Technical and Test Institute for Construction Prague
Prosecká 811/76a
190 00 Prague
Czech Republic
eota@tzus.cz

Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
www.eota.eu

European Technical Assessment

ETA 16/0898 of 07/03/2025

Technical Assessment Body issuing the ETA: Technical and Test Institute for Construction Prague	
Trade name of the construction product	Injection System VM-EA
Product family to which the construction product belongs	Product area code: 33 Bonded injection type anchor for use in uncracked concrete
Manufacturer	MKT Metall-Kunststoff-Technik GmbH & Co.KG Auf dem Immel 2 D-67685 Weilerbach Germany
Manufacturing plant(s)	Werk 1, D and Werk 2, D
This European Technical Assessment contains	19 pages including 16 Annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	EAD 330499-02-0601
This version replaces	ETA 16/0898 issued on 25/04/2020

1. Technical description of the product

The Injection System VM-EA, VM-EA blue, VM-EA express, VM-EA low speed for uncracked concrete is a bonded anchor consisting of a cartridge with injection mortar and a steel element. The steel elements consists of a threaded rod, a hexagon nut and a washer or an internaly threaded anchor rod. The steel elements are made of galvanized steel, stainless steel or high corrosion resistant steel.

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 illustration and the description of the product are given in Annex A.

2. Specification of the intended use in accordance with the applicable EAD

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 provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 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 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)	Annex C1, C2, C3, C5
Characteristic resistance to shear load (static and quasi-static loading)	Annex C1, C4, C6
Displacements under short term and long-term loading	Annex C7
Durability	Annex B1
Characteristic resistance and displacements for seismic performance categories C1 and C2	NPA

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Satisfy the requirements for performance class A1
Resistance to fire	NPA

3.3 Hygiene, health and environment (BWR 3)

No performance determined.

3.4 General aspects relating to fitness for use

Durability and serviceability are only ensured if the specifications of intended use according to Annex B 1 are kept.

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

According to the Decision 96/582/EC of the European Commission[1] the system of assessment verification of constancy of performance (See Annex V to Regulation (EU) No 305/2011) given in the following table applies.

[1] Official Journal of the European Communities L 254 of 08.10.1996

Product	Intended use	Level or class	System
Metal anchors for use in concrete	For fixing and/or supporting to concrete, structural elements (which contributes to the stability of the construction works) or heavy units	-	1

5. Technical details necessary for the implementation of the AVCP system, as provided in the applicable EAD

The factory production control shall be in accordance with the control plan which is a part of the technical documentation of this European Technical Assessment. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Technický a zkušební ústav stavební Praha, s.p.[2] The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

