



**Technical and Test Institute
for Construction Prague**
Prosecká 811/76a
190 00 Prague
Czech Republic
eota@tzus.cz



Member of



www.eota.eu

European Technical Assessment

**ETA 20/0752
of 08/07/2024**

Technical Assessment Body issuing the ETA: Technical and Test Institute
for Construction Prague

Trade name of the construction product

ChemSet™ Reo502™ Plus
ChemSet™ Epcon™ C6 Plus
ChemSet™ Epcon™ G5 PRO

**Product family to which the construction
product belongs**

Product area code: 33
Post installed rebar connections
with ChemSet™ Reo502™ Plus,
ChemSet™ Epcon™ C6 Plus, ChemSet™
Epcon™ G5 PRO injection mortar

Manufacturer

Ramsetreid
A Division of ITW Australia Pty Ltd
1 Ramset Drive, Chirnside Park. Vic 3116
Australia

Manufacturing plant

Ramsetreid Plant 3

**This European Technical Assessment
contains**

19 pages including 16 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 Systems for post-
installed rebar connections with mortar

This version replaces

ETA 20/0752 issued on 02/08/2021

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

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1. Technical description of the product

The ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus, ChemSet™ Epcon™ G5 PRO 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 40 mm and ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus, ChemSet™ Epcon™ G5 PRO 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 |
|--|--------------------|
| Characteristic resistance under static and quasi-static loading | |
| 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 |
| Characteristic resistance under seismic loading | |
| Bond strength under seismic loading | See Annex C 3 |
| Seismic bond efficiency factor | |
| Minimum concrete cover under seismic loading | See Annex B 3 |

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 4 |

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 Commission¹ 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 08.07.2024

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

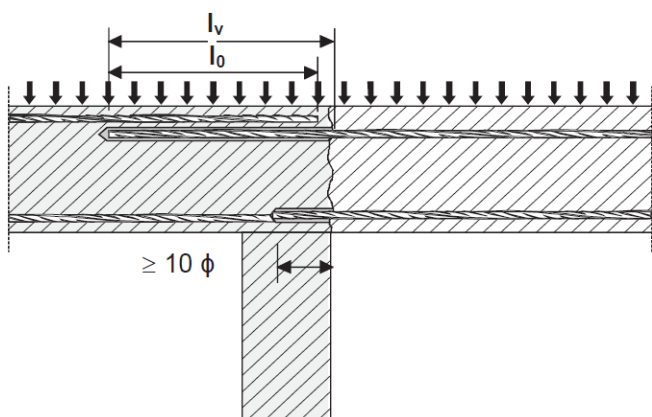


Figure A2: Overlap joint at a foundation of a column or wall where the rebar is stressed in tension

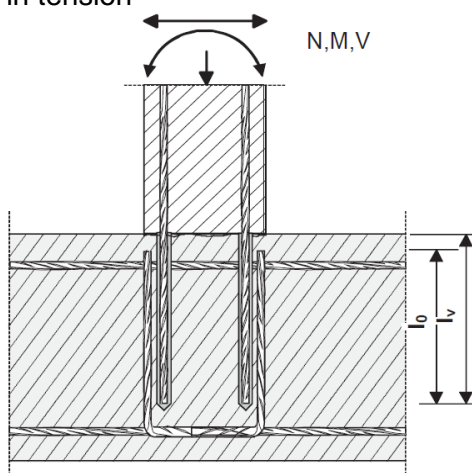


Figure A3: End anchoring of slabs or beams, designed as simply supported

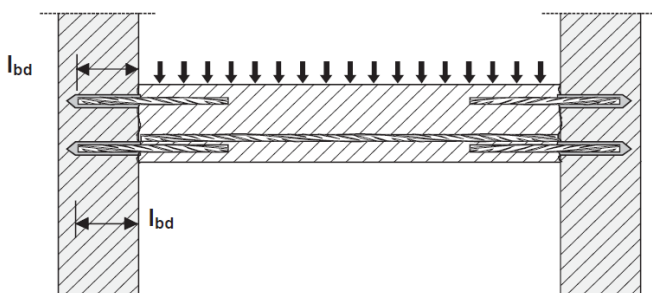


Figure A4: Rebar connection for components stressed primarily in compression. The rebar is stressed in compression.

