regulation</div> <div>3) Value in brackets valid for filled annular gap between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.</div> |                  |       |                                    |      |      |      |      |      |            |      |      |      |
| Rotho Blaas Injection System EPO-FIX Injection system                                                                                                                                                                                                                                                                 |                  |       |                                    |      |      |      |      |      | Annex C 26 |      |      |      |
| <div>Performances</div> <div>Characteristic values of shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (reinforcing bar)</div>                                                                                                                                       |                  |       |                                    |      |      |      |      |      |            |      |      |      |

**Table C33: Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 and 100 years**

| Threaded rod                                                                                                                                                                                    |               |                                         |                   | M12                                     | M16 | M20 | M24 |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------------------------------|-------------------|-----------------------------------------|-----|-----|-----|-----|
| Steel failure                                                                                                                                                                                   |               |                                         |                   |                                         |     |     |     |     |
| Characteristic tension resistance,<br>Steel, strength class 8.8<br>Stainless Steel A4 and HCR,<br>Strength class ≥70                                                                            |               | $N_{Rk,s,eq,C2}$                        | [kN]              | $1,0 \cdot N_{Rk,s}$                    |     |     |     |     |
| Partial factor                                                                                                                                                                                  |               | $\gamma_{Ms,N}$                         | [-]               | see Table C1                            |     |     |     |     |
| Combined pull-out and concrete failure                                                                                                                                                          |               |                                         |                   |                                         |     |     |     |     |
| Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB) |               |                                         |                   |                                         |     |     |     |     |
| Temperature range                                                                                                                                                                               | I: 40°C/24°C  | Dry, wet concrete and flooded bore hole | $\tau_{Rk,eq,C2}$ | [N/mm²]                                 | 5,8 | 4,8 | 5,0 | 5,1 |
|                                                                                                                                                                                                 | II: 72°C/50°C |                                         | $\tau_{Rk,eq,C2}$ | [N/mm²]                                 | 5,0 | 4,1 | 4,3 | 4,4 |
| Increasing factors for concrete                                                                                                                                                                 |               | $\psi_c$                                | [-]               | 1,0                                     |     |     |     |     |
| Characteristic bond resistance depending on the concrete strength class                                                                                                                         |               | $\tau_{Rk,eq,C2} =$                     |                   | $\psi_c \cdot \tau_{Rk,eq,C2,(C20/25)}$ |     |     |     |     |
| Installation factor                                                                                                                                                                             |               |                                         |                   |                                         |     |     |     |     |
| for dry and wet concrete (HD; HDB, CD)                                                                                                                                                          |               | $\gamma_{inst}$                         | [-]               | 1,0                                     |     |     |     |     |
| for flooded bore hole (HD; HDB, CD)                                                                                                                                                             |               |                                         |                   | 1,2                                     |     |     |     |     |

**Table C34: Characteristic values of shear loads under seismic action (performance category C2) for a working life of 50 and 100 years**

| Threaded rod                                                                                                      |                  |      | M12                     | M16 | M20 | M24 |
|-------------------------------------------------------------------------------------------------------------------|------------------|------|-------------------------|-----|-----|-----|
| Steel failure                                                                                                     |                  |      |                         |     |     |     |
| Characteristic shear resistance<br>Steel, strength class 8.8<br>Stainless Steel A4 and HCR,<br>Strength class ≥70 | $V_{Rk,s,eq,C2}$ | [kN] | $0,70 \cdot V^0_{Rk,s}$ |     |     |     |
| Partial factor                                                                                                    | $\gamma_{Ms,V}$  | [-]  | see Table C1            |     |     |     |
| Factor for annular gap                                                                                            | $\alpha_{gap}$   | [-]  | $0,5 (1,0)^1)$          |     |     |     |

<sup>1)</sup> Value in brackets valid for filled annular gap between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

**Rotho Blaas Injection System EPO-FIX Injection system**

**Performances**

Characteristic values of tension and shear loads under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)

**Annex C 27**

**Table C35: Displacements under tension load (threaded rod)**

| Threaded rod                                                                                                            |                         |      | M12  | M16  | M20  | M24  |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------|------|------|------|------|------|
| Uncracked and cracked concrete under seismic action (performance category C2)<br>for a working life of 50 and 100 years |                         |      |      |      |      |      |
| All temperature ranges                                                                                                  | $\delta_{N,eq,C2}(DLS)$ | [mm] | 0,21 | 0,24 | 0,27 | 0,36 |
|                                                                                                                         | $\delta_{N,eq,C2}(ULS)$ | [mm] | 0,54 | 0,51 | 0,54 | 0,63 |

**Table C36: Displacements under shear load (threaded rod)**

| Threaded rod                                                                                                            |                         |      | M12 | M16 | M20 | M24  |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------|------|-----|-----|-----|------|
| Uncracked and cracked concrete under seismic action (performance category C2)<br>for a working life of 50 and 100 years |                         |      |     |     |     |      |
| All temperature ranges                                                                                                  | $\delta_{V,eq,C2}(DLS)$ | [mm] | 3,1 | 3,4 | 3,5 | 4,2  |
|                                                                                                                         | $\delta_{V,eq,C2}(ULS)$ | [mm] | 6,0 | 7,6 | 7,3 | 10,9 |

**Rotho Blaas Injection System EPO-FIX Injection system**

**Annex C 28**

**Performances**

Displacements under seismic action (performance category C2)  
for a working life of 50 and 100 years (threaded rod)