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 25/04/2020

(English language translation, the original version in Czech language)

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 Deutschland
Manufacturing plant(s)	Werk 1, D and Werk 2, D
This European Technical Assessment contains	18 pages including 15 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
This version replaces	ETA 16/0898 issued on 22/11/2016

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

1. Technical description of the product

The VM-EA, VM-EA blue, VM-EA express and VM-EA low speed modified Epoxy acrylate resin without styrene 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 internally threaded anchor rod. The steel elements are made of zinc plated 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, C4
Characteristic resistance to shear load (static and quasi-static loading)	Annex C1, C3, C5
Displacements under short term and long term loading	Annex C6
Durability	Annex B1

3.2 Hygiene, health and environment (BWR 3)

No performance determined.

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if the specifications of intended use according to Annex B1 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.

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

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

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

5.1 Tasks of the manufacturer

The manufacturer may only use raw materials stated in the technical documentation of this European Technical Assessment.

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.

5.2 Tasks of the notified bodies

The notified body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The notified certification body involved by the manufacturer shall issue an certificate of constancy of performance of the product stating the conformity with the provisions of this European Technical assessment.

In cases where the provisions of the European Technical Assessment and its control plan are no longer fulfilled the notified body shall withdraw the certificate of constancy of performance and inform Technický a zkušební ústav stavební Praha, s.p without delay.

