Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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

European Technical Assessment

ETA-17/0194 of 31 May 2018

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 VMZ dynamic
Product family to which the construction product belongs	Post-installed fasteners in concrete under fatigue cyclic loading
Manufacturer	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND
Manufacturing plant	Werk 1, D Werk 2, D
This European Technical Assessment contains	17 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330250-00-0601

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Specific part

1 Technical description of the product

The Injection System VMZ dynamic is a torque controlled bonded anchor consisting of a cartridge with injection mortar VMZ or VMZ Express, an anchor rod with expansion cones and external connection thread, a centring ring (only for through-setting installation), a conical washer, a hexagon nut with spherical contact surface and a locknut. For the pre-setting installation a conical washer with a bore is used. Alternatively the hexagon nut with spherical contact surface can be replaced by a spherical disc with hexagon nut.

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 (Assessment method A)	**Performance**
Characteristic fatigue resistance under cyclic tension loading	
Characteristic steel fatigue resistance $\Delta N_{Rk,s,0,n}$ (n = 1 to n = ∞)	See Annexes C 1 and C 2
Characteristic concrete cone, pull-out, splitting and blow out fatigue resistance $\Delta N_{Rk,c,0,n}$ $\Delta N_{Rk,p,0,n}$ $\Delta N_{Rk,sp,0,n}$ $\Delta N_{Rk,cb,0,n}$ (n = 1 to n = ∞)	
Characteristic combined pull- out /concrete cone fatigue resistance $\Delta N_{Rk,p,0,n}$ (n = 1 to n = ∞)	
Characteristic fatigue resistance under cyclic shear loading	
Characteristic steel fatigue resistance $\Delta V_{Rk,s,0,n}$ (n = 1 to n = ∞)	See Annexes C 1 and C 2
Characteristic concrete edge fatigue resistance $V_{Rk,c,0,n}$ (n = 1 to n = ∞)	
Characteristic concrete pry out fatigue resistance $\Delta V_{Rk,cp,0,n}$ (n = 1 to n = ∞)	

Essential characteristic (Assessment method A)	**Performance**
Characteristic fatigue resistance under cyclic combined tension and shear loading	
Characteristic steel fatigue resistance a_{sn} (n = 1 to n = ∞)	See Annexes C 1 and C 2
Load transfer factor for cyclic tension and shear loading	
Load transfer factor ψ_{FN}, ψ_{FV}	See Annexes C 1 and C 2

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

In accordance with European Assessment Document No. 330250-00-0601, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

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

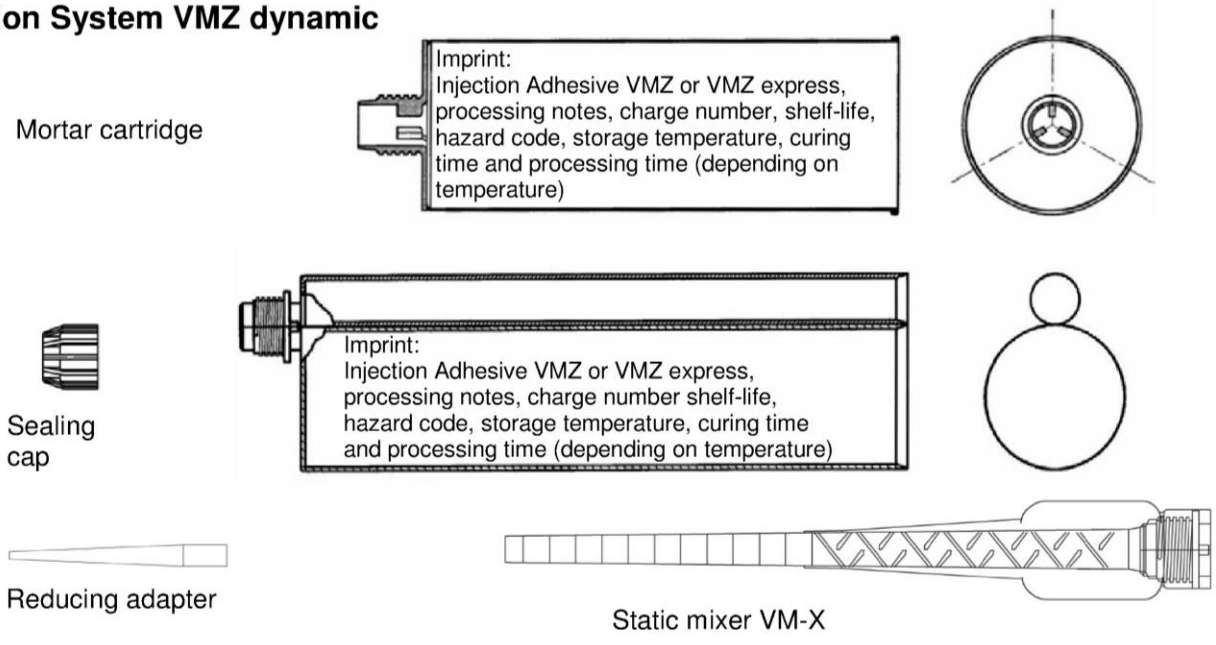
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

