Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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

European Technical Assessment

ETA-11/0079 of 20 October 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	BERNER Multicompound system MCS Uni Plus
Product family to which the construction product belongs	Bonded anchor for use in concrete
Manufacturer	Berner Trading Holding GmbH Bernerstraße 6 74653 Künzelsau DEUTSCHLAND
Manufacturing plant	Berner Herstellwerk 6 Berner manufacturing plant 6
This European Technical Assessment contains	30 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 BERNER multicompound system MCS Uni Plus is a bonded anchor consisting of a cartridge with injection mortar MCS Uni Plus, MCS Uni Plus S or MCS Uni Plus WE and a steel element. The steel element consist of

- an anchor rod MCS Plus A of sizes M6 to M30 or
- an internal threaded anchor MCS Plus I of sizes M8 to M20 or
- a reinforcing bar of sizes ϕ = 8 to 28 mm or
- a rebar anchor BRA 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 resistance for design according to TR 029	See Annex C 1 to C 6
Characteristic resistance for design according to CEN/TS 1992-4:2009	See Annex C 7 to C 12
Displacements under tension and shear loads	See Annex C 13 / C 14

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.

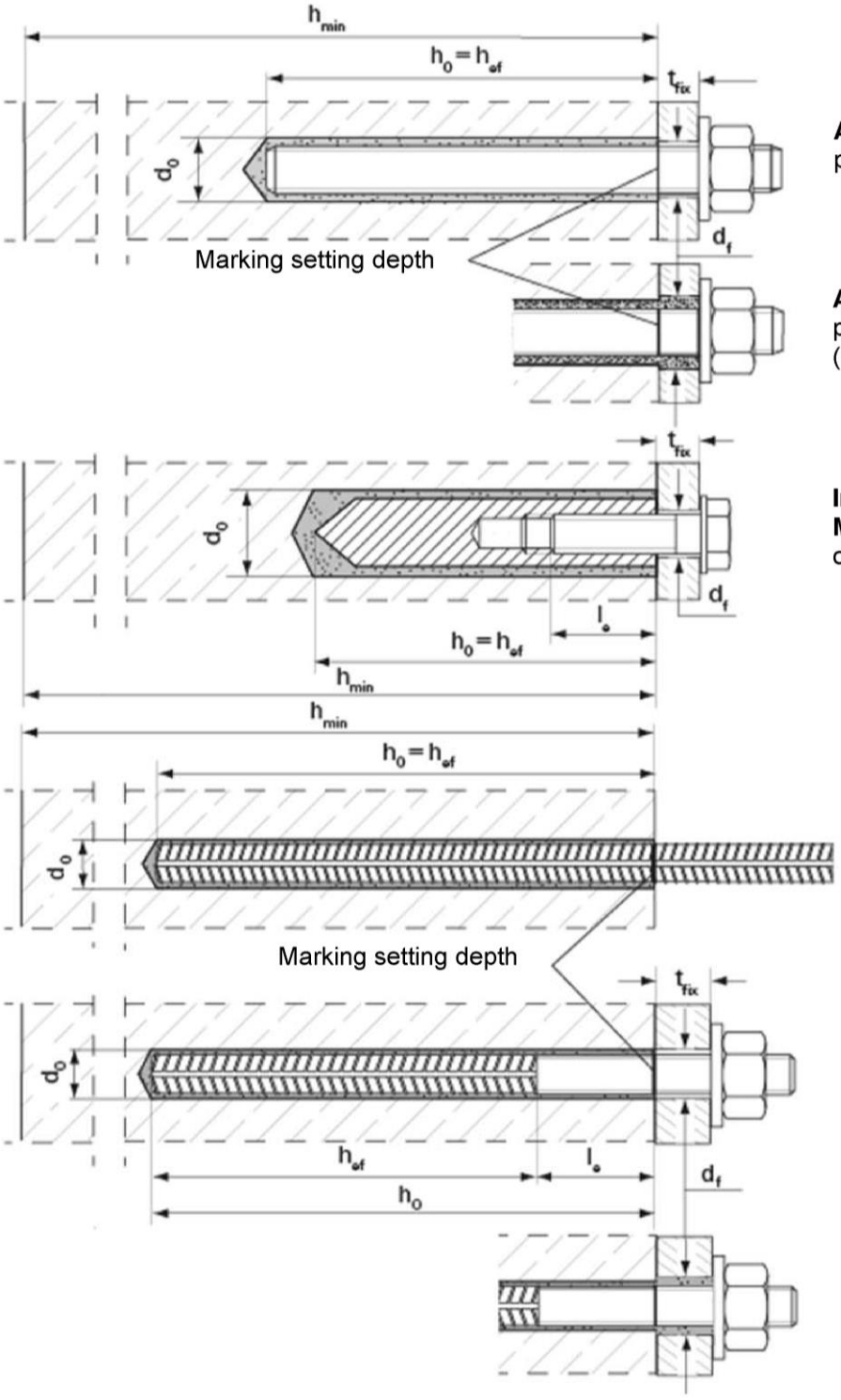
Issued in Berlin on 20 October 2015 by Deutsches Institut für Bautechnik

Andreas Kummerow
p.p. Head of Department

beglaubigt:
Baderschneider

Deutsches Institut für Bautechnik DIBt

Installation condition



Anchor rod MCS Plus A
pre-positioned anchorage

Anchor rod MCS Plus A
push through anchorage
(annular gap filled with mortar)

Internal threaded anchor
MCS Plus I
only pre-positioned anchorage

Reinforcing bar

Rebar anchor BRA
pre-positioned anchorage

Rebar anchor BRA
push through anchorage
(annular gap filled with mortar)

