European Technical Assessment

ETA-17/1043 du 19/07/2018

English translation prepared by CSTB - Original version in French language

General Part

Nom commercial *Trade name*	**Injection system Epcon G5+ XTREM for rebar connection**
Famille de produit *Product family*	Scellement d'armatures rapportées, diamètres 8 à 40mm, avec Système d'injection Epcon G5+ XTREM. **Post installed rebar connections diameter 8 to 40 mm made with Epcon G5+ XTREM injection mortar.**
Titulaire *Manufacturer*	ITW RED HEAD 700 HIGH GROVE BOULEVARD GLENDALE HEIGHTS ILLINOIS 60139 USA
Usine de fabrication *Manufacturing plants*	ITW RED HEAD
Cette evaluation contient: *This Assessment contains*	22 pages incluant 17 annexes qui font partie intégrante de cette évaluation *22 pages including 17 annexes which form an integral part of this assessment*
Base de l'ETE *Basis of ETA*	DEE 330087-00-0601, Edition juillet 2015 *EAD 330087-00-0601, Version July 2015*
Cette évaluation remplace: *This Assessment replaces*	ETE-17/1043 du 27/03/2018 *ETA-17/1043 dated 27/03/2018*

Specific Part

1 Technical description of the product

The Epcon G5+ XTREM is used for the connection, by anchoring or overlap joint, of reinforcing bars (rebars) in existing structures made of ordinary non-carbonated concrete C12/15 to C50/60. The design of the post-installed rebar connections is done in accordance with EN 1992-1-1 and EN 1992-1-2.

Covered are rebar anchoring systems consisting of Epcon G5+ XTREM bonding material and an embedded straight deformed reinforcing bar diameter, d, from 8 to 40 mm with properties according to Annex C of EN 1992-1-1 and EN 10080. The classes B and C of the rebar are recommended. The illustration and the description of the product are given in Annexes A.

2 Specification of the intended use

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

The provisions made in this European technical assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance under static and quasi-static loading	See Annex C1 to C4

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	See Annex C5

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances contained in this European technical approval, there may be requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions).

3.4 Safety in use (BWR 4)

For Basic requirement Safety in use the same criteria are valid as for Basic Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not relevant.

3.6 Energy economy and heat retention (BWR 6)

Not relevant.

3.7 Sustainable use of natural resources ((BWR 7)

For the sustainable use of natural resources no performance was determined for this product.

3.8 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B1 are kept.

4 Assessment and verification of constancy of performance (AVCP)

In accordance with European Assessment Document EAD No. 330087-00-0601, the applicable European legal act is: [96/582/EC].

The system(s) to be applied is (are): 1

5 Technical details necessary for the implementation of the AVCP system

Technical details necessary for the implementation of the Assessment and verification of constancy of performance (AVCP) system are laid down in the control plan deposited at Centre Scientifique et Technique du Bâtiment.

The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

The original French version is signed by

Charles Baloche
Technical Director

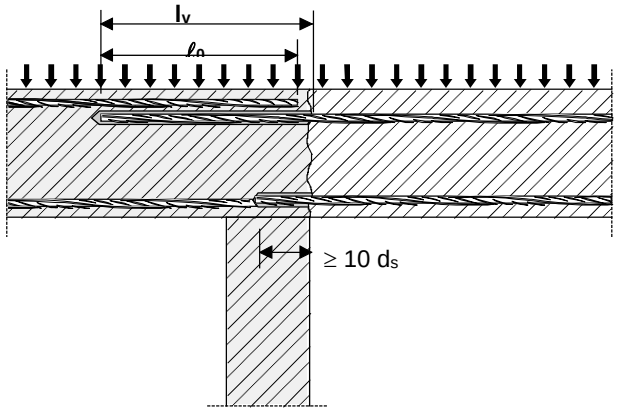


Figure A1: Overlap joint for rebar connections of slabs and beams

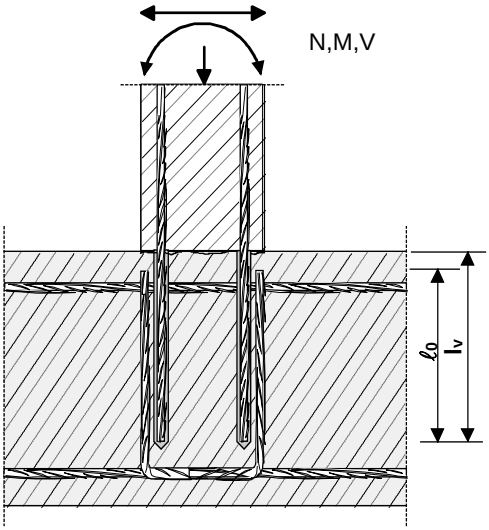


Figure A2: Overlap joint at a foundation of a column or wall where the rebars are stressed in tension

