... eine starke Verbindung

DECLARATION OF PERFORMANCE

DoP Nr.: **MKT-1.1-901uk_en**

- ✧ **Unique identification code of product-type:** **Wedge Anchor BZ3 / BZ3 A4 / BZ3 HCR**
- ✧ **Intended use/es:** Mechanical fastener for use in concrete, see Annex B
- ✧ **Manufacturer:** MKT Metall-Kunststoff-Technik GmbH & Co.KG
  Auf dem Immel 2
  67685 Weilerbach
- ✧ **System or systems of assessment and verification of constancy of performance:** 1
- ✧ **UK Assessment Document:** **UKAD 330232-00-0601**
  - UK Technical Assessment: **UKTA-0836-22/6211, 30.08.2022**
  - Technical Assessment Body: British Board of Agrément (BBA)
  - UK Approved Body/ies: 0836 – British Board of Agrément (BBA)

✧ **Declared performance/s:**

Essential Characteristics	Performance
Mechanical resistance and stability (BWR 1)	
Minimum edge distances and spacing	Annex B3
Characteristic resistance to tension load (static and quasi-static loading)	Annex C1, C2
Characteristic resistance to shear load (static and quasi-static loading)	Annex C3
Characteristic values for seismic performance category C1+C2	Annex C4
Displacements	Annex C7, C8
Durability	Annex B1
Safety in case of fire (BWR 2)	
Reaction to fire	Class A1
Resistance to fire	Annex C5, C6

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, as amended by the UK Construction Products (Amendment etc.) (EU Exit) Regulations 2019 and 2020.

Signed for and on behalf of the manufacturer by:

Stefan Weustenhagen
(General manager)
Weilerbach, 30.08.2022

p.p.
Dipl.-Ing. Detlef Bigalke
(Head of product development)

ANNEX B1
Intended Use / Specifications

Wedge Anchor	BZ3 / BZ3 A4 / BZ3 HCR			
	M8	M10	M12	M16
Static or quasi-static action	✓			
Seismic performance categories C1 and C2	✓			
Fire exposure	R30 / R60 / R90 / R120			
Variable, effective anchorage depth	35 mm to 90 mm	40 mm to 100 mm	50 mm to 125 mm	65 mm to 160 mm

Base materials:

- Cracked or uncracked concrete
- Reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016
- Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions: all materials
- For all other conditions according to EN 1993-1-2006 + A1:2015-10, corresponding to corrosion resistance classes CRC according to Annex A3, Table A2.

Design:

- Anchorages are 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 fastener is indicated on the design drawings (e.g. position of the fastener relative to reinforcement or to supports, etc.).
- Design method EN 1992-4:2018 and Technical Report TR 055:2018

Installation:

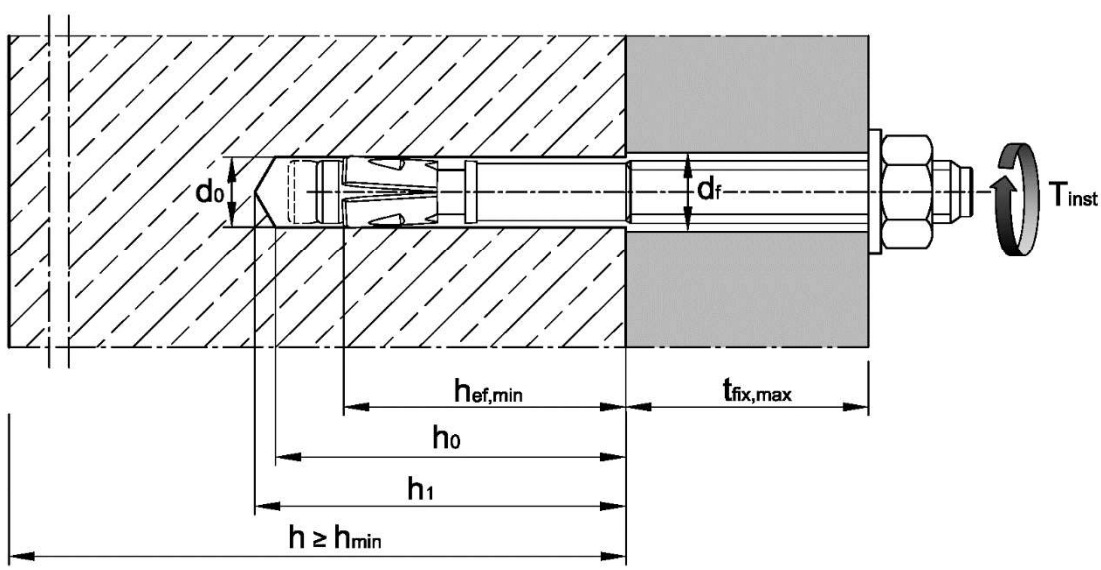
- Hole drilling by hammer drill bit or vacuum drill bit
- Use of the fastener only as supplied by the manufacturer without exchanging the components of the fastener (exception: when using the cap nut HM)
- The anchor can be set in pre- or through-setting installation.
- Optionally, the annular gap between fixture and stud of BZ3 can be filled to reduce the hole clearance. For this purpose, the filling washer (Annex A3) must be used in addition to the supplied washer. For filling use MKT Injection Adhesive VMH, VMU plus, VMZ or other high-strength injection mortar with compressive strength ≥ 40N/mm².

