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European Technical Assessment Body for construction products



European Technical Assessment

ETA-24/0649 of 1 August 2024

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	Injection System FMZ Plus for concrete
Product family to which the construction product belongs	Bonded fasteners and bonded expansion fasteners for use in concrete
Manufacturer	Market Tech (Beijing) Co., Ltd Room 121211, unit 2, building 3, No. 1 Futong East Street BEIJING, CHAOYANG DISTRICT VOLKSREPUBLIK CHINA
Manufacturing plant	Manufacturing plant no. 1 Manufacturing plant no. 2
This European Technical Assessment contains	39 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330499-02-0601, Edition 11/2023



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Specific Part

1 Technical description of the product

The "Injection system FMZ Plus for concrete" is a bonded anchor consisting of a cartridge with injection mortar FMZ Plus and a steel element according to Annex A 3 to A 5.

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 and/or 100 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 to tension load (static and quasi-static loading)	See Annex B3, C 1, C 3, C 4, C 5, C 9, C 10, C 12, C 13
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2, C 6, C 11, C 14
Displacements under short-term and long-term loading	See Annex C 17 to C19
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 7, C 8, C 15, C 16, C 17

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 20 to C 22

3.3 Hygiene, health and the environment (BWR 3)

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



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

In accordance with EAD 330499-02-0601 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 at Deutsches Institut für Bautechnik.

Issued in Berlin on 1 August 2024 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock Head of Section *beglaubigt:* Baderschneider



Installation threaded rod M8 to M30 Pre-setting installation or through-setting installation (optional annular gap filled with mortar) tfix $h_{ef} = h_0$ hmin Installation internally threaded anchor rod IG M6 to IG M20 $h_{ef} = h_0$ tfix hmin Installation reinforcing bar Ø8 to Ø32 = effective anchorage depth hef $h_{ef} = h_0$ = depth of drill hole ho h_{min} = minimum thickness of member hmin = thickness of fixture t_{fix} Injection System FMZ Plus for concrete Annex A1 **Product description** Installation situation

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Cartridge Injection Mortar FMZ Plu	IS		
Coaxial cartridge 150 ml, 280 ml, 300 ml bis 330 ml, 380 ml bis 420 ml		Imprint: FMZ Plus processing and safety instructions, sl charge number, manufacturer's infor quantity information	nelf life, mation,
Side-by-side cartridge 235 ml, 345 ml bis 360 ml, 825 ml		Imprint: FMZ Plus processing and safety instructions, charge number, manufacturer's info quantity information	shelf life, prmation,
Static mixer FM-XHP			
Retaining washer and extension	nozzle		
)
njection System FMZ Plus for concrete			
Product description Cartridge, static mixer and retaining washer			Annex A2

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Threaded rod **Threaded rod FMZ-A and HFZ** M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A4, HCR) with washer and hexagon nut FMZ-A 1 dnom Iges Marking e.g.: M10 identifying mark of \diamond manufacturing plant HFZ M10 size of thread optional: mark of additional marking: embedment depth -8 strength class 8.8 1 A4 stainless steel dnor HC high corrosion resistant steel **Threaded rod HFT** (material sold by the metre, to be cut at the required length) M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR) - Materials, dimensions and mechanical properties see Table A1 Commercial standard threaded rod with: M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR) - Materials, dimensions and mechanical properties see Table A1 - Inspection certificate 3.1 acc. to EN 10204:2004 (documents must be retained) Filling washer FS and reducing adapter for filling the gap between threaded rod and fixture 3b Thickness of filling washer for diameter < M24: t = 5 mm ≥ M24: t = 6 mm Injection System FMZ Plus for concrete Annex A3 **Product description** Threaded rods, Marking, Filling washer



Internally threaded anchor rod		
Internally threaded anchor rod FMZ-IG FMZ-IG M6, FMZ-IG M8, FMZ-IG M10, FMZ-IG M12, FMZ-IG M16, FMZ-IG I (zinc plated, A4, HCR)	W20	
4		
	Marking e.g.:	<>> M8
nef 🛌	 identify manufa interna 	ving mark of acturing plant Il thread (optional) internal thread
Internally threaded anchor rod HFZ-IG	-	r <u>king:</u> th class 8.8 ss steel
HFZ-IG M6, HFZ-IG M8, HFZ-IG M10, HFZ-IG M12, HFZ-IG M16, HFZ-IG M20 (zinc plated, A4, HCR)	HCR high co	prrosion resistant steel
4		
her		
Requirements on the fastening screw or the threaded rod and nut accor	rding to the e	naineerina
 Minimum screw-in depth L_{sd,min} see Table B2 The length of screw or the threaded rod shall be determined depending or existing thread length and the minimum screw-in depth L_{sd,min}. Materials for screws and threaded rods (incl. nut and washer) must at leas strength class of the internally threaded anchor rod used. 	n the thicknes	s of fixture t _{fix} , the
Injection System FMZ Plus for concrete		
Product description Internally threaded anchor rods, Marking		Annex A4

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Part	Designation		Material and mechanical properties							
electr hot-di	p galvanized ≥ 50	μm acc. to El μm in averag μm acc. to E	ge acc. to E	EN ISO	1461:2022	2, EN IS	O 10684:200	4+AC:2009 or		
		characteristic characteristic ultimate strength yield strength			fracture elongation	EN ISO 683-4:2018				
		4.6		400		240	A ₅ > 8 %	EN 10263:2017		
1	Threaded rod	4.8	£	400		320	A5 > 8 %	Commercial standa		
		5.6	f _{uk} [N/mm²]	500	f _{yk} [N/mm²]	300	A5 > 8 %	threaded rod:		
		5.8	[14/1111]	500		400	A5 > 8 %	EN ISO 898-1:2013		
		8.8		800		640	A₅≥ 12% ¹⁾			
		4	for class 4	1.6 or 4.	8 rods					
2	Hexagon nut	5	for class 4	1.6, 4.8,	5.6 or 5.8	rods		EN ISO 898-2:2022		
		8	for class 4	1.6, 4.8,	5.6, 5.8 0	r 8.8 roc	ls			
3a	Washer		e.g.: EN I EN ISO 8			NISO 7	093:2000, EN	NISO 7094:2000,		
3b	Washer with bore		Steel, zin	c plated						
		ally threaded 5.8 Steel, electroplated or sherardized $A_5 > 8\%$								
4	Internally threaded anchor rod	8.8					A5 > 8%			
Stain Stain	anchor rod less steel A2 ²⁾ less steel A4	8.8 C C	RC II (1.4 RC III (1.4	301 / 1.4 401 / 1.4	4307 / 1.4 4404 / 1.4	311 / 1.4	A ₅ > 8% 4567 / 1.454	EN ISO 683-4:2018		
Stain Stain	anchor rod less steel A2 ²⁾	8.8 C C	RC II (1.4	301 / 1.4 401 / 1.4	4307 / 1.4 4404 / 1.4	311 / 1.4	A ₅ > 8% 4567 / 1.454			
Stain Stain	anchor rod less steel A2 ²⁾ less steel A4	8.8 C C	RC II (1.4 RC III (1.4	301 / 1.4 401 / 1.4 529 / 1.4 eristic	4307 / 1.4 4404 / 1.4	311 / 1.4 571 / 1.4 eristic	A ₅ > 8% 4567 / 1.454			
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st	8.8 C ceel HCR C Property	RC II (1.4 RC III (1.4 RC V (1.4) characte	301 / 1.4 401 / 1.4 529 / 1.4 eristic	4307 / 1.4 4404 / 1.4 1565) charact	311 / 1.4 571 / 1.4 eristic	A₅ > 8% 4567 / 1.454 4578) fracture			
Stain Stain	anchor rod less steel A2 ²⁾ less steel A4	8.8 C C C C C C C C C C C C C C C C C C	RC II (1.4 RC III (1.4 RC V (1.4) characte ultimate s	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength	4307 / 1.4 4404 / 1.4 4565) charact yield str	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$) EN 10088-1:2014		
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st	8.8 CC CC CC CC CC CC CC CC CC CC CC CC CC	RC II (1.4 RC III (1.4 RC V (1.4 characte ultimate s	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500	4307 / 1.4 4404 / 1.4 1565) charact yield str	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾	$A_5 > 8\%$ 4567 / 1.4547 4578) fracture elongation $A_5 > 8\%$])		
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st	8.8 C C C C C C C C C C C C C C C C C C	RC II (1.4 RC III (1.4 RC V (1.4) characte ultimate s	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800	4307 / 1.4 4404 / 1.4 4565) charact yield str	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$	EN 10088-1:2014 EN ISO 3506-1:202		
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st	8.8 C C C C C C C C C C C C C C C C C C	RC II (1.4 RC III (1.4 RC V (1.4) characte ultimate s	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800 50 rods	4307 / 1.4 4404 / 1.4 4565) charact yield str f _{yk} [N/mm ²]	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014		
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st Threaded rod	8.8 ceel HCR C Property class 50 70 80 ³⁾ 50	RC II (1.4 RC III (1.4 RC V (1.4) characte ultimate s f _{uk} [N/mm ²] for class {	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800 50 rods 50 or 70	4307 / 1.4 4404 / 1.4 4565) charact yield str f _{yk} [N/mm ²] rods	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014		
Stain Stain High	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st Threaded rod	8.8 eeel HCR C Property class 50 70 80 ³⁾ 50 70	RC II (1.4 RC III (1.4 RC V (1.4) characte ultimate s f _{uk} [N/mm ²] for class s for class s for class s e.g.: EN I	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800 50 rods 50 or 70 50, 70 o SO 708	4307 / 1.4 4404 / 1.4 4565) charact yield str f _{yk} [N/mm ²] rods	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾ 600 (640) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ D93:2000,	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014 EN 10088-1:2014 EN ISO 3506-2:202		
Stain Stain High 1	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st Threaded rod Hexagon nut	8.8 eeel HCR C Property class 50 70 80 ³⁾ 50 70	RC II (1.4 RC III (1.4 RC V (1.44 characte ultimate s f _{uk} [N/mm ²] for class { for for for for for for for for for for	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800 50 rods 50 or 70 50 or 70 50 708 094:200 steel A4	4307 / 1.4 4404 / 1.4 4565) charact yield str f _{yk} [N/mm ²] rods r 80 rods 9:2000, Ef	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾ 600 (640) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ D93:2000,	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014		
Stain Stain High 1 2 3a	anchor rod less steel A2 ²⁾ less steel A4 corrosion resistant st Threaded rod Hexagon nut Washer	8.8 eel HCR C Property class 50 70 80 ³⁾ 50 70 80 ³⁾	RC II (1.4 RC III (1.4 RC V (1.44 characte ultimate s f _{uk} [N/mm ²] for class { for for for for for for for for for for	301 / 1.4 401 / 1.4 529 / 1.4 eristic trength 500 700 800 50 rods 50 or 70 50 or 70 50 708 094:200 steel A4	4307 / 1.4 4404 / 1.4 4565) charact yield str f _{yk} [N/mm ²] rods r 80 rods 9:2000, El 9:2000, El 00; EN ISC	311 / 1.4 571 / 1.4 eristic rength 210 450 (560) ⁴⁾ 600 (640) ⁴⁾	$A_5 > 8\%$ $4567 / 1.454^{-1}$ 4578) fracture elongation $A_5 > 8\%$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ $A_5 \ge 12\%^{1)}$ D93:2000,	EN 10088-1:2014 EN ISO 3506-1:202 EN 10088-1:2014 EN 10088-1:2014 EN ISO 3506-2:202		

