Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment ETA-18/0045 of 22 February 2018

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™
Product family to which the construction product belongs	Bonded fastener for use in concrete
Manufacturer	ITW Australia (Ramset) 1 Ramset Drive Chirnside Park VIC 3116 AUSTRALIEN
Manufacturing plant	Plant 1
This European Technical Assessment contains	29 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330499-00-0601

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Specific Part

Specific Part

1 Technical description of the product

The Injection system RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™ is a bonded anchor consisting of a cartridge with injection mortar Chemset™ 801 Xtrem™ / Chemset™ 800 Xtrem™ and a steel element. The steel element consist of a threaded rod CHEMSET™ ANCHOR STUD with washer and hexagon nut in the range of M8 to M30 or a CHEMSET™ ANCHOR STUD XTREM™ stud in the range of M12, M16 and M20 or a reinforcing bar in the range of diameter ∅ 8 to 20 mm.
The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

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

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

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 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 and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance tension and shear loads	See Annex C 1 to C 11
Displacements under tension and shear loads	See Annex C 7 / C 11

3.2 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release of dangerous substances	No performance assessed

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

In European Assessment Document EAD 330499-00-0601the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 22 February 2018 by Deutsches Institut für Bautechnik

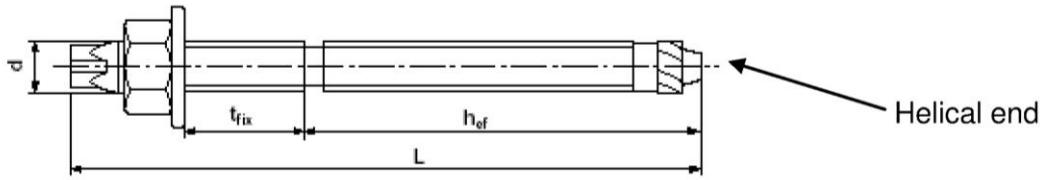
BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Lange

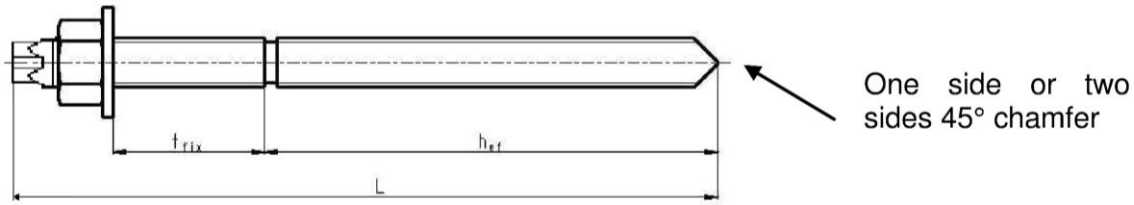
Deutsches Institut für Bautechnik DIBt

Product description: Steel elements

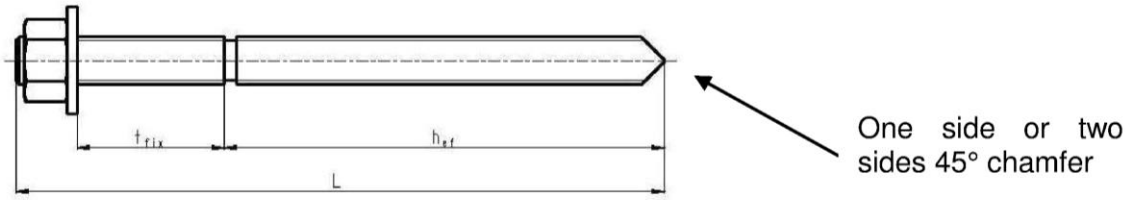
- CHEMSET™ ANCHOR STUD M8 to M16 with washer and nut (Electroplated)



- CHEMSET™ ANCHOR STUD M8 to M16 with washer and nut (A4)



- CHEMSET™ ANCHOR STUD M20 to M30 with washer and nut (Electroplated / A4)



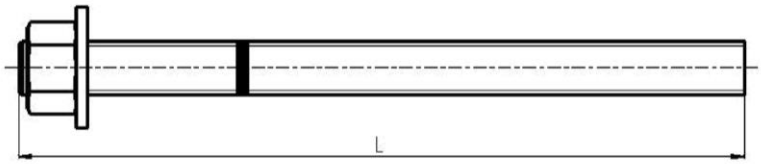
Marking on the CHEMSET™ ANCHOR STUD: letter S, bolt diameter and maximum thickness of the fixture: e.g.: S M10 / 20

Table 1: Dimensions CHEMSET™ ANCHOR STUD

Size	d	L	h_{ef}	max t_{fix}
	[mm]	[mm]	[mm]	[mm]
M8	8	110	80	15
M10	10	130	90	20
M12	12	160	110	25
M16	16	190	125	35
M20	20	260	170	65
M24	24	300	210	63
M30	30	380	280	70

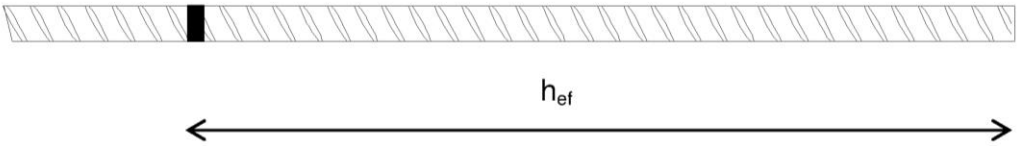
- **Commercial standard threaded rods M8 to M30** (with washer and nut) with inspection certificate 3.1 according to EN 10204:2004
  - Materials, dimensions and mechanical properties acc. to Table A1
  - For steel grade 10.9: Proof of passed preloading test for the detection of hydrogen embrittlement according to EN ISO 15330:1999

marking of the embedment depth

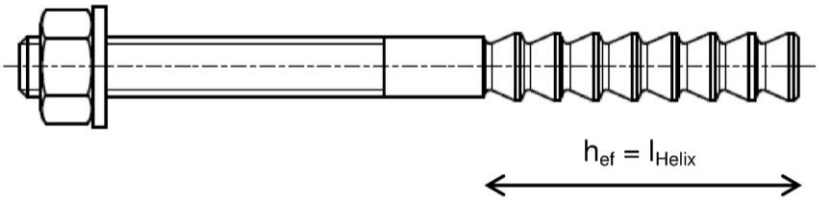


- **Rebars Ø8, Ø10, Ø12, Ø16, Ø20,** properties according to Annex C of EN 1992-1-1

marking of the embedment depth



- **CHEMSET™ XTREM™ M12, M16 and M20**



RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	
Product description Steel elements II	**Annex A2**