Issued in Prague on 07.03.2025

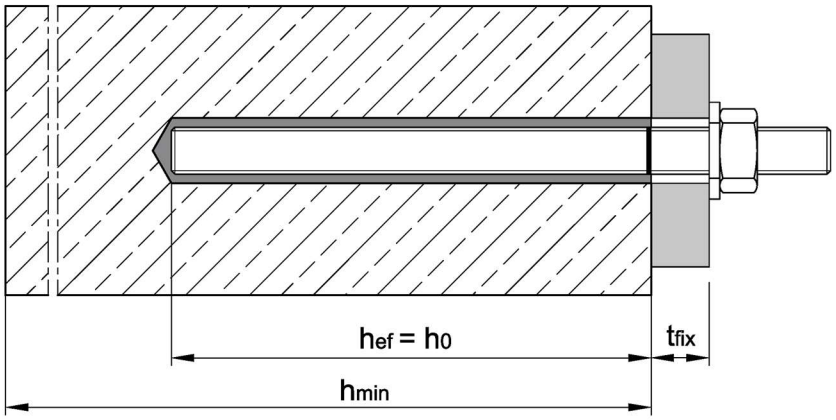
By

Ing. Jiří Studnička Ph.D.
Head of the Technical Assessment Body

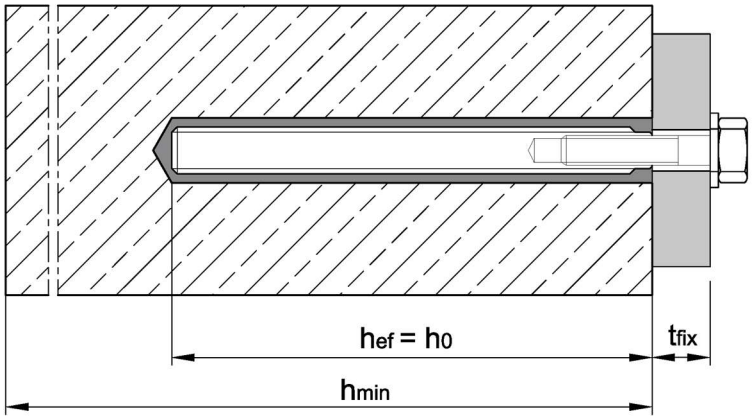
[2] The control plan is a confidential part of the documentation of the European Technical Assessment, but not published together with the ETA and only handed over to the approved body involved in the procedure of AVCP.

Installation threaded rod M8 up to M24

Prepositioned installation or push through installation (optional annular gap filled with mortar)



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



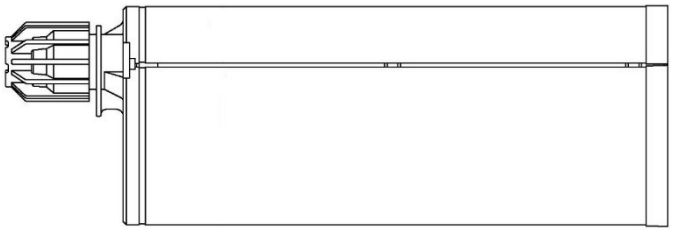
t_{fix} = thickness of fixture
h_{ef} = effective embedment depth
h_{min} = minimum thickness of member
h_0 = depth of drill hole

Injection System VM-EA for concrete	
Product description Installed conditions	**Annex A1**

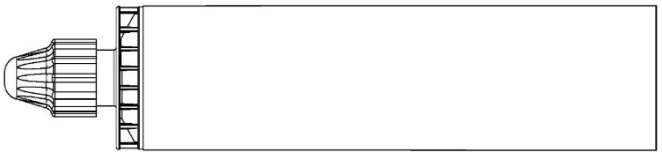
Cartridge: VM-EA, VM-EA blue, VM-EA express, VM-EA low speed

Coaxial cartridge
150 ml, 160ml, 280 ml,
300 ml to 330 ml,
380 ml to 420 ml

Side-by-side cartridge
235 ml,
345 ml to 360 ml,
825 ml



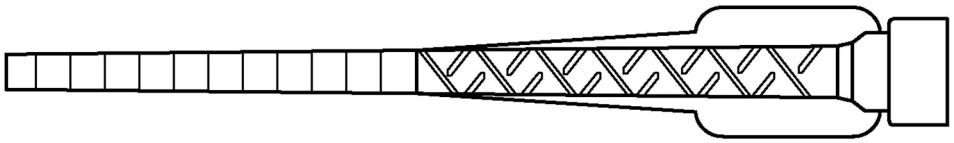
Foil tube cartridge
165 ml
300 ml



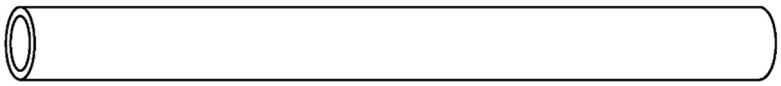
Cartridge imprint:
VM-EA, VM-EA express, VM-EA blue or VM-EA low speed
processing and safety instructions, shelf life, charge number, manufacturer's information, quantity information

