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Bautechnisches Prüfamt

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# European Technical Assessment

# ETA-20/1286 of 1 October 2021

English translation prepared by DIBt - Original version in German language

**General Part**

| | |
|---|---|
| Technical Assessment Body issuing the European Technical Assessment: | Deutsches Institut für Bautechnik |
| Trade name of the construction product | Injection system PURE500+ for rebar connection |
| Product family to which the construction product belongs | Systems for post-installed rebar connections with mortar |
| Manufacturer | Stanley Black & Decker Deutschland GmbH<br>Richard-Klinger-Straße 11<br>65510 Idstein<br>DEUTSCHLAND |
| Manufacturing plant | Plant 1 |
| This European Technical Assessment contains | 16 pages including 3 annexes which form an integral part of this assessment |
| This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of | EAD 330087-01-0601, Edition 06/2021 |

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## Specific Part

## 1 Technical description of the product

The subject of this European Technical Assessment is the post-installed connection, by anchoring or overlap connection joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete, using the "Injection system PURE500+ for rebar connection" in accordance with the regulations for reinforced concrete construction.
Reinforcing bars made of steel with a diameter $\phi$ from 8 to 40 mm according to Annex A and injection mortar PURE500+ are used for rebar connections. The rebar is placed into a drilled hole filled with injection mortar and is anchored via the bond between rebar, injection mortar and concrete.

The product description is given in Annex A.

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

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

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the rebar connections 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 under static and quasi-static loading | See Annex C 1 |
| Characteristic resistance under seismic loading | See Annex B 3 and C 2 |

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

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Class A1 |
| Resistance to fire | See Annex C 3 |

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

In accordance with European Assessment Document EAD No. 330087-01-0601, 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 with Deutsches Institut für Bautechnik.

Issued in Berlin on 1 October 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

*beglaubigt:*
Baderschneider

## Installation post installed rebar connection

**Figure A1:** Overlapping joint for rebar connections of slabs and beams

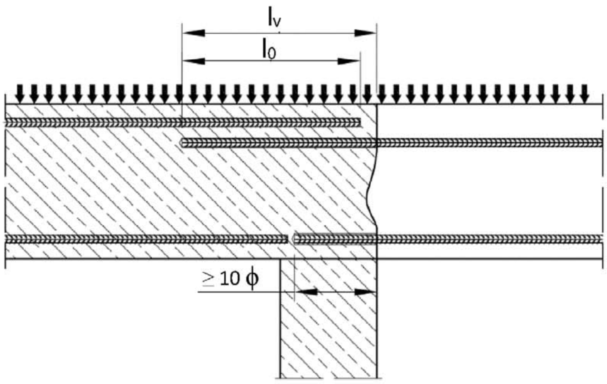



**Figure A2:** Overlapping joint at a foundation of a wall or column where the rebars are stressed in tension

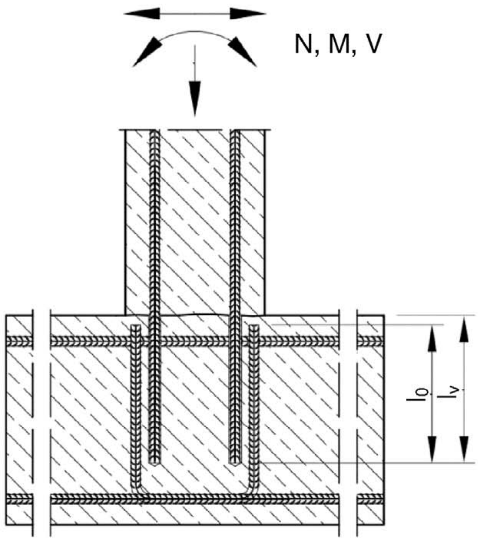



**Figure A3:** End anchoring of slabs or beams (e.g. designed as simply supported)

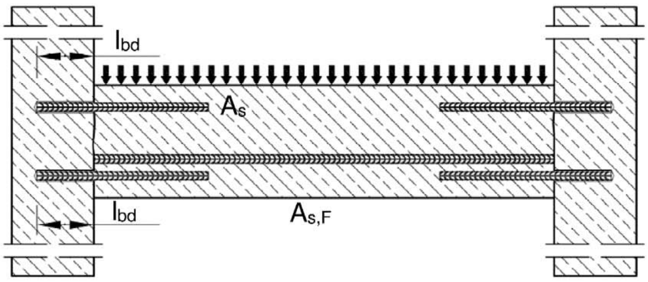



**Figure A4:** Rebar connection for components stressed primarily in compression. The rebars sre stressed in compression

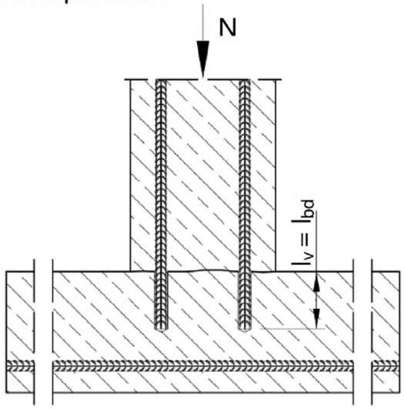
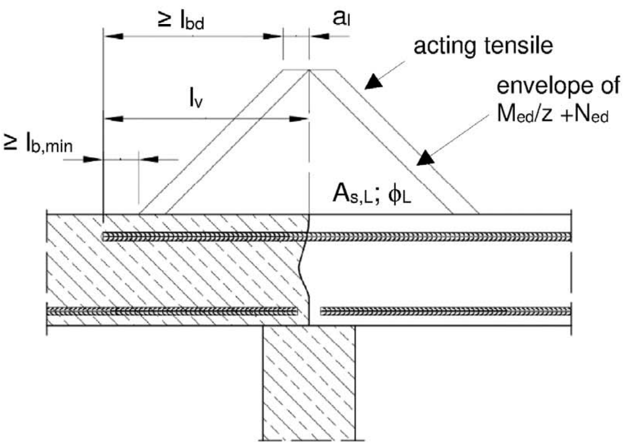



