Deutsches Institut für Bautechnik
Zulassungsstelle für Bauprodukte und Bauarten
Bautechnisches Prüfamt

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

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Authorised and notified according to Article 10 of the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products (89/106/EEC)

Deutsches Institut für Bautechnik DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-11/0415

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	MKT Injektionssystem VMU plus für Beton *MKT Injection System VMU plus for concrete*
Zulassungsinhaber *Holder of approval*	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	Verbunddübel mit Ankerstange zur Verankerung im Beton *Bonded Anchor with Anchor rod for use in concrete*
Geltungsdauer: *Validity:* vom *from*	20 June 2013
bis *to*	15 May 2018
Herstellwerk *Manufacturing plant*	MKT Metall-Kunststoff-Technik GmbH & Co. KG Auf dem Immel 2 67685 Weilerbach DEUTSCHLAND

Diese Zulassung umfasst *This Approval contains*	33 Seiten einschließlich 24 Anhänge *33 pages including 24 annexes*
Diese Zulassung ersetzt *This Approval replaces*	ETA-11/0415 mit Geltungsdauer vom 20.09.2011 bis 13.11.2013 *ETA-11/0415 with validity from 20.09.2011 to 13.11.2013*

I LEGAL BASES AND GENERAL CONDITIONS

1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:

- Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];
- *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998[4], as amended by Article 2 of the law of 8 November 2011[5];*
- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];
- Guideline for European technical approval of "Metal anchors for use in concrete - Part 5: Bonded anchors", ETAG 001-05.

2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.

3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.

4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.

5 Reproduction of this European technical approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Deutsches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European technical approval.

6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

1 Official Journal of the European Communities L 40, 11 February 1989, p. 12
2 Official Journal of the European Communities L 220, 30 August 1993, p. 1
3 Official Journal of the European Union L 284, 31 October 2003, p. 25
4 *Bundesgesetzblatt Teil I 1998*, p. 812
5 *Bundesgesetzblatt Teil I 2011*, p. 2178
6 Official Journal of the European Communities L 17, 20 January 1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product and intended use

1.1 Definition of the construction product

The "MKT Injection system VMU plus for concrete" is a bonded anchor consisting of a cartridge with MKT Injection Adhesive VMU plus and a steel element. The steel elements are commercial threaded rods according to Annex 3 in the range of M8 to M30 or reinforcing bar according to Annex 4 in the range of diameter 8 to 32 mm.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

An illustration of the product and intended use is given in Annexes 1 and 2.

1.2 Intended use

The anchor is intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106 EEC shall be fulfilled and failure of anchorages made with these products would cause risk to human life and/or lead to considerable economic consequences. Safety in case of fire (Essential Requirement 2) is not covered in this European technical approval.

The anchor is to be used only for anchorages subject to static or quasi-static loading in reinforced or unreinforced normal weight concrete of strength classes C20/25 at minimum and C50/60 at most according to EN 206:2000-12.

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

The anchor may also be used under seismic action for performance category C1 according to Annex 23.

The anchor may be installed in dry or wet concrete.

The anchor sizes diameter 8 mm to 16 mm may also be installed in flooded holes.

The anchor may be used in the following temperature ranges:

Temperature range I:	-40 °C to +40 °C	(max long term temperature +24 °C and max short term temperature +40 °C)
Temperature range II:	-40 °C to +80 °C	(max long term temperature +50 °C and max short term temperature +80 °C)
Temperature range III:	-40 °C to +120 °C	(max long term temperature +72 °C and max short term temperature +120 °C)

<u>Elements made of zinc coated steel:</u>

The element made of zinc plated or hot dip galvanised steel may only be used in structures subject to dry internal conditions.

<u>Elements made of stainless steel:</u>

The element made of stainless steel 1.4401, 1.4404 or 1.4571 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure (including industrial and marine environment), or exposure to permanently damp internal conditions, if no particular aggressive conditions exist. Such 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).

Elements made of high corrosion resistant steel:

The element made of high corrosion resistant steel 1.4529 or 1.4565 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions. Such 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 chemical pollution (e. g. in desulphurization plants or road tunnels where de-icing materials are used).

