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-11/0244 of 3 November 2015

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	BTI compound mortar UVT Top-Z
Product family to which the construction product belongs	Bonded anchor in for use in concrete
Manufacturer	BTI Befestigungstechnik GmbH & Co. KG Salzstraße 51 74653 Ingelfingen DEUTSCHLAND
Manufacturing plant	BTI Herstellwerk 1 BTI manufacturing plant 1
This European Technical Assessment contains	40 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	Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 5: "Bonded anchors", April 2013, used as European Assessment Document (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 BTI compound mortar UVT Top-Z is a bonded anchor consisting of a cartridge with injection mortar BTI UVT Top-Z and a steel element. The steel element consist of

- an anchor rod UVT Top A with washer and hexagon nut of sizes M8 to M30 or
- an internal threaded anchor UVT Top I of sizes M8 to M20 or
- a reinforcing bar of sizes ϕ = 8 to 40 mm or
- a BTI rebar anchor FRA of sizes M12 to M24

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 values under static and quasi-static action for design according to TR 029 or CEN/TS 1992-4:2009, Displacements	See Annex C 1 to C 19
Characteristic values for seismic performance categories C1 and C2 for design according to Technical Report TR 045, Displacements	See Annex C 20 to C 23

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.

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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: [98/582/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 at Deutsches Institut für Bautechnik.

Issued in Berlin on 3 November 2015 by Deutsches Institut für Bautechnik

Uwe Bender
Head of Department

beglaubigt:
Baderschneider

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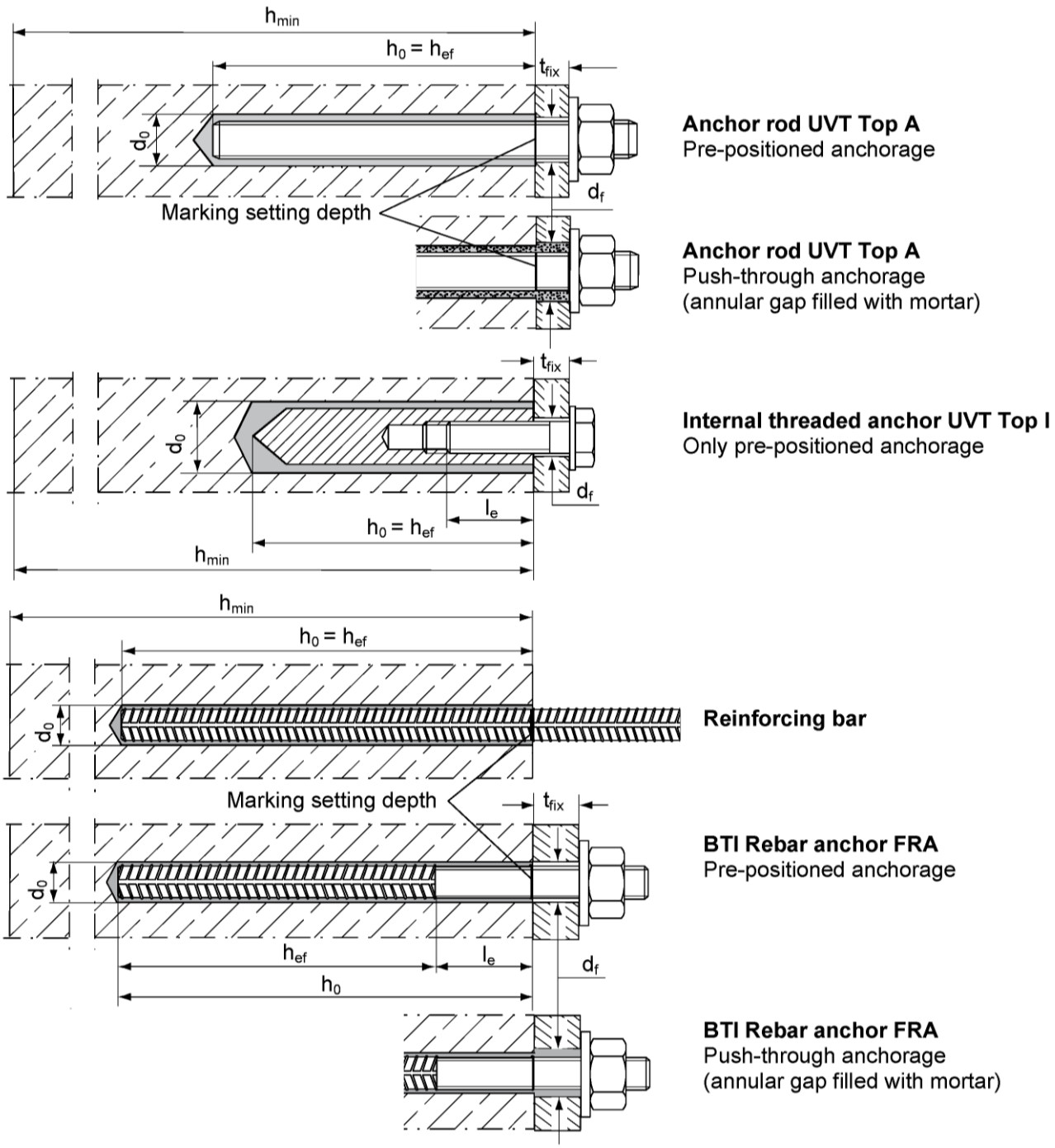
Installation conditions



BTI compound mortar UVT-Top-Z	**Annex A 1**
Product description Installation conditions	

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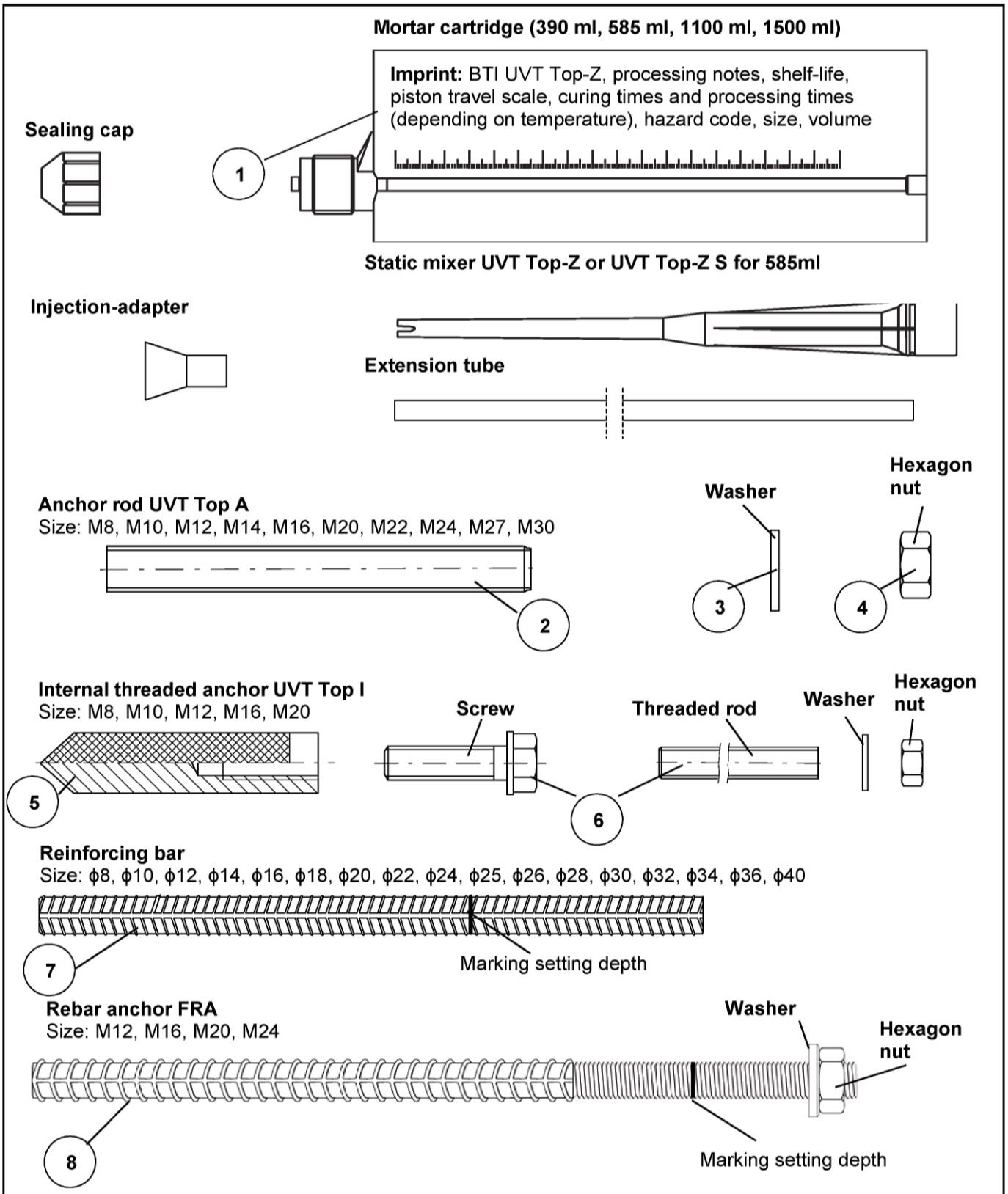