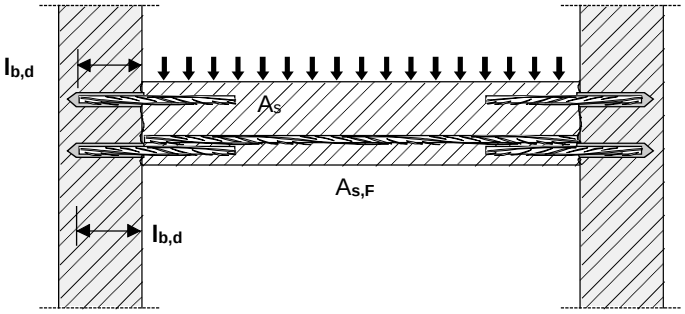


Figure A3: End anchoring of slabs or beams, designed as simply supported

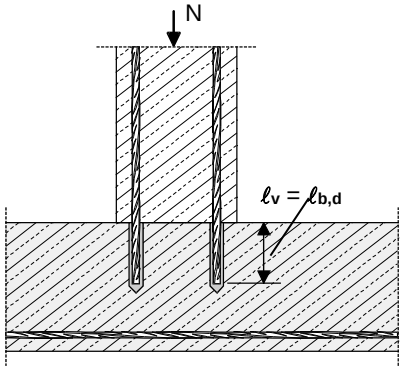


Figure A4: Rebar connection for components stressed primarily in compression. The rebars are stressed in compression

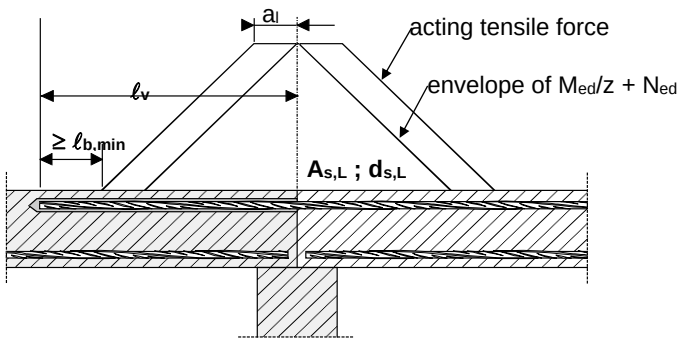


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force

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 existing and new concrete shall be designed according to EN 1992-1-1.
- Preparing of joints according to Annex B2

Injection system EPCON G5+ XTREM	
Product description Installed condition : application example of post-installed rebars	**Annex A1**

Figure A6: **Reinforcing bar "rebar" according to EC2 : Ø8 to Ø40**

Refer to *EAD 330087-00-0601* :

This EAD covers post-installed rebar connections in non-carbonated concrete under the assumption only that the design of post-installed rebar connections is done in accordance with EN 1992-1-1.

Covered are rebar anchoring systems consisting of bonding material and an embedded straight deformed reinforcing bar with properties according to Annex C of EN 1992-1-1; the classes B and C of the rebar are recommended.

Table A1 : Properties of reinforcement refer to EN 1992-1-1 Annex C Table C.1 and C.2N : :

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 or wire) (%)	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	

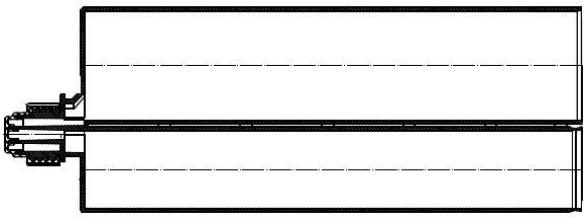
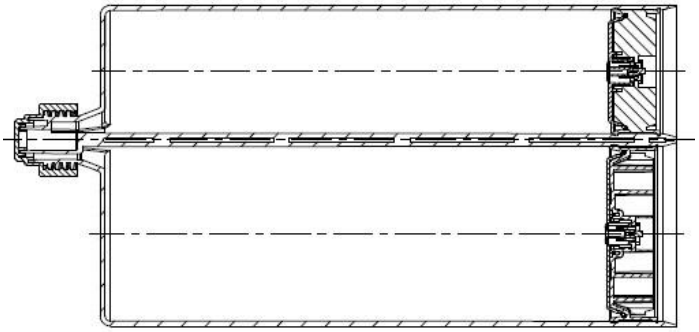
Injection system EPCON G5+ XTREM	**Annex A2**
Product description Reinforcement rebars	

