

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments

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according to
Article 29 of Regula-
tion (EU) No 305/2011
and member of EOTA
(European Organi-
sation for Technical
Assessment)
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★ ★

European Technical Assessment

ETA-19/0483
of 12 May 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Trade name of the construction product

Product family
to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment
contains

This European Technical Assessment is
issued in accordance with Regulation (EU)
No 305/2011, on the basis of

This version replaces

Deutsches Institut für Bautechnik

Injection system VME plus

Bonded fastener for use in concrete

MKT
Metall-Kunststoff-Technik GmbH & Co. KG
Auf dem Immel 2
67685 Weilerbach
DEUTSCHLAND

Werk 1,D und Werk 2,D

39 pages including 3 annexes which form an integral part
of this assessment

EAD 330499-01-0601, Edition 04/2020

ETA-19/0483 issued on 30 August 2019

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European Technical Assessment**ETA-19/0483**

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Specific Part**1 Technical description of the product**

The "Injection system VME Plus for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar VME Plus and a steel element according to Annex A3 and A5.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment**3.1 Mechanical resistance and stability (BWR 1)**

Essential characteristic	Performance
Characteristic resistance to tension load (static and quasi-static loading)	See Annex B 3, C 1, C 3 to C 6, C 9 to 11, C 13 to C 15
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2, C 7, C 12 and C 16
Displacements under short-term and long-term loading	See Annex C 18 to C 21
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 8, C 17 to C 19

3.2 Hygiene, health and the environment (BWR 3)

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

European Technical Assessment

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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 330499-01-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

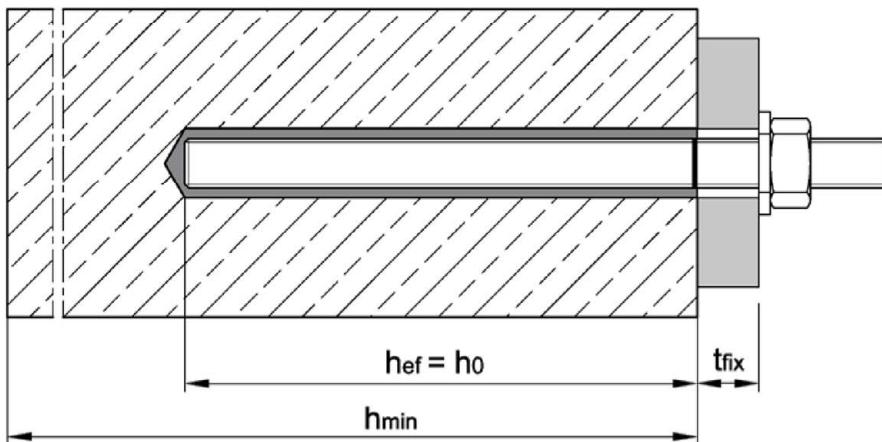
Issued in Berlin on 12 May 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

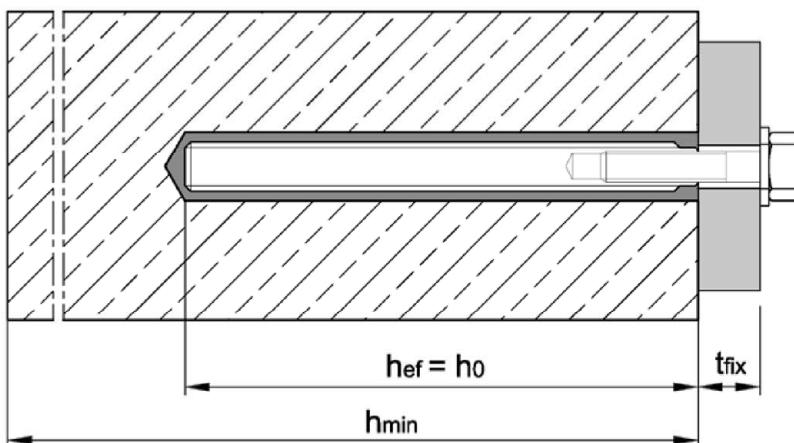
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Baderschneider

Installation threaded rod M8 to M30

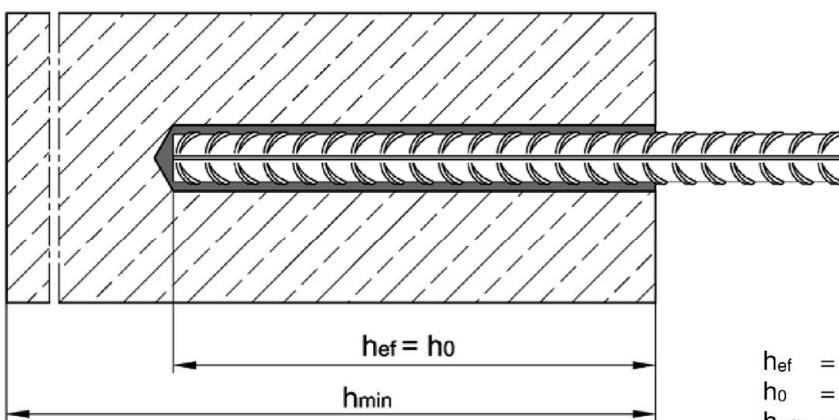
Pre-setting installation or through-setting installation (optional annular gap filled with mortar)



Installation internally threaded anchor rod VMU-IG M6 to VMU-IG M20



Installation reinforcing bar Ø8 to Ø32



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

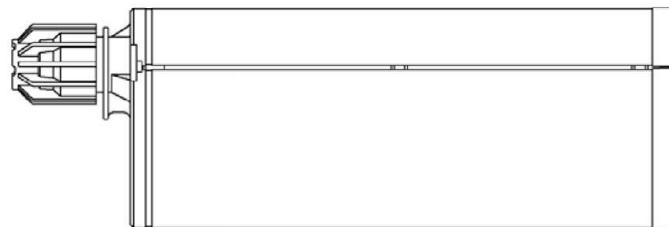
Injection System VME plus Keine Indexeinträge gefunden.