BERNER multicompound system MCS Uni Plus

Product description
Installation condition

Annex A 1

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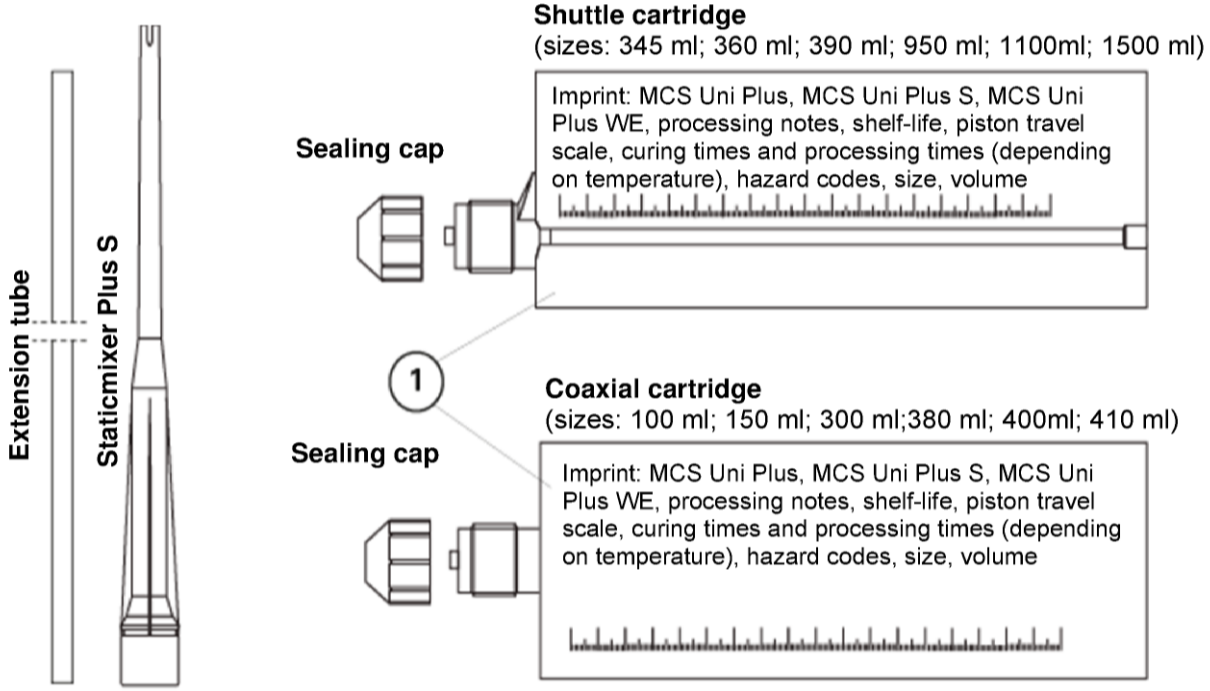

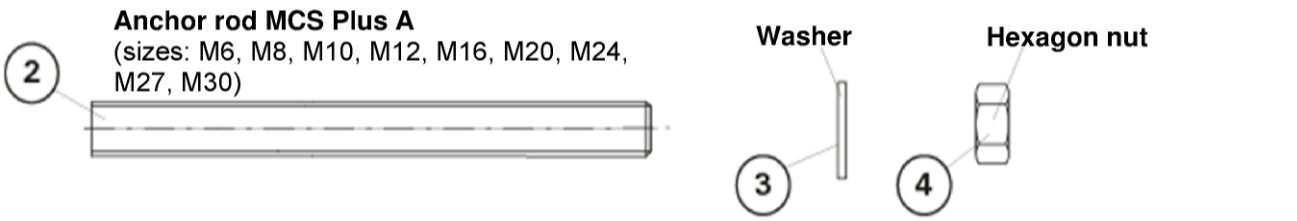

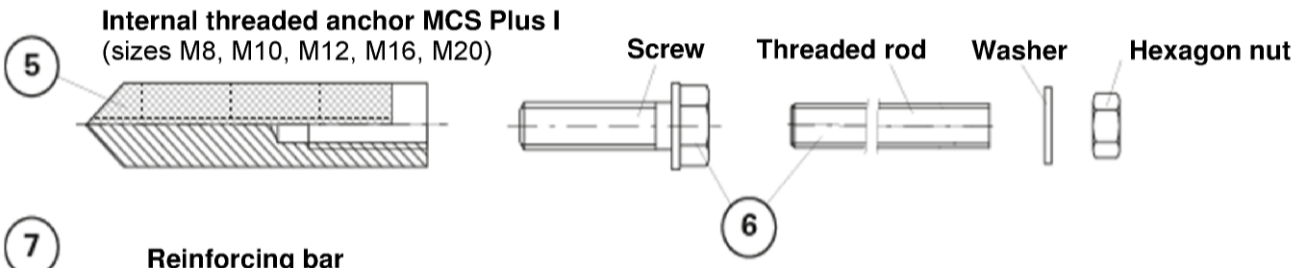

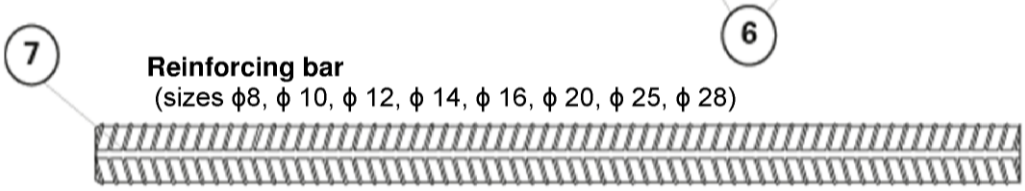

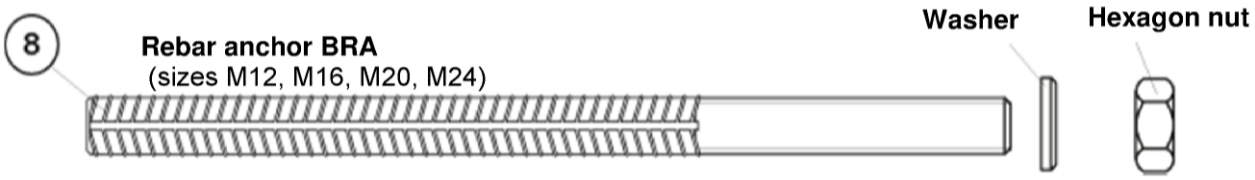

BERNER multicompound system MCS Uni Plus	**Annex A 2**
Product description Cartridges / Static mixer / Steel elements	

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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 MCS Plus 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 $f_{uk} \leq 1000$ N/mm² $A_5 > 8\%$ 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 $f_{uk} \leq 1000$ N/mm² $A_5 > 8\%$ 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 $f_{uk} \leq 1000$ N/mm² $A_5 > 8\%$ 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 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 MCS Plus I	Property class 5.8; EN 10277-1:2008-06 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 for internal threaded anchor MCS Plus 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 BRA	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

BERNER multicompound system MCS Uni Plus

Product description
Materials

Annex A 3

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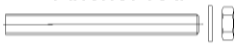
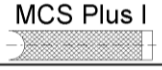
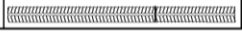
Specifications of intended use (Part 1)

Table B1: Overview use categories and performance categories

Anchorages subject to		**MCS Uni Plus with …**							
		Anchor rod 		Internal threaded anchor MCS Plus I 		Reinforcing bar 		Rebar anchor BRA 	
Hammer drilling		all sizes							
Static and quasi static load, in	un-cracked concrete	M6 to M30	Tables: C1, C5 ,C9, C13, C17, C18	M8 to M20	Tables: C2, C6, C10, C14, C19, C20	ϕ 8 to ϕ 28	Tables: C3, C7, C11, C15, C21, C22	M12 to M24	Tables: C4, C8, C12, C16, C23, C24
	cracked concrete	M10 to M30		--		ϕ 10 to ϕ 28			
Use category	Dry or wet concrete	M6 to M30		M8 to M20		ϕ 8 to ϕ 28		M12 to M24	
	Flooded hole[1)]	M12 to M30		M8 to M20		--		--	
Installation temperature		-10°C to +40°C							
In-service temperature	Temperature range I	-40°C to +80°C		(max. long term temperature +50°C and max. short term temperature +80°C)					
	Temperature range II	-40°C to +120°C		(max. long term temperature +72°C and max. short term temperature +120°C)					