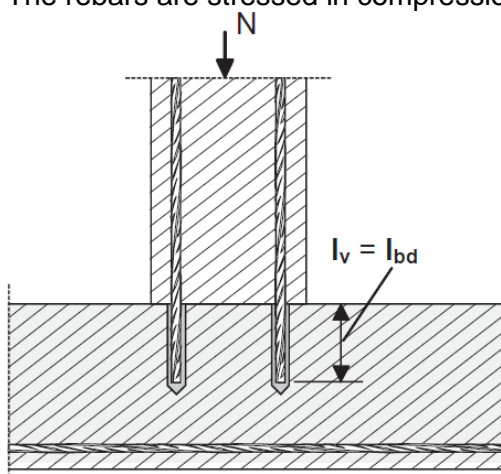
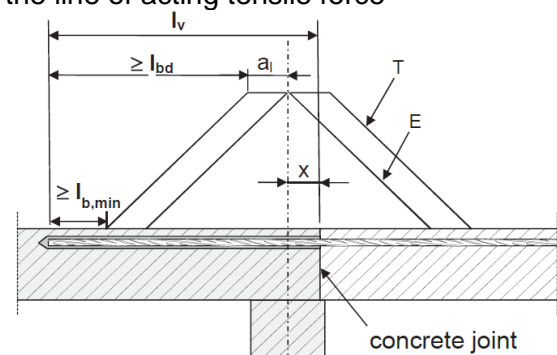


Figure A5: Anchoring of reinforcement to cover the line of acting tensile force



(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 joint

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.

ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus, ChemSet™ Epcon™ G5 PRO for rebar connection

Product description
Installed condition and examples of use for rebars

Annex A 1

Mortar cartridges

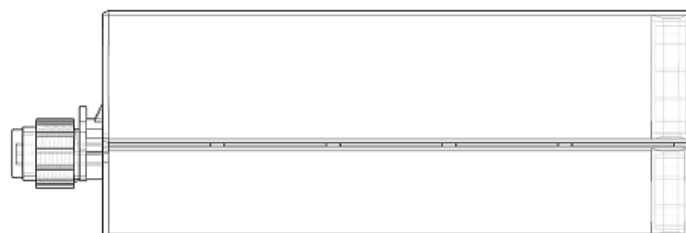
Coaxial cartridge

ChemSet™ Reo502™ Plus, 600 ml
 ChemSet™ Epcon™ C6 Plus
 ChemSet™ Epcon™ G5 PRO



Side by side cartridge

ChemSet™ Reo502™ Plus, 450 ml
 ChemSet™ Epcon™ C6 Plus
 ChemSet™ Epcon™ G5 PRO



Marking of the mortar cartridges

Identifying mark of the producer, Trade name, Charge code number, Storage life, Curing and processing time

Mixing nozzle

Q mixing nozzle



QH mixing nozzle



EF mixing nozzle



**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
 ChemSet™ Epcon™ G5 PRO for rebar connection**

Product description
 Injection system

Annex A 2

Rebar Ø8, Ø10, Ø12, Ø14, Ø16, Ø18, Ø20, Ø22, Ø24, Ø25, Ø26, Ø28, Ø32, Ø40

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 $d + 2 \cdot h$ ($h \leq 0,07 \cdot d$)
(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 $k = (f_t / f_y)_k$ | | $\geq 1,08$ | $\geq 1,15$ < 1,35 |
| Characteristic strain at maximum force ϵ_{uk} (%) | | $\geq 5,0$ | $\geq 7,5$ |
| Bendability | | Bend / Rebend test | |
| Maximum deviation from nominal mass (individual bar) (%) | Nominal bar size (mm) ≤ 8 | $\pm 6,0$ | |
| | > 8 | $\pm 4,5$ | |
| Bond: Minimum relative rib area, $f_{R,min}$ | Nominal bar size (mm) 8 to 12 | 0,040 | |
| | > 12 | 0,056 | |

ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus, ChemSet™ Epcon™ G5 PRO for rebar connection

Product description
Rebar and materials

Annex A 3

Specifications of intended use

Anchorage subject to:

- Static and quasi-static loading: rebar \varnothing 8 to \varnothing 40
- Seismic loading: rebar \varnothing 12 to \varnothing 40
- Fire exposure

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 for static and quasi-static loading
- Strength classes C16/20 to C50/60 according to EN 206:2013 for seismic loading
- 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 $+80^{\circ}\text{C}$ (max. short. term temperature $+80^{\circ}\text{C}$ and max. long term temperature $+50^{\circ}\text{C}$)

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 for static and quasi-static action according to EN 1992-1-1 and for seismic action according to EN 1998-1.
- Design for resistance to fire according to 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, dustless 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).

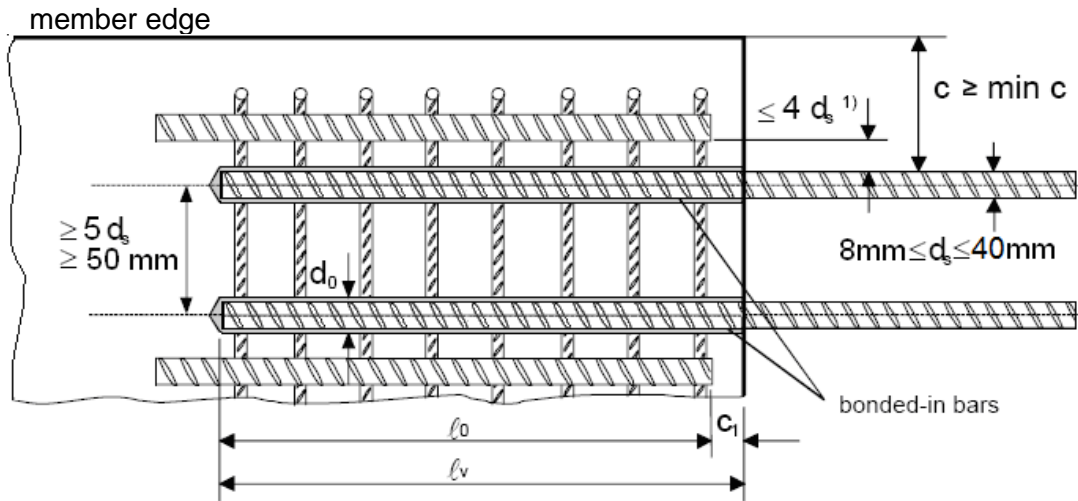
**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
ChemSet™ Epcon™ G5 PRO for rebar connection**

**Intended use
Specifications**

Annex B 1

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 $\geq l_0 + c_1$
- d_0 nominal drill bit diameter, see Table B2

**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
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Intended use
General design rules of construction

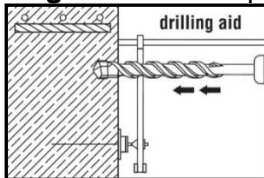
Annex B 2

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 dustless drilling or diamond drilling | < 25 mm | 30 mm + 0,06 $l_v \geq 2 \phi$ | 30 mm + 0,02 $l_v \geq 2 \phi$ |
| | ≥ 25 mm | 40 mm + 0,06 $l_v \geq 2 \phi$ | 40 mm + 0,02 $l_v \geq 2 \phi$ |
| Compressed air drilling | < 25 mm | 50 mm + 0,08 l_v | 50 mm + 0,02 l_v |
| | ≥ 25 mm | 60 mm + 0,08 $l_v \geq 2 \phi$ | 60 mm + 0,02 $l_v \geq 2 \phi$ |

The minimum concrete cover according to EN 1992-1-1 shall be observed. For rebar under seismic loading, apply the same minimum concrete value following that of table B1 and $c_{min,seis} = 2 \phi$.

