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European Technical Assessment

ETA 15/0681 of 03/05/2022

Technical Assessment Body issuing the ETA: Technical and Test Institute for Construction Prague	
Trade name of the construction product	WCF-E3 for rebar connection
Product family to which the construction product belongs	Product area code: 33 Post installed rebar connections with WCF-E3 injection mortar
Manufacturer	KLIMAS sp. z o.o. ul.Wincentego Witosa 135/137 Kuźnica Kiedrzyńska 42-233 Mykanów, Poland
Manufacturing plant	KLIMAS sp. z o.o. Manufacturing plant no. 3
This European Technical Assessment contains	18 pages including 14 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
This version replaces	ETA 15/0681 issued on 05/10/2015

1. Technical description of the product

The WCF-E3 injection system is used for the connection, by anchoring or overlap joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete. The design of the post-installed rebar connections is done in accordance with the regulations for reinforced concrete constructions.

Reinforcing bars made of steel with a diameter d from 8 to 32 mm and WCF-E3 chemical mortar are used for rebar connections. The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between embedded element, injection mortar and concrete.

The illustration and the description of the product are given in Annex A.

2. Specification of the intended use in accordance with the applicable EAD

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

The provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 50 years and 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the 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
Bond strength of post-installed rebar	See Annex C 1, C 2
Reduction factor	See Annex C 1, C 2
Amplification factor for minimum anchorage length	See Annex C 1, C 2

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class (A1) according to EN 13501-1
Resistance to fire	See Annex C 3

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if the specifications of intended use according to Annex B 1 are kept.

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

According to the Decision 96/582/EC of the European Commission[1] the system of assessment verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table apply.

Product	Intended use	Level or class	System
Metal anchors for use in concrete	For fixing and/or supporting concrete structural elements or heavy units such as cladding and suspended ceilings	-	1

[1] Official Journal of the European Communities L 254 of 08.10.1996

5. Technical details necessary for the implementation of the AVCP system, as provided in the applicable EAD

The factory production control shall be in accordance with the control plan which is a part of the technical documentation of this European Technical Assessment. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Technical and Test Institute for Construction Prague.[2] The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

Issued in Prague on 03.05.2022

By

Ing. Jiří Studnička, Ph.D.
Head of the Technical Assessment Body

[2] The control plan is a confidential part of the documentation of the European Technical Assessment, but not published together with the ETA and only handed over to the approved body involved in the procedure of AVCP.

Figure A1: Overlap joint for rebar connections of slabs and beams

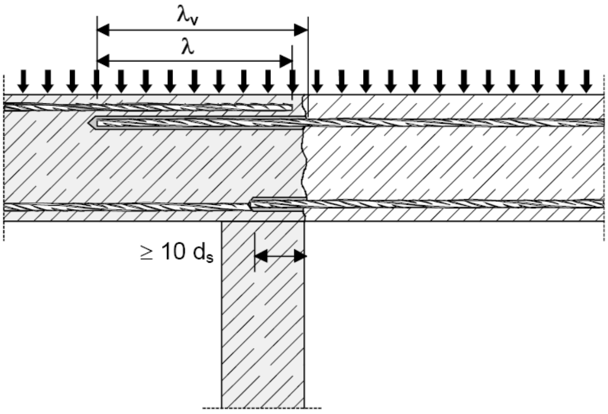


Figure A2: Overlap joint at a foundation of a column or wall where the rebars are stressed in tension