Injection mortar

Injection mortar EPCON G5+ XTREM 450 ml and 900 ml:

Epoxy adhesive two components

Cartridges

450 ml coaxiale cartridge	
900 ml coaxiale cartridge	

Marking

- Trade name **EPCON G5+ XTREM**
- Expire date
- Curing and processing time
- Charge code number

Static mixer

Standard mixing nozzle for 450ml cartridges

High flow missing nozzle for 900 ml cartridges

Plastic piston plug for overhead installation

Injection system EPCON G5+ XTREM	
Product description Injection mortar / Static mixer	**Annex A3**

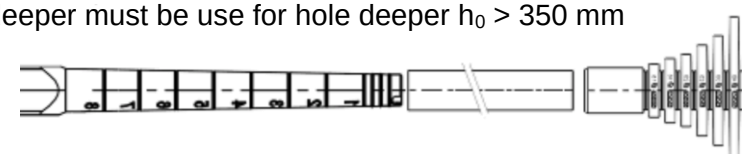
Dispensers

Manual dispenser for 450 ml cartridge

Pneumatic dispenser for 900 ml cartridge

Injection accessories for deep hole

Plastic extension Øext. 13x1000 or Øext. 20x1000 must be use for hole deeper h_0 > 250 mm
Piston plug for hole deeper must be use for hole deeper h_0 > 350 mm



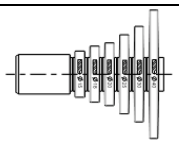
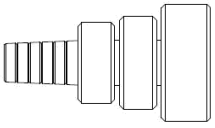
Cartridge volume	Mixing Nozzle	Extension for piston plug	Piston plug
All cartridges	Standard	Ø13x1000	
Cartridge 900 ml	High flow	Ø20x1000	

Table A2: Dimensions of the cleaning tools for reinforcement rebars (bars)

		Reinforcement bars									
Dimensions		Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø25	Ø28	Ø32	Ø40
Ø drilled hole [mm]		10	12	16	18	22	25	30	35	40	50
	Brush Ø [mm] [1)]	11	13	16	20	20	26	35	37	45	55
	Length [mm]	80	80	80	80	80	80	80	80	80	80
	Wire Ø [mm]	0,15	0,15	0,15	0,15	0,15	0,15	0,2	0,2	0,2	0,2

Table A3 : Dimensions of the cleaning tools for reinforcement rebars (bars)

		U.S. Customary unit Reinforcement bars							
Dimensions		No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No.10
Ø drilled hole [mm]		11,1	15,9	19,1	22,2	25,4	28,6	31,8	34,9
	Brush Ø [mm][1)]	15,9	19,1	25,4	31,8	38,1	41,3	41,3	44,5
	Length [mm]	25,4	25,4	25,4	25,4	31,7	34,9	34,9	34,9
	Wire Ø [mm]	0,15	0,15	0,15	0,15	0,25	0,25	0,25	0,25

[1)] The diameter of the round steel brush shall be checked before use. The minimum brush diameter has to be at least equal to the borehole diameter d_0. The round steel brush shall produce natural resistance as it enters the drill hole. If this is not the case, please use a new brush or a brush with a larger diameter.

Specifications of intended use

Anchorages subject to :

- Static and quasi static loading
- Fire exposure

Base material :

- Reinforced or unreinforced normal weight concrete of strength classes C 20/25 at least to C50/60 at most according to EN 206: 2014
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2014
- 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 ϕ + 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.The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

Temperature in the base material:

- Installation temperature : Temperature of base material : +10 °C to +40°C
- In-service temperature : G5+ XTREM may be used in the temperature range:
  - 40°C to +70°C : max short term temperature +70°C
    max long term temperature +42°C

Design:

Rebar connection must be designed in keeping with good engineering practice :

- 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 under static or quasi-static loading in accordance with EN 1992-1-1 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:

- Drilling technique :
  - Rotary hammer drilling technique or Compressed air drilling
  - Diamond drilling + roughening of the hole
- Use category: dry or wet concrete (not in flooded holes)
- Installation direction downwards, horizontal or overhead is admissible from Ø8 to Ø40
- Rebar installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

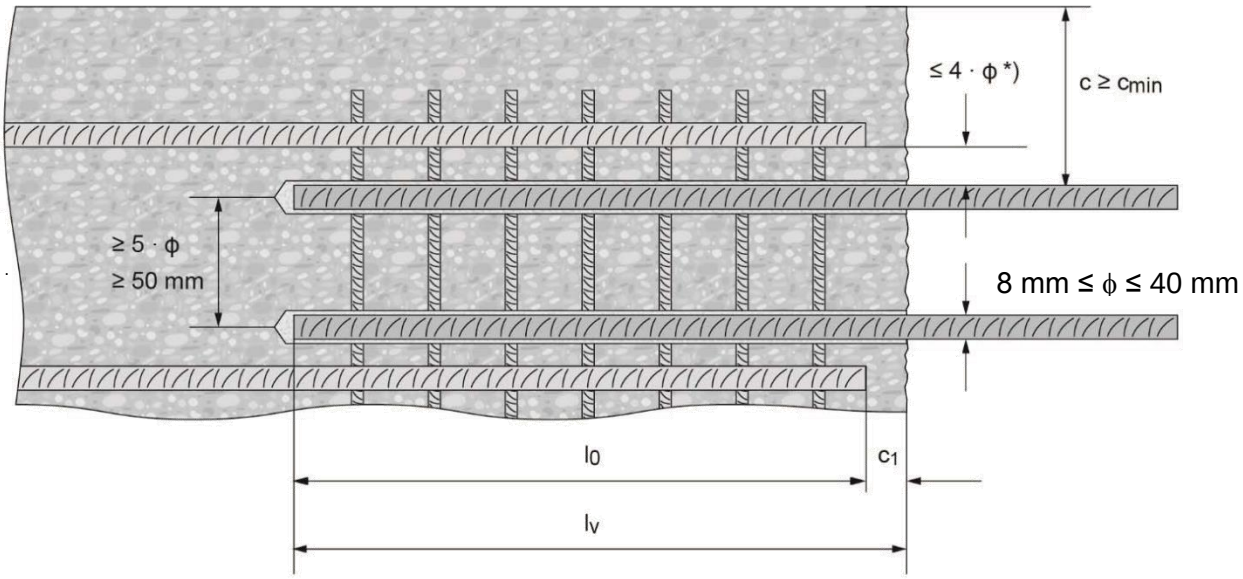
Injection system EPCON G5+ XTREM	**Annex B1**
Intended use Specifications	

Figure B1 : Construction rules for post-installed rebars

▪ Post-installed rebar may be designed for tension forces only.

▪ 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



*) Si l'espacement dans la zone de recouvrement des barres est supérieur à 4 · ϕ, alors la longueur de recouvrement doit être augmentée de la différence entre l'espacement réel et 4 · ϕ.

- 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
- ϕ : diameter of reinforcement bar
- l_0 : lap length, according toEN 1992-1-1:2004/AC:2010, Section 8.7.3
- l_v : effective embedment depth≥ $l_0 + c_1$
- d_0 nominal drill bit diameter, see Table B2
- Minimum clear spacing between two post-installed bars a = 50 mm ≥ 4. ϕ

Injection system EPCON G5+ XTREM	**Annex B2**
Intended used General construction rules for post-installed rebars	