Static mixer

VM-X



Mixer extension



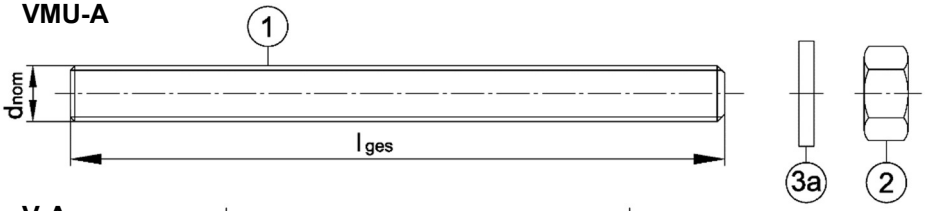
Injection System VM-EA for concrete	
Product description Injection system	**Annex A2**

Threaded rods

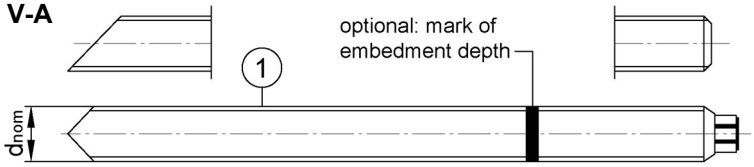
Threaded rod VMU-A and V-A

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

VMU-A



V-A



Marking e.g.: ◇ M10

◇ identifying mark of manufacturing plant

M10 size of thread

additional marking:

-8 strength class 8.8

A4 stainless steel

HC high corrosion resistant steel

Threaded rod VM-A (material sold by the metre, to be cut at the required length)

M8, M10, M12, M16, M20, M24 (zinc plated, A2, A4, HCR)

- Materials, dimensions and mechanical properties see Table A1

Commercial standard threaded rod with:

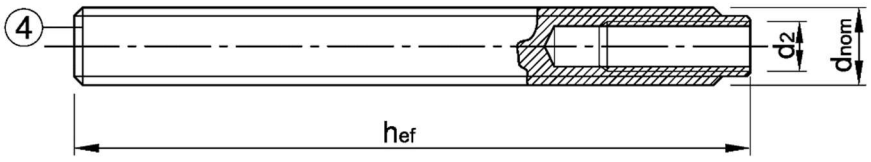
M8, M10, M12, M16, M20; M24 (zinc plated, A2, A4, HCR)

- Materials, dimensions and mechanical properties see Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004 (documents must be retained)

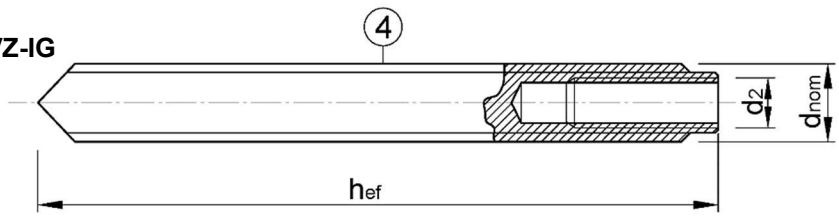
Internally threaded anchor rods VMU-IG and VZ-IG

IG M6, IG M8, IG M10, IG M16
(zinc plated, A4, HCR)

VMU-IG



VZ-IG



Marking e.g.: ◇ M8

◇ identifying mark of manufacturing plant

I internal thread (optional)

M8 size of internal thread

additional marking:

-8 strength class 8.8

A4 stainless steel

HCR high corrosion resistant steel

Injection System VM-EA for concrete	
Product description Threaded rod and internally threaded anchor rods	**Annex A3**