Injection System FMZ Plus for concrete

Product description

Materials

Annex A5



Reinforcing bar $\varnothing~8, \varnothing~10, \varnothing~12, \varnothing~14, \varnothing~16, \varnothing~20, \varnothing~24, \varnothing~25, \varnothing~28, \varnothing~32$ 1 10 11 W 10 1 1 (5 hef Minimum value of related rip area f_{R,min} according to EN 1992-1-1:2004+AC:2010 _ Rip height of the bar shall be in the range $0,05d \le h \le 0,07d$ (d: Nominal diameter of the bar; h: Rip height of the bar) Table A2: Material - Reinforcing bar

Part	Designation	Material
Rebar		
5	Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCI acc. EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Injection System FMZ Plus for concrete

Product description

Product description and material reinforcing bar

Annex A6

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Working life	50 years	100 years						
	cracked or uncrack	ked concrete						
Base material	compacted, reinforced or unreinforced normal weight concrete strength classes C20/25 to C50/60 (without fibers) acc. to EN 206:2013+A2:2021							
Hole drilling	hammer drilling / compressed ai	r drilling / vacuum drilling						
Static and quasi-static action								
Threaded rod Internally threaded anchor rod Rebar	M8 - M3 IG M6 - IG Ø8 - Ø3	M20						
Temperature range ¹⁾	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C						
Seismic action								
Performance category C1	1							
Threaded rod Rebar	M8 - M3 Ø8 - Ø3							
Performance category C2	-							
Threaded rod	M12 – M Steel, zinc plated: pro A4 / HCR property	perty class 8.8;						
Temperature range ¹⁾	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C						
Fire exposure	•							
Threaded rod Internally threaded anchor rod Rebar	M8 - M3 IG M6 - IG Ø8 - Ø3	M20						
Temperature range ¹⁾	I: -40°C to +40°C II: -40°C to +80°C III: -40°C to +120°C IV: -40°C to +160°C	I: -40°C to +40°C II: -40°C to +80°C						
Temperature Range II: max. lo Temperature Range III: max. lo	ng term temperature +50°C and max. ng term temperature +72°C and max.	short term temperature +40°C short term temperature +80°C short term temperature +120°C short term temperature +160°C						



CRC II

Specification of intended use

Use conditions (Environmental conditions):

- · Structures subject to dry internal conditions: all materials
- · For all other conditions:

Intended use of Materials according to Annex A5, Table A1 corresponding corrosion resistance classes CRC according to EN 1993-1-4:2006+A2:2020

- Stainless steel A2 acc. to Annex A4, Table A1:
- Stainless steel A4 acc. to Annex A2, Table A1:
 CRC III
- High corrosion resistant steel HCR, acc. to Annex A4, Table A1: CRC V

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work
- Anchorages are designed in accordance with EN 1992-4:2018 and Technical Report TR 055, Edition February 2018
- Anchorages under fire exposure are designed in accordance with Technical Report TR 082, Edition June 2023

Installation:

- · Dry or wet concrete or waterfilled drill holes (not seawater)
- · Hole drilling by hammer or compressed air drill or vacuum drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person competent for technical matters on site.
- Installation temperature in concrete:
 - -5°C up to +40°C for the standard variation of temperature after installation.
- Clean the drill hole immediately before installing the anchor or protect it against contamination in a suitable manner until installation. In case of water inflow or renewed contamination, cleaning must be repeated before installation.

Injection System FMZ Plus for concrete

Intended Use Specifications (continuation) Annex B2

Deutsches Institut für Bautechnik

Table B1: Installation	on parameters, threaded rods

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30	
Diameter of threade	ed rod	d=d _{nom}	[mm]	8	10	12	16 20 24 27			30	
Nominal drill hole di	ameter	do	[mm]	10	12	14	18	22	28	30	35
Effective encharage	hef,min [mi		[mm]	60	60	70	80	90	96	108	120
Effective anchorage	depth	h _{ef,max}	[mm]	160	200	240	320	400	480	540	600
Diameter of	Pre-setting installation	d _f ≤	[mm]	9	12	14	18	22	26	30	33
clearance hole in the fixture ²⁾	Through setti installation	^{ng} d _f ≤	[mm]	12	14	16	20	24	30	33	40
Maximum installatio	n torque m	nax.T _{inst} ≤	[Nm]	10	20	40 (35) ¹⁾	60 100 170 250			300	
Minimum thickness	Minimum thickness of member h _{min} [mm]			h _{ef} + 30) mm ≥ 1	00 mm			h _{ef} + 2do)	
Minimum spacing		Smin	[mm]	40	50	60	75	95	115	125	140
Minimum edge dista	ance	Cmin	[mm]	35	40	45	50	60	65	75	80

¹⁾ Max. installation torque for M12 with steel grade 4.6

²⁾ For applications under seismic loading the diameter of clearance hole in the fixture shall be at maximum d_{nom} + 1mm or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

Table B2: Installation parameters for internally threaded anchor rods

Internally threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Inner diameter of threaded rod	d ₂	[mm]	6	8	10	12	16	20
Outer diameter of threaded rod ¹⁾ d=d _{nom} [m		[mm]	10	12	16	20	24	30
Nominal drill hole diameter	do	[mm]	12	14	18	22	28	35
Effective encharges depth	$\mathbf{h}_{ef,min}$	[mm]	60	70	80	90	96	120
Effective anchorage depth —	h _{ef,max}	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	d _f ≤	[mm]	7	9	12	14	18	22
Maximum installation torque m	ax.T _{inst} ≤	[Nm]	10	10	20	40	60	100
Minimum screw-in depth	$L_{sd,min}$	[mm]	8	8	10	12	16	20
Minimum thickness of member	\mathbf{h}_{min}	[mm]	h _{ef} + 3 ≥ 100		h _{ef} + 2d ₀			
Minimum spacing	Smin	[mm]	50	60	75	95	115	140
Minimum edge distance	Cmin	[mm]	40	45	50	60	65	80

1) With metric thread

Table B3: Installation parameters for rebar

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Diameter of rebar	$d=d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	^{• 1)} d ₀	[mm]	10 12	12 14	14 16	18	20	25	30 32	30 32	35	40
Effective anchorage	$\mathbf{h}_{\text{ef,min}}$	[mm]	60	60	70	75	80	90	96	100	112	128
depth	h _{ef,max}	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	\mathbf{h}_{min}	[mm]	222350 J 1225	· 30 mm 00 mm	1			h	_{ef} + 2d ₀			
Minimum spacing	Smin	[mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	Cmin	[mm]	35	40	45	50	50	60	70	70	75	85
1) Both nominal drill hole diame	eter mav b	e use	d									

¹⁾ Both nominal drill hole diameter may be used

Injection System FMZ Plus for concrete

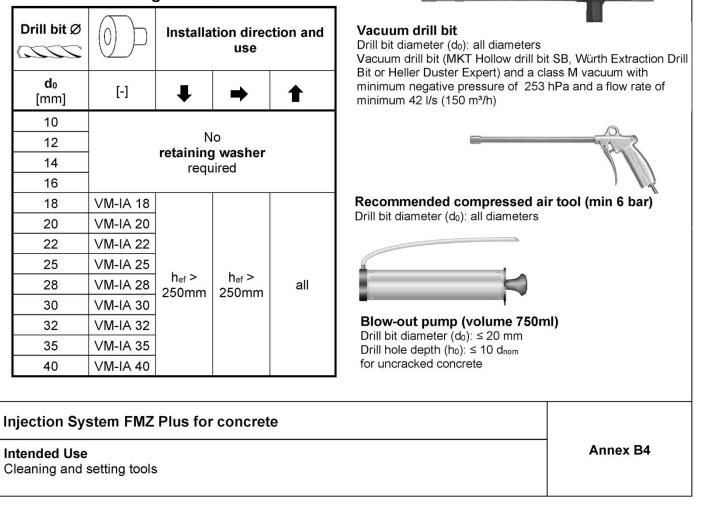
Intended use Installation parameters Annex B3



Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø
				d _b	
[-]	[-]	Ø [mm]	d ₀ [mm]	d ₅[mm]	d _{b,min} [mm]
M8	-	8	10	11,5	10,5
M10	IG M6	8 / 10	12	13,5	12,5
M12	IG M8	10 / 12	14	15,5	14,5
=	-	12	16	17,5	16,5
M16	IG M10	14	18	20,0	18,5
=	-	16	20	22,0	20,5
M20	IG M12	-	22	24,0	22,5
-	-	20	25	27,0	25,5
M24	IG M16	-	28	30,0	28,5
M27	-	24 / 25	30	31,8	30,5
-	-	24 / 25	32	34,0	32,5
M30	IG M20	28	35	37,0	35,5
-	-	32	40	43,5	40,5

Table B4: Parameter cleaning and setting tools

Table B5: Retaining washer





Dr	illing			
	1	÷	Hammer drill or compressed air drill Drill with hammer drill or compressed air drill a hole into the the size required by the selected anchor (Table B1, B2 or B step 2. In case of aborted drill hole, the drill hole shall be fi Vacuum drill bit: see Annex B4	B3). Continue with
			Drill hole into the base material to the embedment size and required by the selected anchor (Table B1, B2 or B3). This removes dust and cleans the drill hole during drilling. Continue of aborted hole, the drill hole shall be filled with more	drilling system inue with <u>step 3</u> .
Cle			vhen using a vacuum drill)	
	Construction of the local sectors of the local sect		water in the drill hole must be removed before cleaning!	
		ning with compr	essed air neters according to Annex B1	
	2a	min. 6		return air stream is
	2b	,	Check brush diameter (Table B4). Brush the hole with an a wire brush $\ge d_{b,min}$ (Table B4) a minimum of two times. If the drill hole ground is not reached with the brush, an ap extension must be used.	
2	2c		Starting from the bottom or back of the drill hole, blow out to compressed air (min. 6 bar) again a minimum of two times stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be	s until return air
		ual cleaning acked concrete, d	ry and wet drill holes; drill hole diameter $d_0 \le 20$ mm and drill hole	e depth h₀ ≤ 10 d _{nom}
	2a		Starting from the bottom or back of the drill hole, blow out the blow-out pump a minimum of four times until return air stree noticeable dust.	
	2b	J T	Check brush diameter (Table B4). Brush the hole with an a wire brush $\geq d_{b,min}$ (Table B4) a minimum of four times. If the drill hole ground is not reached with the brush, an ap extension must be used.	
	2c		Starting from the bottom or back of the drill hole blow out the minimum of four times until return air stream is free of noti	
dis	spensi		le has to be protected against re-contamination in an appropriate ne drill hole. If necessary, the cleaning has to be repeated direct	
ec	tion	System FMZ Pl	us for concrete	
				Annex B5