**Figure A5:** Anchoring of reinforcement to cover the line of acting tensile force




**Note to Figure A1 to A5:**

In the Figures no transverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1:2004+AC:2010.

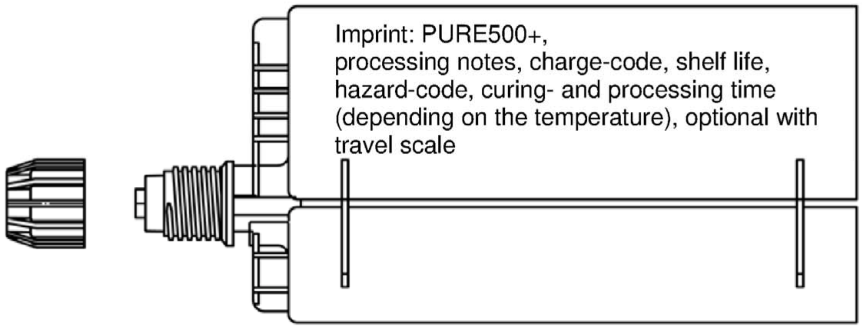
Preparing of joints according to Annex B2

| | |
|---|---|
| **Injection system PURE500+ for rebar connections** | **Annex A1** |
| **Product description**<br>Installed condition and examples of use for rebar connections | |

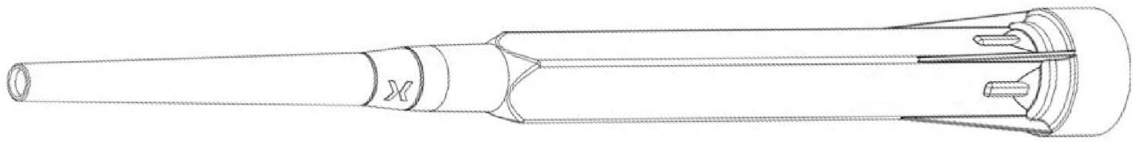
**Injection System PURE500+:**

**Cartridge: PURE500+**

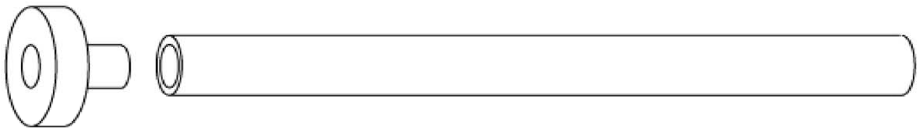
**Type 'side-by-side':**
440 ml,
585 ml and
1400 ml cartridge



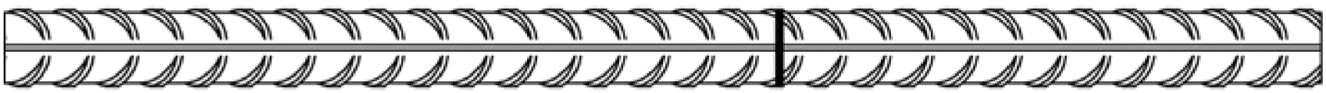

**Static Mixer**



**Piston Plug and Mixer Extension**



**Reinforcing bar (rebar): ⌀8, ⌀10, ⌀12, ⌀14, ⌀16, ⌀20, ⌀22, ⌀24, ⌀25, ⌀28, ⌀32, ⌀34, ⌀36, ⌀40**



- 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 0,05Ø ≤ $h_{rib}$ ≤ 0,07Ø
  (Ø: Nominal diameter of the bar; $h_{rib}$: Rib height of the bar)

**Table A1: Materials**

| Designation | Material |
|---|---|
| Rebar EN 1992-1-1:2004+AC:2010, Annex C | Bars and de-coiled rods class B or C<br>$f_{yk}$ and k according to NDP or NCL of EN 1992-1-1/NA<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ |

**Injection system PURE500+ for rebar connections**

**Product description**
Injection system and reinforcing bar

**Annex A2**

## Specifications of intended use

| **Anchorages subject to:** | | Static and quasi-static loads | Seismic action |
|---|---|---|---|
| Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD), or diamond drilling (DD) | for a working life of 50 years | Ø8 to Ø40 | Ø10 to Ø40 |
| | for a working life of 100 years | Ø8 to Ø40 | Ø10 to Ø40 |
| | Fire exposure | Ø8 to Ø40 | No performance assessed |
| Temperature Range: | - 40 °C to +80 °C (max long-term temperature +50 °C and max short-term temperature +80 °C) | | |

**Base materials:**

- Reinforced or unreinforced normal weight concrete according to EN 206:2013 + A1:2016.
- Strength classes C12/15 to C50/60 according to EN 206:2013 + A1:2016.
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2013 + A1:2016.
- Non-carbonated concrete.