Deutsches Institut für Bautechnik DIBt

Injection mortar

Injection mortar CHEMSET™ 801 XTREM™ 380 ml and 750 ml:
Vinylester adhesive - two components

Marking

- Trade name :
  - CHEMSET™ 801 XTREM™ for Tropical version
  - CHEMSET™ 800 XTREM™ for Regular version
  - Identifying mark of the producer RAMSET
- Expire date
- Curing and processing time
- Charge code number

Static mixer

ISNP mixing nozzle

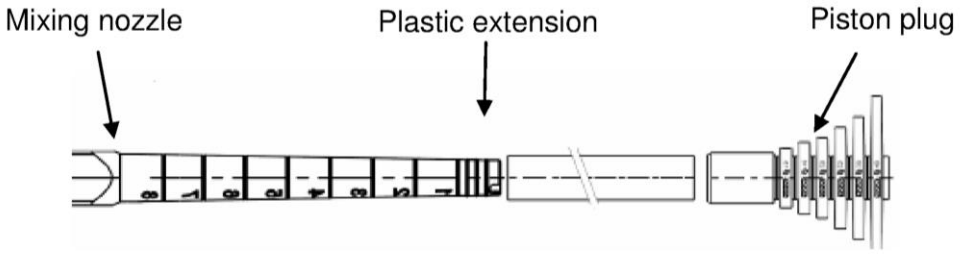
ISNE mixing nozzle

High flow mixing nozzle

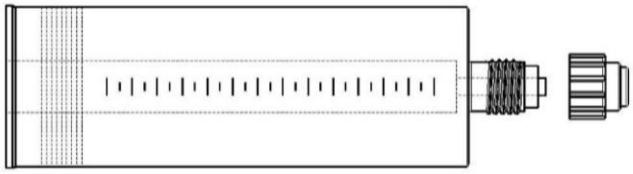
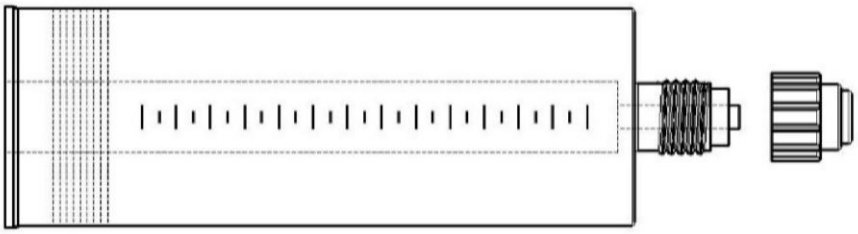
RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	Annex A3
Product description Injection mortar	

Injection accessories for deep hole

Plastic extension Øext. 13x1000 must be used for hole deeper h_0 > 250 mm
Piston plug must be used for deeper holes when h_0 > 350 mm



Cartridges

380 ml coaxial cartridge	
750 ml coaxial cartridge	

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Product description

Injection accessories

Annex A4

Deutsches Institut für Bautechnik DIBt

Table A1: Materials

Part	Size	Material
Carbon steel		
CHEMSET™ ANCHOR STUD with nut and washer	M8	DIN 1654 part 2 or 4, cold formed steel or NFA 35053, cold formed steel, $A_5 \geq 15\%$, Electroplated ≥ 5 µm NF E25-009 or Hot dip galvanized ≥ 45 µm NF EN ISO 1461
	M10 to M16	NFA 35053 cold formed steel, $A_5 \geq 15\%$, Electroplated ≥ 5 µm NF E25-009 or Hot dip galvanized ≥ 45 µm NF EN ISO 1461
	M20 to M30	11SMnPb37 according to NF A35-561, $A_5 \geq 15\%$, Electroplated ≥ 5 µm NF E25-009 or Hot dip galvanized ≥ 45 µm NF EN ISO 1461
CHEMSET™ XTREM™ with nut and washer	M12, M16, M20	Carbon steel grade 8.8, ; $A_5 = 12\%$ Electroplated ≥ 5 µm or Hot dip galvanized ≥ 45 µm or Hot dip galvanized ≥ 45 µm NF EN ISO 1461
Commercial threaded rods with nut and washer	M8 to M30	Carbon steel, grade 5.8 to 10.9 according to EN 1993-1-8:2005 $A_5 \geq 15\%$, Electroplated ≥ 5 µm acc. to ISO 4042:2017
Stainless steel (A4)		
CHEMSET™ ANCHOR STUD (SS) with nut and washer	M8 to M30	X2CrNiMo 17.12.2 according to EN 10088-3:2014 M8 to M24: grade 80, M30: grade 70
Commercial threaded rods with nut and washer	M8 to M30	Stainless steel grade 70: 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 acc. to EN 10088-1:2014
High corrosion resistant steel (HCR)		
Commercial threaded rods with nut and washer	M8 to M30	Stainless steel 1.4529 / 1.4565 acc. to EN 10088-1:2014, grade 70
Ribbed reinforcing bar (rebar)		
ribbed rebar	∅8 to ∅20	EN 1992-1-1:2004, bars and de-coiled rods class B or C, $f_{uk} = f_{tk} = k \cdot f_{yk}$, k according to NDP or NCL of EN 1992-1-1

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Product description

Materials

Annex A5

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Specifications of intended use

Anchorages subject to:

- Static, quasi-static loading (all steel elements)
- Seismic performance category C1 (all steel elements)
- Seismic performance category C2 (only CHEMSET™ XTREM™)

Base materials:

- Reinforced or unreinforced compacted normal weight concrete without fibres of strength classes C20/25 to C50/60 acc. to EN 206: 2013
- Cracked or uncracked concrete

Temperature ranges:

Installation temperature: Temperature of base material: 0 °C to +40°C

In-service temperature:

CHEMSET™ 801 XTREM™ / CHEMSET™ 800 XTREM™ may be used in the following temperature ranges:

- 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 +80°C: max short term temperature +80°C
  max long term temperature +50°C

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions
  (zinc coated steel, stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal conditions, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistance steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal conditions, if other particular aggressive conditions exist
  (high corrosion resistance steel)

  Note: Such particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	Annex B1
Intended used Specifications	

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Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings.
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- The anchorages are designed in accordance FprEN 1992-4:2017 and Technical Report TR 055
- Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure.
- Fastenings in stand-off installation or with a grout layer under seismic action are not allowed.

