Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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

European Technical Assessment

ETA-07/0256 of 1 September 2016

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 HB-VMZ
Product family to which the construction product belongs	Torque controlled bonded anchor with anchor rod HB-VMZ-A and internal threaded rod HB-VMZ-IG for use in concrete
Manufacturer	Halfen GmbH Liebigstraße 14 40764 Langenfeld DEUTSCHLAND
Manufacturing plant	Halfen Herstellwerk HB1
This European Technical Assessment contains	32 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	Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 2: "Torque controlled expansion anchors", April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

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Specific Part

1 Technical description of the product

The Injection System HB-VMZ is a torque controlled bonded anchor consisting of a cartridge with injection mortar HB-VMZ or HB-VMZ Express and an anchor rod with expansion cones and external connection thread (type HB-VMZ-A) or with internal connection thread (type HB-VMZ-IG).

The load transfer is realised by mechanical interlock of several cones in the bonding mortar and then via a combination of bonding and friction forces in the anchorage ground (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 of HB-VMZ-A	See Annex C1 to C7
Displacements under tension and shear loads for HB-VMZ-A	See Annex C8 and C9
Characteristic resistance of HB-VMZ-IG	See Annex C10 to C12
Displacements under tension and shear loads for HB-VMZ-IG	See Annex C12

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	No performance determined (NPD)

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

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

In accordance with guideline for European technical approval ETAG 001, April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

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

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

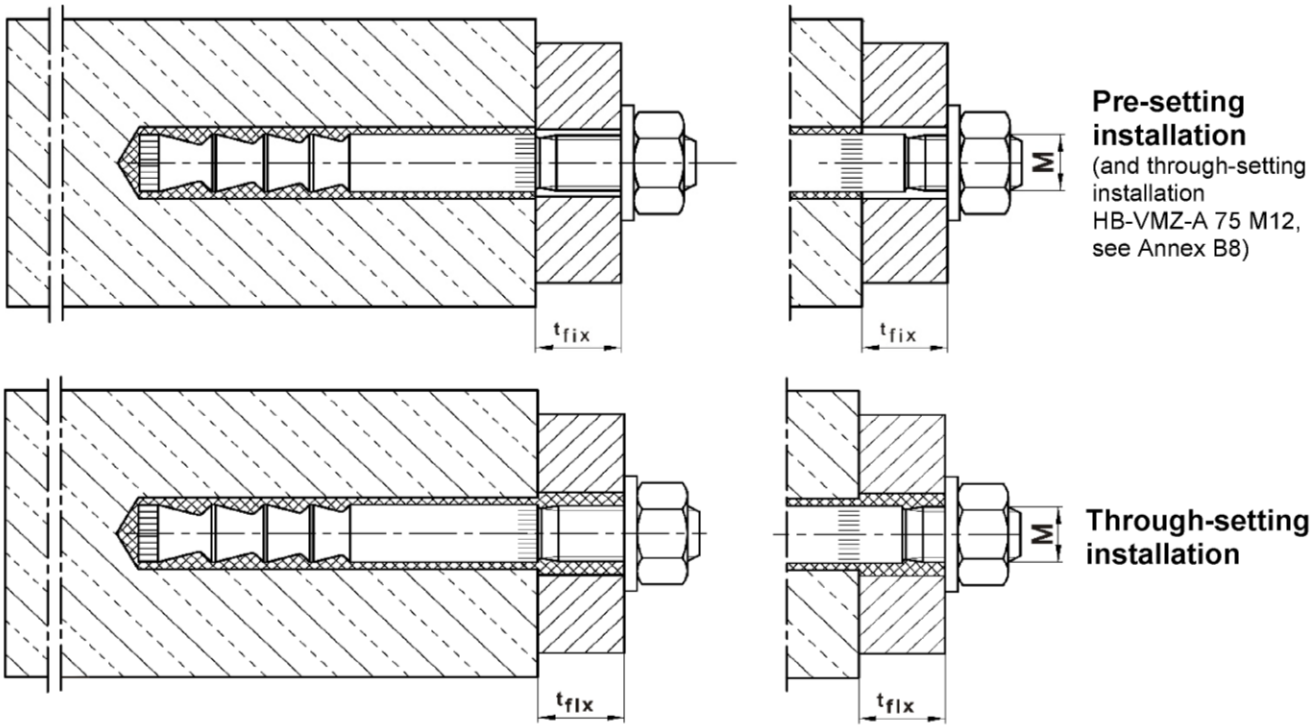
Issued in Berlin on 1 September 2016 by Deutsches Institut für Bautechnik

Uwe Bender
Head of Department

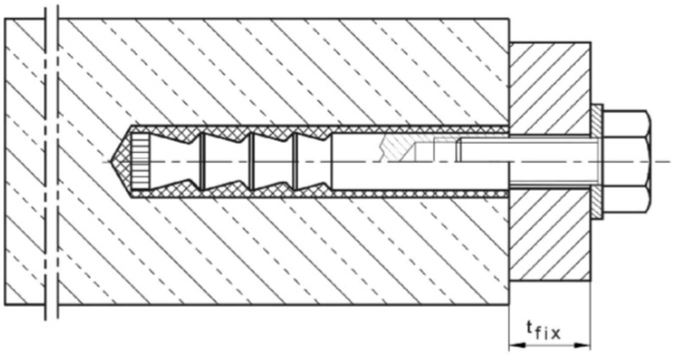
beglaubigt:
Baderschneider

English translation prepared by DIBt

Anchor rod HB-VMZ-A



Anchor rod HB-VMZ-IG [1)]



1) Illustration with hexagon head screw exemplified; other screws or threaded rods also permitted (see Annex A5, requirements of the fastening screw or threaded rod)

Anchor version	Product description	Intended use	Performance
HB-VMZ-A	Annex A1 – Annex A4	Annex B1 – Annex B8	Annex C1 – Annex C9
HB-VMZ-IG	Annex A1 – Annex A2; Annex A5	Annex B1 – Annex B2; Annex B9 – Annex B11	Annex C10 – Annex C12

Injection System HB-VMZ

Product description
Installation situation

Annex A1

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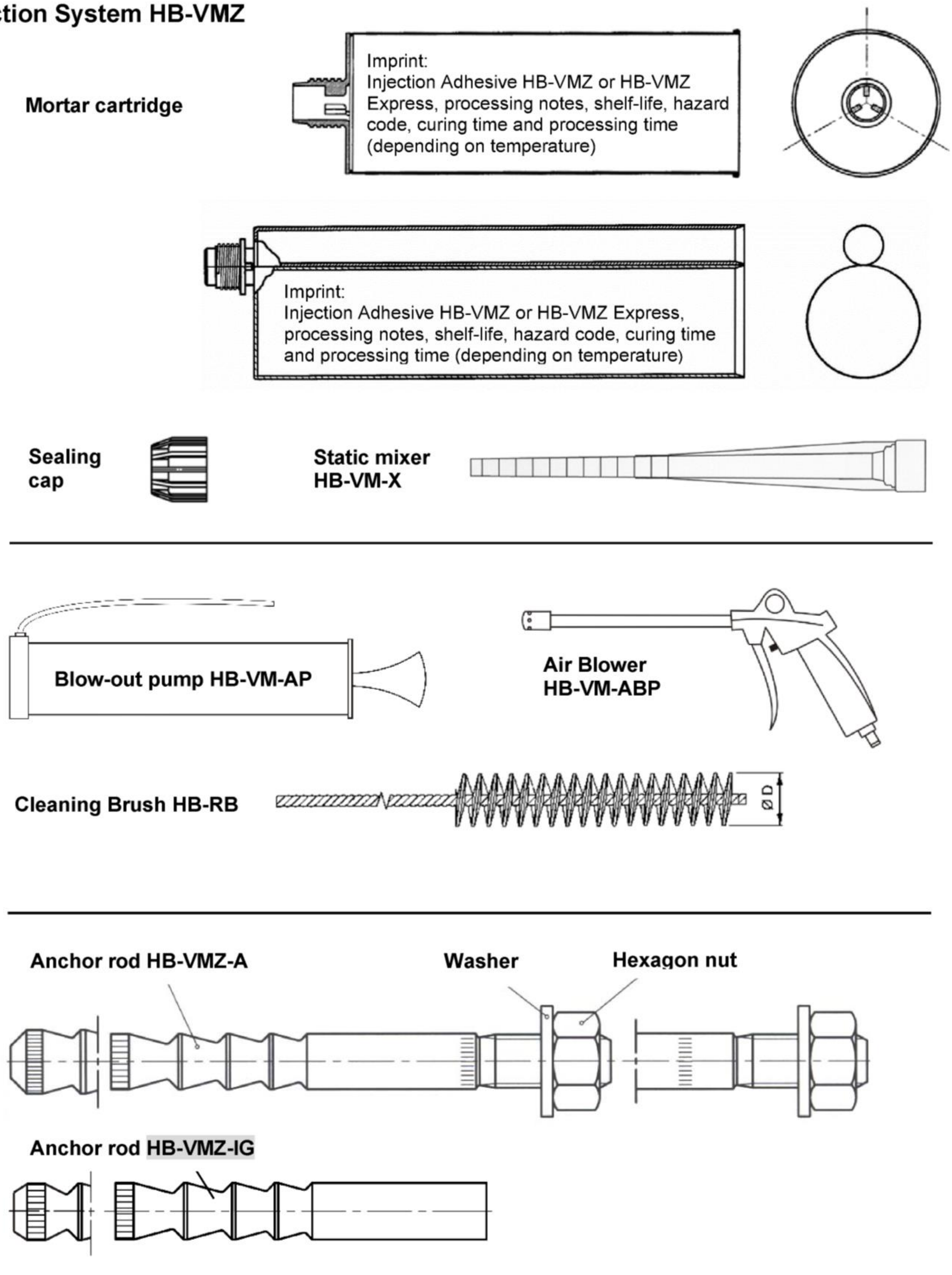
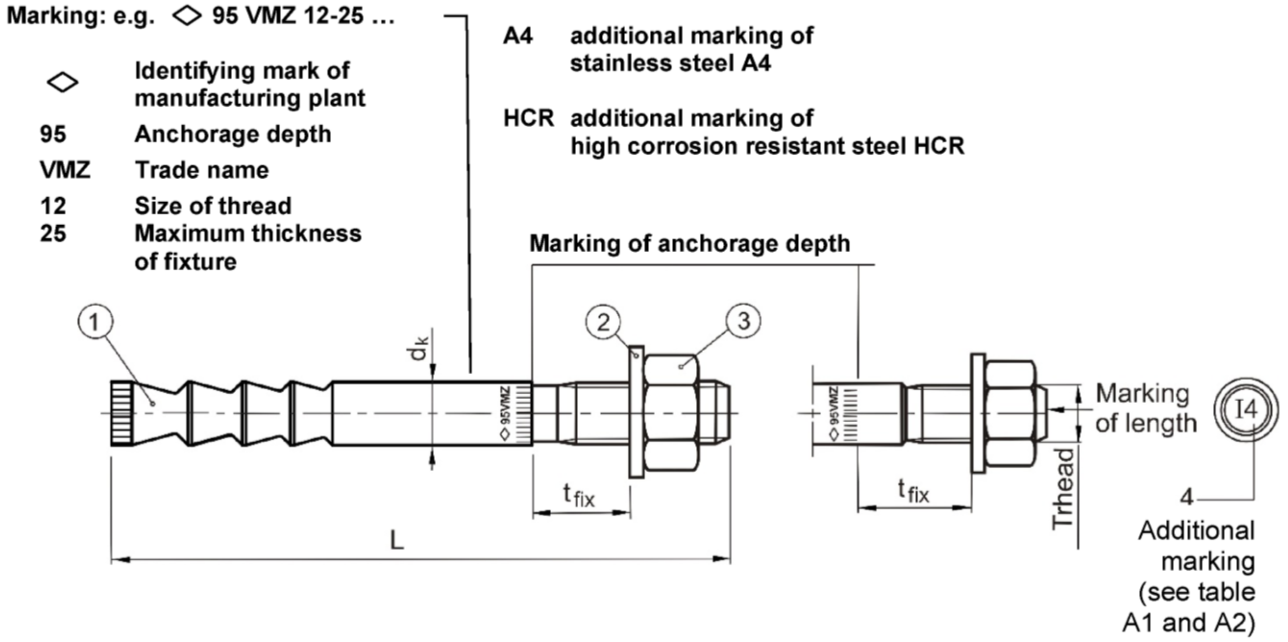
Injection System HB-VMZ



