Deutsches Institut für Bautechnik
DIBt

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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-17/0514 of 14 December 2017

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	SPIT VIPER XTREM / SPIT VIPER XTREM TR
Product family to which the construction product belongs	Bonded anchor for use in concrete
Manufacturer	SPIT ANCHORS & PINS INDUSTRIAL UNIT 150 route de Lyon 26501 BOURG LES VALENCE CEDEX FRANKREICH
Manufacturing plant	SPIT Route de Lyon 26500 Bourg-Les-Valence France
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	ETAG 001 Part 5: "Bonded anchors", April 2013, used as EAD according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

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Specific Part

1 Technical description of the product

The Injection system SPIT VIPER XTREM / SPIT VIPER XTREM TR is a bonded anchor consisting of a cartridge with injection mortar SPIT VIPER XTREM / SPIT VIPER XTREM TR and a steel element. The steel element consist of a threaded rod SPIT MAXIMA with washer and hexagon nut in the range of M8 to M30 or a SPIT MULTICONE 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 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	No performance assessed

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

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

In accordance with guideline for European technical approval ETAG 001, April 2013 used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011 the 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.

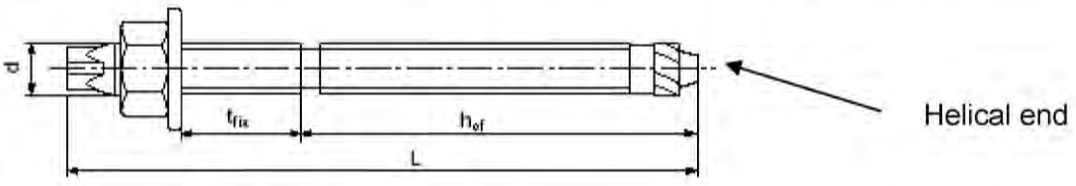
Issued in Berlin on 14 December 2017 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

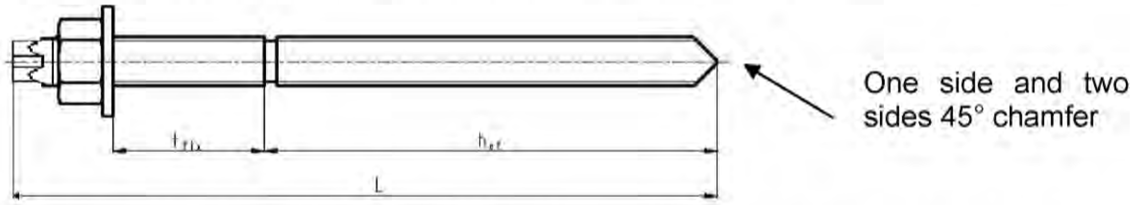
beglaubigt:
Lange

Product description: Steel elements

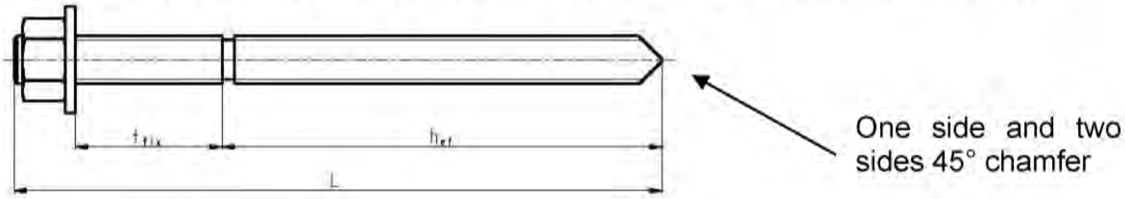
- Anchor rods SPIT MAXIMA M8 to M16 with washer and nut (Electroplated)



- Anchor rods SPIT MAXIMA M8 to M16 with washer and nut (A4)



- Anchor rods SPIT MAXIMA M20 to M30 with washer and nut (Electroplated / A4)



Marking on the anchor rod SPIT MAXIMA: letter S, bolt diameter and maximum thickness of the fixture: e.g.: S M10 / 20

