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Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011

MEMBER OF EOTA

European Technical Assessment ETA-25/0648 of 2026/03/03

I General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011: ETA-Danmark A/S

Trade name of the construction product:	Ramset ChemSet™ Reo 502 Xtrem™ Ramset ChemSet™ Epcon G5 Xtrem™
Product family to which the above construction product belongs:	Bonded fastener with threaded rods or rebars for use in concrete for a working life of 50 and 100 years
Manufacturer:	ITW Construction Asia Pacific (Ramset) 1 Ramset Drive Chirnside Park VIC 3116 Australia
Manufacturing plant:	ITW Construction Asia Pacific (Ramset) 1 Ramset Drive Chirnside Park VIC 3116 Australia
This European Technical Assessment contains:	36 pages including 29 annexes which form an integral part of the document
This European Technical Assessment is issued in accordance with Article 95(4) of Regulation (EU) 2024/3110, on the basis of:	EOTA EAD 330499-02-0601, "Bonded fasteners for use in concrete"
This version replaces:	The ETA with the same number issued on 2026-01-06

II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

1 Technical description of product

The Ramset ChemSet Reo 502 Xtrem / ChemSet Epcon G5 Xtrem fastening system is a bonded anchor (injectione type) for concrete consisting of a mortar with a threaded rod in sizes M10, M12, M16, M20, M24, M27 and M30, and rebar in sizes R10, R12, R16, R20, R25 and R32.
The threaded rod can be made of electroplated carbon steel, stainless steel or HCR.
The threaded rod or rebar is anchored via the bond between anchor rod or rebar, chemical mortar and concrete.

The product specification is given in Annex A.

The characteristic material values, dimensions and tolerances of the anchors not indicated in Annexes shall correspond to the respective values laid down in the technical documentation[1] of this European Technical Assessment.

2 Specification of the intended use in accordance with the applicable European Assessment Document (hereinafter 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 intended working life of the anchor of 50 and 100 years.

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, 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.

1 The technical documentation of this European Technical Assessment is deposited at ETA-Danmark and, as far as relevant for the tasks of the Notified bodies involved in the attestation of conformity procedure, is handed over to the notified bodies.

3 Performance of the product and references to the methods used for its assessment

Characteristic	Assessment of characteristic
3.1 Mechanical resistance and stability (BWR1)	
Characteristic resistance to tension load (static and quasi-static loading)	
Resistance to steel failure	**See Annex C**
Resistance to combined pull-out and concrete failure	**See Annex C**
Resistance to pull-out failure	**Not relevant**
Resistance to concrete cone failure	**See Annex C**
Edge distance to prevent splitting under load	**See Annex C**
Robustness	**See Annex C**
Maximum installation torque	**See Annex B**
Installation torque	**Not relevant**
Minimum edge distance and spacing	**See Annex B**
Characteristic resistance to shear load (static and quasi-static loading)	
Resistance to steel failure	**See Annex C**
Resistance to pry-out failure	**See Annex C**
Resistance to concrete edge failure	**See Annex C**
Displacements under short-term and long-term loading	
Displacements under short-term and long-term loading	**See Annex C**
Resistance in steel fibre reinforced concrete	**No Performance assessed**
Characteristic resistance and displacements for seismic performance categories C1 and C2	
Resistance to tension for seismic performance category C1	**See Annex C**
Resistance to tension and displacements for seismic performance category C2	**See Annex C**
Resistance to shear load for seismic performance category C1	**See Annex C**
Resistance to shear load and displacements for seismic performance categories C2	**See Annex C**

Characteristic	Assessment of characteristic
3.2 Safety in case of fire (BWR2)	
Reaction to fire	**Class A1**
Resistance to fire	
Fire resistance to steel failure under tension loading	**See Annex C**
Fire resistance to bond failure under tension loading	**See Annex C**
Fire resistance to steel failure under shear loading	**See Annex C**
3.3 Hygiene, health and the environment (BWR3)	
Content, emission and/or release of dangerous substances	**No performance assessed**

See additional information in section 3.9.

3.9 General aspects related to the performance of the product.

The European Technical Assessment is issued for the product on the basis of agreed data/information, deposited with ETA-Danmark, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to ETA-Danmark before the changes are introduced. ETA-Danmark will decide whether or not such changes affect the ETA and consequently the validity of the CE marking on the basis of the ETA and if so whether further assessment or alterations to the ETA, shall be necessary.

The assessment of fitness of the anchor for the intended use in relation to Basic Requirements has been made in accordance with EAD 330499-02-0601, “Bonded fasteners for use in concrete” option 1 and 7 and seismic C1 and C2 categories.

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

4.1 AVCP system

According to the decision 96/582/EC of the European Commission, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 1.

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

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking.

Issued in Copenhagen on 2026-03-03 by

Thomas Bruun
Managing Director, ETA-Danmark

Injection mortar
Epoxy adhesive two components

Ramset ChemSet™ Reo 502 Xtrem™
Ramset ChemSet™ Epcon G5 Xtrem™

Marking

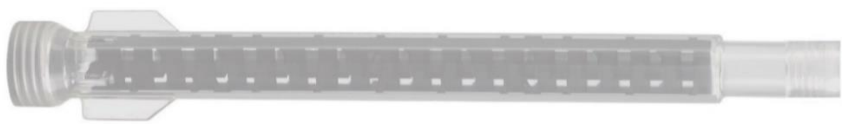
Trade name
ChemSet™ Reo 502 Xtrem™
ChemSet™ Epcon G5 Xtrem™
Identifying mark of the producer **Ramset**

Expire date
Curing and processing time
Charge code number

Static mixer

ISNE mixing nozzle

High flow mixing nozzle



RAMSET Chemset™ Reo 502 Xtrem™
RAMSET Chemset™ Epcon G5 Xtrem™

Product description
Injection system

Annex A1

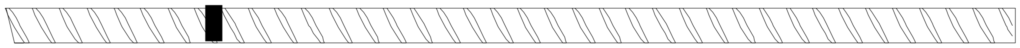
Product description : Steel elements and Injection mortar

Steel elements :

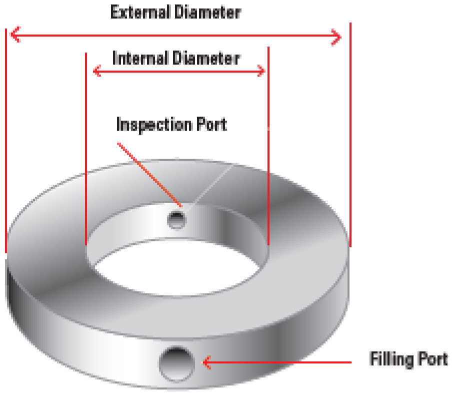
- Commercial standard threaded rods M10 to M30 with identifying mark of the embedment depth:
  - Electroplated carbon steel grade 5.8 to 10.9 (1) ,
  - Stainless steel A4
  - Steel HCR

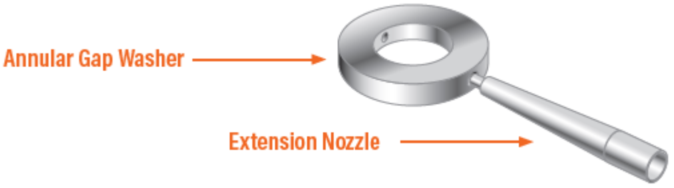
(1) : The commercial threaded rods for grade 10.9 have to verify elongation fractile lower than 15%.