ANNEX B2
Intended Use / Installation parameters

Table B1: Installation parameters

Anchor size				BZ3 / BZ3 A4 / BZ3 HCR			
				M8	M10	M12	M16
Nominal drill hole diameter		d_0	[mm]	8	10	12	16
Cutting diameter of drill bit		$d_{cut} \leq$	[mm]	8.45	10.45	12.5	16.5
Minimum effective anchorage depth		$h_{ef,min}$	[mm]	35	40	50	65
Maximum effective anchorage depth		$h_{ef,max}$	[mm]	90	100	125	160
Depth of drill hole		$h_0 \geq$	[mm]	h_{ef} + 8	h_{ef} + 9	h_{ef} + 10	h_{ef} + 14
		$h_1 \geq$	[mm]	h_{ef} + 10	h_{ef} + 11	h_{ef} + 13	h_{ef} + 17
Diameter of clearance hole in the fixture [1)]		$d_f \leq$	[mm]	9	12	14	18
Projection after anchor has been inserted for installing with cap nut HM (according to Annex B6, Figure 3)		C	[mm]	10.5	12.5	16.0	19.5
Installation torque	BZ3	T_{inst}	[Nm]	15	40	60	110
	BZ3 A4 / HCR	T_{inst}	[Nm]	15	40	55	100

[1)] For larger diameters of clearance hole in the fixture, see EN 1992-4:2018, chapter 6.2.2.2



ANNEX B3
Intended Use / Minimum spacing and edge distances / Required area and applicable concrete thickness

Table B2: Minimum thickness of concrete member, minimum spacings, edge distances

Anchor size			**BZ3 / BZ3 A4 / BZ3 HCR**			
			M8	**M10**	**M12**	**M16**
Minimum member thickness depending on h_{ef}	$h_{min} \geq$	[mm]	max ($1.5 \cdot h_{ef}$; 80)		max ($1.5 \cdot h_{ef}$;100)	max ($1.5 \cdot h_{ef}$;120)
Minimum edge distances and spacings						
Minimum edge distance	c_{min}	[mm]	40	45	55	65
	for s ≥	[mm]	see Table B4			
Minimum spacings	s_{min}	[mm]	35	40	50	65
	for c ≥	[mm]	see Table B4			
The following equation must be fulfilled for the calculation of the minimum spacing and edge distance during installation in combination with variable anchorage depth and member thickness:						
$\mathbf{A_{sp,req} \leq A_{sp,ef}}$ Required splitting area $A_{sp,req}$ and idealized splitting area $A_{sp,ef}$ according to Table B4.						

Table B3: Applicable concrete thickness h_{sp} **and area** A_{sp} to determine characteristic edge distance $c_{cr,sp}$

Anchor size				**M8**	**M10**	**M12**	**M16**
Applicable concrete thickness	BZ3 BZ3 A4 BZ3 HCR	h_{sp}	[mm]	$\min(h\ ;\ h_{ef} + 1.5 \cdot c \cdot \sqrt{2})$			
Area to determine $c_{cr,sp}$[1)]	BZ3	A_{sp}	[mm²]	$\frac{N^0_{Rk,sp} - 2.573}{0.000436}$	$\frac{N^0_{Rk,sp} + 2.040}{0.000693}$	$\frac{N^0_{Rk,sp} + 3.685}{0.000692}$	$\frac{N^0_{Rk,sp} + 3.738}{0.000875}$
	BZ3 A4 BZ3 HCR	A_{sp}	[mm²]	$\frac{N^0_{Rk,sp} + 4.177}{0.000862}$	$\frac{N^0_{Rk,sp} + 7.235}{0.000967}$	$\frac{N^0_{Rk,sp} + 7.847}{0.000951}$	$\frac{N^0_{Rk,sp} + 11.415}{0.000742}$