Table 1: Dimensions anchor rods SPIT MAXIMA

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

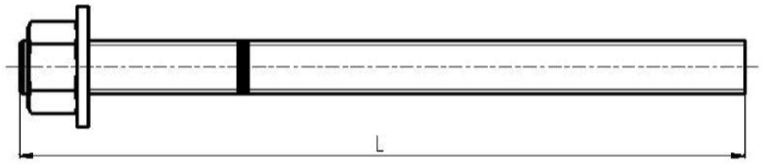
SPIT VIPER XTREM / SPIT VIPER XTREM TR

Product description
Steel elements I

Annex A1

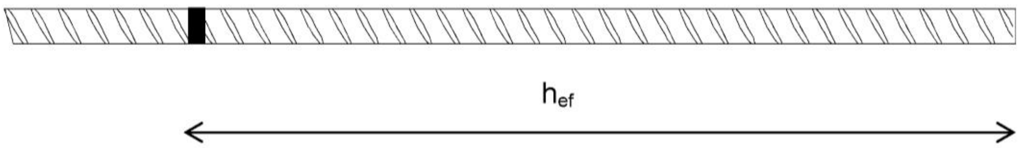
- **Commercial standard threaded rods M8 to M30 (**with washer and nut) with inspection certificate 3.1 according to EN 10204:2004
  - Materials, dimensions and mechanical properties acc. to Table A1
  - For steel grade 10.9: Proof of passed preloading test for the detection of hydrogen embrittlement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

marking of the embedment depth

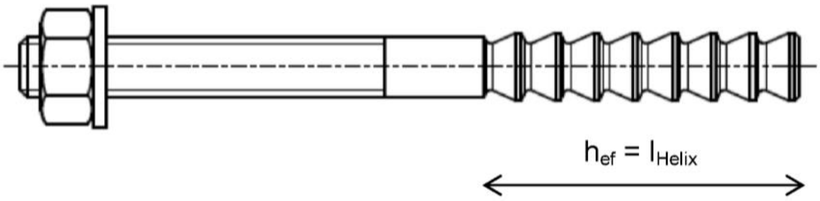


- **Rebars Ø8, Ø10, Ø12, Ø16, Ø20** with properties according to Annex C of EN 1992-1-1

marking of the embedment depth



- **SPIT MULTICONE Studs M12, M16 and M20**



SPIT VIPER XTREM / SPIT VIPER XTREM TR	**Annex A2**
Product description Steel elements II	

Injection mortar

Injection mortar SPIT VIPER XTREM 280 ml, 410 ml and 825 ml:

Vinylester adhesive - two components

Marking

- Trade name
  - **VIPER XTREM** for Regular version
  - **VIPER XTREM TR** for Tropical version
- Identifying mark of the producer **SPIT**
- Expire date
- Curing and processing time
- Charge code number