Injection System HB-VMZ	
Product description Cartridges, Cleaning tools, Anchor types	**Annex A2**



Marking of length	B	C	D	E	F	G	H	I	J	K	L	M
Length of anchor min ≥	50,8	63,5	76,2	88,9	101,6	114,3	127,0	139,7	152,4	165,1	177,8	190,5
Length of anchor max <	63,5	76,2	88,9	101,6	114,3	127,0	139,7	152,4	165,1	177,8	190,5	203,2

Marking of length	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	>Z
Length of anchor min ≥	203,2	215,9	228,6	241,3	254,0	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6
Length of anchor max <	215,9	228,6	241,3	254,0	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6	

Table A1: Dimensions of anchor rod, HB-VMZ-A M8 – M12

	Anchor size HB-VMZ-A		40 M8	50 M8	60 M10	75 M10	75 M12	70 M12	80 M12	95 M12	100 M12	110 M12	125 M12
	Additional marking		1	2	1	2	1	2	3	4	5	6	7
1	Anchor rod	Thread	M8	M8	M10	M10	M12	M12	M12	M12	M12	M12	M12
		Number of cones	2	3	3	3	3	3	4	4	6	6	6
		d_k =	8,0	8,0	9,7	9,7	10,7	12,5	12,5	12,5	12,5	12,5	12,5
		Length L	$52+t_{fix}$	$63+t_{fix}$	$75+t_{fix}$	$90+t_{fix}$	$95+t_{fix}$	$90+t_{fix}$	$100+t_{fix}$	$115+t_{fix}$	$120+t_{fix}$	$130+t_{fix}$	$145+t_{fix}$
3	Hexagon nut	SW	13	13	17	17	19	19	19	19	19	19	19

Dimensions in mm

Injection System HB-VMZ

Product description
Anchor parts, Marking, Anchor dimensions **HB-VMZ-A** M8 – M12

Annex A3

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Table A2: Dimensions of anchor rod, HB-VMZ-A M16 – M24

	Anchor size HB-VMZ-A		90 M16	105 M16	125 M16	145 M16	160 M16	115 M20	170 M20 (LG)	190 M20 (LG)	170 M24 (LG)	200 M24 (LG)	225 M24 (LG)
	Additional marking		1	2	3	4	5	1	2	3	1	2	3
1	Anchor rod	Thread	M16	M16	M16	M16	M16	M20	M20	M20	M24	M24	M24
		Number of cones	3	4	6	6	6	3	6	6	6	6	6
		d_k =	16,5	16,5	16,5	16,5	16,5	19,7	22,0	22,0	24,0	24,0	24,0
		Length L	114 $+t_{fix}$	129 $+t_{fix}$	150 $+t_{fix}$	170 $+t_{fix}$	185 $+t_{fix}$	143 $+t_{fix}$	203 $+t_{fix}$	223 $+t_{fix}$	210 $+t_{fix}$	240 $+t_{fix}$	265 $+t_{fix}$
3	Hexagon nut	SW	24	24	24	24	24	30	30	30	36	36	36

Dimensions in mm

Table A3: Materials HB-VMZ-A

Part	Designation	Steel, zinc plated			Stainless steel A4	High corrosion resistant steel (HCR)
		galvanised	hot-dip galvanised ≥ 40µm	sherardized ≥ 40µm		
1	Anchor rod	Steel acc. to EN 10087:1998, galvanised and coated	Steel acc. to EN 10087:1998, hot-dip galvanised and coated	Steel acc. to EN 10087:1998, sherardized and coated	Stainless steel, 1.4401, 1.4404, 1.4571, 1.4362, EN 10088:2005, coated	High corrosion resistant steel 1.4529, 1.4565 acc. to EN 10088:2005, coated
2	Washer	Steel, zinc plated	Steel, zinc plated	Steel, zinc plated	Stainless steel, 1.4401, 1.4571, EN 10088:2005	High corrosion resistant steel 1.4529 or 1.4565, acc. to EN 10088:2005
3	Hexagon nut	Property class 8 acc. to EN ISO 898-2:2012-08, galvanised	Property class 8 acc. to EN ISO 898-2:2012-08, hot-dip galvanised	Property class 8 acc. to EN ISO 898-2:2012-08, hot-dip galvanised or sherardized	ISO 3506:2009, A4-70, 1.4401, 1.4571, EN 10088:2005	ISO 3506:2009, Property class 70, high corrosion resistant steel 1.4529 or 1.4565, EN 10088:2005
4	Mortar cartridge	Vinylester resin, styrene free, mixing ratio 1:10				

Injection System HB-VMZ

Product description
Anchor dimensions **HB-VMZ-A** M16 – M24, Materials **HB-VMZ-A**

Annex A4

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Marking: e.g. ◇ 80 VMZ M10

◇	Identifying mark of manufacturing plant
80	Anchorage depth
VMZ	Trade name
M10	Size of internal thread
A4	additional marking of stainless steel A4
HCR	additional marking of high corrosion resistant steel HCR

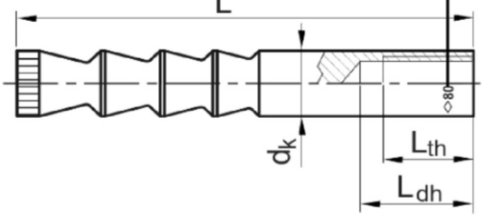


Table A4: Dimensions of anchor rod HB-VMZ-IG

Anchor size HB-VMZ-IG			40 M6	50 M6	60 M8	75 M8	70 M10	80 M10	90 M12	105 M12	125 M12	115 M16	170 M16	170 M20
Internal thread		-	M6	M6	M8	M8	M10	M10	M12	M12	M12	M16	M16	M20
Number of cones		-	2	3	3	3	3	4	3	4	6	3	6	6
Outer diameter	d_k	[mm]	8,0	8,0	9,7	10,7	12,5	12,5	16,5	16,5	16,5	19,7	22,0	24,0
Thread length	L_{th}	[mm]	12	15	16	19	20	23	24	27	30	32	32	40
Total length	L	[mm]	41	52	63	78	74	84	94	109	130	120	180	182
Length identifier		[mm]	L_{dh} < 18	L_{dh} > 19	L_{dh} < 22,5	L_{dh} > 23,5	L_{dh} < 27	L_{dh} > 28	L_{dh} < 31,5	32,5 < L_{dh} < 34,5	L_{dh} > 35,5	d_k < 21	d_k > 21	-

Table A5: Materials HB-VMZ-IG

Part	Designation	Steel, zinc plated		Stainless steel A4	High corrosion resistant steel (HCR)
		galvanized	sherardized ≥ 40µm		
1	Anchor rod	Steel acc. to EN 10087:1998, galvanized and coated	Steel acc. to EN 10087:1998, sherardized and coated	Stainless steel, 1.4401, 1.4404, 1.4571, 1.4362, EN 10088:2005, coated	High corrosion resistant steel 1.4529, 1.4565 acc. to EN 10088:2005, coated
4	Mortar cartridge	Vinylester resin, styrene free, mixing ratio 1:10			