Note: In case of a carbonated surface of the existing concrete structure the carbonated layer shall be removed in the area of the post-installed rebar connection with a diameter of Ø + 60 mm prior to the installation of the new rebar.

The depth of concrete to be removed shall correspond to at least the minimum concrete cover in accordance with EN 1992-1-1:2004+AC:2010. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

**Design:**

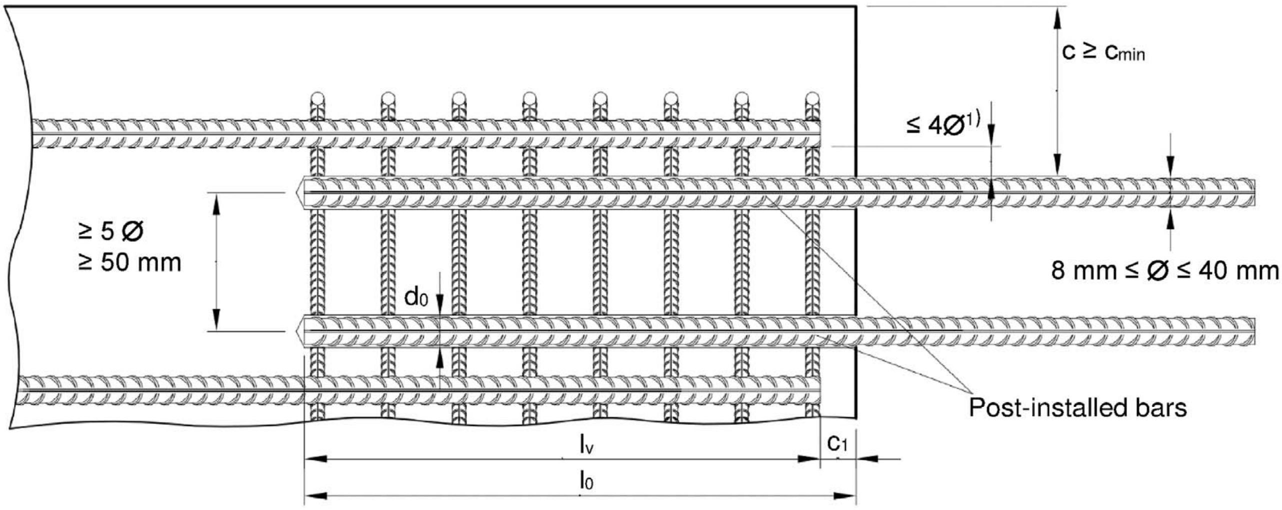
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design according to EN 1992-1-1:2004+AC:2010, EN 1992-1-2:2004+AC:2008 and Annex B2.
- The actual position of the reinforcement in the existing structure shall be determined on the basis of the construction documentation and taken into account when designing.

**Installation:**

- Dry or wet concrete. It must not be installed in flooded holes.
- Overhead installation allowed.
- Hole drilling in hammer drill mode with standard bit (HD) or with hollow drill bit (HDB), or in compressed air drill mode (CD) or with core drill bit in diamond drill mode (DD).
- The installation of post-installed rebar shall be done only by suitable trained installer and under supervision on site; the conditions under which an installer may be considered as suitable trained and the conditions for supervision on site are up to the Member States in which the installation is done.
- Check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint).

## Figure B1: General construction rules for post-installed rebars

- Only tension forces in the axis of the rebar may be transmitted.
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1:2004+AC:2010.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.




[1] If the clear distance between lapped bars exceeds 4Ø, then the lap length shall be increased by the difference between the clear bar distance and 4Ø.

The following applies to Figure B1:

| | |
|---|---|
| $c$ | concrete cover of post-installed rebar |
| $c_1$ | concrete cover at end-face of existing rebar |
| $c_{min}$ | minimum concrete cover according to Table B1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2 |
| Ø | diameter of post-installed rebar |
| $l_0$ | lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3 |
| $l_v$ | effective embedment depth, $\geq l_0 + c_1$ |
| $d_0$ | nominal drill bit diameter, see Table B5 and B6 |

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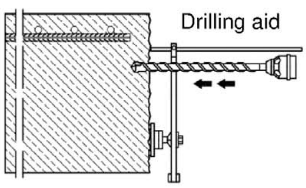
## Table B1: Minimum concrete cover $c_{min}$[1)] of post-installed rebar depending of drilling method

| Drilling method | Rebar diameter | Without drilling aid | With drilling aid |
|---|---|---|---|
| Hammer drilling (HD) Hammer drilling with hollow drill (HDB) | < 25 mm | 30 mm + 0,06 · $l_v$ ≥ 2 ∅ | 30 mm + 0,02 · $l_v$ ≥ 2 ∅ |
| | ≥ 25 mm | 40 mm + 0,06 · $l_v$ ≥ 2 ∅ | 40 mm + 0,02 · $l_v$ ≥ 2 ∅ |
| Compressed air drilling (CD) | < 25 mm | 50 mm + 0,08 · $l_v$ | 50 mm + 0,02 · $l_v$ |
| | ≥ 25 mm | 60 mm + 0,08 · $l_v$ ≥ 2 ∅ | 60 mm + 0,02 · $l_v$ ≥ 2 ∅ |
| Diamond drilling (DD) | < 25 mm | Drill rig used as drilling aid | 30 mm + 0,02 · $l_v$ ≥ 2 ∅ |
| | ≥ 25 mm | | 40 mm + 0,02 · $l_v$ ≥ 2 ∅ |




1) See Annex B2, Figure B1
Comments: The minimum concrete cover acc. EN 1992-1-1:2004+AC:2010 must be observed.
For minimum concrete cover $c_{min,seis}$ in case of seismic action see Table B2.