Table A1: Materials

Part	Designation	Material and mechanical properties						
Steel, zinc plated electroplated ≥ 5 µm acc. to EN ISO 4042:2022 or hot-dip galvanized ≥ 50 µm in average acc. to EN ISO 1461:2022, EN ISO 10684:2004+AC:2009 or sherardized ≥ 45 µm acc. to EN ISO 17668:2016								
1	Threaded rod	Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN ISO 683-4:2018, EN 10263:2017 Commercial standard threaded rod: EN ISO 898-1:2013
		4.6	f_{uk} [N/mm²]	400	f_{yk} [N/mm²]	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 > 8 %	
2	Hexagon nut	4	for class 4.6 or 4.8 rods					EN ISO 898-2:2022
		5	for class 4.6, 4.8, 5.6 or 5.8 rods					
		8	for class 4.6, 4.8, 5.6, 5.8 or 8.8 rods					
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 [3]	5.8	Steel, electroplated or sherardized				A_5 > 8%	EN ISO 683-4:2018
		8.8					A_5 > 8%	
Stainless steel A2 [1] **CRC II** (1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541) **Stainless steel A4** **CRC III** (1.4401 / 1.4404 / 1.4571 / 1.4578) **High corrosion resistant steel HCR** **CRC V** (1.4529 / 1.4565)								
1	Threaded rod	Property class	characteristic ultimate strength		characteristic yield strength		fracture elongation	EN 10088-1:2014 EN ISO 3506-1:2020
		50	f_{uk} [N/mm²]	500	f_{yk} [N/mm²]	210	A_5 > 8%	
		70		700		450 (560) [2]	A_5 > 8 %	
		80		800		600 (640) [2]	A_5 > 8 %	
2	Hexagon nut	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 [3]	70	stainless steel A4; high corrosion resistant steel HCR				A_5 > 8 %	EN 10088-1:2014

[1] Property class 50 and 70
[2] Value in brackets for anchor rods VMU-A and V-A
[3] Using VMU-IG or VZ-IG, screws or 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 VM-EA for concrete

Product description
Materials

Annex A4

Specifications of intended use

Injection System VM-EA		Anchor rod	Internally threaded anchor rod
Static or quasi-static action		**VMU-A, V-A, VM-A,** commercial standard threaded rod M8 – M24 zinc plated, A2, A4, HCR	**VMU-IG, VZ-IG** M6 - M16 electroplated or sherardized, A4, HCR
Base materials		reinforced or unreinforced normal weight concrete acc. to EN 206:2013+A2:2021	
		strength classes acc. to EN 206:2013+A2:2021: C20/25 to C50/60	
		uncracked concrete	
Temperature Range I:	24°C / 40°C	Temperature range from -40°C to +40°C with max. long term temperature +24°C and max. short term temperature +40 °C	
Temperature Range II:	50°C / 80°C	Temperature range from -40°C to +80°C with max. long term temperature +50°C and max. short term temperature +80 °C	

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+A2:2020 corresponding to corrosion resistance class:
  - Stainless steel A2 according to Annex A 4, Table A1: CRC II
  - Stainless steel A4 according to Annex A 4, Table A1: CRC III
  - High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored.
  The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work.
- The fasteners are designed in accordance to EN 1992-4:2018

Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer drill (HD) or compressed air drill mode (CD).
- Overhead installation allowed.
- Fastener installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

Injection System VM-EA for concrete	**Annex B1**
Intended use Specifications	

Table B1: Installation parameters for threaded rod

Threaded rod			M8	M10	M12	M16	M20	M24
Diameter of threaded rod	$d=d_{nom}$	[mm]	8	10	12	16	20	24
Nominal drill hole diameter	d_0	[mm]	10	12	14	18	24	28
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	80	90	96
	$h_{ef,max}$	[mm]	160	200	240	320	400	480
Diameter of clearance hole in the fixture – Pre-setting installation	$d_f \leq$	[mm]	9	12	14	18	22	26
Diameter of clearance hole in the fixture – Through-setting installation	$d_f \leq$	[mm]	12	14	16	20	24	30
Installation torque	$T_{inst} \leq$	[Nm]	10	20	40	80	120	160
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	80	100	120
Minimum edge distance	c_{min}	[mm]	40	50	60	80	100	120

Table B2: Installation parameters for internally threaded anchor rod

Internally threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16
Inner diameter of threaded rod	d_2	[mm]	6	8	10	12	16
Outer diameter of threaded rod[1)]	$d=d_{nom}$	[mm]	10	12	16	20	24
Nominal drill hole diameter	d_0	[mm]	12	14	18	24	28
Effective anchorage depth	$h_{ef,min}$	[mm]	60	70	80	90	96
	$h_{ef,max}$	[mm]	200	240	320	400	480
Diameter of clearance hole in the fixture[1)]	$d_f \leq$	[mm]	7	9	12	14	18
Installation torque	$T_{inst} \leq$	[Nm]	10	10	20	40	60
Minimum screw-in depth	l_{IG}	[mm]	8	8	10	12	16
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm		h_{ef} + $2d_0$		
Minimum spacing	s_{min}	[mm]	50	60	80	100	120
Minimum edge distance	c_{min}	[mm]	50	60	80	100	120