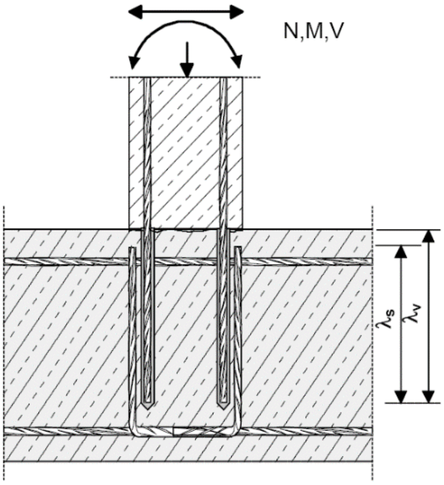


Figure A3: End anchoring of slabs or beams, designed as simply supported

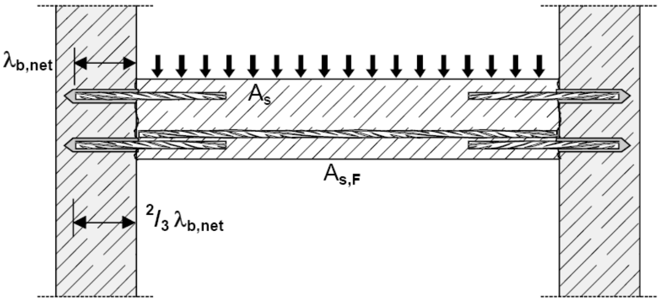


Figure A4: Rebar connection for components stressed primarily in compression.
The rebars are stressed in compression.

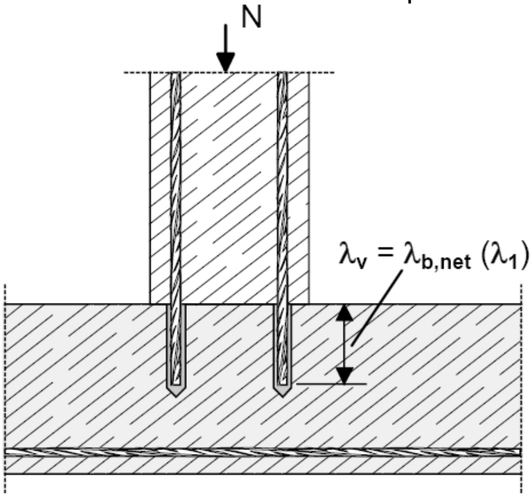
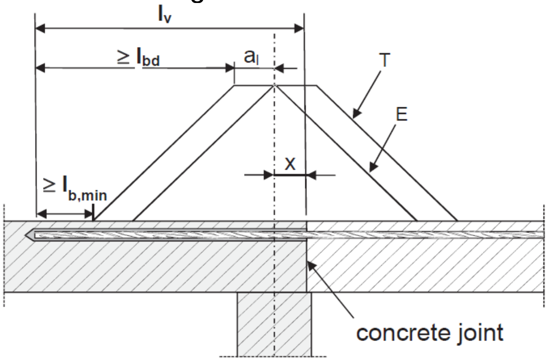


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force



(only post-installed rebar is plotted)

Key to Figure A5

T acting tensile force

E envelope of $M_{ed}/z + N_{ed}$ (see EN 1992-1-1, Figure 9.2)

x distance between the theoretical point of support and concrete join

Note to Figure A1 to A5:

In the Figures no transverse reinforcement is plotted, the transverse reinforcement as required by EN 1992-1-1 shall be present.

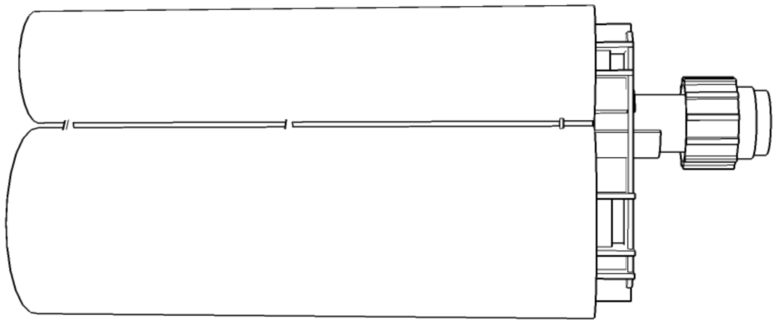
The shear transfer between old and new concrete shall be designed according to EN 1992-1-1.