## Table B2: Minimum concrete cover min $c_{min,seis}$

| Drilling method | Design condition | Distance of 1st edge | Distance of 2nd edge |
|---|---|---|---|
| Hammer drilling (HD); Hammer drilling with hollow drill (HDB); Compressed air drilling (CD) | Edge | ≥ 2 ∅ | ≥ 2 ∅ |
| | Corner | ≥ 2 ∅ | ≥ 2 ∅ |
| Diamond drilling (DD) | Edge | ≥ 4 ∅ | ≥ 8 ∅ |
| | Corner | ≥ 6 ∅ | ≥ 6 ∅ |

## Table B3: Base material temperature, gelling time and curing time

| Concrete temperature | Maximum working time $t_{gel}$[1)] | Initial curing time $t_{cure,ini}$ in dry concrete[2)] | Minimum curing time $t_{cure}$ in dry concrete[3)] |
|---|---|---|---|
| 0 °C to + 4 °C | 80 min | 30 h | 144 h |
| + 5 °C to + 9 °C | 80 min | 20 h | 48 h |
| + 10 °C to + 14 °C | 60 min | 15 h | 28 h |
| + 15 °C to + 19 °C | 40 min | 9 h | 18 h |
| + 20 °C to + 29 °C | 30 min | 6 h | 12 h |
| + 25 °C to + 34 °C | 12 min | 4 h | 9 h |
| + 35 °C to + 39 °C | 8 min | 3 h | 6 h |
| + 40 °C | 8 min | 1,5 h | 4 h |
| Cartridge temperature | +5 °C to +40 °C | | |

1) $t_{gel}$: Maximum time from starting of mortar injection to completing of rebar setting.
2) After $t_{cure,ini}$ has elapsed, the installation of the connecting reinforcement and the formwork can be continued.
3) In wet concrete, the curing time must be doubled.

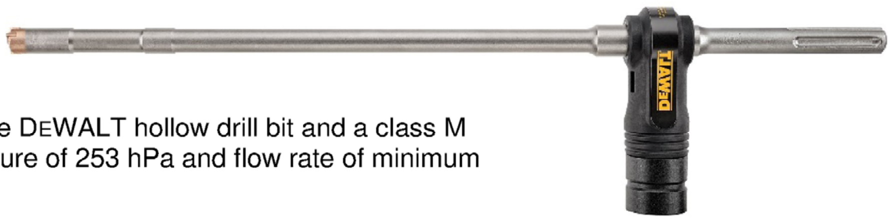
| | |
|---|---|
| **Injection system PURE500+ for rebar connections** | **Annex B3** |
| **Intended use** Minimum concrete cover; gelling and curing time | |

**Table B4: Dispensing tools**

| Cartridge type/size | Hand tools | | Pneumatic tools |
|---|---|---|---|
| Side-by-side cartridges 440, 585 ml |  e.g. Type SA 296C585 |  e.g. Type H 244 C |  e.g. Type TS 444 KX |
| Side-by-side cartridge 1400 ml | - | - |  e.g. Type TS 471 |

All cartridges could also be extruded by battery tools.

## Cleaning and installation accessories



**HDB – Hollow drill bit system**
The hollow drill bit system contains the DEWALT hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m³/h (42 l/s).

**Brush«Produktzusatz**

**SDS Plus Adapter**

**Brush extension**

**Piston Plug**


**Hand pump (volume 750 ml)**

**Compressed air nozzle (min 6 bar)**

| | |
|---|---|
| **Injection system PURE500+ for rebar connections** | **Annex B4** |
| **Intended use**<br>Dispensing, cleaning and installation accessories | |

**Table B5: Brushes, piston plugs, max anchorage depth and mixer extension, hammer drilling with standard bit (HD), compressed air (CD) and diamond drilling (DD)**

| Rebar size | Drill bit diameter $d_0$ | | | Brush diameter nominal | Brush diameter minimum | Piston plug | Cartridge: 440 ml or 585 ml, Hand or battery tool | | Cartridge: 440 ml or 585 ml, Pneumatic tool | | Cartridge: 825 ml, Pneumatic tool | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ø | HD | CD | DD | $d_b$ | $d_{b,min}$ | | $l_{v,max}$ | Mixer extension | $l_{v,max}$ | Mixer extension | $l_{v,max}$ | Mixer extension |
| [mm] | [mm] | | | [mm] | [mm] | [No] | [mm] | | [mm] | | [mm] | |
| 8 | 10 | - | 10 | 11,5 | 10,5 | - | 250 | VL10/0,75 or VL16/1,8 | 250 | VL10/0,75 or VL16/1,8 | 250 | VL10/0,75 or VL16/1,8 |
| | 12 | - | 12 | 13,5 | 12,5 | - | 700 | | 800 | | 800 | |
| 10 | | | | | | | 250 | | 250 | | 250 | |
| | 14 | - | 14 | 15,5 | 14,5 | #14 | 700 | | 1000 | | 1000 | |
| 12 | | | | | | | 250 | | 250 | | 250 | |
| | 16 | | | 17,5 | 16,5 | #16 | 700 | | 1300 | | 1200 | VL16/1,8 |
| 14 | 18 | | | 20,0 | 18,5 | #18 | | | | | 1400 | |
| 16 | 20 | | | 22,0 | 20,5 | #20 | | | | | 1600 | |
| 20 | 25 | - | 25 | 27,0 | 25,5 | #25 | 500 | | 1000 | | 2000 | |
| | - | 26 | - | 28,0 | 26,5 | #25 | | | | | | |
| 22 | 28 | | | 30,0 | 28,5 | #28 | | | | | | |
| 24/25 | 30 | | | 32,0 | 30,5 | #30 | | | | | | |
| | 32 | | | 34,0 | 32,5 | #32 | | | | | | |
| 28 | 35 | | | 37,0 | 35,5 | #35 | | | | | | |
| 32/34 | 40 | | | 43,5 | 40,5 | #40 | | | | | | |
| 36 | 45 | | | 47,0 | 45,5 | #45 | - | - | | | | |
| 40 | - | - | 52 | 54,0 | 52,5 | #52 | | | | | | |
| | 55 | 55 | - | 58,0 | 55,5 | #55 | | | | | | |