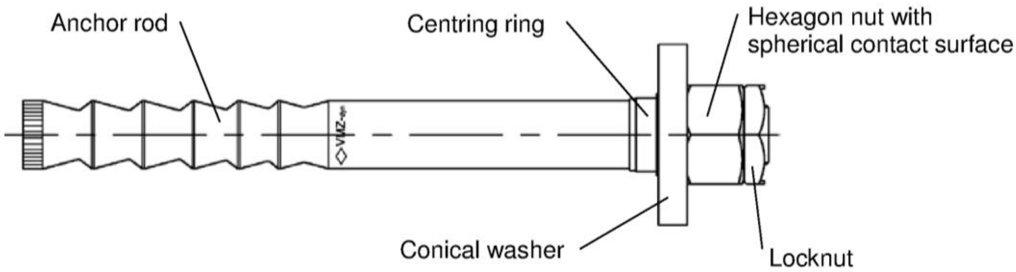
Issued in Berlin on 31 May 2018 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

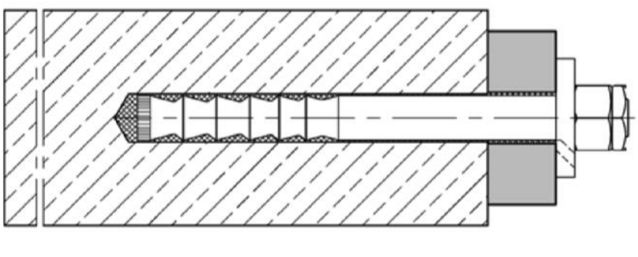
beglaubigt:
Baderschneider

Injection System VMZ dynamic

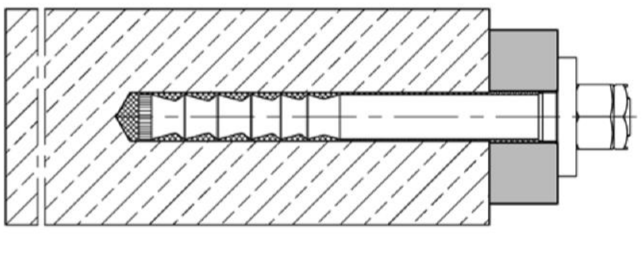




Pre-setting installation



Through-setting installation



Injection System VMZ dynamic	
Product description Product and installed situation	**Annex A1**

Deutsches Institut für Bautechnik DIBt

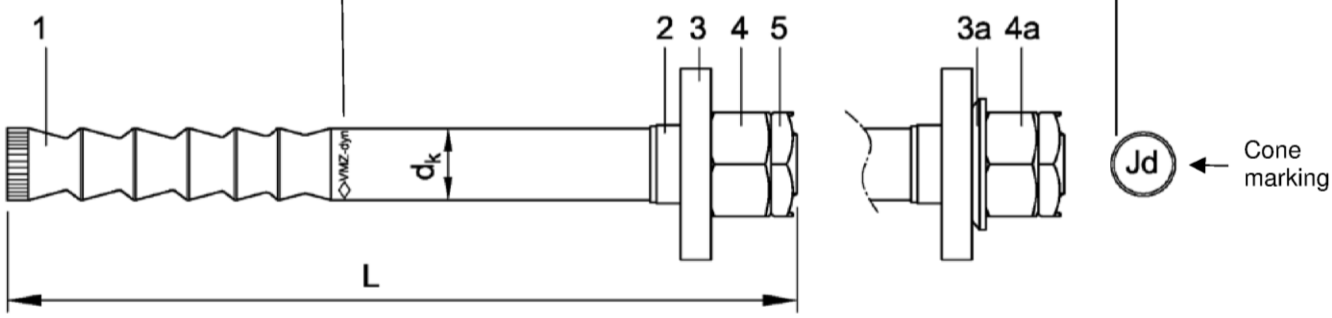
Marking

Marking: e.g. ◇VMZ-dyn 12-25

◇	identifying mark of manufacturing plant
VMZ-dyn	anchor identity
12	size of thread
25	maximum thickness of fixture
A4	additional marking of stainless steel A4, if not on conical washer
HCR	additional marking of high corrosion resistant steel

Cone marking: e.g.