Elements made of reinforcing bars:

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the reinforcing bars act as dowels to take up shear forces. Connections with post-installed reinforcing bars in concrete structures designed in accordance with EN 1992-1-1: 2004 are not covered by this European technical approval.

The provisions made in this European technical approval are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

2 Characteristics of the product and methods of verification

2.1 Characteristics of the product

The anchor corresponds to the drawings and provisions given in the Annexes. The characteristic material values, dimensions and tolerances of the anchor not indicated in the Annexes shall correspond to the respective values laid down in the technical documentation[7] of this European technical approval.

The characteristic values for the design of anchorages are given in the Annexes.

The two components of the injection mortar are delivered in unmixed condition in coaxial cartridges of sizes 150 ml, 280 ml, 300 ml, 310 ml, 330 ml, 380 ml, 410 ml or 420 ml, in side-by side-cartridges of sizes 235 ml, 345 ml or 825 ml or in foil tube cartridges of sizes 165 ml or 300 ml according to Annex 2. Each cartridge is marked with the imprint "MKT Injection Adhesive VMU plus", with processing notes, charge code, storage life, hazard code and curing- and processing time depending on temperature.

Elements made of reinforcing bars shall comply with the specifications given in Annex 4.

The marking of embedment depth may be done on jobsite.

2.2 Methods of verification

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 has been made in accordance with the "Guideline for European technical approval of Metal Anchors for Use in Concrete", Part 1 "Anchors in general" and Part 5 "Bonded anchors", on the basis of Option 1 and ETAG 001 Annex E "Assessment of Metal Anchors under Seismic Action".

[7] The technical documentation of this European technical approval is deposited at the Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3 Evaluation and attestation of conformity and CE marking

3.1 System of attestation of conformity

According to the Decision 96/582/EG of the European Commission[8] system 2(i) (referred to as System 1) of the attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 1: Certification of the conformity of the product by an approved certification body on the basis of:

(a) Tasks for the manufacturer:

- (1) factory production control;
- (2) further testing of samples taken at the factory by the manufacturer in accordance with a control plan;

(b) Tasks for the approved body:

- (3) initial type-testing of the product;
- (4) initial inspection of factory and of factory production control;
- (5) continuous surveillance, assessment and approval of factory production control.

Note: Approved bodies are also referred to as "notified bodies".

3.2 Responsibilities

3.2.1 Tasks for the manufacturer

3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use initial/raw/constituent materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Deutsches Institut für Bautechnik.[9]

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

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

[9] The control plan is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

3.2.1.2 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of anchors in order to undertake the actions laid down in section 3.2.2 For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of this European technical approval.

3.2.2 Tasks for the approved bodies

The approved body shall perform the

- initial type-testing of the product,
- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control, in accordance with the provisions laid down in the control plan.

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

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

3.3 CE marking

The CE marking shall be affixed on each packaging of the anchor. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the holder of the approval (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate of conformity for the product,
- the number of the European technical approval,
- the number of the guideline for European technical approval,
- use category (ETAG 001, Option 1, seismic anchor performance category C1),
- size.

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

The European technical approval is issued for the product on the basis of agreed data/information, deposited at Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced. Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

4.2 Design of anchorages

The fitness of the anchor for the intended use is given under the following conditions:

The anchorages are designed either in accordance with the

The anchorages are designed in accordance with the

- EOTA Technical Report TR 029 "Design of bonded anchors"[10]

or in accordance with the

- CEN/TS 1992-4:2009

and EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action" under the responsibility of an engineer experienced in anchorages and concrete work.

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 under seismic action are not covered by this European technical approval.

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. The basic assumptions for the design according to anchor theory shall be observed. This includes the consideration of tension and shear loads and the corresponding failure modes as well as the assumption that the base material (concrete structural element) remains essentially in the serviceability limit state (either non-cracked or cracked) when the connection is loaded to failure. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the rebars act as dowels to take up shear forces. Connections with reinforcing bars in concrete structures designed in accordance with EN 1992-1-1:2004 (e.g. connection of a wall loaded with tension forces in one layer of the reinforcement with the foundation) are not covered by this European technical approval.

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.).