Static mixer

Turbo mixing nozzle

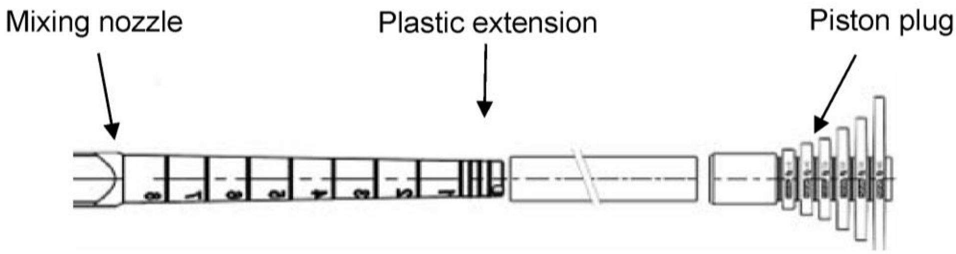
Standard Quadro mixing nozzle

High flow mixing nozzle

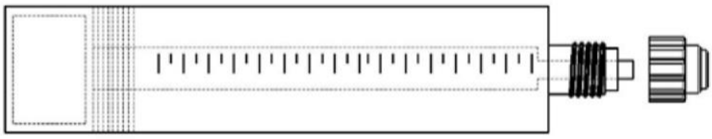
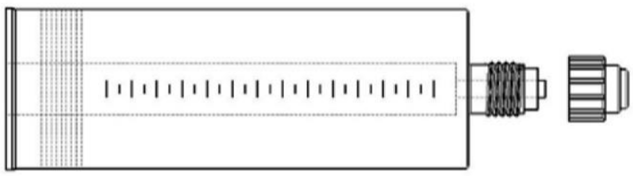
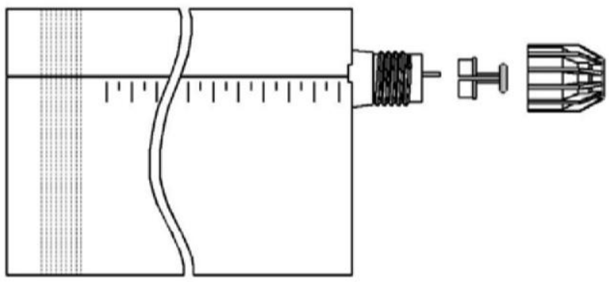
SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex A3
Product description Injection mortar	

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

280 ml coaxial cartridge	
410 ml coaxial cartridge	
825 ml side-by-side cartridge	

SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex A4
Product description Injection accessories	

Table A1: Materials

Part	Size	Material
Carbon steel		
Anchor rod **SPIT MAXIMA** with nut and washer	M8	DIN 1654 part 2 or 4, cold formed steel or NFA 35053, cold formed steel, A_5 ≥ 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 ≥ 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 ≥ 15%, Electroplated ≥ 5 µm NF E25-009 or Hot dip galvanized ≥ 45 µm NF EN ISO 1461
SPIT MULTICONE studs 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 ≥ 15%, Electroplated ≥ 5 µm acc. to ISO 4042:2017
Stainless steel (A4)		
Anchor rod **SPIT MAXIMA A4** 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

SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex A5
Product description Materials	

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 SPIT MULTICONE studs)

Base materials:

- Reinforced or unreinforced normal weight concrete of strength classes C20/25 to C50/60 acc. to EN 206-1: 2000
- Cracked or uncracked concrete

Temperature ranges:

Installation temperature: Temperature of base material: -10 °C to +40°C

In-service temperature:

SPIT VIPER 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).

SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex B1
Intended used Specifications	

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 under static and quasi-static actions are designed in accordance with
  - EOTA TR 029, September 2010
  - CEN/TS 1992-4-4:2009
- The anchorages under seismic actions are designed in accordance with
  - Technical Report TR 045, February 2013
  - 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.

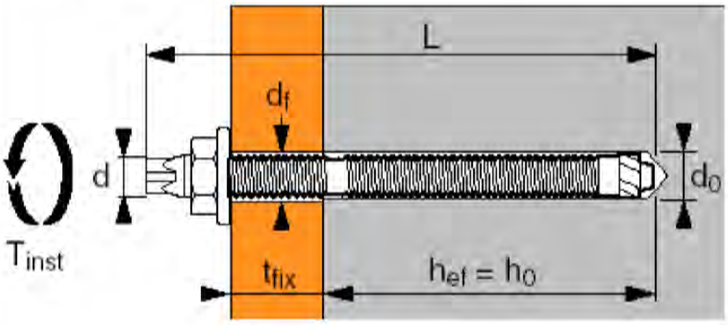
SPIT VIPER XTREM / SPIT VIPER XTREM TR

Intended used

Specifications

Annex B2

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	$h_{ef} + 2d_0$	
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 anchor rods SPIT MAXIMA.

[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

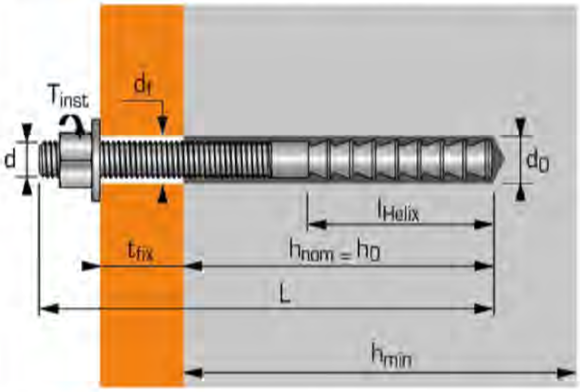
Threaded rods			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M30**
Minimum spacing	s_{min}	[mm]	40	50	60	75	90	115	140
Minimum edge distance	c_{min}	[mm]	40	45	45	50	55	60	80