WCF-E3 for rebar connection	**Annex A 1**
Product description Installed condition and examples of use for rebars	

Mortar cartridges

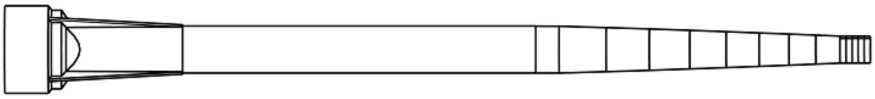
Side by side cartridge

WCF-E3 385 ml
585 ml

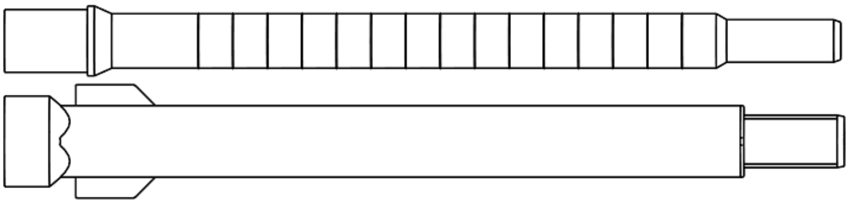


Mixing nozzle

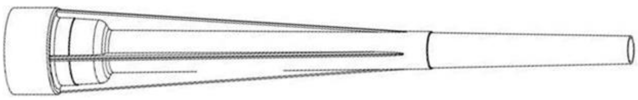
EN mixing nozzle



ELN mixing nozzle



EZ-Flow mixing nozzle



WCF-E3 for rebar connection	**Annex A 2**
Product description Injection system	

Rebar Ø8, Ø10, Ø12, Ø14, Ø16, Ø20, Ø24, Ø25, Ø26, Ø28, Ø32

Figure A6: Reinforcing bar

Minimum value of related rib area $f_{R,min}$ according to EN 1992-1-1:2004.

- The maximum outer rebar diameter over the ribs shall be:
  Nominal diameter of the rib d + 2 • h (h≤0,07 • d)
  (d: nominal diameter of the bar; h: rib height of the bar)

Table A1: Materials

Product form		**Bars and de-coiled rods**	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600	
Minimum value of $k = (f_t / f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	 ± 6,0 ± 4,5	
Bond: Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	 0,040 0,056	

WCF-E3 for rebar connection

Product description
Rebar and materials

Annex A 3

Specifications of intended use

Anchorages subject to:

- Static and quasi-static load.

Base materials

- Reinforced or unreinforced normal weight concrete according to EN 206:2013
- Strength classes C12/15 to C50/60 according to EN 206:2013.
- Maximum chloride concrete of 0,40% (CL 0.40) related to the cement content according to EN 206:2013.
- 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 d_s + 60 mm) prior to the installation of the new rebar. The depth of concrete to be removed shall correspond to at least minimum concrete cover in accordance with EN 1992-1-1:2004.
  The foregoing may be neglected if building components are new and not carbonated.

Temperature range:

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

Use conditions (Environmental conditions)

- The rebars may be used in dry or wet concrete.

Design:

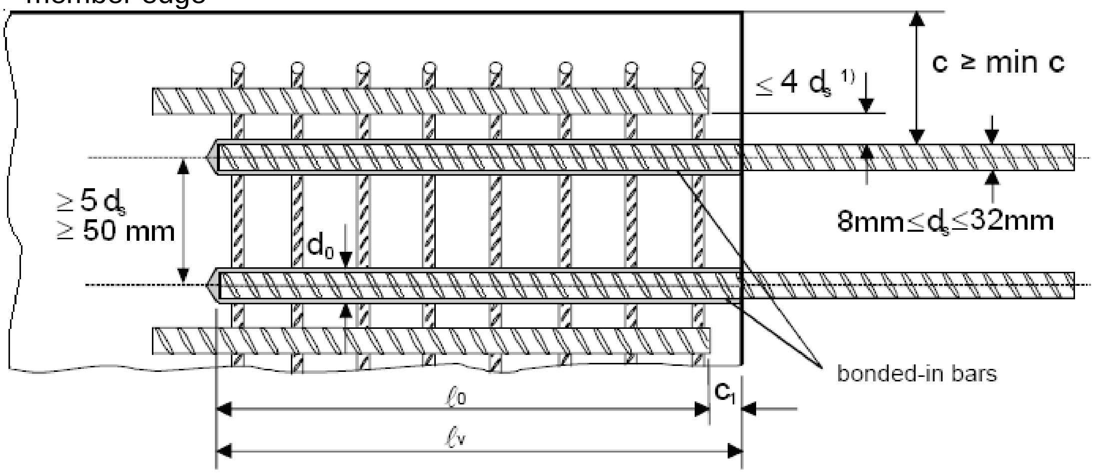
- The anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design according to EN 1992-1-1 and EN 1992-1-2.
- The position of the reinforcement 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.
- Hole drilling by hammer drill, compressed air drill mode or diamond core drilling.
- The installation of post-installed rebars 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 is not known, it shall be determined using a rebar detector suitable for this purpose).

Figure B1: General design rules of construction for bonded-in 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.
- 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 $4d_s$ then the lap length shall be increased by the difference between the clear bar distance and $4d_s$

c	concrete cover of bonded-in bar
c_1	concrete cover at end-face of bonded-in bar
min c	minimum concrete cover acc. Table B1 of this assessment
d_s	diameter of bonded-in bar
ℓ_0	lap length acc. to EN 1992-1-1:2004
ℓ_v	effective embedment depth ≥ $\ell_0 + c_1$
d_0	nominal drill bit diameter, see Table B2

WCF-E3 for rebar connection

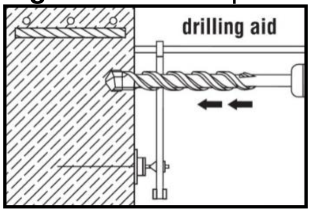
Intended use
General design rules of construction

Annex B 2

Table B1: Minimum concrete cover c_{min} depending on drilling method

Drilling method	Bar diameter ϕ	Without drilling aid c_{min}	With drilling aid c_{min}
Hammer drilling or diamond drilling	< 25 mm	30 mm + 0,06 $\ell_v \geq 2\phi$	30 mm + 0,02 $\ell_v \geq 2\phi$
	≥ 25 mm	40 mm + 0,06 $\ell_v \geq 2\phi$	40 mm + 0,02 $\ell_v \geq 2\phi$
Compressed air drilling	< 25 mm	50 mm + 0,08 ℓ_v	50 mm + 0,02 ℓ_v
	≥ 25 mm	60 mm + 0,08 $\ell_v \geq 2\phi$	60 mm + 0,02 $\ell_v \geq 2\phi$

Figure B2: Example of drilling aid



Minimum anchorage length $\ell_{bd,PIR}$ and minimum anchorage lap length $\ell_{0,PIR}$

Minimum anchorage length

$\ell_{b,PIR} = \alpha_{lb} \cdot \ell_{b,min}$

$\alpha_{lb} = \alpha_{lb,100y}$ = amplification factor for minimum anchorage length
(see Annex C 1, Table C2 for hammer drilling method)
(see Annex C 2, Table C4 for diamond core drilling method)

$\ell_{b,min}$ = minimum anchorage length of cast-in rebar according to EN 1992-1-1, eq. 8.6

Minimum lap length

$\ell_{0,PIR} = \alpha_{lb} \cdot \ell_{0,min}$

$\alpha_{lb} = \alpha_{lb,100y}$ = amplification factor for minimum anchorage length
(see Annex C 1, Table C2 for hammer drilling method)
(see Annex C 2, Table C4 for diamond core drilling method)