[1)] Only coaxial cartridges: 380 ml, 400 ml and 410 ml

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 exist
  (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)

BERNER multicompound system MCS Uni Plus

Product description
Specifications of intended use (Part 1)

Annex B 1

Deutsches Institut für Bautechnik DIBt

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 TR 029 "Design of bonded anchors", Edition September 2010 or CEN/TS 1992-4:2009

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

BERNER multicompound system MCS Uni Plus	**Annex B 2**
Intended Use Specifications of intended use (Part 2)	

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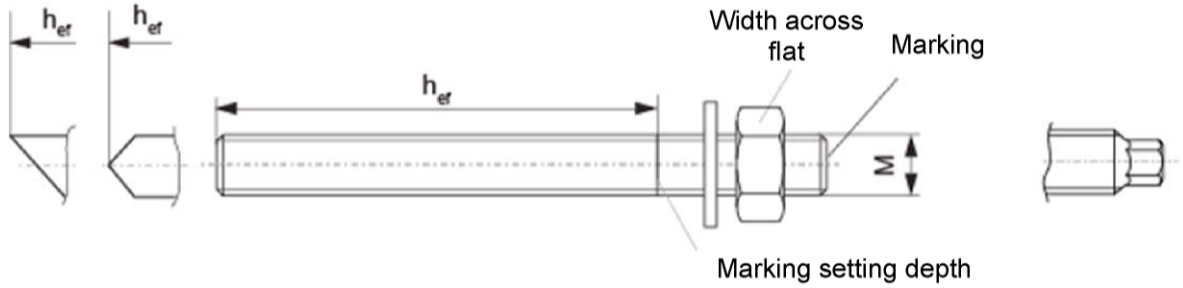
Table B2: Installation parameters anchor rods

Size				M6	M8	M10	M12	M16	M20	M24	M27	M30
Width across flat		SW	[mm]	10	13	17	19	24	30	36	41	46
Nominal drill bit diameter		d_0	[mm]	8	10	12	14	18	24	28	30	35
Drill hole depth		h_0	[mm]	$h_0 = h_{ef}$								
Effective anchorage depth		$h_{ef,min}$	[mm]	50	60	60	70	80	90	96	108	120
		$h_{ef,max}$	[mm]	72	160	200	240	320	400	480	540	600
Maximum torque moment		$T_{inst,max}$	[Nm]	5	10	20	40	60	120	150	200	300
Minimum spacing		s_{min}	[mm]	40	40	45	55	65	85	105	125	140
Minimum edge distance		c_{min}	[mm]	40	40	45	55	65	85	105	125	140
Diameter of clearance hole in the fixture [1]	Pre-positioned anchorage	d_f	[mm]	7	9	12	14	18	22	26	30	33
	Push through anchorage	d_f	[mm]	9	11	14	16	20	26	30	32	40
Minimum thickness of concrete member		h_{min}	[mm]	$h_{ef} + 30$ (≥ 100)				$h_{ef} + 2d_0$				

[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 rods MCS Plus A



Marking:
Property class 8.8 or high corrosion-resistant steel C, property class 80: •
Stainless steel A4, property class 50 or high corrosion-resistant steel C, 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

BERNER multicompound system MCS Uni Plus

Intended Use
Installation parameters anchor rods MCS Plus A

Annex B 3

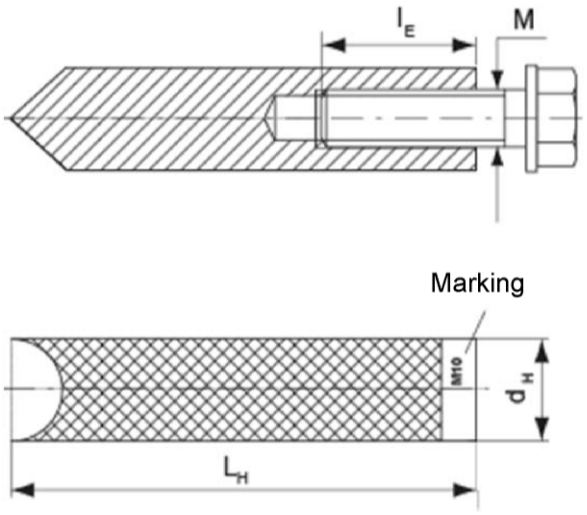
Deutsches Institut für Bautechnik DIBt

Table B3: Installation parameters internal threaded anchor MCS Plus 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	s_{min}	[mm]	55	65	75	95	125
Minimum edge distance	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	210	265
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 MCS Plus I



Marking: anchor size e.g.: M10
Stainless steel in addition A4 e.g.: M10 A4
High corrosion-resistant steel in addition C
e.g.: M10 C

Fastening screw or anchor rods including washer and nuts must comply with the appropriate material and strength class of table A1

BERNER multicompound system MCS Uni Plus

Intended Use
Installation parameters internal threaded anchors MCS Plus I

Annex B 4

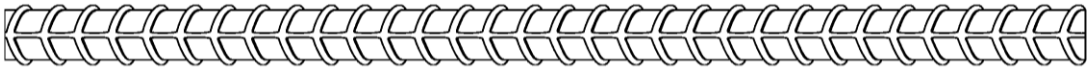
Deutsches Institut für Bautechnik DIBt

Table B4: Installation parameters reinforcing bars

Rebar diameter		ϕ	**8** [1]	**10** [1]	**12** [1]	**14**	**16**	**20**	**25**	**28**
Nominal drill bit diameter	d_0	[mm]	(10)12	(12)14	(14) 16	18	20	25	30	35
Drill hole depth	h_0	[mm]	$h_0 = h_{ef}$							
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	100	112
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	500	560
Minimum spacing	s_{min}	[mm]	40	45	55	60	65	85	110	130
Minimum edge distance	c_{min}	[mm]	40	45	55	60	65	85	110	130
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30 \geq 100$		$h_{ef} + 2d_0$					

[1] Both drill bit diameters can be used.

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)

BERNER multicompound system MCS Uni Plus

Intended Use
Installation parameters reinforcing bars

Annex B 5

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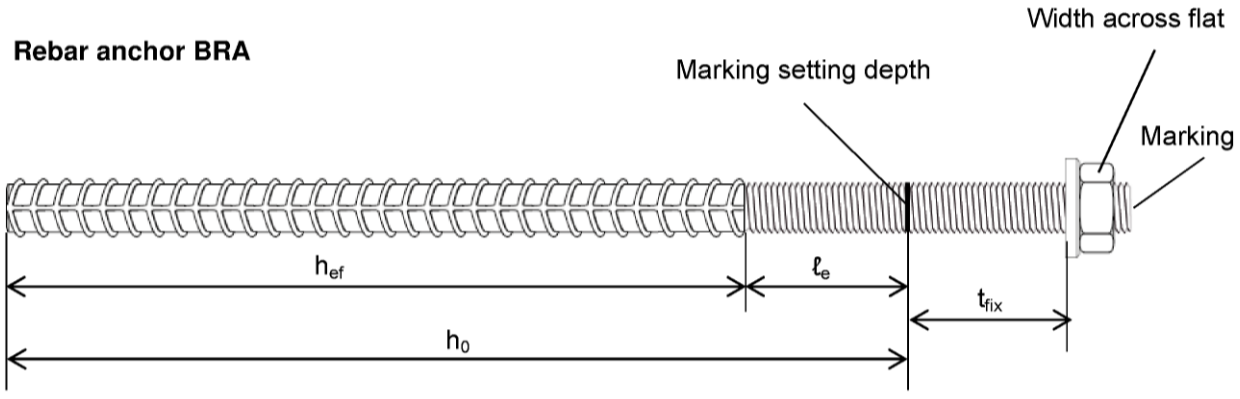
Table B5: Installation parameters rebar anchor BRA

