Deutsches Institut für Bautechnik DIBt

Public-law institution jointly founded by the federal states and the Federation

European Technical Assessment Body for construction products

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

European Technical Assessment

ETA-19/0483 of 16 December 2025

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 VME plus
Product family to which the construction product belongs	Bonded fasteners and bonded expansion fasteners for use in concrete
	(Alternative drilling methods, seismic and fire in steel fibre reinforced concrete, variable working life, time-to-failure assessment)
Manufacturer	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND
Manufacturing plant	Werk 1,D und Werk 2,D
This European Technical Assessment contains	48 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-v01
This version replaces	ETA-19/0483 issued on 12 May 2021

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ETA-19/0483

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Specific Part

1 Technical description of the product

The "Injection system VME plus" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar VME plus and a steel element according to Annex A 3 to Annex A 7.

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 according to Annex B2, use conditions. 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 B4, C1, C3 to C7, C11 to C14 and C16 to C18
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C2, C8, C15 and C19
Displacements under short-term and long-term loading	See Annex C21 to C25
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C9, C10, C20, C21 and C22

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C26 to C28

3.3 Hygiene, health and the environment (BWR 3)

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

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

In accordance with the European Assessment Document EAD 330499-02-0601-v01 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 16 December 2025 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock   *beglaubigt:*
Head of Section   Baderschneider
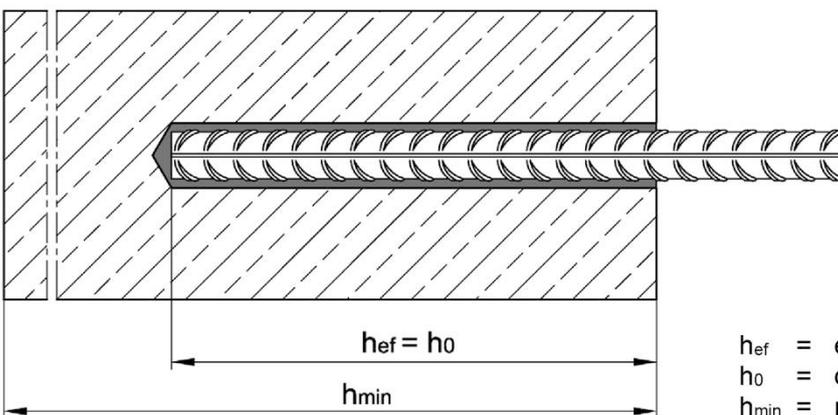
Installation threaded rod M8 to M30
Pre-setting installation or through-setting installation (optional annular gap filled with mortar)

$h_{ef} = h_0$
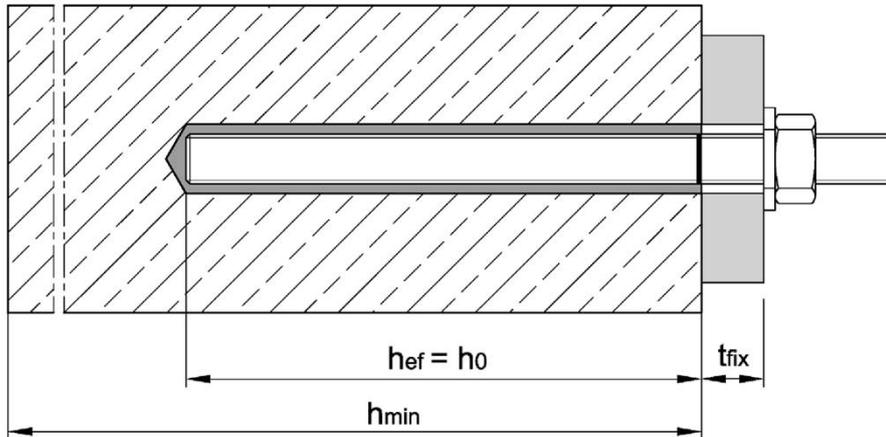
t_{fix}

h_{min}

Installation internally threaded anchor rod IG M6 to IG M20

$h_{ef} = h_0$
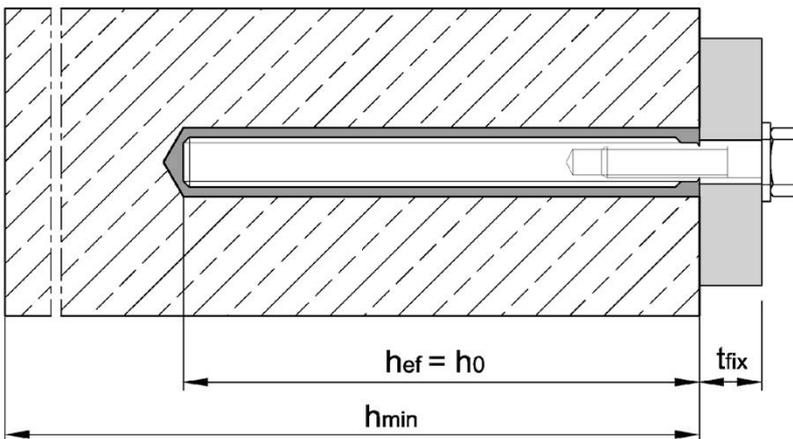
t_{fix}

h_{min}

Installation reinforcing bar Ø8 to Ø40

$h_{ef} = h_0$

h_{min}

h_{ef} = effective anchorage depth
h_0 = depth of drill hole
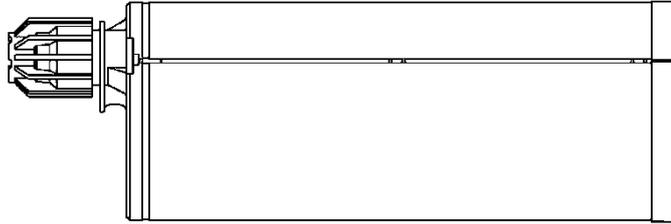h_{min} = minimum thickness of member
t_{fix} = thickness of fixture

Injection System VME plus	
Product description Installation situation	**Annex A1**

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Cartridge Injection Mortar VME plus

**Side-by-side cartridge
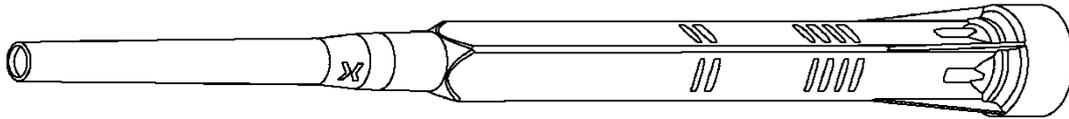440 ml
500 bis 540 ml
585 ml
1400 ml**

Imprint:

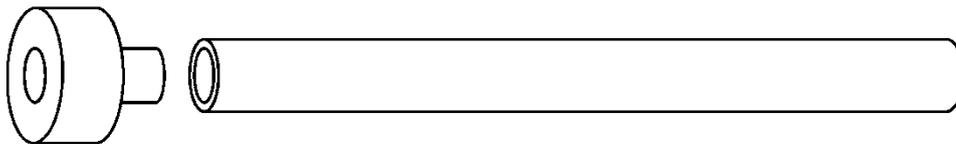**VME plus**
Processing and safety instructions, shelf life, charge number, manufacturer's information, quantity information

Static Mixer VM-XHP

Retaining washer and extension nozzle

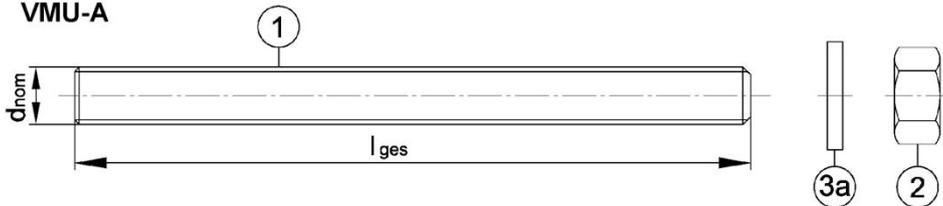| Injection System VME plus	
Product description Cartridge, static mixer and retaining washer with extension nozzle	**Annex A2**

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Threaded rod

Threaded rod VMU-A and V-A

M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A4, HCR)
with washer and hexagon nut

VMU-A

d_{nom}

l_{ges}

(1)

(3a) (2)

V-A

optional: mark of
embedment depth

d_{nom}

(1)

Marking e.g.: ◇M10

◇   identifying mark of
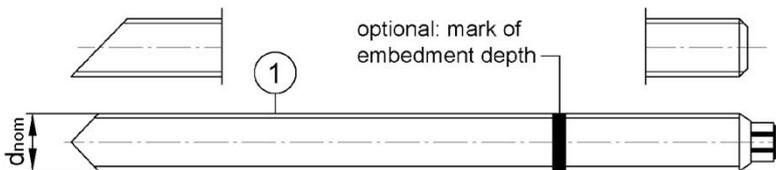manufacturing plant

M10   size of thread

additional marking:

-8   strength class 8.8

A4   stainless steel

HC   high corrosion resistant steel

Threaded rod VM-A

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

**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)

For hot dip galvanized elements, the requirements with regards to the combination of nuts and rods according to
EN ISO 10684:2004+AC:2009 Annex F shall be considered.

Filling Washer and reducing adapter

for filling the gap between threaded rod and fixture

(3b)
t
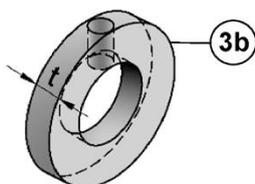
Thickness of filling washer
for diameter
< M24: t = 5 mm
≥ M24: t = 6 mm

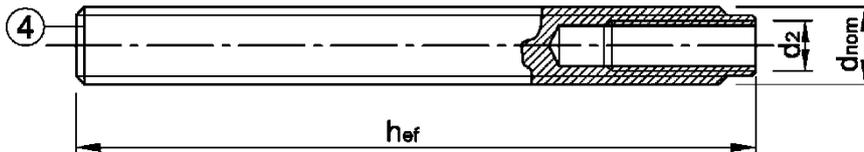| Injection System VME plus	
Product description Threaded rods, Marking, Filling washer VS	**Annex A3**

Internally threaded anchor rod

Internally threaded anchor rod VMU-IG

VMU-IG M6, VMU-IG M8, VMU-IG M10, VMU-IG M12, VMU-IG M16, VMU-IG M20
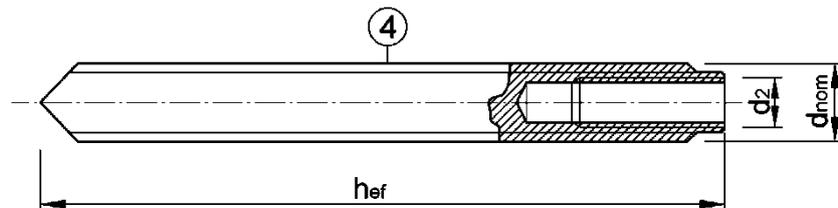(zinc plated, A4, HCR)

Marking e.g.: ◇ I M8

◇   Identifying mark of manu-
     facturing plant

I   internal thread (optional)

M8   size of internal thread

Internally threaded anchor rod VZ-IG

VZ-IG M6, VZ-IG M8, VZ-IG M10, VZ-IG M12, VZ-IG M16, VZ-IG M20
(zinc plated, A4, HCR)

Additional marking:

-8   strength class 8.8

A4   stainless steel

HCR   high corrosion resistant steel

Requirements on the fastening screw or the threaded rod and nut according to the engineering documents:

- Minimum screw-in depth $L_{sd,min}$ see Table B2
- The length of screw or the threaded rod shall be determined depending on the thickness of fixture t_{fix}, available thread length and the minimum screw-in depth L_{sdmin}.
- Materials for screws and threaded rods (incl. nut and washer) must at least correspond to the material and strength class of the internally threaded anchor rod used.