Product description
Installation situation

Annex A1

Cartridge Injection Mortar VME plus

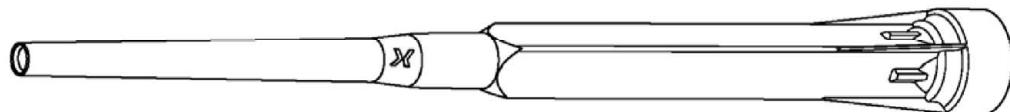
Side-by-side cartridge
440 ml
585 ml
1400 ml



Imprint:

VME plus,
processing notes, batch number, shelf life, hazard-number, storage temperature, curing- and
processing time, optional with travel scale

Static Mixer



Retaining washer and extension nozzle



Injection System VME plus

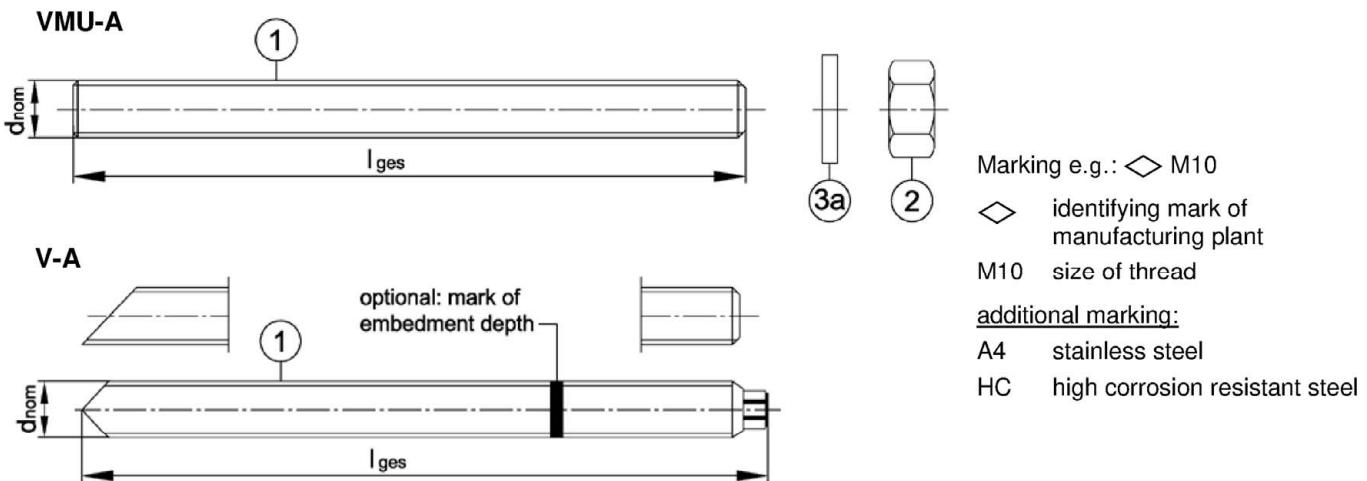
Product description

Cartridge, static mixer and retaining washer with extension nozzle

Annex A2

Threaded rod

Threaded rod VMU-A, V-A with washer and hexagon nut
M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A4, HCR)

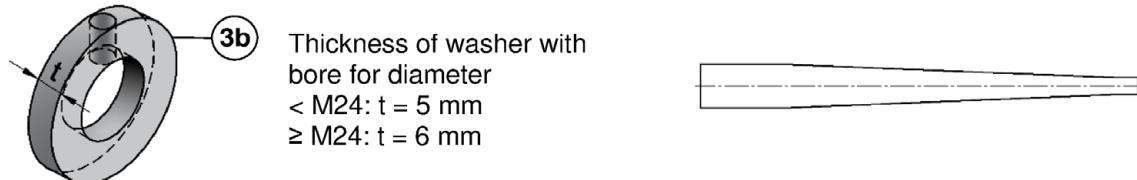


Threaded rod VM-A (material sold by the meter, to be cut at the required length)
M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR)

Commercial standard threaded rod

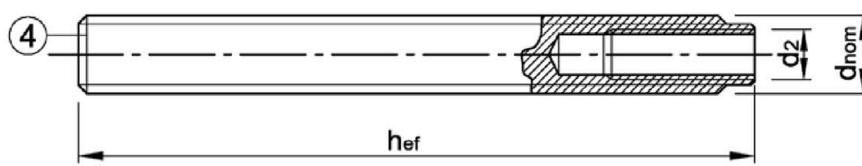
M8, M10, M12, M16, M20, M24, M27, M30 (zinc plated, A2, A4, HCR) with:
- Materials, dimensions and mechanical properties see Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004

Washer with bore and reducing adapter for filling the gap between threaded rod and fixture



Internally threaded anchor rod

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.: ◇ M8
◇ identifying mark of manufacturing plant
I internal thread
M8 size of internal thread
additional marking:
A4 stainless steel
HCR high corrosion resistant steel

Injection System VME plus

Product description

Threaded rod, internally threaded anchor rod and washer with bore

Annex A3

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

Part	Designation	Material									
Steel, zinc plated											
electroplated $\geq 5 \mu\text{m}$ acc. to EN ISO 4042:2018 or											
hot-dip galvanized $\geq 40 \mu\text{m}$ (50 μm in average) acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or											
1	Threaded rod	Property class	characteristic ultimate strength	characteristic yield strength	fracture elongation	EN ISO 683-4:2018, EN 10263:2001; commercial standard threaded rod: EN ISO 898-1:2013					
		4.6	f_{uk} [N/mm ²]	400	240	$A_5 > 8 \%$					
		4.8		400	320	$A_5 > 8 \%$					
		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				EN ISO 898-2:2012				
		5	for class 4.6, 4.8, 5.6, 5.8 rods								
		8	for class 4.6, 4.8, 5.6, 5.8, 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 A2²⁾		CRC II (Materials 1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541)									
Stainless steel A4		CRC III (Materials 1.4401 / 1.4404 / 1.4571 / 1.4578)									
High corrosion resistant steel HCR		CRC V (Materials 1.4529 / 1.4565)									
1	Threaded rod ³⁾	Property class	characteristic ultimate strength	characteristic yield strength	fracture elongation	EN 10088-1:2014 EN ISO 3506-1:2020					
		50	f_{uk} [N/mm ²]	500	210	$A_5 > 8\%$					
		70		700	450	$A_5 \geq 12\%^{1)}$					
		80		800	600	$A_5 \geq 12\%^{1)}$					
2	Hexagon nut ³⁾	50	for class 50 rods				EN 10088-1:2014 EN ISO 3506-2:2020				
		70	for class 50 or 70 rods								
		80	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 10088-1:2014				
3b	Washer with bore	stainless steel A4; high corrosion resistant steel HCR									
4	Internally threaded anchor rod	50	IG-M20			$A_5 > 8\%$	EN 10088-1:2014				
		70	IG-M6 to IG-M16			$A_5 > 8\%$					
Injection System VME plus											
Product description Materials - Threaded rod and internally threaded anchor rod											
Annex A4											

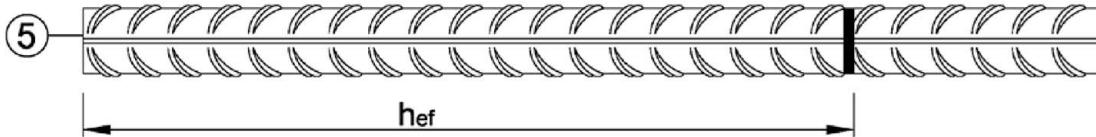
¹⁾ fracture elongation $A_5 > 8 \%$ for applications without requirements for seismic performance category C2