Figure B2: Example of drilling aid



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

Minimum anchorage length

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

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

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

Minimum lap length

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

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

$l_{0,min}$ = 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 $d_{nom}^1)$ [mm] | Nominal drilling diameter d_{cut} [mm] | Max permissible embedment depth l_v [mm] |
|--|--|--|
| 8 | 12 | 400 |
| 10 | 14 | 500 |
| 12 | 16 | 600 |
| 14 | 18 | 700 |
| 16 | 20 | 800 |
| 18 | 22 | 900 |
| 20 | 25 | 1000 |
| 22 | 28 | 1000 |
| 24 | 32 | 1000 |
| 25 | 32 | 1000 |
| 26 | 32 | 1000 |
| 28 | 35 | 1000 |
| 32 | 40 | 1000 |
| 40 | 55 | 1000 |

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

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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: Brush

| Sizes | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø18 | Ø20 | Ø22 | Ø24 | Ø25 | Ø26 | Ø28 | Ø32 | Ø40 |
|---|----------------|----------------|-------|-------|-------|-------|-------|-------|-----|-------|-----|-------|-------|-----|
| Drill hole diameter d ₀ [mm] | 12 | 14 | 16 | 18 | 20 | 22 | 25 | 28 | 32 | 32 | 32 | 35 | 40 | 55 |
| Steel brush diameter [mm] | S12HF S13HF | S14HF S15HF | S18HF | S22HF | S24HF | S27HF | S31HF | S35HF | | S38HF | | S43HF | S58HF | |
| 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 |
|-----------------|--|-----------------|
| 460 mm | Brush head unit + handle unit | (a)+(b) |
| 780 mm | Brush head unit + extension piece + handle unit | (a)+(c)+(b) |
| 1100 mm | Brush head unit + 2x extension piece + handle unit | (a)+(c)+(c)+(b) |

Part (a)



Part (b)



Part (c)



Table B5: Extension hose for deep holes

| Sizes | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø18 | Ø20 | Ø22 | Ø24 | Ø25 | Ø26 | Ø28 | Ø32 | Ø40 |
|---------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Hole diameter [mm] | 12 | 14 | 16 | 18 | 20 | 22 | 25 | 28 | 32 | 32 | 32 | 35 | 40 | 55 |
| Extension hose [mm] | 9 | | 14 | | | | | | | | | | | |
| Resin stopper [mm] | - | - | - | - | 18 | 22 | 30 | | 36 | | 50 | | | |

ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus, ChemSet™ Epcon™ G5 PRO for rebar connection

Intended use
Processing and Load time
Brush, Extension hose for deep holes

Annex B 4

Table B6: Applicator gun

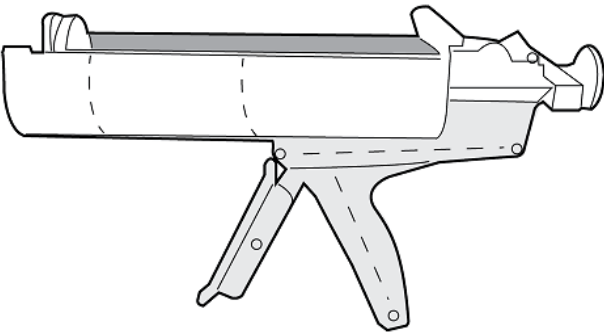
A



A1



B



| Applicator gun | A (A1) | B |
|----------------|-------------------|------------------------|
| Cartridge | Coaxial 600 ml | Side by side 450 ml |

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Intended use
Applicator gun

Annex B 5

Drilling the hole

Drill hole to the require embedment depth using one of the following:

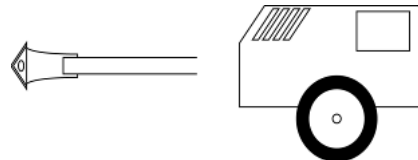
- Hammer drill (HD) with a carbide drill bit set in rotation hammer mode
- Hammer drill with the specified hollow drill bit (HDB) set in hammer mode
- Core drill machine with a diamond core drill bit (DD)
- Compressed air drilling (CA)

Before drilling remove carbonized concrete.