Reinforcing bars ϕ10 to ϕ32 with materials and mechanical properties according to Table A4



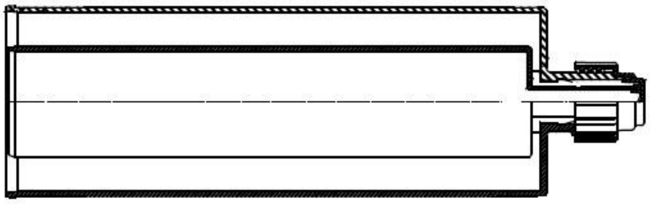
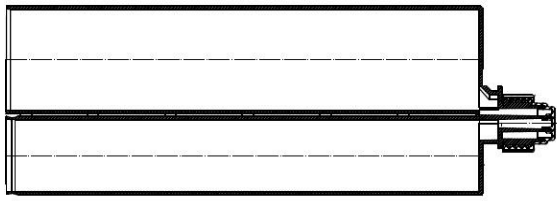
RAMSET Annular gap filling washer to fill the annular gap between steel element and fixture



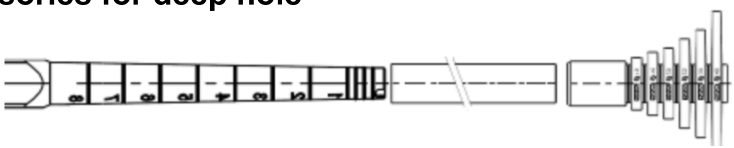


RAMSET Annular gap filling washer					
Size Studs	M10	M12	M16	M20	M24
Internal Diameter [mm]	12	14	17	21	25
External diameter [mm]	26	28	34	41	48
Thickness of filling washer [mm]	5	5	5	5	5
Coating	10 µm zinc plate				

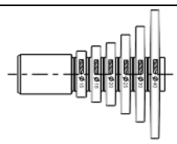
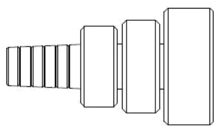
Cartridges

600 ml coaxial cartridge	
450ml side by side cartridge	

Injection accessories for deep hole



Plastic extension and piston plug for hole deeper h_0 > 250 mm and for overhead installation

Cartridge volume	Mixing Nozzle	Extension for piston plug	Piston plug
All cartridges	ISNE mixing nozzle or High flow mixing nozzle	Ø13x1000	
			

RAMSET Chemset™ Reo 502 Xtrem™
RAMSET Chemset™ Epcon G5 Xtrem™

Product description
Cartridges
Injection accessories for deep hole

Annex A3

Table A1: Materials

	Size	Material and EN/ISO reference
Steel elements – Zinc coated steel		
Threaded rods Grade 5.8	M10 to M30	Carbon steel grade 5.8 according to ISO 898-1 Electroplated zinc coated 5µm min. or Hot dip galvanized 45µm min.
Threaded rods Grade 8.8	M10 to M30	Carbon steel grade 8.8 according to ISO 898-1 Electroplated zinc coated 5µm min. or Hot dip galvanized 45µm min.
Threaded rods Grade 10.9*	M10 to M30	Carbon steel grade 10.9 (A% ≤ 15%) according to ISO 898-1 Electroplated zinc coated 5µm min. or Hot dip galvanized 45µm min. *Galvanized rod of high strength are sensitive to hydrogen induced brittle failure
Washer	-	Electroplated zinc coated 5µm min., or Hot dip galvanized 45µm min.
Nut	-	Strength class of nut adapted to strength class of threaded rod. Electroplated zinc coated 5µm min., or Hot dip galvanized 45µm min.
Steel elements – Stainless steel		
Threaded rods Grade A4-70	M10 to M30	Stainless steel A4-70 : 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 acc. EN 10088-1
Nut		Strength class of nut adapted to strength class of threaded rod., Stainless steel A4 according to EN 20898-2
Washer		Stainless steel A4 according to EN 20898-2
Steel elements – High resistance corrosion version (HCR)		
Threaded rods HCR	M10 to M30	Stainless steel HCR acc. EN 10088, 1.4529 / 1.4565 f_{uk} ≥ 650 MPa acc..EN 10088
Nut	-	Stainless steel HCR acc..EN 10088, 1.4529 / 1.4565 f_{uk} ≥ 650 MPa acc.EN 10088
Washer	-	Stainless steel HCR acc..EN 10088, 1.4529 / 1.4565 EN ISO 7089

Table A2 : Materials properties for reinforcing bars

(Refer to EN 1992-1-1 Annex C Table C.1 and C.2N)

Reinforcing bars ϕ10 to ϕ32		**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
Height of the rib h_{rib}		$0,05\ \phi \leq h_{rib} \leq 0,07\ \phi$	
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar or wire) (%)	Nominal bar size (mm) ≤ 8 > 8	± 6,0 ± 4,5	
Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	0,040 0,056	

Specifications of intended use

Anchorages subject to:

- Static, quasi-static loading : Threaded rods M10 to M30 , reinforcing bars ϕ10 to ϕ32 with Hammer drilling, compressed air drilling technique
  Threaded rods M12 to M30 , reinforcing bars ϕ12 to ϕ32 with diamond drilling technique
- Seismic loading Category C1 : Threaded rods M10 to M30 with Hammer drilling, and compressed air drilling technique
  Threaded rods M12 to M30 with diamond drilling technique
- Seismic loading Category C2 : Threaded rods M10 to M30 with Hammer drilling, and compressed air drilling technique
  Threaded rods M12 to M30 with diamond drilling technique
- Fire exposure : Threaded rods M10 to M30

Base material:

- Reinforced or unreinforced normal weight concrete of strength classes C20/25 to C90/105 according to EN 206
- Cracked and uncracked concrete

Temperature range:

- At installation : 5°C to +40°C
- In service :

  Temperature range I : - 40°C to +40°C,
  [max short term temperature +40°C, max long term temperature +24°C]

  Temperature range II : - 40°C to +60°C,
  [max short term temperature +60°C, max long term temperature +36°C]

  Temperature range III : - 40°C to +75°C,
  [max short term temperature +75°C, max long term temperature +45°C]

Use conditions (Environmental conditions)

- Structures subject to dry internal conditions (all materials).
- For all other conditions according EN 1993-1-4 corresponding to corrosion resistance classes Annex A (stainless steel and high corrosion resistant steel (HCR)).