BTI compound mortar UVT-Top-Z

Product description
Cartridges/ Static mixer/ Steel elements

Annex A 2

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Table A1: Materials

Part	Designation	Material		
1	Mortar cartridge	Mortar, hardener, filler		
		Steel, zinc plated	Stainless steel A4	High corrosion-resistant steel C
2	Anchor rod Top A	Property class 5.8 or 8.8; EN ISO 898-1: 2013 zinc plated ≥ 5µm, EN ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004 f_{uk} ≤ 1000 N/mm² A_5 > 12% fracture elongation	Property class 50, 70 or 80 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; 1.4062 EN 10088-1:2014 f_{uk} ≤ 1000 N/mm² A_5 > 12% fracture elongation	Property class 50 or 80 EN ISO 3506:2009 or property class 70 with f_{yk}= 560 N/mm² 1.4565; 1.4529 EN 10088-1:2014 f_{uk} ≤ 1000 N/mm² A_5 > 12% fracture elongation
3	Washer ISO 7089:2000	zinc plated ≥ 5µm, EN ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004	1.4401; 1.4404; 1.4578;1.4571; 1.4439; 1.4362 EN 10088-1:2014	1.4565;1.4529 EN 10088-1:2014
4	Hexagon nut	Property class 5 or 8; EN ISO 898-2:2013 zinc plated ≥ 5µm, ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004	Property class 50, 70 or 80 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 EN 10088-1:2014	Property class 50, 70 or 80 EN ISO 3506:2009 1.4565; 1.4529 EN 10088-1:2014
5	Internal threaded anchor UVT Top I	Property class 5.8 or 8.8; ISO 898-1:2013 zinc plated ≥ 5µm, ISO 4042:1999 A2K	Property class 70 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 EN 10088-1:2014	Property class 70 EN ISO 3506-1:2009 1.4565; 1.4529 EN 10088-1:2014
6	Screw or threaded rod/ anchor rod for internal threaded anchor UVT Top I	Property class 5.8 or 8.8; EN ISO 898-1:2013 zinc plated ≥ 5µm, ISO 4042:1999 A2K	Property class 70 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 EN 10088-1:2014	Property class 70 EN ISO 3506-1:2009 1.4565; 1.4529 EN 10088-1:2014
7	Reinforcing bar EN 1992-1-1:2004 and AC:2010, Annex C	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$		
8	Rebar anchor FRA	Rebar part: Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$		Threaded part: Property class 70 ISO 3506:2009 1.4565; 1.4529 EN 10088-1:2014

BTI compound mortar UVT-Top-Z

Product description
Materials

Annex A 3

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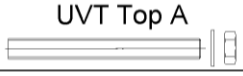
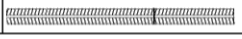
Specifications of intended use (part 1)

Table B1: Overview use categories and performance categories

Anchorages subject to		BTI UVT Top–Z with …							
		Anchor rod UVT Top A 		Internal threaded anchor UVT Top I		Reinforcing bar 		Rebar anchor FRA	
Hammer drilling		all sizes							
Diamond drilling		all sizes							
Static and quasi static load, in	un-cracked concrete	all sizes	Tables: C1, C2, C9, C10	all sizes	Tables: C3, C4, C11, C12	all sizes	Tables: C5, C6, C13, C14	all sizes	Tables: C7, C8, C15, C16
	cracked concrete								
Seismic performance category (only hammer drilling)	C1	M10 – M30	Table C17	--------		ϕ10 - ϕ 32	Table C18	-----	
	C2	M12, M16, M20, M24	Table C19			-----	----		
Use category	Dry or wet concrete	all sizes							
	Flooded hole	all sizes							
Installation temperature		+5°C to +40°C							
Service temperature	Temperature range I	-40°C to +60°C		(max. long term temperature +35°C and max. short term temperature +60°C)					
	Temperature range II	-40°C to +72°C		(max. long term temperature +50°C and max. short term temperature +72°C)					

Base materials:
- Reinforced or unreinforced normal weight concrete according to EN 206:2013
- Strength classes C20/25 to C50/60 according to EN 206:2013

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 condition, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel)
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel)
  Note: 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)

BTI compound mortar UVT-Top-Z	**Annex B 1**
Intended Use Specifications (part 1)	

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Specifications of intended use (part 2)

Design:

- Anchorages have to be designed under the responsibility of an engineer experienced in anchorages and concrete work
- 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 (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages under static or quasi-static actions are designed in accordance with EOTA Technical Report TR 029 "Design of bonded anchors" Edition September 2010 or CEN/TS 1992-4:2009
- Anchorages under seismic actions (cracked concrete) have to be designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition 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 are not allowed.

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- In case of aborted hole: The hole shall be filled with mortar
- Marking and keeping the effective anchorage depth
- Overhead installation is allowed

BTI compound mortar UVT-Top-Z	**Annex B 2**
Intended Use Specifications (part 2)	

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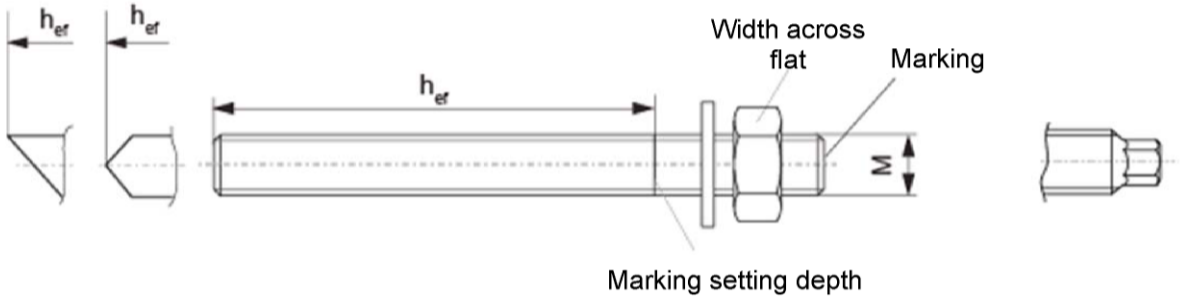
Table B2: Installation parameters for anchor rods

Size			[-]	**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Width across flat		SW		13	17	19	22	24	30	32	36	41	46
Nominal drill bit diameter		d_0	[mm]	12	14	14	16	18	24	25	28	30	35
Depth of drill hole		h_0	[mm]	$h_0 = h_{ef}$									
Effective anchorage depth		$h_{ef,min}$	[mm]	60	60	70	75	80	90	93	96	108	120
		$h_{ef,max}$	[mm]	160	200	240	280	320	400	440	480	540	600
Minimum spacing and minimum edge distance		$s_{min} = c_{min}$	[mm]	40	45	55	60	65	85	95	105	120	140
Diameter of clearance hole in the fixture[1)]	pre-positioned anchorage	d_f	[mm]	9	12	14	16	18	22	24	26	30	33
	Push through anchorage	d_f	[mm]	14	16	16	18	20	26	28	30	33	40
Minimum thickness of concrete member		h_{min}	[mm]	$h_{ef} + 30 \geq 100$			$h_{ef} + 2d_0$						
Maximum torque moment		$T_{inst,max}$	[Nm]	10	20	40	50	60	120	135	150	200	300

[1)] For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

Anchor rod UVT Top A:



Marking (on random place):
Property class 8.8, stainless steel, property class 80 or high corrosion-resistant steel, property class 80: •
Stainless steel A4, property class 50 and high corrosion-resistant steel, property class 50: ••