Table B1 : Minimum concrete cover C_{min} of post-installed rebar

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

Figure B2 : Drilling aid system

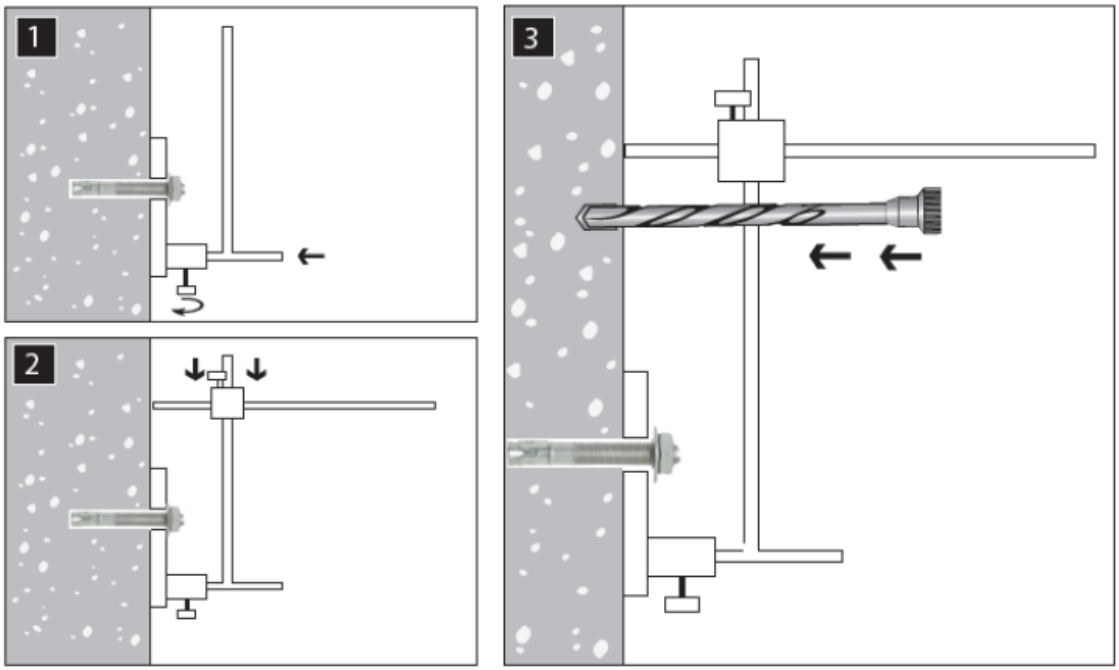


Table B2 : Maximum embedment depth lv,max depending on bar diameter and dispenser

Rebar diameter ϕ	Maximum embedment length $l_{v,max}$ [mm]	
[mm]	Manuel Dispenser	Pneumatic Dispenser
	450 ml	450 ml / 900 ml
8	630	1500
10		
12		
16		
20		
25		
28		
32		
40		1200

Table B3 : Installation parameters

Rebar diameter ϕ [mm]	Nominal drilling diameter d_{cut} [mm]		
	Hammer drilling orCompressed air drilling	Diamond drilling	
		Core drilling diameter	Drill bit used as Roughening tool
8	10	-	-
10	12	-	-
12	15	-	-
16	20	20	20
20	25	25	25
25	30	30	30
28	35	35	35
32	40	40	40
40	50	50	50

Table B4 : Maximum embedment depth lv,max depending on bar diameter and dispenser

Rebar diameter ϕ	Maximum embedment length $l_{v,max}$ [mm]	
[mm]	Manuel Dispenser	Pneumatic Dispenser
	450 ml	450 ml / 900 ml
No.3	630	1500
No.4		
No.5		
No.6		
No.7		
No.8		
No.9		
No.10		

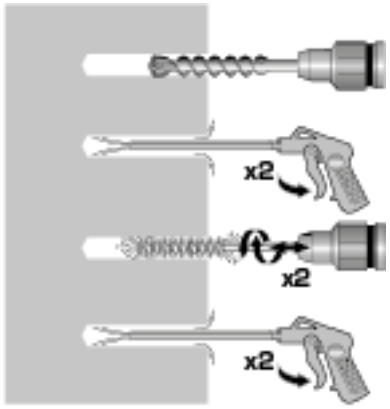
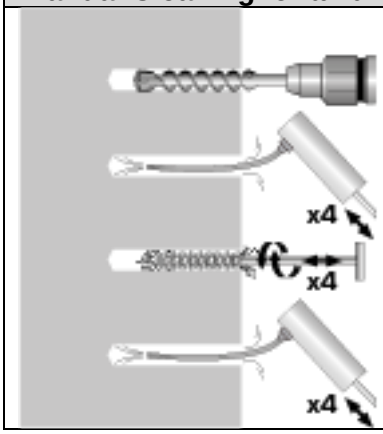
Table B5 : Installation parameters