Design:

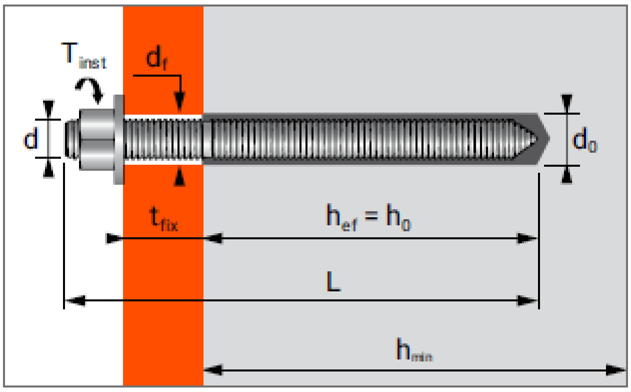
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- The fasteners are designed in accordance with EN 1992-4 and EOTA Technical Report 086. Fasteners under seismic actions shall be positioned outside of critical regions (e.g., plastic hinges) of the concrete structure. Fastening in stand-off installation or with a grout layer under seismic action are not covered in this European technical assessment (ETA).
- For applications with resistance to fire exposure, the fasteners are designed in accordance with EOTA TR 082 “Design of bonded fasteners in concrete under fire conditions”

Installation:

- Use category:
  - Dry, wet (use category 1) and flooded holes (use category 2) for Hammer drilling technique, compressed air drilling and diamond drilling technique
  - Installation direction downwards, horizontal and overhead
- Drilling technique:
  - Hammer drilling technique: Threaded rods M10 to M30 , rebar ϕ10 to ϕ32
  - Compressed air drilling: Threaded rods M10 to M30 , rebar ϕ10 to ϕ32
  - Diamond drilling technique: Threaded rods M12 to M30 , rebar ϕ12 to ϕ32
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor.
- Anchor installation in accordance with the manufacturer’s specifications and drawings and using the appropriate tools
- Effective anchorage depth, edge distances and spacing not less than the specified values without minus tolerances.

In case of aborted hole, drilling of new hole at a minimum distance away of twice the depth of the aborted hole, or smaller distance provided that the aborted drill hole is filled with high strength mortar and no shear or oblique tension loads in the direction of aborted hole.

Table B1 : Installation data with standard, minimum and maximum embedment depth for threaded rods



Nominal diameter	Ø d_0 Nominal diameter of the drill bit	d_f Clearance hole in the fixture	T_{inst} Tightening torque	$h_{ef} = h_0$ Effective embedment depth and drill hole depth		h_{min} minimum thickness of the concrete member
				Minimum	Maximum	
	[mm]	[mm]	[N.m]	[mm]	[mm]	[mm]
M10	12	12	20	60	200	h_{ef} + 30 ≥ 100 mm
M12	14	14	30	70	240	
M16	18	18	60	80	320	$h_{ef} + 2d_0$
M20	25	22	120	90	400	
M24	28	26	150	96	480	
M27	30	30	165	108	540	
M30	35	33	180	120	600	

Table B2 : Minimum spacing and edge distances for threaded rods

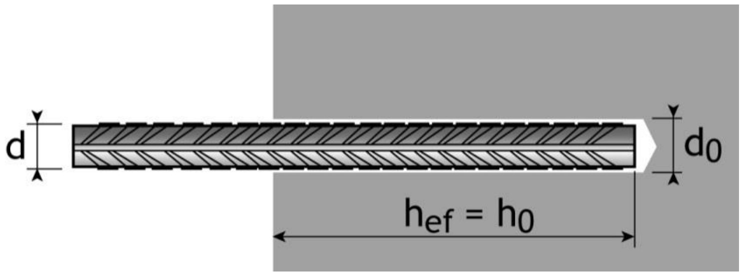
			Threaded rods						
			M10	M12	M16	M20	M24	M27	M30
Minimum spacing	s_{min}	[mm]	40	50	70	85	90	115	140
Minimum edge distance	c_{min}	[mm]	40	40	45	55	60	75	90

RAMSET Chemset™ Reo 502 Xtrem™
RAMSET Chemset™ Epcon G5 Xtrem™

Intended used
Installation parameters for threaded rods

Annex B3

Table B3 : Installation data with standard, minimum and maximum embedment depth for reinforcing bars



Nominal diameter	Ø d_0 Nominal diameter of the drill bit	$h_{ef} = h_0$ Effective embedment depth and drill hole depth		h_{min} minimum thickness of the concrete member
		Minimum	Maximum	min
	[mm]	[mm]	[mm]	[mm]
Ø10	12	60	200	h_{ef} + 30 ≥ 100 mm
Ø12	15	70	240	
Ø16	20	80	320	$h_{ef} + 2d_o$
Ø20	25	90	400	
Ø25	30	100	500	
Ø32	40	128	640	

Table B4 : Minimum spacing and edge distances for reinforcement bars

			Reinforcing bars					
			Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Minimum spacing	s_{min}	[mm]	40	50	70	85	90	140
Minimum edge distance	c_{min}	[mm]	40	40	45	55	60	90

Table B5: Gel time and curing time

Temperature of base material	Working time	Curing time[1)]
5°C	75 min	30 h
10°C	45 min	22 h
15°C	35 min	14 h
20°C	22 min	7 h
25°C	14 min	5 h
30°C	8 min	4 h
35°C	6 min	3 h
40°C	4 min	2 h 45 min

[1)] For wet concrete and diamond core drilling method, the curing time must be doubled

Table B6 : Dimensions of the cleaning tools for threaded rods

Threaded rods							
Dimensions	M10	M12	M16	M20	M24	M27	M30
Ø drilled hole [mm] Drill bit or diamond core	12	14	18	25	28	30	35
Ø Brush [mm] 	13	15	20	26	30	32	37

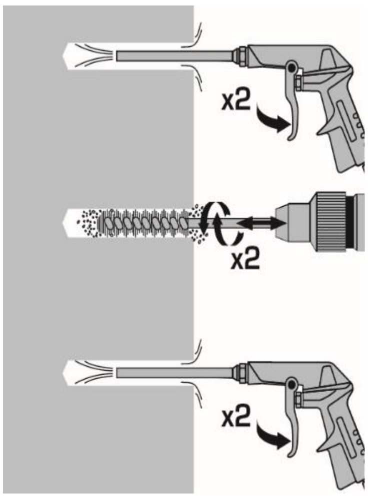
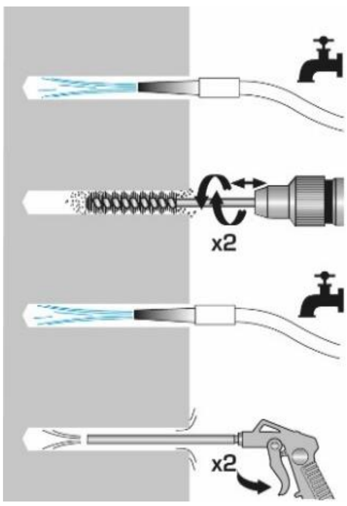
Table B7 : Dimensions of the cleaning tools for reinforcing rebars