Commercial standard threaded rods, washers and hexagon nuts may also be used if the following requirements are fulfilled:
- Materials, dimensions and mechanical properties according Annex A 3, Table A1
- Inspection certificate 3.1 according to EN 10204:2004, the documents should be stored
- Marking of embedment depth

BTI compound mortar UVT-Top-Z

Intended Use
Installation parameters anchor rods

Annex B 3

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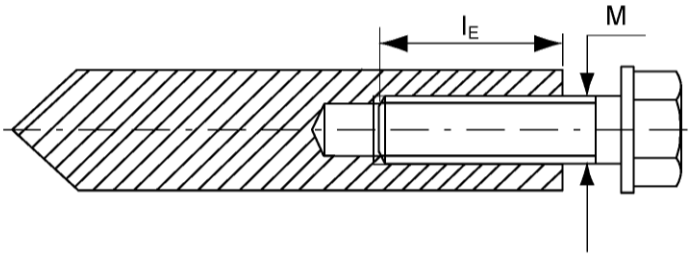
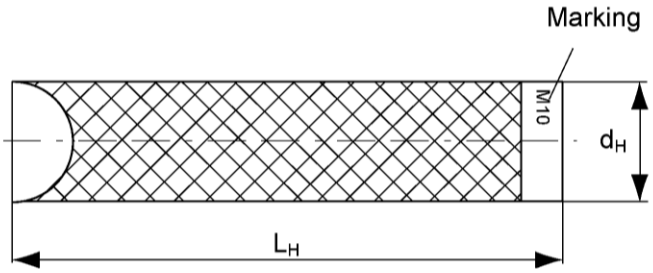
Table B3: Installation parameters internal threaded anchors UVT Top I

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Diameter of anchor	d_H	[mm]	12	16	18	22	28
Nominal drill bit diameter	d_0	[mm]	14	18	20	24	32
Drill hole depth	h_0	[mm]	$h_0 = h_{ef}$				
Effective anchorage depth ($h_{ef} = L_H$)	h_{ef}	[mm]	90	90	125	160	200
Maximum torque moment	$T_{inst,max}$	[Nm]	10	20	40	80	120
Minimum spacing and minimum edge distance	$s_{min} = c_{min}$	[mm]	55	65	75	95	125
Diameter of clearance hole in the fixture[1)]	d_f	[mm]	9	12	14	18	22
Minimum thickness of concrete member	h_{min}	[mm]	120	125	165	205	260
Maximum screw-in depth	$l_{E,max}$	[mm]	18	23	26	35	45
Minimum screw-in depth	$l_{E,min}$	[mm]	8	10	12	16	20

[1)] For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

Internal threaded anchor UVT Top I





Marking: Anchor size
e.g.: **M10**
Stainless steel additional **A4**
e.g.: **M10 A4**
High corrosion-resistant steel additional **C**
e.g.: **M10 C**

Fastening screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of Table A1

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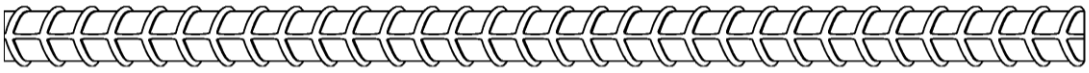
Table B4: Installation parameters reinforcing bars

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Nominal drill bit diameter		d_0	[mm]	12	14	16	18	20	25	25	30	30
Drill hole depth		h_0	[mm]	$h_0 = h_{ef}$								
Effective anchorage depth		$h_{ef,min}$	[mm]	60	60	70	75	80	85	90	94	98
		$h_{ef,max}$	[mm]	160	200	240	280	320	360	400	440	480
Minimum spacing and minimum edge distance		$s_{min} = c_{min}$	[mm]	40	45	55	60	65	75	85	95	105
Minimum thickness of concrete member		h_{min}	[mm]	$h_{ef} + 30 \geq 100$		$h_{ef} + 2d_0$						

Reinforcing bar			**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Nominal drill bit diameter		d_0	[mm]	30	35	35	40	40	40	45	55
Drill hole depth		h_0	[mm]	$h_0 = h_{ef}$							
Effective anchorage depth		$h_{ef,min}$	[mm]	100	104	112	120	128	136	144	160
		$h_{ef,max}$	[mm]	500	520	560	600	640	680	720	800
Minimum spacing and minimum edge distance		$s_{min} = c_{min}$	[mm]	110	120	130	140	160	170	180	200
Minimum thickness of concrete member		h_{min}	[mm]	$h_{ef} + 2d_0$							

Reinforcing bar



- The minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- The maximum outer rebar diameter over the rips shall be:
  - The nominal diameter of the rip $\phi + 2 * h$ ($h \leq 0{,}07 * \phi$)
  - (ϕ: Nominal diameter of the bar; h: rip height of the bar)

BTI compound mortar UVT-Top-Z

Intended Use
Installation parameters reinforcing bars

Annex B 5

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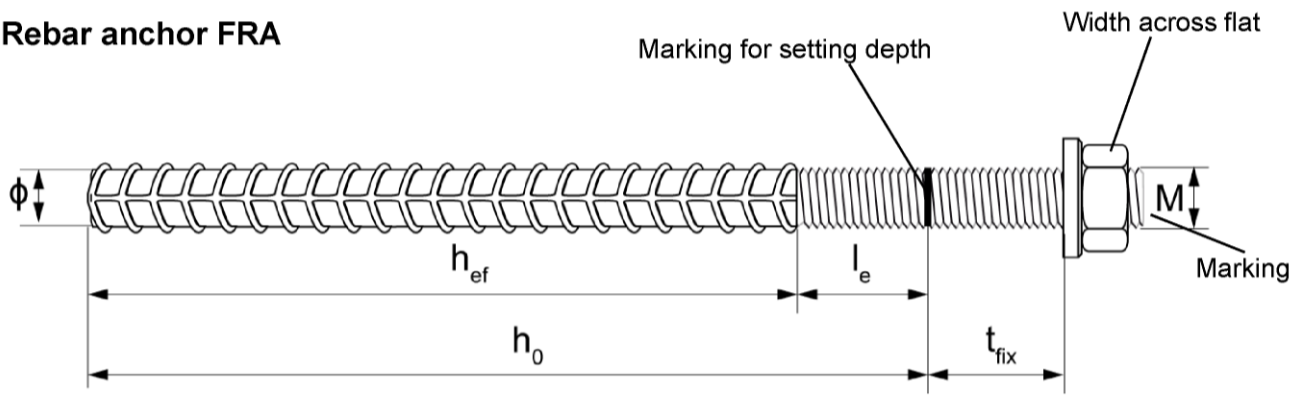
Table B5: Installation parameters rebar anchor FRA

Thread diameter			**M12**	**M16**	**M20**	**M24**
Nominal bar size	ϕ	[mm]	12	16	20	25
Width across flat	SW	[mm]	19	24	30	36
Nominal drill bit diameter	d_0	[mm]	16	20	25	30
Depth of drill hole ($h_0 = l_{ges}$)	h_0	[mm]	$h_{ef} + l_e$			
Effective anchorage depth	$h_{ef,min}$	[mm]	70	80	90	96
	$h_{ef,max}$	[mm]	140	220	300	380
Distance concrete surface to welded join	l_e	[mm]	100			
Minimum spacing and minimum edge distance	$s_{min}=c_{min}$	[mm]	55	65	85	105
Diameter of clearance hole in the fixture[1)]	pre-positioned anchorage $\leq d_f$	[mm]	14	18	22	26
	push through anchorage $\leq d_f$	[mm]	18	22	26	32
Minimum thickness of concrete member	h_{min}	[mm]	$h_0 + 30$ ≥ 100	$h_0 + 2d_0$		
Maximum torque moment	$T_{inst,max}$	[Nm]	40	60	120	150

[1)] For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

Rebar anchor FRA



Marking: on head e.g.: FRA (for stainless steel);
FRA C (for high corrosion-resistant steel)

BTI compound mortar UVT-Top-Z

Intended Use
Installation parameters rebar anchor FRA

Annex B 6

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Table B6: Parameters of steel brush

Drill bit diameter	[mm]	12	14	16	18	20	24	25	28	30	32	35	40	45	55
Steel brush diameter d_b	[mm]	14	16	20		25	26	27	30	40			42	47	58

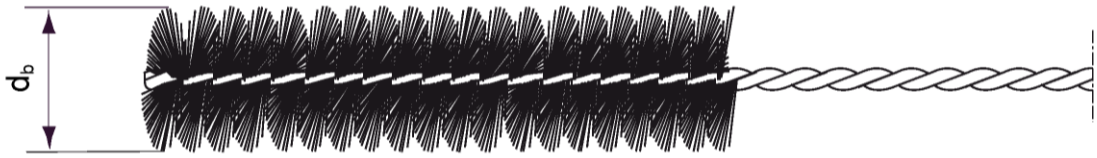

Table B7: Maximum processing time of the mortar and minimum curing time

System temperature [°C]	Maximum processing time t_{work} [minutes]	Minimum curing time[1)] t_{cure} [hours]
+5 to +10	120	40
≥ +10 to +20	30	18
≥ +20 to +30	14	10
≥ +30 to +40	7	5

[1)] In wet concrete or flooded holes the curing times must be doubled.