Injection System VME plus

Product description
Internally threaded anchor rods, Marking

Annex A4

Table A1: Materials - Threaded rod and internally threaded anchor rods

Part	Designation	Material and mechanical properties					
Steel, zinc plated							
electroplated		≥ 5 µm acc. to EN ISO 4042:2022 or					
hot-dip galvanized		≥ 50 µm in average acc. to EN ISO 1461:2022, EN ISO 10684:2004+AC:2009 or					
sherardized		≥ 45 µm acc. to EN ISO 17668:2016					
		Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN ISO 683-4:2018, EN 10263:2017
1	Threaded rod	4.6	f_{uk} [N/mm²]	400	f_{yk} [N/mm²]	240	$A_5 > 8\ \%$	
		4.8		400		320	$A_5 > 8\ \%$	Commercial standard threaded rod: EN ISO 898-1:2013
		5.6		500		300	$A_5 > 8\ \%$	
		5.8		500		400	$A_5 > 8\ \%$	
		8.8		800		640	$A_5 \geq 12\%$ [1]	
2	Hexagon nut	4	for class 4.6 or 4.8 rods					Commercial standard nut: e.g. EN ISO 898-2:2022
		5	for class 4.6, 4.8, 5.6 or 5.8 rods					
		8	for class 4.6, 4.8, 5.6, 5.8 or 8.8 rods					
3a	Washer	e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000, EN ISO 887:2006					
3b	Washer with bore	Steel, zinc plated					
4	Internally threaded anchor rod	5.8	Steel, electroplated or sherardized			$A_5 > 8\%$	EN ISO 683-4:2018
		8.8				$A_5 > 8\%$	

Stainless steel A2 [2]		**CRC II** (1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541)					
Stainless steel A4		**CRC III** (1.4401 / 1.4404 / 1.4571 / 1.4578)					
High corrosion resistant steel HCR		**CRC V** (1.4529 / 1.4565)					
		Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN 10088-1:2023
1	Threaded rod	50	f_{uk} [N/mm²]	500	f_{yk} [N/mm²]	210	$A_5 > 8\%$	
		70		700		450 (560) [4]	$A_5 \geq 12\%$ [1]	Commercial standard threaded rod: EN ISO 3506-1:2020
		80 [3]		800		600 (640) [4]	$A_5 \geq 12\%$ [1]	
2	Hexagon nut	50	for class 50 rods					EN 10088-1:2023 Commercial standard nut: e.g.: EN ISO 3506-2:2020
		70	for class 50 or 70 rods					
		80 [3]	for class 50, 70 or 80 rods					
3a	Washer	e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000; EN ISO 887:2006					EN 10088-1:2023
3b	Washer with bore	stainless steel A4; high corrosion resistant steel HCR					
4	Internally threaded anchor rod	50	IG-M20			$A_5 > 8\ \%$	EN 10088-1:2023
		70	IG-M6 to IG-M20			$A_5 > 8\ \%$	

[1] Fracture elongation $A_5 > 8\ \%$ for applications <u>without</u> requirements for seismic performance category C2
[2] Property classes 50 and 70
[3] Property classes 80: M8 up to M24
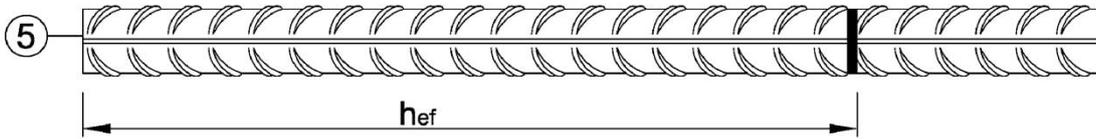[4] Value in brackets for anchor rods VMU-A and V-A

Injection System VME plus

Product description
Materials

Annex A5

Reinforcing bar

∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 24, ∅ 25, ∅ 28, ∅ 32, ∅ 36, ∅ 40

- 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 $0{,}05d \leq h \leq 0{,}07d$
  (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 VME plus

Product description
Product description and material reinforcing bar

Annex A6

Specification of intended use

Static and quasi-static action					
Working life		**50 years**		**100 years**	
Base material		uncracked concrete	cracked concrete	uncracked concrete	cracked concrete
		strength classes **C20/25** to **C90/105 without fibers** strength classes **C20/25** to **C50/60 with fibers** [1]			
Drilling method	hammer drilling (HD) vacuum drilling (VD) compressed air drilling (CD)	**M8 – M30** **IG M6 – IG M20** **Ø8 – Ø32**			
	hammer drilling (HD) compressed air drilling (CD)	**Ø36 – Ø40**	no performance assessed	**Ø36 – Ø40**	no performance assessed
	diamond drilling (DD)	**M8 – M30** **IG M6 – IG M20** **Ø8 – Ø40**	**M16 – M30** **IG M10 – IG M20** (C20/25 - C50/60 without fibers)	**M8 – M30** **IG M6 – IG M20** **Ø8 – Ø40**	no performance assessed

Seismic action				
Performance category		**C1**		**C2**
Base material		cracked or uncracked concrete		
		strength classes **C20/25** to **C50/60 without fibers** strength classes **C20/25** to **C50/60 with fibers** [1]		
Drilling method	hammer drilling (HD) vacuum drilling (VD) compressed air drilling (CD)	**M8 – M30** **Ø8 – Ø32**		**M12 – M30**
	diamond drilling (DD)	no performance assessed		

Fire exposure			
Base material		cracked or uncracked concrete	
		strength classes **C20/25** to **C90/105 without fibers** strength classes **C20/25** to **C50/60 with fibers** [1]	
Drilling method	hammer drilling (HD) vacuum drilling (VD) compressed air drilling (CD)	**M8 – M30** **IG M6 – IG M20** **Ø8 – Ø32**	
	diamond drilling (DD)	no performance assessed	

Temperature range		
I:	-40°C to +40°C	max. long term temperature +24°C and max. short term temperature +40°C
II:	-40°C to +72°C	max. long term temperature +50°C and max. short term temperature +72°C
III:	-40°C to +80°C	max. long term temperature +60°C and max. short term temperature +80°C

[1] With fibers only by hammer drilling (HD), vacuum drilling (VD) or compressed air drilling (CD)

Injection System VME plus

Intended Use Specifications	**Annex B1**

Specification of intended use

Base material:

- compacted, reinforced or unreinforced normal weight concrete with strength classes C20/25 to C90/105 acc. to EN 206:2013+A2:2021
- Steel fiber reinforced concrete according to EN 206:2013 + A2:2021 with steel fibers according to EN 14889-1:2006, section 5, group 1, with a maximum fiber content of 80kg/m³.

Use conditions (Environmental conditions):

For working life for at least 50 and/ or 100 years:
- 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+A1:2015

For variable working life:
- Structures subject to internal and external conditions (carbon steel, hot dip galvanized according to EN ISO 10684:2004 + AC:2009 with mean thickness $\geq 50\ \mu m$): Classification of atmospheric corrosivity, determination and estimation C1-CX according to EN ISO 9223:2012-02 Table C.1 for a variable working life according to Table B1.

Table B1: Variable working life

Corrosivity category[1]	Corrosivity	Working life (years)
C1	very low	50
C2	low	50
C3	medium	25
C4	high	12,5
C5	very High	5
CX	extreme	2

[1] Corrosivity categories according to EN ISO 9233:2012-02, Table C.

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 or Technical Report TR 055, Edition February 2018
- Fasteners in steel fiber reinforced concrete may be designed in accordance with EN 1992-4:2018. All performance parameters are to be applied as for normal concrete of strength classes C20/25 to C50/60 without fibers
- Anchorages under fire exposure are designed in accordance with Technical Report TR 082, Edition June 2023

Injection System VME plus	
Intended Use Specifications of intended use	**Annex B2**

Installation:

- Dry or wet concrete or waterfilled drill holes (not seawater)
- Hole drilling
    - HD: hammer drilling,
    - VD: vacuum drilling
    - CD: compressed air drilling,
    - DD: diamond drilling
- Overhead installation allowed
- Fastener installation carried out by appropriately qualified personnel and under the responsibility of the person responsible for technical matters of the site.
- Drill hole must be cleaned directly before installation of the anchor or it must be protected against recontamination in a suitable manner until installation of the anchor. In the event of water inflow or renewed soiling, cleaning must be repeated before assembly.

Injection System VME plus	
Intended Use Specifications of intended use	**Annex B3**

Table B2: Installation parameters for threaded rods

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Diameter of threaded rod	$d=d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter	d_0	[mm]	10	12	14	18	22	28	30	35
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	80	90	96	108	120
	$h_{ef,max}$	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	Pre-setting installation $d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Through setting installation d_f	[mm]	12	14	16	20	24	30	33	40
Maximum installation torque	$max.T_{inst}$	[Nm]	10	20	40 (35)[1]	60	100	170	250	300
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30mm ≥100mm			h_{ef} + 2d_0				
Minimum spacing	s_{min}	[mm]	40	50	60	75	95	115	125	140
Minimum edge distance	c_{min}	[mm]	35	40	45	50	60	65	75	80

[1] Max. installation torque for property class 4.6

Table B3: 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	$d=d_{nom}$	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0	[mm]	12	14	18	22	28	35
Effective anchorage depth	$h_{ef,min}$	[mm]	60	70	80	90	96	120
	$h_{ef,max}$	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	7	9	12	14	18	22
Maximum installation torque	$max.T_{inst} \leq$	[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	h_{min}	[mm]	h_{ef} + 30mm ≥ 100mm		h_{ef} + 2d_0			
Minimum spacing	s_{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c_{min}	[mm]	40	45	50	60	65	80