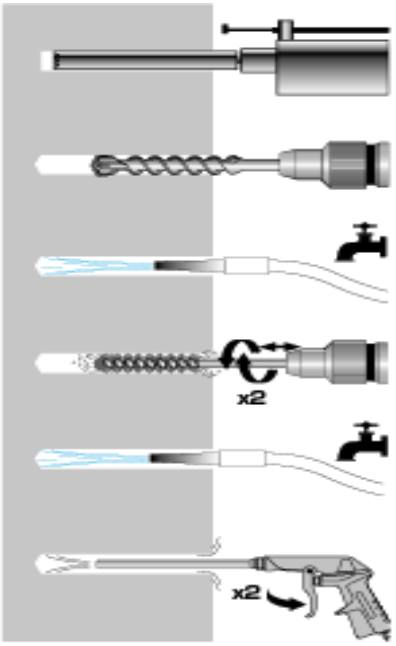
Rebar diameter ϕ [mm]	Nominal drilling diameter d_{cut} [mm]		
	Hammer drilling Compressed air drilling	Diamond drilling	
		Core drilling diameter	Drill bit used as Roughening tool
No.3	11,1	-	-
No.4	15,9	-	-
No.5	19,1	19,1	19,1
No.6	22,2	22,2	22,2
No.7	25,4	25,4	25,4
No.8	28,6	28,6	28,6
No.9	31,8	31,8	31,8
No.10	34,9	34,9	34,9

Table B6: Gel time and curing time

Temperature of base material	Maximum working time	Min curing time in dry concrete
10°C to 14°C	30 min	30 h
15°C to 19°C	20 min	16 h
20°C to 24°C	15 min	6,5 h
25°C to 29°C	15 min	4 h
30°C to 34°C	12 min	2,75 h
35°C to 39°C	10 min	2,5 h
40°C	10 min	2 h

Drilling & Cleaning the hole

Hammer drilling technique **Premium Cleaning *for all drill hole diameters and all drill hole depths***	
	1. Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode using appropriate size carbide drill bit. 2. Using compress air cleaning (min 6 bars), use the appropriate extension, starting from the top of the hole blow out at least 2 times by moving downward to the bottom of the hole then moving upward to the top of the hole and until no dust is evacuated. (not less than 10s per each blowing). 3. Using the relevant brush and extension fitted on an appropriate drilling machine, starting from the top of the hole, move downward to the bottom of the hole then move upward to the top of the hole. Repeat this operation. 4. Using compress air cleaning (min 6 bars), use the appropriate extension, starting from the top of the hole blow out at least 2 times by moving downward to the bottom of the hole then moving upward to the top of the hole and until no dust is evacuated. (not less than 10s per each blowing).
Hammer drilling technique **Manual Cleaning *for all drill hole diameters $d_0 \leq 20$ mm and all drill hole depth $h_0 \leq 10$ d***	
	1. Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode using appropriate size carbide drill bit. 2. Starting from the drill hole base blow out at least 4 times with the SPIT hand pump. 3. Using the relevant brush, starting from the top of the hole, move downward to the bottom of the hole then move upward to the top of the hole. Repeat this operation 4 times. 4. Starting from the drill hole base blow out at least 4 times with the SPIT hand pump.

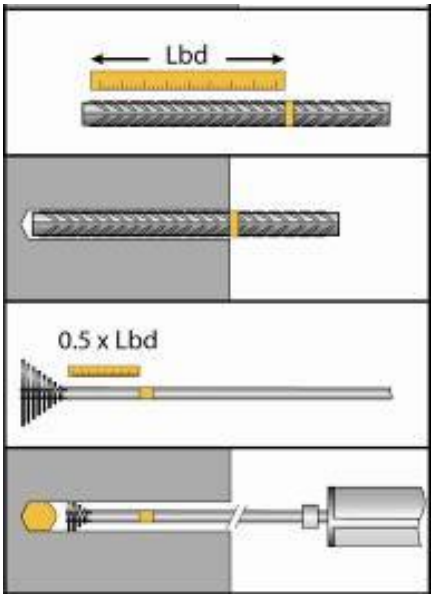
Diamond core drilling technique ***Premium Cleaning***	
	1. Drill hole to the required embedment depth with a diamond core drilling machines and the appropriate size core. 2. Remove water in the hole and use the appropriate drill bit as roughening tool before applying cleaning procedure 3. Clean the hole with tap water. 4. Using the relevant brush and extension fitted on an appropriate drilling machine, starting from the top of the hole, move downward to the bottom of the hole then move upward to the top of the hole. Repeat this operation 5. Clean the hole with tap water 6. Using compress air cleaning (mini 6 bars), use the appropriate extension, starting from the top of the hole blow out at least 2 times by moving downward to the bottom of the hole then moving upward to the top of the hole and until no dust is evacuated. (not less than 10s per each blowing).