SPIT VIPER XTREM / SPIT VIPER XTREM TR

Intended use
Settings data and minimum distances

Annex B3

Table B3: Installation data for SPIT MULTICONE studs



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 SPIT MULTICONE studs

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:

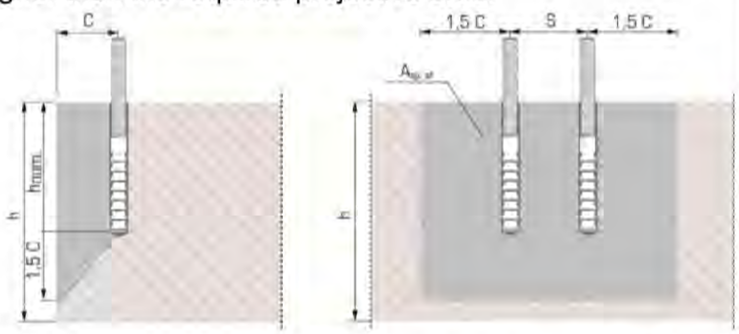
$\mathbf{A_{sp,req} \leq A_{sp,ef}}$

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

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

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

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



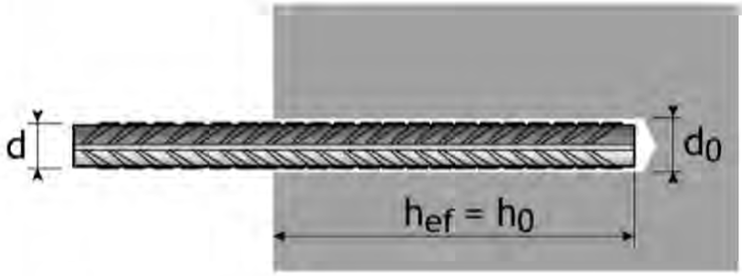
SPIT MULTICONE studs			M12	M16	M20
Absolute minimum edge distance and spacing	$s_{min} = c_{min}$	[mm]	55	60	120
Required area for uncracked concrete	$A_{sp,req}$	[mm²]	31015	44640	134400
Required area for cracked concrete	$A_{sp,req}$	[mm²]	27000	44640	134400

SPIT VIPER XTREM / SPIT VIPER XTREM TR

Intended use
Settings data and minimum distances

Annex B4

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

SPIT VIPER XTREM / SPIT VIPER XTREM TR

Intended use
Settings data and minimum distances

Annex B5

Table B7: Working time and curing time for Regular Version

Temperature of base material	Working time	Curing time in dry concrete
-10°C to -5°C	90 min	24 h
-4°C to 0°C	50 min	240 min
1°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 B8: Working time and curing time for Tropical Version:

Temperature of base material	Working time	Curing time in dry concrete
1°C to 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	60 min
31°C to 40°C	4 min	60 min

In wet concrete the curing time must be doubled

SPIT VIPER XTREM / SPIT VIPER XTREM TR

Intended use
Minimum curing time

Annex B6

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 SPIT MULTICONE studs

SPIT MULTICONE Studs				**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

SPIT VIPER XTREM / SPIT VIPER XTREM TR

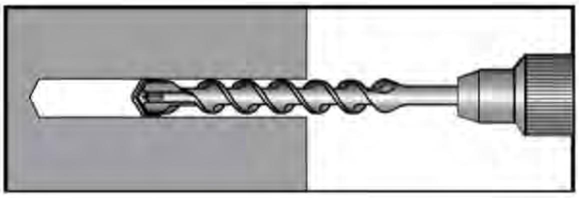
Intended use
Cleaning and installation tools

Annex B7

Installation instruction

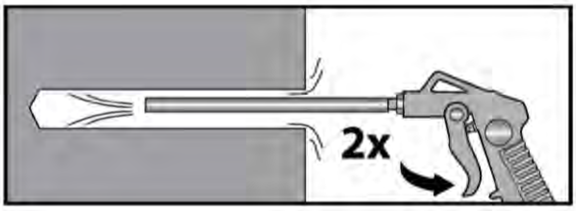
Bore hole drilling

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.