Injection System VM-EA for concrete

Intended use
Installation parameters

Annex B2

Table B3: Parameter cleaning tools

Threaded rod	Internally threaded anchor rod	Drill bit - ∅	Brush	Brush - ∅	min. Brush - ∅
[-]	[-]	d_0 [mm]	[-]	d_b [mm]	$d_{b,min}$ [mm]
M8	-	10	RB 10	12	10,5
M10	IG M6	12	RB 12	14	12,5
M12	IG M8	14	RB 14	16	14,5
M16	IG M10	18	RB 20	20	18,5
M20	IG M12	24	RB 24	26	24,5
M24	IG M16	28	RB 28	30	28,5

Compressed air tool
(min 6 bar)
all applications

Blow-out pump
(volume 750ml)
Drill bit diameter: $d_0 \leq 20$ mm
Drill hole depth: $h_0 \leq 10\ d_{nom}$

Cleaning brush RB

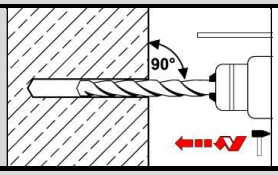
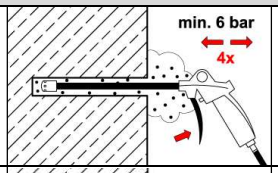
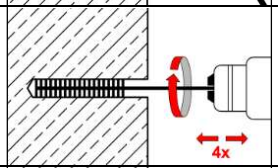
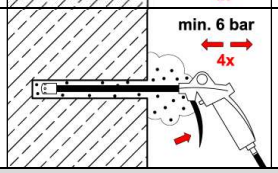
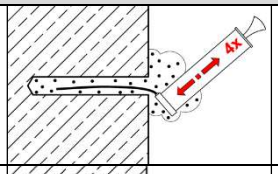
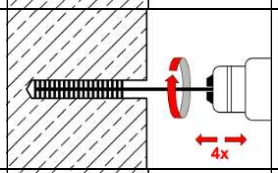
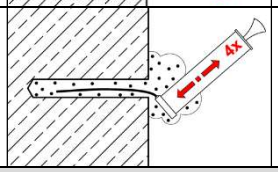
Table B4: Maximum working and minimum curing time

Concrete temperature [°C]	VM-EA low speed		VM-EA, VM-EA blue [1)]		VM-EA express	
	working time	minimum curing time	working time	minimum curing time	working time	minimum curing time
-10 to -6°C	-	-	-	-	60 min	4 h
-5 to -1°C	-	-	90 min	6 h	45 min	2 h
0 to +4°C	-	-	45 min	3 h	25 min	80 min
+5 to +9°C	-	-	25 min	2 h	10 min	45 min
+10 to +14°C	30 min	5 h	20 min	100 min	4 min	25 min
+15 to +19°C	20 min	210 min	15 min	80 min	3 min	20 min
+20 to +29°C	15 min	145 min	6 min	45 min	2 min	15 min
+30 to +34°C	10 min	80 min	4 min	25 min	-	-
+35 to +39°C	6 min	45 min	2 min	20 min	-	-
+40 to +44°C	4 min	25 min	-	-	-	-
+45 °C	2 min	20 min	-	-	-	-
Cartridge temperature	**+5°C to +45°C**		**+5°C to +40°C**		**0°C to +30°C**	

The VM-EA blue injection mortar has a curing time proof by changing the color from blue to grey after minimum curing time. The curing time proof is only valid for the standard version of the mortar.