J Marking of length
d dynamic

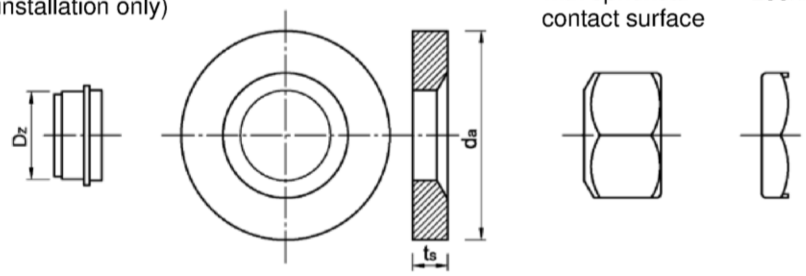


Centring ring (through-setting installation only)

Conical washer

Hexagon nut with spherical contact surface

Locknut



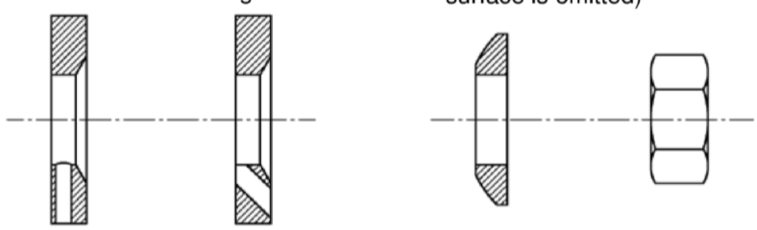
Marking of the anchor version on the conical washer / conical washer with bore
(alternatively: marking on the anchor rod)

Anchor version:		Marking:
galvanized	-	no marking
A4	-	A4
HCR	-	HCR

Alternatively:
Conical washer with bore

radial angular

Alternatively:
Spherical disc with hexagon nut
(hexagon nut with spherical contact surface is omitted)



Marking of length	I	J	K	L	M	N	O	P	Q
Length of anchor min ≥	139,7	152,4	165,1	177,8	190,5	203,2	215,9	228,6	241,3
Length of anchor max <	152,4	165,1	177,8	190,5	203,2	215,9	228,6	241,3	254,0

Marking of length	R	S	T	U	V	W	X	Y	Z	>Z
Length of anchor min ≥	254,0	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6
Length of anchor max <	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6	

Injection System VMZ dynamic

Product description
Components, Marking

Annex A2

Table A1: Materials

Part	Designation	Steel, zinc plated	Stainless steel (A4)	High corrosion resistant steel (HCR)
1	Anchor rod	Steel, acc. to EN 10087:1998, galvanized and coated	High corrosion resistant steel 1.4529, acc. to EN 10088:2014, coated	
2	Centring ring	Plastic		
3	Conical washer	Steel, galvanized	Stainless steel, 1.4401 or 1.4571 acc. to EN 10088:2014	High corrosion resistant steel 1.4529, acc. to EN 10088:2014
3a	Spherical disc	Steel, galvanized	Stainless steel, 1.4401 or 1.4571 acc. to EN 10088:2014	High corrosion resistant steel 1.4529, acc. to EN 10088:2014
4	Hexagon nut with spherical contact surface	Steel, galvanized	ISO 3506, Property class 70, stainless steel 1.4401 or 1.4571, acc. to EN 10088:2014	ISO 3506, Property class 70, high corrosion resistant steel 1.4529 or 1.4565, acc. to EN 10088:2014
4a	Hexagon nut			
5	Locknut	Steel, galvanized	Stainless steel, 1.4401, 1.4571 or 1.4362, acc. to EN 10088:2014	High corrosion resistant steel 1.4565, 1.4529 or 1.4547, acc. to EN 10088:2014
6	Mortar Cartridge	Vinylester resin, styrene-free		

Table A2: Dimensions

Part	Anchor size				100 M12	125 M16	170 M20
1	Anchor rod	Thread		-	M12	M16	M20
		Effective anchorage depth	$h_{ef} \geq$	[mm]	100	125	170
		Shaft diameter	$d_k =$	[mm]	12,5	16,5	22,0
		Length	L_{min}	[mm]	143	180	242
			L_{max}	[mm]	531	565	623
2	Centring ring	External diameter	D_z	[mm]	14	18	23,5
3	Conical washer	Thickness	t_s	[mm]	6	7	8
		External diameter	$d_a \geq$	[mm]	30	38	50
3a	Spherical disc	External diameter	$d_s =$	[mm]	24	30	36
4	Hexagon nut with spherical contact surface	Width across nut	SW	[mm]	18 / 19	24	30
4a	Hexagon nut	Width across nut	SW	[mm]	19	24	30
5	Locknut	Width across nut	SW	[mm]	19	24	30

Injection System VMZ dynamic

Product description
Materials and Dimensions

Annex A3

Specifications of intended use

Anchorages subject to:

- Fatigue cyclic loading
  Note: Static and quasi-static action according to ETA-04/0092

Base materials:

- Compacted reinforced or unreinforced normal weight concrete without fibers according to EN 206:2013
- Strength classes C20/25 to C50/60 according to EN 206:2013
- Cracked and uncracked concrete
- Temperature Range -40 °C to +80 °C:
  maximum short term temperature +80 °C and maximum long term temperature +50 °C