Inj	ection	
3	MILE J	Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B6) as well as for new cartridges, a new static-mixer shall be used.
4	hef	Prior to inserting the rod into the filled drill hole, the position of the embedment depth shall be marked on the threaded rod or rebar. For through-setting installation, observe t _{fix} . The fastening element must be free of dirt, grease, oil and other foreign materials.
5	min.3x	Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey color.
6a		Filling without retaining washer: Starting from the bottom or back of the cleaned drill hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle (with mixer extension if necessary) as the hole fills to avoid air pockets. Observe working times given in Table B6.
6b		Filling with retaining washer (according to Table B5): Insert the retaining washer up to the bottom of the drill hole (use a mixer extension if necessary) and fill the drill hole approx. 2/3 with mortar. During injection, the back pressure of the mortar pushes the retaining washer out of the drill hole. The processing times according to table B6 must be observed.

Injection System FMZ Plus for concrete

Intended Use Installation instructions (continuation) Annex B6



Sett	ting the fastening elem	ent
7		Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.
8		After installation, the annular gap between anchor rod and must be completely filled with mortar, in the case of through-setting installation also in the fixture. If these requirements are not fulfilled, repeat application before end of working time! For overhead installation, the anchor should be fixed (e.g. by wedges).
9	°C	Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B6).
10		Remove excess mortar.
11	Tinst	The fixture can be mounted after curing time. Apply installation torque $\leq T_{inst}$ according to Table B1 or B2.
12		In case of pre-setting installation, the annular gap between anchor rod and fixture may optionally be filled with mortar. Therefore, replace regular washer by filling washer and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.

Table B6: Working time and curing time

Comorate	. 4		Marking time	Minimum o	curing time
Concrete	e ten	nperature	Working time	dry concrete	dry concrete
-5°C	to	-1°C	50 min	5 h	10 h
0°C	to	+4°C	25 min	3,5 h	7 h
+5°C	to	+9°C	15 min	2 h	4 h
+10°C	to	+14°C	10 min	1 h	2 h
+15°C	to	+19°C	6 min	40 min	80 min
+20°C	to	+29°C	3 min	30 min	60 min
+30°C	to	+40°C	2 min	30 min	60 min
Cartridge	e ten	nperature		+ 5°C to + 40°C	

Injection System FMZ Plus for concrete

Intended Use

Installation instructions (continuation) / Working and curing time

Annex B7



Threac	led rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel f	ailure										
Cross s	sectional area	As	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Charao	cteristic resistance under tens	sion load	1)								
ed	Property class 4.6 and 4.8	N _{Rk,s}	[kN]	15 (13) ¹⁾	23 (21) ¹⁾	34	63	98	141	184	224
Steel, zinc plated	Property class 5.6 and 5.8	N _{Rk,s}	[kN]	18 (17) ¹⁾	29 (27) ¹⁾	42	79	123	177	230	281
zir	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27) ¹⁾	46 (43) ¹⁾	67	126	196	282	367	449
steel	Property class 50 (A2 / A4 / HCR)	N _{Rk,s}	[kN]	18	29	42	79	123	177	230	281
Stainless steel	Property class 70 (A2 / A4 / HCR)	N _{Rk,s}	[kN]	26	41	59	110	172	247	321	393
Staii	Property class 80 (A4 / HCR)	N _{Rk,s}	[kN]	29	46	67	126	196	282	_4)	_4)
Partial	factor ²⁾										
	Property class 4.6	γMs,N	[-]				2	,0			
l, ated	Property class 4.8	γMs,N	[-]				1	,5			
Steel, zinc plated	Property class 5.6	γMs,N	[-]				2	,0			
zino	Property class 5.8	γMs,N	[-]				1	,5			
	Property class 8.8	γMs,N	[-]				1,	,5			
steel	Property class 50 (A2 / A4 / HCR)	γMs,N	[-]				2,	86			
Stainless steel	Property class 70 (A2 / A4 / HCR)	γMs,N	[-]				1,5 (1,5	87 5) ³⁾			
Staii	Property class 80 (A4 / HCR)	γMs,N	[-]			1 (1,	,6 5) ³⁾			_4)	_4)
For com accordir In abser Value in	racteristic resistances apply for all imercial standard threaded rods wit ing to EN ISO 10684:2004 + AC:200 nce of other national regulations in brackets for anchor rods FMZ-A of type not part of the ETA	h a smaller 19), the valu	cross-s	sectional	area (e.	g. hot-d					

Injection System FMZ Plus for concrete

Performance

Characteristic values for threaded rods under tension loads



Thread	led rod			M8	M10	M12	M16	M20	M24	M27	M3
Steel f	ailure										1
Cross	sectional area	As	[mm²]	36,6	58,0	84,3	157	245	353	459	56
Chara	cteristic resistances under shear lo	ad ¹⁾									
Steel f	ailure <u>without</u> lever arm							-			
ed	Property class 4.6 and 4.8	V ⁰ Rk,s	[kN]	9 (8)	14 (13)	20	38	59	85	110	13
Steel, zinc plated	Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	16
zin	Property class 8.8	V ⁰ Rk,s	[kN]	15 (13)	23 (21)	34	63	98	141	184	22
SS	Property class 50 (A2 / A4 / HCR)	V ⁰ Rk,s	[kN]	9	15	21	39	61	88	115	14
Stainless steel	Property class 70 (A2 / A4 / HCR)	$V^0{}_{Rk,s}$	[kN]	13	20	30	55	86	124	161	19
St	Property class 80 (A4 / HCR)	V ⁰ Rk,s	[kN]	15	23	34	63	98	141	_4)	
Steel f	ailure <u>with</u> lever arm										
ted	Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	90
Steel, zinc plated	Property class 5.6 and 5.8	$M^{0}_{\mathrm{Rk},\mathrm{s}}$	[Nm]	19 (16)	37 (33)	65	166	325	561	832	11
zin	Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	898	1332	17
SS	Property class 50 (A2 / A4 / HCR)	M ⁰ Rk,s	[Nm]	19	37	65	166	325	561	832	11
Stainless steel	Property class 70 (A2 / A4 / HCR)	$M^{0}_{\mathrm{Rk},\mathrm{s}}$	[Nm]	26	52	92	233	454	785	1165	15
Ś	Property class 80 (A4 / HCR)	M ⁰ Rk,s	[Nm]	30	60	105	266	519	898	_4)	-4
Partial	factor ²⁾			-							
σ	Property class 4.6	γMs,∨	[-]					67			
el, ated	Property class 4.8	γMs,∨	[-]					25			
Steel zinc pla	Property class 5.6	γMs,V	[-]					67			
zin	Property class 5.8	γMs,V	[-]				50 T 11925	25			
	Property class 8.8	γMs,V	[-]				2.	25			
ess	Property class 50 (A2 / A4 / HCR)	γMs,V	[-]				2,	38			
Stainless steel	Property class 70 (A2 / A4 / HCR)	γMs,V	[-]				1,56 (*	1,25) ³⁾		1	
St	Property class 80 (A4 / HCR)	γMs,∨	[-]			1,33 (1,25) ³⁾			_4)	

¹⁾ The characteristic resistances apply for all anchor rods with the cross-sectional area A_s specified here: FMZ-A, HFZ, HFT For commercial standard threaded rods with a smaller cross-sectional area (e.g. hot-dip galvanized threaded rods M8, M10 according to EN ISO 10684:2004 + AC:2009), the values in brackets are valid

²⁾ In absence of other national regulations

³⁾ Value in brackets for anchor rods FMZ-A or HFZ

⁴⁾ Anchor type not part of the ETA

Injection System FMZ Plus for concrete

Performance

Characteristic values for threaded rods under shear loads



Table C3: Characteristic values of concrete cone failure and splitting failure, working life 50 and 100 years

Threaded rods / In	nternally threaded ancho	or rods /	Rebars	all sizes
Concrete cone fai	ilure			
Factorik	uncracked concrete	k ucr,N	[-]	11,0
Factor k ₁	cracked concrete	k cr,N	[-]	7,7
Edge distance		C cr,N	[mm]	1,5 • h _{ef}
Spacing		Scr,N	[mm]	2,0 • c _{cr,N}
Splitting failure				
Characteristic resis	stance	$N^0_{Rk,sp}$	[kN]	min (N _{Rk,p} ; N ⁰ _{Rk,c})
	h/h _{ef} ≥ 2,0			1,0 • h _{ef}
Edge distance	2,0> h/h _{ef} > 1,3	Ccr,sp	[mm]	2 • h _{ef} (2,5 - h / h _{ef})
	h/h _{ef} ≤ 1,3			2,4• h _{ef}
Spacing		Scr,sp	[mm]	2,0 • C _{cr,sp}