Requirements of the fastening screw or the threaded rod and nut

- Minimum screw-in depth L_{sdmin} see Table B8:
- The length of screw or the threaded rod must depending on the thickness of fixture t_{fix}, available thread length L_{th} (= maximum available thread length, see Table B8:) and the minimum screw-in depth L_{sdmin} be established.
- A_5 > 8 % ductility

Steel, zinc plated

- Minimum property class 8.8 according to EN ISO 898-1:2013 or EN ISO 898-2:2012

Stainless steel A4

- Material 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 according to EN 10088:2005
- Minimum property class 70 according to EN ISO 3506:2009

High corrosion resistant steel (HCR)

- Material 1.4529; 1.4565 according to EN 10088:2005
- Minimum property class 70 according to EN ISO 3506:2009

Injection System HB-VMZ

Product description
Anchor parts, anchor dimensions, Materials **HB-VMZ-IG**

Annex A5

Specifications of intended use

Injection System HB-VMZ-A	M8	M10	M12	M16	M20	M24
Static or quasi-static loads	✓					
Seismic loads (Category C1 + C2)	-	✓	✓	✓	✓	✓
Cracked and non-cracked	✓					

Injection System HB-VMZ-IG	M6	M8	M10	M12	M16	M20
Static or quasi-static loads	✓					
Seismic loads	-					
Cracked and non-cracked	✓					

Base materials:

- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000
- Strength classes C20/25 to C50/60 according to EN 206-1:2000

Temperature Range:

- Temperature Range I: -40 °C to +80 °C (max short term temperature +80 °C and max long term temperature +50 °C)
- Temperature Range II: -40 °C to +120 °C (max short term temperature +120 °C and max long term temperature +72 °C)

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions
  (zinc plated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure including industrial and marine environment or exposure to permanently damp internal condition, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions
  (high corrosion resistant steel).

  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- 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 under static or quasi-static actions are designed in accordance with:
  - ETAG 001, Annex C, design method A, Edition August 2010 or
  - CEN/TS 1992-4:2009, design method A
- Anchorages under seismic actions (cracked concrete) are designed in accordance with:
  - EOTA Technical Report TR 045, Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure.
  - Fastenings in stand-off installation or with a grout layer are not allowed.

Injection System HB-VMZ	Annex B1
Intended use Specifications	

Table B1: Installation conditions

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Water filled bore holes (where admissible) must not be polluted – otherwise the cleaning of the drill hole must be repeated.
- The anchor component installation temperature shall be at least +5 °C; during curing of the injection mortar the temperature of the concrete must not fall below -5 °C. Curing time must be observed prior to loading the anchor.

Anchor size HB-VMZ-A				**M8**	**M10** and **75 M12**	**70 M12** and **80 M12 - M24**
Nominal diameter of drill hole		d_0	[mm]	< 14		≥ 14
Installation allowable in	dry concrete		-	yes		yes
	wet concrete		-	yes		yes
	water-filled hole		-	**no**		yes
Hole drilling by	Hammer drill bit		-	yes		yes
	Diamond drill bit (not under seismic action)		-	**no**	yes	yes

Anchor size HB-VMZ-IG				**M6 – M8**	**M10 – M20**
Nominal diameter of drill hole		d_0	[mm]	< 14	≥ 14
Installation allowable in	dry concrete		-	yes	yes
	wet concrete		-	yes	yes
	water-filled hole		-	**no**	yes
Hole drilling by	Hammer drill bit		-	yes	yes
	Diamond drill bit		-	**no**	yes

Table B2: Processing time and curing time HB-VMZ

Temperature [°C] in the drill hole	**Maximum processing time**	**Minimum curing time**	
		dry concrete	**wet concrete**
+ 40 °C	1,4 min	15 min	30 min
+ 35 °C to + 39 °C	1,4 min	20 min	40 min
+ 30 °C to + 34 °C	2 min	25 min	50 min
+ 20 °C to + 29 °C	4 min	45 min	1:30 h
+ 10 °C to + 19 °C	6 min	1:20 h	2:40 h
+ 5 °C to + 9 °C	12 min	2:00 h	4:00 h
0 °C to + 4 °C	20 min	3:00 h	6:00 h
- 4 °C to - 1 °C	45 min	6:00 h	12:00 h
- 5 °C	1:30 h	6:00 h	12:00 h

Table B3: Processing time and curing time HB-VMZ Express

Temperature [°C] in the drill hole	**Maximum processing time**	**Minimum curing time**	
		dry concrete	**wet concrete**
+ 30 °C	1 min	10 min	20 min
+ 20 °C to + 29 °C	1 min	20 min	40 min
+ 10 °C to + 19 °C	3 min	40 min	80 min
+ 5 °C to + 9 °C	6 min	1:00 h	2:00 h
+ 0 °C to + 4 °C	10 min	2:00 h	4:00 h
- 4 °C to - 1 °C	20 min	4:00 h	8:00 h
- 5 °C	40 min	4:00 h	8:00 h

Injection System HB-VMZ

Intended use
Installation conditions, processing and curing time

Annex B2

Table B4: Installation parameters, HB-VMZ-A M8 – M12

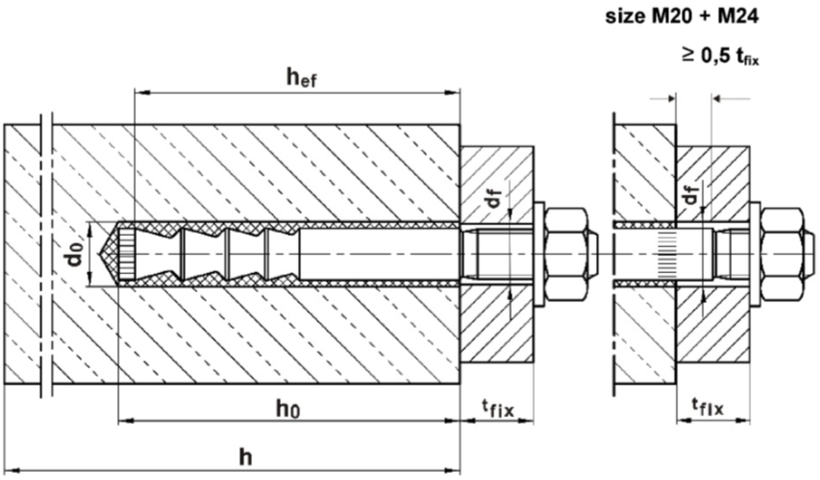
Anchor size HB-VMZ-A			**40 M8**	**50 M8**	**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	50	60	75	75	70	80	95	100	110	125
Nominal diameter of drill hole	$d_0 =$	[mm]	10	10	12	12	12	14	14	14	14	14	14
Depth of drill hole	$h_0 \geq$	[mm]	42	55	65	80	80	75	85	100	105	115	130
Diameter of cleaning brush	$D \geq$	[mm]	10,8	10,8	13,0	13,0	13,0	15,0	15,0	15,0	15,0	15,0	15,0
Installation torque	$T_{inst} \leq$	[Nm]	10	10	15	15	25	25	25	25	30	30	30
Diameter of clearance hole in the fixture													
Pre-setting installation	$d_f \leq$	[mm]	9	9	12	12	14	14	14	14	14	14	14
Through-setting installation	$d_f \leq$	[mm]	-	-	14	14	14[1)] / 16	16	16	16	16	16	16

1) see Annex B8

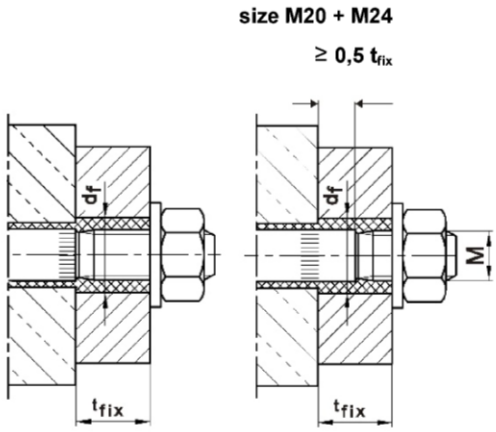
Table B5: Installation parameters, HB-VMZ-A M16 – M24

Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Effective anchorage depth	$h_{ef} \geq$	[mm]	90	105	125	145	160	115	170	190	170	200	225
Nominal diameter of drill hole	$d_0 =$	[mm]	18	18	18	18	18	22	24	24	26	26	26
Depth of drill hole	$h_0 \geq$	[mm]	98	113	133	153	168	120	180	200	185	215	240
Diameter of cleaning brush	$D \geq$	[mm]	19,0	19,0	19,0	19,0	19,0	23,0	25,0	25,0	27,0	27,0	27,0
Installation torque	$T_{inst} \leq$	[Nm]	50	50	50	50	50	80	80	80	100	120	120
Diameter of clearance hole in the fixture													
Pre-setting installation	$d_f \leq$	[mm]	18	18	18	18	18	22	24 (22)	24 (22)	26	26	26
Through-setting installation	$d_f \leq$	[mm]	20	20	20	20	20	24	26	26	28	28	28

Pre-setting installation



Through-setting installation



The annular gap in the clearance hole in the fixture has to be filled completely by excess mortar!