[1)] with $N^0_{Rk,sp}$ in kN

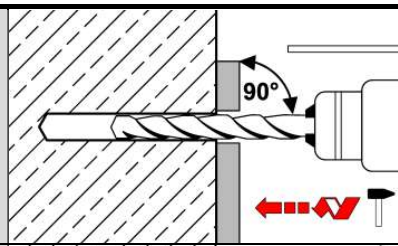
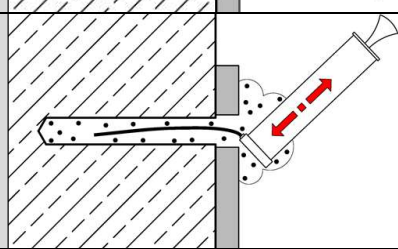
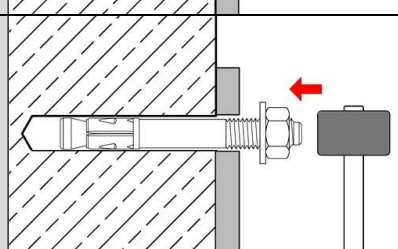
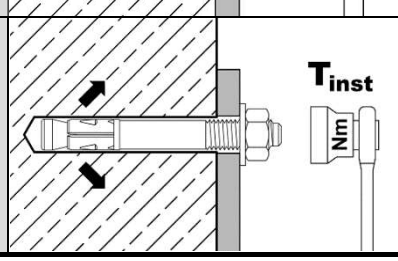
ANNEX B4
Intended Use / Projected effective area to determine spacings and edge distances

Table B4: Areas to determine spacings and edge distances for installation

Anchor size				**BZ3 / BZ3 A4 / BZ3 HCR**			
				M8	**M10**	**M12**	**M16**
The following equation must be fulfilled for the calculation of the minimum spacing and edge distance during installation in combination with variable anchorage depth and member thickness: $A_{sp,req} \leq A_{sp,ef}$							
Idealized splitting area $A_{sp,ef}$ The edge distances and spacings shall be selected or rounded in steps of 5 mm.							
Member thickness: $h > h_{ef} + 1.5 \cdot c$							
Single anchor or anchor group with **$s \geq 3 \cdot c$**							
Effective anchorage depth **$h_{ef} < 1.5 \cdot c$**			$A_{sp.ef} = (6 \cdot c) \cdot (1.5 \cdot c + h_{ef})$ [mm²]				
Effective anchorage depth **$h_{ef} \geq 1.5 \cdot c$**			$A_{sp.ef} = (6 \cdot c) \cdot (3 \cdot c)$ [mm²]				
Anchor group ($s < 3 \cdot c$)							
Effective anchorage depth **$h_{ef} < 1.5 \cdot c$**			$A_{sp.ef} = (3 \cdot c + s) \cdot (1.5 \cdot c + h_{ef})$ [mm²]				
Effective anchorage depth **$h_{ef} \geq 1.5 \cdot c$**			$A_{sp.ef} = (3 \cdot c + s) \cdot (3 \cdot c)$ [mm²]				
Member thickness: $h \leq h_{ef} + 1.5 \cdot c$							
Single anchor or anchor group with **$s \geq 3 \cdot c$**							
Effective anchorage depth **$h_{ef} < 1.5 \cdot c$**			$A_{sp.ef} = (6 \cdot c) \cdot h$ [mm²]				
Effective anchorage depth **$h_{ef} \geq 1.5 \cdot c$**			$A_{sp.ef} = (6 \cdot c) \cdot (h - h_{ef} + 1.5 \cdot c)$ [mm²]				
Anchor group ($s < 3 \cdot c$)							
Effective anchorage depth **$h_{ef} < 1.5 \cdot c$**			$A_{sp.ef} = (3 \cdot c + s) \cdot h$ [mm²]				
Effective anchorage depth **$h_{ef} \geq 1.5 \cdot c$**			$A_{sp.ef} = (3 \cdot c + s) \cdot (h - h_{ef} + 1.5 \cdot c)$ [mm²]				
Required splitting area $A_{sp,req}$							
BZ3	cracked concrete	$A_{sp,req}$	[mm²]	13 900	23 700	31 500	42 300
	uncracked concrete	$A_{sp,req}$	[mm²]	22 500	34 700	41 300	50 200
BZ3 A4 BZ3 HCR	cracked concrete	$A_{sp,req}$	[mm²]	16 900	25 900	29 800	44 300
	uncracked concrete	$A_{sp,req}$	[mm²]	19 700	35 700	35 300	54 800