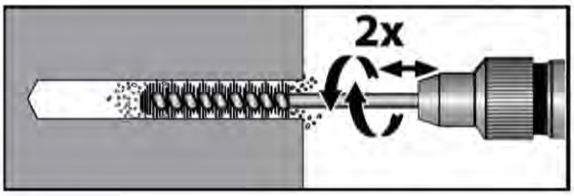


Bore hole cleaning

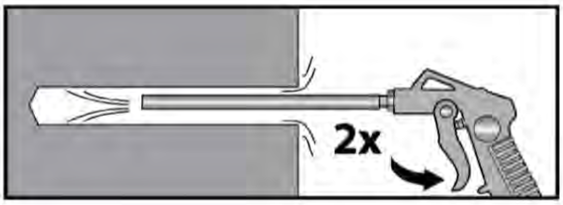
2 Using compress air cleaning (mini 6 bars), use the appropriate extension and air nozzle, starting from the bottom of the hole blow out at least 2 times and until no dust is evacuated



3 Using the relevant SPIT brush and extension fitted on a drilling machine (dimensions of the brush see table B9-B10-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.($Ø_{brush}$ > $Ø_{hole}$, if $Ø_{brush}$ is worn out, the brush must be replace by a new brush)

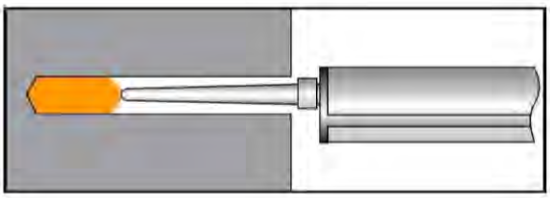


4 Using compress air cleaning (mini 6 bars), use the appropriate extension and air nozzle, starting from the bottom of the hole blow out at least 2 times and until no dust is evacuated.



Injection

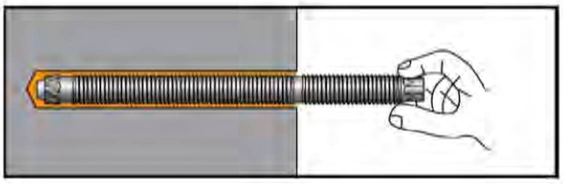
5 Screw the mixing nozzle onto the cartridge and dispense the first part to waste until an even color is achieved for each new cartridge or mixing nozzle. Use tube extensions for holes deeper than 250 mm. Starting from the bottom of the hole fill uniformly. In order to avoid air pocket, withdraw slowly 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 410 ml cartridge, the maximum pressure is 6 bars.



SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex B8
Intended use Installation instruction	

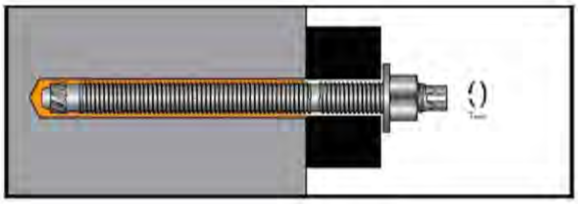
Setting the steel element

6 Insert the steel element (threaded rod, multicone studs 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.



SPIT VIPER XTREM / SPIT VIPER XTREM TR	Annex B9
Intended use Installation instruction	

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 anchor rod SPIT MAXIMA		$N_{Rk,s}$	[kN]	22	35	51	94	118	170	272
Partial factor		$\gamma_{Ms,N}$	[-]	1,71				1,49		
Characteristic resistance of anchor rod SPIT MAXIMA A4		$N_{Rk,s}$	[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]	$N_{Rk,s} = A_s \cdot f_{uk}$						
Partial factor		$\gamma_{Ms,N}$	[-]	$\gamma_{Ms,N}$ = 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
Partial factor		$\gamma_2 = \gamma_{inst}$	[-]	1,0						
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,uncr}$	[N/mm²]	15	15	15	13	11	10	8,5
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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 uncracked concrete C20/25 (use category 2: flooded holes)										
Temperature range I: **40°C / 24°C**		$\tau_{Rk,uncr}$	[N/mm²]	12,0	12,0	12,0	10,0	9,0	8,0	7,0
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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
Factor for uncracked concrete		k_8	[-]	10,1						
Factor for cracked concrete		k_8	[-]	7,2						
Increasing factor for $\tau_{Rk,p}$ 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 $\tau_{Rk,p}$ in cracked concrete		ψ_c	[-]	1,00						