$\ell_{b,min}$ = minimum lap length of cast-in rebar according to EN 1992-1-1, eq. 8.11

Table B2: Drilling diameter and maximum anchorage depth

Rebar diameter d_{nom}[1)]	Nominal drilling diameter d_{cut}	Max permissible embedment depth ℓ_v
[mm]	[mm]	[mm]
8	12	400
10	14	500
12	16	600
14	18	700
16	20	800
20	25	1000
24	32	1000
25	32	1000
26	32	1000
28	35	1000
32	40	1000

[1)] The maximum outer rebar diameter over the ribs shall be:
nominal diameter of the bar d_{nom} + 0,20 d_{nom}

WCF-E3 for rebar connection	
Intended use Minimum concrete cover Minimum anchorage length Maximum embedment length	**Annex B 3**

Table B3: Processing and Cure time

Base Material Temperature °C	Cartridge Temperature °C	T Gel (mins)	T load (hrs)
+5°C	Minimum +10°C	300	24
+5°C to +10°C		150	
+10°C to +15°C	+10°C to +15°C	40	18
+15°C to +20°C	+15°C to +20°C	25	12
+20°C to +25°C	+20°C to +25°C	18	8
+25°C to +30°C	+25°C to +30°C	12	6
+30°C to +35°C	+30°C to +35°C	8	4
+35°C to +40°C	+35°C to +40°C	6	2
Ensure cartridge is > 10°C			

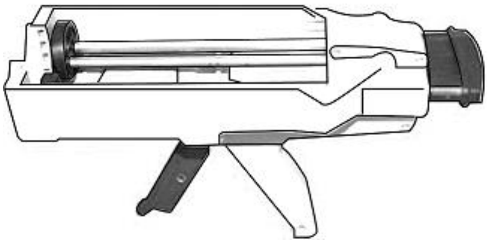
Table B4: Applicator gun

A

B

C

D



Applicator gun	A	B	C	D
Cartridge	Side by side 385	Side by side 385	Side by side 385	Side by side 585

Table B5: Brush

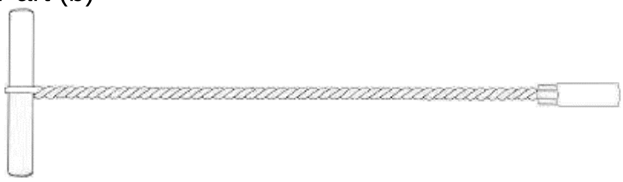
Sizes		Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø26	Ø28	Ø32
Drill hole diameter d_0	[mm]	12	14	16	18	20	25	32	32	32	35	40
Steel brush diameter	[mm]	S12HF S13HF	S14HF S15HF	S18HF	S22HF		S27HF	S35HF			S38HF	S43HF
Brushes head length	[mm]	75										

If required use additional accessories and extension for air nozzle and brush to reach back of hole.

Max. hole depth	Brush / extension configuration	Part
375 mm	Brush head unit + handle unit	(a)+(b)
675 mm	Brush head unit + extension piece + handle unit	(a)+(c)+(b)
975 mm	Brush head unit + 2x extension piece + handle unit	(a)+(c)+(c)+(b)

Part (a)

Part (b)



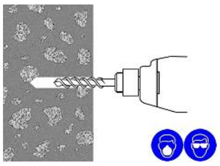
Part (c)

Table B6: Extension hose for deep holes

Sizes		Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø26	Ø28	Ø32
Hole diameter	[mm]	12	14	16	18	20	25	32	32	32	35	40
Extension hose	[mm]	9		14								
Resin stopper	[mm]	-	-	-	-	18	22	30				36

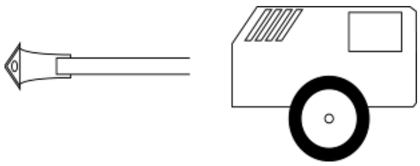
WCF-E3 for rebar connection	**Annex B 6**
Intended use Brush Extension hose for deep holes	

