Deutsches Institut für Bautechnik
DIBt

Zulassungsstelle für Bauprodukte und Bauarten
Bautechnisches Prüfamt
Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts
Mitglied der EOTA, der UEAtc und der WFTAO

Allgemeine bauaufsichtliche Zulassung

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Applicant:
MKT
Metall-Kunststoff-Technik GmbH & Co. KG
Auf dem Immel 2
67685 Weilerbach

Subject of approval:
Injection System VMZ dynamic

The subject of approval mentioned above is herewith generally approved in the field of construction. This *allgemeine bauaufsichtliche Zulassung* ('national technical approval') comprises eight pages and 16 annexes. The subject of approval was first issued on 30 March 2010

I GENERAL PROVISIONS

1 With the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') the fitness for use and the applicability of the subject of approval according to the *Landesbauordnungen* ('Building Regulations of the Land') has been verified.

2 If, in the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') requirements are made concerning the special expertise and experience of persons entrusted with the manufacture of construction products and types of construction according to the relevant regulations of the Land following section 17, sub-section 5 *Musterbauordnung* ('Model Building Code'), it is to be noted that this expertise and experience can also be proven by equivalent verifications from other Member States of the European Union. If necessary, this also applies to verifications presented within the framework of the Agreement on the European Economic Area (EEA) or other bilateral agreements.

3 The *allgemeine bauaufsichtliche Zulassung* ('national technical approval') does not replace the permits, approvals and certificates prescribed by law for carrying out building projects.

4 The *allgemeine bauaufsichtliche Zulassung* ('national technical approval') will be granted without prejudice to the rights of third parties, in particular private property rights.

5 Notwithstanding further regulations in the "Specific Provisions" manufacturers and distributors of the subject of approval shall make copies of the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') available to the user and point out that the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') has to be available at the place of use. Upon request copies of the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') shall be placed at the disposal of the authorities involved.

6 The *allgemeine bauaufsichtliche Zulasssung* ('national technical approval') may be reproduced in full only. Publication in the form of extracts requires the consent of *Deutsches Institut für Bautechnik*. Texts and drawings of advertising brochures may not be in contradiction to the *allgemeine bauaufsichtliche Zulassung* ('national technical approval'). Translations of the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') have to contain the note "Translation of the German original, not checked by *Deutsches Institut für Bautechnik*".

7 The *allgemeine bauaufsichtliche Zulassung* ('national technical approval') is granted until revoked. The provisions of the *allgemeine bauaufsichtliche Zulassung* ('national technical approval') can subsequently be supplemented and amended in particular, if this is required by new technical findings.

II SPECIFIC PROVISIONS

1 Subject of approval and field of application

1.1 Subject of approval

The Injection System VMZ dynamic (hereinafter referred to anchor) in sizes M12, M16 and M20 is a bonded anchor, which is torque controlled anchored in concrete in a cylindrical drill hole.

It consists of an anchor rod with thread, a centring ring (only for through-setting installation), a conical washer, a hexagon nut with spherical contact surface, a locknut and the injection mortar VMZ. 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 anchor rod in sizes M12 and M16 are made of galvanized steel or high-corrosion-resistant steel (HCR). The anchor rod of size M20 is made of galvanized steel.

The washer and the nut are made of galvanized steel, stainless steel (A4) or high-corrosion-resistant steel (HCR).

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 installed anchor is shown in Annex 1.

1.2 Intended use

The anchor may be used for anchorages subject to static, quasi-static or dynamic loading in reinforced or unreinforced normal weight concrete of strength class C20/25 at minimum and C50/60 at maximum according to *DIN EN 206-1:2001-07 "Beton; Festlegung, Eigenschaften, Herstellung und Konformität"* ('Concrete; Specification, performance, production and conformity'); it may also be used in concrete of strength class B 25 at minimum and B 55 at maximum according to *DIN 1045:1988-07 "Beton und Stahlbeton, Bemessung und Ausführung"* ('Reinforced concrete structures; design and construction'). The anchor may only be used when there are no requirements relating to fire resistance that have to be met by the entire structure including the anchor.

The anchor may be anchored in cracked and non-cracked concrete.

The temperature in the mortar area must not exceed +50 °C, short-term +80 °C.

The anchor made of galvanized steel may only be used in structures subject to dry internal conditions.

The anchor rod made of high corrosion resistant steel (HCR) may be used in conjunction with washer and nuts made of stainless steel (A4) under the conditions according to the corrosion resistance class III of the *Allgemeine bauaufsichtliche Zulassung "Erzeugnisse, Verbindungsmittel und Bauteile aus nichtrostenden Stählen" Nr. Z-30.3-6* ('national technical approval Products, connecting elements and components made of stainless steel' no. Z-30.3-6).

The anchor rod made of high corrosion resistant steel (HCR) may be used in conjunction with washer and nuts made of high corrosion resistant steel (HCR) under the conditions according to the corrosion resistance class V of the *Allgemeine bauaufsichtliche Zulassung "Erzeugnisse, Verbindungsmittel und Bauteile aus nichtrostenden Stählen" Nr. Z-30.3-6* ('national technical approval Products, connecting elements and components made of stainless steel' no. Z-30.3-6).

2 Provisions for the construction product

2.1 Properties and composition

The anchor shall comply with the specifications and drawings given in the annexes.

The material properties, dimensions and tolerances of the anchor not given in this *allgemeine bauaufsichtliche Zulassung* shall comply with the information deposited at *Deutsches Institut für Bautechnik*, the certification body and the external surveillance body.

The required verifications for the raw material and the supplied anchor parts shall be in accordance with the control plan which is deposited by *Deutsches Institut für Bautechnik* and by the external surveillance body.

2.2 Packaging, storage and marking

2.2.1 Packaging and storage

The two components of the Injection Mortar VMZ are supplied unmixed in cartridges according to Annex 1.

The injection cartridges shall be protected against sun radiation and shall be stored according to the manufacturer's installation instructions in dry conditions at temperatures of at least +5 °C to not more than +25 °C.

Mortar cartridges with expired shelf life must no longer be used.

The anchor shall be packed and supplied as a complete fastening unit. The mortar cartridges are packed separately from the anchor rods, centring ring, hexagon nuts, conical washer and locking nut.

2.2.2 Marking

The packaging, enclosed instructions or delivery note of the anchor shall be marked by the manufacturer with the conformity mark (Ü-mark) according to the *Übereinstimmungszeichen-Verordnungen der Länder* ('Regulations on the conformity mark of the states of the Federal Republic of Germany'). In addition, the manufacturing mark, the approval number and the complete anchor designation shall be declared.