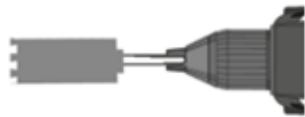
In case of aborted drill hole the drill hole shall be filled with mortar.



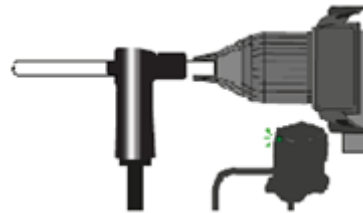
Rotary hammer drilling



Compressed air drill



Diamond core drilling

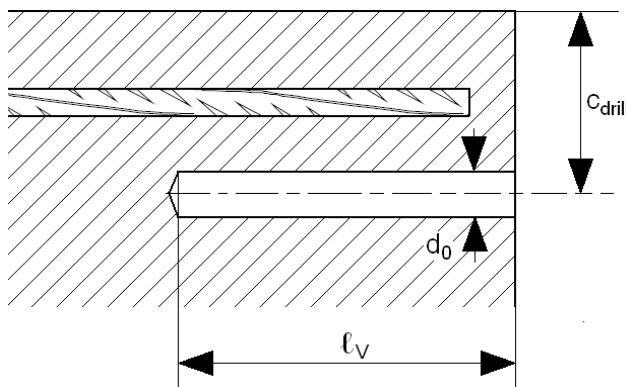


Hollow drill bit (Dustless drilling)

HDB – Hollow Drill Bit System

Heller Duster Expert hollow drill bit
 SDS-Plus $\leq 16\text{mm}$
 SDS-Max $\geq 16\text{mm}$

Class M vacuum
 Minimum flow rate $266\text{ m}^3/\text{h}$ (74 l/s)



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

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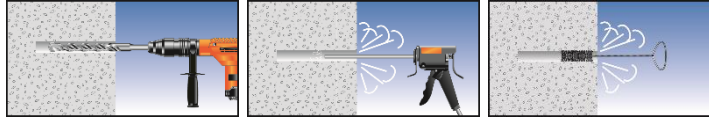
Intended use
 Installation instructions I

Annex B 6

Cleaning the hole

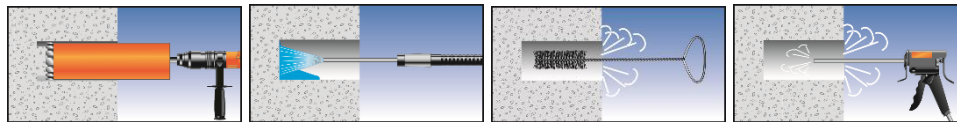
The borehole must be free of dust, debris, water, ice, oil, grease and other contaminants prior to mortar injection.

Hammer drilling (HD) or Compressed air drilling (CA)



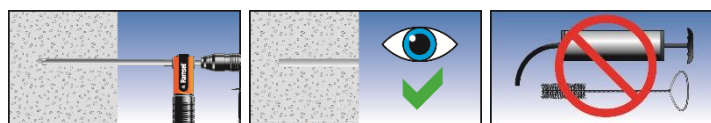
1. After drilling the hole, Blow 2 times from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticed dust. Repeat this action twice.
2. Selecting the appropriate brush and extension if necessary, insert the brush to the bottom of the hole and firmly withdraw with a twisting motion. There should be positive interaction between the bristles of the brush and the side of the hole otherwise a new brush should be chosen. Repeat this action twice.
3. Repeat operation 1 and 2.
4. Perform the blowing operation 1 time again with compressed air until return air stream is free of noticeable dust.