Injection System VM-EA for concrete	**Annex B3**
Intended use Parameter of cleaning tools Working and curing time	

Installation instructions

Drilling of the hole		
1		Drill hole into the base material to the size required by the selected anchor (Table B1 or B2). In case of aborted drill hole, the drill hole shall be filled with mortar.
Cleaning		
2	**Attention! Standing water in the drill hole must be removed before cleaning!**	
	<u>Cleaning with compressed air</u> (all diameters)	
	2a 	Starting from the bottom or back of the drill hole, blow out the hole with compressed air (min. 6 bar) a minimum of **four** times. If the drill hole ground is not reached, an extension must be used.
	2b 	Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B3) a minimum of **four** times. If the drill hole ground is not reached, a brush extension shall be used.
	2c 	Finally blow the hole clean again with compressed air (min. 6 bar) a minimum of **four** times. If the drill hole ground is not reached an extension shall be used.
	<u>Manual cleaning</u> Drill hole diameter $d_0 \leq 20$mm or drill hole depth $h_0 \leq 10d_{nom}$	
	2a 	Starting from the bottom or back of the drill hole, blow the hole clean with the blow-out pump minimum of **four** times. If the drill hole ground is not reached an extension shall be used.
	2b 	Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B3) a minimum of **four** times. If the drill hole ground is not reached, a brush extension shall be used.
	2c 	Finally blow the hole clean again with the blow-out pump a minimum of **four** times. If the drill hole ground is not reached an extension shall be used.
	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 repeated has to be directly before dispensing the mortar. In-flowing water must not contaminate the drill hole again.	

Injection System VM-EA for concrete

Intended use
Installation instructions

Annex B4

Installation instructions (continuation)

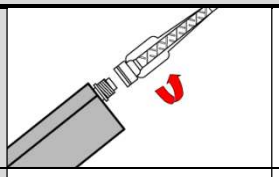
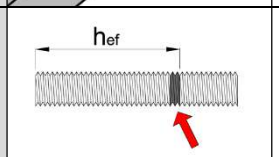
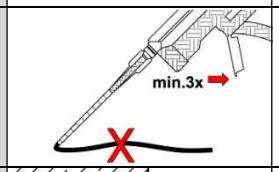
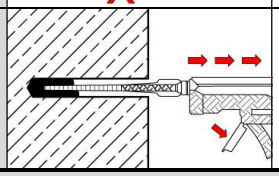
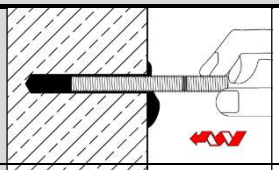
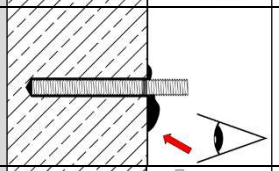
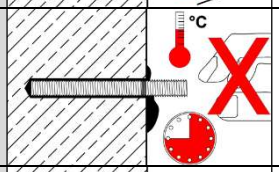
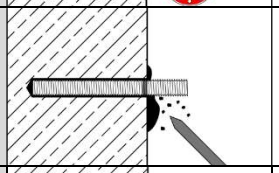
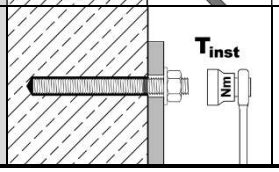
Injection		
3		Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For foil tube cartridges: cut off the foil tube clip before use. For every working interruption longer than the recommended working time (Table B4) as well as for new cartridges, a new static-mixer shall be used.
4		Position of the embedment depth shall be marked on the anchor rod. The anchor shall be free of dirt, grease, oil or other foreign material.
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 blue (VM-EA blue) color. For foil tube cartridges discard a minimum of six full strokes.
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. For embedment larger than 190mm an extension nozzle shall be used. Observe the gel-/ working times given in Table B4.
Inserting the anchor		
7		Push the threaded rod into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.
8		Make sure that the anchor is fully seated up to the full embedment depth and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead installation, the anchor 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 anchor until it is fully cured (attend Table B4).
10		Remove excess mortar.
11		The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B1 or B2.