Issued in Prague on 25.04.2020

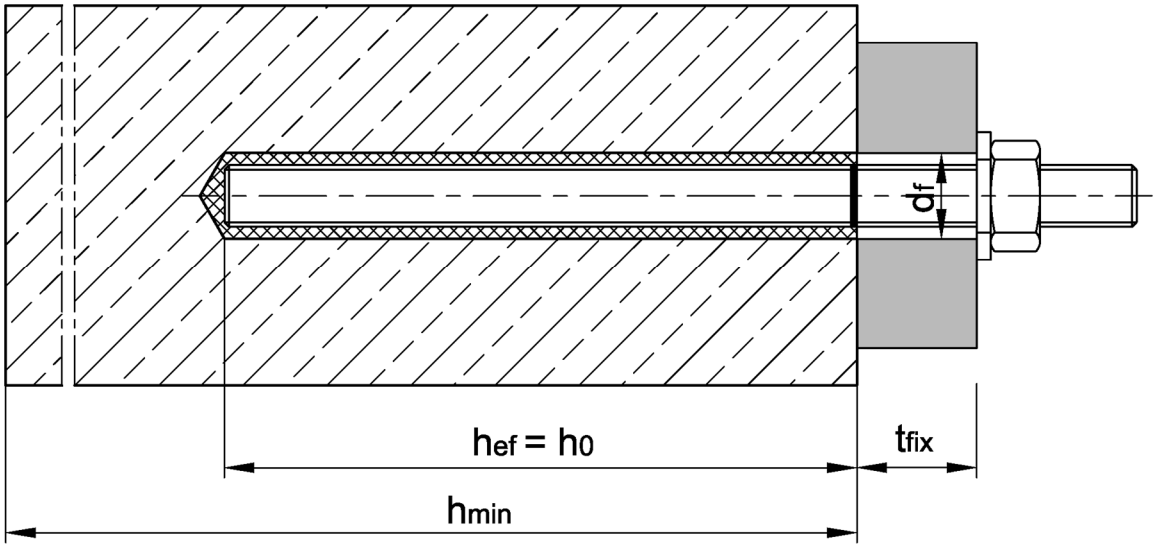
By

Ing. Mária Schaan
Head of the Technical Assessment Body

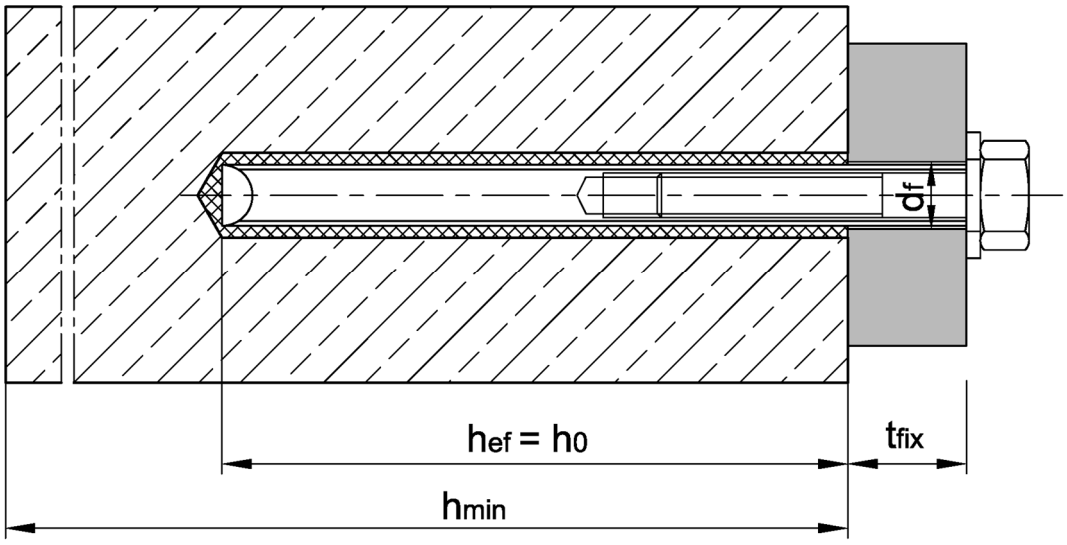
TECHNICKÝ A ZKUŠEBNÍ ÚSTAV STAVEBNÍ PRAHA, s.p.
Technical and Test Institute for Construction Prague, SOE
ZÚS
Czech Republic
Technical Assessment Body
Subjekt pro technické posuzování

[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 to M24



Installation internally threaded anchor rod VMU-IG M6 to M16



t_{fix} = thickness of fixture

d_f = diameter of clearance hole in the fixture

h_{ef} = effective embedment depth

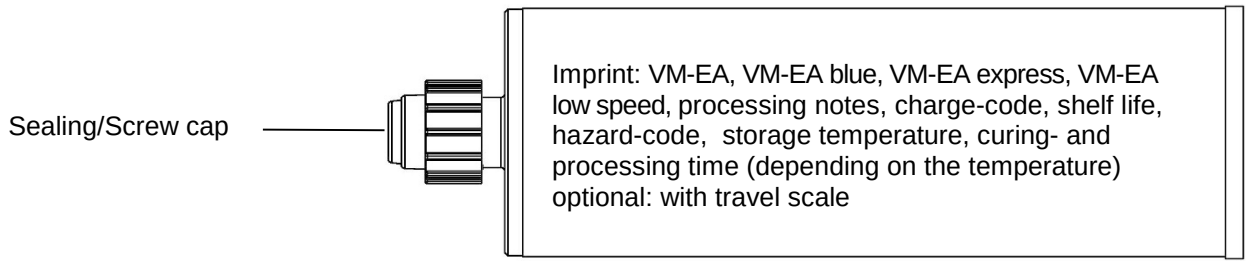
h_0 = depth of drill hole

h_{min} = minimum thickness of member

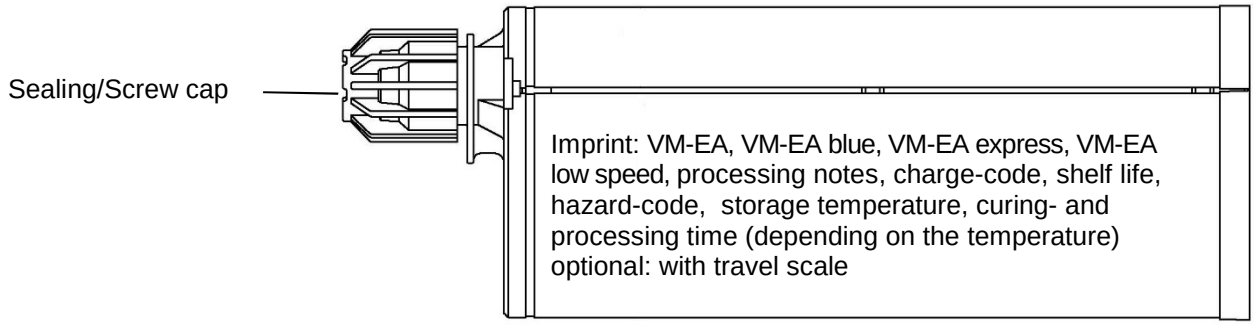
Injection System VM-EA for concrete	**Annex A1**
Product description Installation conditions	