The marking may only be carried out if the requirements according to Section 2.3 *"Übereinstimmungsnachweis"* ('Verification of conformity') have been met.

The mortar cartridge shall be marked in accordance with the *Verordnung über gefährliche Arbeitsstoffe* ('Regulation on hazardous materials') and marked with the words "VMZ" or "VMZ Express" indicating cartridge size as well as information about the shelf life, hazard code and processing. The installation instructions supplied with the mortar shall contain the information on safety measures for dealing with hazardous materials.

Each anchor is marked in accordance with Annex 2. Each anchor rod is marked on the shaft with the identifying mark of manufacturing plant, the trade name, thread size, maximum thickness of the fixture and if necessary an additional marking for stainless steel (A4) or high corrosion resistant steel (HCR). Alternatively the marking for stainless steel (A4) or high corrosion resistant steel (HCR) may be marked on the conical washer.

On the head of the anchor rod is the marking of length and the addition "d" for dynamic marked.

2.3 Übereinstimmungsnachweis ('Verification of conformity')

2.3.1 General

Each manufacturing plant shall confirm that the anchor complies with the provisions of this *allgemeine bauaufsichtliche Zulassung* by means of a certificate of conformity based on the factory production control and a regular external surveillance, including initial testing of the anchor in accordance with the following provisions.

The manufacturer of the anchor shall organize a recognised certification body and a recognised inspection body to issue a certificate of conformity and for the external surveillance, including product testing that has to be carried out.

The manufacturer shall state by marking the products with the conformity mark (Ü-mark) with reference to the intended use, that the certificate of conformity is issued.

The certification body shall send a copy of the issued certificate of conformity to *Deutsches Institut für Bautechnik.*

2.3.2 Factory production control

Each manufacturing plant shall set up and carry out a factory production control. Factory production control is a continuous surveillance of production by the manufacturer who thus ensures that the manufactured construction product is in conformity with the provisions of this *allgemeine bauaufsichtliche Zulassung*.

Extent, type and frequency of the factory production control shall be in accordance with the control plan which is deposited by *Deutsches Institut für Bautechnik* and by the external surveillance body.

The results of factory production control shall be recorded and evaluated. The records shall include at least the following information:

- Designation of the construction product respectively the raw material and its components
- Type of control or test
- Date of manufacture and test of the construction product respectively of the raw material or components
- Results of control and tests and, if applicable, a comparison with requirements
- A signature of the person responsible for factory production control.

The records shall be deposited for at least five years and presented to the recognised external surveillance body. On request, they shall be submitted to *Deutsches Institut für Bautechnik* and to the *zuständige oberste Bauaufsichtsbehörde* ('responsible building authority').

If the test results are unsatisfactory, the manufacturer shall immediately take the action necessary to eliminate the deficiency. Construction products which do not meet requirements shall be treated in such a way that confusion with conforming products is excluded. Once the deficiency has been eliminated, the original test shall be repeated immediately, provided that this is technically possible and also required to verify the elimination of the deficiency.

2.3.3 External surveillance

In each production plant, external surveillance shall be carried out regularly, but at least twice a year, to check the factory production control.

During external surveillance, initial testing of the anchor shall be carried out and random samples taken. Sampling and testing are done on responsibility of the recognised surveillance body.

Extent, type and frequency of the external surveillance shall be in accordance with the control plan which is deposited by *Deutsches Institut für Bautechnik* and by the external surveillance body.

The results of certification and external surveillance shall be deposited for at least five years. On request, they shall be submitted to *Deutsches Institut für Bautechnik* and the responsible building authority by the certification body respectively by the surveillance body.

3 Provisions for design

3.1 Design (concept)

The anchorages shall be designed in accordance with engineering practice. Verifiable calculation notes and design drawings shall be prepared taking into account the loads to be anchored.

The anchor may be used only with the accompanying specific components.

3.2 Design (dimensioning)

3.2.1 General

First the anchorages shall be designed according to Annex C of the "Guideline for European Technical Approval of Metal Anchors for Use in Concrete"[1] (hereinafter referred as Annex C of the Guideline) in accordance with ETA-04/0092. Thereby all actions are considered as static or quasi-static actions. For verification of concrete cone failure under tension load and concrete edge failure under shear load of anchorages in concrete according to *DIN 1045:1988-07* in Equations (5.2a) of Section 5.2.2.4 and in Equation (5.7a) of Section 5.2.3.4 of Annex C of the Guideline the value $f_{ck,cube}$ shall be replaced by 0,97 x β_{WN}.

The design to consider the fatigue influence may be done according to the following design method.

The design method I (Annexes 10 to 13) applies, if a determination of the design value of the lower cyclic limit is possible and (or) an upper limit of the number of load cycles during the service life is known. For an unknown number of load cycles is $n > 10^6$ shall be assumed.
If the determination of the design value of the lower cyclic limit is not possible, all actions shall be assumed as fatigue-relevant actions.

The design method II (Annexes 14 to 16) applies, if a determination of the design value of the lower cyclic is not possible and an upper limit of the number of load cycles during the services life is not available or not known.

The designation of the used values for the design is given in Annex 9.

The partial safety factor for fatigue-relevant actions shall be $\gamma_{F,fat} = 1{,}0$. Thereby the maximum value of fatigue-relevant actions is assumed for the design (maximum value of a load collective). If there is an actual one level collective or an damage-equivalent one level collective the partial safety factor for fatigue-relevant actions is $\gamma_{F,fat} = 1{,}2$.

[1] The guideline is published on the internet site of DIBt under Service/Publications.

For the anchor shear loads with lever arm (bending) are not allowed.

The verification of the immediate local transmission of the anchor loads into the concrete member is proven. The transmission of the anchor loads to the supports of the concrete member shall be proven.

Additional loading due to forces of constraint (e.g. from temperature changes), which can arise in the anchor, the fixture or the component in which the anchor is set, shall be considered.

3.2.2 Displacement behaviour

For the entire service area displacements of 1 mm at the most for single anchors or anchor groups under fatigue-relevant actions (tension and shear load) are expected.

4 Provisions for installation

4.1 General

The anchor shall only be used as a complete fastening unit delivered in series. Components of the anchor may not be exchanged.

The anchor shall be installed in accordance with the design drawings according to Section 3.1. Before placing the anchor the strength class of the concrete member shall be checked. The concrete strength class may not be lower than B 25 or C20/25 and not higher than B 55 or C50/60.

4.2 Drilling and cleaning of the borehole

In order to reduce the risk of aborted drill holes or damage of the reinforcement, the position of the reinforcement shall be located.