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

[1] Both drill bit diameters can be used
[2] 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 BRA



Marking: BRA (for stainless steel)
BRA C (for high corrosion-resistant steel)

BERNER multicompound system MCS Uni Plus

Intended Use
Installation parameters rebar anchor BRA

Annex B 6

Deutsches Institut für Bautechnik DIBt

Table B6: Parameters of steel brush BERNER BS Ø

Drill bit diameter	[mm]	8	10	12	14	16	18	20	24	25	28	30	35
Steel brush diameter d_b	[mm]	9	11	14	16	20	20	25	26	27	30	40	40

Table B7: Maximum processing time of the mortar and minimum curing time
(During the curing time of the mortar the concrete temperature may not fall below the listed minimum temperature).

Temperature at anchoring base [°C]			Minimum curing time[1] t_{cure} [minutes]				System tempera-ture (mortar) [°C]	Maximum processing time t_{work} [minutes]		
			MCS Uni Plus WE	MCS Uni Plus	MCS Uni Plus S			MCS Uni Plus WE	MCS Uni Plus	MCS Uni Plus S
-10	to	-5	12 hours	-	-		-	-	-	-
>-5	to	±0	3 hours	24 hours	-		±0	5	-	-
>±0	to	+5	3 hours	3 hours	6 hours		+5	5	13	-
>+5	to	+10	50	90	3 hours		+10	3	9	20
>+10	to	+20	30	60	2 hours		+20	1	5	10
>+20	to	+30	-	45	60		+30	-	4	6
>+30	to	+40	-	35	30		+40	-	2	4

[1] For wet concrete or flooded hole the curing time must be doubled.

BERNER multicompound system MCS Uni Plus

Intended Use
Cleaning tools / processing - and curing times

Annex B 7

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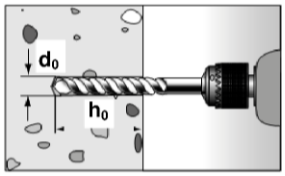
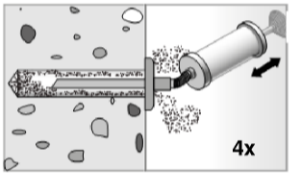
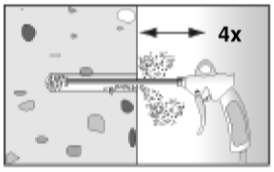
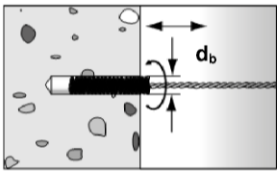
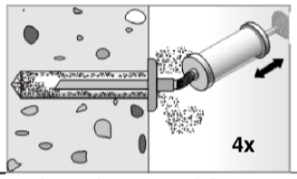
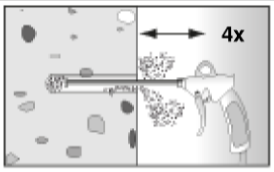
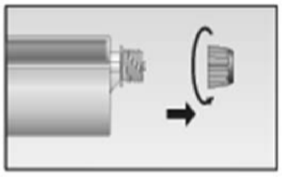
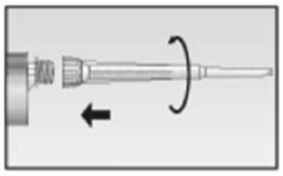
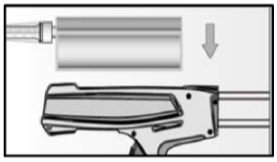
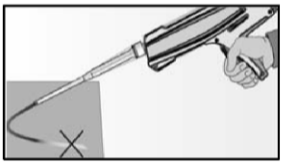
Installation instructions part 1
Drilling and cleaning the hole

1		Drill the hole. Drill hole diameter d_0 and drill hole depth h_0 see Tables **B2, B3, B4**, **B5**.
2		$h_{ef} \leq 12d$ and $d_0 < 18$ mm: Blow out the drill hole four times by hand.
		$h_{ef} > 12d$ and/or $d_0 \geq 18$ mm: Blow out the drill hole four times, using oil-free compressed air ($p > 6$ bar).
3		Brush the drill hole four times using an adequate steel brush (see Table **B6**).
4		$h_{ef} \leq 12d$ and $d_0 < 18$ mm: Blow out the drill hole four times by hand.
		$h_{ef} > 12d$ and/or $d_0 \geq 18$ mm: Blow out the drill hole four times, using oil-free compressed air ($p > 6$ bar).

Preparing the cartridge

5		Twist off the sealing cap.
6		Twist on the static mixer (the spiral in the static mixer must be clearly visible).
7		Place the cartridge into the suitable dispenser.
8		Press out approximately 10 cm of mortar until the resin is permanently grey in colour. Mortar which is not grey in colour will not cure and must be disposed of.

BERNER multicompound system MCS Uni Plus

Intended Use
Installation instructions part 1

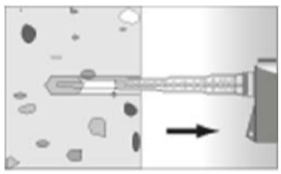
Annex B 8

Deutsches Institut für Bautechnik DIBt

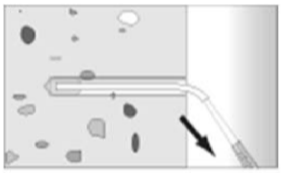
Installation instructions part 2

Injection of the mortar

9



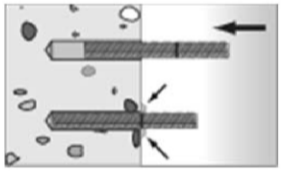
Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole to eliminate voids.

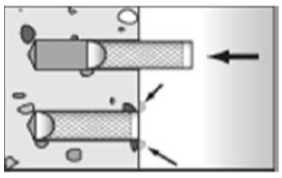


For drill hole depth ≥ 150 mm use an extension tube.

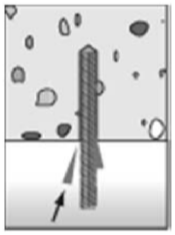
Installation anchor rods MCS Plus A or internal threaded anchors MCS Plus I

10

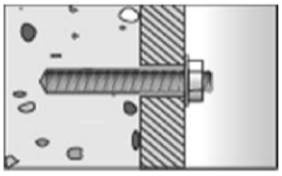




Only use clean and oil-free anchor elements. Press the anchor rod or Internal threaded anchor MCS Plus I down to the bottom of the hole, turning it slightly while doing so. After inserting the anchor element, excess mortar must emerge around the anchor element.



