Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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

European Technical Assessment

ETA-21/0787 of 21 January 2022

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 basic for concrete
Product family to which the construction product belongs	Bonded fastener for use in concrete
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	26 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 330499-01-0601, Edition 04/2020

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Specific Part

1 Technical description of the product

The "Injection system VME basic for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar VME basic 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 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 2, C 1, C 3 C 4, C 6 and C 8
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 2, C 5, C 7 and C 9
Displacements under short-term and long-term loading	See Annex C 10 and C 11
Characteristic resistance and displacements for seismic performance categories C1 and C2	No performance assessed

3.2 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 330499-01-0601 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.

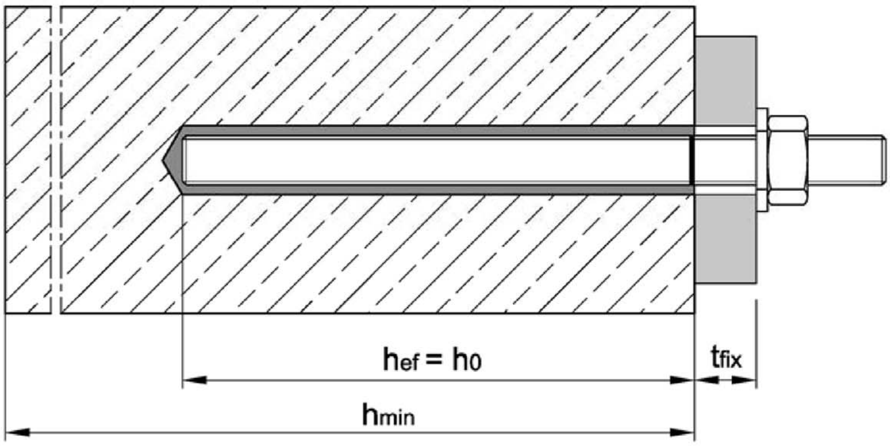
Issued in Berlin 21 January 2022 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

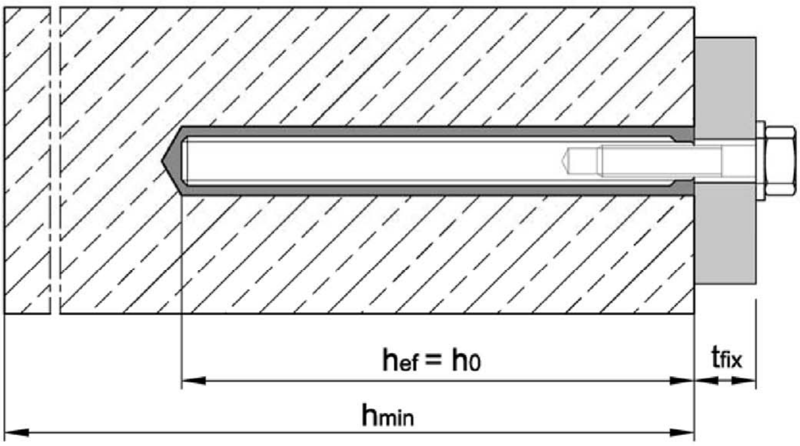
beglaubigt:
Baderschneider

Installation threaded rod M8 to M30

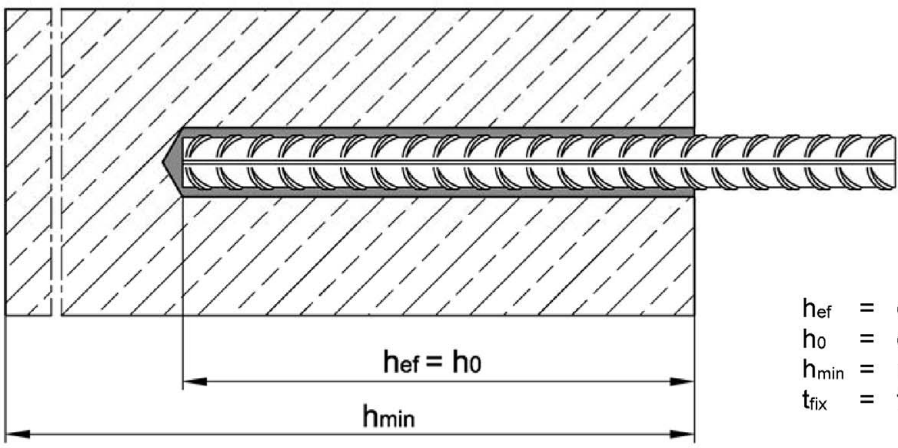
Pre-setting installation or through-setting installation (optional annular gap filled with mortar)