4.3 Installation of anchors

The fitness for use of the anchor can only be assumed if the anchor is installed as follows:

– anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site,
– anchor installation in accordance with the manufacturer’s specifications and drawings using the tools indicated in the technical documentation of this European technical approval,
– use of the anchor only as supplied by the manufacturer without exchanging the components,
– commercial standard threaded rods, washers and hexagon nuts may be used if the following requirements are fulfilled:
    - material, dimensions and mechanical properties of the metal parts according to the specifications given in Annex 3,
    - confirmation of material and mechanical properties of the metal parts by inspection certificate 3.1 according to EN 10204:2004, the documents should be stored,

10 The Technical Report TR 029 "Design of Bonded Anchors" is published in English on EOTA website www.eota.eu.

- marking of the threaded rod with the envisage embedment depth. This may be done by the manufacturer of the rod or the person on jobsite.

- embedded reinforcing bars shall comply with specifications given in Annex 4,
- checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower than that of the concrete to which the characteristic loads apply,
- check of concrete being well compacted, e.g. without significant voids,
- marking and keeping the effective anchorage depth,
- edge distance and spacing not less than the specified values without minus tolerances,
- positioning of the drill holes without damaging the reinforcement,
- drilling by hammer-drilling only,
- in case of aborted drill hole: the drill hole shall be filled with mortar,
- cleaning the drill hole in accordance with Annexes 6 to 8,
- during installation and curing of the chemical mortar the anchor component installation temperature shall be at least -10 °C; the temperature; observing the curing time according to Annex 7, Table 4 until the anchor may be loaded,
- for injection of the mortar in bore holes of diameter d_0 > 20 mm piston plugs according to Annex 8 shall be used for overhead or horizontal injection,
- installation torque moments are not required for functioning of the anchor. However, the torque moments given in Annex 5 must not be exceeded.

5 Indications to the manufacturer

5.1 Responsibility of the manufacturer

The manufacturer is responsible to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to as well as sections 4.2, 4.3 and 5.2 is given to those who are concerned. This information may be made by reproduction of the respective parts of the European technical approval.

In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

- drill bit diameter,
- hole depth,
- diameter of anchor rod,
- minimum effective anchorage depth,
- information on the installation procedure, including cleaning of the hole with the cleaning equipments, preferably by means of an illustration,
- anchor component installation temperature,
- ambient temperature of the concrete during installation of the anchor,
- admissible processing time (open time) of the mortar,
- curing time until the anchor may be loaded as a function of the ambient temperature in the concrete during installation,
- maximum torque moment,
- identification of the manufacturing batch,

All data shall be presented in a clear and explicit form.

5.2 Packaging, transport and storage

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

Cartridges with expired shelf life must no longer be used.

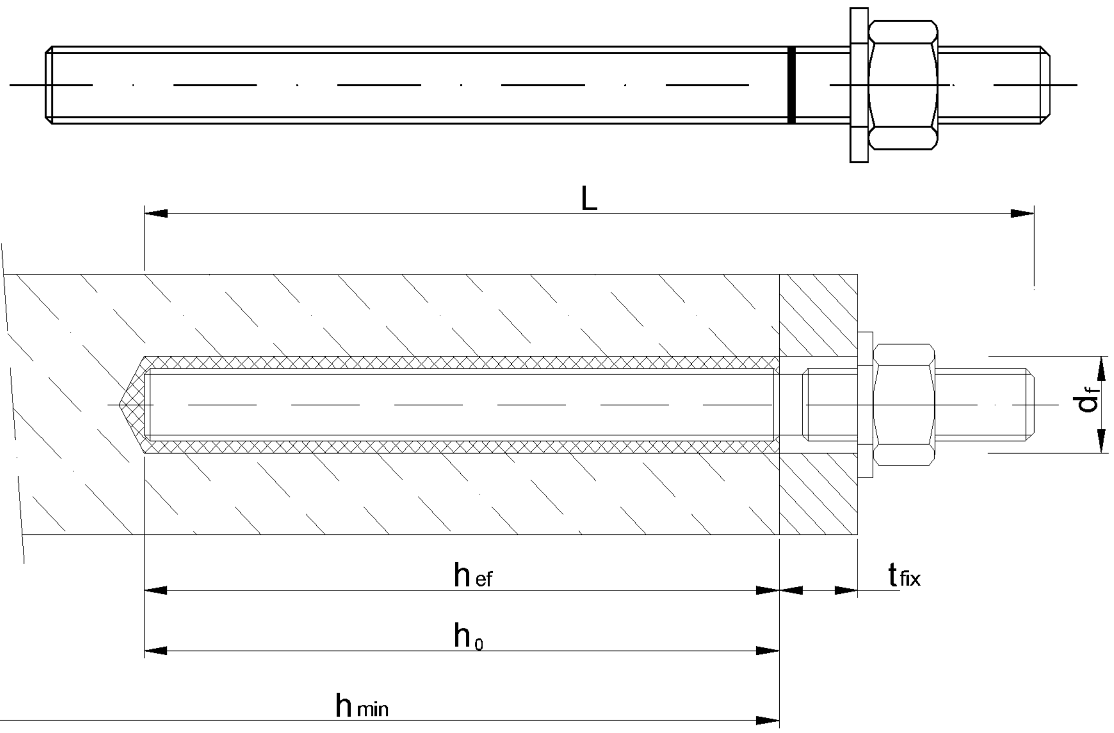
The anchor shall only be packaged and supplied as a complete unit. Cartridges may be packed separately from metal parts.