**Table B6: Brushes, piston plugs, max anchorage depth and mixer extension, hammer drilling with hollow drill bit (HDB)**

| Rebar size | Drill bit diameter $d_0$ | Brush diameter nominal | Brush diameter minimal | Piston plug | Cartridge: 440 ml or 585 ml, Hand or battery tool | | Cartridge: 440 ml or 585 ml, Pneumatic tool | | Cartridge: 825 ml, Pneumatic tool | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ø | HDB | $d_b$ | $d_b$ | | $l_{v,max}$ | Mixer extension | $l_{v,max}$ | Mixer extension | $l_{v,max}$ | Mixer extension |
| [mm] | [mm] | [mm] | [mm] | [No] | [mm] | | [mm] | | [mm] | |
| 8 | 10 | No cleaning required | | - | 250 | VL10/0,75 or VL16/1,8 | 250 | VL10/0,75 or VL16/1,8 | 250 | VL10/0,75 or VL16/1,8 |
| | 12 | | | | 700 | | 800 | | 800 | |
| 10 | | | | | 250 | | 250 | | 250 | |
| | 14 | | | #14 | 700 | | 1000 | | 1000 | |
| 12 | | | | | 250 | | 250 | | 250 | |
| | 16 | | | #16 | 700 | | 1000 | | 1000 | VL16/1,8 |
| 14 | 18 | | | #18 | | | | | | |
| 16 | 20 | | | #20 | | | | | | |
| 20 | 25 | | | #25 | 500 | | | | | |
| 22 | 28 | | | #28 | | | | | | |
| 24/25 | 30 | | | #30 | | | | | | |
| | 32 | | | #32 | | | | | | |
| 28 | 35 | | | #35 | | | | | | |
| 32/34 | 40 | | | #40 | | | | | | |

**Injection system PURE500+ for rebar connections**

**Intended use**
Brushes, piston plugs, max anchorage depth and mixer extension

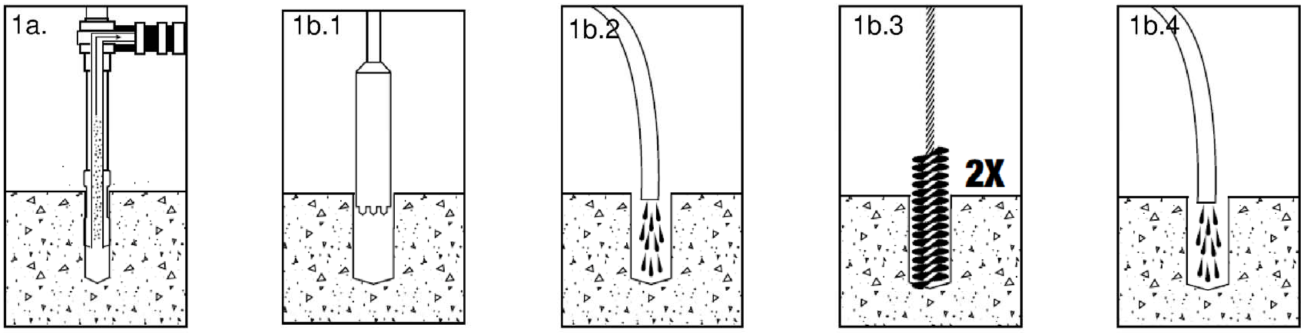
**Annex B5**

## Installation instructions

**Manual Air Cleaning (MAC)**
Cleaning for dry and wet bore hole with diameter $d_0 \leq$ 20mm and bore hole depth $h_0 \leq 10d_{nom}$, uncracked concrete only

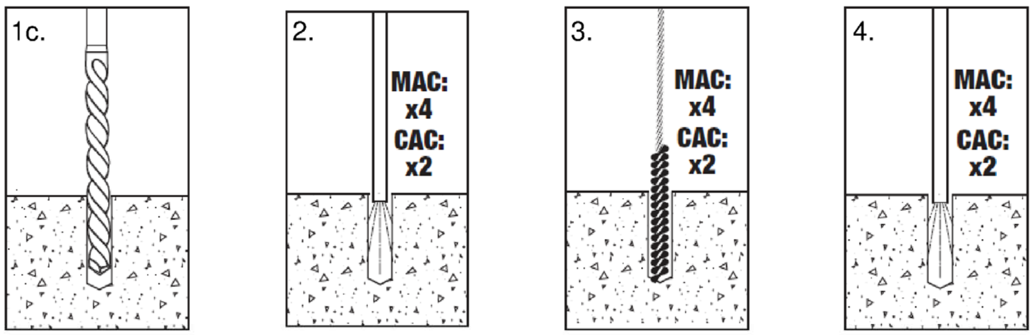
**Compressed Air Cleaning (CAC)**
Cleaning for dry, wet and water filled bore hole with all diameter and hole depth, uncracked and cracked concrete