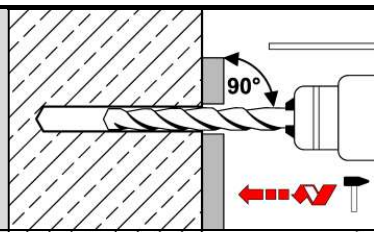
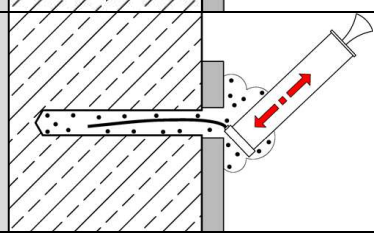
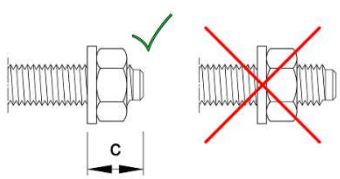
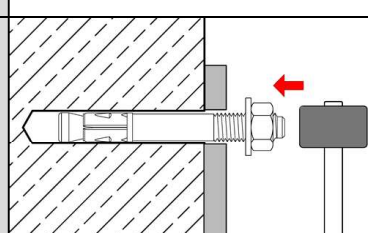
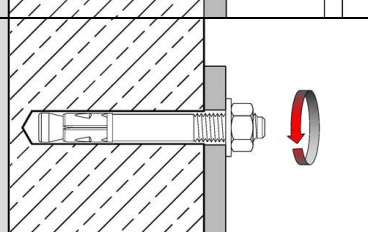
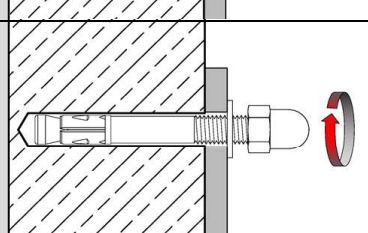
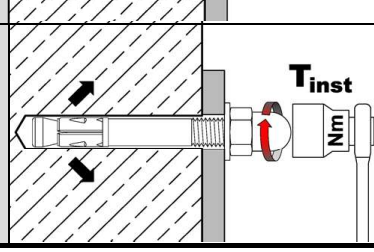
ANNEX B5
Intended Use / Installation instructions

Installation instructions

1		Drill hole perpendicular to concrete surface. If using a vacuum drill bit, proceed with step 3.
2		Blow out dust. Alternatively vacuum clean down to the bottom of the hole.
3		Drive in fastener.
4		Apply installation torque T_{inst}.

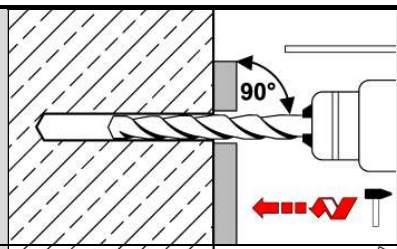
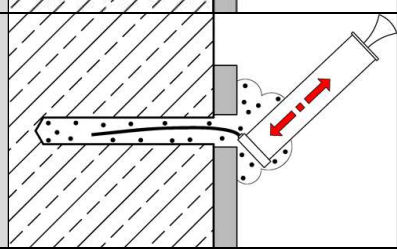
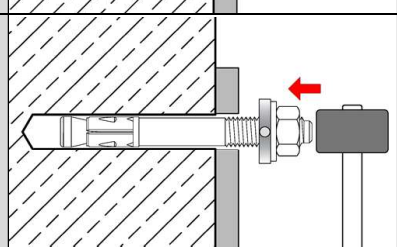
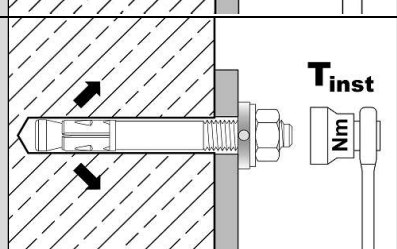
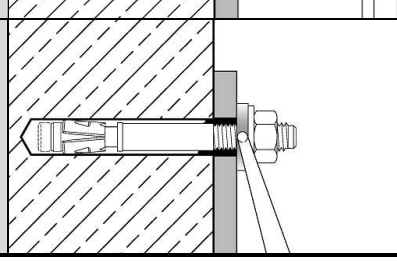
ANNEX B6
Intended Use / Installation instructions with cup nut

Installation with cap nut HM

1		Drill hole perpendicular to concrete surface. If using a vacuum drill bit, proceed with step 3.
2		Blow out dust. Alternatively vacuum clean down to the bottom of the hole.
3		Check position of nut. Projection C after anchor has been inserted see Annex B2, Table B1.
4		Drive in fastener.
5		Remove nut.
6		Screw on cap nut
7		Apply installation torque T_{inst}.