Diamond core drilling (DD)



1. After drilling the hole, starting from the back of the hole, flush with pressurised water a minimum of two times and until there is only clean water.
2. Selecting the appropriate brush and extension if necessary, insert the brush to the bottom of the hole and firmly withdraw with a twisting motion. There should be positive interaction between the bristles of the brush and the side of the hole otherwise a new brush should be chosen. Perform the brushing operation twice.
3. Repeat operation 1 and 2.
4. Blow 2 times from the back of the hole with oil-free compressed air (min. 6 bar) until return air stream is free of noticed dust. Repeat this action twice.

Hammer drilling with hollow drill bit (HDB)



1. Use the specified hollow drill bit and follow the manufacturers instruction. Ensure the vacuum system is on.
2. After drilling the hole, perform a visual inspection to ensure the system has worked correctly and that no debris remains.

No further cleaning process is necessary.

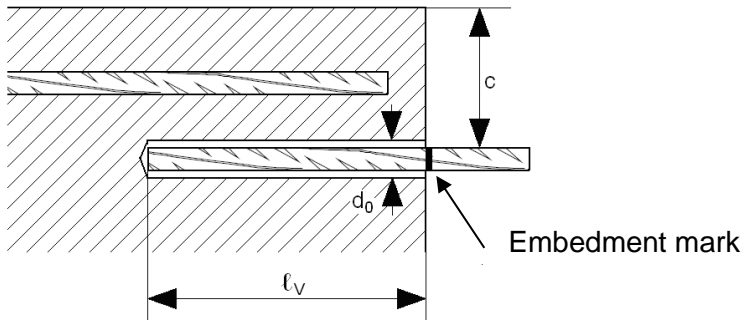
**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
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Intended use
Installation instructions II

Annex B 7

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

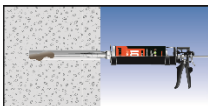
- Check expiration date: See imprint on cartridge. Do not use an expired product
- Cartridge temperature:
Must be between $+10^{\circ}\text{C}$ and $+40^{\circ}\text{C}$ when in use
- Base material temperature at time of installation:
Must be between $+5^{\circ}\text{C}$ and $+40^{\circ}\text{C}$
- Instructions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

Select the appropriate static mixer nozzle for the installation, open the cartridge 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.



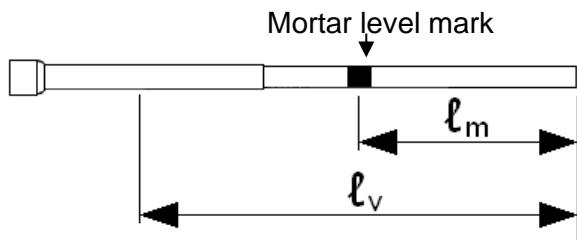
Insert the mixer nozzle (resin stopper / extension tube if applicable) to the bottom of the hole. Begin to extrude the resin and slowly withdraw the mixer nozzle from the hole ensuring that there are no air voids as the mixer nozzle is withdrawn. Fill the hole to approximately $\frac{1}{2}$ to $\frac{3}{4}$ full and remove the mixer nozzle completely.

**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
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Intended use
Installation instructions III

Annex B 8

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: $l_m = 1/2 \cdot l_v$

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.

**ChemSet™ Reo502™ Plus, ChemSet™ Epcon™ C6 Plus,
ChemSet™ Epcon™ G5 PRO for rebar connection**

Intended use
Installation instructions IV

Annex B 9

Design bond strength of post-installed rebar $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ under static loading for working life 50 and 100 years for hammer or dustless drilling

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

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 or dustless 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/mm ²] | 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/mm ²] | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | | |
| Rebar Ø 40 | | | | | | | | | |
| 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 | 0,86 | 0,76 | 0,69 | 0,63 | 0,58 | 0,54 |
| $f_{bd,PIR}$ [N/mm ²] | 1,5 | 1,8 | 2,1 | | | | | | |