Installation:

- Installation in dry or wet concrete (use category 1) and in flooded holes (use category 2).
- All installation directions (floor, wall, overhead).
- 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.

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	
Intended used Specifications	**Annex B2**

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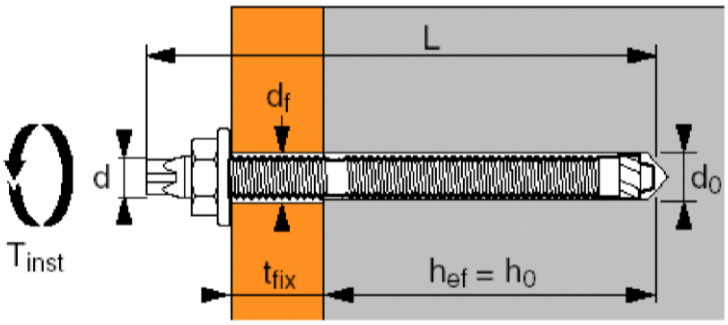
Table B1: Installation data for threaded rods



Nominal thread size	Nominal diameter of the drill bit	Clearance hole in the fixture	Tightening torque	Effective embedment depth and drill hole depth $h_{ef} = h_0$			minimum thickness of the concrete member h_{min}		
	d_0	d_f	T_{inst}	Std [1]	Min	Max [2]	Std [1]	min	max
	[mm]	[mm]	[Nm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
M8	10	9	10	80	56	160	110	h_{ef} + 30 mm ≥ 100 mm	
M10	12	12	20	90	70	200	120		
M12	14	14	30	110	84	240	140		
M16	18	18	60	125	112	320	160	h_{ef} + 2d_o	
M20	25	22	120	170	140	400	220		
M24	28	26	200	210	168	480	265		
M30	35	33	400	280	210	360	350		

[1] Effective embedment depth for CHEMSET™ ANCHOR STUD.

[2] The maximum embedment depth is limited to 12 d for installation in flooded holes

Table B2: Minimum spacing and edge distances for threaded rods

Threaded rods			M8	M10	M12	M16	M20	M24	M30
Minimum spacing	s_{min}	[mm]	40	50	60	75	90	115	140
Minimum edge distance	c_{min}	[mm]	40	45	45	50	55	60	80

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Intended use
Settings data and minimum distances

Annex B3

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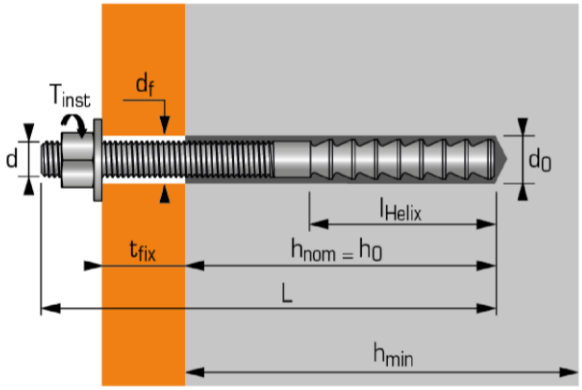
Table B3: Installation data for CHEMSET™ XTREM™



Nominal size	Nominal diameter of the drill bit	Clearance hole in the fixture	Tightening torque	Nominal embedment depth and drill hole depth $h_{nom} = h_0$			minimum thickness of the concrete member h_{min}		
	Ø d_0	d_f	T_{inst}	Std	min	max	Std	min	max
	[mm]	[mm]	[Nm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
M12	14	14	30	110	60	144	140	100	175
M16	18	18	50	125	96	192	160	130	228
M20	22	22	150	170	100	240	215	144	265

Table B4: Minimum spacing and edge distances for CHEMSET™ XTREM™

For the determination of minimum spacing and minimum edge distance of anchors, the projecting area with the effective dimensions shall be higher than the required projective area:

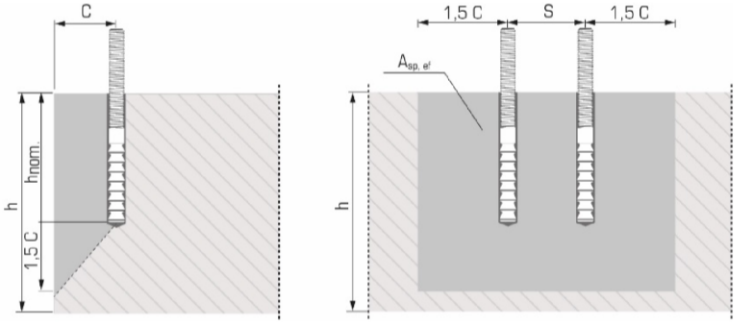
$\mathbf{A_{sp,req} \leq A_{sp,ef}}$

$A_{sp,ef} = h_{sp} \bullet b_{sp}$

With $b_{sp} = (3\,c + s)$ for $s \leq 3\,c$ or

$b_{sp} = 6\,c$ for $s > 3\,c$

and $h_{sp} = \min\{(1{,}5\,c + h_{nom});h\}$



CHEMSET™ XTREM™			M12	M16	M20
Absolute minimum edge distance and spacing	$s_{min} = c_{min}$	[mm]	55	60	120
Required area for uncracked concrete	$A_{sp,req}$	[mm²]	31015	44640	134400
Required area for cracked concrete	$A_{sp,req}$	[mm²]	27000	44640	134400