For overhead installation support the anchor element with wedges.

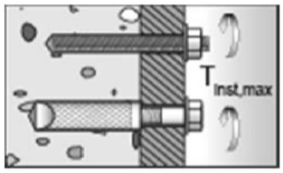


For push through installation fill the annular gap also with mortar.

11

Wait for the specified curing time t_{cure} see Table **B7**.

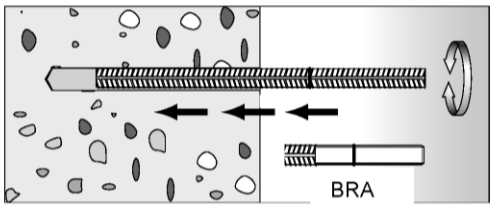
12



Mounting the fixture $T_{inst,max}$ see Tables **B2** or **B3**

Installing reinforcing bars and rebar anchors BRA

10

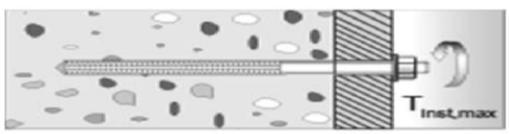


Only use clean and oil-free rebars. Mark the reinforcing bar for setting depth. Using a turning movement, push the reinforcing bar or rebar anchor BRA vigorously into the filled hole up to the insertion depth marking. When reaching the setting depth marking surplus mortar must emerge around the anchor.

11

Wait for the specified curing time t_{cure} see Table **B7**.

12



Mounting the fixture $T_{inst,max}$ see Table **B5**

BERNER multicompound system MCS Uni Plus

Intended Use
Installation instructions part 2

Annex B 9

Deutsches Institut für Bautechnik DIBt

Table C1: Characteristic values of resistance for anchor rods MCS Plus A under tension loads in un-cracked and cracked concrete (Design according to TR 029)

Size				M6	M8	M10	M12	M16	M20	M24	M27	M30
Installation safety factor	Dry and wet concrete	γ_2	[-]	1,0								
	Flooded hole		[-]	--			1,2[1]					
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	6	8	10	12	16	20	24	27	30
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete												
Temperature range I[2]		$\tau_{Rk,ucr}$	[N/mm²]	9,0	11,0	11,0	11,0	10,0	9,5	9,0	8,5	8,5
Temperature range II[2]		$\tau_{Rk,ucr}$	[N/mm²]	6,5	9,5	9,5	9,0	8,5	8,0	7,5	7,0	7,0
Characteristic bond resistance in un-cracked concrete C20/25. Flooded hole [1]												
Temperature range I[2]		$\tau_{Rk,ucr}$	[N/mm²]	--	--	--	9,5	8,5	8,0	7,5	7,0	7,0
Temperature range II[2]		$\tau_{Rk,ucr}$	[N/mm²]	--	--	--	7,5	7,0	6,5	6,0	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete												
Temperature range I[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	6,0	6,0	6,0	5,5	4,5	4,0	4,0
Temperature range II[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	5,0	5,0	5,0	5,0	4,0	3,5	3,5
Characteristic bond resistance in cracked concrete C20/25. Flooded hole [1]												
Temperature range I[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	--	5,0	5,0	4,5	4,0	3,5	3,5
Temperature range II[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	--	4,0	4,0	3,5	3,5	3,0	3,0
Increasing factor Ψ_c	C25/30		[-]	1,05								
	C30/37		[-]	1,10								
	C35/45		[-]	1,15								
	C40/50		[-]	1,19								
	C45/55		[-]	1,22								
	C50/60		[-]	1,26								
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]	$2,26\ h_{ef}$								
Spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								

[1] Only coaxial cartridges: 380 ml, 400 ml and 410 ml
[2] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for anchor rods MCS Plus A under tension loads in un-cracked and cracked concrete (Design according to TR 029)

Annex C 1

Deutsches Institut für Bautechnik DIBt

Table C2: Characteristic values of resistance for internal threaded anchors MCS Plus I under tension loads in un-cracked concrete (Design according to TR 029)

Size				M8	M10	M12	M16	M20
Installation safety factor	Dry and wet concrete	γ_2	[-]	1,0				
	Flooded hole		[-]	1,2[1)]				
Steel failure								
Characteristic resistance with screw $N_{Rk,s}$	Property class 5.8		[kN]	19	29	43	79	123
	Property class 8.8		[kN]	29	47	68	108	179
	Property class 70 A4		[kN]	26	41	59	110	172
	Property class 70 C		[kN]	26	41	59	110	172
Combined pullout and concrete cone failure								
Diameter of calculation		d_H	[mm]	12	16	18	22	28
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete								
Temperature range I[2)]		$N^0_{Rk,p}$	[kN]	30	40	50	75	115
Temperature range II[2)]		$N^0_{Rk,p}$	[kN]	25	30	40	60	95
Characteristic bond resistance in un-cracked concrete C20/25. Flooded hole								
Temperature range I[2)]		$N^0_{Rk,p}$	[kN]	25	35	50	60	95
Temperature range II[2)]		$N^0_{Rk,p}$	[kN]	20	25	35	50	75
Increasing factor Ψ_c	C25/30		[-]	1,05				
	C30/37		[-]	1,10				
	C35/45		[-]	1,15				
	C40/50		[-]	1,19				
	C45/55		[-]	1,22				
	C50/60		[-]	1,26				
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}				
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$				

[1)] Only coaxial cartridges: 380 ml, 400 ml and 410 ml
[2)] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for internal threaded anchors MCS Uni Plus I under tension loads in un-cracked concrete (Design according to TR 029)

Annex C 2

Deutsches Institut für Bautechnik DIBt

Table C3: Characteristic values of resistance for reinforcing bars under tension loads in un-cracked and cracked concrete (Design according to TR 029)

Size	ϕ	[mm]	8	10	12	14	16	20	25	28
Installation safety factor	γ_2	[-]	1,0							
Combined pullout and concrete cone failure										
Diameter of calculation	d	[mm]	8	10	12	14	16	20	25	28
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete										
Temperature range I[1)]	$\tau_{Rk,ucr}$	[N/mm²]	11,0	11,0	11,0	10,0	10,0	9,5	9,0	8,5
Temperature range II[1)]	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,0	8,5	8,5	8,0	7,5	7,0
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete										
Temperature range I[1)]	$\tau_{Rk,cr}$	[N/mm²]	--	3,0	5,0	5,0	5,0	4,5	4,0	4,0
Temperature range II[1)]	$\tau_{Rk,cr}$	[N/mm²]	--	3,0	4,5	4,5	4,5	4,0	3,5	3,5
Increasing factor Ψ_c	C25/30	[-]	1,05							
	C30/37	[-]	1,10							
	C35/45	[-]	1,15							
	C40/50	[-]	1,19							
	C45/55	[-]	1,22							
	C50/60	[-]	1,26							
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]	$2,26\ h_{ef}$							
Spacing	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							