Reinforcing rebars						
Dimensions	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Ø drilled hole [mm] Drill bit or diamond core	12	15	20	25	30	40
Ø Brush [mm] 	13	16	22	26	32	42

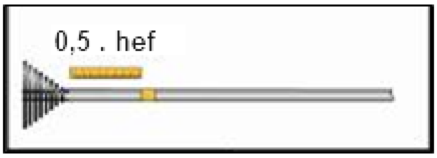
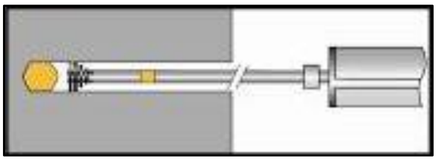
Drilling the hole:

Hammer drilling or compressed air drilling technique	
	Drill hole to the required embedment depth with a hammer drill set in rotation-hammer mode using an appropriately sized carbide drill bit (See Table B6 / B7)
Diamond core drilling technique	
	Diamond coring is permissible when suitable diamond core drilling machines and the corresponding core bits are used (See Table B6/ B7)

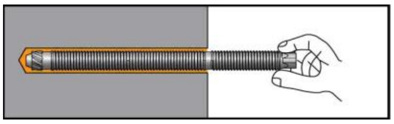
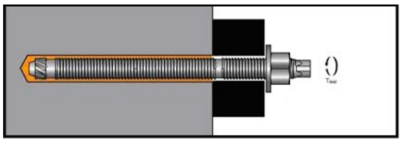
Cleaning the hole:

Hammer drilling or compressed air drilling technique	
	1. Using compress air cleaning (min 6 bars), use the appropriate plastic extension for compressed air cleaning, 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). 2. Using the relevant brush and extension fitted on a Ramset drilling machine, starting from the top of the hole, move downward to the bottom of the hole then moving upward to the top of the hole. Repeat this operation. 3.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).
Diamond core drilling technique	
	1. Clean the hole with tap water with a pipe adapted to enter in the hole. Starting from the top of the hole, move downward to the bottom of the hole then move upward to the top of the hole until water is becoming clear. 2. Using the relevant brush and extension fitted on a Ramset drilling machine, starting from the top of the hole, move downward to the bottom of the hole then moving upward to the top of the hole. Repeat this operation. 3. Clean the hole with tap water with a pipe adapted to enter in the hole. Starting from the top of the hole, move downward to the bottom of the hole then move upward to the top of the hole until water is becoming clear. 4. 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).

Dispensing into the hole:

 	1. Dispense the first part to waste until an even colour is achieved (≈ 5 cm). 2. For hole deeper h_0 > 250 mm and also for overhead installations, the injection is only possible with the using of piston plug, and plastic extension. 3. Cut the piston plug at the relevant diameter. The volume of resin that needs to be injected in the hole must be indicated on the mixing nozzle or its extension. The marking must be placed at 0.5 times the anchorage depth 4. 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 50% of the drill hole to ensure enough adhesive volume between concrete and reinforcing bar. For pneumatic dispenser, the maximum pressure is 6 bars.

Inserting the steel element :

	1. Immediately insert the studs or rebars, 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 which varies according to temperature of base material (See Table B5). Don’t disturb anchor between specified cure time.
	2. After curing time (See Table B5), attach the fixture and tight the nut at the specified torque (See Table B1).

Safety precaution:

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

- Storage temperature of cartridge +5°C to +35 °C
- Cartridge temperature at time of installation: Must be ≥ +5°C
- Base material temperature at time of installation: Must be between 5°C and +40°C
- Check the date of expiry of the cartridge

RAMSET Chemset™ Reo 502 Xtrem™ RAMSET Chemset™ Epcon G5 Xtrem™	**Annex B8**
Product description Installation instructions	

Table C1 : Essential characteristic for threaded rods under tension load in concrete

Threaded rod			M10	M12	M16	M20	M24	M27	M30
For working life of 50 years and 100 years									
Steel failure									
Characteristic resistance – Commercial threaded rods	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$						
Partial safety factor Commercial threaded rods	$\gamma_{Ms,N}$ 1)	[-]	$1{,}2.f_{uk}/f_{yk} \geq 1{,}4$						
Steel grade 5.8	$N_{Rk,s}$	[kN]	29,0	42,2	78,5	122,5	176,5	229,5	280,5
Steel grade 8.8			46,4	67,4	125,6	196,0	282,4	367,2	448,8
Steel grade 10.9			60,3	87,7	163,0	255,0	367,0	477,0	583,0
Stainless Steel grade A4-70			40,6	59	109,9	171,5	247,1	321,3	392,7
HCR Steel 1.4529			40,6	59	109,9	171,5	247,1	321,3	392,7
HCR Steel 1.4565			40,6	59	109,9	171,5	247,1	321,3	392,7
Partial safety factor Grade 5.8, 8.8, 10.9	$\gamma_{Ms,N}$ 1)	[-]	1,5						
Partial safety factor Stainless Steel grade A4-70			1,87						
Partial safety factor HCR Steel 1.4529			1,5						
Partial safety factor HCR Steel 1.4565			1,87						
Installation factor									
Hammer drilling for dry and wet holes	γ_{inst}	[-]	1,0						
Hammer drilling for flooded holes	γ_{inst}	[-]	1,2	1,4					
Diamond drilling for dry and wet holes	γ_{inst}	[-]	1,2						
Diamond drilling for flooded holes	γ_{inst}	[-]	1,2						
Concrete cone failure									
Factor for cracked concrete	$K_{cr,N}$	[-]	7,7						
Factor for uncracked concrete	$K_{ucr,N}$	[-]	11,0						
Edge distance	$C_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$						
Spacing	$S_{cr,N}$	[mm]	$3{,}0 \cdot h_{ef}$						
Splitting failure									
Edge distance $C_{cr,sp}$ [mm] for	$h/h_{ef} \geq 2{,}4$		$1.0.h_{ef}$						
	$2{,}4 > h/h_{ef} > 1{,}4$		$4{,}6.h_{ef} – 1{,}5.h$						
	$h/h_{ef} \leq 1{,}4$		$2{,}5.h_{ef}$						
Spacing	$S_{cr,sp}$	[mm]	$2 \cdot C_{cr,sp}$						

1) In absence of national regulations

Table C1 (Continued) : Essential characteristic for threaded rods under tension load in concrete under static and quasi static loading