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Intended use
Settings data and minimum distances

Annex B4

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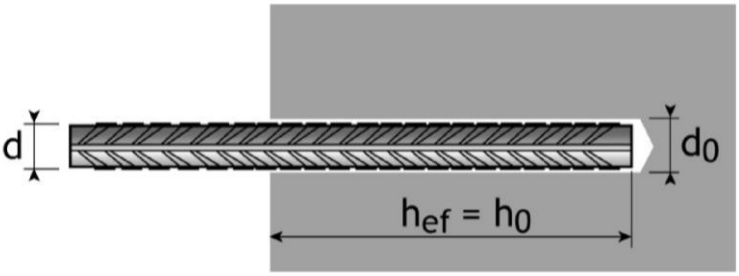
Table B5: Installation data for reinforcement bars



Nominal size of rebar	Nominal diameter of the drill bit	Effective embedment depth and drill hole depth $h_{ef} = h_0$		minimum thickness of the concrete member h_{min}	
	d_0	min	Max [1]	min	max
	[mm]	[mm]	[mm]	[mm]	[mm]
Ø8	10	56	160	h_{ef} + 30 mm ≥ 100 mm	
Ø10	12	70	200		
Ø12	15	84	240		
Ø16	20	112	320	$h_{ef} + 2d_o$	
Ø20	25	140	400		

[1] The maximum embedment depth shall be reduced to 12∅ for installation in flooded holes

Table B6: Minimum spacing and edge distances for reinforcement bars

Reinforcing bars			Ø8	Ø10	Ø12	Ø16	Ø20
Minimum spacing	s_{min}	[mm]	40	50	60	80	100
Minimum edge distance	c_{min}	[mm]	40	45	45	50	65

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Intended use
Settings data and minimum distances

Annex B5

Deutsches Institut für Bautechnik DIBt

Table B8: Working time and curing time for RAMSET Chemset™ 800 Xtrem™ :

Temperature of base material	Working time	Curing time in dry concrete
0°C to 5°C	25 min	120 min
6°C to 10°C	15 min	90 min
11°C to 20°C	7 min	60 min
21°C to 30°C	4 min	45 min
31°C to 40°C	2 min	30 min

In wet concrete the curing time must be doubled

Table B7: Working time and curing time for RAMSET Chemset™ 801 Xtrem™ :

Temperature of base material	Working time	Curing time in dry concrete
+5°C	60 min	240 min
6°C to 10°C	40 min	180 min
11°C to 20°C	15 min	120 min
21°C to 30°C	8 min	90 min
31°C to 40°C	4 min	60 min

In wet concrete the curing time must be doubled

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	**Annex B6**
Intended use Minimum curing time	

Deutsches Institut für Bautechnik DIBt

Table B9: Dimensions of the cleaning tools for threaded rods

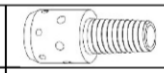
Threaded rods				M8	M10	M12	M16	M20	M24	M30
Diameter of drill hole		d_0	[mm]	10	12	14	18	24	28	35
Air nozzle		Ø	[mm]	6	8	12	14	20	24	29
Steel brush		Ø	[mm]	11	13	15	20	26	30	37

Table B10: Dimensions of the cleaning tools for CHEMSET™ XTREM™

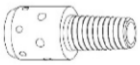
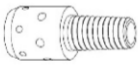
CHEMSET™ XTREM™				M12	M16	M20
Diameter of drill hole		d_0	[mm]	14	18	22
Air nozzle		Ø	[mm]	12	14	20
Steel brush		Ø	[mm]	16	22	26

Table B11: Dimensions of the cleaning tools for reinforcing bars (rebars)

Reinforcing bars (rebars)				Ø8	Ø10	Ø12	Ø16	Ø20
Diameter of drill hole		d_0	[mm]	10	12	15	20	25
Air nozzle		Ø	[mm]	6	8	12	14	20
Steel brush		Ø	[mm]	11	13	16	22	26

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Intended use
Cleaning and installation tools

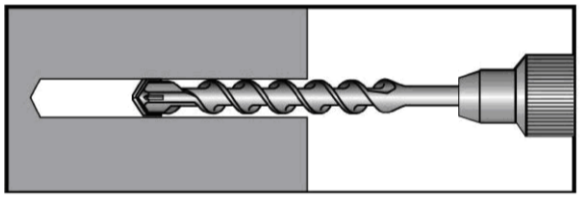
Annex B7

Deutsches Institut für Bautechnik DIBt

Installation instruction

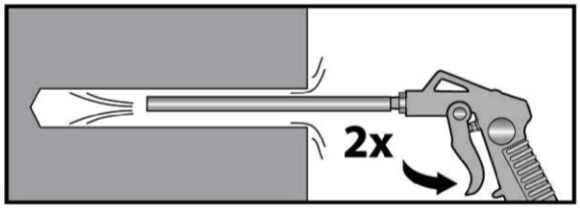
Bore hole drilling

1 Drill hole of diameter (d_0) and depth (h_0) with a hammer drill set in rotation-hammer mode using an appropriately carbide drill bit.

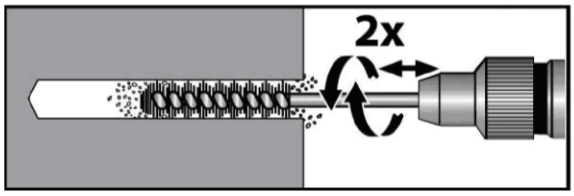


Bore hole cleaning

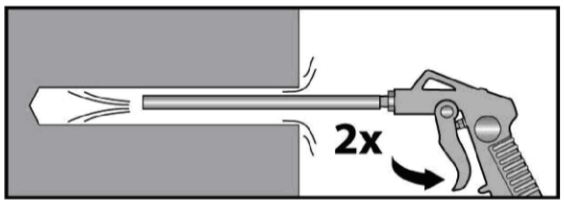
2 Using compress air cleaning (mini 6 bars), use the appropriate extension and air nozzle, starting from the bottom of the hole blow out at least 2 times and until no dust is evacuated



3 Using the relevant RAMSET brush and extension fitted on a drilling machine (dimensions of the brush see table B9, B10 and B11), starting from the top of the hole in rotation, move downward to the bottom of the hole then move upward to the top of the hole. Repeat this operation. Any worn brush must be replaced by a new brush($Ø_{brush} > Ø_{hole}$).