Use conditions (Environmental conditions): according to ETA-04/0092

- Structures subject to dry internal conditions (VMZ dynamic zinc plated, A4 or HCR).
- Structures subject to external atmospheric exposure including industrial and marine environment or exposure to permanently damp internal conditions, if no particular aggressive conditions exist (VMZ dynamic A4 or HCR).
- Structures subject to external atmospheric exposure or exposure in permanently damp internal conditions or particular aggressive conditions ((VMZ dynamic HCR).
  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming 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 are designed according to
  - EOTA TR 061:2018 (Design method I and II) or
  - FprEN 1992-4:2016

Installation:

- Anchor shall only be used as a complete fastening unit delivered in series. Components of the anchor must not be replaced.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the site manager.
- In case of aborted hole: new drilling at a distance of at least two times the depth of the aborted hole or at a smaller distance, if the aborted drill hole is filled with high strength mortar.
- The installation temperature of anchor components shall be at least +5 °C; during curing of the injection mortar the temperature of the concrete must not fall below 0 °C. Curing time must be observed prior to loading the anchor.
- Drilling by hammer drill bit or compressed air drill (use of vacuum drill bit is admissible)
- The filling of the annular gap can be omitted if it is ensured that the anchor is only loaded in axial direction.

Injection System VMZ dynamic	**Annex B1**
Intended use Specifications	

Table B1: Installation parameters

Anchor size / version			100 M12	100 M12 A4 100 M12 HCR	125 M16	125 M16 A4 125 M16 HCR	170 M20
Effective anchorage depth	$h_{ef} \geq$	[mm]	100		125		170
Nominal diameter of drill hole	$d_0 =$	[mm]	14		18		24
Depth of drill hole [1]	$h_0 \geq$	[mm]	105		133		180
Diameter of cleaning brush	$D \geq$	[mm]	15,0		19,0		25,0
Installation torque	$T_{inst} =$	[Nm]	30		50		80
Diameter of clearance hole in the fixture	$d_f =$	[mm]	15		19		25
Fixture thickness [2]	$t_{fix,min} \geq$	[mm]	12		16		20
	$t_{fix,max} \leq$	[mm]	200				
Overstand	$h_p =$	[mm]	$31 + t_{fix}$	$24 + t_{fix}$	$39 + t_{fix}$	$30 + t_{fix}$	$48 + t_{fix}$

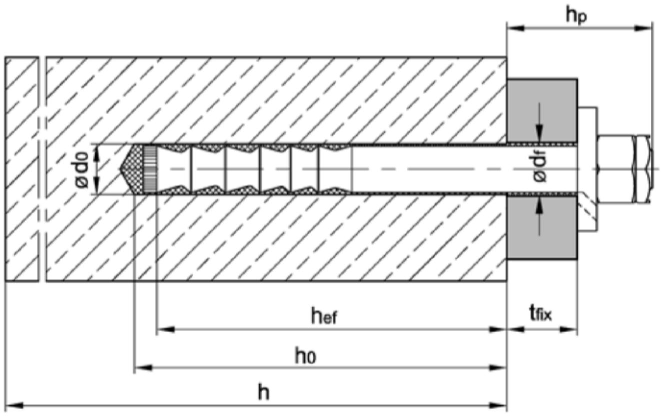
[1] If the present fixture thickness is lower than the maximum fixture thickness of the anchor, the depth of drill hole should be increased accordingly.

[2] $t_{fix,min}$ may be replaced by $t_{fix,min,red}$, if a reduced fatigue resistance $\Delta V_{R,red}$ in transverse direction is considered:

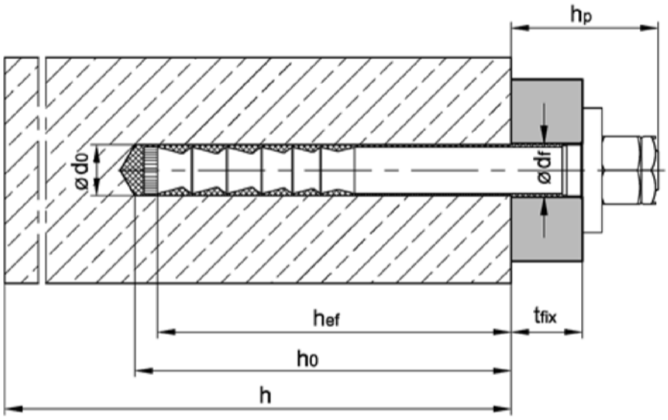
$$t_{fix,min,red} = (0{,}5+0{,}5 \cdot \Delta V_{R,red} / \Delta V_R) \cdot t_{fix,min}$$

where $\Delta V_R = \Delta V_{Rk,s,0,n}$ - Design method I (Table C1)
where $\Delta V_R = \Delta V_{Rk,s,\infty}$ - Design method II (Table C2)

Pre-setting installation



Through-setting installation



Injection System VMZ dynamic

Intended use
Installation parameters

Annex B2

Table B2: Minimum thickness of concrete and minimum spacing and edge distance

Anchor size			**100 M12**	**125 M16**	**170 M20**
Minimum thickness of concrete member	h_{min}	[mm]	130	170 160 [1)]	230 220 [1)]
Cracked concrete					
Minimum spacing	s_{min}	[mm]	50	60	80
Minimum edge distance	c_{min}	[mm]	70	80	110
Uncracked concrete					
Minimum spacing	s_{min}	[mm]	80	60	80
Minimum edge distance	c_{min}	[mm]	75	80	110

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.