Threaded rod			M10	M12	M16	M20	M24	M27	M30
For working life of 50 years and 100 years									
Combined pull-out and concrete cone failure									
Characteristic bond resistance in uncracked concrete C20/25 with HAMMER DRILLING									
Dry and wet holes									
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	17,1	16,3	15,1	14,2	13,5	13,1	12,7
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	14,5	13,8	12,8	12,0	11,4	11,1	10,8
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4,5	4,3	3,9	3,7	3,5	3,4	3,3
Flooded holes									
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	17,1	16,3	15,1	14,0	12,7	11,9	11,2
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	14,5	13,8	12,8	11,8	10,7	10,1	9,5
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4,5	4,3	3,9	3,7	3,3	3,1	2,9
Influence of concrete factor on bond strength $\tau_{Rk,uncr}$ in uncracked concrete									
Temperature range I, II and III : $\Psi c = (f_{ck}/20)^m$	m	[-]	0,20	0,20	0,30	0,30	0,40	0,40	0,40
Characteristic bond resistance in cracked concrete C20/25 with HAMMER DRILLING									
Dry and wet holes									
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	6,6	9,2	9,6	9,7	9,5	9,3	9,2
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	5,6	7,8	8,1	8,2	8,0	7,9	7,8
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	1,7	2,4	2,5	2,5	2,5	2,4	2,4
Flooded holes									
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	6,6	9,2	9,6	9,7	8,9	8,3	8,1
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	5,6	7,8	8,1	8,2	7,5	7,2	6,9
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	1,7	2,4	2,5	2,5	2,3	2,2	2,1
Temperature range I, II and III : $\Psi c = (f_{ck}/20)^m$	m	[-]	0,10	0,10	0,10	0,20	0,20	0,20	0,30
Influence of sustained load									
Temperature range I: **24°C / 40°C**	$\Psi^0_{sus,100}$	[-]	0,72						
Temperature range II: **36°C / 60°C**	$\Psi^0_{sus,100}$	[-]	0,72						
Temperature range III: **45°C / 75°C**	$\Psi^0_{sus,100}$	[-]	0.91						

Table C1 (Continued): Essential characteristic for threaded rods under tension load in concrete under static and quasi static loading

Threaded rod			M12	M16	M20	M24	M27	M30
For working life of 50 years and 100 years								
Combined pull-out and concrete cone failure								
Characteristic bond resistance in uncracked concrete C20/25 with DIAMOND DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	15,8	13,9	12,6	11,6	11,0	10,5
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	13,5	11,8	10,7	9,8	9,3	8,9
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4,1	3,6	3,3	3,0	2,9	2,7
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	15,8	13,9	12,6	11,6	11,0	10,5
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	13,5	11,8	10,7	9,8	9,3	8,9
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4,1	3,6	3,3	3,0	2,9	2,7
Influence of concrete factor on bond strength $\tau_{Rk,uncr}$ in uncracked concrete								
Temperature range I, II and III : $\Psi c = (f_{ck}/20)^m$	m	[-]	0,00	0,00	0,00	0,10	0,20	0,50
Characteristic bond resistance in cracked concrete C20/25 with DIAMOND DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	6,4	6,7	7,5	7,3	7,2	7,1
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	5,4	5,7	6,4	6,2	6,1	6,0
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	2,0	1,9	1,9	1,9	1,9	1,8
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	6,4	6,7	7,5	7,3	7,2	7,1
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	5,4	5,7	6,4	6,2	6,1	6,0
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	2,0	1,9	1,9	1,9	1,9	1,9
Influence of concrete factor on bond strength $\tau_{Rk,cr}$ in cracked concrete								
Temperature range I, II and III : $\Psi c = (f_{ck}/20)^m$	m	[-]	0,10	0,10	0,20	0,30	0,40	0,50
Influence of sustained load								
Temperature range I: **24°C / 40°C**	$\Psi^0_{sus,100}$	[-]	0.72					
Temperature range II: **36°C / 60°C**	$\Psi^0_{sus,100}$	[-]	0.72					
Temperature range III: **45°C / 75°C**	$\Psi^0_{sus,100}$	[-]	0.91					

Table C2 : Essential characteristic for reinforcing bars under tension load in concrete

Reinforcing bar			ϕ10	ϕ12	ϕ16	ϕ20	ϕ25	ϕ32
For working life of 50 years and 100 years								
Steel failure								
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s . f_{uk}$					
Characteristic resistance rebar Fe E500 according to EN 1992-1-1	$N_{Rk,s}$	[kN]	42,4	61,1	108,6	169,6	265,1	434,3
Partial safety factor rebar Fe E500 according to EN 1992-1-1	$\gamma_{Ms,N}$	[-]	1,4					
Installation factor								
Hammer drilling for dry and wet holes	γ_{inst}	[-]	1,0					
Hammer drilling for flooded holes	γ_{inst}	[-]	1,0				1,4	
Diamond drilling for dry and wet holes	γ_{inst}	[-]	1,0					
Diamond drilling for flooded holes	γ_{inst}	[-]	1,0				1,4	
Concrete cone failure								
Factor for cracked concrete	$K_{cr,N}$	[-]	7,7					
Factor for uncracked concrete	$K_{ucr,N}$	[-]	11,0					
Edge distance	$C_{cr,N}$	[mm]	$1,5 . h_{ef}$					
Spacing	$S_{cr,N}$	[mm]	$3,0 . h_{ef}$					
Splitting failure								
Edge distance $C_{cr,sp}$ [mm] for	$h/h_{ef} \geq 2,4$		$1.0.h_{ef}$					
	$2,4 > h/h_{ef} > 1,4$		$4,6.h_{ef} – 1,5.h$					
	$h/h_{ef} \leq 1,4$		$2,5.h_{ef}$					
Spacing	$S_{cr,sp}$	[mm]	$2 . C_{cr,sp}$					
Influence of sustained load								
Temperature range I: **24°C / 40°C**	$\Psi^0_{sus,100}$	[-]	0,72					
Temperature range II: **36°C / 60°C**	$\Psi^0_{sus,100}$	[-]	0,72					
Temperature range III: **45°C / 75°C**	$\Psi^0_{sus,100}$	[-]	0,91					

Table C2 (Continued) : Essential characteristic for reinforcing bars under tension load in concrete under static and quasi static loading