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

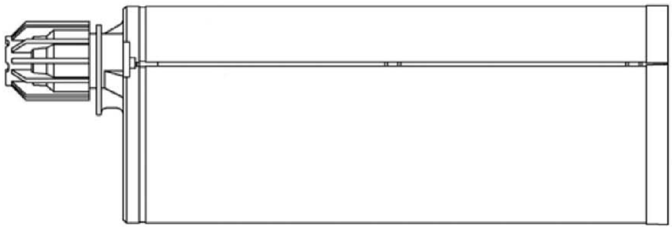
Injection System VME basic for concrete

Product description
Installation situation

Annex A1

Cartridge Injection Mortar VME basic

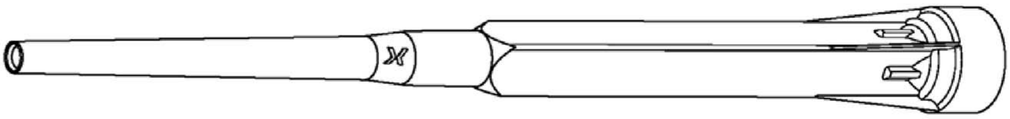
Side-by-side cartridge
440 ml,
585 ml,
1400 ml



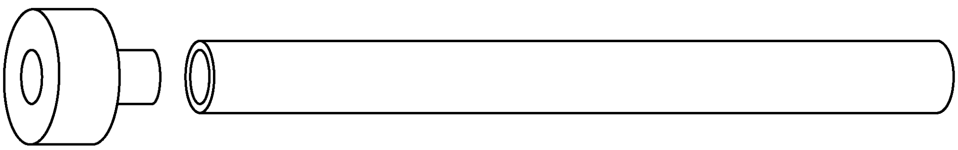
Imprint:

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

Static mixer



Retaining washer and extension nozzle

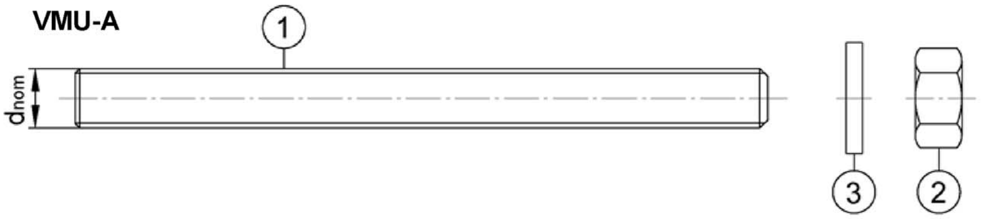


Injection System VME basic for concrete	Annex A2
Product description Cartridge, static mixer and retaining washer	