Table B4: Installation parameters for rebar

Rebar			⌀ 8	⌀ 10	⌀ 12	⌀ 14	⌀ 16	⌀ 20	⌀ 24	⌀ 25	⌀ 28	⌀ 32	⌀ 36	⌀ 40
Diameter of rebar	$d=d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32	36	40
Nominal drill hole diameter [1]	d_0	[mm]	10 | 12	12 | 14	14 | 16	18	20	25	30 | 32	30 | 32	35	40	45	52 | 55
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128	144	160
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640	720	800
Minimum member thickness	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm			h_{ef} + 2d_0								
Minimum spacing	s_{min}	[mm]	40	50	60	70	75	95	120	120	130	150	180	200
Minimum edge distance	c_{min}	[mm]	35	40	45	50	50	60	70	70	75	85	180	200

[1] For ⌀8, ⌀10, ⌀12, ⌀24, ⌀25 and ⌀40 both nominal drill hole diameter can be used

Injection System VME plus	
Intended Use Installation parameters	**Annex B4**

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Table B5: Parameter for cleaning and setting tools

Threaded rod	Internally threaded anchor rod	Rebar	Drill bit Ø	Brush Ø	min. Brush Ø	Retaining washer Installation direction and use			
[-]	[-]	Ø [mm]	d_0 [mm]	d_b [mm]	$d_{b,min}$ [mm]	[-]	↓	→	↑
M8		8	10	11,5	10,5	No **retaining washer** required			
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	VM-IA 18	$h_{ef} >$ 250mm	$h_{ef} >$ 250mm	all
		16	20	22,0	20,5	VM-IA 20			
M20	IG M12		22	24,0	22,5	VM-IA 22			
		20	25	27,0	25,5	VM-IA 25			
M24	IG M16		28	30,0	28,5	VM-IA 28			
M27		24 / 25	30	31,8	30,5	VM-IA 30			
		24 / 25	32	34,0	32,5	VM-IA 32			
M30	IG M20	28	35	37,0	35,5	VM-IA 35			
		32	40	43,5	40,5	VM-IA 40			
		36	45	47,0	45,5	VM-IA 45	all	all	all
	40		52	54,0	52,5	VM-IA 52			
			55	58,5	55,5	VM-IA 55			

Vacuum drill bit Vacuum drill bit (MKT Hollow drill bit SB, Würth Hammer drill bit with suction or Heller Duster Expert hollow drill bit system) and a vacuum cleaner with minimum negative pressure of 253 hPa and flow rate of minimum 42 l/s (150 m³/h)	
Compressed air tool min 6 bar Drill bit diameter (d_0): all diameters	
Cleaning Brush RB	d_b
Retaining washer VM-IA	
Centring Aid ZH	**ZH-Cap** **ZH-Ring**

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Intended Use Cleaning and setting tools	**Annex B5**

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Table B6: Installation parameters centring aid ZH

Threaded rod			M10	M12	M16	M20	M24
Internally threaded anchor rod			**IG-M 6**	**IG-M 8**	**IG-M 10**	**IG-M 12**	**IG-M 16**
Centring aid ZH-Ring / ZH-Cap			ZH-M10	ZH-M12	ZH-M16	ZH-M20	ZH-M24
Centring aid ZH-Ring	h_{Ring}	[mm]	6,5	8,0	9,0	9,0	12,0
Centring aid ZH-Cap	h_{Cap}	[mm]	8,0	10,0	12,0	14,0	16,0
Drill hole depth	h_0	[mm]	$h_0 \geq h_{nom} + 3$ mm
Minimum thickness of member	h_{min}	[mm]	$h_{nom} + 30$mm ≥ 100mm		$h_{nom} + 2d_0$		
Effective anchorage depth[1]	h_{ef}	[mm]	$h_{ef} = h_{nom} - h_{cap} - n \cdot h_{Ring} \geq h_{ef,min}$

[1] The effective anchorage depth h_{ef} is reduced by the height of all centring aids used.
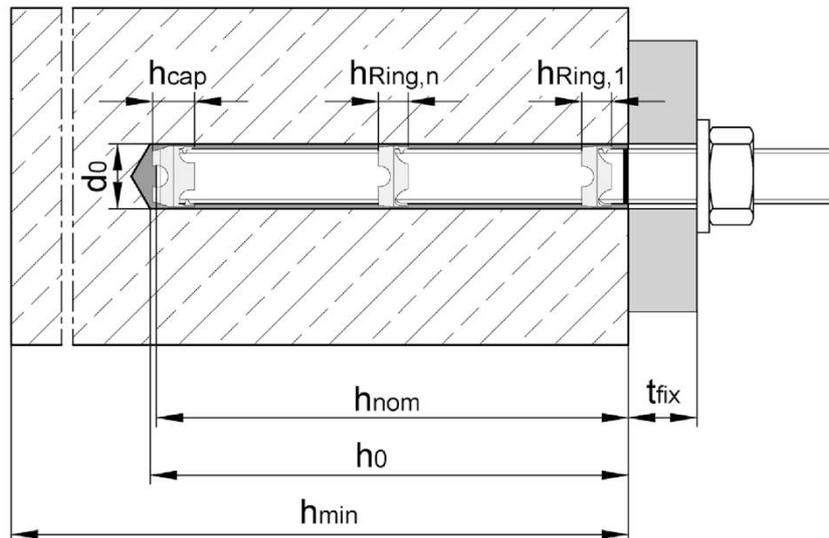
n = number of used centring rings „ZH-Ring"

Table B7: Working time and curing time

Concrete temperature			Maximum working time	Minimum curing time	
				dry concrete	wet concrete
0°C	to	+4°C	80 min	144 h	288 h
+5°C	to	+9°C	80 min	48 h	96 h
+10°C	to	+14°C	60 min	28 h	56 h
+15°C	to	+19°C	40 min	18 h	36 h
+20°C	to	+24°C	30 min	12 h	24 h
+25°C	to	+34°C	12 min	9 h	18 h
+35°C	to	+39°C	8 min	6 h	12 h
\multicolumn{3}{c}{+40°C}	8 min	4 h	8 h
Cartridge temperature			\multicolumn{3}{c}{+5°C to +40°C}

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Intended Use Installation parameters centring aid Working and curing time	**Annex B6**

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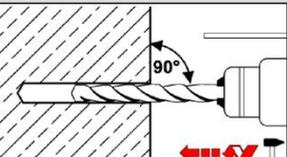Bautechnik**

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Installation instructions

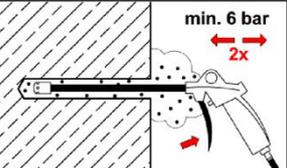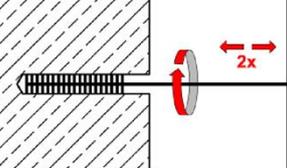|		Hole drilling and cleaning: Vacuum drilling
1		**Vacuum drilling:** see Annex B5 Drill hole with prescribed nominal drill hole diameter (Table B2, B3 or B4) and selected drill hole depth. This drilling method removes dust and cleans the drill hole during drilling. <u>Continue with step 3.</u> In case of aborted drill hole, the drill hole shall be filled with mortar.

No further cleaning steps required when using a vacuum drill!

		Hole drilling and cleaning: Hammer drilling, compressed air drilling
1		**Hammer drilling or compressed air drilling:** Drill hole with hammer drill or compressed air drill into the base material with prescribed nominal drill hole diameter (Table B2, B3 or B4) and selected drill hole depth. <u>Continue with step 2.</u> In case of aborted drill hole, the drill hole shall be filled with mortar.

Attention! Standing water in the drill hole must be removed before cleaning!

Cleaning: dry, wet and water-filled drill holes with all diameter in uncracked and cracked concrete

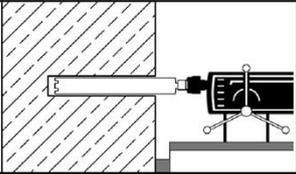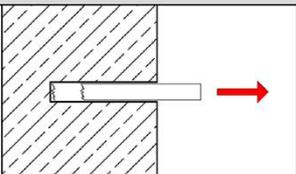|		
2a		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
2b		Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ a minimum of **two** times. If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.
2c		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
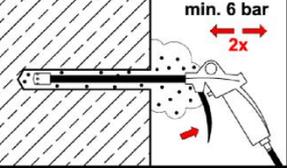
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Intended Use Installation instructions – Drilling and cleaning: Hammer-, compressed air- or vacuum drilling	**Annex B7**

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Installation instructions (continuation)

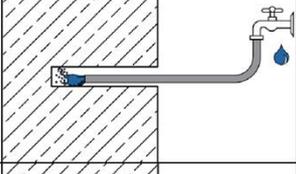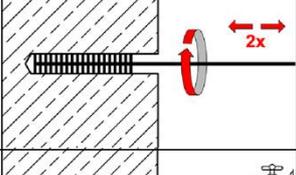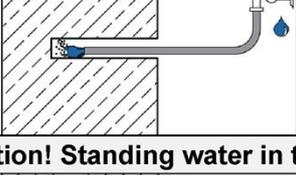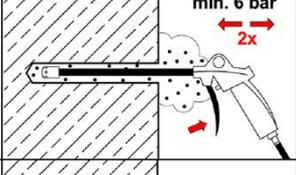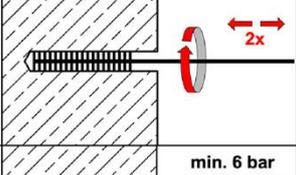| **Hole drilling and cleaning: Diamond drilling**		
1		Drill a hole into the base material with prescribed nominal drill hole diameter (Table B2, B3 or B4) and selected drill hole depth. Continue with step 2. In case of aborted drill hole, the drill hole shall be filled with mortar.
Cleaning: dry, wet and water-filled drill holes		
2a		Remove drill core at least up to the nominal drill hole depth and check drill hole depth.
2b		Flush drill hole with water, starting from the bottom until clear water gets out of the drill hole.
2c		Check brush diameter (Table B5). Brush the hole with an appropriate sized wire brush ≥ $d_{b,min}$ a minimum of **two** times. If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.
2d		Flush drill hole again with water, starting from the bottom until clear water gets out of the drill hole.
Attention! Standing water in the borehole must be removed before proceeding.		
2e		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
2f		Check brush diameter (Table B5). Brush the hole again with an appropriate sized wire brush ≥ $d_{b,min}$ a minimum of **two** times. If the drill hole ground is not reached with the brush, an appropriate brush extension must be used.
2g		Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) again a minimum of **two** times until return air stream is free of noticeable dust. If the drill hole ground is not reached, an extension must be used.
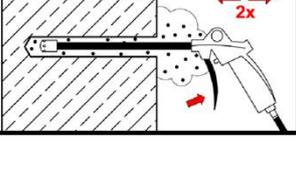
Injection System VME plus	
Intended Use Installation instructions – Drilling and cleaning: Diamond drilling	**Annex B8**

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Installation instructions (continuation)

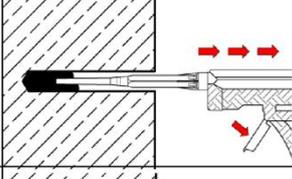|	Injection	
3		Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B7) as well as for new cartridges, a new static-mixer shall be used.
4		Prior to inserting the rod into the filled drill hole, the position of the embedment depth shall be marked on the threaded rod or rebar.
5		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 or red colour.
6		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 as the hole fills to avoid air pockets. If the drill hole ground is not reached, an appropriate mixer extension shall be used. Observe temperature dependent working times given in Table B7.
7		Retaining washer and mixer extensions shall be used according to Table B5 for the following applications: • Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and anchorage depth $h_{ef} > 250$mm • Overhead installation: Drill bit-Ø $d_0 \geq 18$ mm
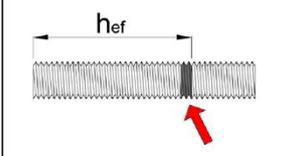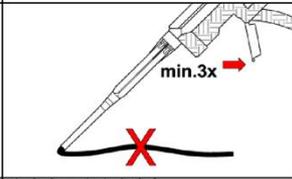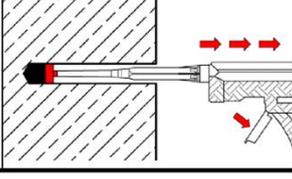
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Intended Use Installation instructions - Injection	**Annex B9**

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Installation instructions (continuation)

Inserting the fastening element		
8		Push the threaded rod or reinforcing bar into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached. The anchor shall be free of dirt, grease, oil or other foreign material.
9		Make sure that excess mortar is visible at the top of the hole and in case of through-setting installation also in the fixture. If these requirements are not maintained, repeat application before end of working time! For overhead installation, the anchor should be fixed (e.g. by wedges).
10		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 B7).
11		Remove excess mortar.
12		The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B2 or B3.
13		In case of pre-setting installation the annular gap between anchor rod and fixture can 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.