Injection System HB-VMZ

Intended use
Installation parameters, **HB-VMZ-A**

Annex B3

Table B6: Minimum spacing and edge distance, HB-VMZ-A M8 – M12

Anchor size HB-VMZ-A			40 M8	50 M8	60 M10	75 M10	75 M12	70 M12	80 M12	95 M12	100 M12	110 M12	125 M12
Minimum thickness of concrete	h_{min}	[mm]	80	80	100	110 100 [1)]	110	110	110	130 125 [1)]	130	140	160
Cracked concrete													
Minimum spacing	s_{min}	[mm]	40	40	40	40	50	55	40	40	50	50	50
Minimum edge distance	c_{min}	[mm]	40	40	40	40	50	55	50	50	50	50	50
Non-cracked concrete													
Minimum spacing	s_{min}	[mm]	40	40	50	50	50	55	55	55	80 [2)]	80 [2)]	80 [2)]
Minimum edge distance	c_{min}	[mm]	40	40	50	50	50	55	55	55	55 [2)]	55 [2)]	55 [2)]

Table B7: Minimum spacing and edge distance, HB-VMZ-A M16 – M24

Anchor size HB-VMZ-A			90 M16	105 M16	125 M16	145 M16	160 M16	115 M20	170 M20 (LG)	190 M20 (LG)	170 M24 (LG)	200 M24 (LG)	225 M24 (LG)
Minimum thickness of concrete	h_{min}	[mm]	130	150	170 160 [1)]	190 180 [1)]	205 200 [1)]	160	230 220 [1)]	250 240 [1)]	230 220 [1)]	270 260 [1)]	300 290 [1)]
Cracked concrete													
Minimum spacing	s_{min}	[mm]	50	50	60	60	60	80	80	80	80	80	80
Minimum edge distance	c_{min}	[mm]	50	50	60	60	60	80	80	80	80	80	80
Non-cracked concrete													
Minimum spacing	s_{min}	[mm]	50	60	60	60	60	80	80	80	80	105	105
Minimum edge distance	c_{min}	[mm]	50	60	60	60	60	80	80	80	80	105	105

1) The remote face of the concrete member shall be inspected to ensure there has been no break-through by drilling. In case of break-through, the ground of the drill hole shall be closed with high strength mortar. The full bonded length h_{ef} shall be achieved and any potential loss of injection mortar shall be compensated.

2) For an edge distance c ≥ 80 mm a minimum spacing s_{min} = 55 mm is applicable.

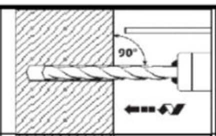
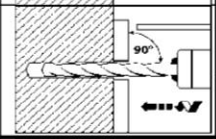
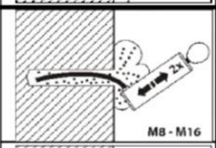
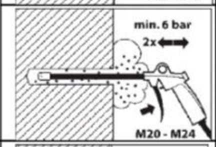
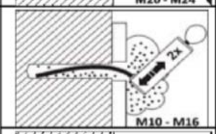
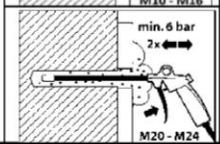
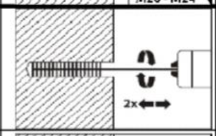
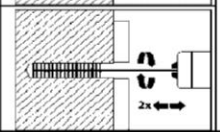
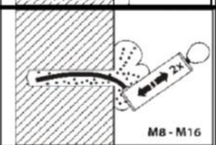
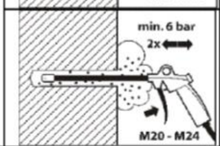
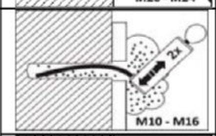
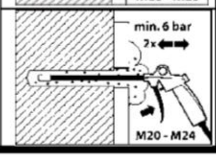
Injection System HB-VMZ

Intended use
Minimum spacing and edge distance, **HB-VMZ-A**

Annex B4

Installation instructions HB-VMZ-A

Making and cleaning of hammer drilled holes

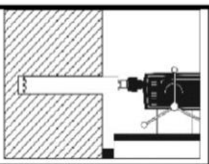
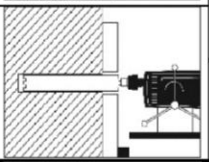
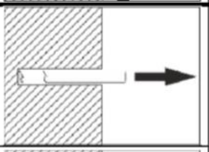
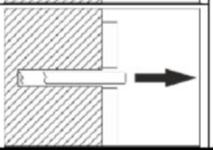
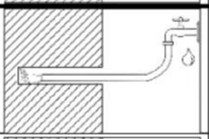
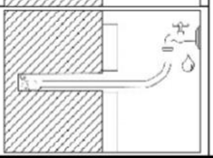
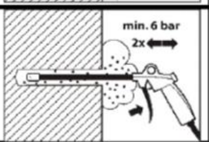
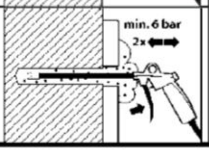
1	Pre-setting installation V		Use Hammer drill or air drill with drill bit and depth gauge. Drill perpendicular to concrete surface.
	Through-setting installation D		**Drill hole must be cleaned directly prior to installation of the anchor.** It must be ensured that icing does not occur in the drill hole.
2	V		**HB-VMZ-A M8 - M16:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times. The Extension Tube with reduced diameter must be added to the Blow-out pump for the diameter M8.
			**HB-VMZ-A M20 - M24:** Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.
	D		**HB-VMZ-A M10 - M16:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times.
			**HB-VMZ-A M20 - M24:** Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.
3	V		Check diameter of cleaning brush HB-RB. If brush can be pushed into the drill hole without any resistance, it must be replaced. Chuck brush into drill machine. Turn on drill machine. Brush drill hole back and forth along the entire drill hole depth at least two times while rotated by drill machine.
	D		
4	V		**HB-VMZ-A M8 - M16:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times. The Extension Tube with reduced diameter must be added to the Blow-out pump for the diameter M8.
			**HB-VMZ-A M20 - M24:** Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.
	D		**HB-VMZ-A M10 - M16:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times.
			**HB-VMZ-A M20 - M24:** Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.

Injection System HB-VMZ

Intended use
Installation instructions **HB-VMZ-A**
Making and cleaning of hammer drilled holes

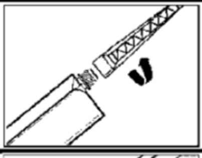
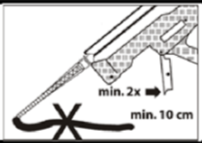
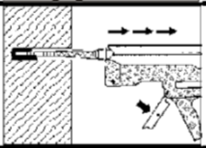
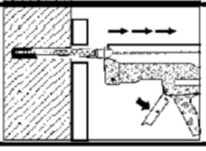
Annex B5

Making and cleaning of diamond core drilled holes

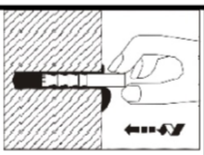
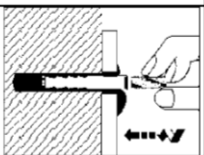
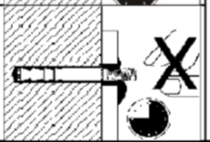
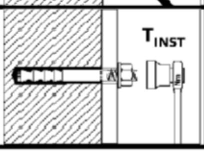
1	Pre-setting installation **V**		Use diamond drill with diamond drill bit and depth gauge. Drill perpendicular to concrete surface.
	Through-setting installation **D**		**Drill hole must be cleaned directly prior to installation of the anchor.** It must be ensured that icing does not occur in the drill hole.
2	**V**		Remove drill core at least up to the nominal hole depth and check drill hole depth.
	D		
3	**V**		Flushing of drill hole: Flush drill hole with water, starting from the bottom, until clear water gets out of the drill hole.
	D		
4	**V**		Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.
	D		

Injection System HB-VMZ	**Annex B6**
Intended use Installation instructions **HB-VMZ-A** Making and cleaning of diamond core drilled holes	

Injection

5	D + V		Check expiration date on HB-VMZ cartridge. Never use when expired. Remove cap from HB-VMZ cartridge. Screw Mixer Nozzle HB-VM-X on cartridge. When using a new cartridge always use a new Mixer Nozzle. Never use cartridge without Mixer Nozzle and never use Mixer Nozzle without helix inside.
6	D + V		Insert cartridge in Dispenser. Before injecting discard mortar (at least 2 full strokes or a line of 10 cm) until it shows a consistent grey colour. Never use this mortar.
7	V		Prior to injection, check if Mixer Nozzle HB-VM-X reaches the bottom of the drill hole. If it does not reach the bottom, plug Mixer Extension HB-VM-XE onto Mixer Nozzle in order to fill the drill hole properly. Fill hole with a sufficient quantity of injection mortar. Start from the bottom of the drill hole and work out to avoid trapping air pockets.
	D		

Insertion of anchor rod

8	V		Insert the anchor rod HB-VMZ-A by hand, rotating slightly up to the full embedment depth as marked on the anchor rod. The anchor rod is properly set when excess mortar seeps from the hole. If the hole is not completely filled, pull out anchor rod, let mortar cure, drill out hole and repeat entire cleaning process.
	D		Insert the anchor rod HB-VMZ-A by hand, rotating slightly up to the full embedment depth. After the installation, the annular gap in the clearance hole in the fixture has to be filled completely by excess mortar. If the hole is not completely filled, pull out anchor rod, let mortar cure, drill out hole and repeat entire cleaning process.
9	V		Follow minimum curing time shown in Table B2 or Table B3 During curing time, anchor rod must not be moved or loaded.
	D		
10	V		Remove excess mortar.
	D		
11	D + V		The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B4 or Table B5 by using torque wrench.