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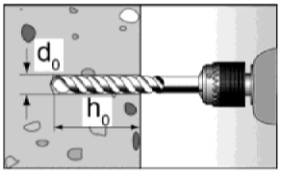
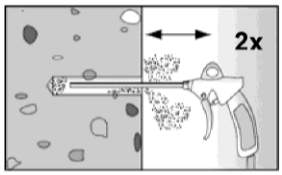
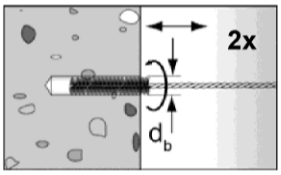
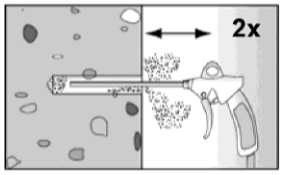
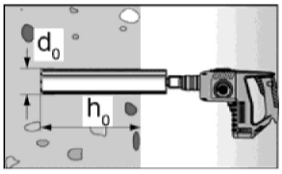
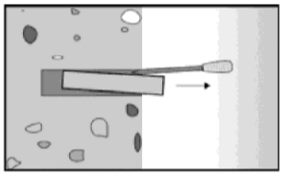
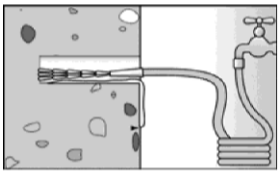
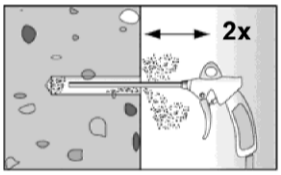
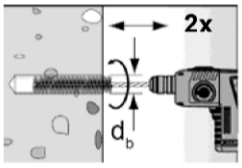
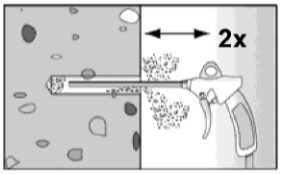
Installation instructions part 1
Drilling and cleaning the hole (hammer drill)

1		Drill the hole. Drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$ see **Tables B2, B3, B4, B5**.
2		Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air (p ≥ 6 bar)
3		Brush the drill hole two times. For drill hole diameter ≥ 30 mm use a power drill. For deep holes use an extension. Corresponding brushes see **Table B6**
4		Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air (p ≥ 6 bar)

Drilling and cleaning the hole (drilling with diamond drill bit)

1		Drill the hole. Drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$ see **Tables B2, B3, B4, B5.**		Break the drill core and draw it out.
2		Flush the drill hole until the water comes clear.		
3		Blow out the drill hole two times, using oil-free compressed air (p > 6 bar)	4 	Brush the drill hole two times using a power drill. Corresponding brushes see **Table B6**
5		Blow out the drill hole two times, using oil-free compressed air (p > 6 bar)		

BTI compound mortar UVT-Top-Z

Intended use
Installation instructions part 1

Annex B 8

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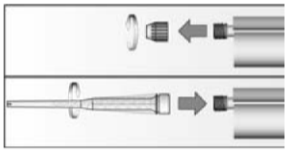
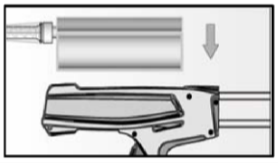
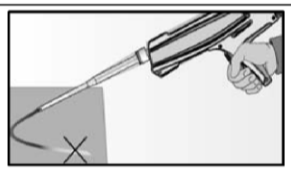
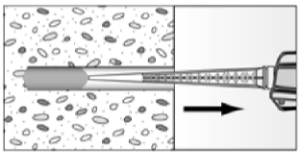
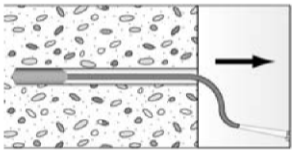
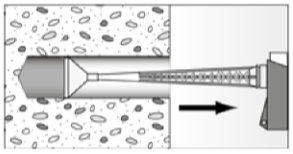
Installation instructions part 2

Preparing the cartridge

6			Twist off the sealing cap Twist on the static mixer (the spiral in the static mixer must be clearly visible).
7			Place the cartridge into the dispenser.
8			Press approximately 10 cm of material out until the resin is evenly grey in colour. Don`t use mortar that is not uniformly grey.

Injection of the mortar

9	 Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles.	 For drill hole depth ≥ 150 mm use an extension tube.	 For overhead installation, deep holes h_0 > 250 mm or drill hole diameter d_0 ≥ 40 mm use an injection-adapter.

BTI compound mortar UVT-Top-Z	**Annex B 9**
Intended use Installation instructions part 2	

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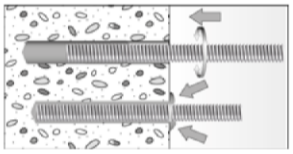
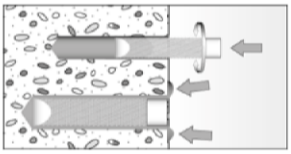
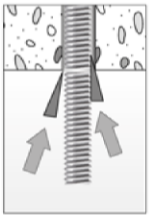
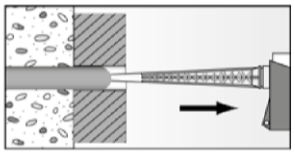
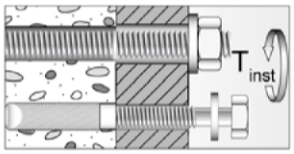
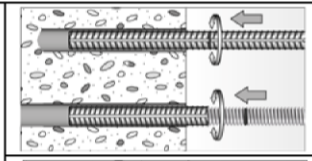
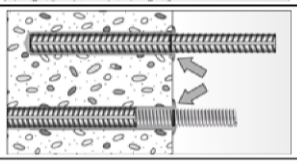
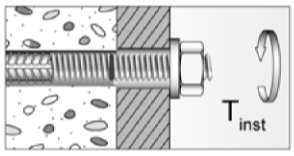
Installation instructions part 3

Installation anchor rods or internal threaded anchors UVT Top I

10	 	Only use clean and oil-free anchor elements. Mark the setting depth of the anchor. Press the threaded rod or internal threaded anchor down to the bottom of the hole, turning it slightly while doing so. After inserting the anchor element, excess mortar must emerge around the anchor element.
	 For overhead installation fasten the anchor rod with wedges until the mortar begins to harden	 For push-through installation fill the annular gap also with mortar
11	Wait for the specified curing time t_{cure} see **Table B7**.	 Mounting the fixture $T_{inst,max}$ see **Tables B2 and B3.**

Installation reinforcing bars and rebar anchor FRA

9		Only use clean and oil-free reinforcing bars or FRA. Mark the setting depth. Using a turning movement, push the reinforcing bar or the FRA vigorously into the filled hole up to the insertion depth marking.
		When reaching the setting depth mark, excess mortar must emerge from the mouth of the drill hole.
10	Wait for the specified curing time t_{cure} see **Table B7**.	 Mounting the fixture $T_{inst,max}$ see **Table B5.**

BTI compound mortar UVT-Top-Z	**Annex B 10**
Intended use Installation instructions part 3	

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Table C1: Characteristic values of resistance for anchor rods under tension load (un-cracked concrete)