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Intended Use Installation instructions – Inserting the fastening element	**Annex B10**

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Table C1: Characteristic **steel resistance** for **threaded rods** under **tension load**

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Cross sectional area	A_s	[mm²]	36,6	58,0	84,3	157	245	353	459	561
Characteristic resistance under tension load [1]										
Steel, zinc plated — 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
Steel, zinc plated — Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)[1]	46 (43)[1]	67	126	196	282	367	449
Stainless 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
Stainless steel — Property class 80 (A4 / HCR)	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-[3]	-[3]
Partial factors [2]										
Steel, zinc plated — Property class 4.6	$\gamma_{Ms,N}$	[-]	2,0							
Steel, zinc plated — Property class 4.8	$\gamma_{Ms,N}$	[-]	1,5							
Steel, zinc plated — Property class 5.6	$\gamma_{Ms,N}$	[-]	2,0							
Steel, zinc plated — Property class 5.8	$\gamma_{Ms,N}$	[-]	1,5							
Steel, zinc plated — Property class 8.8	$\gamma_{Ms,N}$	[-]	1,5							
Stainless steel — Property class 50 (A2 / A4 / HCR)	$\gamma_{Ms,N}$	[-]	2,86							
Stainless steel — Property class 70 (A2 / A4 / HCR)	$\gamma_{Ms,N}$	[-]	1,87 (1,5) [4]							
Stainless steel — Property class 80 (A4 / HCR)	$\gamma_{Ms,N}$	[-]	1,6 (1,5) [4]						-[3]	-[3]

[1] The characteristic resistances apply for all anchor rods with the cross sectional area A_s specified here: VMU-A, V-A, VM-A. 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 national regulation

[3] Anchor type not part of the ETA

[4] Value in brackets for anchor rods VMU-A or V-A

Injection System VME plus

Performance
Characteristic **steel resistance** for **threaded rods** under **tension load**

Annex C1

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Table C2: Characteristic **steel resistance** for **threaded rods** under **shear load**

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Cross sectional area	A_s [mm²]		36,6	58,0	84,3	157	245	353	459	561
Characteristic resistance under shear load [1]										
Steel failure without lever arm										
Steel, zinc plated — Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
Steel, zinc plated — Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
Steel, zinc plated — Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Stainless steel — Property class 50 (A2 / A4 / HCR)	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Stainless steel — Property class 70 (A2 / A4 / HCR)	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
Stainless steel — Property class 80 (A4 / HCR)	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	_[3]	_[3]
Steel failure with lever arm										
Steel, zinc plated — Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
Steel, zinc plated — Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	325	561	832	1124
Steel, zinc plated — Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	898	1332	1799
Stainless steel — Property class 50 (A2 / A4 / HCR)	$M^0_{Rk,s}$	[Nm]	19	37	65	166	325	561	832	1124
Stainless steel — Property class 70 (A2 / A4 / HCR)	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	785	1165	1574
Stainless steel — Property class 80 (A4 / HCR)	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	_[3]	_[3]
Partial factor [2]										
Steel, zinc plated — Property class 4.6	$\gamma_{Ms,V}$	[-]	1,67							
Steel, zinc plated — Property class 4.8	$\gamma_{Ms,V}$	[-]	1,25							
Steel, zinc plated — Property class 5.6	$\gamma_{Ms,V}$	[-]	1,67							
Steel, zinc plated — Property class 5.8	$\gamma_{Ms,V}$	[-]	1,25							
Steel, zinc plated — Property class 8.8	$\gamma_{Ms,V}$	[-]	1,25							
Stainless steel — Property class 50 (A2 / A4 / HCR)	$\gamma_{Ms,V}$	[-]	2,38							
Stainless steel — Property class 70 (A2 / A4 / HCR)	$\gamma_{Ms,V}$	[-]	1,56 (1,25) [4]							
Stainless steel — Property class 80 (A4 / HCR)	$\gamma_{Ms,V}$	[-]	1,33 (1,25) [4]						_[3]	_[3]

[1] The characteristic resistances apply for all anchor rods with the cross sectional area A_s specified here: VMU-A, V-A, VM-A. 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 national regulation
[3] Anchor type not part of the ETA
[4] Value in brackets for anchor rods VM-A or commercial standard threaded rods

Injection System VME plus

Performance
Characteristic **steel resistance** for **threaded rods** under **shear load**

Annex C2

Table C3: Characteristic values for **concrete cone** and **splitting**

Threaded rods / Internally threaded anchor rods / Rebars				all sizes
Concrete cone failure				
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0
	cracked concrete	$k_{cr,N}$	[-]	7,7
Edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$
Spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$
Splitting failure				
Characteristic resistance		$N^0_{Rk,sp}$	[kN]	min ($N_{Rk,p}$; $N^0_{Rk,c}$)
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 \cdot h_{ef}$
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} (2,5 - h / h_{ef})$
	$h/h_{ef} \leq 1,3$			$2,4 \cdot h_{ef}$
Spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$

Injection System VME plus

Performance
Characteristic **values for concrete cone** and **splitting**

Annex C3

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ETA-19/0483 of 16 December 2025

English translation prepared by DIBt

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Table C4: Characteristic values of **tension load** for **threaded rods, static** and **quasi-static action,** working life **50 years**

Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Steel failure													
Characteristic resistance			$N_{Rk,s}$	[kN]		$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]		see Table C1							
Combined pull-out and concrete failure													
Characteristic bond resistance in <u>uncracked</u> concrete C20/25													
Temperature range	I	24°C / 40°C	HD CD	$\tau_{Rk,ucr}$	[N/mm²]	20	20	19	19	18	17	16	16
	II	50°C / 72°C				15	15	15	14	13	13	12	12
	III	60°C / 80°C				6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,5
Temperature range	I	24°C / 40°C	VD	$\tau_{Rk,ucr}$	[N/mm²]	17 (16)[1]	16	16	16 (15)[1]	15	14	14	13
	II	50°C / 72°C				14	14	14	13	13	12	12	11
	III	60°C / 80°C				6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,5
Characteristic bond resistance in <u>cracked</u> concrete C20/25													
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
	II	50°C / 72°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
	III	60°C / 80°C				5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5
Reduction factor ψ^0_{sus}													
Temperature range	I	24°C / 40°C	HD CD VD	ψ^0_{sus}	[-]	0,99							
	II	50°C / 72°C				0,68							
	III	60°C / 80°C				0,70							
Characteristic bond resistance in concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr}$ (C20/25) $\tau_{Rk,cr} = \psi_c \cdot \tau_{Rk,cr}$ (C20/25)				ψ_c	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \leq 1,1$							
Concrete cone failure													
Relevant parameter						see Table C3							
Splitting failure													
Relevant parameter						see Table C3							
Installation factor													
dry or wet concrete		HD CD	γ_{inst}	[-]		1,0							
waterfilled drill hole		VD	γ_{inst}	[-]		1,2							

[1] Value in brackets: characteristic bond resistance for waterfilled drill holes

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Performance
Characteristic **values of tension load** for **threaded rods,** working life **50 years**

Annex C4

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Table C5: Characteristic values of **tension load** for **threaded rods**, **static** and **quasi-static action**, working life **100 years**

Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Steel failure													
Characteristic resistance			$N_{Rk,s}$		[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$		[-]	see Table C1							
Combined pull-out and concrete failure													
Characteristic bond resistance in <u>uncracked</u> concrete C20/25													
Temperature range	I	24°C / 40°C	HD CD	$\tau_{Rk,ucr,100}$	[N/mm²]	20	20	19	19	18	17	16	16
	II	50°C / 72°C				15	15	15	14	13	13	12	12
	III	60°C / 80°C				6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,5
Temperature range	I	24°C / 40°C	VD	$\tau_{Rk,ucr,100}$	[N/mm²]	17 (16)[1]	16	16	16 (15)[1]	15	14	14	13
	II	50°C / 72°C				14	14	14	13	13	12	12	11
	III	60°C / 80°C				6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,5
Characteristic bond resistance in <u>cracked</u> concrete C20/25													
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,cr,100}$	[N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II	50°C / 72°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
	III	60°C / 80°C				5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5
Reduction factor ψ^0_{sus}													
Temperature range	I	24°C / 40°C	HD CD VD	$\psi^0_{sus,100}$	[-]	0,97							
	II	50°C / 72°C				0,68							
	III	60°C / 80°C				0,70							
Characteristic bond resistance in concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk,ucr,100} = \psi_c \cdot \tau_{Rk,ucr,100}$ (C20/25) $\tau_{Rk,cr,100} = \psi_c \cdot \tau_{Rk,cr,100}$ (C20/25)				ψ_c	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \leq 1,1$							
Concrete cone failure													
Relevant parameter						see Table C3							
Splitting failure													
Relevant parameter						see Table C3							
Installation factor													
dry or wet concrete			HD CD	γ_{inst}	[-]	1,0							
waterfilled drill hole			VD	γ_{inst}	[-]	1,2							

[1] Value in brackets: characteristic bond resistance for waterfilled drill holes

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Performance
Characteristic **values of tension load** for **threaded rods**, working life **100 years**

Annex C5

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Table C6: Characteristic values of **tension load** for **threaded rods**, **static** and **quasi-static action,** working life **50 years**, diamond drilling

Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Steel failure													
Characteristic resistance			$N_{Rk,s}$	[kN]		$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]		see Table C1							
Combined pull-out and concrete failure													
Characteristic bond resistance in <u>uncracked</u> **concrete C20/25**													
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,ucr}$	[N/mm²]	15	14	14	13	12	12	11	11
	II	50°C / 72°C				12	12	11	10	9,5	9,5	9,0	9,0
	III	60°C / 80°C				5,5	5,5	5,0	4,5	4,5	4,5	4,0	4,0
Characteristic bond resistance in <u>cracked</u> **concrete C20/25**													
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,cr}$	[N/mm²]	1)				5,5	5,5	5,5	5,5	5,4
	II	50°C / 72°C								4,6	4,6	4,6	4,6	4,5
	III	60°C / 80°C								2,4	2,3	2,4	2,4	2,3
Reduction factor ψ^0_{sus}													
Temperature range	I	24°C / 40°C	DD	ψ^0_{sus}	[-]	0,77							
	II	50°C / 72°C				0,72							
	III	60°C / 80°C				0,72							
Characteristic bond resistance for concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk,ucr} = \psi_{c,ucr} \cdot \tau_{Rk,ucr}$ (C20/25) $\tau_{Rk,cr} = \psi_{c,cr} \cdot \tau_{Rk,cr}$ (C20/25) 2)			$\psi_{c,ucr}$	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,2} \leq 1,2$								
			$\psi_{c,cr}$	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,4} \leq 1,44$								
Concrete cone failure													
Relevant parameter						see Table C3							
Splitting failure													
Relevant parameter						see Table C3							
Installation factor													
dry or wet concrete			γ_{inst}	[-]	1,0								
waterfilled drill hole			γ_{inst}	[-]	1,2			1,4					

1) No performance assessed
2) only concrete strength classes C20/25 to C50/60

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Performance
Characteristic values of **tension load** for **threaded rods,** working life **50 years,**
diamond drilling

Annex C6

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Table C7: Characteristic values of **tension load** for **threaded rods**, **static** and **quasi-static action,** working life **100 years**, diamond drilling

Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Steel failure													
Characteristic resistance			$N_{Rk,s}$		[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$		[-]	see Table C1							
Combined pull-out and concrete failure													
Characteristic bond resistance in <u>uncracked</u> concrete C20/25													
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,ucr,100}$	[N/mm²]	15	14	14	13	12	12	11	11
	II	50°C / 72°C				11	11	10	10	9,5	9,0	8,5	8,5
	III	60°C / 80°C				5,5	5,5	5,0	4,5	4,5	4,5	4,0	4,0
Reduction factor ψ^0_{sus}													
Temperature range	I	24°C / 40°C	DD	$\psi^0_{sus,100}$	[-]	0,73							
	II	50°C / 72°C				0,70							
	III	60°C / 80°C				0,72							
Characteristic bond resistance for concrete ≥ C25/30													
Increasing factor ψ_c for $\tau_{Rk,ucr,100} = \psi_{c,ucr} \cdot \tau_{Rk,ucr,100}$ (C20/25)				$\psi_{c,ucr}$	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,2} \leq 1{,}2$							
Concrete cone failure													
Relevant parameter						see Table C3							
Splitting failure													
Relevant parameter						see Table C3							
Installation factor													
dry or wet concrete			γ_{inst}		[-]	1,0							
waterfilled drill hole			γ_{inst}		[-]	1,2				1,4			

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Performance
Characteristic values of **tension load** for **threaded rods,** working life **100 years,**
diamond drilling

Annex C7

Table C8: Characteristic values of **shear load** for **threaded rods, static** and **quasi-static action**, working life 50 and 100 years

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure <u>without</u> lever arm										
Characteristic shear resistance Steel, property class 4.6, 4.8, 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	— $0,6 \cdot A_s \cdot f_{uk}$ or see Table C2							
Characteristic shear resistance Steel, property class 8.8 Stainless steel A2, A4 and HCR all property classes	$V^0_{Rk,s}$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$ or see Table C2							
Ductility factor	k_7	[-]	1,0							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C2							
Steel failure <u>with</u> lever arm										
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$ or see Table C2							
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C2							
Concrete pry-out failure										
Pry-out factor	k_8	[-]	2,0							
Concrete edge failure										
Effective length of anchor	l_f	[mm]	min (h_{ef};12 d_{nom})						min (h_{ef};300mm)	
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

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Performance
Characteristic values of **shear load** for **threaded rods**

Annex C8

Table C9: Characteristic values of **tension load** for **threaded rods**, **seismic action** performance category **C1**, working life **50** and **100 years**

Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Tension loads												
Steel failure												
Characteristic resistance **C1**		$N_{Rk,s,C1}$	[kN]		$1{,}0 \cdot N_{Rk,s}$							
Partial factor		$\gamma_{Ms,N}$	[-]		see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in concrete C20/25 to C50/60									Working life **50 years**			
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,C1}$ [N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
	II	50°C / 72°C			6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
	III	60°C / 80°C			5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5
Characteristic bond resistance in concrete C20/25 to C50/60									Working life **100 years**			
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,C1,100}$ [N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II	50°C / 72°C			5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
	III	60°C / 80°C			5,0	5,0	5,0	4,5	4,5	4,5	4,5	4,5
Installation factor												
Dry or wet concrete		γ_{inst}	[-]		1,0							
Waterfilled drill hole		γ_{inst}	[-]		1,2							

Table C10: Characteristic values of **shear load** for **threaded rods**, seismic action performance category **C1**, working life **50** and **100 years**

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Shear loads												
Steel failure <u>without</u> lever arm												
Characteristic resistance **C1**		$V_{Rk,s,C1}$	[kN]	$0{,}7 \cdot V^0_{Rk,s}$							
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C2							
Factor for anchorages	without annular gap	α_{gap}	[-]	1,0							
	with annular gap between threaded rod and fixture			0,5							

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Performance Characteristic values for **threaded rods,** seismic action **C1**	**Annex C9**

Table C11: Characteristic values of **tension load** for **threaded rods, seismic action** performance category **C2**, working life **50** and **100 years**

Threaded rod						M8	M10	M12	M16	M20	M24	M27	M30
Tension loads													
Steel failure													
Characteristic resistance **C2** steel, zinc plated, property class 8.8 stainless steel A4 and HCR, property class ≥ 70			$N_{Rk,s,C2}$	[kN]		-[1]				$1{,}0 \cdot N_{Rk,s}$			
Partial factor			$\gamma_{Ms,N}$	[-]		-[1]				see Table C1			
Combined pull-out and concrete failure													
Characteristic bond resistance in concrete C20/25 to C50/60										Working life **50** and **100 years**			
Temperature range	I	24°C / 40°C	HD	$\tau_{Rk,C2}$	[N/mm²]	-[1]		5,8	4,8	5,0	5,1	4,8	5,0
	II	50°C / 72°C	CD			-[1]		5,0	4,1	4,3	4,4	4,1	4,3
	III	60°C / 80°C	VD			-[1]		1,9	1,6	1,6	1,7	1,5	1,6
Installation factor													
Dry or wet concrete			γ_{inst}	[-]		-[1]				1,0			
Waterfilled drill hole			γ_{inst}	[-]		-[1]				1,2			

[1] No performance assessed

Table C12: Characteristic values of **shear load** for **threaded rods, seismic action** performance category **C2**, working life **50** and **100 years**

Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Shear loads												
Steel failure <u>without</u> lever arm												
Characteristic resistance **C2** steel, zinc plated, property class 8.8 stainless steel A4 and HCR, property class ≥ 70		$V_{Rk,s,C2}$	[kN]		-[1]				$0{,}7 \cdot V^0_{Rk,s}$			
Partial factor		$\gamma_{Ms,N}$	[-]		-[1]				see Table C2			
Factor for anchorages	without annular gap	α_{gap}	[-]		-[1]				1,0			
	with annular gap between threaded rod and fixture				-[1]				0,5			

[1] No performance assessed

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Performance Characteristic values for **threaded rods,** seismic action **C2**	**Annex C10**

Table C13: Characteristic values of **tension load** for **internally threaded anchor rod, static** and **quasi-static action,** working life **50 years**

Internally threaded anchor rod						IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure [1]											
Characteristic resistance, steel, zinc plated, property class	5.8		$N_{Rk,s}$	[kN]		10	17	29	42	76	123
	8.8		$N_{Rk,s}$	[kN]		16	27	46	67	121	196
Partial factor 5.8 and 8.8			$\gamma_{Ms,N}$	[-]		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			$\gamma_{Ms,N}$	[-]		1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure											
Characteristic bond resistance in <u>uncracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	HD CD	$\tau_{Rk,ucr}$	[N/mm²]	20	19	19	18	17	16
	II	50°C / 72°C				15	15	14	13	13	12
	III	60°C / 80°C				6,5	6,5	6,0	6,0	5,5	5,5
Temperature range	I	24°C / 40°C	VD	$\tau_{Rk,ucr}$	[N/mm²]	16	16	16 (15)[3]	15	14	13
	II	50°C / 72°C				14	14	13	13	12	11
	III	60°C / 80°C				6,5	6,5	6,0	6,0	5,5	5,5
Characteristic bond resistance in <u>cracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,cr}$	[N/mm²]	7,0	8,5	8,5	8,5	8,5	8,5
	II	50°C / 72°C				6,0	7,0	7,0	7,0	7,0	7,0
	III	60°C / 80°C				5,0	5,0	4,5	4,5	4,5	4,5
Reduction factor ψ^0_{sus}											
Temperature range	I	24°C / 40°C	HD CD VD	ψ^0_{sus}	[-]	0,99					
	II	50°C / 72°C				0,68					
	III	60°C / 80°C				0,70					
Characteristic bond resistance for concrete ≥ C25/30											
Increasing factor ψ_c for $\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr}$ (C20/25) $\tau_{Rk,cr} = \psi_c \cdot \tau_{Rk,cr}$ (C20/25)				ψ_c	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \leq 1,1$					
Concrete cone failure											
Relevant parameter						see Table C3					
Splitting failure											
Relevant parameter						see Table C3					
Installation factor											
dry or wet concrete			γ_{inst}	[-]		1,0					
waterfilled drill hole			γ_{inst}	[-]		1,2					

[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 are valid for the internally threaded anchor rod and the fastening element.