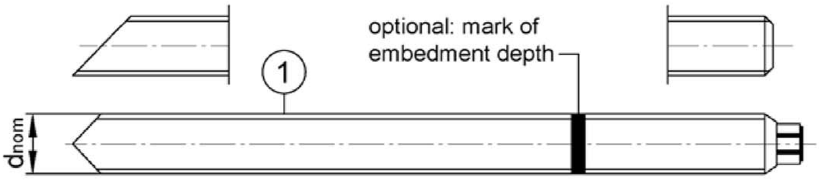
Threaded rod

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

VMU-A



V-A



Marking e.g.: ◇ M10

◇	identifying mark of manufacturing plant
M10	size of thread

<u>additional marking:</u>

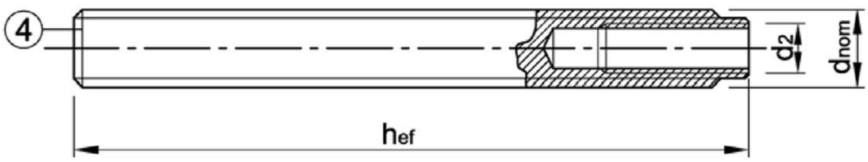
A4	stainless steel
HC	high corrosion resistant steel

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

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

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.: ◇I M8

◇	identifying mark of manufacturing plant
I	internal thread
M8	size of internal thread

<u>additional marking:</u>

A4	stainless steel
HCR	high corrosion resistant steel

Injection System VME basic for concrete	**Annex A3**
Product description Threaded rod and internally threaded anchor rod	

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

Part	Designation	Property class	characteristic ultimate strength f_{uk} [N/mm²]	characteristic yield strength f_{yk} [N/mm²]	fracture elongation	Material
Steel, zinc plated	electroplated ≥ 5 µm acc. to EN ISO 4042:2018 or; hot-dip galvanized ≥ 40 µm (50 µm in average) acc. to EN ISO 1461:2009, EN ISO 10684:2004+AC:2009 or; sherardized ≥ 45 µm acc. to EN ISO 17668:2016					
1	Threaded rod	4.6	400	240	A_5 > 8 %	EN ISO 683-4:2018 EN 10263:2001 Commercial standard threaded rod: EN ISO 898-1:2013
		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 > 8 %	
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 or 5.8 rods			
		8	for class 4.6, 4.8, 5.6, 5.8 or 8.8 rods			
3	Washer		e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000, EN ISO 887:2006			
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 [1] **Stainless steel A4** **High corrosion resistant steel HCR**	**CRC II** (e.g. 1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541) **CRC III** (e.g. 1.4401 / 1.4404 / 1.4571 / 1.4578) **CRC V** (e.g. 1.4529 / 1.4565)					
1	Threaded rod [2]	50	500	210	A_5 > 8%	EN 10088-1:2014 EN ISO 3506-1:2020
		70	700	450	A_5 > 8%	
		80	800	600	A_5 > 8%	
2	Hexagon nut [2]	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			
3	Washer		e.g.: EN ISO 7089:2000, EN ISO 7093:2000, EN ISO 7094:2000; EN ISO 887:2006			EN 10088-1:2014
4	Internally threaded anchor rod	50	IG-M20		A_5 > 8 %	EN 10088-1:2014
		70	IG-M6 to IG-M16		A_5 > 8 %	

[1] Property classes 50 and 70
[2] Property classes 70 and 80 up to M24

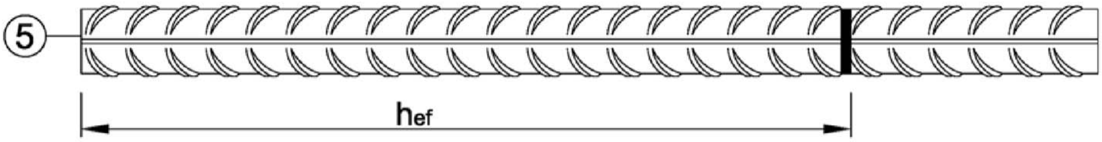
Injection System VME basic for concrete

Product description
Materials - Threaded rod and internally threaded anchor rod

Annex A4

Reinforcing bar

∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 24, ∅ 25, ∅ 28, ∅ 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 ≤ h ≤ 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 basic for concrete	**Annex A5**
Product description Product description and material reinforcing bar	

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Specification of intended use