The drill hole shall be drilled perpendicular to the surface of the anchorage ground with hard metal impact- or hammer drill. The nominal drill hole diameter and the drill hole depth shall comply with Annex 4, Table 3. In case of aborted drill hole a new drill hole with the distance of minimum 2 x depth of the aborted drill hole shall be drilled. Aborted drill holes shall be filled with mortar.The drill hole shall be cleaned according to the installation instructions in Annex 6 and Annex 7.

4.3 Setting the anchor

The injection of the mortar into the drill hole and the installation of the anchor rod shall comply with the manufacturer's installation instructions according to Annex 6 and Annex 7. During installation the temperature of all anchor components shall be at least +5°C. During curing of the injection mortar the temperature of the concrete member shall not fall below -5 °C. During curing time the anchor rod and the fixture shall be locked in position.

The anchor is properly set and may only be loaded if

- the mortar filling reaches on the surface of fixture,
- the torque according to Annex 4, Table 3 can be applied.

During through-setting installation with distance of fixture according to Annex 8 the mortar filling of the annular gap in the fixture may be omitted, if it is ensured, that the anchor is not loaded by shear loads. It is also to ensured, that the drill hole is completely filled (mortar at concrete surface visible).

4.4 Checking the installation

During the installation of the anchors the contractor entrusted with anchorages or the construction supervisor assigned by him or a competent representative of the construction supervisor have to be present on the job site. He has to ensure the proper installation.

During installation of anchors records about proof of the concrete strength class, temperature of base material and proper installation of anchors shall be kept by the construction supervisor or his competent representative.

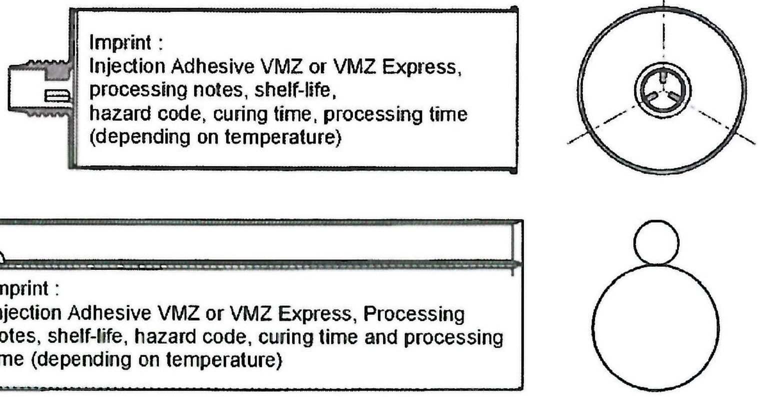
The records must be available on the job site during construction period and they shall be presented on request for inspection. These records, as well as the delivery notes, shall be deposited by the company for at least five years after completion of the construction work.

Andreas Kummerow
Head of Section

Beglaubigt
Aksünger

Injection System VMZ dynamic

Mortar cartridge VMZ



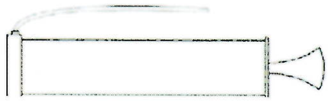
Sealing cap

Adapter for conical washer with bore

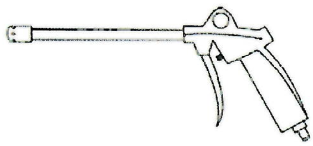
Static mixer VM-X

Cleaning Brush RB

Blow-out pump VM-AP



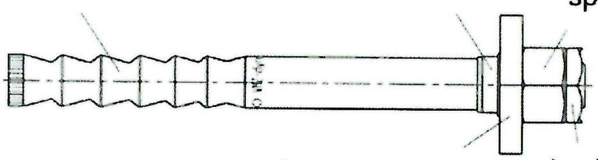
Air Blower VM-ABP



Anchor rod

Centring ring

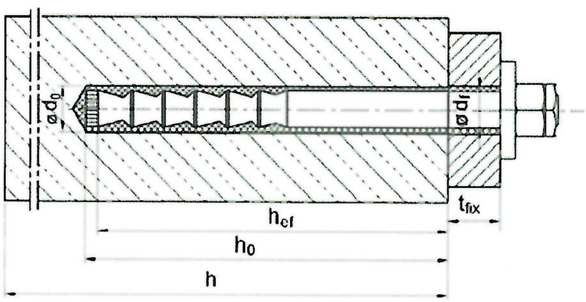
Hexagon nut with spherical contact surface



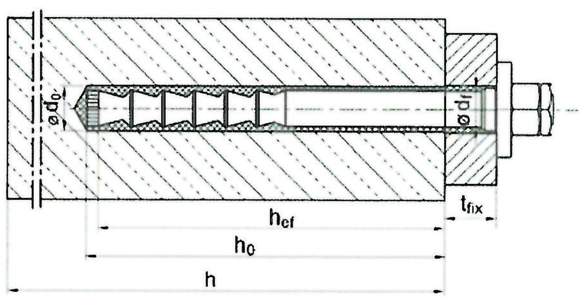
Conical washer

Locknut

Pre-setting installation



Through-setting installation



Injection System VMZ dynamic	**Annex 1**
Product and installation situation	

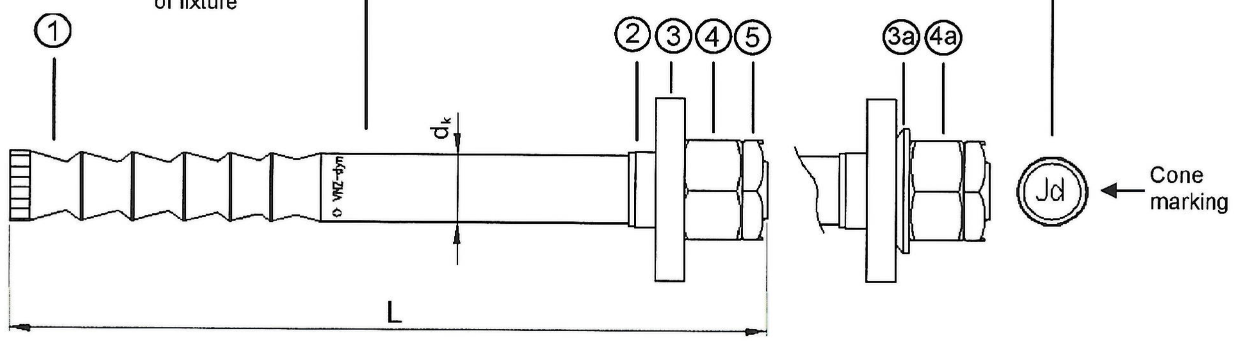
Marking: e.g. ◇ VMZ-dyn 12-25

◇	Identifying mark of manufacturing plant
VMZ-dyn	Trade name
12	Size of thread
25	Maximum thickness of fixture

HCR	additional marking for high corrosion resistant steel HCR
A4	additional marking of stainless steel (A4), if not marked on conical washer

Cone marking: e.g.