[1)] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for reinforcing bars in un-cracked and cracked concrete under tension loads (Design according to TR 029)

Annex C 3

Deutsches Institut für Bautechnik DIBt

Table C4: Characteristic values of resistance for rebar anchors BRA under tension loads in un-cracked and cracked concrete (Design according to TR 029)

Size			M12	M16	M20	M24
Installation safety factor	γ_2	[-]	1,0			
Steel failure						
Characteristic resistance	$N_{Rk,s}$	[kN]	63	111	173	270
Partial safety factor	$\gamma_{Ms,N}$ [1)]	[-]	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. Dry and wet concrete						
Temperature range I [2)]	$\tau_{Rk,ucr}$	[N/mm²]	11,0	10,0	9,5	9,0
Temperature range II [2)]	$\tau_{Rk,ucr}$	[N/mm²]	9,0	8,5	8,0	7,5
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete						
Temperature range I [2)]	$\tau_{Rk,cr}$	[N/mm²]	5,0	5,0	4,5	4,0
Temperature range II [2)]	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,0	3,5
Increasing factor Ψ_c	C25/30	[-]	1,05			
	C30/37	[-]	1,10			
	C35/45	[-]	1,15			
	C40/50	[-]	1,19			
	C45/55	[-]	1,22			
	C50/60	[-]	1,26			
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]	$2,26\ h_{ef}$			
Spacing	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$			

[1)] In absence of other national regulations
[2)] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for rebar anchor BRA in un-cracked and cracked concrete under tension loads (Design according to TR 029)

Annex C 4

Deutsches Institut für Bautechnik DIBt

Table C5: Characteristic values of resistance for anchor rods MCS Plus A under shear loads (Design according to TR 029)

Size			M6	M8	M10	M12	M16	M20	M24	M27	M30
Concrete pryout failure											
Factor k in equation (5.7) of TR 029 for the design of bonded anchors	k	[-]	2,0								

Table C6: Characteristic values of resistance for internal threaded anchors MCS Plus I under shear loads (Design according to TR 029)

Size				M8	M10	M12	M16	M20
Installation safety factor		γ_2	[-]	1,0				
Steel failure without lever arm								
Characteristic resistance $V_{Rk,s}$	Property class	5.8	[kN]	9,2	14,5	21,1	39,2	62,0
		8.8	[kN]	14,6	23,2	33,7	62,7	90,0
	Property class 70	A4	[kN]	12,8	20,3	29,5	54,8	86,0
		C	[kN]	12,8	20,3	29,5	54,8	86,0
Steel failure with lever arm								
Characteristic resistance $M^0_{Rk,s}$	Property class	5.8	[Nm]	20	39	68	173	337
		8.8	[Nm]	30	60	105	266	519
	Property class 70	A4	[Nm]	26	52	92	232	454
		C	[Nm]	26	52	92	232	454
Concrete pryout failure								
Factor k in equation (5.7) of TR 029 for the design of bonded anchors		k	[-]	2,0				

BERNER multicompound system MCS Uni Plus

Annex C 5

Performances
Characteristic values of resistance for anchor rods MCS Plus A and internal threaded anchors MCS Plus I under shear loads (Design according to TR 029)

Deutsches Institut für Bautechnik DIBt

Table C7: Characteristic values of resistance for reinforcing bars under shear loads (Design according to TR 029)

Size	ϕ	[mm]	8	10	12	14	16	20	25	28
Concrete pryout failure										
Factor k in equation (5.7) of Technical Report TR 029, Section 5.2.3.3	k	[-]	2,0							

Table C8: Characteristic values of resistance for rebar anchors BRA under shear loads (Design according to TR 029)

Size			M12	M16	M20	M24
Steel failure without lever arm						
Characteristic resistance	$V_{Rk,s}$	[kN]	30	55	86	124
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56			
Steel failure with lever arm						
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	92	233	454	785
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56			
Concrete pryout failure						
Factor k in equation (5.7) of TR 029 for the design of bonded anchors	k	[-]	2,0			

[1)] In absence of other national regulations

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for reinforcing bars and rebar anchor BRA under shear loads (Design according to TR 029)

Annex C 6

Deutsches Institut für Bautechnik DIBt

Table C9: Characteristic values of resistance for anchor rods MCS Plus A under tension loads in un-cracked and cracked concrete (Design according to CEN/TS 1992-4)

Size				M6	M8	M10	M12	M16	M20	M24	M27	M30
Installation safety factor γ_{inst}	Dry and wet concrete		[-]	1,0								
	Flooded hole		[-]	--			1,2[1]					
Steel failure												
Characteristic resistance		$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$								
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	6	8	10	12	16	20	24	27	30
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete												
Temperature range I[2]		$\tau_{Rk,ucr}$	[N/mm²]	9,0	11,0	11,0	11,0	10,0	9,5	9,0	8,5	8,5
Temperature range II[2]		$\tau_{Rk,ucr}$	[N/mm²]	6,5	9,5	9,5	9,0	8,5	8,0	7,5	7,0	7,0
Characteristic bond resistance in un-cracked concrete C20/25. Flooded hole [1]												
Temperature range I[2]		$\tau_{Rk,ucr}$	[N/mm²]	--	--	--	9,5	8,5	8,0	7,5	7,0	7,0
Temperature range II[2]		$\tau_{Rk,ucr}$	[N/mm²]	--	--	--	7,5	7,0	6,5	6,0	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete												
Temperature range I[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	6,0	6,0	6,0	5,5	4,5	4,0	4,0
Temperature range II[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	5,0	5,0	5,0	5,0	4,0	3,5	3,5
Characteristic bond resistance in cracked concrete C20/25. Flooded hole [1]												
Temperature range I[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	--	5,0	5,0	4,5	4,0	3,5	3,5
Temperature range II[2]		$\tau_{Rk,cr}$	[N/mm²]	--	--	--	4,0	4,0	4,0	3,5	3,0	3,0
Increasing factor Ψ_c		C25/30	[-]	1,05								
		C30/37	[-]	1,10								
		C35/45	[-]	1,15								
		C40/50	[-]	1,19								
		C45/55	[-]	1,22								
		C50/60	[-]	1,26								
Factor acc. CEN/TS 1992-4:2009 Section 6.2.2.3	k_8	cracked concrete	[-]	7,2								
	k_8	un-cracked concrete	[-]	10,1								
Concrete cone failure												
Factor acc. CEN/TS 1992-4:2009 Section 6.2.3.1	k_{cr}	cracked concrete	[-]	7,2								
	k_{ucr}	un-cracked concrete	[-]	10,1								
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]	$2,26\ h_{ef}$								
Spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								

[1] Only coaxial cartridges: 380 ml, 400 ml and 410 ml
[2] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for anchor rods MCS Plus A under tension loads in un-cracked and cracked concrete (Design according to CEN/TS-1992-4)