ANNEX B7
Intended Use / Product types and installation conditions

Installation instructions with filling of annular gap

1		Drill hole perpendicular to concrete surface. If using a vacuum drill bit, proceed with step 3.
2		Blow out dust. Alternatively vacuum clean down to the bottom of the hole.
3		Drive in fastener with additionally mounted filling washer.
4		Apply installation torque T_{inst}.
5		Fill the annular gap between anchor and fixture with injection adhesive (see Annex B1). Use enclosed reducing adapter. The annular gap is completely filled, when excess mortar seeps out.

ANNEX C1
Performance / Characteristics values for tensions loads, BZ3 (Steel, zinc plated)

Table C1: Characteristic values for **tension loads** under static and quasi-static action, **BZ3** (steel, zinc plated)

Fastener size			**BZ3**			
			M8	**M10**	**M12**	**M16**
Installation factor	γ_{inst}	[-]	1.0			
Steel failure						
Characteristic resistance	$N_{Rk,s}$	[kN]	19.8	30.4	44.9	79.3
Partial factor [4]	γ_{Ms}	[-]	1.5			
Pull-out						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p,cr}$	[kN]	9.5	15	22	30
Increasing factor $N_{Rk,p,cr} = \psi_C \cdot N_{Rk,p,cr}$ (C20/25)	ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0.439}$	$\left(\frac{f_{ck}}{20}\right)^{0.265}$	$\left(\frac{f_{ck}}{20}\right)^{0.5}$	$\left(\frac{f_{ck}}{20}\right)^{0.339}$
Characteristic resistance in uncracked concrete C20/25	$N_{Rk,p,ucr}$	[kN]	14	24	30	50
Increasing factor $N_{Rk,p,ucr} = \psi_C \cdot N_{Rk,p,ucr}$ (C20/25)	ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0.489}$	$\left(\frac{f_{ck}}{20}\right)^{0.448}$	$\left(\frac{f_{ck}}{20}\right)^{0.5}$	$\left(\frac{f_{ck}}{20}\right)^{0.203}$
Splitting						
Characteristic resistance	$N^0_{Rk,sp}$	[kN]	min ($N_{Rk,p}$; $N^0_{Rk,c}$ [3])			
Characteristic edge distance [2]	$c_{cr,sp}$	[mm]	$\frac{A_{sp} + 0.8 \cdot (h_{sp} - h_{ef})^2}{(3.41 \cdot h_{sp} - 0.59 \cdot h_{ef})}$			
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$			
Concrete cone failure						
Minimum, effective anchorage depth	$h_{ef,min}$	[mm]	35 [1]	40	50	65
Maximum, effective anchorage depth	$h_{ef,max}$	[mm]	90	100	125	160
Characteristic edge distance	$c_{cr,N}$	[mm]	$1.5 \cdot h_{ef}$			
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$			
Factor — cracked concrete	$k_{cr,N}$	[-]	7.7			
Factor — uncracked concrete	$k_{ucr,N}$	[-]	11.0			

[1] Fastenings with anchorage depth hef < 40mm are restricted to the use of structural components which are statically indeterminate and subject to internal exposure conditions only.

[2] Applicable concrete thickness hsp and area Asp to determine characteristic edge distance ccr,sp according to Table B3

[3] N0Rk,c according to EN 1992-4:2018

[4] In absence of other national regulations

ANNEX C2
Performance / Characteristics values for tensions loads, BZ3 A4 and BZ3 HCR

Table C2: Characteristic values for **tension loads** under static or quasi-static action, **BZ3 A4** and **BZ3 HCR**