J	Marking of length
d	dynamic

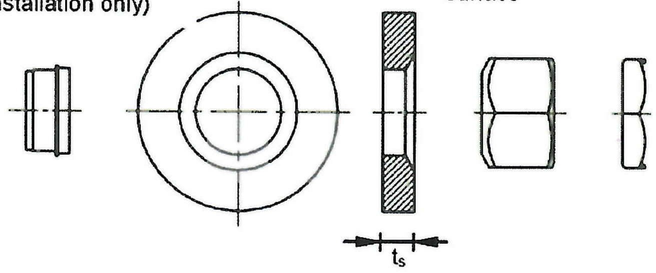


Centring ring (through-setting installation only)

Conical washer

Hexagon nut with spherical contact surface

Locknut



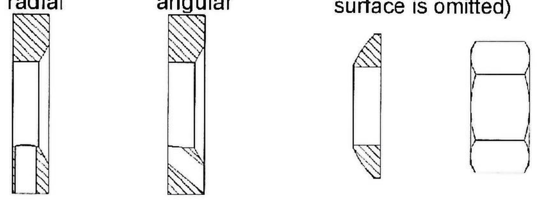
Marking of anchor version on the conical washer / conical washer with bore
(alternatively: Marking on the anchor rod)

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

alternatively:
conical washer with a 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
Anchor length min	≥	139,7	152,4	165,1	177,8	190,5	203,2	215,9	228,6	241,3
Anchor length 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
Anchor length min	≥	254,0	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6
Anchor length max	<	279,4	304,8	330,2	355,6	381,0	406,4	431,8	457,2	482,6	

Injection System VMZ dynamic

Anchor types

Annex 2

Table 1: Dimensions

	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

Table 2: Materials

Part	**Designation**	**Steel, zink plated**	**Stainless steel (A4)**	**High corrosion resistant steel (HCR)**
1	Anchor rod	Steel, acc. to EN 10087, galvanized acc. to DIN EN ISO 4042, coated	High corrosion resistant steel 1.4529, acc. to EN 10088, coated	
2	Centring ring	Plastic		
3	Conical washer DIN 6319 form G or similar	Steel, galvanized acc. to DIN EN ISO 4042	Stainless steel, 1.4401 or 1.4571 acc. to EN 10088	High corrosion resistant steel 1.4529, acc. to EN 10088
3a	Spherical disc DIN 6319 form C	Steel, galvanized acc. to DIN EN ISO 4042	Stainless steel, 1.4401 or 1.4571 acc. to EN 10088	High corrosion resistant steel 1.4529, acc. to EN 10088
4	Hexagon nut with spherical contact surface DIN 6330 or similar	Steel, galvanized acc. to DIN EN ISO 4042	ISO 3506, Property class 70, stainless steel 1.4401 or 1.4571, acc. to EN 10088	ISO 3506, Property class 70, high corrosion resistant steel 1.4529 or 1.4565, acc. to EN 10088
4a	Hexagon nut DIN 934			
5	Locknut	Steel, galvanized acc. to DIN EN ISO 4042	Stainless steel, 1.4401, 1.4571 or 1.4362, acc. to EN 10088	High corrosion resistant steel 1.4565, 1.4529 or 1.4547, acc. to EN 10088
6	Mortar Cartridge	Vinylester resin, styrene-free		

Injection System VMZ dynamic	**Annex 3**
Dimensions, materials	

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Table 3: 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 in the design a reduced fatigue resistance $\Delta V_{R,red}$ in transverse direction is assumend:

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

where $\Delta V_R = \Delta V_{Rd,s;0;n}$ - Design method I (Table 7)
where $\Delta V_R = \Delta V_{Rk,s}$ - Design method II (Table 9)

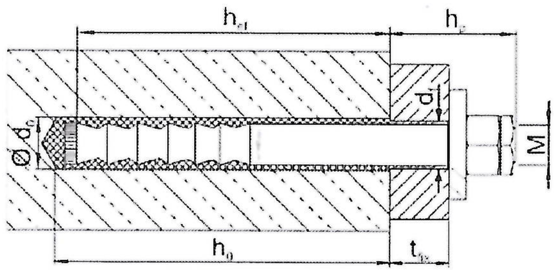


Table 4: Minimum thickness of concrete and minimum spacing and edge distance[3]

Anchor size			100 M12	125 M16	170 M20
Minimum thickness of concrete	h_{min}	[mm]	130	170 160 [4]	230 220 [4]
Cracked concrete					
Minimum spacing	s_{min}	[mm]	50	60	80
Minimum edge distance	c_{min}	[mm]	70	80	110
Non-cracked concrete					
Minimum spacing	s_{min}	[mm]	80	60	80
Minimum edge distance	c_{min}	[mm]	75	80	110

[3] Design of static or quasi-static loadings according to ETA-04/0092.

[4] The remote 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 VMZ dynamic	Annex 4
Installation parameters, Minimum thickness of concrete, minimum spacing and edge distance	

Table 5: 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
- 4 °C to - 1 °C	45 min	6:00 h	12:00 h [1)]
- 5 °C	1:30 h	6:00 h	12:00 h [1)]

[1)] It must be ensured that icing does not occur in the drill hole. The hole must be drilled and cleaned directly prior to the installation of the anchor.

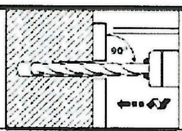
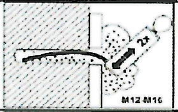
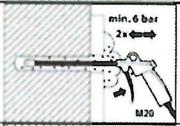
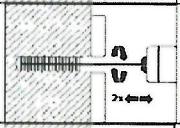
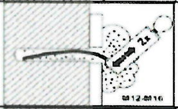
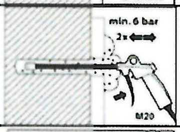
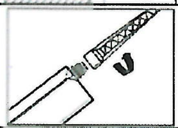
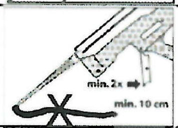
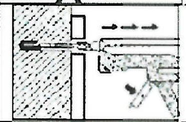
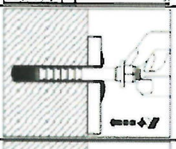
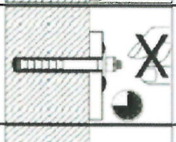
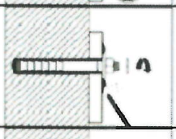
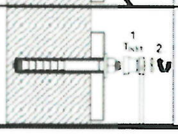
Table 6: Processing time and curing time until the application of the load, VMZ Express

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
- 4 °C to -1 °C	20 min	4:00 h	8:00 h [1)]
-5 °C	40 min	4:00 h	8:00 h [1)]

[1)] It must be ensured that icing does not occur in the drill hole. The hole must be drilled and cleaned directly prior to the installation of the anchor.