²⁾ property classes 50 and 70

³⁾ property classes 70 and 80 up to M24

Reinforcing bar

$\varnothing 8, \varnothing 10, \varnothing 12, \varnothing 14, \varnothing 16, \varnothing 20, \varnothing 24, \varnothing 25, \varnothing 28, \varnothing 32$



- 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 NCL 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 A5

Specification of intended use

Static and quasi-static action	working life 50 years	working life 100 years
Threaded rod Internally threaded anchor rod Rebar	M8 - M30 VMU-IG M6 - VMU-IG M20 Ø8 - Ø32	
Base material	cracked or uncracked concrete	strength classes C20/25 to C50/60 compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013+A1:2016
Hole drilling	cracked concrete: hammer drilling / compressed air drilling / vacuum drilling	uncracked concrete: hammer drilling / compressed air drilling / vacuum drilling / diamond drilling
Temperature range ¹⁾	I: -40°C to +40°C II: -40°C to +72°C	I: -40°C to +40°C II: -40°C to +72°C

Seismic action	performance category C1	performance category C2
Threaded rod Internally threaded anchor rod Rebar	M8 - M30 Ø8 - Ø32	M12 - M24 ---
Base material	cracked or uncracked concrete	strength classes C20/25 to C50/60 compacted, reinforced or unreinforced normal weight concrete (without fibers) acc. to EN 206:2013+A1:2016
Hole drilling	hammer drilling / compressed air drilling / vacuum drilling	
Temperature range ¹⁾	I: -40°C to +40°C II: -40°C to +72°C	I: -40°C to +40°C II: -40°C to +72°C

¹⁾ Temperature Range I: max. long term temperature +24°C and max. short term temperature +40°C
Temperature Range II: max. long term temperature +50°C and max. short term temperature +72°C

Injection System VME plus

Intended use
Specifications

Annex B1

Specification of intended use

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions: all materials
- For all other conditions:
Intended use of Materials according to Annex A4, Table A1 corresponding corrosion resistance classes CRC according to EN 1993-1-4:2006+A1:2015

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, February 2018

Installation:

- Dry or wet concrete or waterfilled drillholes (not seawater)
- Hole drilling by hammer drill, compressed air drill, vacuum drill or diamond drill mode
- Overhead installation allowed
- Anchor installation carried out by appropriately qualified personnel and under the responsibility of the person responsible for technical matters of the site
- Internally threaded anchor rod: 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

Intended use
Specifications

Annex B2

Table B1: Installation parameters for threaded rods

Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30	
Diameter of threaded rod	$d=d_{\text{nom}}$ [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	$h_{\text{ef},\text{min}}$ [mm]	60	60	70	80	90	96	108	120	
	$h_{\text{ef},\text{max}}$ [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	$d_f \leq$ [mm]	12	14	16	20	24	30	33	40
Maximum installation torque	$\text{max. } T_{\text{inst}} \leq$ [Nm]	10	20	40 (35) ¹⁾	60	100	170	250	300	
Minimum thickness of member	h_{min} [mm]	$h_{\text{ef}} + 30\text{mm} \geq 100\text{mm}$			$h_{\text{ef}} + 2d_0$					
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 B2: Installation parameters for internally threaded anchor rods

Internally threaded anchor rod		IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Inner diameter of threaded rod	d_2 [mm]	6	8	10	12	16	20
Outer diameter of threaded rod ¹⁾	$d=d_{\text{nom}}$ [mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm]	12	14	18	22	28	35
Effective anchorage depth	$h_{\text{ef},\text{min}}$ [mm]	60	70	80	90	96	120
	$h_{\text{ef},\text{max}}$ [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	$\text{max. } T_{\text{inst}} \leq$ [Nm]	10	10	20	40	60	100
Minimum screw-in depth	l_{ig} [mm]	8	8	10	12	16	20
Minimum thickness of member	h_{min} [mm]	$h_{\text{ef}} + 30\text{mm} \geq 100\text{mm}$			$h_{\text{ef}} + 2d_0$		
Minimum spacing	s_{min} [mm]	50	60	75	95	115	140
Minimum edge distance	c_{min} [mm]	40	45	50	60	65	80

¹⁾ with metric thread acc. to EN 1993-1-8:2005+AC:2009

Table B3: Installation parameters for rebar

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

¹⁾ for $\varnothing 8$, $\varnothing 10$, $\varnothing 12$, $\varnothing 24$ and $\varnothing 25$ both nominal drill hole diameter can be used

Injection System VME plus

Intended use
Installation parameters

Annex B3

Table B4: Parameter for cleaning and setting tools

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

Table B5: Retaining washer

Drill bit Ø		Installation direction and use		
d ₀ [mm]	[-]			
10	No retaining washer required			
12				
14				
16				
18	VM-IA 18	$h_{ef} > 250\text{mm}$	$h_{ef} > 250\text{mm}$	all
20	VM-IA 20			
22	VM-IA 22			
25	VM-IA 25			
28	VM-IA 28			
30	VM-IA 30			
32	VM-IA 32			
35	VM-IA 35			
40	VM-IA 40			



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)



Recommended compressed air tool (min 6 bar)

Drill bit diameter (d₀): all diameters

Injection System VME plus

Intended use

Cleaning and setting tools

Annex B4

Table B6: Working time and curing time

Concrete temperature	Working time	Minimum curing time	
		dry concrete	wet concrete
0°C to +4°C	90 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
+40°C	8 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		

Injection System VME plus

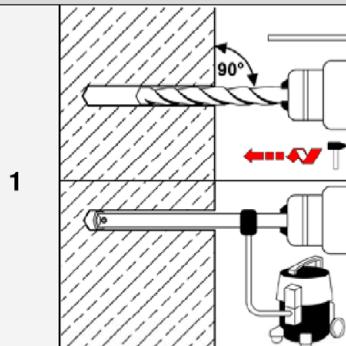
Intended use

Working and curing time

Annex B5

Installation instructions

Drilling of the drill hole and cleaning: Hammer drilling, compressed air drilling and vacuum drilling



Hammer drilling or compressed air drilling:

Drill with hammer drill or compressed air drill a hole into the base material with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole depth. Continue with **step 2**.

In case of aborted drill hole, the drill hole shall be filled with mortar.

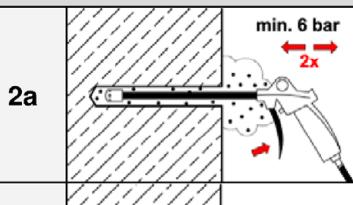
Vacuum drilling: see Annex B4

Drill drillhole with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole depth. This drilling method removes dust and cleans the drillhole during drilling. Continue with step 3.

In case of aborted drill hole, the drill hole shall be filled with mortar.