Annex C 7

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Table C10: Characteristic values of resistance for internal threaded anchors MCS Plus I under tension loads in un-cracked concrete (Design according to CEN/TS 1992-4)

Size				M8	M10	M12	M16	M20
Installation safety factor γ_{inst}	Dry and wet concrete		[-]	1,0				
	Flooded hole		[-]	1,2 [1]				
Steel failure								
Characteristic resistance with screw $N_{Rk,s}$	Property class	5.8	[kN]	19	29	43	79	123
		8.8	[kN]	29	47	68	108	179
	Property class 70	A4	[kN]	26	41	59	110	172
		C	[kN]	26	41	59	110	172
Partial safety factor $\gamma_{Ms,N}$ [3]	Property class	5.8	[-]	1,50				
		8.8	[-]	1,50				
	Property class 70	A4	[-]	1,87				
		C	[-]	1,87				
Combined pullout and concrete cone failure								
Diameter of calculation		d_H	[mm]	12	16	18	22	28
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete								
Temperature range I [2]		$N^0_{Rk,p}$	[kN]	30	40	50	75	115
Temperature range II [2]		$N^0_{Rk,p}$	[kN]	25	30	40	60	95
Characteristic bond resistance in un-cracked concrete C20/25. Flooded hole [1]								
Temperature range I [2]		$N^0_{Rk,p}$	[kN]	25	35	50	60	95
Temperature range II [2]		$N^0_{Rk,p}$	[kN]	20	25	35	50	75
Increasing factor Ψ_c		C25/30	[-]	1,05				
		C30/37	[-]	1,10				
		C35/45	[-]	1,15				
		C40/50	[-]	1,19				
		C45/55	[-]	1,22				
		C50/60	[-]	1,26				
Factor acc. CEN/TS 1992-4-5:2009 Section 6.2.2.3		k_8	[-]	10,1				
Concrete cone failure								
Factor acc. CEN/TS 1992-4-5:2009 Section 6.2.3.1		k_{ucr}	[-]	10,1				
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}				
Spacing		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$				

[1] Only coaxial cartridges: 380 ml, 400 ml and 410 ml
[2] See Annex B1
[3] In absence of other national regulations

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for internal threaded anchors MCS Plus I under tension loads in un-cracked concrete (Design according to CEN/TS 1992-4)

Annex C 8

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Table C11: Characteristic values of resistance for reinforcing bars under tension loads in un-cracked and cracked concrete (Design according to CEN/TS 1992-4)

Size	ϕ	[mm]	8	10	12	14	16	20	25	28
Installation safety factor	γ_{inst}	[-]	1,0							
Steel failure										
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$							
Combined pullout and concrete cone failure										
Diameter of calculation	d	[mm]	8	10	12	14	16	20	25	28
Characteristic bond resistance in un-cracked concrete C20/25. Dry and wet concrete										
Temperature range I[1)]	$\tau_{Rk,ucr}$	[N/mm²]	11,0	11,0	11,0	10,0	10,0	9,5	9,0	8,5
Temperature range II[1)]	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,5	9,0	8,5	8,5	8,0	7,5	7,0
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete										
Temperature range I[1)]	$\tau_{Rk,cr}$	[N/mm²]	--	3,0	5,0	5,0	5,0	4,5	4,0	4,0
Temperature range II[1)]	$\tau_{Rk,cr}$	[N/mm²]	--	3,0	4,5	4,5	4,5	4,0	3,5	3,5
Increasing factor Ψ_c	C25/30	[-]	1,05							
	C30/37	[-]	1,10							
	C35/45	[-]	1,15							
	C40/50	[-]	1,19							
	C45/55	[-]	1,22							
	C50/60	[-]	1,26							
Factor acc. CEN/TS 1992-4-5: 2009 Section 6.2.3.3	k_8 cracked concrete	[-]	7,2							
	k_8 un-cracked concrete	[-]	10,1							
Concrete cone failure										
Factor acc. CEN/TS 1992-4-5: 2009 Section 6.2.3.1	k_{cr} cracked concrete	[-]	7,2							
	k_{ucr} un-cracked concrete	[-]	10,1							
Edge distance	$c_{cr,N}$	[mm]	$1,5\ h_{ef}$							
Axial distance	$s_{cr,N}$	[mm]	$3,0\ h_{ef}$							
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]	$2,26\ h_{ef}$							
Spacing	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							

[1)] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for reinforcing bars under tension loads in un-cracked and cracked concrete (Design according to CEN/TS-1992-4)

Annex C 9

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Table C12: Characteristic values of resistance for rebar anchors BRA under tension loads in un-cracked and cracked concrete (Design according to CEN/TS 1992-4)

Size				M12	M16	M20	M24
Installation safety factor		γ_{inst}	[-]	1,0			
Steel failure							
Characteristic resistance		$N_{Rk,s}$	[kN]	63	111	173	270
Partial safety factor		$\gamma_{Ms,N}$ [1)]	[-]	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. Dry and wet concrete							
Temperature range I [2)]		$\tau_{Rk,ucr}$	[N/mm²]	11,0	10,0	9,5	9,0
Temperature range II [2)]		$\tau_{Rk,ucr}$	[N/mm²]	9,0	8,5	8,0	7,5
Characteristic bond resistance in cracked concrete C20/25. Dry and wet concrete							
Temperature range I [2)]		$\tau_{Rk,cr}$	[N/mm²]	5,0	5,0	4,5	4,0
Temperature range II [2)]		$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,0	3,5
Increasing factor Ψ_c		C25/30	[-]	1,05			
		C30/37	[-]	1,10			
		C35/45	[-]	1,15			
		C40/50	[-]	1,19			
		C45/55	[-]	1,22			
		C50/60	[-]	1,26			
Factor acc. CEN/TS 1992-4-5: 2009 Section 6.2.2.3	k_8	cracked concrete	[-]	7,2			
	k_8	un-cracked concrete	[-]	10,1			
Concrete cone failure							
Factor acc. CEN/TS 1992-4-5: 2009 Section 6.2.3.1	k_{cr}	cracked concrete	[-]	7,2			
	k_{ucr}	un-cracked concrete	[-]	10,1			
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]	$2,26\ h_{ef}$			
Spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$			

[1)] In absence of other national regulations
[2)] See Annex B1

BERNER multicompound system MCS Uni Plus

Performances
Characteristic values of resistance for Rebar anchor BRA under tension loads in un-cracked and cracked concrete (Design according to CEN/TS-1992-4)

Annex C 10

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Table C13: Characteristic values of resistance for anchor rods under shear loads (Design according to CEN/TS 1992-4)

Size			M6	M8	M10	M12	M16	M20	M24	M27	M30
Installation safety factor	γ_{inst}	[-]	1,0								
Steel failure without lever arm											
Characteristic resistance	$V_{Rk,s}$	[kN]	$0,5\ A_s \times f_{uk}$								
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 resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \times W_{el} \times f_{uk}$								
Concrete pryout failure											
Factor in equation of CEN/TS 1992-4-5:2009 Section 6.3.3	k_3	[-]	2,0								
Concrete edge failure											
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$								
Outside diameter of anchor	d_{nom}	[mm]	6	8	10	12	16	20	24	27	30