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Performances
Characteristic resistance under tension load – threaded rods

Annex C1

Table C2: Characteristic values of tension resistance for static and quasi-static action for SPIT MULTICONE studs:

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
Partial factor		$\gamma_2 = \gamma_{inst}$	[-]	1,0		
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)						
Temperature range I: **40°C / 24°C**		$\tau_{Rk,uncr}$	[N/mm²]	17	17	17
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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**		$\tau_{Rk,uncr}$	[N/mm²]	17	17	17
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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
Factor for uncracked concrete		k_8	[-]	10,1		
Factor for cracked concrete		k_8	[-]	7,2		
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 and splitting failure						
Effective embedment depth		h_{ef}	[mm]	$h_{ef} = h_{nom}$		
Factor for uncracked concrete		k_{ucr}	[-]	10,1		
Factor for cracked concrete		k_{cr}	[-]	7,2		
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}		
Spacing		$s_{cr,N}$	[mm]	3 h_{ef}		
Edge distance		$c_{cr,sp}$	[mm]	$h / h_{nom} \geq 2$	$c_{cr,sp} = h_{nom}$	
				$1,3 \leq h / h_{nom} \leq 2$	$c_{cr,sp} = 5,6\ h_{nom} - 2,3.h$	
				$h / h_{nom} \leq 1,3$	$c_{cr,sp} = 2,6\ h_{nom}$	
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$		

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Performances
Characteristic resistance under tension load - SPIT MULTICONE studs

Annex C2

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]	$N_{Rk,s} = A_s \cdot f_{uk}$				
Partial factor		$\gamma_{Ms,N}$	[-]	$\gamma_{Ms,N} = \max\{1,4;\ 1,2\ f_{uk} / f_{yk}\}$				
Combined pull-out and concrete cone failure								
Diameter of threaded rod		$d = d_{nom}$	[mm]	8	10	12	16	20
Partial factor		$\gamma_2 = \gamma_{inst}$	[-]	1,0				
Characteristic bond resistance in uncracked concrete C20/25 (use category 1: dry and wet concrete)								
Temperature range I: **40°C / 24°C**		$\tau_{Rk,uncr}$	[N/mm²]	13	13	13	13	13
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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**		$\tau_{Rk,uncr}$	[N/mm²]	10	10	10	10	10
Temperature range II: **80°C / 50°C**		$\tau_{Rk,uncr}$	[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
Factor for uncracked concrete		k_8	[-]	10,1				
Factor for cracked concrete		k_8	[-]	7,2				
Increasing factor for $\tau_{Rk,p}$ in uncracked concrete	C30/37	ψ_c	[-]	1,04				
	C40/50			1,07				
	C50/60			1,09				
Increasing factor for $\tau_{Rk,p}$ in cracked concrete		ψ_c	[-]	1,00				

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Performances
Characteristic resistance under tension load - rebar

Annex C3

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 anchor rods SPIT MAXIMA	$V_{Rk,s}$	[kN]	11	17	25	47	59	85	136
Characteristic resistance for anchor rods SPIT MAXIMA A4	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	140
Characteristic resistance for commercial threaded rods	$V_{Rk,s}$	[kN]	$V_{Rk,s} = 0{,}5 \bullet A_s \bullet f_{uk}$						
Steel failure without lever arm									
Characteristic resistance for anchor rods SPIT MAXIMA	$M^0_{Rk,s}$	[Nm]	22	45	79	200	301	520	1052
Characteristic resistance for anchor rods SPIT MAXIMA A4	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1125
Characteristic resistance for commercial threaded rods	$M^0_{Rk,s}$	[Nm]	$M^0_{Rk,s} = 1{,}2 \bullet W_{el} \bullet f_{uk}$						
Partial factor for anchor rod SPIT MAXIMA	$\gamma_{Ms,V}$ 1)	[-]	1,43				1,5		
Partial factor for anchor rod SPIT MAXIMA A4	$\gamma_{Ms,V}$ 1)	[-]	1,56						2,38
Partial factor for commercial threaded rods	$\gamma_{Ms,V}$ 1)	[-]	$\gamma_{Ms,V} = \max\{1{,}25;\ f_{uk} / f_{yk}\}$						
Concrete pryout failure									
Factor	$k = k_3$	[-]	1,0 for $h_{ef} < 60mm$ 2,0 for $h_{ef} \geq 60mm$						
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0						
Concrete edge failure									
Effective length of anchor	ℓ_f	[mm]	$\ell_f = \min\{h_{ef},\ 8\ d_{nom}\}$						
Outside diameter of anchor	$d = d_{nom}$	[mm]	8	10	12	16	20	24	30
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0						