Size				M8	M10	M12	M14	M16	M20	M22	M24	M27	M30
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0						1,2			
	flooded hole		[-]	1,4									
Steel failure													
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$									
Combined pullout and concrete cone failure													
Diameter of calculation		d	[mm]	8	10	12	14	16	20	22	24	27	30
Characteristic bond resistance in un-cracked concrete C20/25													
Hammer-drilling (dry and wet concrete)													
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	16	15	14	14	13	13	13	12	12
Temperature rangel II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	13	12	12	12	11	11
Hammer-drilling (flooded hole)													
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	16	15	13	13	11	11	10	10	9
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	12	11	10	10	9	9
Diamond-drilling (dry and wet concrete)													
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	15	13	12	12	10	10	10	9	9
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	12	11	11	10	9	9	8	8
Diamond-drilling (flooded hole)													
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	15	13	12	12	10	10	10	9	9
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	12	11	11	10	9	9	8	8
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1									
Increasing factor for τ_{Rk}		Ψ_c	C25/30	[-]	1,02								
			C30/37	[-]	1,04								
			C35/45	[-]	1,06								
			C40/50	[-]	1,07								
			C45/55	[-]	1,08								
			C50/60	[-]	1,09								
Splitting failure													
Edge distance		$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$								
			$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$								
			$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$								
Axial distance		$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$								

[1)] See Annex B 1

BTI compound mortar UVT-Top-Z

Performances
Characteristic values for static or quasi-static action under tension load for anchor rods (un-cracked concrete)

Annex C 1

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Table C1.1: Characteristic values of resistance for anchor rods under tension load (cracked concrete)

Size				**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0						1,2			
	flooded hole		[-]	1,2					1,4				
Steel failure													
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$									
Combined pullout and concrete cone failure													
Diameter of calculation		d	[mm]	8	10	12	14	16	20	22	24	27	30
Characteristic bond resistance in cracked concrete C20/25													
Hammer-drilling and diamond drilling (dry and wet concrete)													
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	7	7	7	6	6	7	7	7	7
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	7	7	7	6	6	7	7	7	7
Hammer-drilling and diamond drilling (flooded hole)													
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	6	7,5	7,5	7	6	6	6	6	6	6
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	6	7	7	7	6	6	6	6	6	6
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{cr}	[-]	7,2									
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02									
		C30/37	[-]	1,04									
		C35/45	[-]	1,06									
		C40/50	[-]	1,07									
		C45/55	[-]	1,08									
		C50/60	[-]	1,09									
Splitting failure													
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$									
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$									
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$									
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$									

[1)] See Annex B 1

BTI compound mortar UVT-Top-Z

Performances
Characteristic values for static or quasi-static action under tension load for anchor rods (cracked concrete)

Annex C 2

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Table C2: Characteristic values of resistance for anchor rods under shear load

Size			**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0									
Steel failure without lever arm												
Characteristic steel resistance	$V_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$									
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]	0,8									
Steel failure with lever arm												
Characteristic bending moment[1)]	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$									
Concrete pryout failure												
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0									
Concrete edge failure												
The value of h_{ef} for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by:			min (h_{ef}; 8d)									
Diameter of calculation	d	[mm]	8	10	12	14	16	20	22	24	27	30

BTI compound mortar UVT-Top-Z

Performances
Characteristic values for static or quasi-static action under shear load foranchor rods

Annex C 3

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Table C3: Characteristic values of resistance for internal threaded anchors UVT Top I under tension load (un-cracked concrete)

Size				**M8**	**M10**	**M12**	**M16**	**M20**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0			1,2	
	flooded hole		[-]	1,2			1,4	
Steel failure								
Characteristic resistance with screw		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$				
Combined pullout and concrete cone failure								
Diameter of calculation		d	[mm]	12	16	18	22	28
Characteristic bond resistance in un-cracked concrete C20/25								
Hammer-drilling (dry and wet concrete)								
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	12
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	14	13	13	12	11
Hammer-drilling (flooded hole)								
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	14	12	12	11	10
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	13	12	11	10	9
Diamond-drilling (dry and wet concrete)								
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	13	12	11	10	9
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	12	11	10	9	8
Diamond-drilling (flooded hole)								
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	13	12	11	10	9
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	12	11	10	9	8
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1				
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02				
		C30/37	[-]	1,04				
		C35/45	[-]	1,06				
		C40/50	[-]	1,07				
		C45/55	[-]	1,08				
		C50/60	[-]	1,09				
Splitting failure								
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$				
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$				
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$				
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$				

[1)] See Annex B 1

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BTI compound mortar UVT-Top-Z

Performances
Characteristic values for static or quasi-static action under tension load for internal threaded anchors UVT Top I (un-cracked concrete)

Annex C 4

Table C3.1: Characteristic values of resistance for internal threaded anchors UVT Top I under tension load (cracked concrete)

Size				**M8**	**M10**	**M12**	**M16**	**M20**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0			1,2	
	flooded hole		[-]	1,2			1,4	
Steel failure								
Characteristic resistance with screw		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$				
Combined pullout and concrete cone failure								
Diameter of calculation		d_H	[mm]	12	16	18	22	28
Characteristic bond resistance in cracked concrete C20/25								
Hammer-drilling and diamond drilling (dry and wet concrete)								
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	6	6	7	7
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	6	6	7	7
Hammer-drilling and diamond drilling (flooded hole)								
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	6,5	6	6	6
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	6	6	6	6
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{cr}	[-]	7,2				
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02				
		C30/37	[-]	1,04				
		C35/45	[-]	1,06				
		C40/50	[-]	1,07				
		C45/55	[-]	1,08				
		C50/60	[-]	1,09				
Splitting failure								
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$				
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$				
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$				
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$				

[1)] See Annex B 1

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BTI compound mortar UVT-Top-Z

Performances
Characteristic values for static or quasi-static action under tension load for internal threaded anchors UVT Top I (cracked concrete)

Annex C 5

Table C4: Characteristic values of resistance for internal threaded anchors UVT Top I under shear load

Size			**M8**	**M10**	**M12**	**M16**	**M20**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0				
Steel failure without lever arm							
Characteristic resistance with screw	$V_{Rk,s}$	[-]	$0{,}5 \cdot A_s \cdot f_{uk}$				
Ductility factor acc. to CEN/TS 1992-4-5: 2009 Section 6.3.2.1	k_2	[-]	0,8				
Steel failure with lever arm							
Characteristic bending moment with screw	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$				
Concrete pryout failure							
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0				
Concrete edge failure							
The value of h_{ef} for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by:			min (h_{ef}; 8d)				
Diameter of calculation	d	[mm]	12	16	18	22	28

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Characteristic values for static or quasi-static action under shear load for internal threaded anchors UVT Top I

Annex C 6

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Table C5: Characteristic values of resistance for reinforcing bars under tension loads (hammer-drilling; un-cracked concrete; ϕ 8- ϕ 24)

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	γ_2 = γ_{inst}	[-]	1,0							1,2	
	flooded hole		[-]	1,4								
Steel failure												
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$								
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	8	10	12	14	16	18	20	22	24
Characteristic bond resistance in un-cracked concrete												
Hammer-drilling (dry and wet concrete)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	16	15	14	14	14	13	13	13
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	13	13	12	12	12
Hammer-drilling (flooded hole)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	16	14	13	12	12	11	11	10
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	13	12	11	12	11	10	10
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1								
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02								
		C30/37	[-]	1,04								
		C35/45	[-]	1,06								
		C40/50	[-]	1,07								
		C45/55	[-]	1,08								
		C50/60	[-]	1,09								
Splitting failure												
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$								
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$								
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$								
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$								

[1)] See Annex B 1

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Performances
Characteristic values in static or quasi-static action under tension load for rebars (hammer-drilling; un-cracked concrete; ϕ 8- ϕ 24)

Annex C 7

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Table C5.1: Characteristic values of resistance for reinforcing bars under tension loads (hammer-drilling; un-cracked concrete ϕ 25- ϕ 40)

Reinforcing bar			**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,2							
	flooded hole		[-]	1,4							
Steel failure											
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$							
Combined pullout and concrete cone failure											
Diameter of calculation		d	[mm]	25	26	28	30	32	34	36	40
Characteristic bond resistance in un-cracked concrete											
Hammer-drilling (dry and wet concrete)											
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	13	13	13	12	12	12	12	12
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	12	11	11	11	11	11	11	10
Hammer-drilling (flooded hole)											
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	10	10	10	9	9	9	8	8
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	9	9	9	9	8	8	8	8
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1							
Increasing factor for τ_{Rk}	C25/30	Ψ_c	[-]	1,02							
	C30/37		[-]	1,04							
	C35/45		[-]	1,06							
	C40/50		[-]	1,07							
	C45/55		[-]	1,08							
	C50/60		[-]	1,09							
Splitting failure											
Edge distance	$h / h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$							
	$2{,}0 > h / h_{ef} > 1{,}3$		[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$							
	$h / h_{ef} \leq 1{,}3$		[mm]	$2{,}26\ h_{ef}$							
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							