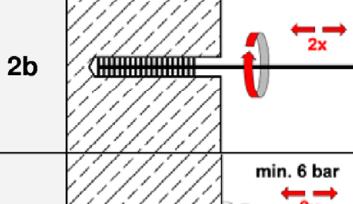
Attention! Standing water in the drill hole must be removed before cleaning!

Cleaning: dry, wet and water-filled drill holes with all diameter in uncracked and cracked concrete
(Cleaning not applicable when using vacuum drilling)



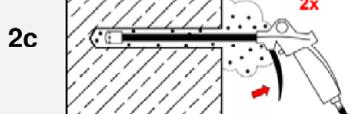
Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **two** times until return air stream is free of noticeable dust.

If the drillhole ground is not reached, an extension must be used.



Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (Table B4) a minimum of **two** times.

If the drillhole ground is not reached with the brush, an appropriate brush extension must be used.



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 drillhole ground is not reached, an extension must be used.

After cleaning, the drillhole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drillhole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drillhole again.

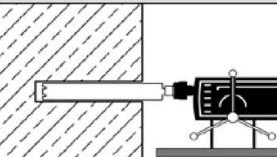
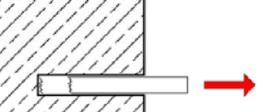
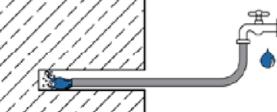
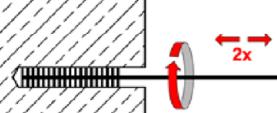
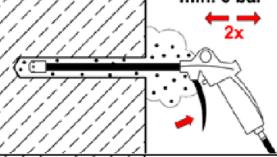
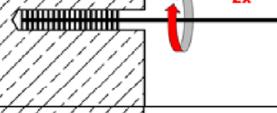
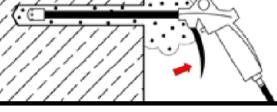
Injection System VME plus

Intended use

Installation instructions – Drilling and cleaning: Hammer drilling, compressed air drilling and vacuum drilling

Annex B6

Installation instructions (continuation)

Drilling of the drill hole and cleaning: Diamond drilling		
1		Drill a hole into the base material with prescribed nominal drill hole diameter (Table B1, B2 or B3) and selected drillhole 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 with all diameter in uncracked concrete		
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 B4). Brush the hole with an appropriate sized wire brush $\geq d_{b,min}$ (Table B4) a minimum of two times. If the drillhole 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.
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 drillhole ground is not reached, an extension must be used.
2f		Check brush diameter (Table B4). Brush the hole again with an appropriate sized wire brush $\geq d_{b,min}$ (Table B4) a minimum of two times. If the drillhole 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 drillhole ground is not reached, an extension must be used.

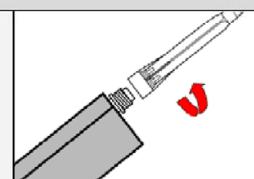
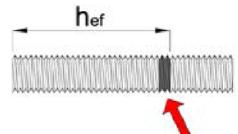
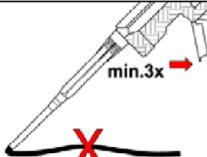
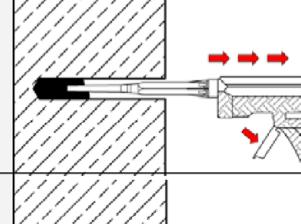
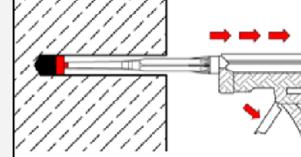
Injection System VME plus

Intended use

Installation instructions – Drilling and cleaning: Diamond drilling

Annex B

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 B6) as well as for new cartridges, a new static-mixer shall be used.
4		Prior to inserting the rod into the filled drillhole, 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 extension nozzle shall be used. Observe temperature dependent working times given in Table B6.
7		Retaining washer and mixer nozzle extensions shall be used according to Table B5 for the following applications: <ul style="list-style-type: none">Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and anchorage depth $h_{ef} > 250$mmOverhead installation: Drill bit-Ø $d_0 \geq 18$ mm

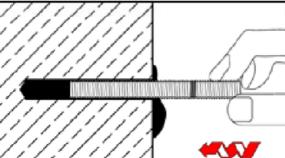
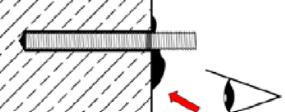
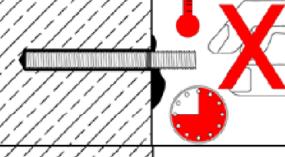
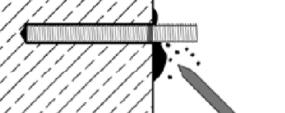
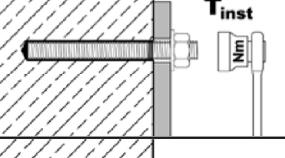
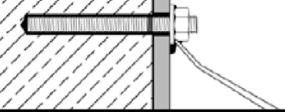
Injection System VME plus

Intended use

Installation instructions – Injection

Annex B8

Installation instructions (continuation)

Setting 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 B6).
11	 Remove excess mortar.
12	 The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B1 or B2.
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 washer with drill and plug on reducing adapter on static mixer. Annular gap is completely filled, when excess mortar seeps out.

Injection System VME plus

Intended use

Installation instructions – Setting the fastening element

Annex B9

¹⁾ 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 [mm ²]	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)	23 (21)	34	63	98	141	184	224
	Property class 5.6 and 5.8	$N_{Rk,s}$ [kN]	18 (17)	29 (27)	42	78	122	176	230	280
	Property class 8.8	$N_{Rk,s}$ [kN]	29 (27)	46 (43)	67	125	196	282	368	449
Stainless steel	A2, A4 and HCR Property class 50	$N_{Rk,s}$ [kN]	18	29	42	79	123	177	230	281
	A2, A4 and HCR Property class 70	$N_{Rk,s}$ [kN]	26	41	59	110	171	247	- ³⁾	- ³⁾
	A4 and HCR Property class 80	$N_{Rk,s}$ [kN]	29	46	67	126	196	282	- ³⁾	- ³⁾
Partial factors ²⁾										
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,N}$ [-]					2,0			
	Property class 4.8	$\gamma_{Ms,N}$ [-]					1,5			
	Property class 5.6	$\gamma_{Ms,N}$ [-]					2,0			
	Property class 5.8	$\gamma_{Ms,N}$ [-]					1,5			
	Property class 8.8	$\gamma_{Ms,N}$ [-]					1,5			
Stainless steel	A2, A4 and HCR Property class 50	$\gamma_{Ms,N}$ [-]					2,86			
	A2, A4 and HCR Property class 70	$\gamma_{Ms,N}$ [-]					1,87	- ³⁾	- ³⁾	
	A4 and HCR Property class 80	$\gamma_{Ms,N}$ [-]					1,6	- 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