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

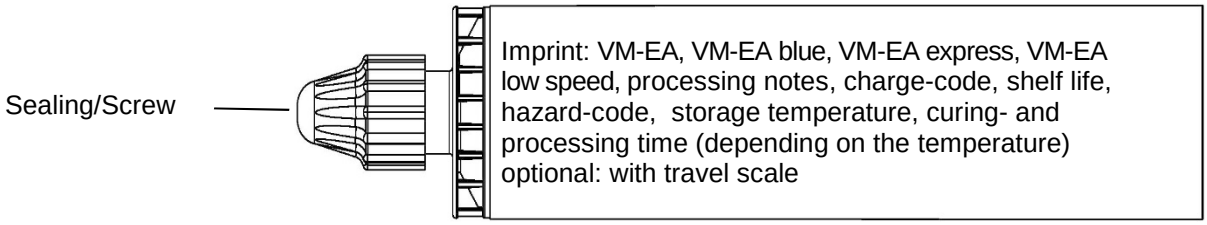
150 ml, 280 ml, 300 ml up to 330 ml and 380 ml up to 420 ml cartridge (Type: coaxial)



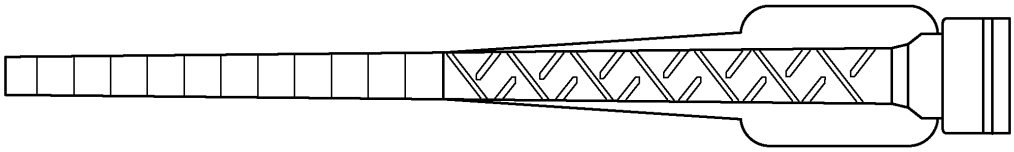
235 ml, 345 ml up to 360 ml and 825 ml cartridge (Type: "side-by-side")



165 ml and 300 ml cartridge (Type: "foil tube")



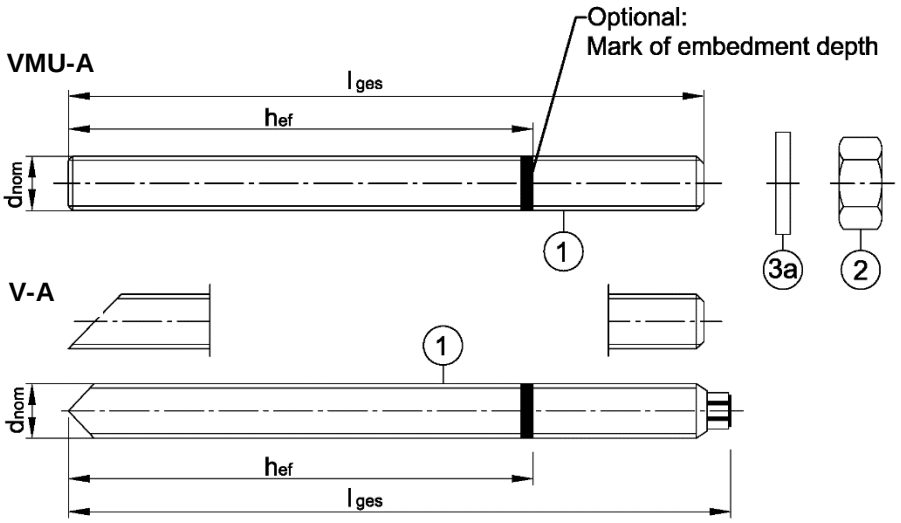
Static mixer



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

Threaded rod

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



Marking: e.g. ◇ M10

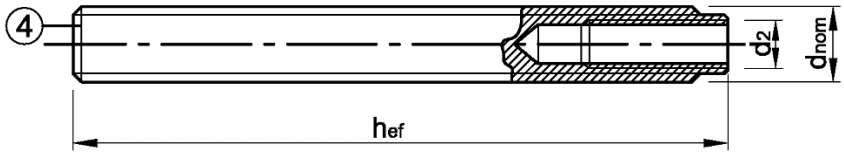
◇	Identifying mark of manufacturing plant
M10	Size of thread
A4	additional marking for stainless steel
HCR	additional marking for High corrosion resistant steel