Injection System HB-VMZ	**Annex B7**
Intended use Installation instructions **HB-VMZ-A** Anchor installation	

Installation instructions <u>HB-VMZ-A 75 M12</u>

Through-setting installation with clearance between concrete and anchor plate

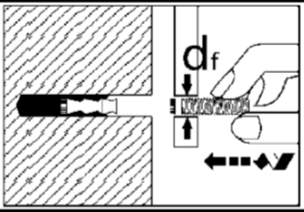
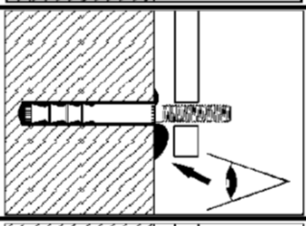
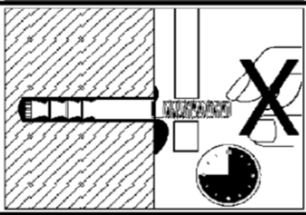
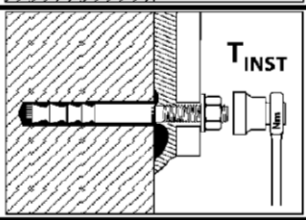
Work step 1-7 as illustrated in Annexes B5 – B7		
Requirement: Diameter of clearance hole in the fixture $d_f \leq 14$ mm		
8		Insert the anchor rod HB-VMZ-A by hand, rotating slightly up to the full embedment depth.
9		Check if excess mortar seeps from the hole. If the hole is not completely filled, pull out anchor rod, let mortar cure, drill out hole and repeat the entire cleaning process. **The annular gap in the fixture does not have to be filled.**
10		During curing time according to Table B2 or Table B3 anchor rod must not be moved or loaded.
11		Washer and nut can be mounted after curing time and backfilling of anchor plate. Apply installation torque T_{inst} according to Table B4 by using torque wrench.

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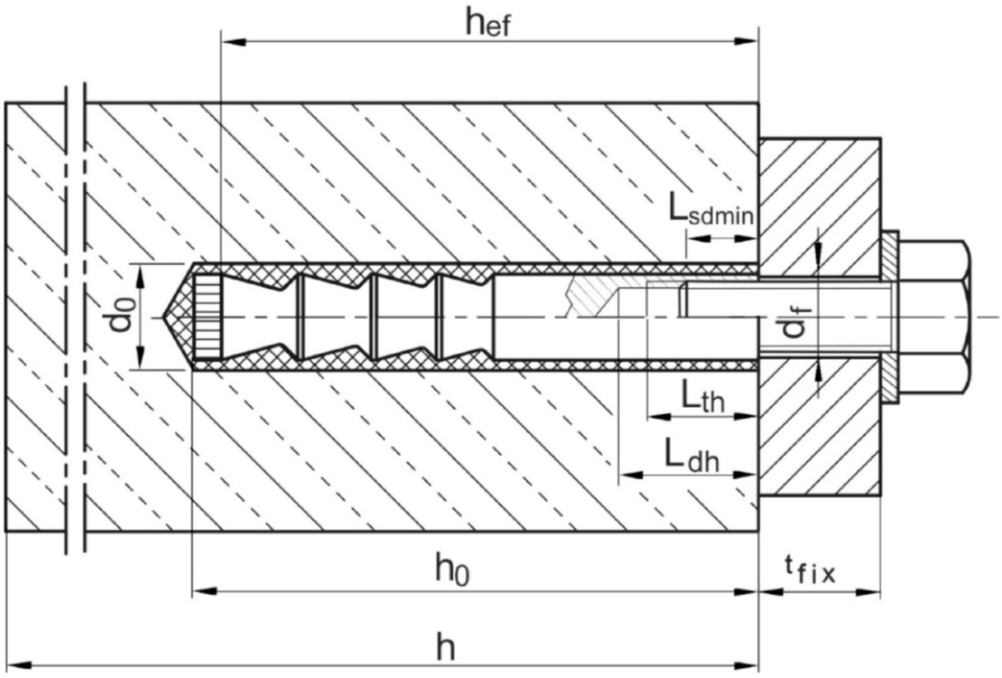
Table B8: Installation parameters HB-VMZ-IG

Anchor size HB-VMZ-IG			40 M6	50 M6	60 M8	75 M8	70 M10	80 M10	90 M12	105 M12	125 M12	115 M16	170 M16	170 M20
Effective anchorage depth	h_{ef} =	[mm]	40	50	60	75	70	80	90	105	125	115	170	170
Nominal diameter of drill hole	d_0 =	[mm]	10	10	12	12	14	14	18	18	18	22	24	26
Depth of drill hole	$h_0 \geq$	[mm]	42	55	65	80	80	85	98	113	133	120	180	185
Diameter of cleaning brush	D ≥	[mm]	10,8	10,8	13,0	13,0	15,0	15,0	19,0	19,0	19,0	23,0	25,0	27,0
Installation torque	$T_{inst} \leq$	[Nm]	8	8	10	10	15	15	25	25	25	50	50	80
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	7	7	9	9	12	12	14	14	14	18	18	22
Available thread length	L_{th}	[mm]	12	15	16	19	20	23	24	27	30	32	32	40
Minimum screw-in depth	L_{sdmin}	[mm]	7	7	9	9	12	12	14	14	14	18	18	22
Minimum thickness of concrete	h_{min}	[mm]	80	80	100	110	110	110	130	150	170 160 1)	160	230 220 1)	230 220 1)
Cracked concrete														
Minimum spacing	s_{min}	[mm]	40	40	40	40	55	40	50	50	60	80	80	80
Minimum edge distance	c_{min}	[mm]	40	40	40	40	55	50	50	50	60	80	80	80
Non-cracked concrete														
Minimum spacing	s_{min}	[mm]	40	40	50	50	55	55	50	60	60	80	80	80
Minimum edge distance	c_{min}	[mm]	40	40	50	50	55	55	50	60	60	80	80	80

1) The remote face of the concrete member shall be inspected to ensure there has been no break-through by drilling. In case of break-through the ground of the drill hole shall be closed with high strength mortar. The full bonded length h_{ef} shall be achieved and any potential loss of injection mortar shall be compensated.



Injection System HB-VMZ

Intended use
Installation parameters **HB-VMZ-IG**

Annex B9

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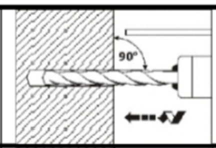
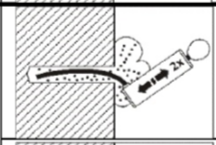
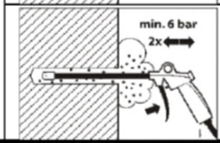
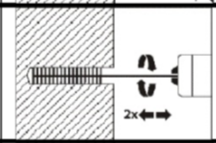
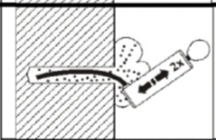
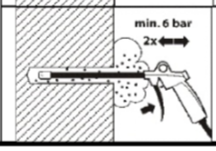
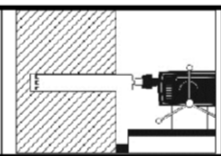
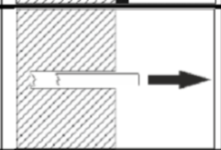
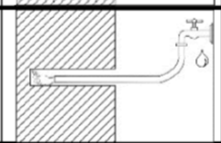
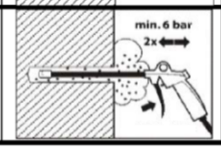
Installation instructions HB-VMZ-IG

Making and cleaning of hammer drilled holes

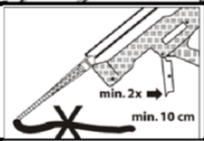
1		Use Hammer drill or air drill with drill bit and depth gauge. Drill perpendicular to concrete surface.
		Drill hole must be cleaned directly prior to installation of the anchor. It must be ensured that icing does not occur in the drill hole.
2		**HB-VMZ-IG M6 - M12:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times. The Extension Tube with reduced diameter must be added to the Blow-out pump for the diameter M6.
		**HB-VMZ-IG M16 - M20:** Connect MKT Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.
3		Check diameter of Cleaning Brush HB-RB. If brush can be pushed into the drill hole without any resistance, it must be replaced. Chuck brush into drill machine. Turn on drill machine. Brush drill hole back and forth along the entire drill hole depth at least two times while rotated by drill machine.
4		**HB-VMZ-IG M6 - M12:** Blow out drill hole from the bottom with Blow-out pump HB-VM-AP at least two times. The Extension Tube with reduced diameter must be added to the Blow-out pump for the diameter M6.
		**HB-VMZ-IG M16 - M20:** Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.

Making and cleaning of diamond drilled holes

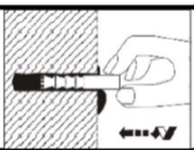
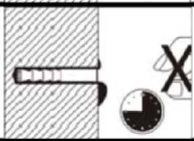
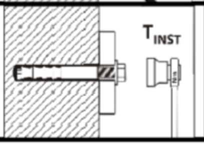
1		Use diamond drill with diamond drill bit and depth gauge. Drill perpendicular to concrete surface.
		Drill hole must be cleaned directly prior to installation of the anchor. It must be ensured that icing does not occur in the drill hole.
2		Remove drill core at least up to the nominal hole depth and check drill hole depth.
3		Flushing of drill hole: Flush drill hole with water, starting from the bottom, until clear water gets out of the drill hole.
4		Connect Air Blower HB-VM-ABP to compressed air (min. 6 bar, oil-free). Open air valve and blow out drill hole along the entire depth with back and forth motion at least two times.

Injection System HB-VMZ	**Annex B10**
Intended use Installation instructions **HB-VMZ-IG** Drilling and cleaning	

Injection

5		Check expiration date on HB-VMZ cartridge. Never use when expired. Remove cap from HB-VMZ cartridge. Screw Mixer Nozzle HB-VM-X on cartridge. When using a new cartridge always use a new Mixer Nozzle. Never use cartridge without Mixer Nozzle and never use Mixer Nozzle without helix inside.
6		Insert cartridge in dispenser. Before injecting discard mortar (at least 2 full strokes or a line of 10 cm) until it shows a consistent grey colour. Never use this mortar.
7		Prior to injection, check if Mixer Nozzle HB-VM-X reaches the bottom of the drill hole. If it does not reach the bottom, plug Mixer Extension HB-VM-XE onto Mixer Nozzle in order to fill the drill hole properly. Fill cleaned drill hole with a sufficient quantity of injection mortar. Start from the bottom of the drill hole and work out to avoid trapping air pockets.