[1)] See Annex B 1

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Performances
Characteristic values in static or quasi-static action under tension load for rebars (hammer-drilling; un-cracked concrete; ϕ 25- ϕ 40)

Annex C 8

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Table C5.2: Characteristic values of resistance for reinforcing bars under tension loads (diamond-drilling; un-cracked concrete ϕ 8- ϕ 24)

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0							1,2	
	flooded hole		[-]	1,4								
Steel failure												
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$								
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	8	10	12	14	16	18	20	22	24
Characteristic bond resistance in un-cracked concrete												
Diamond-drilling (dry and wet concrete)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	15	13	12	12	11	10	10	10
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	12	11	11	10	10	9	9
Diamond-drilling (flooded hole)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	16	15	13	12	12	11	10	10	10
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	12	11	11	10	10	9	9
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1								
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02								
		C30/37	[-]	1,04								
		C35/45	[-]	1,06								
		C40/50	[-]	1,07								
		C45/55	[-]	1,08								
		C50/60	[-]	1,09								
Splitting failure												
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$								
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$								
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$								
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$								

[1)] See Annex B 1

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BTI compound mortar UVT-Top-Z

Performances
Characteristic values in static or quasi-static action under tension load for rebars (diamond-drilling; un-cracked concrete; ϕ 8- ϕ 24)

Annex C 9

Table C5.3: Characteristic values of resistance for reinforcing bars under tension loads (diamond-drilling; un-cracked concrete ϕ 25- ϕ 40)

Reinforcing bar			ϕ	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,2							
	flooded hole		[-]	1,4							
Steel failure											
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$							
Combined pullout and concrete cone failure											
Diameter of calculation		d	[mm]	25	26	28	30	32	34	36	40
Characteristic bond resistance in un-cracked concrete C20/25											
Diamond-drilling (dry and wet concrete)											
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	9	9	9	9	8	8	8	7
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	9	8	8	8	8	7	7	7
Diamond-drilling (flooded hole)											
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	9	9	9	9	8	8	8	7
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	9	8	8	8	8	7	7	7
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1							
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02							
		C30/37	[-]	1,04							
		C35/45	[-]	1,06							
		C40/50	[-]	1,07							
		C45/55	[-]	1,08							
		C50/60	[-]	1,09							
Splitting failure											
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$							
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$							
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$							
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$							

[1)] See Annex B 1

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Performances
Characteristic values in static or quasi-static action under tension load for rebars (diamond-drilling; un-cracked concrete; ϕ 25- ϕ 40)

Annex C 10

Table C5.4: Characteristic values of resistance for reinforcing bars under tension loads (hammer-drilling and diamond-drilling; cracked concrete ϕ 8- ϕ 24)

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0							1,2	
	flooded hole		[-]	1,2						1,4		
Steel failure												
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$								
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	8	10	12	14	16	18	20	22	24
Characteristic bond resistance in cracked concrete												
Hammer-drilling and diamond-drilling (dry and wet concrete)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	7	7	7	7	6	6	6	7	7
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	7	7	7	7	6	6	6	7	7
Hammer-drilling and diamond-drilling (flooded hole)												
Temperature range I[1)]		$\tau_{Rk,ucr}$	[N/mm²]	6	7,5	6,5	6,5	6,5	6	6	6	6
Temperature range II[1)]		$\tau_{Rk,ucr}$	[N/mm²]	6	6,5	6,5	6	6	6	6	6	6
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{cr}	[-]	7,2								
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02								
		C30/37	[-]	1,04								
		C35/45	[-]	1,06								
		C40/50	[-]	1,07								
		C45/55	[-]	1,08								
		C50/60	[-]	1,09								
Splitting failure												
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$								
		$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$								
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$								
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$								

[1)] See Annex B 1

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Performances
Characteristic values in static or quasi-static action under tension load for rebars (hammer-drilling and diamond-drilling; cracked concrete; ϕ 8- ϕ 24)

Annex C 11

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Table C5.5: Characteristic values of resistance for reinforcing bars under tension loads (hammer-drilling and diamond-drilling; cracked concrete ϕ 25- ϕ 40)

Reinforcing bar			ϕ	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Installation safety factor	dry and wet concrete	γ_2 = γ_{inst}	[-]	1,2							
	flooded hole		[-]	1,4							
Steel failure											
Characteristic steel resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$							
Combined pullout and concrete cone failure											
Diameter of calculation		d	[mm]	25	26	28	30	32	34	36	40
Characteristic bond resistance in cracked concrete C20/25											
Hammer-drilling and diamond drilling (dry and wet concrete)											
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	7	7	7	5	5	5	5
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	7	7	7	7	5	5	5	5
Hammer-drilling and diamond drilling (flooded hole)											
Temperature range I[1)]		$\tau_{Rk,cr}$	[N/mm²]	6	6	6	6	5	5	5	5
Temperature range II[1)]		$\tau_{Rk,cr}$	[N/mm²]	6	6	6	6	5	5	5	5
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{cr}	[-]	7,2							
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02							
		C30/37	[-]	1,04							
		C35/45	[-]	1,06							
		C40/50	[-]	1,07							
		C45/55	[-]	1,08							
		C50/60	[-]	1,09							
Splitting failure											
Edge distance $c_{cr,sp}$		$h / h_{ef} \geq 2,0$	[mm]	$1,0\ h_{ef}$							
		$2,0 > h / h_{ef} > 1,3$	[mm]	$4,6\ h_{ef} - 1,8\ h$							
		$h / h_{ef} \leq 1,3$	[mm]	$2,26\ h_{ef}$							
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							

[1)] See Annex B 1

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Performances
Characteristic values in static or quasi-static action under tension load for rebars (hammer-drilling and diamond-drilling; cracked concrete; ϕ 25- ϕ 40)

Annex C 12

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Table C6: Characteristic values of resistance for reinforcing bars under shear load (ϕ 8- ϕ 24)

Reinforcing bar		ϕ	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0								
Steel failure without lever arm											
Characteristic steel resistance	$V_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$								
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]	0,8								
Steel failure with lever arm											
Characteristic bending moment	$M^0_{Rk,s}$	[kN]	$1{,}2 \cdot W_{el} \cdot f_{uk}$								
Concrete pryout failure											
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0								
Concrete edge failure											
The value of h_{ef} for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by:			min (h_{ef}; 8d)								
Diameter of calculation	d	[mm]	8	10	12	14	16	18	20	22	24

Table C6.1: Characteristic values of resistance for reinforcing bars under shear load(ϕ 25- ϕ 40)

Reinforcing bar		ϕ	**25**	**26**	**28**	**30**	**32**	**34**	**26**	**40**
Installation safety factor	γ_2	[-]	1,0							
Steel failure without lever arm										
Characteristic steel resistance	$V_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$							
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	K_2	[-]	0,8							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s}$	[kN]	$1{,}2 \cdot W_{el} \cdot f_{uk}$							
Concrete pryout failure										
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0							
Concrete edge failure										
The value of h_{ef} for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by:			min (h_{ef}; 8d)							
Diameter of calculation	d	[mm]	25	26	28	30	32	34	26	40

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Performances
Characteristic values in static or quasi-static action of rebars under shear loads

Annex C 13

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Table C7: Characteristic values of resistance for rebar anchors FRA under tension loads (un-cracked concrete)