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)

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

Internally threaded anchor rod

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



Marking e.g.: ◇ I M8

◇	Identifying mark of manufacturing plant
I	Internal thread
M8	Size of internal thread
A4	additional marking for stainless steel
HCR	additional marking for high corrosion resistant steel

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

Table A1: Materials

Part	Designation		Material			
Steel, zinc plated electroplated ≥ 5 µm hot-dip galvanized ≥ 45 µm sherardized ≥ 45 µm			acc. to EN ISO 4042:1999 or acc. to EN ISO 1461:2009, EN ISO 10684:2004+AC:2009 or acc. to EN ISO 17668:2016			
1	Threaded rod	Property class	characteristic steel ultimate strength	characteristic steel yield strength	fracture elongation	EN 10087:1998, EN 10263:2001; Commercial standard threaded rod: EN ISO 898-1:2013
		4.6	f_{uk}≥ 400 N/mm²;	f_{yk}≥ 240 N/mm²;	A_5 > 8 %	
		4.8	f_{uk}≥ 400 N/mm²	f_{yk}≥ 320 N/mm²	A_5 > 8 %	
		5.6	f_{uk}≥ 500 N/mm²	f_{yk}≥ 300 N/mm²	A_5 > 8 %	
		5.8	f_{uk}≥ 500 N/mm²	f_{yk}≥ 400 N/mm²	A_5 > 8 %	
		8.8	f_{uk}≥ 800 N/mm²	f_{yk}≥ 640 N/mm²	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 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000			
4	Internally threaded anchor rod	5.8	Steel, electroplated or sherardized		A_5 > 8%	EN 10087:1998
		8.8	Steel, electroplated or sherardized		A_5 > 8%	
Stainless steel A2[1)] **Stainless steel A4** **High corrosion resistant steel HCR**			(e.g. 1.4301 / 1.4307 / 1.4311 / 1.4567 / 1.4541) (e.g. 1.4401 / 1.4404 / 1.4571 / 1.4578 / 1.4362) (e.g. 1.4529 / 1.4565)			
1	Threaded rod	Property class	characteristic steel ultimate strength	characteristic steel yield strength	fracture elongation	EN 10088-1:2014 EN ISO 3506-1:2009
		50	f_{uk}= 500 N/mm²	f_{yk}= 210 N/mm²	A_5 > 8 %	
		70	f_{uk}= 700 N/mm²	f_{yk}= 450 N/mm²	A_5 > 8 %	
		80	f_{uk}= 800 N/mm²	f_{yk}= 600 N/mm²	A_5 > 8 %	
2	Hexagon nut	50	for class 50 rods			EN 10088-1:2014 EN ISO 3506-2:2009
		70	for class 50 or 70 rods			
		80	for class 50,70 or 80 rods			
3	Washer		e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000			EN 10088-1:2014
4	Internally threaded anchor rod	70	property class 70		A_5 > 8 %	EN 10088-1:2014

[1)] For property classes 50 and 70

Injection System VM-EA for concrete	**Annex A4**
Product description Materials	

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** M6 - M16 electroplated or sherardized, A4, HCR
Base materials		reinforced or unreinforced normal weight concrete acc. to EN 206:2013+A1:2016	
		strength classes acc. to EN 206:2013+A1:2016: 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+A1:2015 corresponding to corrosion resistance classes:
  - Stainless steel A2 according to Annex A, Table A3: CRC II
  - Stainless steel A4 according to Annex A, Table A3: CRC III
  - High corrosion resistant steel HCR according to Annex A, Table A3: CRC V

  Steel grades of a higher corrosion resistance class may be used

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 TR 055.