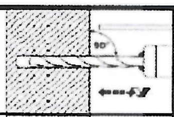
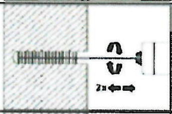
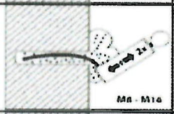
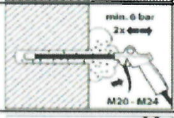
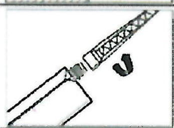
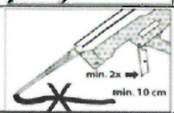
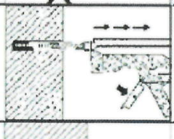
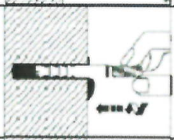
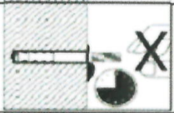
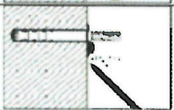
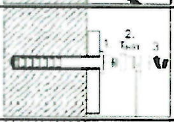
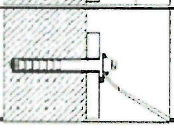
Injection System VMZ dynamic	Annex 5
Processing time and curing time	

Installation instructions for through-setting installation

1		Drill perpendicular to concrete surface with hammer drill or air drill. **Drill hole must be cleaned directly prior to installation of the anchor.**
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.
5		Check mimimum 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.
8		Insert the pre-assambled 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 ist set correctly 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 No 2.
9		Follow minimum curing time shown in Table 5 and Table 6 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 3 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	**Annex 6**
Trough-setting installation instructions	

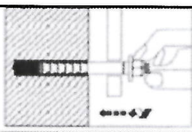
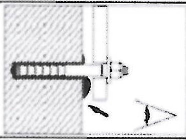
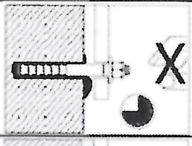
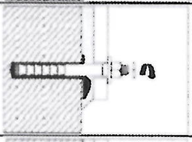
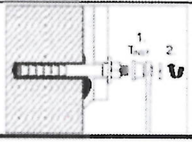
Installation instructions for pre-setting installation

1		Drill perpendicular to concrete surface with hammer drill or air drill. **Drill hole must be cleaned directly prior to installation of the anchor.**
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.
5		Check mimimum 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.
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 Table 5 and Table 6 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 Table 3 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 mortar seeps from hole.

Injection System VMZ dynamic	**Annex 7**
Pre-setting installation instructions	

Installation with clearance between concrete and anchor plate is only admitted, if the conditions in part 4.3 are fulfilled.

Work step 1-7 as illustrated in Annex 6.

8		Insert the pre-assambled 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 out 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 Table 5 and Table 6 as well as on cartridge label. Do not move or load the anchor rod during the curing time.
11		Lock nut can be removed after curing time and backfilling of anchor plate.
12		1. Apply installation torque T_{inst} according to Table 3 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	**Annex 8**
Installation instructions for installation with clearance between concrete and anchor plate	

Terminology and symbols for design

Indices

E	effect of action
R	resistance
M	material
k	characteristic value
d	design value
s	steel
c	concrete
cp	concrete pry-out
p	pull-out
sp	splitting
n	number of load cycles

Actions and resistances

F_{Eud}	design value of the lower cyclic stress limit (lower cyclic limit: can be positive, zero or negative)
ΔF_{Ed}	design value of fatigue-relevant cyclic action (load range: can only be positive)
F_{Eod}	$= F_{Eud} + \Delta F_{Ed}$ design value of the upper cyclic stress limit (upper cyclic limit: can be positive, zero or negative)
F_{Rd}	design value of static resistance (Annex 13, Table 7, value at n = 1)
$\Delta F_{Rd;0;n}$	design value of fatigue-bearing capacity without static actions ($F_{Eud} = 0$) and n load cycles (Annex 12, 13)
$\Delta F_{Rd;E;n}$	design value of fatigue-bearing capacity (Annex 12) at pulsating or alternate range ($F_{Eud} \neq 0$) after n load cycles
$\Delta F_{Rd;0;\infty}$	design value of fatigue limit resistance without static actions ($F_{Eud} = 0$, Annexes 12, 13, $n > 10^6$ load cycles)
$\Delta F_{Rd;E;\infty}$	design value of fatigue limit resistance (here: $n > 10^6$ load cycles) in pulsating or alternate range ($F_{Eud} \neq 0$, Annex 12)
$\Delta N_{Rd,s;0;n}$ ($\Delta V_{Rd,s;0;n}$)	design value of steel fatigue-bearing capacity without static actions in axial direction (transverse direction) and n load cycles (Annex 13, Table 7)
$\Delta N_{Rd,s;E;n}$ ($\Delta V_{Rd,s;E;n}$)	design value of steel fatigue-bearing capacity in pulsating or alternate range ($F_{Eud} \neq 0$, Annex 12) in axial direction (transverse direction) and n load cycles
$\Delta N_{Rd,c(sp);E;n}$ ($\Delta V_{Rd,c(cp);E;n}$)	design value of concrete fatigue-bearing capacity in pulsating or alternate range ($F_{Eud} \neq 0$, Annex 12) in axial direction (transverse direction) and n load cycles
ΔF_{Rk}	characteristic value of fatigue-bearing capacity
$\Delta F_{Rk;0;\infty}$	characteristic value of fatigue limit resistance without static actions

Design method I

The verification is is performed in accordance with this method if

(1) a determination of the design value of the lower cyclic limit F_{Eud} in the pulsating respectively alternate range is possible (cf. annex 12, Figure 1) and (or)

(2) an upper limit of the number of load cycles n during the service life is known.

Case I.1 → only condition (1) is fulfilled: $\Delta F_{Rd;E;n} = \Delta F_{Rd;E;\infty}$

Case I.2 → only condition (2) is fulfilled: *)

$\Delta F_{Rd;E;n} = \Delta F_{Rd;0;n}$ and $\Delta F_{Ed} = F_{Eod}$ if $F_{Eud} \geq 0$

$\Delta F_{Ed} = -F_{Eud}$ if $F_{Eud} < 0$

*) Only valid for pulsating range and wihout static actions. In alternate range it is assumed that F_{Eud} and ΔF_{ed} are known and thus Case I.3 occurs (cf. Figure 1, annex 12).