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Performances
Characteristic resistance under shear load – Threaded rods

Annex C4

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Table C5: Characteristic values of shear resistance for static and quasi-static actions for SPIT MULTICONE studs

SPIT MULTICONE studs			M12	M16	M20
Steel failure without lever arm					
Characteristic resistance	$V_{Rk,s}$	[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	$k = k_3$	[-]	1,0 for $h_{ef} < 60mm$ 2,0 for $h_{ef} \geq 60mm$		
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0		
Concrete edge failure					
Effective length of anchor	ℓ_f	[mm]	$\ell_f = \min \{h_{nom}, 8\ d_{nom})$		
Outside diameter of anchor	$d = d_{nom}$	[mm]	12	16	20
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0		

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Performances
Characteristic resistance under shear load – SPIT MULTICONE studs

Annex C5

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	$V_{Rk,s}$	[kN]	$V_{Rk,s} = 0,5\ N_{RK,s}$				
Steel failure with lever arm							
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$M^0_{Rk,s} = 1,2 \cdot W_{el} \cdot f_{uk}$				
Partial factor	$\gamma_{Ms,V}$	[-]	$\gamma_{Ms,V} = \max\{1,25;\ f_{uk}/f_{yk}\}$				
Concrete pryout failure							
Factor	$k = k_3$	[-]	1,0 for $h_{ef} < 60$mm 2,0 for $h_{ef} \geq 60$mm				
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0				
Concrete edge failure							
Effective length of anchor	ℓ_f	[mm]	$\ell_f = \min\{h_{nom},\ 8\ d_{nom}\}$				
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20
Installation factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0				

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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 SPIT MULTICONE studs

SPIT MULTICONE studs			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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Design according to TR045 under seismic category C1

The definition of seismic performance category C1 is given in Technical Report TR 045

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 anchor rods SPIT MAXIMA	$N_{Rk,s,seis}$	[kN]	22	35	51	94	118	170	272
Partial factor	$\gamma_{Ms,N}$	[-]	1,71				1,49		
Characteristic resistance for anchor rods SPIT MAXIMA A4	$N_{Rk,s,seis}$	[kN]	29	46	67	125	196	282	393
Partial factor	$\gamma_{Ms,N}$	[-]	1,60						1,87
Characteristic resistance for commercial threaded rods	$N_{Rk,s,seis}$	[kN]	$N_{Rk,s,seis} = A_s \cdot f_{uk}$						
Partial factor	$\gamma_{Ms,N}$	[-]	$\gamma_{Ms,N} = \max\{1{,}4;\ 1{,}2\ f_{uk} / f_{yk}\}$						
Combined pull-out and concrete cone failure									
Characteristic bond resistance (use category 1: dry or wet concrete)									
Temperature range I: **40°C / 24°C**	$\tau_{Rk,seis}$	[N/mm²]	6,0	6,2	6,5	6,1	6,2	6,5	6,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[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**	$\tau_{Rk,seis}$	[N/mm²]	6,0	6,2	6,0	5,7	5,3	5,0	5,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[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 anchor rods SPIT MAXIMA	$V_{Rk,s,seis}$	[kN]	8	12	18	33	41	60	82
Partial factor	$\gamma_{Ms,V}$	[-]	1,43				1,5		
Characteristic resistance for anchor rods SPIT MAXIMA A4	$V_{Rk,s,seis}$	[kN]	9	14	21	39	60	87	84
Partial factor	$\gamma_{Ms,V}$	[-]	1,56						2,38
Characteristic resistance for commercial threaded rods	$V_{Rk,s,seis}$	[kN]	$V_{Rk,s,seis} = 0{,}35 \bullet A_s \bullet f_{uk}$						
Partial factor	γ_{MsV}	[-]	$\gamma_{MsV} = \max\{1{,}4;\ 1{,}2\ f_{uk} / f_{yk}\}$						