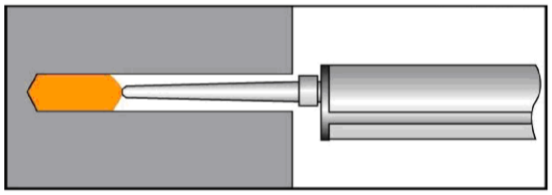


4 Using compress air cleaning (mini 6 bars), use the appropriate extension and air nozzle, starting from the bottom of the hole blow out at least 2 times and until no dust is evacuated.



Injection

5 Screw the mixing nozzle onto the cartridge and dispense the first part to waste until an even color is achieved for each new cartridge or mixing nozzle. Use tube extensions for holes deeper than 250 mm. Starting from the bottom of the hole fill uniformly. In order to avoid air pocket, withdraw slowly the mixing nozzle while injecting the resin. Fill the hole until 1/2 full. for hole deeper than 350mm use piston plug. For pneumatic dispenser with 380 ml cartridge, the maximum pressure is 6 bars.



RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Intended use
Installation instruction

Annex B8

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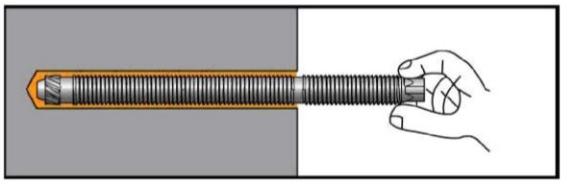
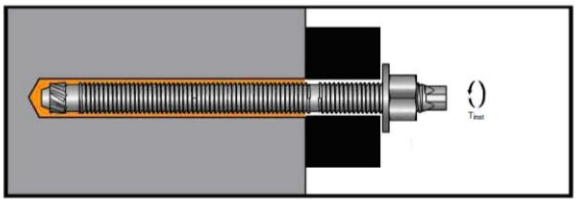
Setting the steel element

6 Insert the steel element (threaded rod, CHEMSET™ XTREM™ or rebar), slowly and with a slight twisting motion in respect of the gel time indicated in table B7 or B8. Remove excess resin from around the mouth of the hole before it sets. Control the embedment depth



7 Do not disturb anchor between specified cure time (acc. to table B7 or B8)

Attach the fixture and tight the nut at the specified torque as given in Annex B3 and B4.



RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™	Annex B9
Intended use Installation instruction	

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Table C1: Characteristic values of tension resistance for static and quasi-static action for threaded rods:

Threaded rods				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M30**
Steel failure										
Characteristic resistance of Chemset™ Anchor Stud		$N_{Rk,s}$	[kN]	22	35	51	94	118	170	272
Partial factor		$\gamma_{Ms,N}$	[-]	1,71				1,49		
Characteristic resistance of Chemset™ Anchor Stud (SS)		$N_{Rk,s}$	[kN]	26	41	59	110	172	247	281
Partial factor		$\gamma_{Ms,N}$	[-]	1,87						2,86
Characteristic resistance for commercial standard rods		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$						
Partial factor		$\gamma_{Ms,N}$	[-]	max {1,4; 1,2 f_{uk} / f_{yk}}						
Combined pull-out and concrete cone failure										
Nominal diameter		$d = d_{nom}$	[mm]	8	10	12	16	20	24	30
Robustness to installation		γ_{inst}	[-]	1,0						
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,ucr}$	[N/mm²]	15	15	15	13	11	10	8,5
Temperature range II: **80°C / 50°C**		$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	12	10	9	8
Characteristic bond resistance in cracked concrete C20/25 (use category 1: dry and wet concrete)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,cr}$	[N/mm²]	6,5	6,5	6,5	6,5	6,5	6,5	6,0
Temperature range II: **80°C / 50°C**		$\tau_{Rk,cr}$	[N/mm²]	6,5	6,5	6,5	6,5	6,0	6,0	5,5
Characteristic bond resistance in ucracked concrete C20/25 (use category 2: flooded holes)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,ucr}$	[N/mm²]	12,0	12,0	12,0	10,0	9,0	8,0	7,0
Temperature range II: **80°C / 50°C**		$\tau_{Rk,ucr}$	[N/mm²]	11,0	11,0	11,0	9,5	8,0	7,5	6,5
Characteristic bond resistance in cracked concrete C20/25 (use category 2: flooded holes)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,cr}$	[N/mm²]	6,5	6,5	6,0	6,0	5,5	5,0	5,0
Temperature range II: **80°C / 50°C**		$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	6,0	5,5	5,0	5,0	4,5
Increasing factor for $\tau_{Rk,ucr}$ in uncracked concrete	C30/37	ψ_c	[-]	1,04	1,04	1,04	1,04	1,12	1,12	1,17
	C40/50			1,07	1,07	1,07	1,07	1,23	1,23	1,32
	C50/60			1,09	1,09	1,09	1,09	1,30	1,30	1,42
Increasing factor for $\tau_{Rk,cr}$ in cracked concrete		ψ_c	[-]	1,00						
Concrete cone failure										
Factor for uncracked concrete		$k_{ucr,N}$	[-]	11,0						
Factor for cracked concrete		$k_{cr,N}$	[-]	7,7						
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{nom}						
Spacing		$s_{cr,N}$	[mm]	3,0 h_{nom}						
Splitting										
Edge distance	$h / h_{nom} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{nom}						
	$2,0 > h / h_{nom} > 1,3$			5,6 h_{nom} – 2,3 h						
	$h / h_{nom} \leq 1,3$			2,6 h_{nom}						
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$						

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Performances
Characteristic resistance under tension load – threaded rods

Annex C1

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Table C2: Characteristic values of tension resistance for static and quasi-static action for Chemset™ Xtrem™:

Muticone Studs				**M12**	**M16**	**M20**
Steel failure						
Characteristic resistance		$N_{Rk,s}$	[kN]	50	89	140
Partial factor		$\gamma_{Ms,N}$	[-]	1,5		
Combined Pull-out and Concrete cone failure						
Nominal diameter		$d = d_{nom}$	[mm]	12	16	20
Effective embedment depth		$h_{ef} = l_{Helix}$	[mm]	60	96	100
Robustness to installation		γ_{inst}	[-]	1,0		
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)						
Temperature range I: **40°C / 24°C**		$\tau_{Rk,ucr}$	[N/mm²]	17	17	17
Temperature range II: **80°C / 50°C**		$\tau_{Rk,ucr}$	[N/mm²]	16	16	16
Characteristic bond resistance in cracked concrete C20/25 (use category 1: dry and wet concrete)						
Temperature range I: **40°C / 24°C**		$\tau_{Rk,cr}$	[N/mm²]	17	16	14
Temperature range II: **80°C / 50°C**		$\tau_{Rk,cr}$	[N/mm²]	16	14	13
Characteristic bond resistance in uncracked concrete C20/25 (use category 2: flooded holes)						
Temperature range I: **40°C / 24°C**		$\tau_{Rk,ucr}$	[N/mm²]	17	17	17
Temperature range II: **80°C / 50°C**		$\tau_{Rk,ucr}$	[N/mm²]	16	16	16
Characteristic bond resistance in cracked concrete C20/25 (use category 2: flooded holes)						
Temperature range I: **40°C / 24°C**		$\tau_{Rk,cr}$	[N/mm²]	17	16	14
Temperature range II: **80°C / 50°C**		$\tau_{Rk,cr}$	[N/mm²]	16	14	13
Increasing factor for $\tau_{Rk,p}$	C30/37	ψ_c	[-]	1,08	1,08	1,17
	C40/50		[-]	1,15	1,15	1,32
	C50/60		[-]	1,19	1,19	1,42
Concrete cone failure						
Effective embedment depth		h_{ef}	[mm]	h_{nom}		
Factor for uncracked concrete		$k_{ucr,N}$	[-]	11,0		
Factor for cracked concrete		$k_{cr,N}$	[-]	7,7		
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}		
Spacing		$s_{cr,N}$	[mm]	3 h_{ef}		
Splitting						
Edge distance	$h / h_{nom} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{nom}		
	$2,0 > h / h_{nom} > 1,3$			5,6 h_{nom} – 2,3 h		
	$h / h_{nom} \leq 1,3$			2,6 h_{nom}		
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$		

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Performances
Characteristic resistance under tension load - CHEMSET™ ANCHOR STUD XTREM™

Annex C2

Deutsches Institut für Bautechnik DIBt

Table C3: Characteristic values of tension resistance for static and quasi-static action for reinforcing bars (rebars):

Reinforcing bars (rebars)			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**
Steel failure							
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$				
Partial factor	$\gamma_{Ms,N}$	[-]	max {1,4; 1,2 f_{uk} / f_{yk}}				
Combined pull-out and concrete cone failure							
Diameter of threaded rod	$d = d_{nom}$	[mm]	8	10	12	16	20
Robustness to installation	γ_{inst}	[-]	1,0				
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	13	13
Temperature range II: **80°C / 50°C**	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12	12
Characteristic bond resistance in cracked concrete C20/25 (use category 1: dry and wet concrete)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,cr}$	[N/mm²]	5	5	5,5	5,5	6
Temperature range II: **80°C / 50°C**	$\tau_{Rk,cr}$	[N/mm²]	5	5	5,5	5,5	6
Characteristic bond resistance in uncracked concrete C20/25 (use category 2: flooded holes)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,ucr}$	[N/mm²]	10	10	10	10	10
Temperature range II: **80°C / 50°C**	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,5	9,5	9,5
Characteristic bond resistance in cracked concrete C20/25 (use category 2: flooded holes)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,cr}$	[N/mm²]	5	5	5	5	5,5
Temperature range II: **80°C / 50°C**	$\tau_{Rk,cr}$	[N/mm²]	5	5	5	5	5
Increasing factor for $\tau_{Rk,ucr}$ in uncracked concrete C30/37	ψ_c	[-]	1,04				
Increasing factor for $\tau_{Rk,ucr}$ in uncracked concrete C40/50	ψ_c	[-]	1,07				
Increasing factor for $\tau_{Rk,ucr}$ in uncracked concrete C50/60	ψ_c	[-]	1,09				
Increasing factor for $\tau_{Rk,cr}$ in cracked concrete	ψ_c	[-]	1,00				
Concrete cone failure							
Factor for uncracked concrete	$k_{ucr,N}$	[-]	11,0				
Factor for cracked concrete	$k_{cr,N}$	[-]	7,7				
Edge distance	$c_{cr,N}$	[mm]	1,5 h_{ef}				
Spacing	$s_{cr,N}$	[mm]	3 h_{ef}				
Splitting							
$h / h_{nom} \geq 2,0$			1,0 h_{nom}				
Edge distance $2,0 > h / h_{nom} > 1,3$	$c_{cr,sp}$	[mm]	5,6 h_{nom} – 2,3.h				
$h / h_{nom} \leq 1,3$			2,6 h_{nom}				
Spacing	$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$				

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Performances

Characteristic resistance under tension load - rebar

Annex C3

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Table C4: Characteristic values of shear resistance for static and quasi-static actions for threaded rods