Safety precaution :

The safety data sheet must be read before using the product and the safety instructions followed.

- Storage temperature of cartridge +0°C à +35 °C
- Cartridge temperature at time of installation: Must be ≥ +20°C
- Base material temperature at time of installation: Must be between 10°C and +40°C
- Check the date of expiry of the cartridge

Dispensing into the hole:



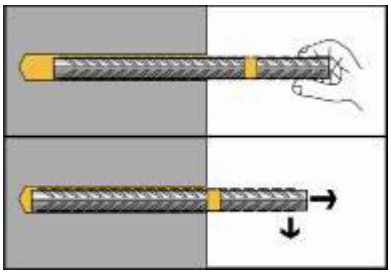
1. Put the anchorage depth mark on the rebar

2. Check the anchorage depth

3. Cut the piston plug at the relevant diameter. The volume of resin that need to be injected in the hole must be indicated on the mixing nozzle or its extension. The marking must be placed at 0.5 time the anchorage depth

4. Dispense the first part to waste until an even colour is achieved (≈ 20cm). Insert the nozzle to the far end of the hole, and inject the resin, withdrawing the nozzle as the hole fills in order to avoid trapping air bubbles. Fill the hole until the mark appear..

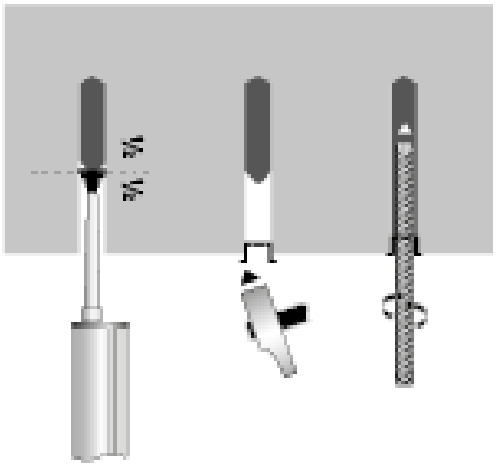
Inserting the rebar:



1. Immediately insert the rebar, slowly and with a slight twisting motion. Remove excess resin from around the mouth of the hole before it sets. Control the embedment depth during the working time (See Annex 6 Table B6) which varies according to
temperature of base material.

2. Leave the rebar undisturbed until the curing time has elapse. (See Annex 6 Table B6)

For overhead application:



For ensuring that the mortar doesn't flow out during the insertion of the rebar, and to support the rebar and secure it from falling until mortar has started to harden it is recommended to use the appropriate size of piston plug

This piston plug is inserted by hammering after injection of the mortar.

Injection system EPCON G5+ XTREM	
Product description Installation instruction	**Annex B9**

Table C1 : Amplification factor α_{lb} for Hammer drilling, compressed air drilling for EU reinforcing bars

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor α_{lb} given in Table C1.

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ8 - ϕ40	1.0								

Table C2 : Bond efficiency value k_b for Hammer drilling, compressed air drilling for EU reinforcing bars

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ8 - ϕ40	1.00								

Table C3 : Design values of the ultimate bond resistance $f_{bd,PIR}$[1)] in N/mm² for Hammer drilling, compressed air drilling for EU reinforcing bars

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ8 - ϕ40	1.6	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.3

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Table C4 : Amplification factor α_{lb} for Hammer drilling, compressed air drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor α_{lb} given in Table C4.

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 3 - 10	1.0								

Table C5 : Bond efficiency value k_b for Hammer drilling, compressed air drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 3 - 10	1.0								

Table C6 : Design values of the ultimate bond resistance $f_{bd,PIR}$[1)] in N/mm² for Hammer drilling, compressed air drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

Bar diameter	Concrete class								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 3 - 10	1.6	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.3

1) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Table C7 : Amplification factor α_{lb} for diamond drilling for EU reinforcing bars

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor α_{lb} given in Table C7.

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ16 - ϕ40	1.0								

Table C8 : Bond efficiency value k_b for diamond drilling for EU reinforcing bars

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ16 - ϕ40	1.00								

Table C9 : Design values of the ultimate bond resistance $f_{bd,PIR}$[1)] in N/mm² for diamond drilling for EU reinforcing bars

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
ϕ16 - ϕ40	1.6	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.3

2) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Table C10 : Amplification factor α_{lb} for diamond drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1 shall be multiplied by the relevant amplification factor α_{lb} given in Table C10.