Size				M12	M16	M20	M24
Installation safety factor	dry and wet concrete	γ_2 = γ_{inst}	[-]	1,0			1,2
	flooded hole		[-]	1,2			1,4
Steel failure							
Characteristic steel resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$			
Partial safety factor		$\gamma_{Ms,N}$ [2]	[-]	1,4			
Combined pullout and concrete cone failure							
Diameter of calculation		d	[mm]	12	16	20	25
Characteristic bond resistance in un-cracked concrete C20/25							
Hammer-drilling (dry and wet concrete)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	15	14	13	13
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	14	13	12	12
Hammer-drilling (flooded hole)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	15	13	11	10
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	14	12	11	10
Diamond-drilling (dry and wet concrete)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	13	12	10	10
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	12	11	10	9
Diamond-drilling (flooded hole)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	13	12	10	10
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	12	11	10	9
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1			
Increasing factor for τ_{Rk}		Ψ_c	C25/30	[-]	1,02		
			C30/37	[-]	1,04		
			C35/45	[-]	1,06		
			C40/50	[-]	1,07		
			C45/55	[-]	1,08		
			C50/60	[-]	1,09		
Splitting failure							
Edge distance		$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$		
			$2{,}0 > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$		
			$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$		
Axial distance		$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$		

[1] See Annex B 1
[2] In absence of other national regulations

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Performances
Characteristic values in static or quasi-static action under tension load for rebar anchors FRA (un-cracked concrete)

Annex C 14

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Table C7.1: Characteristic values of resistance for rebar anchors FRA under tension load (hammer and diamond-drilling; cracked concrete)

Size				M12	M16	M20	M24
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0			1,2
	flooded hole		[-]	1,2			1,4
Steel failure							
Characteristic steel resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$			
Partial safety factor		$\gamma_{Ms,N}$ [2]	[-]	1,4			
Combined pullout and concrete cone failure							
Diameter of calculation		d	[mm]	12	16	20	25
Characteristic bond resistance in un-cracked concrete C20/25							
Hammer and diamond-drilling (dry and wet concrete)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	7	6	6	7
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	7	6	6	7
Hammer and diamaond-drilling (flooded hole)							
Temperature range I [1]		$\tau_{Rk,ucr}$	[N/mm²]	8	8	6	6
Temperature range II [1]		$\tau_{Rk,ucr}$	[N/mm²]	8	7	6	6
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1		k_{cr}	[-]	7,2			
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02			
		C30/37	[-]	1,04			
		C35/45	[-]	1,06			
		C40/50	[-]	1,07			
		C45/55	[-]	1,08			
		C50/60	[-]	1,09			
Splitting failure							
Edge distance	$c_{cr,sp}$	$h / h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$			
		$2{,}0\ h > h / h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$			
		$h / h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$			
Axial distance	$s_{cr,sp}$		[mm]	$2\ c_{cr,sp}$			

[1] See Annex B 1
[2] In absence of other national regulations.

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Table C8: Characteristic values of resistance for rebar anchors FRA under shear load

Size			**M12**	**M16**	**M20**	**M24**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0			
Steel failure without lever arm						
Characteristic steel resistance	$V_{Rk,s}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$			
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56			
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]	0,8			
Steel failure with lever arm						
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$			
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56			
Concrete pryout failure						
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0			
Concrete edge failure						
The value of h_{ef} for calculation in equations (5.8a) and (5.8b) of Technical Report TR 029 is limited by:			min (h_{ef}; 8d)			
Diameter of calculation	d	[mm]	12	16	20	25

[1)] In absence of other national regulations

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Table C9: Displacements under tension load for anchor rods[1)]

Size			M8	M10	M12	M16	M20	M24	M27	M30
Un-cracked and cracked concrete; temperature range I, II										
Displacement	δ_{N0} - factor	[mm/(N/mm²)]	0,07	0,08	0,09	0,10	0,11	0,12	0,13	0,13
Displacement	$\delta_{N\infty}$ - factor	[mm/(N/mm²)]	0,13	0,14	0,15	0,17	0,17	0,18	0,19	0,19

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{ - factor} \cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}\text{ - factor} \cdot \tau$
(τ: design bond strength)

Table C10: Displacements under shear load for anchor rods[1)]

Size			M8	M10	M12	M16	M20	M24	M27	M30
Un-cracked and cracked concrete; temperature range I, II										
Displacement	δ_{V0} - factor	[mm/kN]	0,18	0,15	0,12	0,09	0,07	0,06	0,05	0,05
Displacement	$\delta_{V\infty}$ - factor	[mm/kN]	0,27	0,22	0,18	0,14	0,11	0,09	0,08	0,07

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{ - factor} \cdot V$
$\delta_{V\infty} = \delta_{V\infty}\text{ - factor} \cdot V$
(V: design shear resistance)

Table C11: Displacements under tension load for internal threaded anchors UVT Top I[1)]

Size			M8	M10	M12	M16	M20
Un-cracked and cracked concrete; temperature range I, II							
Displacement	δ_{N0} - factor	[mm/(N/mm²)]	0,09	0,10	0,10	0,11	0,19
Displacement	$\delta_{N\infty}$ - factor	[mm/(N/mm²)]	0,13	0,15	0,15	0,17	0,19

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{ - factor} \cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}\text{ - factor} \cdot \tau$
(τ: design bond strength)

Table C12: Displacements under shear load for internal threaded anchors UVT Top I[1)]

Size			M8	M10	M12	M16	M20
Un-cracked and cracked concrete; temperature range I, II							
Displacement	δ_{V0} - factor	[mm/kN]	0,12	0,09	0,08	0,07	0,05
Displacement	$\delta_{V\infty}$ - factor	[mm/kN]	0,18	0,14	0,12	0,10	0,08

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{ - factor} \cdot V$
$\delta_{V\infty} = \delta_{V\infty}\text{ - factor} \cdot V$
(V: design shear resistance)

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Performances
Displacements anchor rods and internal threaded anchor UVT Top I

Annex C 17

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Table C13: Displacements under tension load for reinforcing bars [1)]

Size		**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Un-cracked and cracked concrete; temperature range I, II											
Displacement	δ_{N0} - factor	[mm/(N/mm²)]	0,07	0,08	0,09	0,09	0,10	0,10	0,11	0,11	0,12
Displacement	$\delta_{N\infty}$ - factor	[mm/(N/mm²)]	0,11	0,12	0,13	0,14	0,15	0,16	0,16	0,17	0,18

Size		**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Un-cracked and cracked concrete; temperature range I, II										
Displacement	δ_{N0} - factor	[mm/(N/mm²)]	0,12	0,12	0,13	0,13	0,13	0,14	0,14	0,15
Displacement	$\delta_{N\infty}$ - factor	[mm/(N/mm²)]	0,18	0,18	0,19	0,19	0,20	0,20	0,21	0,22

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{ - factor} \cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}\text{ - factor} \cdot \tau$
(τ: design bond strength)

Table C14: Displacements under shear load for reinforcing bars [1)]

Size		**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Un-cracked and cracked concrete; temperature range I, II											
Displacement	δ_{V0} - factor	[mm/kN]	0,18	0,15	0,12	0,10	0,09	0,08	0,07	0,07	0,06
Displacement	$\delta_{V\infty}$ - factor	[mm/kN]	0,27	0,22	0,18	0,16	0,14	0,12	0,11	0,10	0,09

Size		**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Un-cracked and cracked concrete; temperature range I, II										
Displacement	δ_{V0} - factor	[mm/kN]	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,04
Displacement	$\delta_{V\infty}$ - factor	[mm/kN]	0,09	0,08	0,08	0,07	0,07	0,06	0,06	0,05

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{ - factor} \cdot V$
$\delta_{V\infty} = \delta_{V\infty}\text{ - factor} \cdot V$
(V: design shear resistance)

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Table C15: Displacements under tension load for rebar anchors FRA [1)]

Size		**ϕ**	**12**	**16**	**20**	**24**
Un-cracked and cracked concrete; temperature range I, II						
Displacement	δ_{N0} - factor	[mm/(N/mm²)]	0,09	0,10	0,11	0,12
Displacement	$\delta_{N\infty}$ - factor	[mm/(N/mm²)]	0,13	0,16	0,16	0,18

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - factor· • τ
$\delta_{N\infty} = \delta_{N\infty}$ - Factor· • τ
(τ: design bond strength)

Table C16: Displacements under shear load for rebar anchors FRA [1)]

Size		**ϕ**	**12**	**16**	**20**	**24**
Un-cracked and cracked concrete; temperature range I, II						
Displacement	δ_{V0} - factor	[mm/kN]	0,12	0,09	0,07	0,06
Displacement	$\delta_{V\infty}$ - factor	[mm/kN]	0,18	0,14	0,11	0,09

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - factor· • V
$\delta_{V\infty} = \delta_{V\infty}$ - factor· • V
(V: design shear resistance)