Injections System VME basic	Threaded rod	Internally threaded anchor rod	Rebar
Static and quasi-static action	**M8 - M30**	**VMU-IG M6 – VMU-IG M20**	**Ø8 - Ø32**
Base material	cracked or uncracked concrete		
	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 I: -40°C to +40°C	max. long term temperature +24°C and max. short term temperature +40°C		
Temperature range II: -40°C to +60°C	max. long term temperature +35°C and max. short term temperature +60°C		
Temperature range III: -40°C to +70°C	max. long term temperature +43°C and max. short term temperature +70°C		

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 fastened. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports etc.)
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work
- Fasteners are designed in accordance with EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

Installation:

- Dry or wet concrete or waterfilled drill holes (not seawater)
- Hole drilling by hammer or compressed air drill or vacuum drill mode
- Overhead installation allowed
- Fastener installation carried out by appropriately qualified personnel and under the responsibility of the person competent for technical matters on 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

Injection System VME basic for concrete	Annex B1
Intended Use Specifications	

Table B1: 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
Diameter of clearance hole in the fixture – Through setting installation	$d_f \leq$	[mm]	12	14	16	20	24	30	33	40
Installation torque	$max.T_{inst} \leq$	[Nm]	10	20	40 (35)[1]	60	100	170	250	300
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm			$h_{ef} + 2d_0$				
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 M12 with steel grade 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]	$d=d_{nom}$	[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
Installation torque	$max.T_{inst} \leq$	[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_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$			
Minimum spacing	s_{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c_{min}	[mm]	40	45	50	60	65	80

[1] With metric thread acc. to EN 1993-1-8:2005+AC:2009

Table B3: Installation parameters for rebar

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

[1] For diameter ∅8, ∅10 and ∅12 both nominal drill hole diameter can be used

Injection System VME basic for concrete

Intended use
Installation parameters

Annex B2

Deutsches Institut für Bautechnik DIBt

Table B4: Parameter cleaning and setting tools

Threaded rod	Internally threaded anchor rod	Rebar	Drill bit ∅	Brush ∅	min. Brush ∅
					
[-]	[-]	∅ [mm]	d_0 [mm]	d_b [mm]	$d_{b,min}$ [mm]
M8		8	10	11,5	10,5
M10	VMU-IG M 6	8 / 10	12	13,5	12,5
M12	VMU-IG M 8	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			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 ∅ 		Installation direction and use		
d_0 [mm]	[-]	↓	→	↑
10	No retaining washer required			
12				
14				
16				
18	VM-IA 18	h_{ef} > 250mm	h_{ef} > 250mm	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
Drill bit diameter (d_0): all diameters
Vacuum drill bit (MKT Hollow drill bit SB, Würth Extraction Drill Bit or Heller Duster Expert) and a class M vacuum with minimum negative pressure of 253 hPa and a flow rate of minimum 42 l/s (150 m³/h)

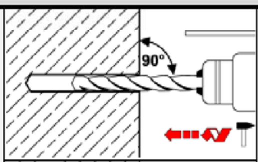
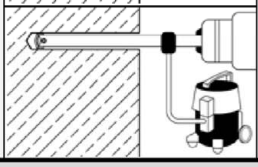
Recommended compressed air tool (min 6 bar)
Drill bit diameter (d_0): all diameters

Blow-out pump (volume 750ml)
Drill bit diameter (d_0): 10 mm to 20 mm
Drill hole depth (h_0): ≤ 10 d_{nom}
for uncracked concrete

Injection System VME basic for concrete	**Annex B3**
Intended Use Cleaning and setting tools	

Installation Instructions

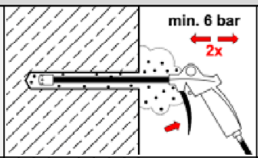
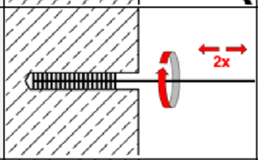
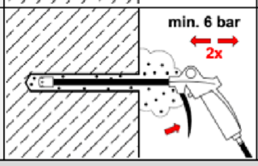
Drilling of the hole

1		**Hammer drill or compressed air drill** Drill with hammer drill or compressed air drill a hole into the base material to the size required by the selected fastener (Table B1, B2 or B3). Continue with <u>step 2.</u> In case of aborted drill hole, the drill hole shall be filled with mortar.
		**Vacuum drill bit**: see Annex B3 Drill hole into the base material to the embedment size and embedment depth required by the selected fastener (Table B1, B2 or B3). This drilling system removes dust and cleans the drill hole during drilling. Continue with <u>step 3</u>. In case of aborted hole, the drill hole shall be filled with mortar.