Reinforcing bar			ϕ10	ϕ12	ϕ16	ϕ20	ϕ25	ϕ32
For working life of 50 years and 100 years								
Combined pull-out and concrete cone failure								
Characteristic bond resistance in uncracked concrete C20/25 with HAMMER DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	14,5	14,5	14,4	14,4	14,3	14,3
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	12,3	12,2	12,2	12,2	12,1	12,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	3,8	3,8	3,8	3,8	3,7	3,7
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	14,5	14,5	14,4	14,2	13,4	13,0
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	12,3	12,2	12,2	12,0	11,4	11,0
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	3,8	3,8	3,8	3,7	3,5	3,4
Influence of concrete factor on bond strength $\tau_{Rk,uncr}$ in uncracked concrete								
Temperature range I and II $\Psi c = (f_{ck}/20)^m$	m	[-]	0,00	0,05	0,05	0,05	0,10	0,10
Characteristic bond resistance in cracked concrete C20/25 with HAMMER DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	10,8	10,6	10,4	10,2	10,1	9,9
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	9,1	9,0	8,8	8,7	8,5	8,4
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	2,8	2,8	2,7	2,7	2,6	2,6
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	10,8	10,6	10,4	10,1	9,5	9,0
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	9,1	9,0	8,8	8,6	8,0	7,6
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	2,8	2,8	2,7	2,6	2,5	2,3
Influence of concrete factor on bond strength $\tau_{Rk,cr}$ in cracked concrete								
Temperature range I and II $\Psi c = (f_{ck}/20)^m$	m	[-]	0,10	0,10	0,10	0,20	0,20	0,30
Influence of sustained load								
Temperature range I: **24°C / 40°C**	$\Psi^0_{sus,100}$	[-]	0,72					
Temperature range II: **40°C / 60°C**	$\Psi^0_{sus,100}$	[-]	0,72					
Temperature range III: **45°C / 75°C**	$\Psi^0_{sus,100}$	[-]	0,91					

Table C2 (Continued) : Essential characteristic for reinforcing bars under tension load in concrete under static and quasi static loading

Reinforcing bar			ϕ12	ϕ16	ϕ20	ϕ25	ϕ32
For working life of 50 years and 100 years							
Combined pull-out and concrete cone failure							
Characteristic bond resistance in uncracked concrete C20/25 with DIAMOND DRILLING							
Dry and wet holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	15,1	14,1	13,3	12,6	11,9
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	12,9	12,0	11,3	10,7	10,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4.0	3,7	3,5	3,3	3,1
Flooded holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,uncr}$	[N/mm²]	15,1	14,1	13,3	12,6	11,9
Temperature range II: **36°C / 60°C**	$\tau_{Rk,uncr}$	[N/mm²]	12,9	12,0	11,3	10,7	10,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,uncr}$	[N/mm²]	4.0	3,7	3,5	3,3	3,1
Influence of concrete factor on bond strength $\tau_{Rk,uncr}$ in uncracked concrete							
Temperature range I and II $\Psi c = (f_{ck}/20)^m$	m	[-]	0,00	0,00	0,00	0,10	0,50
Characteristic bond resistance in cracked concrete C20/25 with DIAMOND DRILLING							
Dry and wet holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	9,3	9,9	11,1	10,9	10,7
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	7,9	8,4	9,5	9,3	9,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	2,9	2,8	2,8
Flooded holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,cr}$	[N/mm²]	9,3	9,9	11,1	10,9	10,7
Temperature range II: **36°C / 60°C**	$\tau_{Rk,cr}$	[N/mm²]	7,9	8,4	9,5	9,3	9,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	2,9	2,8	2,8
Influence of concrete factor on bond strength $\tau_{Rk,cr}$ in cracked concrete							
Temperature range I and II $\Psi c = (f_{ck}/20)^m$	m	[-]	0,10	0,10	0,20	0,40	0,50
Influence of sustained load							
Temperature range I: **24°C / 40°C**	$\Psi^0_{sus,100}$	[-]	0,72				
Temperature range II: **40°C / 60°C**	$\Psi^0_{sus,100}$	[-]	0,72				
Temperature range III: **45°C / 75°C**	$\Psi^0_{sus,100}$	[-]	0,91				

RAMSET Chemset™ Reo 502 Xtrem™ RAMSET Chemset™ Epcon G5 Xtrem™	**Annex C5**
Performance Essential characteristics for reinforcing bars under static and quasi-static tension loading for a working life of 50 or 100 years with diamond drilling	

Table C3 : Essential characteristic for threaded rods under shear load in concrete under static and quasi static loading

Threaded rod			M10	M12	M16	M20	M24	M27	M30
For working life of 50 years and 100 years									
Steel failure without level arm									
Characteristic resistance – Commercial threaded rods	$V^0_{Rk,s}$	[kN]	$K_6 . N_{Rk,s}$						
Factor for commercial threaded rods	K_6	[-]	0,5						
Steel grade 5.8	$V^0_{Rk,s}$	[kN]	14,5	21,1	39,3	61,3	88,3	114,8	140,3
Steel grade 8.8			23,2	33,7	62,8	98,0	141,2	183,6	224,4
Steel grade 10.9			30,2	43,9	81,5	127,5	183,5	238,5	291,5
Stainless steel grade A4-70			20,3	29,5	55,0	85,8	123,6	160,7	196,4
HCR Steel 1.4529			20,3	29,5	55,0	85,8	123,6	160,7	196,4
HCR Steel 1.4565			20,3	29,5	55,0	85,8	123,6	160,7	196,4
Partial safety factor									
Partial safety factor commercial threaded rods	$\gamma_{Ms,V}$ 1)	[-]	1,0 . $f_{uk}/f_{yk} \geq 1,25$ when $f_{uk} \leq 800$ N/mm² and $f_{yk}/f_{uk} \geq 0,8$ 1,0 . $f_{uk}/f_{yk} \geq 1,5$ when $f_{uk} > 800$ N/mm² or $f_{yk}/f_{uk} > 0,8$						
Partial safety factor Grade 5.8, 8.8			1,25						
Partial safety factor Grade 10.9			1,5						
Partial safety factor Grade A4-70			1,56						
Partial safety factor HCR Steel 1.4529			1,25						
Partial safety factor HCR Steel 1.4565			1,56						
Ductility factor	K_7	[-]	1,0 for steel with rupture elongation $A_5 > 8\%$						
Steel failure with level arm									
Characteristic bending moment - Commercial threaded rods	$M^0_{Rk,s}$	[Nm]	$1,2 . W_{el} . f_{uk}$						
Steel grade 5.8	$M^0_{Rk,s}$	[Nm]	37	66	166	325	561	832	1125
Steel grade 8.8			60	105	266	519	898	1332	1799
Steel grade 10.9			75	131	333	649	1123	1664	2249
Stainless Steel grade A4-70			52	92	233	454	786	1165	1574
HCR Steel 1.4529			52	92	233	454	786	1165	1574
HCR Steel 1.4565			52	92	233	454	786	1165	1574
Concrete pryout failure									
Concrete pryout factor	K_8	[-]	2,0						
Concrete edge failure									
Concrete pryout factor	l_f	[mm]	min(h_{ef} ; 12.d_{nom})					min(h_{ef} ; 8.d_{nom})	
External diameter	d_{nom}	[mm]	10	12	16	20	24	27	30

1) In absence of national regulations

Table C4 : Essential characteristic for reinforcing bars under shear load in concrete under static and quasi static loading