Threaded rods			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M30**
Steel failure without lever arm									
Characteristic resistance for Chemset™ Anchor Stud	$V^0_{Rk,s}$	[kN]	11	17	25	47	59	85	136
Characteristic resistance for Chemset™ Anchor Stud (SS)	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	140
Characteristic resistance for commercial threaded rods	$V^0_{Rk,s}$	[kN]	$0,5 \bullet A_s \bullet f_{uk}$						
Steel failure without lever arm									
Characteristic resistance for Chemset™ Anchor Stud	$M^0_{Rk,s}$	[Nm]	22	45	79	200	301	520	1052
Characteristic resistance for Chemset™ Anchor Stud (SS)	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1125
Characteristic resistance for commercial threaded rods	$M^0_{Rk,s}$	[Nm]	$1,2 \bullet W_{el} \bullet f_{uk}$						
Partial factor for Chemset™ Anchor Stud	$\gamma_{Ms,V}$	[-]	1,43				1,5		
Partial factor for Chemset™ Anchor Stud (SS)	$\gamma_{Ms,V}$	[-]	1,56						2,38
Partial factor for commercial threaded rods	$\gamma_{Ms,V}$	[-]	$\max \{1,25; f_{uk} / f_{yk}\}$						
Concrete pryout failure									
Factor $h_{ef} < 60mm$	k_8	[-]	1,0						
Factor $h_{ef} \geq 60$ mm	k_8	[-]	2,0						
Concrete edge failure									
Effective length of anchor	ℓ_f	[mm]	$\min \{h_{ef}; 8\ d_{nom}\}$						
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	30

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Performances
Characteristic resistance under shear load – Threaded rods

Annex C4

Deutsches Institut für Bautechnik DIBt

Table C5: Characteristic values of shear resistance for static and quasi-static actions for CHEMSET™ XTREM™

CHEMSET™ XTREM™				**M12**	**M16**	**M20**
Steel failure without lever arm						
Characteristic resistance		$V^0_{Rk,s}$	[kN]	34	63	98
Steel failure without lever arm						
Characteristic resistance		$M^0_{Rk,s}$	[Nm]	105	266	519
Partial factor		$\gamma_{Ms,V}$	[-]	1,25		
Concrete pryout failure						
Factor	$h_{ef} < 60mm$	k_8	[-]	1,0		
	$h_{ef} \geq 60$ mm			2,0		
Concrete edge failure						
Effective length of anchor		ℓ_f	[mm]	min {h_{nom}, 8 d_{nom})		
Outside diameter of anchor		d_{nom}	[mm]	12	16	20

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Performances

Characteristic resistance under shear load – CHEMSET™ ANCHOR STUD XTREM™

Annex C5

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Table C6: Characteristic values of shear resistance for static and quasi-static actions for rebar

Reinforcing bars (rebars)				**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**
Steel failure without lever arm								
Characteristic resistance		$V^0_{Rk,s}$	[kN]	0,5 $N_{RK,s}$				
Steel failure with lever arm								
Characteristic resistance		$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$				
Partial factor		$\gamma_{Ms,V}$	[-]	max {1,25; f_{uk}/f_{yk}}				
Concrete pryout failure								
Factor	$h_{ef} < 60mm$	k_8	[-]	1,0				
	$h_{ef} \geq 60$ mm			2,0				
Concrete edge failure								
Effective length of anchor		ℓ_f	[mm]	min {h_{nom}, 8 d_{nom}}				
Outside diameter of anchor		d_{nom}	[mm]	8	10	12	16	20

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Performances
Characteristic resistance under shear load - rebar

Annex C6

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Table C7: Displacement under tension loads[1)] for threaded rods

Threaded rods			M8	M10	M12	M16	M20	M24	M30
Uncracked concrete									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,01	0,02	0,02	0,02	0,03	0,02	0,04
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,05						
Cracked concrete									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,02	0,03	0,03	0,05	0,05	0,06	0,06
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,08	0,13	0,12	0,14	0,09	0,10	0,09

Table C8: Displacement under tension loads[1)] for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Uncracked concrete					
Displacement	δ_{N0}	[mm/(N/mm²)]	0,02	0,03	0,02
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,05		
Cracked concrete					
Displacement	δ_{N0}	[mm/(N/mm²)]	0,03	0,05	0,05
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,09	0,07	0,08

Table C9: Displacement under tension loads[1)] for reinforcing bars

Reinforcing bars (rebars)			Ø8	Ø10	Ø12	Ø16	Ø20
Uncracked concrete							
Displacement	δ_{N0}	[mm/(N/mm²)]	0,01	0,01	0,07	0,06	0,3
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,05				
Cracked concrete							
Displacement	δ_{N0}	[mm/(N/mm²)]	0,03	0,1	0,1	0,09	0,09
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,27	0,31	0,31	0,10	0,10

[1)] Calculation of displacement under tension load: τ_{Sd} design value of bond stress.

Displacement under short term loading = $\delta_{N0} \cdot \tau_{Sd} / 1,4$

Displacement under long term loading = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$

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Performances
Displacements under static and quasi-static loading

Annex C7

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Seismic performance category C1

The definition of seismic performance category C1 is given in FprEN 1992-4

Table C10: Characteristic tension resistance for seismic performance category C1 for threaded rods

Threaded rods			M8	M10	M12	M16	M20	M24	M30
Steel failure									
Characteristic resistance for Chemset™ Anchor Stud	$N_{Rk,s,eq,C1}$	[kN]	22	35	51	94	118	170	272
Partial factor	$\gamma_{Ms,N}$	[-]	1,71				1,49		
Characteristic resistance for Chemset™ Anchor Stud (SS)	$N_{Rk,s,eq,C1}$	[kN]	29	46	67	125	196	282	393
Partial factor	$\gamma_{Ms,N}$	[-]	1,60						1,87
Characteristic resistance for commercial threaded rods	$N_{Rk,s,eq,C1}$	[kN]	$A_s \cdot f_{uk}$						
Partial factor	$\gamma_{Ms,N}$	[-]	max {1,4; 1,2 f_{uk} / f_{yk}}						
Combined pull-out and concrete cone failure									
Characteristic bond resistance (use category 1: dry or wet concrete)									
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,2	6,5	6,1	6,2	6,5	6,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,2	6,5	6,1	5,7	6,0	5,5
Characteristic bond resistance (use category 2: flooded holes)									
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,2	6,0	5,7	5,3	5,0	5,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	5,5	5,7	6,0	5,2	4,8	5,0	4,5

Table C11: Characteristic shear resistance for seismic performance category C1 for threaded rods