Cleaning (not applicable when using a vacuum drill)

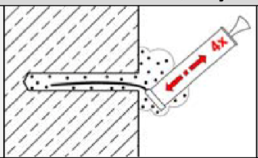
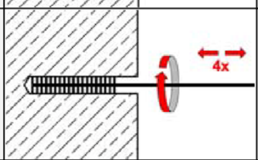
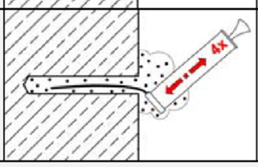
Attention! Standing water in the drill hole must be removed before cleaning!

<u>Cleaning with compressed air</u>
all substrates and diameters according to Annex B1

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 B4). Brush the hole with an appropriate sized wire brush ≥ $d_{b,min}$ (Table B4) 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.

2

<u>Manual cleaning</u>
uncracked concrete, dry or wet drill holes; drill hole diameter $d_0 \leq 20$mm and drill hole depth $h_0 \leq 10\ d_{nom}$

2a		Starting from the bottom or back of the drill hole, blow out the hole with the blow-out pump a minimum of **four** times until return air stream is free of noticeable dust.
2b		Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush ≥ $d_{b,min}$ (Table B4) a minimum of **four** 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 again a minimum of **four** times until return air stream is free of noticeable dust.

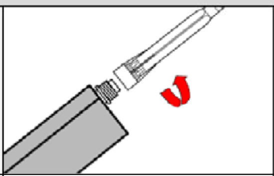
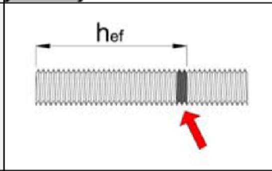
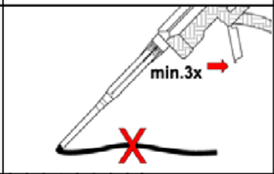
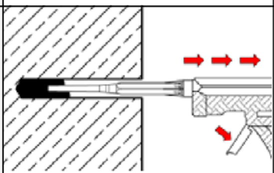
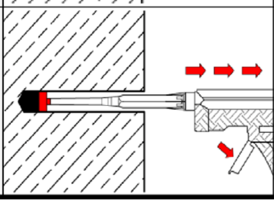
After cleaning, the drill hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the drill hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.

Injection System VME basic for concrete

Intended Use
Installation instructions

Annex B4

Installation instructions (continuation)

Injection		
3		Attach the supplied static mixer 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 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.
6a		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 working times given in Table B6.
6b		Retaining washer and mixer nozzle 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

Installation instructions (continuation)

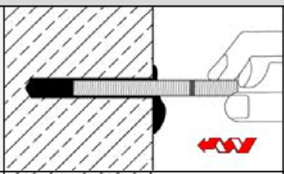
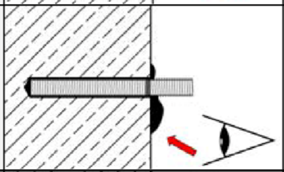
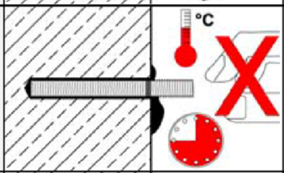
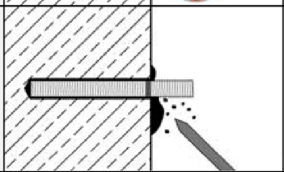
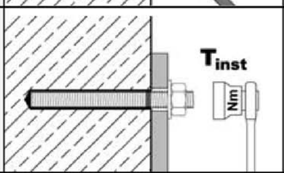
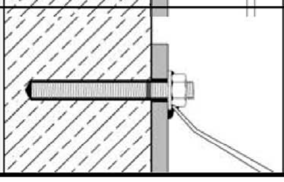
Setting the fastening element		
7		Push the fastening element into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached. The fastener shall be free of dirt, grease, oil or other foreign material.
8		After installation, the annular gap between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