**Hollow Drill Bit (HDB) Core Drill Bit, diamond drill mode (DD)**




1a.) Connect the hollow drill bit of proper size to the vacuum and drill a hole into the base material to the required depth while the vac is running. The drill dust is removed during the drilling process. Proceed with Step 5.
1b.) 1 Using the proper drill bit size, drill a hole to the required depth.
2 Rinse the hole until access water is clear.
3 Brush the hole with the proper wire brush 2 times minimum.
4 Rinse the hole until access water is clear. Proceed with Step 2.

**Standard Drill Bit, hammer drill mode (HD) or compressed air drill mode (CD)**

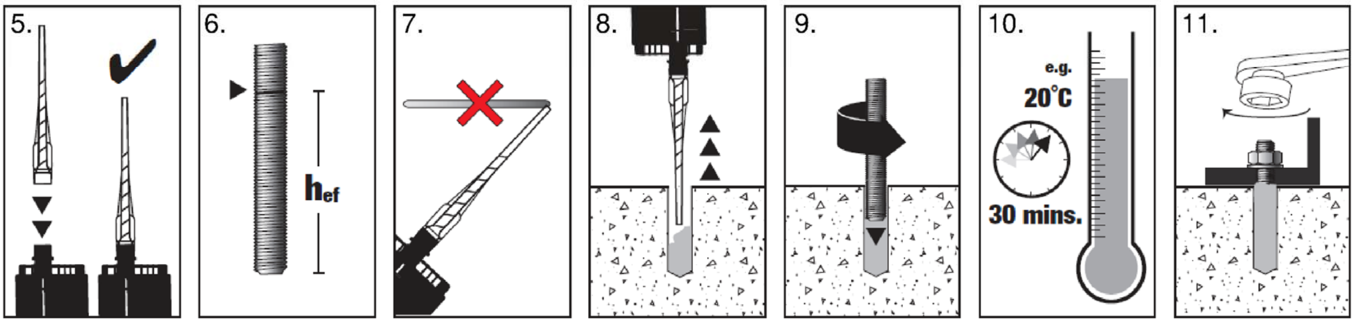



1c.) Using the proper drill bit size, drill a hole into the base material to the required depth. Proceed with Step 2
2.) Before cleaning, remove any standing water out of the drilled hole. Starting from the bottom of the hole, blow the hole clean with a hand pump minimum of 4 times (MAC) or with compressed air (min. 6 bar) minimum of 2 times (CAC). If the hole ground cannot be reached, an extension must be used.
3.) Select a brush of the correct diameter. Starting from the hole ground, brush the hole a minimum of 4 times (MAC) or 2 times (CAC), respectively. If the hole ground is not reached, a brush extension must be used.
4.) Finally, blow the hole clean again with a hand pump minimum of 4 times (MAC) or with compressed air (min. 6 bar) minimum of 2 times (CAC). If the hole ground cannot be reached, an extension must be used.

**After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the adhesive in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the adhesive. In-flowing water must not contaminate the bore hole.**

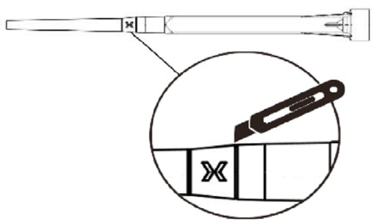
| | |
|---|---|
| **Injection system PURE500+ for rebar connections** | **Annex B6** |
| **Intended use**<br>Installation instructions | |

## Installation instructions (continued)

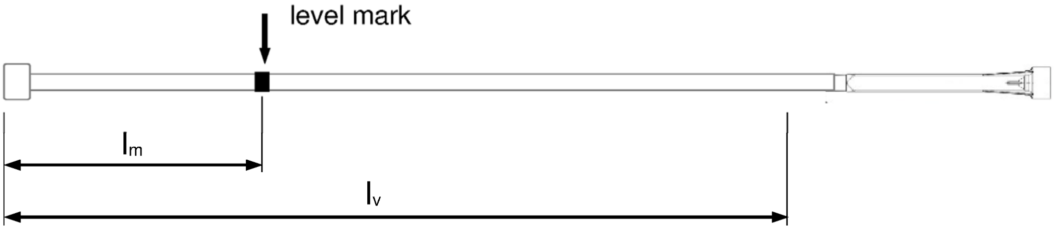



5.) Attach a supplied static mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For foil tube type cartridges, cut off the foil clip before use. For every working interruption longer than the recommneded working time as well as for new cartridges, a new mixer nozzle must be used.
6.) Mark the required embedment depth on the anchor rod.
7.) Squeeze out a minimum of 3 full strokes and discard non-balanced adhesive until the adhesive shows a consistent colour.
8.) Starting from the back of the cleaned hole, fill the hole approximately two thirds with adhesive. Slowly withdraw the nozzle as the hole fills to avoid creating air pockets. For holes with embedment depths greater than 190 mm, a proper extension nozzle must be used. For vertical down installations and horizontal installations in holes deeper than 250 mm, and for overhead installation always, use a piston plug if the hole is 18 mm or larger.
9.) Push the threaded rod or reinforcing bar into the hole while turning slightly to properly distribute the adhesive. The anchor should be clean and free of dirt, grease or oil. Be sure that the gap is completedly filled with adhesive. Excess adhesive must be visible at the top of the hole. For overhead application, the threaded rod or reinforcing bar must be fixed (e.g. wedges) until the mortar has started to harden.
10.) Allow the adhesive to cure for the specified time prior to applying any load. Do not load the anchor until it is fully cured.
11.) After full curing, the fixture can be installed. Make sure the maximum torque is not exceeded.