Table C1: Characteristic **steel resistance** for **threaded rods**

Threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
Steel failure									
Cross section area		A_s	[mm²]	36,6	58,0	84,3	157	245	353
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
	Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	79	123	177
	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	126	196	282
Stainless steel	A2, A4 and HCR, property class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177
	A2, A4 and HCR, property class 70	$N_{Rk,s}$	[kN]	26	41	59	110	172	247
	A4 and HCR, property class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282
Partial factor [2]									
Steel, zinc plated	Property class 4.6 and 5.6	$\gamma_{Ms,N}$	[-]	2,0					
	Property class 4.8, 5.8 and 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 (1,5) [3]					
	A4 and HCR, property class 80	$\gamma_{Ms,N}$	[-]	1,6 (1,5) [3]					
Characteristic resistance under shear load [1]									
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
	Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106
	Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141
Stainless steel	A2, A4 and HCR, property class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88
	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 <u>with</u> lever arm - Characteristic bending moment									
Steel, zinc plated	Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449
	Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	325	561
	Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	898
Stainless steel	A2, A4 and HCR, property class 50	$M^0_{Rk,s}$	[Nm]	19	37	65	166	325	561
	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	785
	A4 and HCR, property class 80	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898
Partial factor [2]									
Steel, zinc plated	Property class 4.6 and 5.6	$\gamma_{Ms,V}$	[-]	1,67					
	Property class 4.8, 5.8 and 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 (1,25) [3]					
	A4 and HCR, property class 80	$\gamma_{Ms,V}$	[-]	1,33 (1,25) [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 regulation

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

Injection System VM-EA for concrete

Performances
Characteristic values for steel resistance of threaded rods

Annex C1

Table C2: Characteristic values of **concrete cone failure and splitting failure**

Threaded rods / Internally threaded anchor rods				**all sizes**
Concrete cone failure				
Factor k_1	uncracked concrete	$k_{ucr,N}$	[-]	11,0
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]	$2,0 \cdot c_{cr,sp}$

Table C3: Characteristic values of tension load for threaded rods

Threaded rod			M8	M10	M12	M16	M20	M24
Steel failure								
Characteristic tension resistance	$N_{Rk,s}$	[kN]	$A_s * f_{uk}$ (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: 24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,0	8,0	8,0	8,0	8,0
Temperature range II: 50°C / 80°C	$\tau_{Rk,ucr}$	[N/mm²]	6,5	6,0	6,0	6,0	6,0	6,0
Reduction factor ψ^0_{sus} in uncracked concrete C20/25								
Temperature range I: 24°C / 40°C	ψ^0_{sus}	[-]	0,60					
Temperature range II: 50°C / 80°C	ψ^0_{sus}	[-]	0,71					
Characteristic bond resistance in uncracked concrete > C20/25								
Increasing factors for $\tau_{Rk,ucr}$ $\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr\,(C20/25)}$	ψ_c	[-]	$(f_{ck} / 20)^{0,2}$					
Concrete cone failure								
Relevant parameter			see Table C3					
Splitting failure								
Relevant parameter			see Table C3					
Installation factor								
for all installation conditions	γ_{inst}	[-]	1,2					

Injection System VM-EA for concrete

Performances
Characteristic values of tension load – threaded rod

Annex C3

Table C4: Characteristic values of shear load - threaded rods

Threaded rod			M8	M10	M12	M16	M20	M24
Steel failure <u>without</u> lever arm								
Characteristic shear resistance Steel, zinc plated 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 C1					
Characteristic shear resistance Steel, property 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 C1					
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1					
Ductility factor	k_7	[-]	1,0					
Steel failure <u>with</u> lever arm								
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$ or see Table C1					
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1					
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})					
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24
Installation factor								
for all installation conditions	γ_{inst}	[-]	1,0					

Table C5: Characteristic values of tension load - internally threaded anchor rods