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 18 | | 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 22 | | 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 | 1,1 | 1,2 | 1,3 |
| Ø 32 | | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,1 | 1,2 | 1,3 |
| Ø 40 | | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |

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Performances

Design values of the ultimate bond resistance for hammer drilling

Annex C 1

Design bond strength of post-installed rebar $f_{bd,PIR}$ and $f_{bd,PIR,100y}$ under static loading for working life 50 and 100 years for diamond core drilling

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

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/mm ²] | 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/mm ²] | 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/mm ²] | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | | | |
| Rebar Ø 40 | | | | | | | | | |
| 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 | 0,86 | 0,76 | 0,69 | 0,63 | 0,58 | 0,54 |
| $f_{bd,PIR}$ [N/mm ²] | 1,5 | 1,8 | 2,1 | | | | | | |

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 40 | $\alpha_{lb} = \alpha_{lb,100y}$ | 1,5 |

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Performances

Design values of the ultimate bond resistance for diamond core drilling

Annex C 2

Design bond strength of post-installed rebar $f_{bd,PIR,seis}$ and $f_{bd,PIR,100y,seis}$ under seismic loading for working life 50 and 100 years for hammer or dustless drilling

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

$k_{b,seis}$ = reduction factor for seismic loading

f_{bd} = design bond strength of cast-in rebar according to EN 1992-1-1

Table C5: Values of the design bond strength of post installed rebar $f_{bd,PIR,seis} = f_{bd,PIR,100y,seis}$ with reduction factor $k_{b,seis} = k_{b,100y,seis}$ under seismic loading for hammer or dustless drilling methods for good bond conditions

| Rebar Ø 12 to Ø 28 | | | | | | | | |
|--|--------|--------|--------|--------|--------|--------|--------|--------|
| Concrete class | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| $k_{b,seis}$ [-] | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| $f_{bd,PIR,seis}$ [N/mm ²] | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,3 |
| Rebar Ø 32 | | | | | | | | |
| Concrete class | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| $k_{b,seis}$ [-] | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 0,92 | 0,86 |
| $f_{bd,PIR,seis}$ [N/mm ²] | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | | |
| Rebar Ø 40 | | | | | | | | |
| Concrete class | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| $k_{b,seis}$ [-] | 1,0 | 1,0 | 0,86 | 0,76 | 0,69 | 0,63 | 0,58 | 0,54 |
| $f_{bd,PIR,seis}$ [N/mm ²] | 1,8 | 2,1 | | | | | | |

Tabulated values are valid for good bond conditions according to EN 1992-1-1.

If Nationally Determined Parameter for α_{ct} differs from the recommended value given in EN 1992-1-1, f_{bd} shall be multiplied with α_{ct} .

If Nationally Determined Parameter for γ_c differs from the recommended value given in EN 1992-1-1, f_{bd} shall be multiplied with $1,5/\gamma_c$.

For all other than good bond conditions f_{bd} shall be multiplied with η_1 according to EN 1992-1-1, section 8.4.2.

For the minimum concrete cover see Annex B 3.

Table C6: Amplification factor for minimum anchorage length for hammer or dustless drilling methods

| Rebar | Amplification factor | Concrete class | | | | | | | |
|-------|----------------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|
| | | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| Ø 12 | $\alpha_{lb} = \alpha_{lb,100y}$ | 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 |
| Ø 16 | | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| Ø 18 | | 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 |
| Ø 22 | | 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 |
| Ø 25 | | 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 |
| Ø 28 | | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,1 | 1,2 | 1,3 |
| Ø 32 | | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 | 1,1 | 1,2 | 1,3 |
| Ø 40 | | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |

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Performances

Design values of the ultimate bond strength under seismic loading for hammer or dustless drilling