Injection System VME plus

Performance

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

Annex C1

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 [mm ²]	36,6	58,0	84,3	157	245	353	459	561	
Characteristic resistance under shear load¹⁾										
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
	Property class 5.6 and 5.8	$V^0_{Rk,s}$ [kN]	11 (10)	17 (16)	25	47	74	106	138	168
	Property class 8.8	$V^0_{Rk,s}$ [kN]	15 (13)	23 (21)	34	63	98	141	184	224
Stainless steel	A2, A4 and HCR, property class 50	$V^0_{Rk,s}$ [kN]	9	15	21	39	61	88	115	140
	A2, A4 and HCR, property class 70	$V^0_{Rk,s}$ [kN]	13	20	30	55	86	124	-	-
	A4 and HCR, property class 80	$V^0_{Rk,s}$ [kN]	15	23	34	63	98	141	-	-
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
	Property class 5.6 and 5.8	$M^0_{Rk,s}$ [Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
	Property class 8.8	$M^0_{Rk,s}$ [Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
Stainless steel	A2, A4 and HCR, property class 50	$M^0_{Rk,s}$ [Nm]	19	37	66	167	325	561	832	1125
	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$ [Nm]	26	52	92	232	454	784	- ³⁾	- ³⁾
	A4 and HCR, property class 80	$M^0_{Rk,s}$ [Nm]	30	59	105	266	519	896	- ³⁾	- ³⁾
Partial factor²⁾										
Steel, zinc plated	Property class 4.6	$\gamma_{Ms,V}$ [-]	1,67							
	Property class 4.8	$\gamma_{Ms,V}$ [-]	1,25							
	Property class 5.6	$\gamma_{Ms,V}$ [-]	1,67							
	Property class 5.8	$\gamma_{Ms,V}$ [-]	1,25							
	Property class 8.8	$\gamma_{Ms,V}$ [-]	1,25							
Stainless steel	A2, A4 and HCR, property class 50	$\gamma_{Ms,V}$ [-]	2,38							
	A2, A4 and HCR, property class 70	$\gamma_{Ms,V}$ [-]	1,56					⁻³⁾	⁻³⁾	
	A4 and HCR, property class 80	$\gamma_{Ms,V}$ [-]	1,33					⁻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

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 failure**

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

Injection System VME plus

Performance

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

Annex C3

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]								
Partial factor $\gamma_{Ms,N}$ [-]								
Combined pull-out and concrete failure								
Characteristic bond resistance in uncracked concrete C20/25								
Temperature range I: 40°C / 24°C	hammer- or compressed air drilling	$\tau_{Rk,ucr}$ [N/mm ²]	20	20	19	19	18	17
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$ [N/mm ²]	15	15	15	14	13	12
Temperature range I: 40°C / 24°C	vacuum drilling	$\tau_{Rk,ucr}$ [N/mm ²]	17 (16) ¹⁾	16	16	16 (15) ¹⁾	15	14
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$ [N/mm ²]	14	14	14	13	13	12
Characteristic bond resistance in cracked concrete C20/25								
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	$\tau_{Rk,cr}$ [N/mm ²]	7,0	7,0	8,5	8,5	8,5	8,5
Temperature range II: 72°C / 50°C		$\tau_{Rk,cr}$ [N/mm ²]	6,0	6,0	7,0	7,0	7,0	7,0
Reductionfactor ψ_{sus}^0 in concrete C20/25								
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	ψ_{sus}^0 [-]						0,80
Temperature range II: 72°C / 50°C		ψ_{sus}^0 [-]						0,68
Increasing factors for concrete	C25/30	ψ_c	[-]					1,02
	C30/37		[-]					1,04
	C35/45		[-]					1,07
	C40/50		[-]					1,08
	C45/55		[-]					1,09
	C50/60		[-]					1,10
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⁾ value in brackets: characteristic bond resistance for waterfilled drill holes								
Injection System VME plus								Annex C4
Performance Characteristic values of tension loads for threaded rods , working life 50 years								

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]																
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 uncracked concrete C20/25																
Temperature range I: 40°C / 24°C	Hammer- or compressed air drilling	$\tau_{Rk,ucr,100}$ [N/mm²]	20	20	19	19	18	17	16	16						
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$ [N/mm²]	15	15	15	14	13	13	12	12						
Temperature range I: 40°C / 24°C	Vacuum drilling	$\tau_{Rk,ucr,100}$ [N/mm²]	17 (16) ¹⁾	16	16	16 (15) ¹⁾	15	14	14	13						
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$ [N/mm²]	14	14	14	13	13	12	12	11						
Characteristic bond resistance in cracked concrete C20/25																
Temperature range I: 40°C / 24°C	Hammer-, compressed air or vacuum drilling	$\tau_{Rk,cr,100}$ [N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5						
Temperature range II: 72°C / 50°C		$\tau_{Rk,cr,100}$ [N/mm²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5						
Increasing factors for concrete	C25/30	ψ_c	[-]	1,02												
	C30/37		[-]	1,04												
	C35/45		[-]	1,07												
	C40/50		[-]	1,08												
	C45/55		[-]	1,09												
	C50/60		[-]	1,10												
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⁾ Value in brackets: characteristic bond resistance for waterfilled drill holes																
Injection System VME plus								Annex C5								
Performance Characteristic values of tension loads for threaded rods , working life 100 years								Annex C5								

Table C6: Characteristic values of **tension load for threaded rods, static and quasi-static action, working life 50 and 100 years, diamond drilling** in uncracked concrete

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 uncracked concrete C20/25								Working life 50 years		
Temperature range I: 40°C / 24°C	diamond drilling	$\tau_{Rk,ucr}$ [N/mm²]	15	14	14	13	12	12	11	11
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$ [N/mm²]	12	12	11	10	9,5	9,5	9,0	9,0
Reduction factor ψ^0_{sus} in uncracked concrete C20/25										
Temperature range I: 40°C / 24°C	diamond drilling	ψ^0_{sus} [-]							0,77	
Temperature range II: 72°C / 50°C		ψ^0_{sus} [-]							0,72	
Characteristic bond resistance in uncracked concrete C20/25								Working life 100 years		
Temperature range I: 40°C / 24°C	diamond drilling	$\tau_{Rk,ucr,100}$ [N/mm²]	15	14	14	13	12	12	11	11
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$ [N/mm²]	11	11	10	10	9,5	9,0	8,5	8,5
Increasing factors for concrete	C25/30	ψ_c	[-]						1,04	
	C30/37		[-]						1,08	
	C35/45		[-]						1,12	
	C40/50		[-]						1,15	
	C45/55		[-]						1,17	
	C50/60		[-]						1,19	
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	
Injection System VME plus								Annex C6		
Performance Characteristic values of tension loads for threaded rods, working life 50 and 100 years, diamond drilling										