Reinforcing bar			ϕ10	ϕ12	ϕ16	ϕ20	ϕ25	ϕ32
For working life of 50 years and 100 years								
Steel failure without level arm								
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$ 1)					
Partial safety factor	$\gamma_{Ms,V}$ 2)		$1,0 \cdot f_{uk}/f_{yk} \geq 1,25$ when $f_{uk} \leq 800$ N/mm² and $f_{yk}/f_{uk} \geq 0,8$ $1,0 \cdot f_{uk}/f_{yk} \geq 1,5$ when $f_{uk} > 800$ N/mm² or $f_{yk}/f_{uk} > 0,8$					
Characteristic resistance Rebar Fe E500 according to EN 1992-1-1	$V^0_{Rk,s}$	[kN]	21,2	30,5	54,3	84,8	132,5	217,1
Partial safety factor Rebar Fe E500 according to EN 1992-1-1	$\gamma_{Ms,V}$ 2)	[-]	1,5					
Ductility factor	K_7	[-]	1,0					
Steel failure with level arm								
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$					
Characteristic resistance Rebar Fe E500 according to EN 1992-1-1	$M^0_{Rk,s}$	[Nm]	63,6	109,9	260,6	508,9	994,0	2084,6
Ductility factor	K_7	[-]	1,0					
Concrete pryout failure								
Concrete pryout factor	K_8	[-]	2,0					
Concrete edge failure								
Concrete pryout factor	l_f	[mm]	min(h_{ef} ; 12.d_{nom})				min(h_{ef} ; 8.d_{nom})	
External diameter	d_{nom}	[mm]	10	12	16	20	25	32

1) f_{uk} according to the rebar specification

2) En l'absence de réglementation nationale,

Table C5 : Displacement for threaded rods under tensile load in concrete

Threaded rod		M10	M12	M16	M20	M24	M27	M30
Displacement in uncracked concrete and in cracked concrete								
With HAMMER DRILLING								
δ_{N0}	[mm/(N/mm²)]	0,04	0,04	0,04	0,04	0,04	0,06	0,06
$\delta_{N\infty}$	[mm/(N/mm²)]	0,05	0,06	0,07	0,07	0,08	0,08	0,07
With DIAMOND DRILLING								
δ_{N0}	[mm/(N/mm²)]	-	0,04	0,04	0,04	0,04	0,06	0,06
$\delta_{N\infty}$	[mm/(N/mm²)]	-	0,06	0,07	0,07	0,08	0,08	0,07

Table C6 : Displacement for reinforcing bars under tensile load in concrete

Rebar		ϕ10	ϕ12	ϕ16	ϕ20	ϕ25	ϕ32
Displacement in cracked and non cracked concrete							
δ_{N0}	[mm/(N/mm²)]	0,04	0,05	0,05	0,05	0,06	0,06
$\delta_{N\infty}$	[mm/(N/mm²)]	0,09	0,06	0,07	0,05	0,08	0,06

Table C7 : Essential characteristic for threaded rods under tensile load in concrete under seismic loading category C1

Threaded rod			M10	M12	M16	M20	M24	M30
For working life of 50 years and 100 years								
Steel failure								
Characteristic resistance – Commercial threaded rods	$N_{Rk,s,C1}$	[kN]	$N_{Rk,s}$					
Combined pull-out and concrete cone failure								
Characteristic bond resistance in cracked concrete C20/25 with HAMMER DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	6,2	8,6	9,3	9,2	9,5	8,3
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	5,3	7,3	7,8	7,8	8,0	7,1
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	1,6	2,3	2,4	2,4	2,5	2,2
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	6,2	8,6	9,3	9,2	8,9	7,3
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	5,3	7,3	7,8	7,8	7,5	6,2
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C1}=\tau_{Rk,100,C1}$	[N/mm²]	1,7	2,4	2,5	2,5	2,3	1,9
Influence of concrete factor on bond strength $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$								
Temperature range I, II and III	Ψ_c	[-]	1,0					

Table C7 (Continued) : Essential characteristic for threaded rods under tensile load in concrete under seismic loading category C1

Threaded rod			M12	M16	M20	M24	M30
For working life of 50 years and 100 years							
Steel failure							
Characteristic resistance – Commercial threaded rods	$N_{Rk,s,C1}$	[kN]	$N_{Rk,s}$				
Combined pull-out and concrete cone failure							
Characteristic bond resistance in cracked concrete C20/25 with DIAMOND DRILLING							
Dry and wet holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	6,4	6,7	7,5	7,3	6,7
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	5,4	5,7	6,4	6,2	5,6
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	2,0	1,9	1,9	1,9	1,7
Flooded holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	6,4	6,7	7,5	7,3	6,7
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	5,4	5,7	6,4	6,2	5,6
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C1}$= $\tau_{Rk,100,C1}$	[N/mm²]	2,0	1,9	1,9	1,9	1,7
Influence of concrete factor on bond strength $\tau_{Rk,C1}$ and $\tau_{Rk,100,C1}$							
Temperature range I, II and III	Ψ_c	[-]	1,0				

Table C8 : Essential characteristic for threaded rod under shear load in concrete under seismic loading category C1

Threaded rod			M10	M12	M16	M20	M24	M30
For working life of 50 years and 100 years								
Annular gap factor without filling annular gap	α_{gap}	[-]	0,5					
Annular gap factor with Ramset filling washer	α_{gap}	[-]	1.0 1)					
Steel failure without level arm								
Steel grade 5.8	$V_{Rk,s,C1}$	[kN]	10,2	17,7	32,2	50,2	55,6	88,4
Steel grade 8.8			16,2	28,3	51,5	80,4	89,0	141,4
Stainless steel grade A4-70			14,2	24,8	45,1	70,3	77,8	123,7
HCR Steel 1.4529			14,2	24,8	45,1	70,3	77,8	123,7
HCR Steel 1.4565			14,2	24,8	45,1	70,3	77,8	123,7

1) According to EN 1992-4

Table C9 : Essential characteristic for threaded rods under tensile load in concrete under seismic loading category C2

Threaded rod			M10	M12	M16	M20	M24	M30
For working life of 50 years and 100 years								
Steel failure								
Characteristic resistance – Commercial threaded rods	$N_{Rk,s,C2}$	[kN]	$N_{Rk,s}$					
Combined pull-out and concrete cone failure								
Characteristic bond resistance in cracked concrete C20/25 with HAMMER DRILLING								
Dry and wet holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	4,0	5,2	4,1	3,8	2,9	4,8
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	3,4	4,4	3,5	3,2	2,5	4,0
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	1,0	1,4	1,1	1,0	0,8	1,2
Flooded holes								
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	4,0	5,2	4,1	3,7	2,7	4,3
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	3,4	4,4	3,5	3,2	2,3	3.6
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	1,0	1,4	1,1	1,0	0,7	1,1
Influence of concrete factor on bond strength $\tau_{Rk,C2}$ and $\tau_{Rk,100,C2}$								
Temperature range I, II and III	Ψ_c	[-]	1,0					

Table C9 (Continued) : Essential characteristic for threaded rods under tensile load in concrete under seismic loading category C2