Drilling the hole



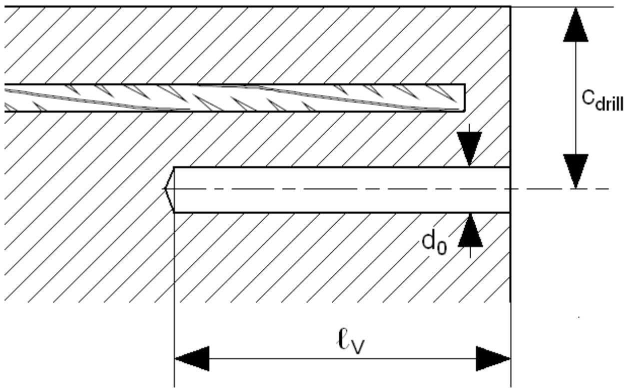
Drill hole to the required embedment depth using a hammer-drill with carbide drill bit set in rotation hammer mode, or a compressed air drill or diamond core drill.

Rotary hammer drilling



Compressed air drill

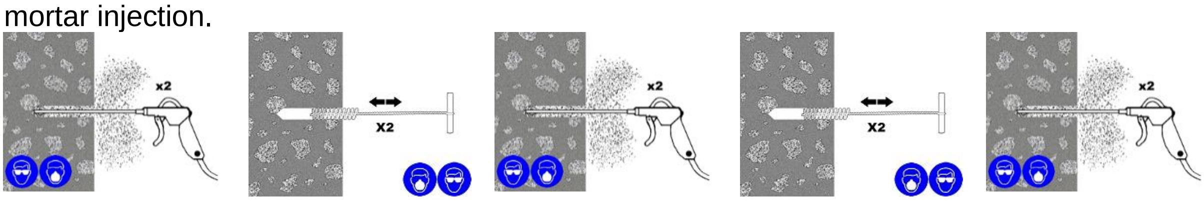
Before drilling remove carbonized concrete.
In case of aborted drill hole the drill hole shall be filled with mortar.



- Observe concrete coverage c, as per setting plan and Table B1
- Drill parallel to the edge and to existing rebar

Cleaning the hole

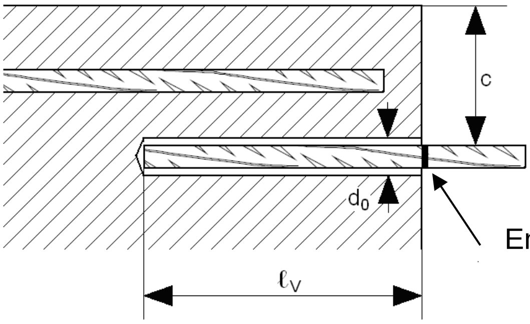
The borehole must be free of dust, debris, water, ice, oil, grease and other contaminants prior to mortar injection.



- Blowing 2 time from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticed dust.
- Brushing 2 time with the special brush size (brush Ø ≥ borehole Ø) by inserting the brush to the back of the hole in a twisting motion. The brush shall produce natural resistance as it enters the anchor hole. If this is not the case, please use a new brush or a brush with a larger diameter.
- Repeat operation 1 and 2.
- Blowing 1 time again with compressed air until return air stream is free of noticeable dust.

Mortar injection

If the hole collects water after initial cleaning,
this water must be removed before injecting the resin.



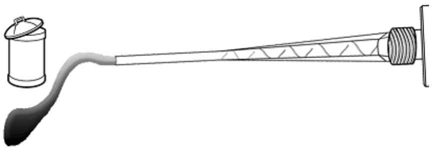
Before use, make sure the rebar is dry and free of oil or other residue.