Fastener size				**BZ3 A4 / BZ3 HCR**			
				M8	**M10**	**M12**	**M16**
Installation factor		γ_{inst}	[-]	1.0			
Steel failure							
Characteristic resistance		$N_{Rk,s}$	[kN]	19.8	30.4	44.9	74.6
Partial factor [4]		γ_{Ms}	[-]	1.5			
Pull-out							
Characteristic resistance in cracked concrete C20/25		$N_{Rk,p,cr}$	[kN]	9.5	17	22	35
Increasing factor $N_{Rk,p,cr} = \psi_C \cdot N_{Rk,p,cr}$ (C20/25)		ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0.488}$	$\left(\frac{f_{ck}}{20}\right)^{0.5}$	$\left(\frac{f_{ck}}{20}\right)^{0.435}$	$\left(\frac{f_{ck}}{20}\right)^{0.350}$
Characteristic resistance in uncracked concrete C20/25		$N_{Rk,p,ucr}$	[kN]	20	25	42	50
Increasing factor $N_{Rk,p,ucr} = \psi_C \cdot N_{Rk,p,ucr}$ (C20/25)		ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0.240}$	$\left(\frac{f_{ck}}{20}\right)^{0.364}$	$\left(\frac{f_{ck}}{20}\right)^{0.213}$	$\left(\frac{f_{ck}}{20}\right)^{0.196}$
Splitting							
Characteristic resistance		$N^0_{Rk,sp}$	[kN]	min ($N_{Rk,p}$; $N^0_{Rk,c}$ [3])			
Characteristic edge distance [2]		$c_{cr,sp}$	[mm]	$\frac{A_{sp} + 0.8 \cdot (h_{sp} - h_{ef})^2}{(3.41 \cdot h_{sp} - 0.59 \cdot h_{ef})}$			
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$			
Concrete cone failure							
Minimum, effective anchorage depth		$h_{ef,min}$	[mm]	35 [1]	40	50	65
Maximum, effective anchorage depth		$h_{ef,max}$	[mm]	90	100	125	160
Characteristic edge distance		$c_{cr,N}$	[mm]	$1.5 \cdot h_{ef}$			
Characteristic spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$			
Factor	cracked concrete	$k_{cr,N}$	[-]	7.7			
	uncracked concrete	$k_{ucr,N}$	[-]	11.0			

[1] Fastenings with anchorage depth hef < 40 mm are restricted to the use of structural components which are statically indeterminate and subject to internal exposure conditions only

[2] Applicable concrete thickness hsp and area Asp according to Table B3 to determine characteristic edge distance ccr,sp

[3] N0Rk,c according to EN 1992-4:2018

[4] In absence of other national regulations

ANNEX C3
Performance / Characteristics values for shear loads

Table C3: Characteristic values for **shear loads** under static and quasi-static action

Fastener size				**BZ3 / BZ3 A4 / BZ3 HCR**			
				M8	**M10**	**M12**	**M16**
Installation factor		γ_{inst}	[-]	1.0			
Steel failure <u>without</u> lever arm							
Characteristic resistance	BZ3	$V^0_{Rk,s}$	[kN]	15.7	26.8	38.3	60.0
	BZ3 A4 / HCR	$V^0_{Rk,s}$	[kN]	16.8	27.8	39.8	69.5
Partial factor [2]		γ_{Ms}	[-]	1.25			
Ductility factor		k_7	[-]	1.0			
Steel failure <u>with</u> lever arm							
Characteristic bending resistance	BZ3	$M^0_{Rk,s}$	[Nm]	30	60	105	240
	BZ3 A4 / HCR	$M^0_{Rk,s}$	[Nm]	27	55	99	223
Partial factor [2]		γ_{Ms}	[-]	1.25			
Concrete pry-out failure							
Pry-out factor	BZ3	k_8	[-]	2.8	3.1	3.0	3.6
	BZ3 A4 / HCR	k_8	[-]	2.7	2.8	3.3	3.4
Concrete edge failure							
Effective length of fastener in shear loading		l_f	[mm]	h_{ef} [1]			
Outside diameter of fastener		d_{nom}	[mm]	8	10	12	16

[1] Fastenings with anchorage depth $h_{ef} < 40$ mm are restricted to the use of structural components which are statically indeterminate and subject to internal exposure conditions only.

[2] In absence of other national regulations

ANNEX C4
Performance / Characteristics values for seismic loading

Table C4: Characteristic values for **seismic loading,** performance category **C1**

Fastener size				**BZ3 / BZ3 A4 / BZ3 HCR**							
				M8		**M10**		**M12**		**M16**	
Effective anchorage depth		$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Tension load											
Installation factor		γ_{inst}	[-]	1.0							
Steel failure											
Characteristic resistance	BZ3	$N_{Rk,s,C1}$	[kN]	19.8		30.4		44.9		79.3	
	BZ3 A4 / HCR	$N_{Rk,s,C1}$	[kN]	19.8		30.4		44.9		74.6	
Pull-out											
Characteristic resistance	BZ3	$N_{Rk,p,C1}$	[kN]	9.1		15.0		22.0		30.0	
	BZ3 A4 / HCR	$N_{Rk,p,C1}$	[kN]	9.0		17.0		22.0		35.0	
Shear load											
Steel failure without lever arm											
Characteristic resistance	BZ3	$V_{Rk,s,C1}$	[kN]	11.7	13.4	22.5	24.4	30.0	33.8	48.8	52.3
	BZ3 A4 / HCR	$V_{Rk,s,C1}$	[kN]	11.0	12.7	20.6	22.2	33.2	33.2	61.1	64.3
Factor for anchorages	**with** annular gap	α_{gap}	[-]	0.5							
	without annular gap	α_{gap}	[-]	1.0							