Table B6: Working time and curing time

Concrete temperature	Working time	Minimum curing time	
		dry concrete	wet concrete
+5°C to +9°C	80 min	60 h	120 h
+10°C to +14°C	60 min	48 h	96 h
+15°C to +19°C	40 min	24 h	48 h
+20°C to +24°C	30 min	12 h	24 h
+25°C to +34°C	12 min	10 h	20 h
+35°C to +39°C	8 min	7 h	14 h
+40°C	8 min	4 h	8 h
Cartridge temperature	+ 5°C to + 40°C		

Injection System VME basic for concrete

Intended Use
Installation instructions (continuation) / Working and curing time

Annex B6

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)	23 (21)	34	63	98	141	184	224
Steel, zinc plated	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280
Steel, zinc plated	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
Stainless steel	A2, A4 and HCR Property class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-[3]	-[3]
Stainless steel	A4 and HCR Property class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-[3]	-[3]
Partial factor [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	A2, A4 and HCR Property class 50	$\gamma_{Ms,N}$	[-]	2,86							
Stainless steel	A2, A4 and HCR Property class 70	$\gamma_{Ms,N}$	[-]	1,87						-[3]	-[3]
Stainless steel	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 other national regulations

[3] Fastener version not part of the ETA

Injection System VME basic for concrete	Annex C1
Performance Characteristic values for **threaded rods** under **tension loads**	

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 resistances under shear load1)											
Steel failure <u>without</u> 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	-3)	-3)
	A4 and HCR, property class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-3)	-3)
Steel failure <u>with</u> 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 factor 2)											
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 other national regulations
3) Fastener version is not part of the ETA

Injection System VME basic for concrete	**Annex C2**
Performance Characteristic values for **threaded rods** under **shear loads**	

Table C3: Characteristic values of **concrete cone failure** and **splitting failure**

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]	$2,0 \cdot c_{cr,N}$
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]	$2,0 \cdot c_{cr,sp}$

Injection System VME basic for concrete

Performance
Characteristic values of **concrete cone failure** and **splitting failure**

Annex C3

Table C4: Characteristic values of **tension loads** for **threaded rods**

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	40°C / 24°C	$\tau_{Rk,ucr}$	[N/mm²]	15	15	15	14	14	13	13	13
	II	60°C / 35°C			10	10	10	9,5	9,5	9,0	9,0	9,0
	III	70°C / 43°C			7,0	7,0	7,0	6,5	6,5	6,0	6,0	6,0
Characteristic bond resistance in <u>cracked</u> concrete C20/25												
Temperature range	I	40°C / 24°C	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,0	7,0	7,0	6,0	6,0	6,0
	II	60°C / 35°C			5,0	5,0	5,0	5,0	5,0	4,5	4,5	4,5
	III	70°C / 43°C			3,5	3,5	3,5	3,5	3,5	3,0	3,0	3,0
Reduction factor ψ^0_{sus} in concrete C20/25												
Temperature range	I	40°C / 24°C	ψ^0_{sus}	[-]	0,60							
	II	60°C / 35°C										
	III	70°C / 43°C										
Increasing factors for τ_{Rk} $\tau_{Rk} = \psi_c \cdot \tau_{Rk}(C20/25)$			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 or water filled drill hole			γ_{inst}	[-]	1,4							