Design according to TR045 under seismic category C1
The definition of seismic performance category C1 is given in Technical Report TR 045

Table C12: Characteristic tension resistance for seismic performance category C1 for SPIT MULTICONE studs

SPIT MULTICONE Studs			M12	M16	M20
Steel failure					
Characteristic resistance	$N_{Rk,s,seis}$	[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**	$\tau_{Rk,seis}$	[N/mm²]	17,0	13,5	12,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[N/mm²]	16,0	12,0	11,0
Characteristic bond resistance (use category 2: flooded holes)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,seis}$	[N/mm²]	17,0	13,5	12,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[N/mm²]	16,0	12,0	11,0

Table C13: Characteristic shear resistance for seismic performance category C1 for SPIT MULTICONE studs

SPIT MULTICONE Studs			M12	M16	M20
Steel failure without level arm					
Electroplated version					
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	23,6	44,0	68,6
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		
Hot Dip Galvanised version					
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	12	22	34,3
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		

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Performances
Characteristic values for seismic performance category C1 – SPIT MULTICONE studs

Annex C9

Design according to TR045 under seismic category C1

The definition of seismic performance category C1 is given in Technical Report TR 045

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	$N_{Rk,s,seis}$	[kN]	$N_{Rk,s,seis} = A_s \cdot f_{uk}$				
Partial factor	$\gamma_{Ms,N}$	[-]	$\gamma_{Ms,N}$ = 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**	$\tau_{Rk,seis}$	[N/mm²]	3,5	3,8	5,5	5,5	6,0
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[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**	$\tau_{Rk,seis}$	[N/mm²]	3,5	3,8	5,0	5,0	5,5
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[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	$V_{Rk,s,seis}$	[kN]	$V_{Rk,s,seis}$ = 0,35 • As • f_{uk}				
Partial factor	$\gamma_{Ms,V}$	[-]	$\gamma_{Ms,V}$ = max {1,25; f_{uk} / f_{yk}}				

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Performances

Characteristic values for seismic performance category C1 - rebar

Annex C10

Design according to TR045 under seismic category C2

The definition of seismic performance category C2 is given in Technical Report TR 045

Table C16: Characteristic tension resistance for seismic performance category C2 for SPIT MULTICONE studs

SPIT MULTICONE Studs			M12	M16	M20
Steel failure					
Characteristic resistance	$N_{Rk,s,seis}$	[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**	$\tau_{Rk,seis}$	[N/mm²]	7,1	9,6	6,8
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[N/mm²]	6,6	8,9	6,3
Characteristic bond resistance (use category 2: flooded holes)					
Temperature range I: **40°C / 24°C**	$\tau_{Rk,seis}$	[N/mm²]	7,1	9,6	6,8
Temperature range II: **80°C / 50°C**	$\tau_{Rk,seis}$	[N/mm²]	6,6	8,9	6,3

Table C17: Characteristic shear resistance for seismic performance category C2 for SPIT MULTICONE studs

Multicone Studs			M12	M16	M20
Steel failure without level arm					
Electroplated version					
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	23,6	44,0	68,6
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		
Hot Dip Galvanised version					
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	12	22	34,3
Partial factor	$\gamma_{Ms,V}$	[-]	1,25		

Table C18: Displacements under seismic tension loading, seismic performance category C2 for SPIT MULTICONE studs

SPIT MULTICONE Studs			M12	M16	M20
Displacement DLS	$\delta_{N,seis\ (DLS)}$	[mm]	0,72	0,98	1,15
Displacement ULS	$\delta_{N,seis\ (ULS)}$	[mm]	1,65	2,07	3,20

Table C19: Displacements under seismic shear loading, seismic performance category C2 for SPIT MULTICONE studs

SPIT MULTICONE Studs			M12	M16	M20
Displacement DLS	$\delta_{V,seis\ (DLS)}$	[mm]	2,01	2,63	2,99
Displacement ULS	$\delta_{V,seis\ (ULS)}$	[mm]	3,57	4,67	4,53

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Performances

Characteristic values for seismic performance category C2– SPIT MULTICONE studs

Annex C11