Table B3: Processing time and curing time until the application of the load, 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

Table B4: Processing time and curing time until the application of the load, VMZ express

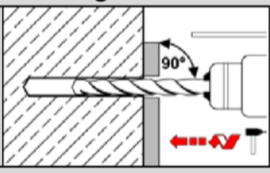
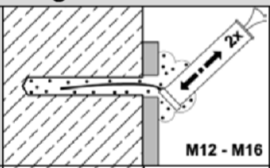
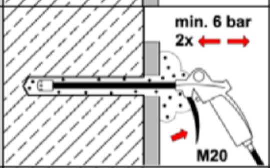
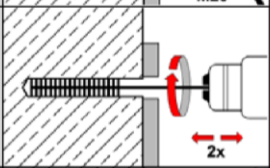
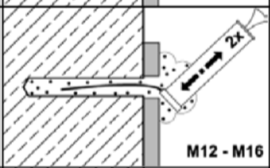
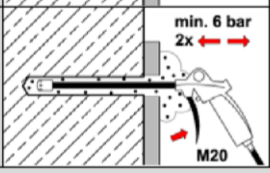
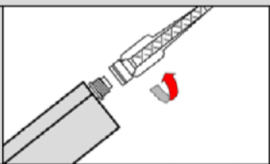
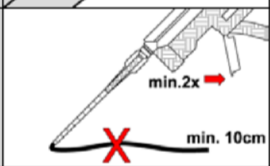
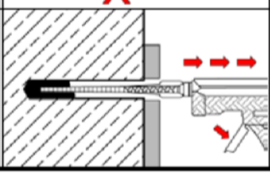
Temperature [°C] in the drill hole	**Maximum processing time**	**Minimum curing time**	
		dry concrete	**wet concrete**
+ 30 °C	1 min	10 min	20 min
+ 20 °C to + 29 °C	1 min	20 min	40 min
+ 10 °C to + 19 °C	3 min	40 min	80 min
+ 5 °C to + 9 °C	6 min	1:00 h	2:00 h
0 °C to + 4 °C	10 min	2:00 h	4:00 h

Injection System VMZ dynamic

Intended use
Minimum thickness of concrete, spacing and edge distances, processing and curing time

Annex B3

Installation instructions – Through-setting installation

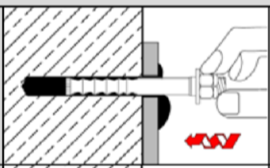
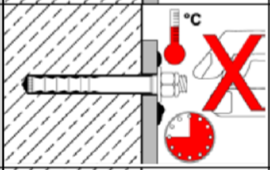
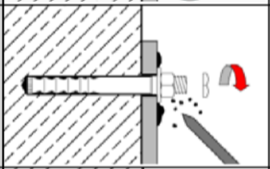
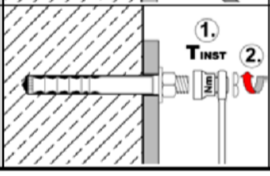
Hole drilling		
1		Drill hole perpendicular to concrete surface with hammer drill, vacuum drill or compressed air drill. **Drill hole must be cleaned directly prior to installation of the anchor.**
Cleaning		
2a		**VMZ M12 - M16:** Blow out drill hole from the bottom using Blow-out Pump VM-AP at least two times.
2b		**VMZ M20:** Connect Air Blower 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 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.
4a		**VMZ M12 - M16:** Blow out drill hole from the bottom using Blow-out Pump VM-AP at least two times.
4b		**VMZ M20:** Connect Air Blower 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		
5		Check minimum shelf-life on VMZ cartridge. Never use when expired. Remove cap from VMZ cartridge. Screw Mixer Nozzle 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 VM-X reaches the bottom of the drill hole. If it does not reach the bottom, plug Mixer Extension VM-XE onto Mixer Nozzle, in order to properly fill the drill hole. 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.