Table C7: Characteristic values of **shear loads for threaded rods, static and quasi-static action**

Threaded rod	M8	M10	M12	M16	M20	M24	M27	M30
Steel failure without 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 with 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} [mm ³]	31	62	109	277	541	935	1387
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]							$\min(h_{ef}; 12 d_{nom})$ $\min(h_{ef}; 300\text{mm})$
Outside diameter of anchor	d_{nom} [mm]	8	10	12	16	20	24	27
Installation factor	γ_{inst} [-]							1,0

Injection System VME plus

Performance

Characteristic values of **shear loads for threaded rods**

Annex C7

Table C8: Characteristic values of **tension load** for **threaded rods, seismic action** (performance category **C1 + C2**), working life **50 and 100 years**

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

¹⁾ No performance assessed

Table C9: Characteristic values of **shear loads** for **threaded rods, seismic action** (performance category **C1 + C2**)

Threaded rod	M8	M10	M12	M16	M20	M24	M27	M30		
Shear loads										
Steel failure without lever arm										
Characteristic resistance C1	$V_{Rk,s,C1}$	[kN]						$0,7 \cdot V_{Rk,s}^0$		
Characteristic resistance C2 steel, zinc plated, property class 8.8 stainless steel A4 and HCR, property class ≥ 70	$V_{Rk,s,C2}$	[kN]	⁻¹⁾			$0,7 \cdot V_{Rk,s}^0$		⁻¹⁾		
Partial factor	$\gamma_{Ms,N}$	[-]						see Table C2		
Factor for anchorage	without annular gap with annular gap between threaded rod and fixture	α_{gap}	[-]					1,0		
								0,5		
Injection System VME plus										
Performance Characteristic values for threaded rods under seismic action							Annex C8			

Table C10: Characteristic values of **tension loads** for **internally threaded anchor rod**, **static** and **quasi-static action**, working life **50 years**

Internally threaded anchor rod			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20	
Steel failure¹⁾									
Characteristic resistance, steel, zinc plated, property class	5.8 8.8	N _{Rk,s} [kN]	10 16	17 27	29 46	42 67	76 121	123 196	
Partial factor 5.8 and 8.8		γ _{Ms,N} [-]				1,5			
Characteristic resistance, Stainless steel A4 / HCR, property class 70		N _{Rk,s} [kN]		14	26	41	59	110 124 ²⁾	
Partial factor		γ _{Ms,N} [-]				1,87		2,86	
Combined pull-out and concrete failure									
Characteristic bond resistance in uncracked concrete C20/25									
Temperature range I: 40°C / 24°C	hammer- or compressed air drilling	τ _{Rk,ucr} [N/mm ²]	20	19	19	18	17	16	
Temperature range II: 72°C / 50°C		τ _{Rk,ucr} [N/mm ²]	15	15	14	13	13	12	
Temperature range I: 40°C / 24°C	vacuum drilling	τ _{Rk,ucr} [N/mm ²]	16	16	16 (15) ³⁾	15	14	13	
Temperature range II: 72°C / 50°C		τ _{Rk,ucr} [N/mm ²]	14	14	13	13	12	11	
Characteristic bond resistance in cracked concrete C20/25									
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	τ _{Rk,cr} [N/mm ²]	7,0	8,5	8,5	8,5	8,5	8,5	
Temperature range II: 72°C / 50°C		τ _{Rk,cr} [N/mm ²]	6,0	7,0	7,0	7,0	7,0	7,0	
Reductionfactor ψ⁰_{sus}									
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	ψ ⁰ _{sus}	[-]			0,80			
Temperature range II: 72°C / 50°C		ψ ⁰ _{sus}	[-]			0,68			
Increasing factor for concrete	ψ/c	C25/30				1,02			
		C30/37				1,04			
		C35/45				1,07			
		C40/50				1,08			
		C45/55				1,09			
		C50/60				1,10			
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			
Injection System VME plus									
Performance Characteristic values of tension loads for internally threaded anchor rod , working life 50 years							Annex C9		

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 VMU-IG M20: property class 50

³⁾ value in bracket is valid for waterfilled drill hole

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

Internally threaded anchor rod			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20
Steel failure¹⁾								
Characteristic resistance, steel, zinc plated, property class	5.8 8.8	N _{Rk,s} [kN]	10 16	17 27	29 46	42 67	76 121	123 196
Partial factor 5.8 and 8.8		γ _{Ms,N} [-]			1,5			
Characteristic resistance, Stainless steel A4 / HCR, property class 70		N _{Rk,s} [kN]	14	26	41	59	110	124 ²⁾
Partial factor		γ _{Ms,N} [-]			1,87			2,86
Combined pull-out and concrete failure								
Characteristic bond resistance in uncracked concrete C20/25								
Temperature range I: 40°C / 24°C	hammer- or compressed air drilling	τ _{Rk,ucr,100} [N/mm ²]	20	19	19	18	17	16
Temperature range II: 72°C / 50°C		τ _{Rk,ucr,100} [N/mm ²]	15	15	14	13	13	12
Temperature range I: 40°C / 24°C	vacuum drilling	τ _{Rk,ucr,100} [N/mm ²]	16	16	16 (15) ³⁾	15	14	13
Temperature range II: 72°C / 50°C		τ _{Rk,ucr,100} [N/mm ²]	14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25								
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	τ _{Rk,cr,100} [N/mm ²]	6,5	7,5	7,5	7,5	7,5	7,5
Temperature range II: 72°C / 50°C		τ _{Rk,cr,100} [N/mm ²]	5,5	6,5	6,5	6,5	6,5	6,5
Increasing factor for concrete	ψ/c	C25/30				1,02		
		C30/37				1,04		
		C35/45				1,07		
		C40/50				1,08		
		C45/55				1,09		
		C50/60				1,10		
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		
Injection System VME plus								
Performance Characteristic values of tension loads for internally threaded anchor rod, working life 100 years							Annex C10	

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 VMU-IG M20: property class 50

³⁾ value in bracket is valid for waterfilled drill hole

Table C12: Characteristic values of tension loads for internally threaded anchor rod, static and quasi-static action, working life 50 and 100 years, diamond drilling