In case of using the mixer extension VL16/1,8,
the tip of the mixer nozzle has to be cut off at position ‘X’:



Piston plugs shall be used according to Table B5 or B6 for overhead and horizontal applications, and for vertical downward installation in case of bore holes deeper than 250 mm




Injection tool must be marked by mortar level mark $l_m$ and anchorage depth $l_v$ with tape or marker:
For estimation of mortar volume: $l_m = 1/3 \cdot l_v$
For optimum mortar volume: $l_m = l_v \cdot (1{,}2\ \varnothing^2/d_0^2 - 0{,}2)$
Continue injection until the mortar level mark $l_m$ becomes visible

| **Injection system PURE500+ for rebar connections** | |
|---|---|
| **Intended use**<br>Installation instructions | **Annex B7** |

## Minimum anchorage length and minimum lap length under static or quasi-static loading

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1:2004+AC:2010 ($l_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $l_{0,min}$ acc. to Eq. 8.11) shall be multiplied by the amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ according to Table C1.

**Table C1: Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ related to concrete class and drilling method; working life 50 and 100 years**

| Concrete class | Drilling method | Rebar size | Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ |
|---|---|---|---|
| C12/15 to C50/60 | all drilling methods | 8 mm to 40 mm | 1,0 |

**Table C2: Reduction factor $k_b = k_{b,100y}$ for all drilling methods; working life 50 and 100 years**

| Rebar | Concrete class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ∅ | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8 to 40 mm | 1,0 | | | | | | | | |

**Table C3: Design values of the ultimate bond stress $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ in N/mm² for all drilling methods and for good conditions; working life 50 and 100 years**

$$f_{bd,PIR} = k_b \cdot f_{bd}$$

$$f_{bd,PIR,100y} = k_{b,100y} \cdot f_{bd}$$

with

$f_{bd}$: Design value of the ultimate bond stress in N/mm² considering the concrete classes, the rebar diameter, the drilling method for good bond condition (for all other bond conditions multiply the values by $\eta_1 = 0.7$) and recommended partial factor $\gamma_c = 1,5$ according to EN 1992-1-1:2004+AC:2010.

$k_b$, $k_{b,100y}$: Reduction factor according to Table C2

| Rebar | Concrete class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ∅ | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8 to 32 mm | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,3 |
| 34 mm | 1,6 | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 | 4,2 |
| 36 mm | 1,5 | 1,9 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 | 4,1 |
| 40 mm | 1,5 | 1,8 | 2,2 | 2,5 | 2,8 | 3,1 | 2,4 | 3,7 | 4,0 |

## Minimum anchorage length and minimum lap length under seismic action

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1:2004+AC:2010 ($l_{b,min}$ acc. to Eq. 8.6 and Eq. 8.7 and $l_{0,min}$ acc. to Eq. 8.11) shall be multiplied by the amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis,100y}$ according to Table C4.

**Table C4: Amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis,100y}$ related to concrete class and drilling method; working life 50 and 100 years**

| Concrete class | Drilling method | Rear size | Amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis,100y}$ |
|---|---|---|---|
| C16/20 to C50/60 | all drilling methods | 10 mm to 40 mm | 1,0 |

**Table C5: Reduction factor $k_{b,seis} = k_{b,seis,100y}$ for all drilling methods; working life 50 and 100 years**

| Rebar | Concrete class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ∅ | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 10 to 40 mm | No performance assessed | 1,0 | | | | | | | |

**Table C7: Design values of the ultimate bond stress $f_{bd,PIR,seis}$ and $f_{bd,PIR,seis,100y}$ in N/mm² for all drilling methods and for good conditions; working life 50 and 100 years**

$$f_{bd,PIR,seis} = k_{b,seis} \cdot f_{bd}$$

$$f_{bd,PIR,seis,100y} = k_{b,seis,100y} \cdot f_{bd}$$

with

$f_{bd}$: Design value of the ultimate bond stress in N/mm² considering the concrete classes, the rebar diameter, the drilling method for good bond condition (for all other bond conditions multiply the values by $\eta_1 = 0.7$) and recommended partial factor $\gamma_c = 1{,}5$ according to EN 1992-1-1:2004+AC:2010.