Mark embedment depth on the rebar (e.g. with tape) ℓ_v

Insert rebar in borehole, to verify hole and setting depth ℓ_v

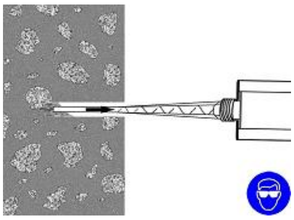
- Check expiration date: See imprint on cartridge. Do not use an expired product
- Cartridge temperature:
  Must be between +10°C and +40°C when in use
- Base material temperature at time of installation:
  Must be between +5°C and +40°C
- Instructions for transport and storage:
  Keep in a cool, dry and dark place at +5°C to +20°C achieve maximum shelf life

Select the appropriate static mixer nozzle for the installation, open the cartridge/foil and screw onto the mouth of the cartridge. Insert the cartridge into the correct applicator gun.



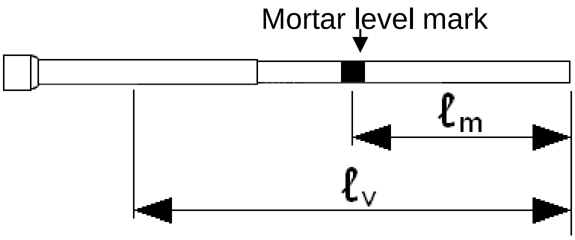
Extrude the first part of the cartridge to waste until an even colour has been achieved without streaking in the resin

If necessary, cut the extension tube to the depth of the hole and push onto the end of the mixer nozzle, and (for rebars 16 mm dia. or more) fit the correct resin stopper to the other end. Attach extension tubing and resin stopper.



Insert the mixer nozzle (resin stopper / extension tube if applicable) to the bottom of the hole. Begin to extrude the resin and slowly withdraw the mixer nozzle from the hole ensuring that there are no air voids as the mixer nozzle is withdrawn. Fill the hole to approximately ½ to ¾ full and remove the mixer nozzle completely.

Inserting the rebar

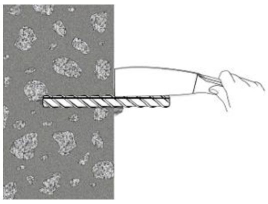


Mark the required mortar level ℓ_m and embedment depth ℓ_v with tape or marker on the injection extension.

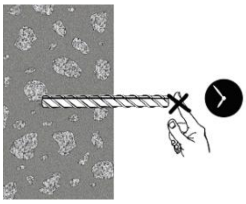
Quick estimation: $\ell_m = 1/2 \cdot \ell_v$

Continue injection until the mortar level mark ℓ_m becomes visible.

Insert the rebar, free from oil or other release agents, to the bottom of the hole using a back and forth twisting motion ensuring all the threads are thoroughly coated. Adjust to the correct position within the stated working time.



Any excess resin should be expelled from the hole evenly around the steel element showing that the hole is full.
This excess resin should be removed from around the mouth of the hole before it sets.



Leave the anchor to cure.

Do not disturb the anchor until the appropriate loading/curing time has elapsed depending on the substrate conditions and ambient temperature.

Design bond strength of post-installed rebar $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ for working life 50 and 100 years

$f_{bd,PIR} = k_b \cdot f_{bd}$
k_b = reduction factor
f_{bd} = design bond strength of cast-in rebar according to EN 1992-1-1

Table C1: Values of the design bond strength of post installed rebar $f_{bd,PIR} = f_{bd,PIR,100y}$ with reduction factor $k_b = k_{b,100y}$ for hammer drilling methods for good bond conditions

Rebar Ø 8 to Ø 28									
Concrete class	**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
k_b [-]	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
$f_{bd,PIR}$ [N/mm²]	**1,6**	**2,0**	**2,3**	**2,7**	**3,0**	**3,4**	**3,7**	**4,0**	**4,3**
Rebar Ø 32									
Concrete class	**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
k_b [-]	1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,92	0,86
$f_{bd,PIR}$ [N/mm²]	**1,6**	**2,0**	**2,3**	**2,7**	**3,0**	**3,4**	**3,7**		

Tabulated values are valid for good bond conditions according to EN 1992-1-1.
For all other bond conditions multiply the values by 0,7.