[2] Value in bracket is valid for property class 50

[3] Value in bracket is valid for waterfilled drill hole

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Performance
Characteristic values of **tension load** for **internally threaded anchor rods,** working life **50 years**

Annex C11

Table C14: Characteristic values of **tension load** for **internally threaded anchor rod static** and **quasi-static action,** working life **100 years**

Internally threaded anchor rod						IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure [1]											
Characteristic resistance, steel, zinc plated, property class		5.8	$N_{Rk,s}$	[kN]		10	17	29	42	76	123
		8.8	$N_{Rk,s}$	[kN]		16	27	46	67	121	196
Partial factor 5.8 and 8.8			$\gamma_{Ms,N}$	[-]		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			$\gamma_{Ms,N}$	[-]		1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure											
Characteristic bond resistance in <u>uncracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	HD CD	$\tau_{Rk,ucr,100}$	[N/mm²]	20	19	19	18	17	16
	II	50°C / 72°C				15	15	14	13	13	12
	III	60°C / 80°C				6,5	6,5	6,0	6,0	5,5	5,5
Temperature range	I	24°C / 40°C	VD	$\tau_{Rk,ucr,100}$	[N/mm²]	16	16	16 (15) [3]	15	14	13
	II	50°C / 72°C				14	14	13	13	12	11
	III	60°C / 80°C				6,5	6,5	6,0	6,0	5,5	5,5
Characteristic bond resistance in <u>cracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,cr,100}$	[N/mm²]	6,5	7,5	7,5	7,5	7,5	7,5
	II	50°C / 72°C				5,5	6,5	6,5	6,5	6,5	6,5
	III	60°C / 80°C				5,0	5,0	4,5	4,5	4,5	4,5
Reduction factor ψ^0_{sus}											
Temperature range	I	24°C / 40°C	HD CD VD	$\psi^0_{sus,100}$	[-]	0,97					
	II	50°C / 72°C				0,68					
	III	60°C / 80°C				0,70					
Characteristic bond resistance for concrete ≥ C25/30											
Increasing factor ψ_c for $\tau_{Rk,ucr,100} = \psi_c \cdot \tau_{Rk,ucr,100}$ (C20/25) $\tau_{Rk,cr,100} = \psi_c \cdot \tau_{Rk,cr,100}$ (C20/25)			ψ_c	[-]		$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \leq 1,1$					
Concrete cone failure											
Relevant parameter						see Table C3					
Splitting failure											
Relevant parameter						see Table C3					
Installation factor											
dry or wet concrete			γ_{inst}	[-]		1,0					
waterfilled drill hole			γ_{inst}	[-]		1,2					

[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 are valid for the internally threaded anchor rod and the fastening element.

[2] For property class 50

[3] Value in bracket is valid for waterfilled drill hole

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Performance Characteristic values of **tension load** for **internally threaded anchor rods,** working life **100 years**	**Annex C12**

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Table C15: Characteristic values of **tension loads** for **internally threaded anchor rod**, **static** and **quasi-static action**, working life **50 years**, diamond drilling

Internally threaded anchor rod						IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
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 5.8 and 8.8				$\gamma_{Ms,N}$	[-]	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				$\gamma_{Ms,N}$	[-]	1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure											
Characteristic bond resistance in <u>uncracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	12	12	11
	II	50°C / 72°C				12	11	10	9,5	9,5	9,0
	III	60°C / 80°C				5,5	5,0	4,5	4,5	4,5	4,0
Characteristic bond resistance in <u>cracked</u> concrete C20/25											
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,cr}$	[N/mm²]	[3]		5,5	5,5	5,5	5,4
	II	50°C / 72°C						4,6	4,6	4,6	4,5
	III	60°C / 80°C						2,4	2,3	2,4	2,3
Reduction factor ψ^0_{sus}											
Temperature range	I	24°C / 40°C	DD	ψ^0_{sus}	[-]	0,77					
	II	50°C / 72°C				0,72					
	III	60°C / 80°C				0,72					
Characteristic bond resistance for concrete ≥ C25/30											
Increasing factor ψ_c for $\tau_{Rk,ucr} = \psi_{c,ucr} \cdot \tau_{Rk,ucr\,(C20/25)}$ $\tau_{Rk,cr} = \psi_{c,cr} \cdot \tau_{Rk,cr\,(C20/25)}$ [4]				$\psi_{c,ucr}$	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,2} \leq 1,2$					
				$\psi_{c,cr}$	[-]	[3]	$\left(\dfrac{f_{ck}}{20}\right)^{0,4} \leq 1,44$				
Concrete cone failure											
Relevant parameter						see Table C3					
Splitting failure											
Relevant parameter						see Table C3					
Installation factor											
dry or wet concrete				γ_{inst}	[-]	1,0					
waterfilled drill hole				γ_{inst}	[-]	1,2		1,4			

[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 are valid for the internally threaded anchor rod and the fastening element.
[2] For property class 50
[3] No performance assessed
[4] Only concrete strength classes C20/25 to C50/60

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Performance Characteristic values of **tension load** for **internally threaded anchor rods**, working life **50 years**, diamond drilling	**Annex C13**

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Table C16: Characteristic values of **tension loads** for **internally threaded anchor rod,** **static** and **quasi-static action,** working life **100 years, diamond drilling**

Internally threaded anchor rod					IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure [1]										
Characteristic resistance, steel, zinc plated, property class	5.8		$N_{Rk,s}$	[kN]	10	17	29	42	76	123
	8.8		$N_{Rk,s}$	[kN]	16	27	46	67	121	196
Partial factor 5.8 and 8.8			$\gamma_{Ms,N}$	[-]	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			$\gamma_{Ms,N}$	[-]	1,87					1,87 (2,86) [2]
Combined pull-out and concrete failure										
Characteristic bond resistance in <u>uncracked</u> concrete C20/25										
Temperature range	I	24°C / 40°C	DD	$\tau_{Rk,ucr,100}$	[N/mm²]	14	14	13	12	12	11
	II	50°C / 72°C				11	10	10	9,5	9,0	8,5
	III	60°C / 80°C				5,5	5,0	4,5	4,5	4,5	4,0
Reduction factor ψ^0_{sus}										
Temperature range	I	24°C / 40°C	DD	$\psi^0_{sus,100}$	[-]	0,73					
	II	50°C / 72°C				0,70					
	III	60°C / 80°C				0,72					
Characteristic bond resistance for concrete ≥ C25/30										
Increasing factor $\psi_{c,ucr}$ for $\tau_{Rk,ucr,100} = \psi_{c,ucr} \cdot \tau_{Rk,ucr,100}$ (C20/25)			$\psi_{c,ucr}$	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,2} \le 1,2$					
Concrete cone failure										
Relevant parameter					see Table C3					
Splitting failure										
Relevant parameter					see Table C3					
Installation factor										
dry or wet concrete			γ_{inst}	[-]	1,0					
waterfilled drill hole			γ_{inst}	[-]	1,2			1,4			

[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 are valid for the internally threaded anchor rod and the fastening element.

[2] For property class 50

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Performance Characteristic values of **tension load** for **internally threaded anchor rods,** working life **100 years**, **diamond drilling**	**Annex C14**

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Table C17: Characteristic values of **shear load** for **internally threaded anchor rod,**
static and **quasi-static action,** working life 50 and 100 years

Internally threaded anchor rod					IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Steel failure without lever arm [1]										
Steel, zinc plated	Characteristic resistance, property class	5.8	$V^0_{Rk,s}$	[kN]	6	10	17	25	45	74
		8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60	98
	Partial factor 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Stainless steel	Characteristic resistance, A4 / HCR, property class 70		$V^0_{Rk,s}$	[kN]	7	13	20	30	55	62 [2]
	Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Ductility factor			k_7	[-]	1,0					
Steel failure with lever arm [1]										
Steel, zinc plated	Characteristic bending resistance, property class	5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
		8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
	Partial factor 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Stainless steel	Characteristic bending resistance A4 / HCR, property class 70		$M^0_{Rk,s}$	[Nm]	11	26	53	92	234	643 [2]
	Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Concrete pry-out failure										
Pry-out factor			k_8	[-]	2,0					
Concrete edge failure										
Effective length of anchor			l_f	[mm]	min (h_{ef};12 d_{nom})					min (h_{ef}; 300mm)
Outside diameter of anchor			d_{nom}	[mm]	10	12	16	20	24	30
Installation factor			γ_{inst}	[-]	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 are valid for the internally threaded anchor rod and the fastening element.

[2] For IG-M20: Internally threaded rod: property class 50;
Fastening screws or threaded rods (incl. nut and washer): property class 70

Injection System VME plus

Performance
Characteristic values of **shear load** for **internally threaded anchor rods,**
working life 50 and 100 years

Annex C15

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Table C18: Characteristic values of **tension loads** for **rebar**, **static** and **quasi-static action**, working life **50 years**

Reinforcing bar						Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Steel failure																	
Characteristic tension resistance		$N_{Rk,s}$	[kN]			— $A_s \cdot f_{uk}$ [1]											
Cross sectional area		A_s	[mm²]			50	79	113	154	201	314	452	491	616	804	1018	1256
Partial factor		$\gamma_{Ms,N}$	[-]			1,4 [2]											
Combined pull-out and concrete failure																	
Characteristic bond resistance in <u>uncracked</u> concrete C20/25																	
Temperature range	I	24°C / 40°C	HD CD	$\tau_{Rk,ucr}$	[N/mm²]	16	16	16	16	16	16	15	15	15	15	15	15
	II	50°C / 72°C				12	12	12	12	12	12	12	12	11	11	11	11
	III	60°C / 80°C				5,5	5,5	5,5	5,5	5,5	5,5	5,0	5,0	5,0	5,0	4,5	4,5
Temperature range	I	24°C / 40°C	VD	$\tau_{Rk,ucr}$	[N/mm²]	14 (13)[3]	14 (13)[3]	13	13	13	13	13	13	13	13	[4]	
	II	50°C / 72°C				12 (11)[3]	12 (11)[3]	12 (11)[3]	11	11	11	11	11	11	11		
	III	60°C / 80°C				5,5	5,5	5,5	5,5	5,5	5,5	5,0	5,0	5,0	5,0		
Characteristic bond resistance in <u>cracked</u> concrete C20/25																	
Temperature range	I	24°C / 40°C	HD CD VD	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	[4]	
	II	50°C / 72°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0		
	III	60°C / 80°C				4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5		
Reduction factor ψ^0_{sus}																	
Temperature range	I	24°C / 40°C	HD CD VD	ψ^0_{sus}	[-]	0,99											
	II	50°C / 72°C				0,68											
	III	60°C / 80°C				0,70											

Characteristic bond resistance for concrete ≥ C25/30

Increasing factor ψ_c for $\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr\,(C20/25)}$ $\tau_{Rk,cr} = \psi_c \cdot \tau_{Rk,cr\,(C20/25)}$	ψ_c	[-]	$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \le 1,1$

Concrete cone failure

Relevant parameter	see Table C3

Splitting failure

Relevant parameter	see Table C3

Installation factor

dry or wet concrete	γ_{inst}	[-]	1,0	1,2
waterfilled drill hole	γ_{inst}	[-]	1,2	[4]

[1] f_{uk} shall be taken from the specifications of reinforcing bars
[2] In absence of national regulation
[3] Value in brackets: characteristic bond resistance for waterfilled drill holes
[4] No performance assessed

Injection System VME plus

Performance
Characteristic values of **tension load** for **rebar,** working life **50 years**