Injection System VME basic for concrete

Performance
Characteristic values of **tension loads** for **threaded rods**

Annex C4

Table C5: Characteristic values of **shear loads** for **threaded rods**

Threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic resistance steel, zinc plated, 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 resistance steel, zinc plated, class 8.8, stainless steel A2, A4 and HCR	$V^0_{Rk,s}$	[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}	[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 fastener	l_f	[mm]	min (h_{ef}; 12 d_{nom})						min (h_{ef}; 300mm)	
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

Injection System VME basic for concrete

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

Annex C5

Table C6: Characteristic values of **tension loads** for **internally threaded anchor rod**

Internally threaded anchor rod				**VMU-IG M6**	**VMU-IG M8**	**VMU-IG M10**	**VMU-IG M12**	**VMU-IG M16**	**VMU-IG M20**
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		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic resistance, stainless steel A4 / HCR, property class	70	$N_{Rk,s}$	[kN]	14	26	41	59	110	124 [2]
Partial factor		$\gamma_{Ms,N}$	[-]	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	$\tau_{Rk,ucr}$	[N/mm²]	15	15	14	14	13	13
	II: 60°C / 35°C			10	10	9,5	9,5	9,0	9,0
	III: 70°C / 43°C			7,0	7,0	6,5	6,5	6,0	6,0
Characteristic bond resistance in cracked concrete C20/25									
Temperature range	I: 40°C / 24°C	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	7,0	7,0	6,0	6,0
	II: 60°C / 35°C			5,0	5,0	5,0	5,0	4,5	4,5
	III: 70°C / 43°C			3,5	3,5	3,5	3,5	3,0	3,0
Reduction factor ψ^0_{sus} in concrete C20/25									
Temperature range	I: 40°C / 24°C	ψ^0_{sus}	[-]	0,60					
	II: 60°C / 35°C								
	III: 70°C / 43°C								
Increasing factors for τ_{Rk}; $\tau_{Rk} = \psi_c \cdot \tau_{Rk}(C20/25)$		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 or water filled drill hole		γ_{inst}	[-]	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

Table C7: Characteristic values of **shear loads** for **internally threaded anchor rod**

Internally threaded anchor rod					VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-IG M16	VMU-IG M20
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
	Characteristic resistance	property class 8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60	98
	Partial factor		$\gamma_{Ms,V}$	[-]	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
	Characteristic bending resistance	property class 8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
	Partial factor		$\gamma_{Ms,V}$	[-]	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 fastener			l_f	[mm]	min (h_{ef};12 d_{nom})					min (h_{ef}; 300mm)
Outside diameter of fastener			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: 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

Injection System VME basic for concrete

Performance
Characteristic values of **shear loads** for **internally threaded anchor rod**

Annex C7

Table C8: Characteristic values of **tension loads** for **rebar**

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			$N_{Rk,s}$	[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 <u>uncracked</u> concrete C20/25														
Temperature range	I:	40°C / 24°C	$\tau_{Rk,ucr}$	[N/mm²]	14	14	14	12	12	12	12	11	11	11
	II:	60°C / 35°C			9,5	9,5	9,5	8,5	8,5	8,5	7,5	7,5	7,5	7,5
	III:	70°C / 43°C			6,0	6,0	6,0	6,0	6,0	5,5	5,5	5,5	5,0	5,0
Characteristic bond resistance in <u>cracked</u> concrete C20/25														
Temperature range	I:	40°C / 24°C	$\tau_{Rk,cr}$	[N/mm²]	6,0	7,0	7,0	6,5	6,5	6,0	6,0	6,0	5,5	5,5
	II:	60°C / 35°C			4,0	4,5	4,5	4,5	4,0	4,0	4,0	4,0	3,5	3,5
	III:	70°C / 43°C			2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5
Reduction factor ψ^0_{sus} in concrete C20/25														
Temperature range	I:	40°C / 24°C	ψ^0_{sus}	[-]	0,60									
	II:	60°C / 35°C												
	III:	70°C / 43°C												
Increasing factor for τ_{Rk} $\tau_{Rk} = \psi_c \cdot \tau_{Rk}(C20/25)$			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 or water filled drill hole			γ_{inst}	[-]	1,4									