Injection System FMZ Plus for concrete

Performance Characteristic values of concrete cone failure and splitting failure



Threaded roo	ł				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure								<i>4</i> .				
Characteristic	resistance	e	N Rk,s	[kN]			c		• f _{uk} Table C	1		
Partial factor			γMs,N	[-]				see Ta	able C1			
Combined p	ull-out and	d concrete failur	e									
Characterist	c bond re	sistance in <u>uncr</u>	acked o	concrete (C20/25	5						
	I	24°C / 40°C			17	17	16	15	14	13	13	13
Temperature	11	50°C / 80°C		[N] / may may 21	17	17	16	15	14	13	13	13
range	Ш	72°C / 120°C	$ au_{Rk,ucr}$	[N/mm²]	15	14	14	13	12	12	11	11
	IV	100°C / 160°C			12	11	11	10	9,5	9,0	9,0	9,0
Characterist	c bond re	sistance in <u>crac</u>	<u>ked</u> cor	ncrete C2	0/25			2. 10		~~~		
	I	24°C / 40°C			7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
Temperature	11	50°C / 80°C		FN1/ 21	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
range	Ш	72°C / 120°C	τ _{Rk,cr}	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	IV	100°C / 160°C			5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Reduction fa	ctor ψ ⁰ sus	in concrete C20/	25									
	I	24°C / 40°C						0,	90			
Temperature	Ш	50°C / 80°C	Ψ^0 sus	[-]				0,	87			
range		72°C / 120°C	ψ sus	[-]				0,	75			
	IV	100°C / 160°C						0,	66			
Characterist	c bond re	sistance in cond	rete ≥ (C25/30								
Increasing fac τ _{Rk} = ψ _c · τ	•		ψc	[-]				(f _{ck} / :	20) ^{0,1}			
Concrete co	ne failure											
Relevant para	ameter							see Ta	able C3			
Splitting faile												
Relevant para								see Ta	ble C3			
Installation f					-							
dry or wet		acuum cleaning					0	1	,2			
concrete		manual cleaning sed air cleaning	γinst	[-]		1	,2	1	<u> </u> No ре ,0	13 13 12 11 9,0 9,0 7,0 7,0 6,0 6,0 5,5 5,5	essed	
water filled drill hole		sed air cleaning	γinst	[-]					,0 ,4			

Injection System FMZ Plus for concrete

Performance

Characteristic values of tension loads for threaded rods, working life 50 years



Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure	eel failure NRk,s NRk,s Intial factor $\gamma_{Ms,N}$ ombined pull-out and concrete failure maracteristic bond resistance in uncracked concreteristic bond resistance in cracked concreteristic bond resistance in cracked concreteristic bond resistance in cracked concretering mperature 1 24°C / 40°C TRk,ucr,100 [N mperature 1 24°C / 40°C TRk,cr,100 [N mperature 1 24°C / 40°C TRk											
Characteristic res	istano	ce	N _{Rk,s}	[kN]			с	A _s or see 1	• f _{uk} able C	1		
Partial factor			γMs,N	[-]	or see Table C1							
Combined pull-o	ut an	d concrete fai	ilure									
Characteristic bo	ond r	esistance in <u>u</u>	ncracked	concrete	C20/25	;						
Temperature	I	24°C / 40°C		[N] /ma.ma 2]	17	17	16	15	14	13	13	13
range	II	50°C / 80°C	τRk,ucr,100	[N/mm ²]	17	17	16	15	14	13	13	13
Characteristic bo	ond r	esistance in <u>c</u>	racked co	ncrete C2	0/25							
Temperature	Ι	24°C / 40°C	-	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
range	Ш	50°C / 80°C	¹ Rk,cr,100	[[N/1111-]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
Reduction factor	' ψ ⁰ sι	in concrete	C20/25									
Temperature _	I	24°C / 40°C)u ⁰	[-]				0,	90			
range	II	50°C / 80°C	Ψ sus,100	[]				0,	87			
Characteristic be	ond r	esistance in c	oncrete ≥	C25/30								
·····			Ψα	[-]				(f _{ck} / :	20) ^{0,1}			
					[see Ta	ble C3			
								000 10				
	er				[see Ta	ble C3	1		
•												
Installation facto		vacuum cle	aning		[1	,2			
dry or wet				[-]		1	,2			rforma	nce ass	esse
concrete _	com						,_	1	,0		100 400	
water filled		-		[-]					,4			
jection System	EM7	Plue for cor	ocrete									



Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure <u>without</u> lever an	failure without lever arm cteristic resistance $V^{0}_{Rk,s}$ [cteristic plated, class 8.8, $v^{0}_{Rk,s}$ [factor k_7 [factor $\gamma_{Ms,v}$ [factor $\gamma_{Ms,v}$ [cteristic bending ince $M^{0}_{Rk,s}$ [esection modulus W_{el} [factor $\gamma_{Ms,v}$ [ete pry-out failure [[t Faktor k_8 [ete edge failure [[ve length of anchor Ir [e diameter of anchor dnom [
Characteristic resistance Steel, zinc plated Class 4.6, 4.8, 5.6 and 5.8	V ⁰ Rk,s	[kN]					A _s ∙ f _{uk} Γable C2			
Characteristic resistance Steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR	V ⁰ Rk,s	[kN]					A₅ • f _{uk} Γable C2			
Ductility factor	k 7	[-]				1	,0			
Partial factor	γMs,∨	[-]				see Ta	ble C2			
Steel failure <u>with</u> lever arm										
Characteristic bending resistance	M ⁰ Rk,s	[Nm]					V _{el} ∙ f _{uk} able C2			
Elastic section modulus	Wel	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	γMs,∨	[-]				or see T	able C2			
Concrete pry-out failure										
Pry-out Faktor	k ₈	[-]				2	,0			
Concrete edge failure										
Effective length of anchor	lf	[mm]		Γ	min (h _{ef} ;	12 d _{nom})			m (h _{ef} ;30	in)0mm)
Outside diameter of anchor	d _{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γinst	[-]				1	,0			



Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic re	eistan		NRk,s,C1	[kN]				1,0 •	N _{Rk,s}			
Characteristic re	51510110		NRk,s,C2	[kN]	-	2)		1,0 •	N _{Rk,s}		د	2)
Partial factor			γMs,N	[-]				see Ta	ble C1			
Combined pull	-out an	id concrete failu	ire									
Characteristic	bond r	esistance in con	crete C20)/25 to C5	0/60							
	Ŀ	24°C / 40°C	$ au_{Rk,C1}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	1.	24 07 40 0	$ au_{Rk,C2}$	[N/mm²]	_	2)	3,6	3,5	3,3	2,3	ن	2)
	П:	50°C / 80°C	$ au_{Rk,C1}$	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
Temperature _	п.	30 07 80 0	$ au_{Rk,C2}$	[N/mm²]	-	2)	3,6	3,5	3,3	2,3	t.	2)
range		72°C / 120°C	€7. TRk,C1	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
_		72 07 120 0	$ au_{Rk,C2}$	[N/mm²]	-	2)	3,1	3,0	2,8	2,0	Ľ.	2)
	IV/·	100°C / 160°C	$ au_{Rk,C1}$	[N/mm²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
	IV.	100 C / 100 C	$ au_{Rk,C2}$	[N/mm²]	_	2)	2,5	2,7	2,5	1,8	Ľ.	2)
Installation fac	tor											
Compressed air		dry or wet conc		. 1				1	,0			
cleaning	37	water filled drill I	nole ^{Yinst}	[-]				1	,4			
Vacuum cleanin	g	dry or wet conc	rete Yinst	[-]				1	,2			

¹⁾ Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class \geq 70 ²⁾ No performance assessed

Injection System FMZ Plus for concrete

Performance Characteristic values for threaded rods under seismic action



Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Steel failure													
Characteristic resis	stance	1)	NRk,	s,C1	[kN]				1,0 •	$N_{Rk,s}$			
Characteristic resis	stance	3 ./	N _{Rk,}	s,C2	[kN]	-	2)		1,0 •	N _{Rk,s}		ت	2)
Partial factor			γr	Ms,N	[-]				see Ta	ble C1			
Combined pull-ou	ut and	l concrete failu	ıre										
Characteristic bo	nd re	sistance in cor	ncrete	C20)/25 to C5	0/60							
	Ŀ	24°C / 40°C	τ _r	k,C1	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
Temperature	1.	24 0740 0	τr	k,C2	[N/mm²]		2)	3,6	3,5	3,3	2,3	د	2)
range	П:	50°C / 80°C	τ _R	k,C1	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
	н.	50 C / 80 C	τ _R	k,C2	[N/mm²]	-	2)	3,6	3,5	3,3	2,3	2	2)
Installation factor	•												
Compressed air		dry or wet conc			L 1				1	,0			
cleaning	Ň	vater filled drill	hole	γinst	[-]				1	,4			
Vacuum cleaning		dry or wet conc	rete	Yinst	[-]				1	,2			

¹⁾ Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class ≥ 70 ²⁾ No performance assessed

Table C9: Characteristic values of shear load for threaded rods, seismic action (performance category C1 + C2), working life 50 and 100 years

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure <u>v</u>	<u>vithout</u> lever arm										
Characteristic	resistence ¹)	V _{Rk,s,C1}	[kN]				0,7 ·	V ⁰ Rk,s		~	
Characteristic	resistance" -	VRk,s,C2	[kN]	-	2)		0,7 ·	V ⁰ Rk,s		2	2)
Partial factor		γ̂Ms,∨	[-]				see Ta	able C2	2		
Easter for	without hole clearance						1	,0			
actor for with hole cle	with hole clearance between fastener and fixture	$lpha_{gap}$	[-]				0	,5			

¹⁾ Performance category C2: steel, zinc plated, property class 8.8; stainless steel A4 and HCR, property class \geq 70 ²⁾ No performance assessed

Injection System FMZ Plus for concrete

Performance

Characteristic values for threaded rods under seismic action



Table C10: Characteristic values of tension load for internally threaded anchor rod, static and quasi-static action, working life 50 years IG M6 IG M8 IG M10 IG M12 IG M16 IG M20 Internally threaded anchor rod Steel failure 1) 5.8 [kN] 10 17 29 42 76 123 N_{Rk,s} Characteristic resistance, steel, zinc plated, property class 8.8 N_{Rk,s} [kN] 16 27 46 67 121 196 [-] Partial factor 1.5 YMs,N Characteristic resistance, stainless 172 70 14 26 41 59 [kN] 110 N_{Rk,s} (123) 2) steel A4 / HCR, property class 1,87 Partial factor [-] 1,87 YMs,N (2,86) 2) Combined pull-out and concrete failure Characteristic bond resistance in uncracked concrete C20/25 24°C / 40°C 1: 17 16 15 14 13 13 II: 50°C / 80°C 17 16 15 14 13 13 Temperature τ_{Rk,ucr} [[N/mm²] range III: 72°C / 120°C 14 14 13 12 12 11 100°C / 160°C IV: 11 11 10 9,5 9,0 9,0 Characteristic bond resistance in cracked concrete C20/25 24°C / 40°C 1: 7,5 8,0 9,0 8,5 7,0 7,0 11: 50°C / 80°C 7,5 8,0 9,0 8,5 7,0 7,0 Temperature τ_{Rk,cr} [N/mm²] range III: 72°C / 120°C 6.5 7.0 7.5 7.0 6.0 6.0 IV: 100°C / 160°C 5,5 6,0 6,5 6,0 5,5 5,5 Reduction factor ψ^{0}_{sus} in concrete C20/25 1: 24°C / 40°C 0.90 II: 50°C / 80°C 0,87 Temperature Ψ^0 sus [-] range III: 72°C / 120°C 0,75 IV: 100°C / 160°C 0,66 Characteristic bond resistance in concrete ≥ C25/30 Increasing factor w_c for (f_{ck} / 20) 0,1 Ψc [-] $\tau_{Rk} = \Psi_c \cdot \tau_{Rk} (C20/25)$ Concrete cone failure Relevant parameter see Table C3 Splitting failure see Table C3 Relevant parameter Installation factor vacuum cleaning 1.2 dry or wet 1.2 No performance assessed manual cleaning [-] Yinst concrete compressed air cleaning 1,0 waterfilled compressed air 1.4 [-] Yinst drill hole cleaning ¹⁾ Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class is valid for the internally threaded anchor rod and the fastening element ²⁾ Value in brackets: property class 50 Injection System FMZ Plus for concrete Performance