Annex C16

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Table C19: Characteristic values of **tension loads** for **rebar, static** and **quasi-static action,** working life **100 years**

Reinforcing bar					Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Steel failure																
Characteristic tension resistance	$N_{Rk,s}$		[kN]		— $A_s \cdot f_{uk}$ [1]											
Cross sectional area	A_s		[mm²]		50	79	113	154	201	314	452	491	616	804	1018	1256
Partial factor	$\gamma_{Ms,N}$		[-]		1,4 [2]											
Combined pull-out and concrete failure																
Characteristic bond resistance in <u>uncracked</u> concrete C20/25																
Temperature range	I: 24°C/40°C	HD CD	$\tau_{Rk,ucr,100}$	[N/mm²]	16	16	16	16	16	16	15	15	15	15	15	15
	II: 50°C/72°C				12	12	12	12	12	12	12	12	11	11	11	11
	III: 60°C/80°C				5,5	5,5	5,5	5,5	5,5	5,5	5,0	5,0	5,0	5,0	4,5	4,5
Temperature range	I: 24°C/40°C	VD	$\tau_{Rk,ucr,100}$	[N/mm²]	14 (13)[3]	14 (13)[3]	13	13	13	13	13	13	13	13	[4]	
	II: 50°C/72°C				12 (11)[3]	12 (11)[3]	12 (11)[3]	11	11	11	11	11	11	11		
	III: 60°C/80°C				5,5	5,5	5,5	5,5	5,5	5,5	5,0	5,0	5,0	5,0		
Characteristic bond resistance in <u>cracked</u> concrete C20/25																
Temperature range	I: 24°C/40°C	HD CD VD	$\tau_{Rk,cr,100}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	[4]	
	II: 50°C/72°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0		
	III: 60°C/80°C				4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5		
Reduction factor ψ^0_{sus}																
Temperature range	I: 24°C/40°C	HD CD VD	$\psi^0_{sus,100}$	[-]	0,97											
	II: 50°C/72°C				0,68											
	III: 60°C/80°C				0,70											
Characteristic bond resistance for concrete ≥ C25/30																
Increasing factor ψ_c for $\tau_{Rk,ucr,100} = \psi_c \cdot \tau_{Rk,ucr,100}$ (C20/25)		ψ_c	[-]		$\left(\dfrac{f_{ck}}{20}\right)^{0,1} \le 1,1$											
Concrete cone failure																
Relevant parameter					see Table C3											
Splitting failure																
Relevant parameter					see Table C3											
Installation factor																
dry or wet concrete		γ_{inst}	[-]		1,0											1,2
waterfilled drill hole		γ_{inst}	[-]		1,2											[4]

[1] f_{uk} shall be taken from the specifications of reinforcing bars
[2] In absence of national regulation
[3] Value in brackets: characteristic bond resistance for waterfilled drill holes
[4] No performance assessed

Injection System VME plus

Performance
Characteristic values of **tension load** for **rebar,** working life **100 years**

Annex C17

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Table C20: Characteristic values of **tension loads** for **rebar,
static** and **quasi-static action,** working life **50 and 100 years,**
diamond drilling

Reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Steel failure															
Characteristic tension resistance	$N_{Rk,s}$		[kN]						$A_s \cdot f_{uk}$[1]						
Cross sectional area	A_s		[mm²]	50	79	113	154	201	314	452	491	616	804	1018	1256
Partial factor	$\gamma_{Ms,N}$		[-]						1,4 [2]						
Combined pull-out and concrete failure															
Characteristic bond resistance in uncracked concrete C20/25												**Working life 50 years**			
Temperature range	I: 24°C/40°C	DD	$\tau_{Rk,ucr}$[N/mm²]	14	13	13	13	12	12	11	11	11	11	11	10
	II: 50°C/72°C		$\tau_{Rk,ucr}$[N/mm²]	11	11	10	10	10	9,5	9,5	9,5	9,0	9,0	8,5	8,5
	III: 60°C/80°C		$\tau_{Rk,ucr}$[N/mm²]	5,0	5,0	5,0	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0	4,0
Reductionfactor ψ^0_{sus}															
Temperature range	I: 24°C/40°C	DD	ψ^0_{sus}	[-]					0,77						
	II: 50°C/72°C		ψ^0_{sus}	[-]					0,72						
	III: 60°C/80°C		ψ^0_{sus}	[-]					0,72						
Characteristic bond resistance in uncracked concrete C20/25												**Working life 100 years**			
Temperature range	I: 24°C/40°C	DD	$\tau_{Rk,ucr,100}$[N/mm²]	14	13	13	13	12	12	11	11	11	11	11	10
	II: 50°C/72°C		$\tau_{Rk,ucr,100}$[N/mm²]	11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5	8,0	8,0
	III: 60°C/80°C		$\tau_{Rk,ucr,100}$[N/mm²]	5,0	5,0	5,0	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0	4,0
Reduction factor $\psi^0_{sus,100}$															
Temperature range	I: 24°C/40°C	DD	$\psi^0_{sus,100}$	[-]					0,73						
	II: 50°C/72°C		$\psi^0_{sus,100}$	[-]					0,70						
	III: 60°C/80°C		$\psi^0_{sus,100}$	[-]					0,72						

Characteristic bond resistance for concrete ≥ C25/30

Increasing factor ψ_c for

$\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr}$ (C20/25) ψ_c [-]

$\tau_{Rk,ucr,100} = \psi_c \cdot \tau_{Rk,ucr,100}$ (C20/25)

$$\left(\frac{f_{ck}}{20}\right)^{0,2} \leq 1,2$$

Concrete cone failure		
Relevant parameter		see Table C3
Splitting failure		
Relevant parameter		see Table C3
Installation factor		
dry or wet concrete	γ_{inst} [-]	1,0 1,2
waterfilled drill hole	γ_{inst} [-]	1,2 1,4 [3]

[1] f_{uk} shall be taken from the specifications of reinforcing bars
[2] In absence of national regulation
[3] No performance assessed

Injection System VME plus

Performance
Characteristic values of **tension load** for **rebar,** working life **50 and 100 years,**
Diamond drilling

Annex C18

Table C21: Characteristic values of **shear loads** for **rebar, static** and **quasi-static action,** working life **50 and 100 years**

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Steel failure <u>without</u> lever arm														
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]						$0{,}50 \cdot A_s \cdot f_{uk}$[1]						
Cross sectional area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804	1018	1256
Partial factor	$\gamma_{Ms,V}$	[-]						$1{,}5$ [2]						
Ductility factor	k_7	[-]						$1{,}0$						
Steel failure <u>with</u> lever arm														
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]						$1{,}2 \cdot W_{el} \cdot f_{uk}$[1]						
Elastic section modulus	W_{el}	[mm³]	50	98	170	269	402	785	1357	1534	2155	3217	4580	6283
Partial factor	$\gamma_{Ms,V}$	[-]						$1{,}5$ [2]						
Concrete pry-out failure														
Pry-out factor	k_8	[-]						$2{,}0$						
Concrete edge failure														
Effective length of rebar	l_f	[mm]				min $(h_{ef}; 12\, d_{nom})$					min $(h_{ef}; 300\text{mm})$			
Outside diameter of rebar	d_{nom}	[mm]	8	10	12	14	16	20	24	25	28	32	36	40
Installation factor	γ_{inst}	[-]						$1{,}0$						

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

Injection System VME plus

Performance
Characteristic values of **shear load** for **rebar,** working life **50 and 100 years**

Annex C19

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Table C22: Characteristic values of **tension load** for **rebar,
seismic action** (performance category **C1**), working life **50 and 100 years**

Reinforcing bar				⌀ 8	⌀ 10	⌀ 12	⌀ 14	⌀ 16	⌀ 20	⌀ 24	⌀ 25	⌀ 28	⌀ 32
Steel failure													
Characteristic resistance	$N_{Rk,s,C1}$		[kN]	— $A_s \cdot f_{uk}$[1]									
Cross sectional area	A_s		[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,N}$		[-]	1,4[2]									
Combined pull-out and concrete failure													
Characteristic bond resistance in concrete C20/25 to C50/60										Working life **50 years**			
Temperature range	I: 24°C/40°C	HD CD VD	$\tau_{Rk,C1}$ [N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 50°C/72°C		$\tau_{Rk,C1}$ [N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
	III: 60°C/80°C		$\tau_{Rk,C1}$ [N/mm²]	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Characteristic bond resistance in concrete C20/25 to C50/60										Working life **100 years**			
Temperature range	I: 24°C/40°C	HD CD VD	$\tau_{Rk,C1,100}$ [N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 50°C/72°C		$\tau_{Rk,C1,100}$ [N/mm²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5
	III: 60°C/80°C		$\tau_{Rk,C1,100}$ [N/mm²]	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5	4,5
Installation factor													
dry or wet concrete	γ_{inst}		[-]	1,0									
waterfilled drill hole	γ_{inst}		[-]	1,2									

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

Table C23: Characteristic values of **shear loads** for **rebar,
seismic action** (performance category **C1**), working life **50 and 100 years**

Reinforcing bar			⌀ 8	⌀ 10	⌀ 12	⌀ 14	⌀ 16	⌀ 20	⌀ 24	⌀ 25	⌀ 28	⌀ 32
Steel failure _without_ lever arm									Working life 50 and 100 years			
Characteristic resistance	$V_{Rk,s,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}$[1]									
Cross sectional area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5[2]									
Ductility factor	k_7	[-]	1,0									

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

Injection System VME plus	
Performance Characteristic values for **rebar**, **seismic action C1**	**Annex C20**

Table C24: Displacements under tension load, threaded rod

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Hammer-, compressed air or vacuum drilling (HD, CD, VD)										
Displacement factor[1] **Uncracked concrete, static and quasi-static action, working life 50 and 100 years**										
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$[\frac{mm}{N/mm^2}]$	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
	$\delta_{N\infty}$- factor		0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,038	0,039	0,040	0,044	0,047	0,051	0,052	0,055
	$\delta_{N\infty}$- factor		0,047	0,049	0,051	0,055	0,059	0,064	0,067	0,070
Displacement factor[1] **Cracked concrete, static and quasi-static action, working life 50 and 100 years**										
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$[\frac{mm}{N/mm^2}]$	0,069	0,071	0,072	0,074	0,076	0,079	0,081	0,082
	$\delta_{N\infty}$- factor		0,100	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,092	0,095	0,096	0,099	0,102	0,106	0,109	0,110
	$\delta_{N\infty}$- factor		0,134	0,154	0,163	0,172	0,181	0,189	0,207	0,229
Displacement **Uncracked and cracked concrete, seismic action (C2)**										
All temperature ranges	$\delta_{N,C2 (DLS)}$	[mm]	_[2]		0,21	0,24	0,27	0,36	0,92	0,70
	$\delta_{N,C2 (ULS)}$				0,54	0,51	0,54	0,63	1,70	0,92
Diamond drilling (DD)										
Displacement factor[1] **Uncracked concrete, static and quasi-static action, working life 50 years**										
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$[\frac{mm}{N/mm^2}]$	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$- factor		0,018	0,019	0,019	0,020	0,022	0,023	0,024	0,025
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$- factor		0,052	0,053	0,055	0,058	0,062	0,065	0,068	0,070
Displacement factor[1] **Uncracked concrete, static and quasi-static action, working life 100 years**										
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$[\frac{mm}{N/mm^2}]$	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$- factor		0,020	0,021	0,021	0,023	0,024	0,025	0,026	0,027
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$- factor		0,038	0,039	0,040	0,043	0,045	0,047	0,049	0,051