Injection System VMZ dynamic

Intended use
Installation instructions – Through-setting installation

Annex B4

Installation instructions – Through-setting installation (continuation)

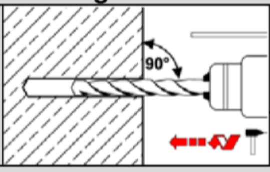
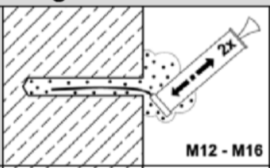
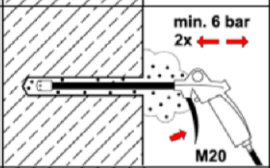
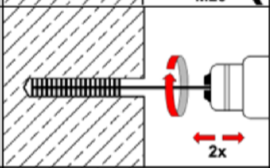
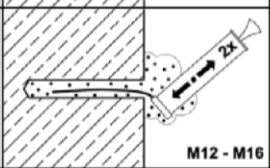
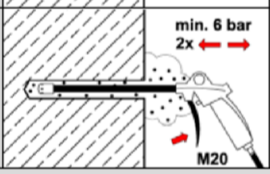
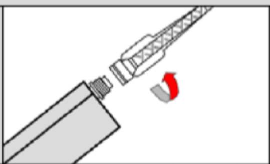
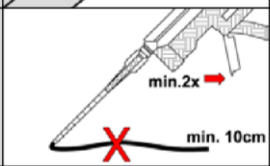
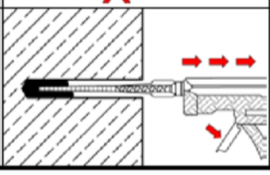
Insertion of anchor rod		
8		Insert the pre-assembled anchor within processing time by hand, rotating slightly up to the full embedment depth, until the conical washer lies against the fixture. The anchor rod is properly set when the gap between anchor rod and fixture is completely filled. If the hole is not completely filled, pull out anchor rod, let mortar cure, drill out hole and start again from step 2.
9		Follow minimum curing time shown in Table B3 and Table B4 as well as on cartridge label. During curing time anchor rod must not be moved or loaded.
10		Remove excess mortar after curing time. Remove locknut.
11		1. Apply installation torque T_{inst} according to Table B1 by using torque wrench. 2. Screw on locknut until hand tight then tighten $^{1}/_{4}$ to ½ turn using a screw wrench.

Injection System VMZ dynamic

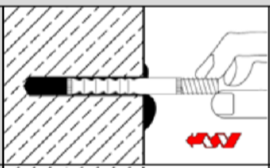
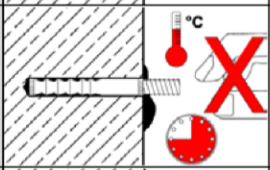
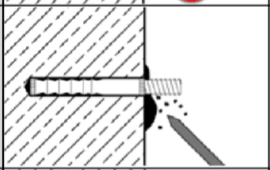
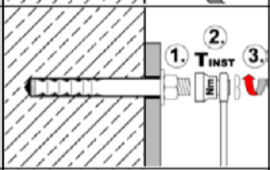
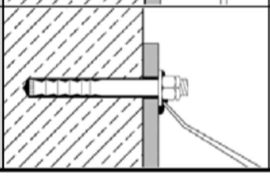
Intended use
Installation instructions – Through-setting installation (continuation)

Annex B5

Installation instructions – Pre-setting installation

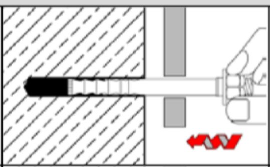
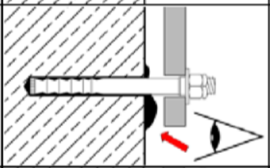
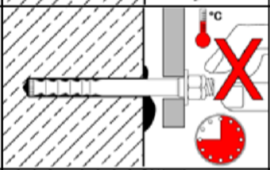
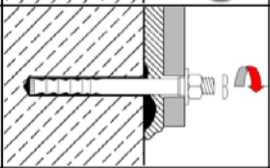
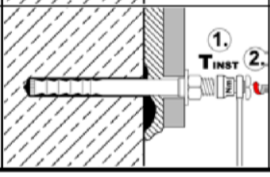
Hole drilling		
1		Drill perpendicular to concrete surface with hammer drill, vacuum drill or compressed air drill. **Drill hole must be cleaned directly prior to installation of the anchor.**
Cleaning		
2a		**VMZ M12 - M16:** Blow out drill hole from the bottom using Blow-out Pump VM-AP at least two times.
2b		**VMZ M20:** Connect Air Blower 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 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.
4a		**VMZ M12 - M16:** Blow out drill hole from the bottom using Blow-out Pump VM-AP at least two times.
4b		**VMZ M20:** Connect Air Blower 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		
5		Check minimum shelf-life on VMZ cartridge. Never use when expired. Remove cap from VMZ cartridge. Screw Mixer Nozzle 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 VM-X reaches the bottom of the drill hole. If it does not reach the bottom, plug Mixer Extension VM-XE onto Mixer Nozzle in order to properly fill the drill hole. 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.