Characteristic values of tension loads for internally threaded anchor rod, working life 50 years



Table C11: Characteristic values of tension load for internally threaded anchor rod, static and quasi-static action, working life 100 years

Internally threaded anchor rod	l,			IG M6	IG M8	IG M10	IG M12	IG M16	IG M20
Steel failure 1)									
Characteristic resistance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123
steel, zinc plated, property class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196
Partial factor		γMs,N	[-]			1	,5		
Characteristic resistance, stainless steel A4 / HCR, property class	70	N _{Rk,s}	[kN]	14	26	41	59	110	172 (123) ²
Partial factor		γMs,N	[-]			1,87			1,87 (2,86)
Combined pull-out and concret	te fai	lure		.					
Characteristic bond resistance	in <u>u</u>	ncracked	concrete	e C20/25					
Temperature I: 24°C / 4		τRk,ucr,100	[N/mm²]	17	16	15	14	13	13
range II: 50°C / 8	30°C	CRK,UCF, 100	[iwinin]	17	16	15	14	13	13
Characteristic bond resistance	in <u>cr</u>	racked co	oncrete C	20/25					
Temperature I: 24°C / 4		TRk,cr100	[N/mm²]	6,0	6,5	6,5	6,5	6,5	6,5
range II: 50°C / 8	and the second		[]	6,0	6,5	6,5	6,5	6,5	6,5
Reduction factor ψ^0_{sus} in concre									
Temperature I: 24°C / 4		ψ^0 sus,100	[-]				90		
range II: 50°C / 8						0,	87		
Characteristic bond resistance	e in co	oncrete 2	2 C25/30	ſ					
Increasing factor ψ_c for $\tau_{Rk} = \psi_c \cdot \tau_{Rk} (C20/25)$		ψ_{c}	[-]			(f _{ck} / 2	20) ^{0,1}		
Concrete cone failure	1			L					
Relevant parameter						see Ta	ble C3		
Splitting failure									
Relevant parameter						see Ta	ble C3		
Installation factor									
vacuum clear	ning					1	,2		
dry or wet manual clear	ning	γinst	[-]		1,2		No perfo	ormance a	ssessed
compressed air clear	ning					1	,0		
waterfilled compressed drill hole clear		γinst	[-]			1	,4		
¹⁾ Fastening screws or threaded rods (the internally threaded anchor rod. T for the internally threaded anchor rod ²⁾ Value in brackets: property class 50	The ch d and	aracteristi	c tension re	esistance f					

Injection System FMZ Plus for concrete

Performance

Characteristic values of **tension loads** for **internally threaded anchor rod**, working life **100 years**



Table C12: Characteristic values of shear load for internally threaded anchor rod,static and quasi-static action, working life 50 and 100 years

Interna	ally threaded anc	hor rod			IG M6	IG M8	IG M10	IG M12	IG M16	IG M20
Steel fa	ailure <u>without</u> lev	ver arm ¹⁾								
ted	Characteristic resistance	property class 5.8	V ⁰ Rk,s	[kN]	6	10	17	25	45	74
Steel, zinc plated	Characteristic resistance	property class 8.8	V ⁰ Rk,s	[kN]	8	14	23	34	61	98
zi	Partial factor		γMs,∨	[-]			1,	25		
Stainless steel	Characteristic resistance A4 / HCR	property class 70	V ⁰ Rk,s	[kN]	7	13	20	30	55	86 (62) ²⁾
Sta s	Partial factor		γMs,∨	[-]			1,56			1,56 (2,38) ²⁾
Ductility	y factor		k 7	[-]			1	,0		
Steel fa	ailure <u>with</u> lever a	arm ¹⁾								
ted	Characteristic bending resistance	property class 5.8	M ⁰ Rk,s	[Nm]	8	19	37	66	167	325
Steel, zinc plated	Characteristic bending resistance	property class 8.8	M ⁰ Rk,s	[Nm]	12	30	60	105	267	519
	Partial factor		γMs,∨	[-]			. 1,	25	·	
Stainless steel	Characteristic bending resistance A4 / HCR	property class 70	M ⁰ Rk,s	[Nm]	11	26	53	92	234	454
S	Partial factor		γMs,∨	[-]			1,	56		
Concre	ete pry-out failur	е								
Pry-out	factor		k 8	[-]			2	,0		
Concre	ete edge failure									
Effectiv	ve length of ancho	r	lf	[mm]		mir	n (h _{ef} ;12 d	nom)		min (h _{ef} ; 300mm)
Outside	e diameter of anch	lor	\mathbf{d}_{nom}	[mm]	10	12	16	20	24	30
Installa	tion factor		γinst	[-]			1	,0		

¹⁾ Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod (exception: IG M20). The characteristic shear resistance for steel failure of the given strength class is valid for the internally threaded anchor rod and the fastening element.

²⁾ Value in brackets: Internally threaded rod: property class 50 with fastening screws or threaded rods (incl. nut and washer): property class 70

Injection System FMZ Plus for concrete

Performance

Characteristic values of shear loads for internally threaded anchor rod



		cteristic values g life 50 years		ision loa	ad fo	or reb	oar, s	tatic	and	qua	si-st	atic a	actio	n,
Reinforcing	bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure					•	1	•							
Characteristic	c resistar	nce	N _{Rk,s}	[kN]					As •	f uk ¹⁾				
Cross section	al area		As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			γMs,N	[-]					1,4	4 ²⁾				
Combined p	ull-out a	nd concrete fai	lure	•										
Characterist	ic bond	resistance in <u>u</u>	ncracke	<u>d</u> concre	te C2	0/25						<i></i>		
	I:	24°C / 40°C			14	14	14	14	13	13	13	13	13	13
Temperature	11:	50°C / 80°C		[NI/mm2]	14	14	14	14	13	13	13	13	13	13
range	111:	72°C / 120°C	$ au_{Rk,ucr}$	[N/mm ²]	13	12	12	12	12	11	11	11	11	11
	IV:	100°C / 160°C			9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5
Characterist	ic bond	resistance in <u>cı</u>	racked o	oncrete	C20/2	25								
	l:	24°C / 40°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Temperature	11:	50°C / 80°C	7 -1	[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
range	111:	72°C / 120°C	τRk,cr		4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	IV:	100°C / 160°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Reduction fa	ictor ψ^0_s	_{us} in concrete C	20/25											
	l:	24°C / 40°C							0,	90				
Temperature	11:	50°C / 80°C	Ψ^0 sus	r 1					0,	87				
range	111:	72°C / 120°C	Ψ°sus	[-]					0,	75				
		100°C / 160°C							0,	66				
		resistance in co	oncrete	≥ C25/30										
Increasing fac	ctor ψ _c fc _{Rk} = ψ _c · τ _f		ψc	[-]					(f _{ck} / 2	20) ^{0,1}				
Concrete co														
Relevant para	ameter							s	ee Ta	able C	3			
Splitting faile	ure													
Relevant para	ameter							s	ее Та	able C	3			
Installation f	actor													
		vacuum cleani	ng						1	,2				
dry or wet concrete		manual cleani	ng γ _{ins}	t [-]			1,2			Nop	perform	mance	asse	ssed
Concrete	compr	ressed air cleani	ng						1	,0				
waterfilled drill hole	compr	ressed air cleani	ng γ _{ins}	t [-]					1	,4				

f_{uk} shall be taken from the specifications of reinforcing bars
 In absence of national regulation

Injection System FMZ Plus for concrete

Performance

Characteristic values of tension loads for rebar, working life 50 years



		teristic valu g life 100 y e		sion loa	ad fo	r reb	ar, s	tatic	and	qua	si-sta	atic a	actio	n,
Reinforcing b	bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure									J	L				Į
Characteristic	resistar	ice	$N_{Rk,s}$	[kN]					As •	f uk ¹⁾				_
Cross section	al area		As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor			γMs,N	[-]					1,4	4 ²⁾				
Combined pu	III-out a	nd concrete f	ailure											
Characteristi	c bond	resistance in	<u>uncracke</u>	<u>d</u> concret	te C2	0/25								
Temperature	l:	24°C / 40°C		[N]/mm2]	14	14	14	14	13	13	13	13	13	13
range	II:	50°C / 80°C	$ au_{Rk,ucr,100}$	[N/mm²]	14	14	14	14	13	13	13	13	13	13
Characteristi	c bond	resistance in	<u>cracked</u> c	oncrete	C20/2	5								
Temperature	l:	24°C / 40°C		[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
range	II:	50°C / 80°C	$ au_{Rk,cr,100}$	[18/1111-]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Reduction fa	ctor ψ ⁰ s	us in concrete	C20/25											
Temperature	1:	24°C / 40°C	Ψ^0 sus,100	[-]					0,	90				
range	II:	50°C / 80°C	Ψ sus,100	[-]					0,	87				
Characteristi	c bond	resistance in	concrete	≥ C25/30										
Increasing fac _{TRk}	tor ψ _c fo = ψ _c · τ _R		ψc	[-]					(f _{ck} / 2	20) ^{0,1}				
Concrete cor	ne failur	e			-									
Relevant para	meter							s	ee Ta	ble C	3			
Splitting failu	ıre				£.									
Relevant para	meter							s	ee Ta	ble C	3			
Installation fa	actor													
		vacuum clea	ning						1	,2				
dry or wet		manual clea	ning γ _{ins}	[-]			1,2			N L S	perforr			

[-]

Yinst

¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars

compressed air cleaning

compressed air cleaning

²⁾ In absence of national regulation

Injection System FMZ Plus for concrete

Performance

waterfilled

drill hole

Characteristic values of tension loads for rebar, working life 100 years

Annex C13

1,0

1,4



Table C15: Characteristic values of shear load for rebar, static and quasi-static action,working life 50 and 100 year