Internally threaded anchor rod			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20	
Steel failure¹⁾									
Characteristic resistance, steel, zinc plated, property class	5.8 8.8	N _{Rk,s} [kN]	10 16	17 27	29 46	42 67	76 121	123 196	
Partial factor 5.8 and 8.8		γ _{Ms,N} [-]				1,5			
Characteristic resistance, stainless steel A4 / HCR, property class 70		N _{Rk,s} [kN]	14	26	41	59	110	124 ²⁾	
Partial factor		γ _{Ms,N} [-]			1,87			2,86	
Combined pull-out and concrete failure									
Characteristic bond resistance in uncracked concrete C20/25							Working life 50 years		
Temperature range I: 40°C / 24°C	diamond drilling	τ _{Rk,ucr} [N/mm ²]	14	14	13	12	12	11	
Temperature range II: 72°C / 50°C		τ _{Rk,ucr} [N/mm ²]	12	11	10	9,5	9,5	9,0	
Reduktionsfaktor ψ⁰_{sus}									
Temperature range I: 40°C / 24°C	diamond drilling	ψ ⁰ _{sus} [-]				0,77			
Temperature range II: 72°C / 50°C		ψ ⁰ _{sus} [-]				0,72			
Characteristic bond resistance in uncracked concrete C20/25							Working life 100 years		
Temperature range I: 40°C / 24°C	diamond drilling	τ _{Rk,ucr,100} [N/mm ²]	14	14	13	12	12	11	
Temperature range II: 72°C / 50°C		τ _{Rk,ucr,100} [N/mm ²]	11	10	10	9,5	9,0	8,5	
Increasing factor for τ _{Rk,ucr}			C25/30			1,04			
			C30/37			1,08			
			C35/45			1,12			
			C40/50			1,15			
			C45/55			1,17			
			C50/60			1,19			
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 VMU-IG M20: property class 50									
³⁾ value in bracket is valid for waterfilled drill hole									
Injection System VME plus							Annex C11		
Performance Characteristic values of tension loads for internally threaded anchor rod, working life 50 and 100 years, diamond drilling									

Table C13: Characteristic values of shear loads for internally threaded anchor rod, static and quasi-static action

Internally threaded anchor rod			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20			
Steel failure without lever arm¹⁾											
Steel, zinc plated	Characteristic resistance, property class	5.8	$V_{Rk,s}^0$ [kN]	6	10	17	25	45	74		
		8.8	$V_{Rk,s}^0$ [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	$V_{Rk,s}^0$ [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 arm¹⁾											
Steel, zinc plated	Characteristic bending resistance, property class	5.8	$M_{Rk,s}^0$ [Nm]	8	19	37	66	167	325		
		8.8	$M_{Rk,s}^0$ [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	$M_{Rk,s}^0$ [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 ($h_{ef}; 300\text{mm}$)				
Outside diameter of anchor		d_{nom}	[mm]	10	12	16	20	24	30		
Installation factor		γ_{inst}	[-]	1,0							
Injection System VME plus											
Performance Characteristic values of shear loads for internally threaded anchor rod							Annex C12				

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

Table C14: Characteristic values of tension loads for rebar, static and quasi-static action, working life 50 years

Reinforcing bar	$\varnothing 8$	$\varnothing 10$	$\varnothing 12$	$\varnothing 14$	$\varnothing 16$	$\varnothing 20$	$\varnothing 24$	$\varnothing 25$	$\varnothing 28$	$\varnothing 32$										
Steel failure																				
Characteristic tension resistance $N_{Rk,s}$ [kN]																				
Cross sectional area A_s [mm ²]	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 uncracked concrete C20/25																				
Temperature range I: 40°C / 24°C	hammer- and compressed air drilling	$\tau_{Rk,ucr}$ [N/mm ²]	16	16	16	16	16	15	15	15										
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$ [N/mm ²]	12	12	12	12	12	12	11	11										
Temperature range I: 40°C / 24°C	vacuum drilling	$\tau_{Rk,ucr}$ [N/mm ²]	14 (13) ³⁾	14 (13) ³⁾	13	13	13	13	13	13										
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$ [N/mm ²]	12 (11) ³⁾	12 (11) ³⁾	11	11	11	11	11	11										
Characteristic bond resistance in cracked concrete C20/25																				
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	$\tau_{Rk,cr}$ [N/mm ²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5										
Temperature range II: 72°C / 50°C		$\tau_{Rk,cr}$ [N/mm ²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0										
Reductionfactor ψ_{sus}^0																				
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	ψ_{sus}^0 [-]	0,80																	
Temperature range II: 72°C / 50°C		ψ_{sus}^0 [-]	0,68																	
Increasing factor for concrete	ψ_c	C25/30	1,02																	
		C30/37	1,04																	
		C35/45	1,07																	
		C40/50	1,08																	
		C45/55	1,09																	
		C50/60	1,10																	
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⁾ 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																				
Injection System VME plus																				
Performance Characteristic values of tension loads for rebar, working life 50 years										Annex C13										

**Table C15: 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	
Steel failure											
Characteristic tension resistance $N_{Rk,s}$	[kN]										
Cross sectional area A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor $\gamma_{Ms,N}$	[-]										
Combined pull-out and concrete failure											
Characteristic bond resistance in uncracked concrete C20/25											
Temperature range I: 40°C / 24°C	hammer- and compressed air drilling	$\tau_{Rk,ucr,100}$	[N/mm ²]	16	16	16	16	16	15	15	15
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	12	12	12	12	12	12	12	11
Temperature range I: 40°C / 24°C	vacuum drilling	$\tau_{Rk,ucr,100}$	[N/mm ²]	14 (13) ³⁾	14 (13) ³⁾	13	13	13	13	13	13
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	12 (11) ³⁾	12 (11) ³⁾	12 (11) ³⁾	11	11	11	11	11
Characteristic bond resistance in cracked concrete C20/25											
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	$\tau_{Rk,cr,100}$	[N/mm ²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
Temperature range II: 72°C / 50°C		$\tau_{Rk,cr,100}$	[N/mm ²]	5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factor for concrete ψ_c			C25/30								1,02
			C30/37								1,04
			C35/45								1,07
			C40/50								1,08
			C45/55								1,09
			C50/60								1,10
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
Injection System VME plus											
Performance Characteristic values of tension loads for rebar, working life 100 years											Annex C14

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

Table C16: 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									
Steel failure																			
Characteristic tension resistance $N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^1)$																	
Cross sectional area A_s	[mm ²]	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 uncracked concrete C20/25																			
Working life 50 years																			
Temperature range I: 40°C / 24°C	diamond drilling	$\tau_{Rk,ucr}$	[N/mm ²]	14	13	13	13	12	12	11	11	11	11						
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr}$	[N/mm ²]	11	11	10	10	10	9,5	9,5	9,5	9,0	9,0						
Reductionfactor ψ_{sus}^0																			
Temperature range I: 40°C / 24°C	diamond drilling	ψ_{sus}^0	[-]	0,77															
Temperature range II: 72°C / 50°C		ψ_{sus}^0	[-]	0,72															
Characteristic bond resistance in uncracked concrete C20/25																			
Working life 100 years																			
Temperature range I: 40°C / 24°C	diamond drilling	$\tau_{Rk,ucr,100}$	[N/mm ²]	14	13	13	13	12	12	11	11	11	11						
Temperature range II: 72°C / 50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5						
Increasing factor for concrete ψ_c																			
C25/30											1,04								
C30/37											1,08								
C35/45											1,12								
C40/50											1,15								
C45/55											1,17								
C50/60											1,19								
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												
Injection System VME plus																			
Performance Characteristic values of tension loads for rebar, working life 50 and 100 years , diamond drilling	Annex C15																		