Installation instructions – Pre-setting installation (continuation)

Insertion of anchor rod		
8		Mark the embedment depth on the anchor rod. Insert the anchor rod by hand, rotating slightly up within processing time. 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 start again from step 2.
9		Follow minimum curing time shown in Annex B3 (Table B3 and Table B4) as well as on cartridge label. During curing time anchor rod must not be moved or loaded.
10		Remove excess mortar after curing time.
11		1. Fixture, washer and nut (without centring ring) can be mounted. 2. Apply installation torque T_{inst} according to Annex B2 (Table B1) by using torque wrench. 3. Screw on locknut until hand tight then tighten $^{1}/_{4}$ to ½ turn using a screw wrench.
12		Annular gap between anchor rod and fixture must be filled with injection mortar through the bore of the conical washer using the adapter plugged onto the static mixer. The annular gap is properly filled when excess mortar seeps out.

Injection System VMZ dynamic	Annex B7
Intended use Installation instructions – Pre-setting installation (continuation)	

Installation instructions – Installation with clearance between concrete and anchor plate (only if the fastener is only loaded in axial direction)

Work steps 1 - 7 as illustrated in Annex B4		
Insertion of anchor rod		
8		Inserting the pre-assembled anchor within processing time by hand, rotating slightly until the conical washer lies against the fixture.
9		Check, if excess mortar seeps from hole. If the hole is not completely filled, pull our anchor rod, let mortar cure, drill out hole and start again from step 2. The annular gap in the fixture does not have to be filled.
10		Follow minimum curing time shown in Annex B3 (Table B3 and Table B4) as well as on cartridge label. During curing time anchor rod must not be moved or loaded.
11		Remove locknut after curing time has expired and backfilling of anchor plate.
12		1. Apply installation torque T_{inst} according to Annex B2 (Table B1) by using torque wrench. 2. Screw on locknut until hand tight then ¼ to ½ turn using a screw wrench.

Injection System VMZ dynamic	**Annex B8**
Intended use Installation instructions – Installation with clearance between concrete and anchor plate	

Table C1: Characteristic values of the fatigue resistance after n load cycles without static actions ($F_{Elod} = 0$) for design method I according to TR 061

Anchor size / version		100 M12		100 M12 A4 100 M12 HCR		125 M16		125 M16 A4 125 M16 HCR		170 M20	
Steel failure[1]											
	n	$\Delta N_{Rk,s,0,n}$	$\Delta V_{Rk,s,0,n}$	$\Delta N_{Rk,s,0,n}$	$\Delta V_{Rk,s,0,n}$	$\Delta N_{Rk,s,0,n}$	$\Delta V_{Rk,s,0,n}$	$\Delta N_{Rk,s,0,n}$	$\Delta V_{Rk,s,0,n}$	$\Delta N_{Rk,s,0,n}$	$\Delta V_{Rk,s,0,n}$
Characteristic resistance without static-actions [kN]	1	53,9	34,0	53,9	34,0	83,4	63,0	83,4	63,0	112,1	149,0
	$\leq 10^3$	48,3	27,6	52,6	31,3	78,8	54,0	72,5	54,0	92,7	113,5
	$\leq 3 \cdot 10^3$	45,9	23,8	50,9	28,3	77,1	47,2	68,2	47,2	89,9	91,6
	$\leq 10^4$	41,4	18,6	47,6	23,5	73,1	36,5	62,4	36,5	83,4	65,0
	$\leq 3 \cdot 10^4$	35,9	14,1	42,8	18,1	66,3	26,2	56,7	26,2	73,8	43,9
	$\leq 10^5$	29,1	10,5	36,3	12,8	55,8	18,4	50,5	18,4	60,9	29,0
	$\leq 3 \cdot 10^5$	24,2	8,9	30,1	9,8	45,5	15,6	45,7	15,6	50,7	23,2
	$\leq 10^6$	21,1	8,2	24,9	8,5	37,4	15,0	41,8	15,0	44,9	21,3
	$\geq 10^6$	20,1	8,2	21,2	8,2	34,0	15,0	37,3	15,0	43,5	21,1
Partial factor	$\gamma_{Ms,fat}$	Acc. to TR 061, Eq. (3)									
Exponent for combined loading	α_{sn}	1,5		1,2		1,5		1,5		1,5	
Concrete failure $\Delta N_{Rk,(c/sp/cb),0,n} = \eta_{k,c,N\,fat,n} \cdot N_{Rk,(c/sp/cb)}$ and $\Delta V_{Rk,(c/cp),0,n} = \eta_{k,c,V,fat,n} \cdot V_{Rk,(c/cp)}$ [2]											
	n	$\eta_{k,c,N,fat,n}$	$\eta_{k,c,V,fat,n}$	$\eta_{k,c,N,fat,n}$	$\eta_{k,c,V,fat,n}$	$\eta_{k,c,N,fat,n}$	$\eta_{k,c,V,fat,n}$	$\eta_{k,c,N,fat,n}$	$\eta_{k,c,V,fat,n}$	$\eta_{k,c,N,fat,n}$	$\eta_{k,c,V,fat,n}$
Reduction factor η_{fat} for characteristic resistance	1	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	$\leq 10^3$	0,932	0,799	0,932	0,799	0,932	0,799	0,932	0,799	0,932	0,799
	$\leq 3 \cdot 10^3$	0,893	0,760	0,893	0,760	0,893	0,760	0,893	0,760	0,893	0,760
	$\leq 10^4$	0,841	0,725	0,841	0,725	0,841	0,725	0,841	0,725	0,841	0,725
	$\leq 3 \cdot 10^4$	0,794	0,700	0,794	0,700	0,794	0,700	0,794	0,700	0,794	0,700
	$\leq 10^5$	0,750	0,680	0,750	0,680	0,750	0,680	0,750	0,680	0,750	0,680
	$\leq 3 \cdot 10^5$	0,722	0,668	0,722	0,668	0,722	0,668	0,722	0,668	0,722	0,668
	$\leq 10^6$	0,704	0,660	0,704	0,660	0,704	0,660	0,704	0,660	0,704	0,660
	$\geq 10^6$	0,693	0,652	0,693	0,652	0,693	0,652	0,693	0,652	0,693	0,652
Partial factor	$\gamma_{Mc,fat}$	1,5									
Exponent for combined loading	α_c	1,5									
Load-transfer factor for fastener groups	ψ_{FN}	0,79									
	ψ_{FV}	0,81									