				1	1			1				
Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure <u>without</u> lever a	ırm											
Characteristic shear resistance	V ⁰ Rk,s	[kN]				(0,50 • A	$h_{s} \cdot f_{uk}^{1}$)			
Cross sectional area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γMs,V	[-]					1,	5 ²⁾				
Ductility factor	k 7	[-]					1	,0				
Steel failure <u>with</u> lever arm												
Characteristic bending resistance	M ⁰ Rk,s	[Nm]										
Elastic section modulus	Wel	[mm ³]	50	98	170	269	402	785	1357	1534	2155	3217
Partial factor	γMs,V	[-]					1,	5 ²⁾				
Concrete pry-out failure												
Pry-out Factor	k ₈	[-]					2	,0				
Concrete edge failure												
Effective length of rebar	lf	[mm]			min	(h _{ef} ;12	d _{nom})			min (h _{ef} ; 300	Omm)
Outside diameter of rebar	d _{nom}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation factor	γinst	[-]	1,0									

¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars

²⁾ In absence of national regulation

Injection System FMZ Plus for concrete



	aracteristic value							nic a	ctior	ı			
Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure								k.				h.	
Characteristic re	sistance	NRk,s,C1	[kN]					$A_{s} \boldsymbol{\cdot}$	f _{uk} 1)				
Cross sectional	area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor		γMs,N	[-]					1,4	ļ ²⁾				
Combined pull-	out and concrete	failure											
Characteristic b	oond resistance in	concrete	e C20/25 1	to C50	0/60								
	l: 24°C / 40°C			5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Temperature	II: 50°C / 80°C	-	[NI/mm2]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
range	III: 72°C / 120°C	$ au_{Rk,C1}$	[N/mm²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
2	IV: 100°C / 160°C			4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Installation fact	or												
dry or wet	vacuum cleaning	γinst	[-]					1	,2				
concrete	compressed air	γînst	[-]					1	,0				
waterfilled drill hole	cleaning	γînst	[-]					1	,4				

 $^{\rm 1)}\,f_{uk}\, shall \, be taken from the specifications of reinforcing bars <math display="inline">^{\rm 2)}$ In absence of national regulation

Injection System FMZ Plus for concrete



	aracteristic value							nic a	ctio	ı			
Reinforcing bar	r			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic re	sistance	NRk,s,C1	[kN]					$A_{s} \boldsymbol{\cdot}$	f uk ¹⁾				
Cross sectional a	area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor		γMs,N	[-]			-		1,4	1 ²⁾	-			
Combined pull-	out and concrete f	ailure											
Characteristic b	oond resistance in	concrete	e C20/25	to C50	0/60								
Temperature	l: 24°C / 40°C		[N]/ma.ma.21	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
range	II: 50°C / 80°C	τ _{Rk,C1}	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Installation fact	or												
dry or wet	vacuum cleaning	γinst	[-]					1	,2				
concrete	compressed air	γinst	[-]					1	,0				
waterfilled drill hole	cleaning	γinst	[-]					1	,4				
²⁾ In absence of nat Table C18: Ch	from the specifications ional regulation naracteristic value ismic action (pe	es of s	hear loa				king	life 5	0 and	d 100	yea	rs	
Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure wit	hout lever arm								<i>.</i>	л	ăși-		

Steel failure without lever arm	7											
Characteristic resistance	$V_{Rk,s,C1}$	[kN]				0	,35 • A	A _s ∙ f _{uk}	1)			
Cross sectional area	As	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γMs,V	[-]					1,5	5 ²⁾				

¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars

²⁾ In absence of national regulation

Injection System FMZ Plus for concrete

Performance

 $Characteristic \ values \ for \ rebar \ under \ seismic \ action$



Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Displacement facto uncracked concrete,		uasi-static acti	on							
Temperature range I: 24°C / 40°C	δ _{N0} -factor		0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,04
II: 50°C / 80°C	$\delta_{N\infty}$ -factor		0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,06
Temperature range	δ_{N0} -factor	1	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,04
III: 72°C / 120°C	$\delta_{N\infty}$ -factor	[N/mm²]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,06
Temperature range	δ_{N0} -factor		0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,17
IV: 100°C / 160°C	$\delta_{N\infty}$ -factor		0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,18
Displacement facto cracked concrete, sta		si-static action								
Displacement factor cracked concrete, stat Temperature range I: 24°C / 40°C —	δ_{N0} -factor		0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,10
II: 50°C / 80°C	δ _{N∞} -factor		0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,13
Temperature range	δ_{N0} -factor	[mm [<mark>N/mm²</mark>]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,11
III: 72°C / 120°C	δ _{N∞} -factor	^L N/mm ²	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,14
Temperature range	δ_{N0} -factor		0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,41
IV: 100°C / 160°C	δ _{N∞} -factor		0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,42
Displacement, seisi	mic action (C2)								
All 1	$\delta_{N,C2}$ (DLS)			0	0,24	0,27	0,29	0,27		2)
All temperature	ON,02 (DL3)	[mm]	_	2) [,				-	2)

 τ : acting bond stress for tension $\delta_{NO} = \delta_{NO}$ -factor $\cdot \tau$;

 $\delta_{N\infty} = \delta_{N\infty}$ -factor $\cdot \tau$;

²⁾ No performance assessed

Table C20: Displacements under shear load (threaded rod)

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Displacement factor cracked and uncrac		static and qua	asi-static	action						
All temperature	δ_{V0} -factor	, mm	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
ranges	δ _{ν∞} -factor	[<u>]</u>]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Displacement, seis	smic action (C2)								
All temperature	δ V,C2(DLS)	[mm]		2)	3,6	3,0	3,1	3,5		2)
ranges	$\delta_{\text{V,C2(ULS)}}$	[mm]	-	_,	7,0	6,6	7,0	9,3	_	_/
¹⁾ Calculation of the dis $\delta_{V0} = \delta_{V0}$ -factor · V; $\delta_{V\infty} = \delta_{V\infty}$ -factor · V; ²⁾ No performance asso		V: acting she	ar load							
njection System F	MZ Plus for	concrete								
Performance Displacements (thread	ded rod)								Annex (517



Internally threaded and	hor rod		IG M 6	IG M8	IG M10	IG M12	IG M16	IG M20
Displacement factor ¹⁾ uncracked concrete, stat	tic and quasi-sta	atic action						
Temperature range I: 24°C / 40°C	δ _{N0} -factor		0,032	0,034	0,037	0,039	0,042	0,046
II: 50°C / 80°C	δ _{N∞} -factor		0,042	0,044	0,047	0,051	0,054	0,060
Temperature range	δ _{N0} -factor	, mm ,	0,034	0,035	0,038	0,041	0,044	0,048
III: 72°C / 120°C	δ _{N∞} -factor	$\left[\frac{1}{N/mm^2}\right]$	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range	δ _{N0} -factor		0,126	0,131	0,142	0,153	0,163	0,179
IV: 100°C / 160°Č	δ _{N∞} -factor		0,129	0,135	0,146	0,157	0,168	0,184
Displacement factor ¹⁾ cracked concrete, static	and quasi-statio	c action						
Temperature range I: 24°C / 40°C	δ_{N0} -factor		0,083	0,085	0,090	0,095	0,099	0,106
II: 50°C / 80°C	δ _{N∞} -factor		0,107	0,110	0,116	0,122	0,128	0,137
Temperature range	δ _{N0} -factor	, mm ,	0,086	0,088	0,093	0,098	0,103	0,110
III: 72°C / 120°C	δ _{N∞} -factor	[<u>N/mm²</u>]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range	δ _{N0} -factor		0,321	0,330	0,349	0,367	0,385	0,412
IV: 100°C / 160°Č	δ _{N∞} -factor		0,330	0,340	0,358	0,377	0,396	0,424

¹⁾ Calculation of the displacement

 $\delta_{N0} = \delta_{N0}$ -factor $\cdot \tau$; τ : acting bond stress for tension

 $\delta_{N^{\infty}} = \delta_{N^{\infty}}$ -factor $\cdot \tau$;

Table C22: Displacements under shear load (internally threaded anchor rod)

				85				
Internally threaded anch	or rod		IG M 6	IG M8	IG M10	IG M12	IG M16	IG M20
Displacement factor ¹⁾ cracked and uncracked co	oncrete, static	and quasi-sta	tic action					<u>-</u>
	δ_{V0} -factor	$\left[\frac{mm}{kN}\right]$	0,07	0,06	0,06	0,05	0,04	0,04
All temperature ranges -	δ _{∨∞} -factor	[[] kN]	0,10	0,09	0,08	0,08	0,06	0,06
$\delta_{V^{\infty}} = \delta_{V^{\infty}}$ -factor · V;								
ijection System FMZ P	lus for conc	rete						
erformance isplacements (internally th	readed anchor	rod)					Annex	C18



Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor uncracked concrete, s		uasi-statio	action									
Temperature range : 24°C / 40°C -	δ_{N0} -factor		0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,04
ll: 50°C / 80°C	$\delta_{N\infty}$ -factor		0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,06
Temperature range	δ_{N0} -factor	, mm ,	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,05
III: 72°C / 120°C	$\delta_{N\infty}$ -factor	[[] N/mm²]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,06
Temperature range	δ_{N0} -factor		0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,18
IV: 100°C / 160°C	$\delta_{N\infty}$ -factor		0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,19
Displacement factor cracked concrete, sta		si-static a	ction									
Temperature range l: 24°C / 40°C -	δ_{N0} -factor		0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,10
ll: 50°C / 80°C	$\delta_{N\infty}$ -factor		0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,14
Temperature range	δ_{N0} -factor	, mm ,	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,11
III: 72°C / 120°C	$\delta_{N\infty}$ -factor	[[] N/mm²]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,14
Temperature range	δ_{N0} -factor		0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,42
IV: 100°C / 160°C	δ _{N∞} -factor		0,321	0,330	0,340	0,349	0,358	0,377	0,396	0,396	0,410	0,44
$\begin{array}{l} \mbox{Calculation of the displ}\\ \delta_{N0} = \delta_{N0} \mbox{-factor} & \tau;\\ \delta_{N\infty} = \delta_{N\infty} \mbox{-factor} & \tau; \end{array}$		acting bon	d stress	for tens	sion							

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement fac cracked and uncra		e, static an	d quasi	i-static	action							
All temperature	δ_{V0} -factor	, mm	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
ranges	$\delta_{V\infty}$ -factor	[<u>kN</u>]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04
δ _{V0} = δ _{V0} -factor · V; δ _{V∞} = δ _{V∞} -factor · V		V: acting she	ear load									
njection System	FMZ Plus fo	or concre	te									
Performance Displacements (reba	ır)									Ar	nex C	19



Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										I	
Steel zinc plated (prop	perty class	s ≥ 5.8)	and stainless steel	A2, A4	, HCR	(propei	ty clas	s ≥ 50))		
			R30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,
Characteristic			R60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,
tension resistance	N _{Rk,s,fi}	[kN]	R90	0,7	1,0	1,6	3,0	6,7	6,7	8,7	10,
			R120	0,5	0,8	1,2	2,2	4,9	4,9	6,4	7,9
Characteristic bond exposure for temper		ce in cra	acked and uncrack	ed coi	ncrete	C20/25	5 up to	C50/6	0 unde	er fire	
· · ·			θ < 24°C				1	,0			
Temperature- dependent	k _{fi,p} (θ)	[-]	24°C ≤ θ ≤ 379°C			1.30		, ^{0,011*θ} ≤	1,0		
reduction factor			θ > 379°C			.,		,0			
- 8'0 F - 8'0 F - 9'0 F											
0,0	50 istance	100	150 200 Temperatu	²⁵⁰ re θ [°C]	300		50	400	450		
Characteristic bond res	istance e (θ)	τ _{Rk,fi} (θ)						400 Rk,cr(20/25	03096049753		
Characteristic bond res for a given temperature Steel failure without	istance e (θ) lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²]	re θ [°C]		k _{fi,j}	_{>} (θ) * τ _f	Rk,cr(20/25	₅₎ 1)		
Characteristic bond res for a given temperature Steel failure without	istance e (θ) lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm ²] and stainless steel /	re θ [°C] A2, A4	, HCR	k _{fi,j}	_o (θ) * τ _f	Rk,cr(20/25 s ≥ 50)	₅₎ 1)	40.5	
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop	istance e (θ) lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] and stainless steel / R30	re θ [°C] A2, A4 1,1	, HCR 1,7	k _{fi,j} (proper 3,0	o(θ) * τ _f ty clas 5,7	Rk,cr(20/25 s ≥ 50) 8,8	^{5) 1)}	16,5	
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop Characteristic	istance e (θ) lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm ²] and stainless steel <i>J</i> R30 R60	re θ [°C] A2, A4 1,1 0,9	, HCR 1,7 1,4	k _{fi,j} (proper 3,0 2,3	ty clas 5,7 4,2	^{Rk,cr(20/25} s ≥ 50) 8,8 6,6	^{5) 1)} 12,7 9,5	12,4	15,
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop Characteristic	istance e (θ) lever arn perty class	τ _{Rk,fi} (θ) n s ≥ 5.8)	Temperatu [N/mm ²] and stainless steel / R30 R60 R90	re θ [°C] A2, A4 1,1 0,9 0,7	, HCR 1,7 1,4 1,0	k _{fi,f} (proper 3,0 2,3 1,6	(θ) * τ _f ty clas 5,7 4,2 3,0	Rk,cr(20/28 s ≥ 50) 8,8 6,6 4,7	^{5) 1)} 12,7 9,5 6,7	12,4 8,7	15, 10,
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (prop Characteristic shear resistance	istance e (θ) lever arn perty class V _{Rk,s,fi}	τ _{Rk,fi} (θ) n s ≥ 5.8)	Temperatu [N/mm ²] and stainless steel <i>J</i> R30 R60	re θ [°C] A2, A4 1,1 0,9	, HCR 1,7 1,4	k _{fi,j} (proper 3,0 2,3	ty clas 5,7 4,2	^{Rk,cr(20/25} s ≥ 50) 8,8 6,6	^{5) 1)} 12,7 9,5	12,4	15, 10,
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop Characteristic shear resistance Steel failure with lev	istance e (θ) lever arn perty class V _{Rk,s,fi} er arm	τ _{Rk,fi} (θ) n s ≥ 5.8) [kN]	Temperatu [N/mm ²] and stainless steel / R30 R60 R90 R120	re θ [°C] A2, A4 1,1 0,9 0,7 0,5	, HCR 1,7 1,4 1,0 0,8	k _{fi,i} (proper 3,0 2,3 1,6 1,2	ty clas 5,7 4,2 3,0 2,2	s ≥ 50) 8,8 6,6 4,7 3,4	5) 1) 12,7 9,5 6,7 4,9	12,4 8,7	15, 10,
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop Characteristic shear resistance Steel failure with lev	istance e (θ) lever arn perty class V _{Rk,s,fi} er arm	τ _{Rk,fi} (θ) n s ≥ 5.8) [kN]	Temperatu [N/mm ²] and stainless steel / R30 R60 R90 R120	re θ [°C] A2, A4 1,1 0,9 0,7 0,5	, HCR 1,7 1,4 1,0 0,8	k _{fi,i} (proper 3,0 2,3 1,6 1,2	ty clas 5,7 4,2 3,0 2,2	s ≥ 50) 8,8 6,6 4,7 3,4	5) 1) 12,7 9,5 6,7 4,9	12,4 8,7	15, 10, 7,9
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (prop Characteristic shear resistance Steel failure with lev Steel zinc plated (prop	istance e (θ) perty class V _{Rk,s,fi} er arm perty class	τ _{Rk,fi} (θ) n s ≥ 5.8) [kN] s ≥ 5.8)	Temperatu [N/mm ²] and stainless steel / R30 R60 R90 R120 and stainless steel /	re θ [°C] 42, A4 1,1 0,9 0,7 0,5 42, A4	, HCR 1,7 1,4 1,0 0,8	(proper 3,0 2,3 1,6 1,2 (proper	(θ) * τ _f 5,7 4,2 3,0 2,2 ty clas	s ≥ 50) 8,8 6,6 4,7 3,4 s ≥ 50)	⁵⁾ ¹⁾ 12,7 9,5 6,7 4,9	12,4 8,7 6,4	20, 15, 10, 7,§ 81, 60,
Characteristic bond rest for a given temperature Steel failure without Steel zinc plated (prop Characteristic shear resistance Steel failure with lev Steel zinc plated (prop Characteristic	istance e (θ) lever arn perty class V _{Rk,s,fi} er arm	τ _{Rk,fi} (θ) n s ≥ 5.8) [kN]	Temperatu [N/mm ²] and stainless steel / R30 R60 R90 R120 and stainless steel / R30	re θ [°C] A2, A4 1,1 0,9 0,7 0,5 A2, A4 1,1	, HCR 1,7 1,4 1,0 0,8 , HCR 2,2	k _{fi,i} (proper 3,0 2,3 1,6 1,2 (proper 4,7	(θ) * τ _f ty clas 5,7 4,2 3,0 2,2 ty clas 12,0	<pre>Rk,cr(20/25 s ≥ 50) 8,8 6,6 4,7 3,4 s ≥ 50) 23,4</pre>	5) 1) 12,7 9,5 6,7 4,9 40,4	12,4 8,7 6,4 59,9	15, 10, 7,9 81,
0,0	istance e (θ) perty class V _{Rk,s,fi} er arm perty class	τ _{Rk,fi} (θ) n s ≥ 5.8) [kN] s ≥ 5.8)	Temperature [N/mm ²] and stainless steel R30 R60 R90 R120 and stainless steel R30 R30 R60	re θ [°C] A2, A4 1,1 0,9 0,7 0,5 A2, A4 1,1 0,9	, HCR 1,7 1,4 1,0 0,8 , HCR 2,2 1,8	(proper 3,0 2,3 1,6 1,2 (proper 4,7 3,5	(θ) * τ _f 5,7 4,2 3,0 2,2 ty clas 12,0 9,0	s ≥ 50) 8,8 6,6 4,7 3,4 s ≥ 50) 23,4 17,5	⁵⁾ ¹⁾ 12,7 9,5 6,7 4,9 40,4 30,3	12,4 8,7 6,4 59,9 44,9	15, 10, 7,9 81, 60,

Characteristic values of tension and shear loads under fire exposure (threaded rods)