Case I.3 → conditions (1) and (2) are fulfilled: $\Delta F_{Rd;E;n}$

The load range of the fatigue-bearing capacity $\Delta F_{Rd;E;n}$ is calculated in accordance with Annex 12.

Required Verifications

Steel failure:

$$\left(\gamma_{FN} \cdot \frac{\Delta N_{Ed}}{\Delta N_{Rd,s;E;n}}\right)^{\alpha} + \left(\gamma_{FV} \cdot \frac{\Delta V_{Ed}}{\Delta V_{Rd,s;E;n}}\right)^{\alpha} \leq 1{,}0$$

(Verification of the maximum loaded anchor)

$\gamma_{FN} = \gamma_{FV} = 1{,}0$	for single fastenings	
$\gamma_{FN} = \gamma_{FV} = 1{,}3$	for anchor groups	
$\alpha = 1{,}2$	for size / version	100 M12 A4, 100 M12 HCR
$\alpha = 1{,}5$	for size / version	100 M12, 125 M16, 125 M16 A4, 125 M16 HCR, 170 M20

Design method I

Concrete failure without influence of the concrete edge:

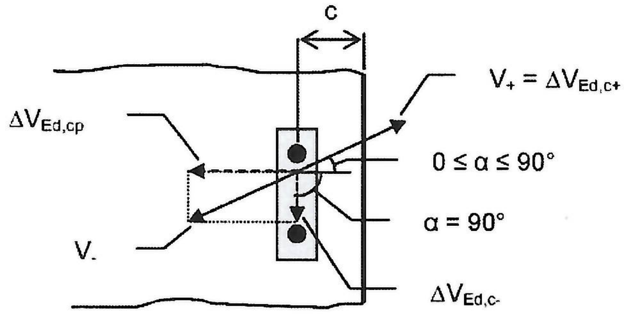
$$\left(\frac{\Delta N_{Ed,c}}{\Delta N_{Rd,c;E;n}}\right)^{1,5} + \left(\frac{\Delta V_{Ed,c}{}^{*)}}{\Delta V_{Rd,cp;E;n}}\right)^{1,5} \leq 1,0$$

*) for alternating load only the load direction with the higher value is taken into account.

Concrete edge failure:

$$(\beta_{N,c})^{1,5} + (\beta_{V,c+} + \beta_{V,c-} + \beta_{V,cp})^{1,5} \leq 1,0$$

Distribution of the shear load



Proof:	Tension load	Concrete edge failiure	Concrete failure parallel to the edge	Pry-out
Load:	$\Delta N_{Ed,c}$	$\Delta V_{Ed,c+}$	$\Delta V_{Ed,c-}$	$\Delta V_{Ed,cp}$
Associated resistances:	$\Delta N_{Rd,c(sp);E;n}$ with $\Delta N_{Rd,c(sp);0;n}$ = min ($\Delta N_{Rd,c;0;n}$; $\Delta N_{Rd,sp;0;n}$) acc. to Table 7	$\Delta V_{Rd,c+;E;n}$ acc. to Table 7, with $V_{Rk,c}$ acc. to ETAG 001, Annex C, equation 5.7 considering the angle $0 \leq \alpha \leq 90°$	$\Delta V_{Rd,c-;E;n}$ acc. to Table 7, with $V_{Rk,c}$ acc. to ETAG 001, Annex C, equation 5.7 considering the angle $\alpha = 90°$	$\Delta V_{Rd,cp;E;n}$ acc. to Table 7, with $V_{Rk,cp}$ acc. to ETAG 001, Annex C, equation 5.6
Utilisation:	$\beta_{N,c} = \frac{\Delta N_{Ed,c}}{\Delta N_{Rd,c(sp);E;n}}$	$\beta_{V,c+} = \frac{\Delta V_{Ed,c+}}{\Delta V_{Rd,c+;E;n}}$	$\beta_{V,c-} = \frac{\Delta V_{Ed,c-}}{\Delta V_{Rd,c-;E;n}}$	$\beta_{V,cp} = \frac{\Delta V_{Ed,cp}}{\Delta V_{Rd,cp;E;n}}$

Injection System VMZ dynamic

Design method I,
required verifications, concrete failure

Annex 11

Design method I

Determination of the load range of the fatigue-bearing capacity $\Delta F_{Rd;E;n}$

The determination of the load range of the fatigue-bearing capacity $\Delta F_{Rd;E;n}$ must be performed for steel failure ($\Delta N_{Rd,s;E;n}$, $\Delta V_{Rd,s;E;n}$) and concrete failure ($\Delta N_{Rd,c;E;n}$, $\Delta V_{Rd,c(cp);E;n}$) using the values from Annex 13, Table 7 separately for the axial direction (F = N) and the transverse direction (F = V) of the anchor.

Pulsating load and without static action (Figure 1):

$$\Delta F_{Rd;E,n} = \Delta F_{Rd;0;n} \cdot \left(1 - \frac{F_{Eud}}{F_{Rd}}\right), \quad \text{if} \quad F_{Eud} \geq 0$$

$$\Delta F_{Rd;E,n} = \Delta F_{Rd;0;n} \cdot \left(1 + \frac{F_{Eud}+\Delta F_{Rd;0;n}}{F_{Rd}-\Delta F_{Rd;0;n}}\right), \quad \text{if} \quad F_{Eud} \leq -\Delta F_{Rd;0;n}$$

Alternating range (Figure 1): $\Delta F_{Rd;E;n} = \sqrt{r^2 - (F_{Eud} - x_0)^2} - x_0 - F_{Eud}$ if $-\Delta F_{Rd;0;n} \leq F_{Eud} \leq 0$

where $x_0 = r \cdot \sin\delta$; $r = \sqrt{0{,}5} \cdot \Delta F_{Rd;0;n} / \sin\beta$;

$\beta = \frac{\pi}{4} - \delta$ [rad]; $\delta = \arctan\left(\frac{F_{Rd} - \Delta F_{Rd;0;n}}{F_{Rd} - \Delta F_{fix}}\right)$ [rad];