Table C14: Characteristic values of resistance for internal threaded anchor rods MCS Plus I under shear loads (Design according to CEN/TS 1992-4)

Size				M8	M10	M12	M16	M20
Installation safety factor		γ_{inst}	[-]	1,0				
Steel failure without lever arm								
Characteristic resistance $V_{Rk,s}$	Property class	5.8	[kN]	9,2	14,5	21,1	39,2	62,0
		8.8	[kN]	14,6	23,2	33,7	62,7	90,0
	Property class 70	A4	[kN]	12,8	20,3	29,5	54,8	86,0
		C	[kN]	12,8	20,3	29,5	54,8	86,0
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 resistance $M^0_{Rk,s}$	Property class	5.8	[Nm]	20	39	68	173	337
		8.8	[Nm]	30	60	105	266	519
	Property class 70	A4	[Nm]	26	52	92	232	454
		C	[Nm]	26	52	92	232	454
Concrete pryout failure								
Factor in equation of CEN/TS 1992-4-5:2009 Section 6.3.3		k_3	[-]	2,0				
Concrete edge failure								
Outside diameter of anchor		d_{nom}	[mm]	12	16	18	22	28

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Annex C 11

Performances
Characteristic values of resistance for anchor rods MCS Plus A and internal threaded anchors MCS Plus I under shear loads (Design according to CEN/TS 1992-4)

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Table C15: Characteristic values of resistance for reinforcing bars under shear loads (Design according to CEN/TS 1992-4)

Size	ϕ	[mm]	8	10	12	14	16	20	25	28
Installation safety factor	γ_{inst}	[-]	1,0							
Steel failure without lever arm										
Characteristic resistance	$V_{Rk,s}$	[kN]	$0,5\ A_s \times f_{uk}$							
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]	0,8							
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \times W_{el} \times f_{uk}$							
Concrete pryout failure										
Factor in equation of CEN/TS 1992-4-5:2009 Section 6.3.3	k_3	[-]	2,0							
Concrete edge failure										
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	14	16	20	25	28

Table C16: Characteristic values of resistance for rebar anchors BRA under shear loads (Design according to CEN/TS 1992-4)

Size			M12	M16	M20	M24
Installation safety factor	γ_{inst}	[-]	1,0			
Steel failure without lever arm						
Characteristic resistance	$V_{Rk,s}$	[kN]	30	55	86	124
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 resistance	$M^0_{Rk,s}$	[Nm]	92	233	454	785
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56			
Concrete pryout failure						
Factor in equation of CEN/TS 1992-4-5, Section 6.3.3	k_3	[-]	2,0			
Concrete edge failure						
Outside diameter of anchor	d_{nom}	[mm]	12	16	20	24

[1)] In absence of other national regulations

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Performances
Characteristic values of resistance for reinforcing bars and rebar anchors BRA under shear loads (Design according to CEN/TS 1992-4)

Annex C 12

Table C17: Displacements under tension load [1] for anchor rods MCS Plus A

Size		M6	M8	M10	M12	M16	M20	M24	M27	M30
Un-cracked concrete										
δ_{N0}-factor	[mm/N/mm²]	0,09	0,09	0,09	0,10	0,10	0,10	0,10	0,11	0,12
$\delta_{N\infty}$-factor	[mm/N/mm²]	0,10	0,10	0,10	0,12	0,12	0,12	0,13	0,13	0,14
Cracked concrete										
δ_{N0}-factor	[mm/N/mm²]	--	--	0,12	0,12	0,13	0,13	0,13	0,14	0,15
$\delta_{N\infty}$-factor	[mm/N/mm²]	--	--	0,27	0,30	0,30	0,30	0,35	0,35	0,40

[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 C18: Displacements under shear load [1] for anchor rods MCS Plus A

Size		M6	M8	M10	M12	M16	M20	M24	M27	M30
δ_{V0}-factor	[mm/kN]	0,11	0,11	0,11	0,10	0,10	0,09	0,09	0,08	0,07
$\delta_{V\infty}$-factor	[mm/kN]	0,12	0,12	0,12	0,11	0,11	0,10	0,10	0,09	0,09

[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 C19: Displacements under tension load [1] for internal threaded anchors MCS Plus I

Size		M8	M10	M12	M16	M20
δ_{N0}-factor	[mm/N/mm²]	0,1	0,11	0,12	0,13	0,14
$\delta_{N\infty}$-factor	[mm/N/mm²]	0,13	0,14	0,15	0,16	0,18

[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 C20: Displacements under shear load [1] for internal threaded anchors MCS Plus I

Size		M8	M10	M12	M16	M20
δ_{V0}-factor	[mm/kN]	0,12	0,12	0,12	0,12	0,12
$\delta_{V\infty}$-factor	[mm/kN]	0,14	0,14	0,14	0,14	0,14

[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 MCS Plus A and internal threaded anchor MCS Plus I

Annex C 13

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Table C21: Displacements under tension load [1] for reinforcing bars

Size ϕ	[mm]	8	10	12	14	16	20	25	28
Un-cracked concrete									
δ_{N0}-factor	[mm/N/mm²]	0,09	0,09	0,10	0,10	0,10	0,10	0,10	0,11
$\delta_{N\infty}$-factor	[mm/N/mm²]	0,10	0,10	0,12	0,12	0,12	0,12	0,13	0,13
Cracked concrete									
δ_{N0}-Factor	[mm/N/mm²]	--	0,12	0,12	0,13	0,13	0,13	0,13	0,14
$\delta_{N\infty}$-factor	[mm/N/mm²]	--	0,27	0,30	0,30	0,30	0,30	0,35	0,37

[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 C22: Displacements under shear load [1] for reinforcing bars

Size ϕ	[mm]	8	10	12	14	16	20	25	28
δ_{V0}-factor	[mm/kN]	0,11	0,11	0,10	0,10	0,10	0,09	0,09	0,08
$\delta_{V\infty}$-factor	[mm/kN]	0,12	0,12	0,11	0,11	0,11	0,10	0,10	0,09

[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 C23: Displacements under tension load [1] for rebar anchor BRA

Size		M12	M16	M20	M24
Un-cracked concrete					
δ_{N0}-factor	[mm/N/mm²]	0,10	0,10	0,10	0,10
$\delta_{N\infty}$-factor	[mm/N/mm²]	0,12	0,12	0,12	0,13
Cracked concrete					
δ_{N0}-factor	[mm/N/mm²]	0,12	0,13	0,13	0,13
$\delta_{N\infty}$-factor	[mm/N/mm²]	0,30	0,30	0,30	0,35

[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 C24: Displacements under shear load [1] for rebar anchor BRA

Size		M12	M16	M20	M24
δ_{V0}-factor	[mm/kN]	0,1	0,1	0,09	0,09
$\delta_{V\infty}$-factor	[mm/kN]	0,11	0,11	0,10	0,1

[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 reinforcing bars and rebar anchor BRA

Annex C 14