1) The failure in cracked concrete due to combined pull- out /concrete cone failure $\Delta N_{Rk,p,0,n}$ in the low-cyclic loading range has been taken into account;

2) $N_{Rk,c}$, $N_{Rk,sp}$, $N_{Rk,cb}$, $V_{Rk,c}$ and $V_{Rk,cp}$ – Characteristic values of resistance to concrete failure under static or quasi-static actions according to ETA-04/0092

Injection System VMZ dynamic

Performance
Characteristic fatigue resistance for design method I according to TR 061

Annex C1

Table C2: Characteristic fatigue limit resistance for design according to FprEN 1992-4 and design method II according to TR 061

Anchor size / version			100 M12	100 M12 A4 100 M12 HCR	125 M16	125 M16 A4 125 M16 HCR	170 M20
Tension load							
Steel failure							
Characteristic tension resistance	$\Delta N_{Rk,s,0,\infty}$	[kN]	20	21,2	34	37	43
Partial factor	$\gamma_{Ms,N,fat}$	-	1,35				
Exponent for combined loading	α_s	-	1,5	1,2	1,5		
Concrete failure							
Characteristic tension resistance	$\Delta N_{Rk,c,0,\infty}$	[kN]	$0{,}693\ N_{Rk,c}$ [1)]				
	$\Delta N_{Rk,sp,0,\infty}$	[kN]	$0{,}693\ N_{Rk,sp}$ [1)]				
	$\Delta N_{Rk,cb,0,\infty}$	[kN]	$0{,}693\ N_{Rk,cb}$ [1)]				
Effective anchorage depth	h_{ef}	[mm]	100		125		170
Partial factor	$\gamma_{Mc,fat}$	-	1,5				
Exponent for combined loading	α_c	-	1,5				
Load-transfer factor for fastener groups	$\psi_{F,N}$	-	0,79				
Shear load							
Steel failure without lever arm							
Characteristic shear resistance	$\Delta V_{Rk,s,0,\infty}$	[kN]	8,2		15		21
Partial factor	$\gamma_{Ms,V,fat}$	-	1,35				
Exponent for combined loading	α_s	-	1,5	1,2	1,5		
Concrete pry-out failure							
Characteristic shear resistance	$\Delta V_{Rk,cp,0,\infty}$	[kN]	$0{,}652\ V_{Rk,cp}$ [1)]				
Partial factor	$\gamma_{Mc,fat}$	-	1,5				
Concrete edge failure							
Characteristic shear resistance	$\Delta V_{Rk,c,0,\infty}$	[kN]	$0{,}652\ V_{Rk,c}$ [1)]				
Effective length of anchor	l_f	[mm]	100		125		170
Diameter of anchor	d_{nom}	[mm]	14		18		24
Partial factor	$\gamma_{Mc,fat}$	-	1,5				
Exponent for combined loading	α_c	-	1,5				
Load-transfer factor for fastener groups	$\psi_{F,V}$	-	0,81				

[1)] $N_{Rk,c}$, $N_{Rk,sp}$, $N_{Rk,cb}$, $V_{Rk,c}$ and $V_{Rk,cp}$ – Characteristic values of resistance to concrete failure under static or quasi-static actions according to ETA-04/0092

Injection System VMZ dynamic	**Annex C2**
Performance Characteristic fatigue limit resistance for design according to FprEN 1992-4 and design method II according to TR 061	