$\Delta F_{fix} = 0{,}9 \cdot \Delta F_{Rd;0;\infty}$

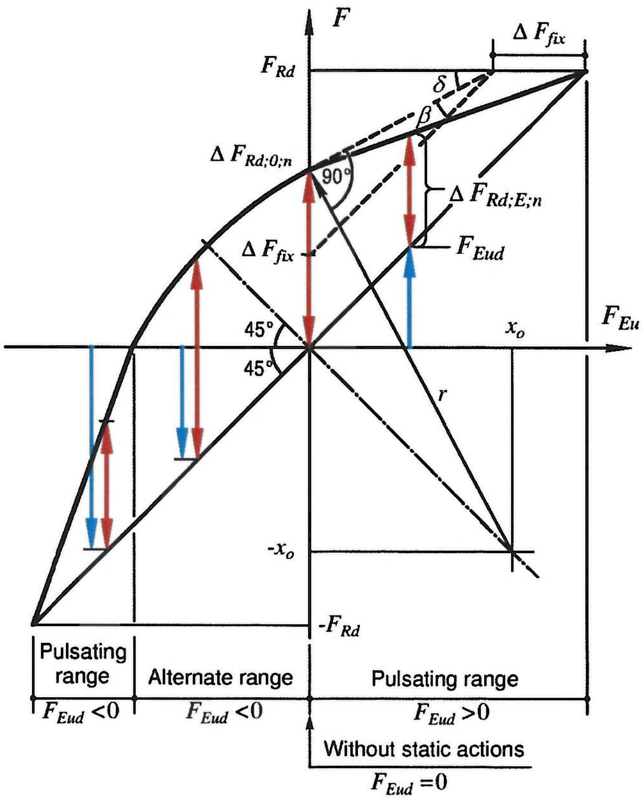


Figure 1: Fatigue-bearing capacity depending on the design value of lower cyclic limit F_{Eud} (valid for n load cycles)

Injection System VMZ dynamic	Annex 12
Design method I, Determination of the fatigue-bearing capacity	

Design method I

Table 7: Design values of the fatigue-bearing capacity after n load cycles with load without static actions [3)]

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	$\Delta N_{Rd,s;0;n}$	$\Delta V_{Rd,s;0;n}$	$\Delta N_{Rd,s;0;n}$	$\Delta V_{Rd,s;0;n}$	$\Delta N_{Rd,s;0;n}$	$\Delta V_{Rd,s;0;n}$	$\Delta N_{Rd,s;0;n}$	$\Delta V_{Rd,s;0;n}$	$\Delta N_{Rd,s;0;n}$	$\Delta V_{Rd,s;0;n}$
Design values of resistance [kN] without static-actions	≤ 10	35,9	27,2	35,9	27,2	55,6	50,4	55,6	50,4	74,7	119,2
	$\leq 10^3$	32,7	21,6	35,2	24,8	53,0	42,5	49,4	42,5	63,5	88,7
	$\leq 3 \cdot 10^3$	31,3	18,4	34,2	22,2	52,0	36,7	46,9	36,7	61,8	70,6
	$\leq 10^4$	28,6	14,2	32,3	18,2	49,7	27,9	43,5	27,9	57,9	49,3
	$\leq 3 \cdot 10^4$	25,2	10,6	29,5	13,8	45,7	19,7	40,0	19,7	52,0	32,9
	$\leq 10^5$	20,9	7,8	25,5	9,6	39,3	13,7	36,2	13,7	43,8	21,6
	$\leq 3 \cdot 10^5$	17,7	6,6	21,6	7,3	32,8	11,6	33,1	11,6	37,1	17,2
	$\leq 10^6$	15,6	6,1	18,2	6,3	27,5	11,1	30,6	11,1	33,2	15,8
	$> 10^6$	14,9	6,1	15,7	6,1	25,2	11,1	27,6	11,1	32,2	15,6
Concrete failure $\Delta N_{Rd,c(sp);0;n} = \eta_{fat,N;n} \cdot N_{Rd,c(sp)}$ and $\Delta V_{Rd,c(cp);0;n} = \eta_{fat,V;n} \cdot V_{Rd,c(cp)}$ [2)]											
	n	$\eta_{fat,N;n}$	$\eta_{fat,V;n}$	$\eta_{fat,N;n}$	$\eta_{fat,V;n}$	$\eta_{fat,N;n}$	$\eta_{fat,V;n}$	$\eta_{fat,N;n}$	$\eta_{fat,V;n}$	$\eta_{fat,N;n}$	$\eta_{fat,V;n}$
Reduction factor η_{fat} for design values for tension and shear load after number of load cycles n	≤ 10	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	$\leq 10^3$	0,954	0,845	0,954	0,845	0,954	0,845	0,954	0,845	0,954	0,845
	$\leq 3 \cdot 10^3$	0,925	0,814	0,925	0,814	0,925	0,814	0,925	0,814	0,925	0,814
	$\leq 10^4$	0,887	0,784	0,887	0,784	0,887	0,784	0,887	0,784	0,887	0,784
	$\leq 3 \cdot 10^4$	0,850	0,763	0,850	0,763	0,850	0,763	0,850	0,763	0,850	0,763
	$\leq 10^5$	0,815	0,746	0,815	0,746	0,815	0,746	0,815	0,746	0,815	0,746
	$\leq 3 \cdot 10^5$	0,793	0,736	0,793	0,736	0,793	0,736	0,793	0,736	0,793	0,736
	$\leq 10^6$	0,778	0,729	0,778	0,729	0,778	0,729	0,778	0,729	0,778	0,729
	$> 10^6$	0,770	0,720	0,770	0,720	0,770	0,720	0,770	0,720	0,770	0,720

1) Failure by pullout in cracked concrete in the low-cycle load range has been taken into account;

2) $N_{Rd,c(sp)}$ and $V_{Rd,c(cp)}$ – Design values of concrete resistance under static or quasi-static load in accordance with ETA-04/0092 (values for h_{ef}, l_f and d_{nom}, see Annex 16, Table 8 and 9; $\gamma_{Mc} = 1,5$)

3) without static actions: see Annex 12, Figure 1, $F_{Eud} = 0$ (design value of the lower cyclic stress limit)

Injection System VMZ dynamic	Annex 13
Design method I, Design values of the fatigue-bearing capacity	

Design method II

The verification is performed in accordance with this method if

(1) a determination of the design value of the lower cyclic F_{Eud} in the pulsating respectively alternate range is not possible (cf. annex 12, Figure 1) and

(2) an upper limit of the number of load cycles n during the service life is not available or not known.

The following applies: Pulsating range: $\Delta F_{Ed} = F_{Eod}$, if $F_{Eud} > 0$ *)

$\Delta F_{Ed} = - F_{Eud}$, if $F_{Eud} < 0$ **)

Alternate range: $\Delta F_{Ed} = (F_{Eod} - F_{Eud})$ ***)

$\Delta F_{Rk} = \Delta F_{Rk;0;\infty}$

*) The positive value for F_{Eud} is not known.

**) The negative value for F_{Eod} is not known.

***) The values for F_{Eod} and F_{Eud} are not known.
The value of the difference $(F_{Eod} – F_{Eud})$ is known.

where ΔF_{Ed} and ΔF_{Rk} have to be determined for steel failure and concrete failure separately for the axial direction (F = N) and the transverse direction (F = V) of the anchor.