Table C5: Characteristic values for **seismic loading,** performance category **C2**

Fastener size				**BZ3 / BZ3 A4 / BZ3 HCR**							
				M8		**M10**		**M12**		**M16**	
Effective anchorage depth		$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Tension load											
Installation factor		γ_{inst}	[-]	1.0							
Steel failure											
Characteristic resistance	BZ3	$N_{Rk,s,C2}$	[kN]	19.8		30.4		44.9		79.3	
	BZ3 A4 / HCR	$N_{Rk,s,C2}$	[kN]	19.8		30.4		44.9		74.6	
Pull-out											
Characteristic resistance	BZ3	$N_{Rk,p,C2}$	[kN]	2.8	3.6	7.3	12.5	10.7	19.0	19.8	35.2
	BZ3 A4 / HCR	$N_{Rk,p,C2}$	[kN]	2.3	3.2	5.0	7.7	8.0	13.8	19.0	29.4
Shear load											
Steel failure without lever arm											
Characteristic resistance	BZ3	$V_{Rk,s,C2}$	[kN]	7.3	11.3	15.4	19.0	18.3	28.0	39.4	43.3
	BZ3 A4 / HCR	$V_{Rk,s,C2}$	[kN]	7.5	8.6	12.5	15.9	22.4	25.6	42.7	46.1
Factor for anchorages	**with** annular gap	α_{gap}	[-]	0.5							
	without annular gap	α_{gap}	[-]	1.0							

ANNEX C5
Performance / Characteristics values under fire exposure BZ3 (steel, zinc plated)

Table C6 Characteristic values **for tension and shear load** under **fire exposure, BZ3** (steel, zinc plated)

Fastener size				**BZ3**			
				M8	**M10**	**M12**	**M16**
Tension load							
Steel failure							
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	1.2	2.6	4.6	7.7
	R60			1.0	1.9	3.3	5.6
	R90			0.7	1.3	2.1	3.5
	R120			0.6	1.0	1.5	2.5
Shear load							
Steel failure <u>without</u> lever arm							
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	4.0	7.5	12.3	20.7
	R60			2.7	5.1	8.5	14.2
	R90			1.4	2.7	4.6	7.7
	R120			0.8	1.6	2.7	4.5
Steel failure <u>with</u> lever arm							
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	4.1	9.6	19.1	43.8
	R60			2.8	6.6	13.1	30.1
	R90			1.5	3.5	7.2	16.4
	R120			0.8	2.0	4.2	9.6

$N_{Rk,p,fi}$ and $N_{Rk,c,fi}$ according to EN 1992-4:2018

ANNEX C6
Performance / Characteristic values under fire exposure, BZ3 A4 and BZ3 HCR

Table C7 Characteristic values **for tension and shear load** under **fire exposure, BZ3 A4** und **BZ3 HCR**

Fastener size				**BZ3 A4 / BZ3 HCR**			
				M8	**M10**	**M12**	**M16**
Tension load							
Steel failure							
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	4.0	6.9	11.0	18.1
	R60			2.9	5.0	8.0	13.1
	R90			1.8	3.1	4.9	8.1
	R120			1.2	2.1	3.4	5.6
Shear load							
Steel failure <u>without</u> lever arm							
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	8.5	17.6	32.0	52.6
	R60			6.2	12.6	22.6	37.1
	R90			3.9	7.5	13.1	21.5
	R120			2.8	5.0	8.4	13.8
Steel failure <u>with</u> lever arm							
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	8.7	22.7	49.8	111.5
	R60			6.3	16.2	35.1	78.6
	R90			4.0	9.7	20.4	45.6
	R120			2.8	6.5	13.0	29.2

$N_{Rk,p,fi}$ and $N_{Rk,c,fi}$ according to EN 1992-4:2018

ANNEX C7
Performance / Displacements under shear load

Table C8: Displacements under **tension load, BZ3** (steel, zinc plated)