Performance



Internally threaded a	anchor ro	d		IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure							1,		
Steel zinc plated (pro	perty clas	s 5.8 an	d 8.8) and stainless	steel A4	and HCF	R (proper	ty class 7	0)	
			R30	0,3	1,1	1,7	3,0	5,7	8,8
Characteristic	N _{Rk,s,fi}	[kN]	R60	0,2	0,9	1,4	2,3	4,2	6,6
tension resistance	INKK,S,TI		R90	0,2	0,7	1,0	1,6	3,0	4,7
			R120	0,1	0,5	0,8	1,2	2,2	3,4
Characteristic bond conditions for a give				ed conc	rete C20	/25 up to	C50/60 (under fire)
-			θ < 24°C	[1	,0		
Temperature reduction factor	k _{fi,p} (θ)	[-]	24°C ≤ θ ≤ 379°C	-	1	,301 * e -	5 (No. 6)	,0	
			θ > 379°C			0	,0		
- 8,0 [-] - 8,0 kti(0) [-] - 0,4 - - 0,4 -									
0,0	50	100	150 200	250	300	350	400	450	
0,0	2004		Temperatu		199097060		10.0000 M		
0,0	sistance	100 τ _{Rk,fi} (θ)	Temperatu		199097060	350 k _{fi,p} (θ) * τ _f	10.0000 M		
0,0 0	sistance e (θ)	τ _{Rk,fi} (θ)	Temperatu		199097060		10.0000 M		
Characteristic bond rea	sistance e (θ) t lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] d 8.8) and stainless	reθ[°C] steel A4	and HCF	k _{fi,p} (θ) * τ _f R (propert	Rk,cr(20/25) ¹ t y class 7) 0)	
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro	sistance e (θ) t lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] d 8.8) and stainless R30	re θ [°C] steel A4 0,3	and HCF 1,1	k _{fi,p} (θ) * τ _f R (propert	Rk,cr(20/25) ¹ ty class 7 3,0) 0) 5,7	8,8
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic	sistance e (θ) t lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] d 8.8) and stainless R30 R60	re θ [°C] steel A4 0,3 0,2	and HCF 1,1 0,9	k _{fi,p} (θ) * τ _f R (propert 1,7 1,4	ty class 7 3,0 2,3) 0) 5,7 4,2	6,6
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro	sistance e (θ) t lever arn perty class	τ _{Rk,fi} (θ) n s 5.8 an	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90	re θ [°C] steel A4 0,3 0,2 0,2	and HCF 1,1 0,9 0,7	k _{fi,p} (θ) * τ _f R (propert 1,7 1,4 1,0	ty class 7 3,0 2,3 1,6	0) 5,7 4,2 3,0	6,6 4,7
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance	sistance e (θ) t lever arn perty class	τ _{Rk,fi} (θ) n s 5.8 an	Temperatu [N/mm²] d 8.8) and stainless R30 R60	re θ [°C] steel A4 0,3 0,2	and HCF 1,1 0,9	k _{fi,p} (θ) * τ _f R (propert 1,7 1,4	ty class 7 3,0 2,3) 0) 5,7 4,2	6,6
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance Steel failure with lev	sistance e (θ) t lever arn perty class V _{Rk,s,fi} ver arm	τ _{Rk,fi} (θ) n s 5.8 an [kN]	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90 R120	re θ [°C] steel A4 0,3 0,2 0,2 0,1	and HCF 1,1 0,9 0,7 0,5	k _{fi,p} (θ) * τ _f R (propert 1,7 1,4 1,0 0,8	ty class 7 3,0 2,3 1,6 1,2	0) 5,7 4,2 3,0 2,2	6,6 4,7
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance	sistance e (θ) t lever arn perty class V _{Rk,s,fi} ver arm	τ _{Rk,fi} (θ) n s 5.8 an [kN]	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90 R120	re θ [°C] steel A4 0,3 0,2 0,2 0,1 steel A4	and HCF 1,1 0,9 0,7 0,5 and HCF	k _{fi,p} (θ) * τ _f (propert 1,7 1,4 1,0 0,8 R (propert	ty class 7 3,0 2,3 1,6 1,2 ty class 7	0) 5,7 4,2 3,0 2,2 0)	6,6 4,7 3,4
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance Steel failure with lev Steel zinc plated (pro	sistance e (θ) t lever arm perty class V _{Rk,s,fi} ver arm perty class	τ _{Rk,fi} (θ) s 5.8 an [kN] s 5.8 an	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90 R120 d 8.8) and stainless	re θ [°C] steel A4 0,3 0,2 0,2 0,1	and HCF 1,1 0,9 0,7 0,5	k _{fi,p} (θ) * τ _f (properf 1,7 1,4 1,0 0,8 (properf 2,2	ty class 7 3,0 2,3 1,6 1,2 ty class 7 4,7	0) 5,7 4,2 3,0 2,2	6,6 4,7 3,4 23,4
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance Steel failure with lev	sistance e (θ) t lever arn perty class V _{Rk,s,fi} ver arm	τ _{Rk,fi} (θ) n s 5.8 an [kN]	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90 R120 d 8.8) and stainless R30	re θ [°C] steel A4 0,3 0,2 0,2 0,1 steel A4 0,2	and HCF 1,1 0,9 0,7 0,5 and HCF 1,1	k _{fi,p} (θ) * τ _f (propert 1,7 1,4 1,0 0,8 R (propert	ty class 7 3,0 2,3 1,6 1,2 ty class 7	0) 5,7 4,2 3,0 2,2 0) 12,0	6,6 4,7 3,4
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance Steel failure with lev Steel zinc plated (pro Characteristic	sistance e (θ) t lever arm perty class V _{Rk,s,fi} ver arm perty class	τ _{Rk,fi} (θ) s 5.8 an [kN] s 5.8 an	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R90 R120 d 8.8) and stainless R30 R60	re θ [°C] steel A4 0,3 0,2 0,2 0,1 steel A4 0,2 0,2	and HCF 1,1 0,9 0,7 0,5 and HCF 1,1 0,9	k _{fi,p} (θ) * τ _f (propert 1,7 1,4 1,0 0,8 (propert 2,2 1,8	ty class 7 3,0 2,3 1,6 1,2 ty class 7 4,7 3,5	0) 5,7 4,2 3,0 2,2 0) 12,0 9,0	6,6 4,7 3,4 23,4 17,5
Characteristic bond res for a given temperature Steel failure without Steel zinc plated (pro Characteristic shear resistance Steel failure with lev Steel zinc plated (pro Characteristic	sistance e (θ) t lever arm perty class V _{Rk,s,fi} ver arm perty class	τ _{Rk,fi} (θ) s 5.8 an [kN] s 5.8 an [Nm]	Temperatu [N/mm ²] d 8.8) and stainless R30 R60 R120 d 8.8) and stainless R30 R60 R30 R60 R90 R120	re θ [°C] steel A4 0,3 0,2 0,2 0,1 steel A4 0,2 0,2 0,2 0,1 0,1	and HCF 1,1 0,9 0,7 0,5 and HCF 1,1 0,9 0,7 0,5	k _{fi,p} (θ) * τ _f (propert 1,7 1,4 1,0 0,8 (propert 2,2 1,8 1,3 1,0	ty class 7 3,0 2,3 1,6 1,2 ty class 7 4,7 3,5 2,5 1,8	0) 5,7 4,2 3,0 2,2 0) 12,0 9,0 6,3 4,7	6,6 4,7 3,4 23,4 17,5 12,3 9,1



Rebar				Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø3
Steel failure										I			
BSt 500													
			R30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,
Characteristic	N	[LNI]	R60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,
tension resistance	N _{Rk,s,fi}	[kN]	R90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,
			R120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,0	8,
Characteristic bond conditions for a give				ced co	oncre	te C2	0/25	up to	C50/	60 un	der f	ire	
conditions for a give		ature	θ < 22°C					1	,0				
Temperature	k _{fi,p} (θ)	[-]	22°C ≤ θ ≤ 370°C				1,268	3*e-		≤ 1,0			
reduction factor	-1P (- 7		θ > 370°C				,		,0	, 2			
Fac	1												
• • • • • • • • • • • • • • • • • • •	50	100	150 200	250		300	350		400	45	0		
0,0		100	150 200 Temperatu		c]	300	350	_	400	45	0		
0,0	istance	100 τ _{Rk,fi} (θ)			c]	300		θ) * τι	27029		0		
characteristic bond res	istance e (θ)	τ _{Rk,fi} (θ)	Temperatu		c]	, 300			27029		0	_	
Characteristic bond res for a given temperature Steel failure without	istance e (θ)	τ _{Rk,fi} (θ)	Temperatu		c]				27029	^(25) 1)	0		
Characteristic bond res for a given temperature Steel failure without BSt 500	istance e (θ)	τ _{Rk,fi} (θ)	Temperatu [N/mm²] R30	ure θ [°ι 0,5	1,2	2,3	k _{fi,p} (θ) * τ _ι 4,0	Rk,cr(20)	⁽²⁵⁾ ¹⁾ 9,0	9,8	12,3	
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic	istance e (θ)	τ _{Rk,fi} (θ)	Temperatu [N/mm²] R30 R60	0,5 0,5	1,2 1,0	2,3 1,7	k _{fi,p} (3,1 2,3	θ) * τ _f 4,0 3,0	6,3 4,7	^{25) 1)} 9,0 6,8	9,8 7,4	9,2	12
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic	istance (θ) lever arn	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] R30 R60 R90	0,5 0,5 0,4	1,2 1,0 0,8	2,3 1,7 1,5	k _{fi,p} (3,1 2,3 2,0	θ) * τ _f 4,0 3,0 2,6	6,3 4,7 4,1	9,0 6,8 5,9	9,8 7,4 6,4	9,2 8,0	12 10
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic shear resistance	istance e (θ) Iever arm	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] R30 R60	0,5 0,5	1,2 1,0	2,3 1,7	k _{fi,p} (3,1 2,3	θ) * τ _f 4,0 3,0	6,3 4,7	^{25) 1)} 9,0 6,8	9,8 7,4	9,2	12 10
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic shear resistance Steel failure with leve	istance e (θ) Iever arm	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] R30 R60 R90	0,5 0,5 0,4	1,2 1,0 0,8	2,3 1,7 1,5	k _{fi,p} (3,1 2,3 2,0	θ) * τ _f 4,0 3,0 2,6	6,3 4,7 4,1	9,0 6,8 5,9	9,8 7,4 6,4	9,2 8,0	12 10
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic shear resistance Steel failure with leve	istance e (θ) Iever arm	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] R30 R60 R90	0,5 0,5 0,4	1,2 1,0 0,8	2,3 1,7 1,5	k _{fi,p} (3,1 2,3 2,0	θ) * τ _f 4,0 3,0 2,6	6,3 4,7 4,1 3,1	9,0 6,8 5,9 4,5	9,8 7,4 6,4	9,2 8,0 6,0	12 10 8,
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic shear resistance Steel failure with leve BSt 500 Characteristic	istance (θ) lever arm V _{Rk,s,fi} er arm	τ _{Rk,fi} (θ) n [kN]	Temperatu [N/mm²] R30 R60 R90 R120	0,5 0,5 0,4 0,3	1,2 1,0 0,8 0,6	2,3 1,7 1,5 1,1	k _{fi,p} (3,1 2,3 2,0 1,5	 θ) * τ₁ 4,0 3,0 2,6 2,0 9,7 7,2 	6,3 4,7 4,1 3,1 18,8 14,1	9,0 6,8 5,9 4,5 32,6 24,4	9,8 7,4 6,4 4,9 36,8 27,6	9,2 8,0 6,0 51,7 38,8	12 10 8, 77 57
Characteristic bond res for a given temperature Steel failure without BSt 500 Characteristic shear resistance Steel failure with leve BSt 500 Characteristic	istance e (θ) Iever arm	τ _{Rk,fi} (θ) n	Temperatu [N/mm²] R30 R60 R90 R120 R30 R30 R60 R90	0,5 0,5 0,4 0,3 0,6 0,5 0,4	1,2 1,0 0,8 0,6 1,8 1,5 1,2	2,3 1,7 1,5 1,1 4,1 3,1 2,6	k _{fi,p} (3,1 2,3 2,0 1,5 6,5 4,8 4,2	 θ) * τ₁ 4,0 3,0 2,6 2,0 9,7 7,2 6,3 	6,3 4,7 4,1 3,1 18,8 14,1 12,3	9,0 6,8 5,9 4,5 32,6 24,4 21,2	9,8 7,4 6,4 4,9 36,8 27,6 23,9	9,2 8,0 6,0 51,7 38,8 33,6	12 10 8, 77 57 50
Characteristic bond res for a given temperature Steel failure without BSt 500	istance (θ) Iever arm V _{Rk,s,fi} er arm M ⁰ _{Rk,s,fi}	τ _{Rk,fi} (θ) n [kN]	Temperatu [N/mm²] R30 R60 R90 R120 R120 R30 R60 R90 R120	0,5 0,5 0,4 0,3 0,6 0,5 0,4 0,3	1,2 1,0 0,8 0,6 1,8 1,5 1,2 0,8	2,3 1,7 1,5 1,1 4,1 3,1 2,6 2,0	k _{fi,p} (3,1 2,3 2,0 1,5 6,5 4,8 4,2 3,2	 θ) * τ_f 4,0 3,0 2,6 2,0 9,7 7,2 6,3 4,8 	6,3 4,7 4,1 3,1 18,8 14,1 12,3 9,4	9,0 6,8 5,9 4,5 32,6 24,4 21,2 16,3	9,8 7,4 6,4 4,9 36,8 27,6 23,9 18,4	9,2 8,0 6,0 51,7 38,8 33,6 25,9	12 10 8, 77 57 50 38