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Table C17A: Characteristic values of resistance for anchor rods UVT Top A under seismic action performance category C1 in hammer drilled hole

Size				M10	M12	M14	M16	M20	M22	M24	M27	M30
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0					1,2			
	flooded hole		[-]	1,4								
Characteristic resistance tension load, steel failure												
$N_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	29	43	58	79	123	152	177	230	281
			8.8	47	68	92	126	196	243	282	368	449
	Stainless steel A4 and steel C	Property class	50	29	43	58	79	123	152	177	230	281
			70	41	59	81	110	172	212	247	322	393
			80	47	68	92	126	196	243	282	368	449
$\gamma_{M,s,C1}$ [1)] [-]	Zinc plated steel	Property class	5.8	1,50								
			8.8	1,50								
	Stainless steel A4 and steel C	Property class	50	2,86								
			70	1,50[2)] / 1,87								
			80	1,6								
Characteristic bond resistance, combined pullout and concrete cone failure												
(dry and wet concrete)												
Temperature range I[3)]	$\tau_{Rk,C1}$	[N/mm²]		7,0	7,0	6,7	5,7	5,7	6,7	6,7	6,7	6,7
Temperature range II[3)]	$\tau_{Rk,C1}$	[N/mm²]		7,0	7,0	6,7	5,7	5,7	6,7	6,7	6,7	6,7
(flooded hole)												
Temperature range I[3)]	$\tau_{Rk,C1}$	[N/mm²]		7,5	7,5	6,5	6,5	5,7	6,7	5,7	5,7	5,7
Temperature range II[3)]	$\tau_{Rk,C1}$	[N/mm²]		6,8	6,8	6,5	5,7	5,7	5,7	5,7	5,7	5,7
Characteristic resistance shear load, steel failure without lever arm												
$V_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	15	21	29	39	61	76	89	115	141
			8.8	23	34	46	63	98	122	141	184	225
	Stainless steel A4 and steel C	Property class	50	15	21	29	39	61	76	89	115	141
			70	20	30	40	55	86	107	124	161	197
			80	23	34	46	63	98	122	141	184	225
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]		1,0								

1) For threaded rods UVT Top A the factor for steel ductility is 1,0
2) f_{uk} = 700 N/mm² ; f_{yk} = 560 N/mm²
3) See Annex B 1

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Performances
Characteristic values under seismic action (performances C1) for anchor rods UVT Top A

Annex C 20

Table C17B: Characteristic values of resistance for standard threaded rods under seismic action performance category C1 in hammer drilled hole

Size				**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor				See Table C17A								
Characteristic resistance tension load, steel failure				See Table C17A								
Characteristic bond resistance, combined pullout and concrete cone failure				See Table C17A								
Characteristic resistance shear load, steel failure without lever arm												
$V_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	11	15	20	27	43	53	62	81	99
			8.8	16	24	32	44	69	85	99	129	158
	Stainless steel A4 and steel C	Property class	50	11	15	20	27	43	53	62	81	99
			70	14	21	28	39	60	75	87	113	138
			80	16	24	32	44	69	85	99	129	158
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0								

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Performances
Characteristic values under seismic action (performances C1) for standard threaded rods

Annex C 21

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Table C18: Characteristic values of resistance for reinforcing bars under seismic action performance category C1 in hammer drilled hole

Reinforcing bar			**ϕ**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0						1,2	
	flooded hole		[-]	1,2					1,4		
Characteristic resistance tension load, steel failure											
$N_{Rk,s,C1}$			[kN]	44	63	85	111	140	173	209	249
Characteristic bond resistance, combined pullout and concrete cone failure											
(dry and wet concrete)											
Temperature range I[1)]	$\tau_{Rk,C1}$		[N/mm²]	7,0	7,0	6,7	5,7	5,7	5,7	6,7	6,7
Temperature range II[1)]	$\tau_{Rk,C1}$		[N/mm²]	7,0	7,0	6,7	5,7	5,7	5,7	6,7	6,7
(flooded hole)											
Temperature range I[1)]	$\tau_{Rk,C1}$		[N/mm²]	7,5	7,0	6,5	5,7	5,7	5,7	6,7	5,7
Temperature range II[1)]	$\tau_{Rk,C1}$		[N/mm²]	6,8	6,8	5,8	5,8	5,7	5,7	5,7	5,7
Characteristic resistance shear load, steel failure without lever arm											
$V_{Rk,s,C1}$			[kN]	15	22	30	39	49	61	74	88
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0							

Reinforcing bar			**ϕ**	**25**	**26**	**28**	**30**	**32**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,2				
	flooded hole		[-]	1,4				
Characteristic resistance tension load, steel failure								
$N_{Rk,s,C1}$			[kN]	270	292	339	389	443
Characteristic bond resistance, combined pullout and concrete cone failure								
(dry and wet concrete)								
Temperature range I[1)]	$\tau_{Rk,s,C1}$		[N/mm²]	6,7	6,7	6,7	6,7	4,8
Temperature range II[1)]	$\tau_{Rk,s,C1}$		[N/mm²]	6,7	6,7	6,7	6,7	4,8
(flooded hole)								
Temperature range I[1)]	$\tau_{Rk,s,C1}$		[N/mm²]	5,7	5,7	5,7	5,7	5,7
Temperature range II[1)]	$\tau_{Rk,s,C1}$		[N/mm²]	5,7	5,7	5,7	5,7	4,8
Characteristic resistance shear load, steel failure without lever arm								
$V_{Rk,s,C1}$			[kN]	95	102	119	137	155
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0				

[1)] See Annex B 1

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Table C19: Characteristic values of resistance for anchor rods UVT Top A and standard threaded rods under seismic action performance category C2 in hammer drilled hole

Size				**M12**	**M16**	**M20**	**M24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0			1,2
	flooded hole		[-]	1,2		1,4	
Characteristic resistance tension load, steel failure							
$N_{Rk,s,C2}$ [kN]	Zinc plated steel	Property class	5.8	39	72	108	177
			8.8	61	116	173	282
	Stainless steel A4 and steel C	Property class	50	39	72	108	177
			70	53	101	152	247
			80	61	116	173	282
Characteristic bond resistance, combined pullout and concrete cone failure (dry and wet concrete)							
Temperature range I[1]	$\tau_{Rk,C2}$	[N/mm²]		2,2	3,5	1,8	2,4
Temperature range II[1]	$\tau_{Rk,C2}$	[N/mm²]		2,2	3,5	1,8	2,4
Characteristic bond resistance, combined pullout and concrete cone failure (flooded hole)							
Temperature range I[1]	$\tau_{Rk,C2}$	[N/mm²]		2,3	3,5	1,8	2,1
Temperature range II[1]	$\tau_{Rk,C2}$	[N/mm²]		2,3	3,5	1,8	2,1
Displacements							
$\delta_{N,(DLS)}$ - factor [3]		[mm/(N/mm²)]		0,09	0,10	0,11	0,12
$\delta_{N,(ULS)}$ - factor [3]		[mm/(N/mm²)]		0,15	0,17	0,17	0,18
Characteristic resistance shear load, steel failure without lever arm							
$V_{Rk,s,C2}$[2] [kN]	Zinc plated steel	Property class	5.8	14	27	43	62
			8.8	22	44	69	99
	Stainless steel A4 and steel C	Property class	50	14	27	43	62
			70	20	39	60	87
			80	22	44	69	99
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0			
Displacements							
$\delta_{V,(DLS)}$ - factor [4]		[mm/kN]		0,18	0,10	0,07	0,06
$\delta_{V,(ULS)}$ - factor [4]		[mm/kN]		0,25	0,14	0,11	0,09

[1] See Annex B 1
[2] For anchor rods UVT Top A the factor for steel ductility is 1,0

[3] Calculation for displacement

$\delta_{N(DLS)} = \delta_{N(DLS)}\text{-Factor} \cdot \tau;$
$\delta_{N(ULS)} = \delta_{N(ULS)}\text{-Factor} \cdot \tau;$

(τ: design bond strength)

[4] Calculation for displacement

$\delta_{V(DLS)} = \delta_{V(DLS)}\text{)-Factor} \cdot V;$
$\delta_{V(ULS)} = \delta_{V(ULS)}\text{)-Factor} \cdot V;$

(V: design shear resistance)

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Performances
Characteristic values under seismic action (performances C2) for anchor rods UVT Top A and standard anchor rods

Annex C 23

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