Fastener size			**BZ3**							
			M8		**M10**		**M12**		**M16**	
Displacements under static or quasi-static action $\delta_{N0} = \delta_{N0\text{-factor}} * N$ N: acting tension load $\delta_{N\infty} = \delta_{N\infty\text{-factor}} * N$										
Effective anchorage depth	$h_{ef} \geq$	[mm]	35		40		50		65	
Cracked concrete										
Factor for displacement	$\delta_{N0\text{-factor}}$	[mm/kN]	0.13		0.05		0.04		0.03	
	$\delta_{N\infty\text{-factor}}$	[mm/kN]	0.29		0.20		0.15		0.11	
Uncracked concrete										
Factor for displacement	$\delta_{N0\text{- factor}}$	[mm/kN]	0.03		0.01		0.004		0.005	
	$\delta_{N\infty\text{- factor}}$	[mm/kN]	0.03		0.03		0.03		0.03	
Displacement under seismic action C2										
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Displacements for DLS	$\delta_{N, C2(DLS)}$	[mm]	3.9	4.9	2.8	4.7	2.4	4.2	2.5	4.5
Displacements for ULS	$\delta_{N, C2(ULS)}$	[mm]	11.3	14.3	9.4	16.1	7.3	12.9	7.2	12.8

Table C9: Displacements under **tension load, BZ3 A4** and **BZ3 HCR**

Fastener size			**BZ3 A4 / BZ3 HCR**							
			M8		**M10**		**M12**		**M16**	
Displacements under static or quasi-static action $\delta_{N0} = \delta_{N0\text{-factor}} * N$ N: acting tension load $\delta_{N\infty} = \delta_{N\infty\text{-factor}} * N$										
Effective anchorage depth	$h_{ef} \geq$	[mm]	35		40		50		65	
Cracked concrete										
Factor for displacement	$\delta_{N0\text{-factor}}$	[mm/kN]	0.11		0.06		0.05		0.02	
	$\delta_{N\infty\text{-factor}}$	[mm/kN]	0.27		0.17		0.16		0.08	
Uncracked concrete										
Factor for displacement	$\delta_{N0\text{- factor}}$	[mm/kN]	0.02		0.00		0.001		0.00	
	$\delta_{N\infty\text{- factor}}$	[mm/kN]	0.05		0.05		0.05		0.05	
Displacement under seismic action C2										
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Displacements for DLS	$\delta_{N, C2(DLS)}$	[mm]	2.0	2.9	2.6	4.1	3.3	5.7	3.3	5.1
Displacements for ULS	$\delta_{N, C2(ULS)}$	[mm]	7.7	11.1	10.8	16.8	10.4	18.0	9.0	13.9

ANNEX C8
Performance / Displacements under tension load

Table C10: Displacements under **shear load,** BZ3 (steel, zinc plated)

Fastener size			**BZ3**							
			M8		**M10**		**M12**		**M16**	
Displacements under static or quasi-static action $\delta_{V0} = \delta_{V0\text{-factor}} * V$ V: acting shear load $\delta_{V\infty} = \delta_{V\infty\text{-factor}} * V$										
Effective anchorage depth	$h_{ef} \geq$	[mm]	35		40		50		65	
Factor for displacement	$\delta_{V0\text{- factor}}$	[mm/kN]	0.15		0.09		0.09		0.07	
	$\delta_{V\infty\text{- factor}}$	[mm/kN]	0.22		0.13		0.14		0.11	
Displacement under seismic action C2 [1)]										
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Displacements for DLS	$\delta_{V,C2(DLS)}$	[mm]	2.8	2.7	3.0	3.1	3.4	3.7	3.4	3.8
Displacements for ULS	$\delta_{V,C2(ULS)}$	[mm]	5.1	5.0	5.0	5.5	6.3	9.9	6.0	9.6

[1)] For anchorages with clearance in the fixture the annular gap must also be taken into account.

Table C11: Displacements under **shear load,** BZ3 A4 and BZ3 HCR

Fastener size			**BZ3 A4 / BZ3 HCR**							
			M8		**M10**		**M12**		**M16**	
Displacements under static or quasi-static action $\delta_{V0} = \delta_{V0\text{-factor}} * V$ V: acting shear load $\delta_{V\infty} = \delta_{V\infty\text{-factor}} * V$										
Effective anchorage depth	$h_{ef} \geq$	[mm]	35		40		50		65	
Factor for displacement	$\delta_{V0\text{- factor}}$	[mm/kN]	0.26		0.14		0.12		0.09	
	$\delta_{V\infty\text{- factor}}$	[mm/kN]	0.39		0.20		0.17		0.14	
Displacement under seismic action C2 [1)]										
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	45	40	60	50	70	65	85
Displacements for DLS	$\delta_{V,C2(DLS)}$	[mm]	2.8	3.0	3.4	3.5	3.5	4.2	3.8	4.4
Displacements for ULS	$\delta_{V,C2(ULS)}$	[mm]	5.2	5.1	7.0	8.4	7.5	11.8	7.8	11.1

[1)] For anchorages with clearance in the fixture the annular gap must also be taken into account