Required Verifications

Steel failure:

$$\left(\gamma_{FN} \cdot \frac{\Delta N_{Ed}}{\Delta N_{Rk,s}/\gamma_{MsN}}\right)^{\alpha} + \left(\gamma_{FV} \cdot \frac{\Delta V_{Ed}}{\Delta V_{Rk,s}/\gamma_{MsV}}\right)^{\alpha} \leq 1{,}0$$

(Verification of the maximum loaded anchor)

$\gamma_{FN} = \gamma_{FV} = 1{,}0$	for single fastenings	
$\gamma_{FN} = \gamma_{FV} = 1{,}3$	for anchor groups	
$\alpha = 1{,}2$	for size / version	100 M12 A4, 100 M12 HCR
$\alpha = 1{,}5$	for size / version	100 M12, 125 M16, 125 M16 A4, 125 M16 HCR, 170 M20

Design method II

Concrete pry-out failure:

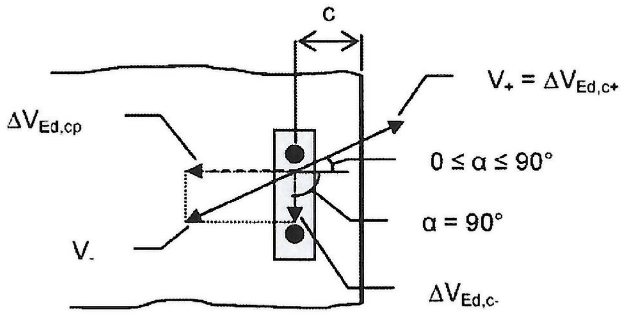
$$\left(\frac{\Delta N_{Ed,c}}{\Delta N_{Rk,c}/\gamma_{Mc}}\right)^{1,5} + \left(\frac{\Delta V_{Ed,c}\ ^{*)}}{\Delta V_{Rk,cp}/\gamma_{Mc}}\right)^{1,5} \leq 1,0$$

*) for alternating load only the load direction with the higher value is taken into account

Concrete edge failure:

$$(\beta_{N,c})^{1,5} + (\beta_{V,c+} + \beta_{V,c-} + \beta_{V,cp})^{1,5} \leq 1,0$$

Distribution of the shear load



Proof:	Tension load	Concrete edge failure	Concrete failure parallel to the edge	Pry-out
Load :	$\Delta N_{Ed,c}$	$\Delta V_{Ed,c+}$	$\Delta V_{Ed,c-}$	$\Delta V_{Ed,cp}$
Associated resistances:	$\Delta N_{Rk,c(sp)}$ with $\Delta N_{Rk,c(sp)}$ = min ($\Delta N_{Rk,c}$; $\Delta N_{Rk,sp}$) acc. to Table 8	$\Delta V_{Rk,c+}$ acc. to Table 9, with $V_{Rk,c}$ acc. to ETAG 001, Annex C, equation 5.7 considering the angle $0 \leq \alpha \leq 90°$	$\Delta V_{Rk,c-}$ acc. to Table 9, with $V_{Rk,c}$ acc. to ETAG 001, Annex C, equation 5.7 considering the angle $\alpha = 90°$	$\Delta V_{Rk,cp}$ acc.to Table 9, with $V_{Rk,cp}$ acc. to ETAG 001, Annex C, equation 5.6
Utilisation:	$\beta_{N,c} = \frac{\Delta N_{Ed,c}}{\Delta N_{Rk,c(sp)}/\gamma_{Mc}}$	$\beta_{V,c+} = \frac{\Delta V_{Ed,c+}}{\Delta V_{Rk,c+}/\gamma_{Mc}}$	$\beta_{V,c-} = \frac{\Delta V_{Ed,c-}}{\Delta V_{Rk,c-}/\gamma_{Mc}}$	$\beta_{V,cp} = \frac{\Delta V_{Ed,cp}}{\Delta V_{Rk,cp}/\gamma_{Mc}}$

Design method II

Table 8: Characteristic values for the fatigue limit resistance under tension load for the design method II

Anchor size / version			100 M12	100 M12 A4 100 M12 HCR	125 M16	125 M16 A4 125 M16 HCR	170 M20
Steel failure							
Characteristic tension resistance	$\Delta N_{Rk,s}$	[kN]	20	21,2	34	37	43
Partial safety factor	γ_{Ms}	-	1,35				
Concrete failure [1]							
Characteristic resistance	$\Delta N_{Rk,c}$	[kN]	0,77 $N_{Rk,c}$ [2]				
Effective anchorage depth	h_{ef}	[mm]	100		125		170
Partial safety factor	γ_{Mc}	-	1,35				
Splitting [1]							
Characteristic resistance	$\Delta N_{Rk,sp}$	[kN]	0,77 $N_{Rk,sp}$ [2]				
Partial safety factor	γ_{Mc}	-	1,35				

[1] For anchorages in concrete in accordance with DIN 1045:1988-07 see section 3.2.1.
[2] Determination of $N_{Rk,c}$ according to equation 5.2 and $N_{Rk,sp}$ according to equation 5.3, Annex C of the guideline, with the values of the ETA-04/0092.

Table 9: Characteristic values for the fatigue limit resistance under shear load for the design method II

Anchor size / version			100 M12	100 M12 A4 100 M12 HCR	125 M16	125 M16 A4 125 M16 HCR	170 M20
Steel failure without lever arm [1]							
Characteristic shear resistance	$\Delta V_{Rk,s}$	[kN]	8,2		15		21
Partial safety factor	γ_{Ms}	-	1,35				
Concrete pryout failure							
Characteristic shear resistance	$\Delta V_{Rk,cp}$	[kN]	0,72 $V_{Rk,cp}$ [2]				
Factor in equation (5.6) ETAG 001, Annex C, 5.2.3.3	k	[-]	2,0				
Partial safety factor	γ_{Mc}	-	1,35				
Concrete edge failure [4]							
Characteristic shear resistance	$\Delta V_{Rk,c}$	[kN]	0,72 $V_{Rk,c}$ [3]				
Effective length of anchor	l_f	[mm]	100		125		170
Diameter of anchor	d_{nom}	[mm]	14		18		24
Partial safety factor	γ_{Mc}	-	1,35				

[1] The requirements according to section 4.2.2.2, Annex C of the guideline have to be observed.
[2] Determination of $V_{Rk,cp}$ according to equation 5.6, Annex C of the guideline.
[3] Determination of $V_{Rk,c}$ according to equation 5.7, Annex C of the guideline.
[4] For anchorages in concrete according to DIN 1045:1988-07 see section 3.2.1.

Spacings and edge distances and characteristic resistances under static or quasi-static loading, see ETA-04/0092.