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

²⁾ in absence of national regulation

Table C17: Characteristic values of **shear loads** for **rebar**, **static** and **quasi-static action**

Reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever arm											
Characteristic shear resistance	$V^0_{Rk,s}$ [kN]										$0,50 \cdot A_s \cdot f_{uk}^{(1)}$
Cross sectional area	A_s [mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$ [-]										1,5 ⁽²⁾
Ductility factor	k_7 [-]										1,0
Steel failure with lever arm											
Characteristic bending resistance	$M^0_{Rk,s}$ [Nm]										$1,2 \cdot W_{el} \cdot f_{uk}^{(1)}$
Elastic section modulus	W_{el} [mm ³]	50	98	170	269	402	785	1357	1534	2155	3217
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]										$\min(h_{ef}; 12 d_{nom})$
Outside diameter of rebar	d_{nom} [mm]	8	10	12	14	16	20	24	25	28	32
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 loads for rebar**

Annex C16

Table C18: Characteristic values of **tension load** for rebar,
seismic action (performance category **C1**), 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										
Steel failure																				
Characteristic resistance $N_{Rk,s,C1}$ [kN]																				
Cross sectional area A_s [mm ²]	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																				
Temperature range I: 40°C / 24°C	hammer-, compressed air or vacuum drilling	$\tau_{Rk,C1}$ [N/mm ²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5										
Temperature range II: 72°C / 50°C		$\tau_{Rk,C1}$ [N/mm ²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0										
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 C19: Characteristic values of **shear loads** for rebar,
seismic action (performance category **C1**)

Reinforcing bar	Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever arm										
Characteristic resistance $V_{Rk,s,C1}$ [kN]										
Cross sectional area A_s [mm ²]	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** under **seismic action**

Annex C17

Table C20: Displacements under tension load, threaded rod

Threaded rod	M8	M10	M12	M16	M20	M24	M27	M30			
Hammer-, compressed air or vacuum drilling											
Displacement factor¹⁾											
Uncracked concrete, static and quasi-static action, working life 50 and 100 years											
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°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 factor¹⁾											
Cracked concrete, static and quasi-static action, working life 50 and 100 years											
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°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)	$[\text{mm}]$	²⁾	0,21	0,24	0,27	0,36	²⁾			
	$\delta_{N,C2}$ (ULS)			0,54	0,51	0,54	0,63				
Diamond drilling											
Displacement factor¹⁾											
Uncracked concrete, static and quasi-static action, working life 50 years											
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°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 factor¹⁾											
Uncracked concrete, static and quasi-static action, working life 100 years											
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°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											
$\delta_{N0} = \delta_{N0\text{-factor}} \cdot \tau;$ $\tau:$ acting bond stress under tension load											
$\delta_{N\infty} = \delta_{N\infty\text{-factor}} \cdot \tau;$											
²⁾ No Performance assessed											
Injection System VME plus								Annex C18			
Performance Displacements (threaded rod under tension load)											

Table C21: Displacements under shear load, threaded rod

Threaded rod	M8	M10	M12	M16	M20	M24	M27	M30		
All drilling methods										
Displacement factor¹⁾ Uncracked and cracked concrete, static and quasi-static action										
All temperature ranges	δv_0 - factor	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	δv_∞ - 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	δv_{c2} (DLS)	[mm]	²⁾	3,1	3,4	3,5	4,2	²⁾		
	δv_{c2} (ULS)			6,0	7,6	7,3	10,9			

¹⁾ Calculation of the displacement

$$\delta v_0 = \delta v_0\text{-factor} \cdot V; \quad V: \text{acting shear load}$$

$$\delta v_\infty = \delta v_\infty\text{-factor} \cdot V;$$

²⁾ No Performance assessed

Injection System VME plus

Performance

Displacements (threaded rod under shear load)

Annex C19

Table C22: Displacement factors¹⁾ under tension load, internally threaded anchor rod

Internally threaded anchor rod		VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20	
Hammer-, compressed air or vacuum drilling								
Uncracked concrete, static and quasi-static action, working life 50 and 100 years								
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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								
Uncracked concrete, static and quasi-static action, working life 50 years								
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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
Cracked concrete, static and quasi-static action, working life 100 years								
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	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 C23: Displacement factors¹⁾ under shear load, internally threaded anchor rod

Internally threaded anchor rod		VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16	VMU-IG M 20	
Uncracked and cracked concrete, static and quasi-static action								
All temperature ranges	δ_{V0} - factor	$[\text{mm}/(\text{kN})]$	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

Displacements (internally threaded anchor rod)

Annex C20

Table C24: Displacement factors¹⁾ 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	
Hammer-, compressed air or vacuum drilling												
Uncracked concrete, static and quasi-static action, working life 50 and 100 years												
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	
	$\delta_{N\infty}$ - factor		0,015	0,015	0,016	0,017	0,017	0,019	0,020	0,020	0,021	
Temperature range II: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	
	$\delta_{N\infty}$ - factor		0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	
Cracked concrete, static and quasi-static action, working life 50 and 100 years												
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	
	$\delta_{N\infty}$ - factor		0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	
Temperature range II: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,092	0,095	0,096	0,098	0,099	0,102	0,106	0,106	0,109	
	$\delta_{N\infty}$ - factor		0,154	0,163	0,172	0,181	0,189	0,207	0,229	0,229	0,242	
Diamond drilling												
Uncracked concrete, static and quasi-static action, working life 50 years												
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	
	$\delta_{N\infty}$ - factor		0,018	0,018	0,019	0,020	0,021	0,024	0,027	0,027	0,028	
Temperature range II: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	
	$\delta_{N\infty}$ - factor		0,048	0,051	0,054	0,058	0,061	0,068	0,076	0,076	0,081	
Uncracked concrete, static and quasi-static action, working life 100 years												
Temperature range I: 40°C / 24°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	
	$\delta_{N\infty}$ - factor		0,018	0,020	0,021	0,022	0,024	0,026	0,029	0,029	0,031	
Temperature range II: 72°C / 50°C	δ_{N0} - factor	$\frac{\text{mm}}{\text{N/mm}^2}$	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	
	$\delta_{N\infty}$ - factor		0,035	0,037	0,040	0,042	0,045	0,049	0,055	0,055	0,059	

¹⁾ Calculation of the displacement

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

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

Table C25: Displacement factors¹⁾ 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	
Uncracked and cracked concrete, static and quasi-static action												
All temperature ranges	δ_{V0} - factor	$[\text{mm}/(\text{kN})]$	0,06	0,05	0,05	0,04	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	0,04	
Injection System VME plus												
Performance												
Displacements (rebar)												
Annex C21												