Setting of anchor

8		Insert the anchor rod HB-VMZ-IG by hand, rotating slightly up to about 1mm below the concrete surface in the drill hole. The anchor rod is properly set when excess mortar seeps from the hole. If the hole is not completely filled, pull out anchor rod, let mortar cure, drill out hole and repeat the entire cleaning process.
9		Follow minimum curing time shown in Table B2 and Table B3. During curing time anchor rod must not be moved or loaded.
10		Remove excess mortar.
11		The fixture can be mounted after curing time. Apply installation torque T_{inst} according to Table B8 by using torque wrench.

Injection System HB-VMZ	**Annex B11**
Intended use Installation instructions **HB-VMZ-IG** Anchor installation	

Table C1: Characteristic values for **tension loads, HB-VMZ-A M8 – M12, cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**40 M8**	**50 M8**	**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0										
Steel failure													
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	15	18	25		35	49	54		57		
	A4, HCR	[kN]	15	18	25		35	49	54		57		
Partial safety factor	γ_{Ms}	[-]	1,5										
Pull-out													
Characteristic resistance $N_{Rk,p}$ in concrete C20/25	50°C / 80°C[2]	[kN]	[1]										
	72°C / 120°C[2]	[kN]	5	7,5	12	12	12	16	20	20	30	30	30
Increasing factor	ψ_C	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$										
Concrete cone failure													
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	50	60	75	75	70	80	95	100	110	125
Factor acc. to CEN/TS 1992-4	k_{cr}	[-]	7,2										

[1] Pull-out failure is not decisive
[2] Maximum long term temperature / Maximum short term temperature

Table C2: Characteristic values for **tension loads, HB-VMZ-A M16 – M24, cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0										
Steel failure													
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	88	95	111		97	96	188		222		
	A4, HCR	[kN]	88	95	111		97	114	165		194		
Partial safety factor	γ_{Ms}	[-]	1,5					1,68	1,5		1,5		
Pull-out													
Characteristic resistance $N_{Rk,p}$ in concrete C20/25	50°C / 80°C[2]	[kN]	[1]										
	72°C / 120°C[2]	[kN]	25	30	50		51	30	60		75		
Increasing factor	ψ_C	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$										
Concrete cone failure													
Effective anchorage depth	$h_{ef} \geq$	[mm]	90	105	125	145	160	115	170	190	170	200	225
Factor acc. to CEN/TS 1992-4	k_{cr}	[-]	7,2										

[1] Pull-out failure is not decisive
[2] Maximum long term temperature / Maximum short term temperature

Table C3: Characteristic values for **tension loads, HB-VMZ-A M8 – M12** in **non-cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**40 M8**	**50 M8**	**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0										
Steel failure													
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	15	18	25		35	49	54		57		
	A4, HCR	[kN]	15	18	25		35	49	54		57		
Partial safety factor	γ_{Ms}	[-]	1,5										
Pull-out													
Characteristic resistance $N_{Rk,p}$ in non-cracked concrete C20/25	50°C / 80°C[2)]	[kN]	9	[1)]	[1)]		[1)]			40	[1)]	50	50
	72°C / 120°C[2)]	[kN]	6	9	16		16	16	25	25	30	30	30
Splitting													
Splitting for **standard thickness of concrete member** (The higher resistance of Case 1 and Case 2 may be applied.)													
Standard thickness of concrete	$h_{std} \geq 2\ h_{ef}$	[mm]	100		120	150	150	140	160	190	200	220	250
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)													
Characteristic resistance in non-cracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	7,5	9	16	20	20	20	[1)]	30	40	40	40
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}										
Case 2													
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	6 h_{ef}		5 h_{ef}	7 h_{ef}	7 h_{ef}	5 h_{ef}	3 h_{ef}	5 h_{ef}	4 h_{ef}	6 h_{ef}	5 h_{ef}
Splitting for **minimum thickness of concrete member** (The higher resistance of Case 1 and Case 2 may be applied.)													
Minimum thickness of concrete	$h_{min} \geq$	[mm]	80		100		110	110	110	125	130	140	160
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)													
Characteristic resistance in non-cracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	7,5	-	16		16	20	25	25	30	30	30
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}	-	3 h_{ef}		3 h_{ef}						
Case 2													
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	6 h_{ef}	7 h_{ef}	6 h_{ef}	7 h_{ef}	7 h_{ef}	7 h_{ef}	6 h_{ef}	7 h_{ef}	6 h_{ef}	6 h_{ef}	6 h_{ef}
Increasing factor for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_C	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$										
Concrete cone failure													
Effective anchorage depth	$h_{ef} \geq$	[mm]	40	50	60	75	75	70	80	95	100	110	125
Factor acc. to CEN/TS 1992-4	k_{ucr}	[-]	10,1										

[1)] Pull-out failure is not decisive
[2)] Maximum long term temperature / Maximum short term temperature

Injection System HB-VMZ

Performance
Characteristic values for **tension loads, HB-VMZ-A M8 – M12, non-cracked concrete,** static and quasi-static action

Annex C2

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Table C4: Characteristic values for **tension loads, HB-VMZ-A M16 – M24, non-cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0										
Steel failure													
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	88	95	111	111	97	96	188	188	222	222	222
	A4, HCR	[kN]	88	95	111	111	97	114	165	165	194	194	194
Partial safety factor	γ_{Ms}	[-]	1,5					1,68	1,5		1,5		
Pull-out													
Characteristic resistance $N_{Rk,p}$ in non-cracked concrete C20/25	50°C / 80°C [2)]	[kN]	[1)]			75	90	[1)]			[1)]		
	72°C / 120°C [2)]	[kN]	25	35	50	50	53	40	75	75	95	95	95
Splitting													
Splitting for **standard thickness of concrete** (The higher resistance of Case 1 and Case 2 may be applied.)													
Standard thickness of concrete	$h_{std} \geq 2\ h_{ef}$	[mm]	180	200	250	290	320	230	340	380	340	400	450
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)													
Characteristic resistance in non-cracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	40	50	50	60	80	[1)]		115	[1)]		140
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}										
Case 2													
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	4 h_{ef}	4 h_{ef}	4 h_{ef}	4 h_{ef}	4 h_{ef}	3 h_{ef}	3 h_{ef}	4 h_{ef}	3 h_{ef}	3 h_{ef}	3,6 h_{ef}
Splitting for **minimum thickness of concrete** (The higher resistance of Case 1 and Case 2 may be applied.)													
Minimum thickness of concrete	$h_{min} \geq$	[mm]	130	150	160	180	200	160	220	240	220	260	290
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)													
Characteristic resistance in non-cracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	35	50	40	50	71	-	75	75	[1)]	115	115
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}										
Case 2													
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	5 h_{ef}	5 h_{ef}	6 h_{ef}	5 h_{ef}	5 h_{ef}	5 h_{ef}	5,2 h_{ef}	4,4 h_{ef}	5,2 h_{ef}	4,4 h_{ef}	4,4 h_{ef}
Increasing factor for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_C	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$										
Concrete cone failure													
Effective anchorage depth	$h_{ef} \geq$	[mm]	90	105	125	145	160	115	170	190	170	200	225
Factor acc. to CEN/TS 1992-4	k_{ucr}	[-]	10,1										

[1)] Pull-out failure is not decisive
[2)] Maximum long term temperature / Maximum short term temperature

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Table C5: Characteristic values for **shear load**, **HB-VMZ-A M8 – M12, cracked and non-cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**40 M8**	**50 M8**	**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0										
Steel failure without lever arm													
Characteristic shear resistance $V_{Rk,s}$	Steel, zinc plated	[kN]	14		21		34						
	A4, HCR	[kN]	15		23		34						
Partial safety factor	γ_{Ms}	[-]	1,25										
Factor for ductility	k_2	[-]	1,0										
Steel failure with lever arm													
Characteristic bending moments $M^0_{Rk,s}$	Steel, zinc plated	[Nm]	30		60		105						
	A4, HCR	[Nm]	30		60		105						
Partial safety factor	γ_{Ms}	[-]	1,25										
Concrete pry-out failure													
Factor k acc. ETAG 001, Annex C or k_3 acc. CEN/TS 1992-4	$k_{(3)}$	[-]	2										
Concrete edge failure													
Effective length of anchor in shear load	l_f	[mm]	40	50	60	75	75	70	80	95	100	110	125
Diameter of anchor	d_{nom}	[mm]	10		12		12	14					

Injection System HB-VMZ

Performance
Characteristic values for **shear load**, **HB-VMZ-A M8 – M12, cracked and non-cracked concrete,** static and quasi-static action

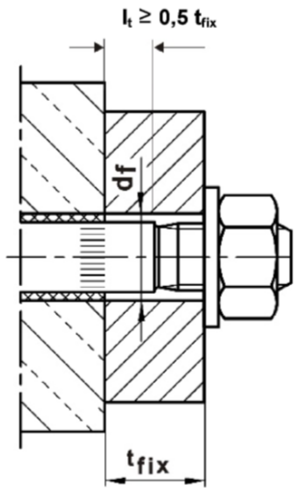
Annex C4

Table C6: Characteristic values for **shear load, HB-VMZ-A M16 – M24, cracked and non-cracked concrete,** static and quasi-static action

Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0										
Steel failure without lever arm													
Characteristic shear resistance $V_{Rk,s}$	Steel, zinc plated	[kN]	63					70	149 [1)] (98)		178 [1)] (141)		
	A4, HCR	[kN]	63					86	131 [1)] (86)		156 [1)] (123)		
Partial safety factor	γ_{Ms}	[-]	1,25					1,4	1,25		1,25		
Factor for ductility	k_2	[-]	1,0										
Steel failure with lever arm													
Characteristic bending moments $M^0_{Rk,s}$	Steel, zinc plated	[Nm]	266					392	519		896		
	A4, HCR	[Nm]	266					454			784		
Partial safety factor	γ_{Ms}	[-]	1,25					1,4	1,25		1,25		
Concrete pry-out failure													
Factor k acc. ETAG 001, Annex C or k_3 acc. CEN/TS 1992-4	$k_{(3)}$	[-]	2										
Concrete edge failure													
Effective length of anchor in shear load	l_f	[mm]	90	105	125	145	160	115	170	190	170	200	225
Diameter of anchor	d_{nom}	[mm]	18					22	24		26		

[1)] This value may only be applied if $l_t \geq 0,5\ t_{fix}$

Size M20 + M24:



Injection System HB-VMZ

Performance
Characteristic values for **shear load, HB-VMZ-A M16 – M24, cracked and non-cracked concrete,** static and quasi-static action

Annex C5

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Table C7: Characteristic resistances for **seismic loading**
HB-VMZ-A M10 – M12 performance category **C1** and **C2**

Tension loads												
Anchor size HB-VMZ-A				**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Installation safety factor	$\gamma_2=\gamma_{inst}$		[-]	1,0								
Steel failure, steel zinc plated												
Characteristic resistance **C1**	$N_{Rk,s,seis,C1}$		[kN]	25		35	49	54		57		
Characteristic resistance **C2**	$N_{Rk,s,seis,C2}$		[kN]	25		35	49	54		57		
Steel failure, stainless steel A4, HCR												
Characteristic resistance **C1**	$N_{Rk,s,seis,C1}$		[kN]	25		35	49	54		57		
Characteristic resistance **C2**	$N_{Rk,s,seis,C2}$		[kN]	25		35	49	54		57		
Partial safety factor	$\gamma_{Ms,seis}$		[-]	1,5								
Pull-out												
Characteristic resistance **C1**	$N_{Rk,p,seis,C1}$	50°C / 80°C [1)]	[kN]	14,5		14,5		30,6				
		72°C / 120°C [1)]	[kN]	10,9		10,9		20,0				
Characteristic resistance **C2**	$N_{Rk,p,seis,C2}$	50°C / 80°C [1)]	[kN]	7,4		7,4		8,7				
		72°C / 120°C [1)]	[kN]	5,1		5,1		6,5				
Increasing factor for $N_{Rk,p,seis}$	Ψ_c		[-]	1,0								

Shear loads											
Anchor size HB-VMZ-A			**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0								
Steel failure without lever arm, steel zinc plated											
Characteristic resistance **C1**	$V_{Rk,s,seis,C1}$	[kN]	11,8		27,2						
Characteristic resistance **C2**	$V_{Rk,s,seis,C2}$	[kN]	12,6		27,2						
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,25								
Steel failure without lever arm, stainless steel A4, HCR											
Characteristic resistance **C1**	$V_{Rk,s,seis,C1}$	[kN]	12,9		27,2						
Characteristic resistance **C2**	$V_{Rk,s,seis,C2}$	[kN]	13,8		27,2						
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,25								
Steel failure with lever arm											
Characteristic bending moment **C1**	$M^0_{Rk,s,seis,C1}$	[Nm]	no performance determined								
Characteristic bending moment **C2**	$M^0_{Rk,s,seis,C2}$	[Nm]	no performance determined								

[1)] Maximum long term temperature / Maximum short term temperature

Injection System HB-VMZ

Performance
Characteristic resistances for **seismic loading, HB-VMZ-A M10 – M12**, performance category **C1** and **C2**

Annex C6

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Table C8: Characteristic resistances for **seismic loading**
HB-VMZ-A M16 – M24 performance category **C1** and **C2**

Tension loads													
Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0										
Steel failure, steel zinc plated													
Characteristic resistance **C1**	$N_{Rk,s,seis,C1}$	[kN]	88	95	111		97	96	188		222		
Characteristic resistance **C2**	$N_{Rk,s,seis,C2}$	[kN]	88	95	111		97	96	188		222		
Steel failure, stainless steel A4, HCR													
Characteristic resistance **C1**	$N_{Rk,s,seis,C1}$	[kN]	88	95	111		97	114	165		194		
Characteristic resistance **C2**	$N_{Rk,s,seis,C2}$	[kN]	88	95	111		97	114	165		194		
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,5					1,68	1,5		1,5		
Pull-out													
Characteristic resistance **C1**	$N_{Rk,p,seis,C1}$ 50°C / 80°C [1]	[kN]	30,6		43,7			30,6	88,2		90,7		
	$N_{Rk,p,seis,C1}$ 72°C / 120°C [1]	[kN]	20,0		38,5			20,0	55,8		59,3		
Characteristic resistance **C2**	$N_{Rk,p,seis,C2}$ 50°C / 80°C [1]	[kN]	13,5	16,1	26,1			16,1	59,7		59,7		
	$N_{Rk,p,seis,C2}$ 72°C / 120°C [1]	[kN]	10,0	12,0	19,5			11,0	44,4		44,4		
Increasing factor for $N_{Rk,p,seis}$	Ψ_c	[-]	1,0										

Shear loads													
Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0										
Steel failure without lever arm, steel zinc plated													
Characteristic resistance **C1**	$V_{Rk,s,seis,C1}$	[kN]	39,1					39,1	82,3		107		
Characteristic resistance **C2**	$V_{Rk,s,seis,C2}$	[kN]	50,4					51,0	108,8 [1] (71,5)		154,9 [1] (122,7)		
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,25					1,4	1,25		1,25		
Steel failure without lever arm, stainless steel A4, HCR													
Characteristic resistance **C1**	$V_{Rk,s,seis,C1}$	[kN]	39,1					39,1	72,2		93		
Characteristic resistance **C2**	$V_{Rk,s,seis,C2}$	[kN]	50,4					62,6	95,6 [1] (62,8)		135,7 [1] (107)		
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,25					1,4	1,25		1,25		
Steel failure with lever arm													
Characteristic bending moment **C1**	$M^0_{Rk,s,seis,C1}$	[Nm]	no performance determined										
Characteristic bending moment **C2**	$M^0_{Rk,s,seis,C2}$	[Nm]	no performance determined										

[1] This value may only be applied if $l_t \geq 0,5\ t_{fix,}$ (see Annex C5)

Injection System HB-VMZ

Performance
Characteristic resistances for **seismic loading, HB-VMZ-A M16 – M24**, performance category **C1** and **C2**

Annex C7

Table C9: Displacements under tension loads, HB-VMZ-A M8 – M12

Anchor size HB-VMZ-A			40 M8	50 M8	60 M10	75 M10	75 M12	70 M12	80 M12	95 M12	100 M12	110 M12	125 M12
Tension load in cracked concrete	N	[kN]	4,3	6,1	8,0	11,1	11,1	10,0	12,3	15,9	17,1	19,8	24,0
Displacement	δ_{N0}	[mm]	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,7	0,7
	$\delta_{N\infty}$	[mm]	1,3										
Tension load in non-cracked concrete	N	[kN]	4,3	8,5	11,1	15,6	15,6	14,1	17,2	19,0	24,0	23,8	23,8
Displacement	δ_{N0}	[mm]	0,2	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,6	0,6
	$\delta_{N\infty}$	[mm]	1,3										
Displacements under seismic tension loads **C2**													
Displacements for DLS	$\delta_{N,seis,C2(DLS)}$	[mm]	-	-	1,0		1,0		1,3				
Displacements for ULS	$\delta_{N,seis,C2(ULS)}$	[mm]	-	-	3,0		3,0		3,9				

Table C10: Displacements under tension loads, HB-VMZ-A M16 – M24

Anchor size HB-VMZ-A			90 M16	105 M16	125 M16	145 M16	160 M16	115 M20	170 M20 (LG)	190 M20 (LG)	170 M24 (LG)	200 M24 (LG)	225 M24 (LG)
Tension load in cracked concrete	N	[kN]	14,6	18,4	24,0	30,0	34,7	21,1	38,0	44,9	38,0	48,5	57,9
Displacement	δ_{N0}	[mm]	0,7	0,7	0,7	0,8	1,2	0,7	0,8	0,8	0,8	0,9	0,9
	$\delta_{N\infty}$	[mm]	1,3				1,6	1,1	1,3		1,3		
Tension load in non-cracked concrete	N	[kN]	20,5	25,9	33,0	35,7	48,1	29,6	53,3	63,0	53,3	67,9	81,1
Displacement	δ_{N0}	[mm]	0,6	0,6	0,6	0,6	0,8	0,5	0,6	0,6	0,6	0,6	0,6
	$\delta_{N\infty}$	[mm]	1,3				1,6	1,1	1,3		1,3		
Displacements under seismic tension loads **C2**													
Displacements for DLS	$\delta_{N,seis,C2(DLS)}$	[mm]	1,5					1,9			1,9		
Displacements for ULS	$\delta_{N,seis,C2(ULS)}$	[mm]	4,4					4,5			4,5		

Injection System HB-VMZ

Performance
Displacements under tension loads, **HB-VMZ-A**

Annex C8

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Table C11: Displacements under shear loads HB-VMZ-A M8 – M12