Concrete condition:

- I1 = installation in dry or wet (water saturated) concrete and use in service in dry or wet concrete
- I2 = installation in water-filled drill holes (not sea water) and use in service in dry or wet concrete

Installation:

- Hole drilling by hammer or compressed air drill mode
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site

Installation direction:

- D3 = downward and horizontal and upwards (e.g. overhead) installation

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

Table B1: Installation parameters for threaded rod

Threaded rod			M 8	M 10	M 12	M 16	M 20	M 24
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	$d_f \leq$	[mm]	9	12	14	18	22	26
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			VMU-IG M 6	VMU-IG M 8	VMU-IG M 10	VMU-IG M 12	VMU-IG M 16
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

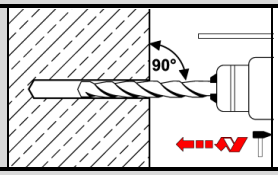
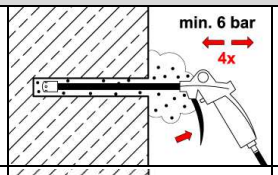
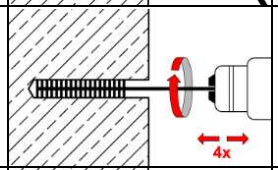
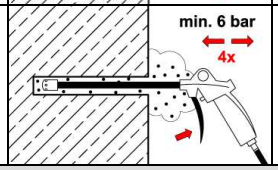
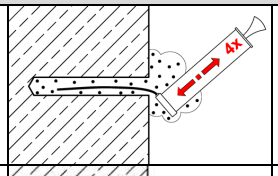
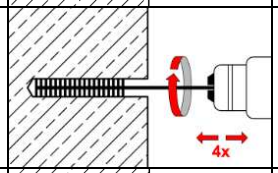
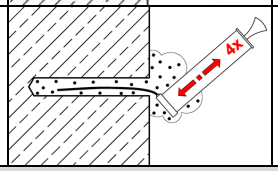
[1)] With metric thread acc. to EN 1993-1-8:2005+AC:2009

Injection System VM-EA for concrete

Intended use
Installation parameters

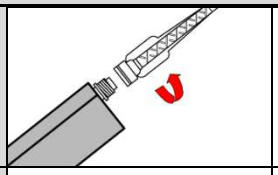
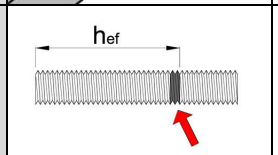
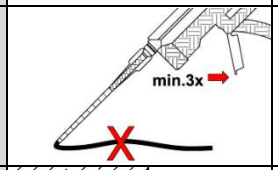
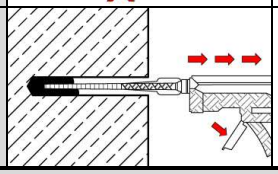
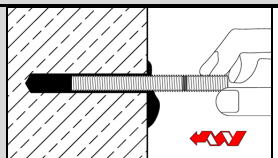
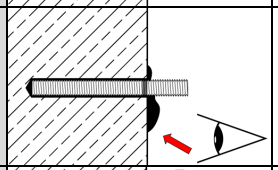
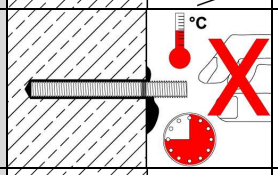
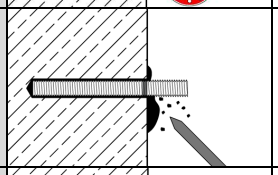
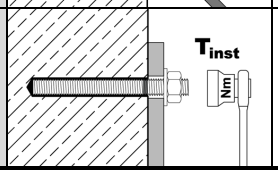
Annex B2

Installation instructions

Drilling of the hole		
1.		Drill with hammer drill a 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 $h_0 \leq 240$mm	
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	**Annex B3**
Intended use Installation instructions	

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.		Prior to inserting the anchor rod into the filled drill hole, the position of the embedment depth shall be marked on the anchor rod.
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. The anchor shall be free of dirt, grease, oil or other foreign material.
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.