$k_{b,seis}$, $k_{b,seis,100y}$: Reduction factor according to Table C5

| Rebar | Concrete class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ∅ | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 10 to 32 mm | No performance assessed | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,3 |
| 34 mm | | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 | 4,2 |
| 36 mm | | 1,9 | 2,2 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 | 4,1 |
| 40 mm | | 1,8 | 2,1 | 2,5 | 2,8 | 3,1 | 3,4 | 3,7 | 4,0 |

## Design value of the ultimate bond stress $f_{bd,fi}$, $f_{bd,fi,100y}$ at increased temperature for concrete classes C12/15 to C50/60, (all drilling methods); working life 50 and 100 years:

The design value of the bond stress $f_{bd,fi}$ at increased temperature has to be calculated by the following equation:

For working life 50 years: $\mathbf{f_{bd,fi} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \gamma_c / \gamma_{M,fi}}$

with: $\theta \leq 278°C$: $k_{fi}(\theta) = 4673{,}8 \cdot \theta^{(-1{,}598)} / (f_{bd,PIR} \cdot 4{,}3) \leq 1{,}0$

$\theta > 278°C$: $k_{fi}(\theta) = 0$

For working life 100 years: $\mathbf{f_{bd,fi,100y} = k_{fi,100y}(\theta) \cdot f_{bd,PIR,100y} \cdot \gamma_c / \gamma_{M,fi}}$

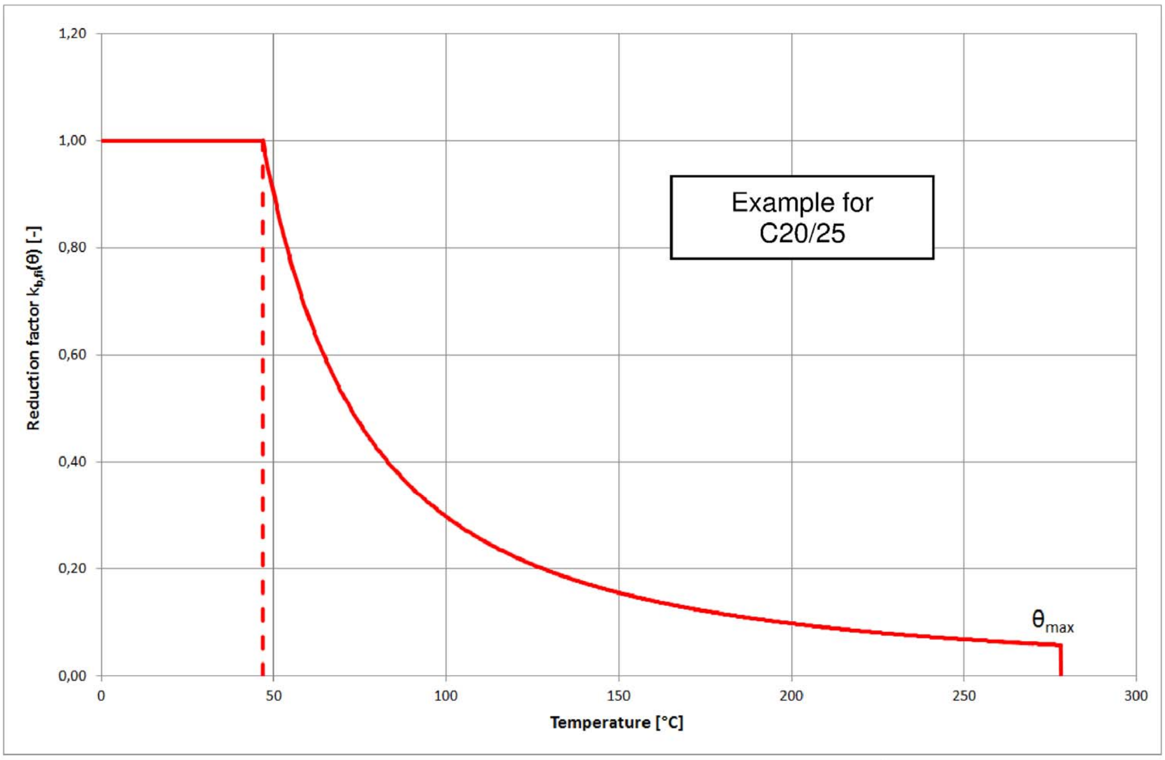
with: $\theta \leq 278°C$: $k_{fi,100y}(\theta) = 4673{,}8 \cdot \theta^{(-1{,}598)} / (f_{bd,PIR,100y} \cdot 4{,}3) \leq 1{,}0$

$\theta > 278°C$: $k_{fi,100y}(\theta) = 0$

| | |
|---|---|
| $f_{bd,fi}$, $f_{bd,fi,100y}$ | Design value of the ultimate bond stress at increased temperature in N/mm² |
| $\theta$ | Temperature in °C in the mortar layer |
| $k_{fi}(\theta)$, $k_{fi,100y}(\theta)$ | Reduction factor at increased temperature |
| $f_{bd,PIR}$, $f_{bd,PIR,100y}$ | Design value of the bond stress $f_{bd,PIR} = f_{bd,PIR,100y}$ in N/mm² in cold condition according to Table C3 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2004+AC:2010 |
| $\gamma_c$ | = 1,5, recommended partially safety factor according to EN 1992-1-1:2004+AC:2010 |
| $\gamma_{M,fi}$ | = 1,0, recommended partially safety factor according to EN 1992-1-2:2004+AC:2008 |

For evidence at increased temperature the anchorage length shall be designed according to EN 1992-1-1:2004+AC:2010 Equation 8.3 using the temperature-dependent design value of ultimate bond stress $f_{bd,fi}$.

## Example graph of Reduction factor $k_{fi}(\theta)$ for concrete classes C20/25 for good bond conditions:




| | |
|---|---|
| **Injection system PURE500+ for rebar connections** | **Annex C3** |
| **Performances**<br>Design value of ultimate bond stress at increased temperature | |