Table C2: Amplification factor for minimum anchorage length for hammer drilling methods

Rebar	Amplification factor	Concrete class								
		C12/15	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
Ø 8	$\alpha_{lb} = \alpha_{lb,100y}$	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 10		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 12		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 14		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 16		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 20		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 24		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 25		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 26		1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
Ø 28		1,0	1,0	1,0	1,0	1,0	1,0	1,5	1,5	1,5
Ø 32		1,0	1,0	1,0	1,0	1,0	1,0	1,5	1,5	1,5

Design bond strength of post-installed rebar $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ for working life 50 and 100 years

$f_{bd,PIR} = k_b \cdot f_{bd}$
k_b = reduction factor
f_{bd} = design bond strength of cast-in rebar according to EN 1992-1-1

Table C3: Values of the design bond strength of post installed rebar $f_{bd,PIR} = f_{bd,PIR,100y}$ with reduction factor $k_b = k_{b,100y}$ for diamond core drilling methods for good bond conditions

Rebar Ø 8 to Ø 26									
Concrete class	**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
k_b [-]	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0
$f_{bd,PIR}$ [N/mm²]	**1,6**	**2,0**	**2,3**	**2,7**	**3,0**	**3,4**	**3,7**	**4,0**	**4,3**
Rebar Ø 28									
Concrete class	**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
k_b [-]	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	0,93
$f_{bd,PIR}$ [N/mm²]	**1,6**	**2,0**	**2,3**	**2,7**	**3,0**	**3,4**	**3,7**	**4,0**	
Rebar Ø 32									
Concrete class	**C12/15**	**C16/20**	**C20/25**	**C25/30**	**C30/37**	**C35/45**	**C40/50**	**C45/55**	**C50/60**
k_b [-]	1,0	1,0	1,0	1,0	1,0	1,0	0,91	0,84	0,79
$f_{bd,PIR}$ [N/mm²]	**1,6**	**2,0**	**2,3**	**2,7**	**3,0**	**3,4**			

Tabulated values are valid for good bond conditions according to EN 1992-1-1.
For all other bond conditions multiply the values by 0,7.

Table C4: Amplification factor for minimum anchorage length for diamond core drilling methods

Rebar	**Amplification factor**	**Concrete class C12/15 to C50/60**
Ø 8 to Ø 32	$\alpha_{lb} = \alpha_{lb,100y}$	1,5

Design values of the bond strength $f_{bk,fi}$ and $f_{bk,fi,100y}$ under fire exposure for hammer drilling for working life 50 and 100 years

The design value of the bond strength $f_{bk,fi}$ = $f_{bk,fi,100y}$ under fire exposure has to be calculated according the following equation:

$$f_{bk,fi}(\theta) = f_{bk,fi,100y}(\theta) = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{M,fi}}$$

if:	20°C ≤ θ ≤ 50,8°C	$k_{fi}(\theta) = 1$
	> 50,8°C ≤ θ ≤ 179,7°C	$k_{fi}(\theta) = 68359 \cdot \theta^{-2,248} / (f_{bd,PIR} \cdot 4,3) \leq 1$
	θ > 179,7°C	$k_{fi}(\theta) = 0$

with:

k_{fi}	temperature reduction factor
(θ)	temperature in °C
$f_{bd,PIR}$	design value of the bond strength in N/mm² according to Table C1 considering the concrete class, the rebar diameter and the bond conditions according to EN 1992-1-1
γ_c	partial safety factor according to EN 1992-1-1
$\gamma_{M,fi}$	partial safety factor according to EN 1992-1-1

The anchorage length shall be determined in accordance with EN 1992-1-1 equation (8.3) using the bond strength $f_{bk,fi}(\theta)$.

Figure C1: Example of the graph of reduction factor $k_{fi}(\theta)$ for concrete strength class C20/25 for good bond conditions