[1] Calculation of the displacement
  $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$ τ: acting bond stress under tension load
  $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau;$
[2] No Performance assessed

Injection System VME plus

Performance Displacements (**threaded rod** under tension load)	**Annex C21**

Table C25: Displacements under shear load, threaded rod

Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
All drilling methods										
Displacement factor[1] **Uncracked and cracked concrete, static and quasi-static action, working life 50 and 100 years**										
All temperature ranges	δ_{V0}- factor	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$- factor		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Displacement **Uncracked and cracked concrete, seismic action (C2)**										
All temperature ranges	$\delta_{V,C2\,(DLS)}$	[mm]	_[2]		3,1	3,4	3,5	4,2	4,0	3,8
	$\delta_{V,C2\,(ULS)}$				6,0	7,6	7,3	10,9	11,1	11,2

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$- factor $\cdot V$; V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}$- factor $\cdot V$;
[3] No Performance assessed

Injection System VME plus	
Performance Displacements (**threaded rod** under shear load)	**Annex C22**

Table C26: Displacement factors[1] under tension load, internally threaded anchor rod

Internally threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Hammer-, compressed air or vacuum drilling (HD, CD, VD)								
Uncracked concrete, static and quasi-static action, working life 50 and 100 years								
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,029	0,030	0,033	0,035	0,038	0,041
	$\delta_{N\infty}$- factor		0,029	0,030	0,033	0,035	0,038	0,041
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,039	0,040	0,044	0,047	0,051	0,055
	$\delta_{N\infty}$- factor		0,049	0,051	0,055	0,059	0,064	0,070
Cracked concrete, static and quasi-static action, working life 50 and 100 years								
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,071	0,072	0,074	0,076	0,079	0,082
	$\delta_{N\infty}$- factor		0,115	0,122	0,128	0,135	0,142	0,171
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,095	0,096	0,099	0,102	0,106	0,110
	$\delta_{N\infty}$- factor		0,154	0,163	0,172	0,181	0,189	0,229
Diamond drilling (DD)								
Cracked and uncracked concrete, static and quasi-static action, working life 50 years								
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$- factor		0,019	0,019	0,020	0,022	0,023	0,025
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$- factor		0,053	0,055	0,058	0,062	0,065	0,070
Uncracked concrete, static and quasi-static action, working life 100 years								
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$- factor		0,021	0,021	0,023	0,024	0,025	0,027
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$- factor		0,039	0,040	0,043	0,045	0,047	0,051

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$- factor $\cdot\ \tau$; τ: acting bond stress under tension load
$\delta_{N\infty} = \delta_{N\infty}$- factor $\cdot\ \tau$;

Table C27: Displacement factors[1] under shear load, internally threaded anchor rod

Internally threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Cracked and uncracked concrete, static and quasi-static action, working life 50 and 100 years								
All temperature ranges	δ_{V0}- factor	[mm/(kN)]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$- factor		0,10	0,09	0,08	0,08	0,06	0,06

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$- factor $\cdot\ V$;   V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}$- factor $\cdot\ V$;

Injection System VME plus	
Performance Displacement **(internally threaded anchor rod)**	**Annex C23**

Table C28: Displacement factors[1] under tension load, rebar

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Hammer-, compressed air or vacuum drilling (HD, CD, VD)														
Uncracked concrete, static and quasi-static action, working life 50 and 100 years														
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043	0,045	0,047
	$\delta_{N\infty}$- factor		0,015	0,015	0,016	0,017	0,017	0,019	0,020	0,020	0,021	0,023	0,045	0,047
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	0,058	0,060	0,063
	$\delta_{N\infty}$- factor		0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	0,072	0,074	0,079
Cracked concrete, static and quasi-static action, working life 50 and 100 years														
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	0,084	no performance assessed	
	$\delta_{N\infty}$- factor		0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	0,194		
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,092	0,095	0,096	0,098	0,099	0,102	0,106	0,106	0,109	0,113		
	$\delta_{N\infty}$- factor		0,154	0,163	0,172	0,181	0,189	0,207	0,229	0,229	0,242	0,260		
Diamond drilling (DD)														
Uncracked concrete, static and quasi-static action, working life 50 years														
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	0,015	0,016	0,017
	$\delta_{N\infty}$- factor		0,018	0,018	0,019	0,020	0,021	0,024	0,027	0,027	0,028	0,031	0,032	0,034
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018	0,019	0,020
	$\delta_{N\infty}$- factor		0,048	0,051	0,054	0,058	0,061	0,068	0,076	0,076	0,081	0,088	0,090	0,097
Uncracked concrete, static and quasi-static action, working life 100 years														
Temperature range I: 24°C / 40°C	δ_{N0}- factor	$\left[\dfrac{mm}{N/mm^2}\right]$	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	0,015	0,016	0,017
	$\delta_{N\infty}$- factor		0,018	0,020	0,021	0,022	0,024	0,026	0,029	0,029	0,031	0,034	0,035	0,037
Temperature range II: 50°C / 72°C III: 60°C / 80°C	δ_{N0}- factor		0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018	0,019	0,020
	$\delta_{N\infty}$- factor		0,035	0,037	0,040	0,042	0,045	0,049	0,055	0,055	0,059	0,064	0,066	0,070

[1] Calculation of the displacement

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

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

Injection System VME plus	
Performance Displacement (**rebar** under tension load)	**Annex C24**

Table C29: Displacement factors[1] under **shear load**, rebar

Reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	Ø 36	Ø 40
Uncracked and cracked concrete, static and quasi-static action, working life 50 and 100 years														
All temperature ranges	δ_{V0}- factor	$\frac{mm}{kN}$	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03	0,03	0,03
	$\delta_{V\infty}$- factor		0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04	0,04	0,04

[1] Calculation of the displacement

$\delta_{V0} = \delta_{V0}$- factor $\cdot$ V;   V: acting shear load

$\delta_{V\infty} = \delta_{V\infty}$- factor $\cdot$ V;

Injection System VME plus

Performance
Displacement (**rebar** under shear load)

Annex C25

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Table C30: Characteristic values of tension and shear loads under fire exposure, threaded rod

Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)											
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,2
			R60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,1
			R90	0,7	1,0	1,6	3,0	4,7	6,7	8,7	10,7
			R120	0,5	0,8	1,2	2,2	3,4	4,9	6,4	7,9

Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire exposure for temperature θ

Temperature-dependent reduction factor	$k_{fi,p}(\theta)$	[-]	θ < 23°C	1,0
			23°C ≤ θ ≤ 278°C	$150{,}28 \cdot \theta^{-1{,}598} \leq 1{,}0$
			θ > 278°C	0,0

Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]	$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1]

Steel failure without lever arm

Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)

Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,2
			R60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,1
			R90	0,7	1,0	1,6	3,0	4,7	6,7	8,7	10,7
			R120	0,5	0,8	1,2	2,2	3,4	4,9	6,4	7,9

Steel failure with lever arm

Steel zinc plated (property class ≥ 5.8) and stainless steel A2, A4, HCR (property class ≥ 50)

Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	1,1	2,2	4,7	12,0	23,4	40,4	59,9	81,0
			R60	0,9	1,8	3,5	9,0	17,5	30,3	44,9	60,7
			R90	0,7	1,3	2,5	6,3	12,3	21,3	31,6	42,7
			R120	0,5	1,0	1,8	4,7	9,1	15,7	23,3	31,5

[1] $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range and working life

Injection System VME plus

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

Annex C26

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Table C31: Characteristic values of tension and shear loads under fire exposure
(internally threaded anchor rod)

Internally threaded anchor rod VMU-IG and VZ-IG				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure									
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)									
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	0,3	1,1	1,7	3,0	5,7	8,8
			R60	0,2	0,9	1,4	2,3	4,2	6,6
			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 resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire conditions for a given temperature θ									
Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	$\theta < 23°C$	1,0					
			$23°C \leq \theta \leq 278°C$	$150{,}28 \cdot \theta^{-1{,}598} \leq 1{,}0$					
			$\theta > 278°C$	0,0					

Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]	$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1]					
Steel failure without lever arm								
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)								
Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	0,3	1,1	1,7	3,0	5,7	8,8
			R60	0,2	0,9	1,4	2,3	4,2	6,6
			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
Steel failure with lever arm									
Steel zinc plated (property class 5.8 and 8.8) and stainless steel A4 and HCR (property class 70)									
Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	0,2	1,1	2,2	4,7	12,0	23,4
			R60	0,2	0,9	1,8	3,5	9,0	17,5
			R90	0,1	0,7	1,3	2,5	6,3	12,3
			R120	0,1	0,5	1,0	1,8	4,7	9,1

[1] $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range and working life

Injection System VME plus	
Performance Characteristic values of tension and shear loads under fire exposure (internally threaded rods)	**Annex C27**

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Table C32: Characteristic values of tension and shear loads under fire exposure (rebar)

Rebar				Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
Steel failure													
BSt 500													
Characteristic tension resistance	$N_{Rk,s,fi}$	[kN]	R30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,1
			R60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,1
			R90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,5
			R120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,0	8,0

Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire conditions for a given temperature θ

Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	$\theta < 25°C$	1,0
			$25°C \leq \theta \leq 278°C$	$176{,}37 \cdot \theta^{-1{,}598} \leq 1{,}0$
			$\theta > 278°C$	0,0

Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]	$k_{fi,p}(\theta) * \tau_{Rk,cr(20/25)}$ [1]

Steel failure without lever arm													
BSt 500													
Characteristic shear resistance	$V_{Rk,s,fi}$	[kN]	R30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,1
			R60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,1
			R90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,5
			R120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,0	8,0
Steel failure with lever arm													
BSt 500													
Characteristic bending moment	$M^0_{Rk,s,fi}$	[Nm]	R30	0,6	1,8	4,1	6,5	9,7	18,8	32,6	36,8	51,7	77,2
			R60	0,5	1,5	3,1	4,8	7,2	14,1	24,4	27,6	38,8	57,9
			R90	0,4	1,2	2,6	4,2	6,3	12,3	21,2	23,9	33,6	50,2
			R120	0,3	0,8	2,0	3,2	4,8	9,4	16,3	18,4	25,9	38,6

[1] $\tau_{Rk,cr(20/25)}$ characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range and working life

Injection System VME plus

Performance
Characteristic values of tension and shear loads under fire exposure
(rebar)

Annex C28