Threaded rod			M12	M16	M20	M24	M30
For working life of 50 years and 100 years							
Steel failure							
Characteristic resistance – Commercial threaded rods	$N_{Rk,s,C2}$	[kN]	$N_{Rk,s}$				
Combined pull-out and concrete cone failure							
Characteristic bond resistance in cracked concrete C20/25 with DIAMOND DRILLING							
Dry and wet holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	4,5	2,9	2,9	1,7	2,0
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	3,8	2,4	2,5	1,5	1,7
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	1,2	0,8	0,8	0,5	0,5
Flooded holes							
Temperature range I: **24°C / 40°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	4,5	2,9	2,9	1,6	1,8
Temperature range II: **36°C / 60°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	3,8	2,4	2,4	1,4	1,5
Temperature range III: **45°C / 75°C**	$\tau_{Rk,C2}=\tau_{Rk,100,C2}$	[N/mm²]	1,2	0,8	0,8	0,4	0,5
Influence of concrete factor on bond strength $\tau_{Rk,C2}$ and $\tau_{Rk,100,C2}$							
Temperature range I, II and III	Ψ_c	[-]	1,0				

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Performance
Essential characteristics for threaded rods
Seismic tension loading category C2
for a working life of 50 or 100 years with diamond drilling

Annex C13

Table C10 : Essential characteristic for threaded rods under shear load in concrete under seismic loading category C2

Threaded rod			M10	M12	M16	M20	M24	M30
For working life of 50 years and 100 years								
Annular gap factor without filling annular gap	α_{gap}	[-]	0,5					
Annular gap factor with Ramset filling washer	α_{gap}	[-]	1.0 1)					
Steel failure without level arm								
Steel grade 5.8	$V_{Rk,s,C2}$	[kN]	11,6	17,9	31,5	49,1	52,4	88,4
Steel grade 8.8			18,6	28,7	50,4	78,6	83,9	134,6
Stainless steel grade A4-70			16,2	25,1	44,1	68,8	73,4	117,8
HCR Steel 1.4529			16,2	25,1	44,1	68,8	73,4	117,8
HCR Steel 1.4565			16,2	25,1	44,1	68,8	73,4	117,8

1) According to EN 1992-4

Table C11 : Displacement for threaded rod under tensile load in concrete under seismic loading C2

Threaded rod			M10	M12	M16	M20	M24	M30
Displacement with HAMMER DRIILING								
Displacement	$\delta_{N,C2\ (DLS)}$	[mm]	0.39	0.52	0.30	0.30	0.54	0.54
	$\delta_{N,C2\ (ULS)}$	[mm]	0.58	0.66	1.30	0.88	1.73	1.07
Displacement with DIAMOND DRIILING								
Displacement	$\delta_{N,C2\ (DLS)}$	[mm]	-	0.52	0.30	0.30	0.54	0.54
	$\delta_{N,C2\ (ULS)}$	[mm]	-	0.66	1.30	0.88	1.73	1.07

Table C12 : Displacement for threaded rod under shear load in concrete under seismic loading C2

Threaded rod			M10	M12	M16	M20	M24	M30
Displacement	$\delta_{V,C2\ (DLS)}$	[mm]	2,16	2,17	3,96	3,96	4,17	4,17
	$\delta_{V,C2\ (ULS)}$	[mm]	5,02	5,24	10,19	10,19	13,84	13,84

Essential characteristics under fire exposure

Characteristic bond resistance $\tau_{Rk,fi,p}$ (θ) for concrete strength classes C20/25 to C50/60 with all drilling methods under fire conditions

The characteristic bond strength of single bonded fasterner under fire conditions $\tau_{Rk,fi,p}$ for a given temperature (θ) has to be calculated by the following equation:

$$\tau_{Rk,fi,p}(\theta) = k_{fi,p}(\theta) \bullet \tau_{Rk,cr,C20/25}$$

where

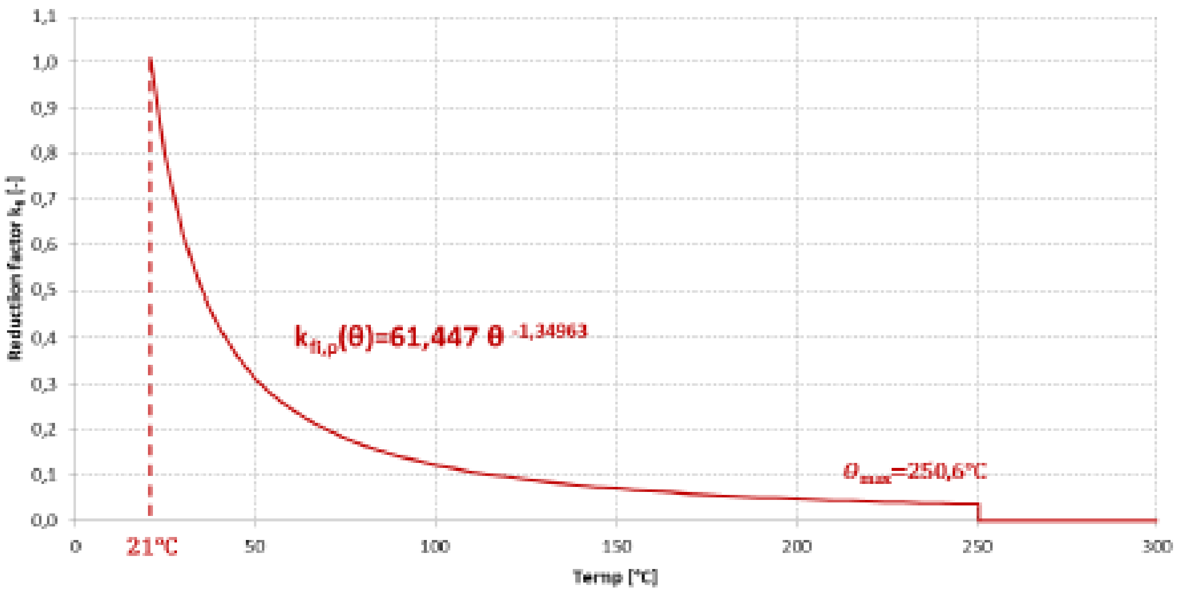
$\theta < 21°C$	$k_{fi,p}(\theta) = 1$
$21°C \leq \theta \leq 250{,}6\ °C$:	$K_{fi,p}(\theta) = K_{fi,p,100y}(\theta) = 61{,}447 \bullet \theta^{(-1.34963)}$
$\theta > 250{,}6\ °C$:	$k_{fi,p}(\theta) = 0$

$\tau_{Rk,fi,p}$: Characteristic bond resistance for cracked concrete under fire exposure for a given temperature (θ)

$k_{fi,p}(\theta)$: Reduction factor for bond resistance under fire exposure

$\tau_{Rk,cr,C20/25}$: Characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

Figure C1: Graph of reduction factor k_b (θ) for concrete strength class C20/25 for good bond conditions



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Performance Reduction factor for pull-out failure of single fasteners under fire conditons	