Injection System VM-EA for concrete	**Annex B4**
Intended use Installation instructions (continuation)	

Table B3: Parameter cleaning tools

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

Recommended compressed air tool (min 6 bar)
all applications

Blow-out pump (volume 750ml)
Drill bit diameter (d_0): 10 mm to 20 mm
Drill hole depth (h_0): ≤ 240 mm

Cleaning brush RB

Table B4: Working time and curing time

Concrete temperature	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**	

[1)] 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 B5**
Intended Use Parameter cleaning tools, working time and curing time	

Table C1: Characteristic **steel resistance** under tension and shear loads for **threaded rods**

Threaded rod				**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M 24**
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	78	122	176
	Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	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	171	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					
	A4 and HCR, property class 80	$\gamma_{Ms,N}$	[-]	1,6					
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	324	560
	Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896
Stainless steel	A2, A4 and HCR, property class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561
	A2, A4 and HCR, property class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784
	A4 and HCR, property class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896
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					
	A4 and HCR, property class 80	$\gamma_{Ms,V}$	[-]	1,33					

[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

Injection System VM-EA for concrete

Performance
Characteristic steel resistance for threaded rods

Annex C1

Table C2: Characteristic values under **tension loads** for **threaded rods**

Threaded rod				**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**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 <u>uncracked</u> 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
Increasing factors for $\tau_{Rk,ucr}$		ψ_c	C25/30	1,04					
			C30/37	1,08					
			C35/45	1,13					
			C40/50	1,15					
			C45/55	1,17					
			C50/60	1,19					
Concrete cone failure									
Factor for k_1		$k_{ucr,N}$	[-]	11,0					
Edge distance		$c_{cr,N}$	[mm]	$1,5\ h_{ef}$					
Spacing		$s_{cr,N}$	[mm]	$3,0\ h_{ef}$					
Splitting failure									
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0\ h_{ef}$					
	$2,0 > h/h_{ef} > 1,3$			$2*h_{ef}\,(2,5 - h / h_{ef})$					
	$h/h_{ef} \leq 1,3$			$2,4\ h_{ef}$					
Spacing		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$					
Installation factor		γ_{inst}	[-]	1,2					

Injection System VM-EA for concrete

Performance
Characteristic values under tension loads for threaded rods

Annex C2

Table C3: Characteristic values under **shear loads** for **threaded rods**

Threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**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]	$l_f = \min(h_{ef}; 12\ d_{nom})$					
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24
Installation factor	γ_{inst}	[-]	1,0					

Injection System VM-EA for concrete

Performance
Characteristic values under shear loads for threaded rods

Annex C3

Table C4: Characteristic values under **tension loads** for **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**
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 <u>uncracked</u> 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
Increasing factors for $\tau_{Rk,ucr}$			ψ_c	C25/30	1,04					
				C30/37	1,08					
				C35/45	1,13					
				C40/50	1,15					
				C45/55	1,17					
				C50/60	1,19					
Concrete cone failure									
Factor for k_1			$k_{ucr,N}$	[-]	11,0				
Edge distance			$c_{cr,N}$	[mm]	1,5 h_{ef}				
Spacing			$s_{cr,N}$	[mm]	3,0 h_{ef}				
Splitting failure									
Edge distance	$h/h_{ef} \geq 2,0$		$c_{cr,sp}$	[mm]	1,0 h_{ef}				
	$2,0 > h/h_{ef} > 1,3$				$2*h_{ef}(2,5 - h / h_{ef})$				
	$h/h_{ef} \leq 1,3$				2,4 h_{ef}				
Spacing			$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$				
Installation factor			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 shear 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

Performance
Characteristic values under tension loads for internally threaded anchor rods

Annex C4

Table C5: Characteristic values under **shear loads** for **internally threaded anchor rods**

Internally threaded anchor rod				**VMU-IG M 6**	**VMU-IG M 8**	**VMU-IG M 10**	**VMU-IG M 12**	**VMU-IG M 16**
Steel failure[1] <u>without</u> 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] <u>with</u> 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	24
Installation factor		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 shear 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

Performance
Characteristic values under shear loads for internally threaded anchor rods

Annex C5

Table C6: Displacements under tension load [1)]

Threaded rod			M 8	M 10	M 12	M 16	M 20	M24
Internally threaded anchor rod			-	VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-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
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$;
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C7: Displacements under shear load [1)]

Threaded rod			M 8	M 10	M 12	M 16	M 20	M24
Internally threaded anchor rod			-	VMU-IG M6	VMU-IG M8	VMU-IG M10	VMU-IG M12	VMU-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
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$;
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Injection System VM-EA for concrete

Performance
Displacements

Annex C6