Internally threaded anchor rod				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16
Steel failure [1]								
Characteristic resistance under tension load								
Steel, zinc plated	Property class 5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76
	Property class 8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121
	Partial factor	$\gamma_{Ms,N}$	[-]	1,5				
Stainless steel	A4 / HCR, property class 70	$N_{Rk,s}$	[kN]	14	26	41	59	110
	Partial factor	$\gamma_{Ms,N}$	[-]	1,87				
Combined pull-out and concrete failure								
Characteristic bond resistance in uncracked concrete C20/25								
Temperature range I:	24°C / 40°C	$\tau_{Rk,ucr}$	[N/mm²]	8,0	8,0	8,0	8,0	8,0	8,0
Temperature range II:	50°C / 80°C	$\tau_{Rk,ucr}$	[N/mm²]	6,0	6,0	6,0	6,0	6,0	6,0
Reduction factor ψ^0_{sus} in uncracked concrete C20/25								
Temperature range I:	24°C / 40°C	ψ^0_{sus}	[-]	0,60				
Temperature range II:	50°C / 80°C	ψ^0_{sus}	[-]	0,71				
Characteristic bond resistance in uncracked concrete > C20/25								
Increasing factors for $\tau_{Rk,ucr}$ $\tau_{Rk,ucr} = \psi_c \cdot \tau_{Rk,ucr\,(C20/25)}$		ψ_c	[-]	$(f_{ck} / 20)^{0,2}$				
Concrete cone failure								
Relevant parameter				see Table C3				
Splitting failure								
Relevant parameter				see Table C3				
Installation factor								
All installation conditions		γ_{inst}	[-]	1,2				

[1] Fastening screws or threaded rods (incl. nut and washer) must comply with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

Table C6: Characteristic values of shear load for internally threaded anchor rod

Internally threaded anchor rod				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16
Steel failure[1] without lever arm								
Characteristic resistance under shear load								
Steel, zinc plated	property class 5.8	$V^0_{Rk,s}$	[kN]	6	10	17	25	45
	property class 8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60
	Partial factor	$\gamma_{Ms,V}$	[-]	1,25				
Stainless steel	A4 / HCR property class 70	$V^0_{Rk,s}$	[kN]	7	13	20	30	55
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56				
Ductility factor		k_7	[-]	1,0				
Steel failure[1] with lever arm								
Characteristic bending resistance								
Steel, zinc plated	property class 5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167
	property class 8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267
	Partial factor	$\gamma_{Ms,V}$	[-]	1,25				
Stainless steel	A4 / HCR property class 70	$M^0_{Rk,s}$	[Nm]	11	26	53	92	234
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56				
Concrete pry-out failure								
Pry-out factor		k_8	[-]	2,0				
Concrete edge failure								
Effective length of anchor		l_f	[mm]	$l_f = \min(h_{ef};\ 12\ d_{nom})$				
Outside diameter of anchor		d_{nom}	[mm]	10	12	16	20	24
Installation factor								
All installation conditions		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. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.

Injection System VM-EA for concrete

Performances
Characteristic values of shear loads – internally threaded anchor rod

Annex C6

Table C7: Displacement under tension load[1)]

Threaded rod			M8	M10	M12	M16	M20	M24
Internally threaded anchor rod			-	IG-M6	IG-M8	IG-M10	IG-M12	IG-M16
Uncracked concrete C20/25								
Temperature range I: 24°C / 40°C	δ_{N0}-factor	[mm/(N/mm²)]	0,03	0,04	0,05	0,07	0,08	0,10
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,07	0,08	0,08	0,08	0,08	0,10
Temperature range II: 50°C / 80°C	δ_{N0}-factor	[mm/(N/mm²)]	0,02	0,03	0,03	0,04	0,04	0,05
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,15	0,17	0,17	0,17	0,17	0,17

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

Table C8: Displacement under shear load[1)]

Threaded rod			M8	M10	M12	M16	M20	M24
Internally threaded anchor rod			-	IG-M6	IG-M8	IG-M10	IG-M12	IG-M16
Uncracked concrete C20/25								
All temperature ranges	δ_{V0}-factor	[mm/(kN)]	0,02	0,02	0,01	0,01	0,01	0,01
	$\delta_{V\infty}$-factor	[mm/(kN)]	0,03	0,02	0,02	0,01	0,01	0,01

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

Injection System VM-EA for concrete

Performances
Displacements

Annex C7