Annex C 3

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

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

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

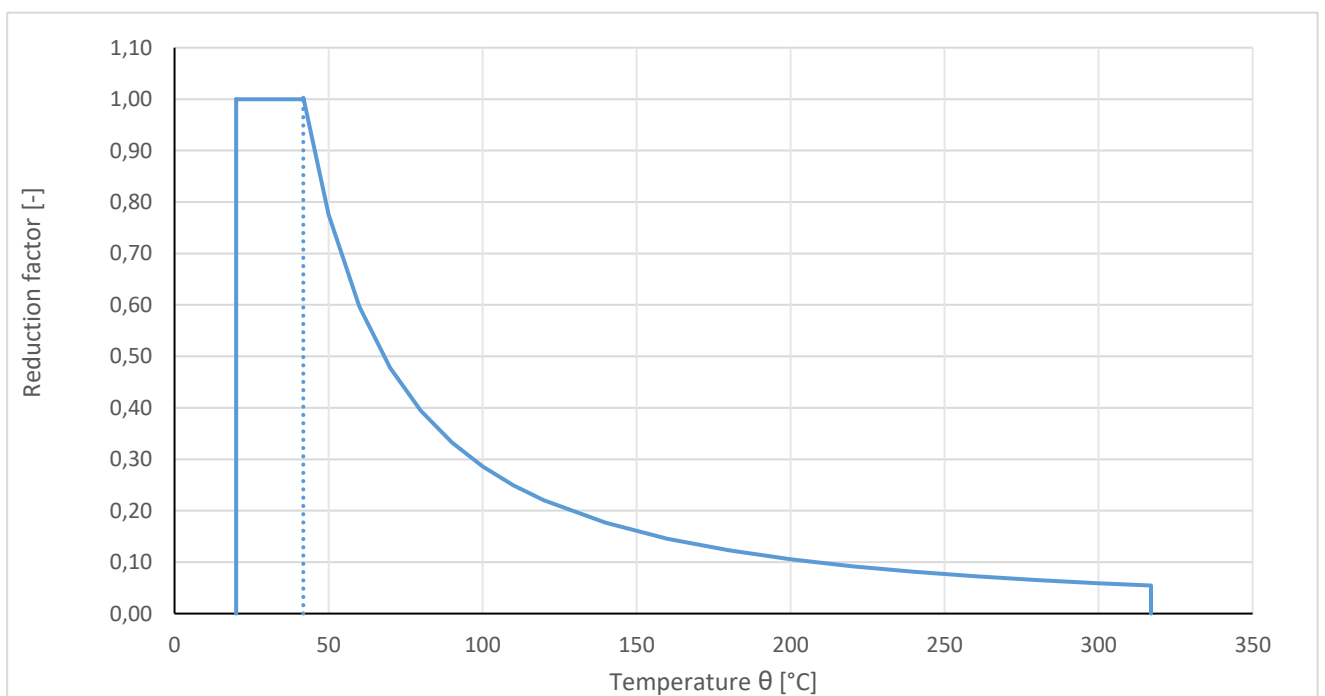
where: $\theta \leq 317^\circ\text{C}$ $k_{b,fi}(\theta) = 2150 \cdot \theta^{-1,438} / (f_{bd,PIR} \cdot 4,3) \leq 1$
 $\theta > 317^\circ\text{C}$ $k_{b,fi}(\theta) = 0$

with:

- $k_{b,fi}(\theta)$ reduction factor in case of fire
- (θ) temperature in °C in the mortar layer
- $f_{bd,PIR}$ design value of the bond strength in N/mm² according to Table C1 considering the concrete class, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2004+AC:2010
- γ_c partial safety factor according to EN 1992-1-1:2004+AC:2010
- $\gamma_{M,fi}$ partial safety factor according to EN 1992-1-2:2004+AC:2008+A1:2019

The anchorage length shall be determined in accordance with EN 1992-1-1:2004+AC:2010 equation (8.3) using the bond strength $f_{bd,fi}(\theta)$.

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



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Performances
Essential characteristics under fire exposure

Annex C 4