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 5 - 10	1.0								

Table C11 : Bond efficiency value k_b for diamond drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 5 - 10	1.0								

Table C12: Design values of the ultimate bond resistance $f_{bd,PIR}$[1)] in N/mm² for diamond drilling for U.S. CUSTOMARY UNIT REINFORCING BAR

Bar diameter	**Concrete class**								
	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
No. 5 - 10	1.6	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.3

2) According to EN 1992-1-1 for good bond conditions. For all other bond conditions multiply the values by 0,7.

Design value of ultimate bond stress in case of fire $f_{bk,fi}$ (θ) [N/mm²] for concrete strength classes C12/15 to C50/60

The design value of bond strength under fire exposure $f_{bd,fi}$ shall be calculated by the following equation:

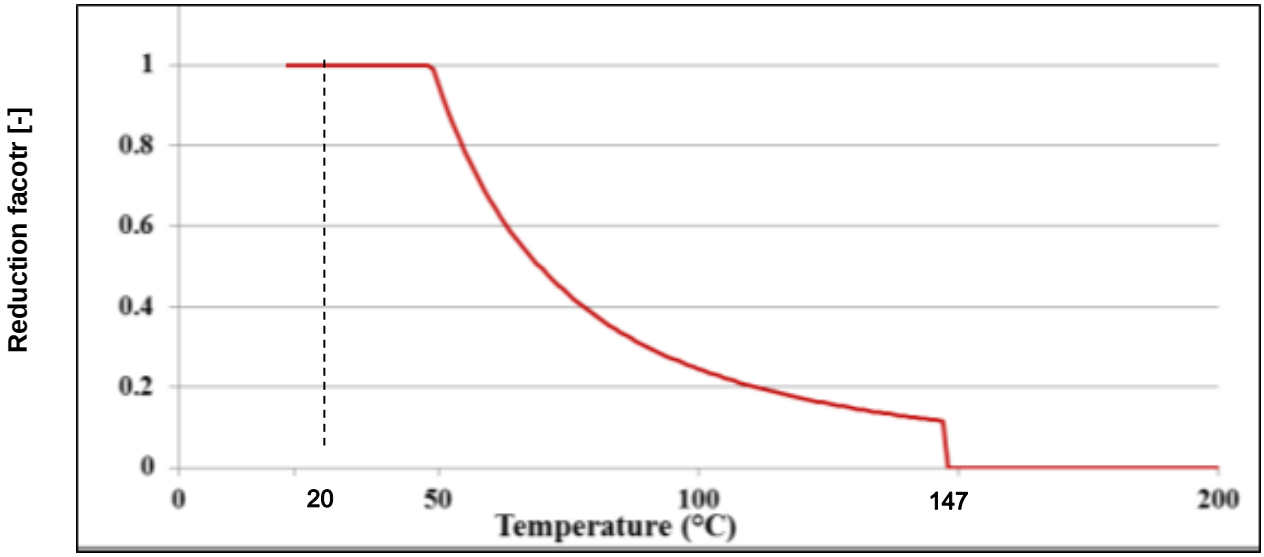
$$f_{bk,fi}(\theta) = k_{fi}(\theta) \bullet f_{bd,PIR} \bullet \gamma_c / \gamma_{M,fi}$$

where

θ ≤ 49 °C:	$k_{fi}(\theta) = 1$
49 °C < θ ≤ 147 °C:	$k_{fi}(\theta) = min\{1{,}0\ ;\ 19609 \times \theta^{-1.951} / (f_{bd,PIR} \cdot 4{,}3)\}$
θ > 147 °C:	$k_{fi}(\theta) = 0$

$f_{bk,fi}$ Design value of ultimate bond stress in case of fire
k_{fi} (θ) Reduction factor according to Figure C1
$f_{bd,PIR}$ Design values of the ultimate bond stress in cold state according to Annexes C1 or C2 depending on concrete strength class, size of rebar, drilling method and bond condition according to EN 1992-1-1
γ_c safety factor according to EN 1992-1-1
$\gamma_{M,fi}$ safety factor according to EN 1992-1-2

Graph C1 : Example of temperature reduction factor k_{fi}(θ) in C20/25 for good bond conditions



Injection system EPCON G5+ XTREM	
Performance Bond strength in case of fire for concrete C20/25 to C50/60	**Annex C5**