Threaded rods			M8	M10	M12	M16	M20	M24	M30
Steel failure without level arm									
Characteristic resistance for Chemset™ Anchor Stud	$V_{Rk,s,eq,C1}$	[kN]	8	12	18	33	41	60	82
Partial factor	$\gamma_{Ms,V}$	[-]	1,43				1,5		
Characteristic resistance for Chemset™ Anchor Stud (SS)	$V_{Rk,s,eq,C1}$	[kN]	9	14	21	39	60	87	84
Partial factor	$\gamma_{Ms,V}$	[-]	1,56						2,38
Characteristic resistance for commercial threaded rods	$V_{Rk,s,eq,C1}$	[kN]	0,35 • A_s • f_{uk}						
Partial factor	γ_{MsV}	[-]	max {1,4; 1,2 f_{uk} / f_{yk}}						
Factor for clearance hole	α_{gap}	[-]	0,50						

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Performances

Characteristic values for seismic performance category C1 – threaded rods

Annex C8

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Seismic performance category C1

The definition of seismic performance category C1 is given in FprEN 1992-4

Table C12: Characteristic tension resistance for seismic performance category C1 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Steel failure					
Characteristic resistance	$N_{Rk,s,eq,C1}$	[kN]	50	89	140
Partial factor	$\gamma_{Ms,N}$	[-]	1.5		
Combined pull-out and concrete cone failure					
Characteristic bond resistance (use category 1: dry or wet concrete)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	17,0	13,5	12,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	16,0	12,0	11,0
Characteristic bond resistance (use category 2: flooded holes)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	17,0	13,5	12,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	16,0	12,0	11,0

Table C13: Characteristic shear resistance for seismic performance category C1 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Steel failure without level arm					
Electroplated version					
Characteristic resistance	$V_{Rk,s,eq,C1}$	[kN]	23,6	44,0	68,6
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		
Factor for clearance hole	α_{gap}	[-]	0,50		
Hot Dip Galvanised version					
Characteristic resistance	$V_{Rk,s,eq,C1}$	[kN]	12	22	34,3
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		
Factor for clearance hole	α_{gap}	[-]	0,50		

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Performances

Characteristic values for seismic performance category C1 – CHEMSET™ ANCHOR STUD XTREM™

Annex C9

Deutsches Institut für Bautechnik DIBt

Seismic performance category C1

The definition of seismic performance category C1 is given in FprEN 1992-4

Table C14: Characteristic tension resistance for seismic performance category C1 for reinforcement bars (rebars)

Reinforcement bars (rebars)			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**
Steel failure							
Characteristic resistance	$N_{Rk,s,eq,C1}$	[kN]	$A_s \cdot f_{uk}$				
Partial factor	$\gamma_{Ms,N}$	[-]	max {1,4; 1,2 f_{uk} / f_{yk}}				
Combined pull-out and concrete cone failure							
Characteristic bond resistance (use category 1: dry or wet concrete)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	3,5	3,8	5,5	5,5	6,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	3,5	3,8	5,5	5,5	6,0
Characteristic bond resistance (use category 2: flooded holes)							
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	3,5	3,8	5,0	5,0	5,5
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C1}$	[N/mm²]	3,5	3,8	5,0	5,0	5,5

Table C15: Characteristic shear resistance for seismic performance category C1 for reinforcement bars (rebars)

Reinforcement bars (rebars)			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**
Steel failure							
Characteristic resistance	$V_{Rk,s,eq,C1}$	[kN]	0,35 • As • f_{uk}				
Partial factor	$\gamma_{Ms,V}$	[-]	max {1,25; f_{uk} / f_{yk}}				
Factor for clearance hole	α_{gap}	[-]	0,50				

RAMSET Chemset™ 801 Xtrem™ / RAMSET Chemset™ 800 Xtrem™

Performances

Characteristic values for seismic performance category C1 - rebar

Annex C10

Deutsches Institut für Bautechnik DIBt

Seismic performance category C2

The definition of seismic performance category C2 is given in FprEN 1992-4

Table C16: Characteristic tension resistance for seismic performance category C2 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Steel failure					
Characteristic resistance	$N_{Rk,s,eq,C2}$	[kN]	50	89	140
Partial factor	$\gamma_{Ms,N}$	[-]		1.5	
Combined Pull-out and Concrete cone failure					
Characteristic bond resistance (use category 1: dry or wet concrete)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C2}$	[N/mm²]	7,1	9,6	6,8
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C2}$	[N/mm²]	6,6	8,9	6,3
Characteristic bond resistance (use category 2: flooded holes)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,eq,C2}$	[N/mm²]	7,1	9,6	6,8
Temperature range II: **80°C / 50°C**	$\tau_{Rk,eq,C2}$	[N/mm²]	6,6	8,9	6,3

Table C17: Characteristic shear resistance for seismic performance category C2 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Steel failure without level arm					
Electroplated version					
Characteristic resistance	$V_{Rk,s,eq,C2}$	[kN]	23,6	44,0	68,6
Partial factor	$\gamma_{Ms,V}$	[-]		1,25	
Factor for clearance hole	α_{gap}	[-]		0,50	
Hot Dip Galvanised version					
Characteristic resistance	$V_{Rk,s,eq,C2}$	[kN]	12	22	34,3
Partial factor	$\gamma_{Ms,V}$	[-]		1,25	
Factor for clearance hole	α_{gap}	[-]		0,50	

Table C18: Displacements under seismic tension loading, seismic performance category C2 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Displacement DLS	$\delta_{N,eq\ (DLS)}$	[mm]	0,72	0,98	1,15
Displacement ULS	$\delta_{N,eq\ (ULS)}$	[mm]	1,65	2,07	3,20

Table C19: Displacements under seismic shear loading, seismic performance category C2 for CHEMSET™ XTREM™

CHEMSET™ XTREM™			M12	M16	M20
Displacement DLS	$\delta_{V,eq\ (DLS)}$	[mm]	2,01	2,63	2,99
Displacement ULS	$\delta_{V,eq\ (ULS)}$	[mm]	3,57	4,67	4,53

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Performances

Characteristic values for seismic performance category C2– CHEMSET™ XTREM™

Annex C11