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

Injection System VME basic for concrete

Performance
Characteristic values of **tension loads** for **rebar**

Annex C8

Table C9: Characteristic values of **shear loads** for **rebar**

Reinforcing bar			**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 24**	**∅ 25**	**∅ 28**	**∅ 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	[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									
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}	[mm³]	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})							min (h_{ef}; 300mm)		
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

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Performance
Characteristic values of **shear loads** for **rebar**

Annex C9

Table C10: Displacement factor under tension load (threaded rod and internally threaded anchor rod)

Threaded rod			M8	M10 IG-M6	M12 IG-M8	M16 IG- M10	M20 IG-M12	M24 IG-M16	M27	M30 IG-M20
Displacement factor [1)] uncracked concrete, static and quasi-static action										
Temperature range I: 40°C / 24°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: 60°C / 35°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
Temperature range III: 70°C / 43°C	δ_{N0}-factor		0,042	0,043	0,044	0,048	0,052	0,056	0,057	0,061
	$\delta_{N\infty}$-factor		0,052	0,054	0,056	0,061	0,065	0,070	0,074	0,077
Displacement factor [1)] cracked concrete, static and quasi-static action										
Temperature range I: 40°C / 24°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		0,193	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 60°C / 35°C	δ_{N0}-factor		0,092	0,095	0,096	0,099	0,102	0,106	0,109	0,110
	$\delta_{N\infty}$-factor		0,259	0,154	0,163	0,172	0,181	0,189	0,207	0,229
Temperature range III: 70°C / 43°C	δ_{N0}-factor		0,101	0,105	0,106	0,109	0,112	0,117	0,120	0,121
	$\delta_{N\infty}$-factor		0,285	0,169	0,179	0,189	0,199	0,208	0,228	0,252

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

Table C11: Displacement factor under shear load (threaded rod and internally threaded anchor rod)

Threaded rod			M8	M10 IG-M6	M12 IG-M8	M16 IG- M10	M20 IG-M12	M24 IG-M16	M27	M30 IG-M20
Displacement factor [1)] cracked and uncracked concrete, static and quasi-static action										
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

[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;

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Performance Displacements (threaded rod and internally threaded anchor rod)	

Table C12: Displacement factor under tension load (rebar)

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor [1)] uncracked concrete, static and quasi-static action												
Temperature range I: 40°C / 24°C	δ_{N0}-factor	$[\frac{mm}{N/mm^2}]$	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
	$\delta_{N\infty}$-factor		0,015	0,015	0,016	0,017	0,017	0,019	0,020	0,020	0,021	0,023
Temperature range II: 60°C / 35°C	δ_{N0}-factor		0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	0,058
	$\delta_{N\infty}$-factor		0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	0,072
Temperature range III: 70°C / 43°C	δ_{N0}-factor		0,042	0,043	0,044	0,046	0,048	0,052	0,056	0,056	0,059	0,064
	$\delta_{N\infty}$-factor		0,052	0,054	0,056	0,058	0,061	0,065	0,072	0,072	0,075	0,079
Displacement factor [1)] cracked concrete, static and quasi-static action												
Temperaturbereich I: 40°C / 24°C	δ_{N0}-factor	$[\frac{mm}{N/mm^2}]$	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	0,084
	$\delta_{N\infty}$-factor		0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	0,194
Temperaturbereich II: 60°C / 35°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
Temperaturbereich III: 70°C / 43°C	δ_{N0}-factor		0,101	0,105	0,106	0,108	0,109	0,112	0,117	0,117	0,120	0,124
	$\delta_{N\infty}$-factor		0,169	0,179	0,189	0,199	0,208	0,228	0,252	0,252	0,266	0,286

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

Table C13: Displacement factor under shear load (rebar)

Rebar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement factor [1)] cracked and uncracked concrete, static and quasi-static action												
All temperature ranges	δ_{V0}-factor	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	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

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

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Performance
Displacements (rebar)

Annex C11