Anchor size HB-VMZ-A			**40 M8**	**50 M8**	**60 M10**	**75 M10**	**75 M12**	**70 M12**	**80 M12**	**95 M12**	**100 M12**	**110 M12**	**125 M12**
Shear load	V	[kN]	8,3		13,3		19,3						
Displacements	δ_{V0}	[mm]	2,4	2,5	2,9		3,3						
	$\delta_{V\infty}$	[mm]	3,6	3,8	4,4		5,0						
Displacements under seismic shear loads **C2**													
Displacements for DLS	$\delta_{V,seis,C2(DLS)}$	[mm]	-	-	2,1		2,5						
Displacements for ULS	$\delta_{V,seis,C2(ULS)}$	[mm]	-	-	3,7		5,1						

Table C12: Displacements under shear loads HB-VMZ-A M16 – M24

Anchor size HB-VMZ-A			**90 M16**	**105 M16**	**125 M16**	**145 M16**	**160 M16**	**115 M20**	**170 M20 (LG)**	**190 M20 (LG)**	**170 M24 (LG)**	**200 M24 (LG)**	**225 M24 (LG)**
Shear load	V	[kN]	36					44	75 (49)		89 (71)		
Displacements	δ_{V0}	[mm]	3,8					3,0	4,3 (3,0)		4,6 (3,5)		
	$\delta_{V\infty}$	[mm]	5,7					4,5	6,5 (4,5)		6,9 (5,3)		
Displacements under seismic shear loads **C2**													
Displacements for DLS	$\delta_{V,seis,C2(DLS)}$	[mm]	2,9					3,5			3,7		
Displacements for ULS	$\delta_{V,seis,C2(ULS)}$	[mm]	6,8					9,3			9,3		

Injection System HB-VMZ

Performance
Displacements under shear loads, **HB-VMZ-A**

Annex C9

Table C13: Characteristic values for **tension load, HB-VMZ-IG , cracked concrete**

Anchor size HB-VMZ-IG			**40 M6**	**50 M6**	**60 M8**	**75 M8**	**70 M10**	**80 M10**	**90 M12**	**105 M12**	**125 M12**	**115 M16**	**170 M16**	**170 M20**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0											
Steel failure														
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	15	16	19	29	35		67			52	125	108
	A4, HCR	[kN]	11		19	21	33		47			65	88	94
Partial safety factor	γ_{Ms}	[-]	1,5											
Pull-out														
Characteristic resistance $N_{Rk,p}$ in cracked concrete C20/25	50°C / 80°C [2)]	[kN]	[1)]											
	72°C / 120°C [2)]	[kN]	5	7,5	12		16	20	20	30	50	30	60	75
Increasing factor	ψ_c	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$											
Concrete cone failure														
Effective anchorage depth	h_{ef}	[mm]	40	50	60	75	70	80	90	105	125	115	170	170
Factor according to CEN/TS 1992-4	k_{cr}	[-]	7,2											

[1)] Pull-out failure is not decisive
[2)] Maximum long term temperature / Maximum short term temperature

Injection System HB-VMZ

Performance
Characteristic values for **tension load, HB-VMZ-IG, cracked concrete**

Annex C10

Table C14: Characteristic values for **tension load**, **HB-VMZ-IG**, **non-cracked concrete**

Anchor size HB-VMZ-IG			**40 M6**	**50 M6**	**60 M8**	**75 M8**	**70 M10**	**80 M10**	**90 M12**	**105 M12**	**125 M12**	**115 M16**	**170 M16**	**170 M20**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0											
Steel failure														
Characteristic tension resistance $N_{Rk,s}$	Steel, zinc plated	[kN]	15	16	19	29	35		67			52	125	108
	A4, HCR	[kN]	11		19	21	33		47			65	88	94
Partial safety factor	γ_{Ms}	[-]	1,5											
Pull-out														
Characteristic resistance $N_{Rk,p}$ in non-cracked concrete C20/25	50°C / 80°C [2]	[kN]	9	[1]	[1]									
	72°C / 120°C [2]	[kN]	6	9	16		16	25	25	35	50	40	75	95
Splitting														
Splitting for standard thickness of concrete (The higher resistance of Case 1 and Case 2 may be applied.)														
Standard thickness of concrete	$h_{std} \geq 2h_{ef}$	[mm]	100		120	150	140	160	180	200	250	230	340	340
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)														
Characteristic resistance in concrete C20/25	$N^0_{Rk,sp}$	[kN]	7,5	9	16	20	20	[1]	40	50	50	[1]		[1]
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}											
Case 2														
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	6h_{ef}	6h_{ef}	5h_{ef}	7h_{ef}	5h_{ef}	3h_{ef}	4h_{ef}	4h_{ef}	4h_{ef}	3h_{ef}	3h_{ef}	3h_{ef}
Splitting for minimum thickness of concrete (The higher resistance of Case 1 and Case 2 may be applied.)														
Minimum thickness of concrete	$h_{min} \geq$	[mm]	80		100	110	110		130	150	160	160	220	220
Case 1 ($N^0_{Rk,c}$ has to be replaced by $N^0_{Rk,sp}$)														
Characteristic resistance in concrete C20/25	$N^0_{Rk,sp}$	[kN]	7,5	-	16		20	25	35	50	40	-	75	[1]
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	3 h_{ef}											
Case 2														
Spacing (edge distance)	$s_{cr,sp}$ (= 2 $c_{cr,sp}$)	[mm]	6 h_{ef}	7 h_{ef}	6 h_{ef}	7 h_{ef}	7 h_{ef}	6 h_{ef}	5 h_{ef}	5 h_{ef}	6 h_{ef}	5 h_{ef}	5,2h_{ef}	5,2h_{ef}
Increasing factor for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_c	[-]	$\left(\frac{f_{ck,cube}}{25}\right)^{0,5}$											
Concrete cone failure														
Effective anchorage depth	h_{ef}	[mm]	40	50	60	75	70	80	90	105	125	115	170	170
Factor according to CEN/TS 1992-4	k_{ucr}	[-]	10,1											

[1] Pull-out failure is not decisive
[2] Maximum long term temperature / Maximum short term temperature

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Table C15: Characteristic values for **shear load, HB-VMZ-IG, cracked and non-cracked concrete**

Anchor size HB-VMZ-IG			**40 M6**	**50 M6**	**60 M8**	**75 M8**	**70 M10**	**80 M10**	**90 M12**	**105 M12**	**125 M12**	**115 M16**	**170 M16**	**170 M20**
Installation safety factor	$\gamma_2=\gamma_{inst}$	[-]	1,0											
Steel failure without lever arm														
Characteristic shear resistance $V_{Rk,s}$	Steel, zinc plated	[kN]	8,0		9,5	15	18		34			26	63	54
	A4, HCR	[kN]	5,5		9,5	10	16		24			32	44	47
Partial safety factor	γ_{Ms}	[-]	1,25											
Factor for ductility	k_2	[-]	1,0											
Steel failure with lever arm														
Characteristic bending moments $M^0_{Rk,s}$	Steel, zinc plated	[kN]	12		30		60		105			212	266	519
	A4, HCR	[kN]	8,5		21		42		74			187	187	365
Partial safety factor	γ_{Ms}	[-]	1,25											
Concrete pry-out failure														
Factor k acc. ETAG 001, Annex C or k_3 acc. CEN/TS 1992-4	$k_{(3)}$	[-]	2											
Concrete edge failure														
Effective length of anchor in shear load	l_f	[mm]	40	50	60	75	70	80	90	105	125	115	170	170
Diameter of anchor	d_{nom}	[mm]	10		12		14		18			22	24	26

Table C16: Displacements under **tension loads, HB-VMZ-IG**

Anchor size HB-VMZ-IG			**40 M6**	**50 M6**	**60 M8**	**75 M8**	**70 M10**	**80 M10**	**90 M12**	**105 M12**	**125 M12**	**115 M16**	**170 M16**	**170 M20**
Tension load in **cracked** concrete	N	[kN]	4,3	6,1	8,0	11,1	10,0	12,3	14,6	18,4	24,0	21,1	38,0	38,0
Displacement	δ_{N0}	[mm]	0,5		0,5	0,6	0,6		0,7			0,7	0,8	0,8
	$\delta_{N\infty}$	[mm]	1,3									1,1	1,3	1,3
Tension load in **non-cracked** concrete	N	[kN]	4,3	8,5	11,1	15,6	14,1	17,2	20,5	25,9	33,0	29,6	53,3	53,3
Displacement	δ_{N0}	[mm]	0,2	0,4	0,4		0,4		0,6			0,5	0,6	0,6
	$\delta_{N\infty}$	[mm]	1,3									1,1	1,3	1,3

Table C17: Displacements under **shear loads, HB-VMZ-IG**

Anchor size HB-VMZ-IG			**40 M6**	**50 M6**	**60 M8**	**75 M8**	**70 M10**	**80 M10**	**90 M12**	**105 M12**	**125 M12**	**115 M16**	**170 M16**	**170 M20**
Shear load **Steel, zinc plated**	V	[kN]	4,6		5,4	8,4	10,1		19,3			14,8	35,8	30,7
Displacement	δ_{V0}	[mm]	0,4		0,5	0,4	0,5		1,2			0,8	1,9	1,2
	$\delta_{V\infty}$	[mm]	0,7		0,8	0,7	0,8		1,9			1,2	2,8	1,9
Shear load **Stainless steel A4 / HCR**	V	[kN]	3,2		5,4	5,9	9,3		13,5			18,5	25,2	26,9
Displacement	δ_{V0}	[mm]	0,3		0,5	0,3	0,5		0,9			1,0	1,4	1,1
	$\delta_{V\infty}$	[mm]	0,4		0,7	0,5	0,7		1,4			1,5	2,1	1,6

Injection System HB-VMZ

Performance
Characteristic values for **shear load, HB-VMZ-IG, cracked and non-cracked concrete**, **Displacements**

Annex C12