Andreas Kummerow
p.p. Head of Department

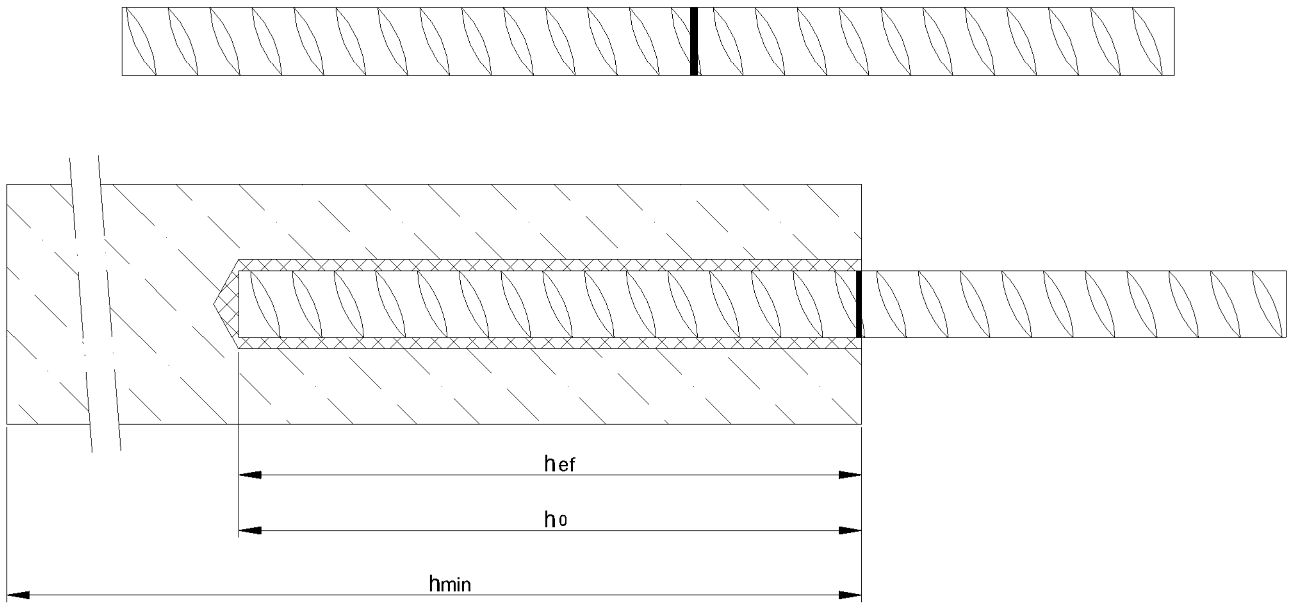
beglaubigt:
Baderschneider

Deutsches Institut für Bautechnik

Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut



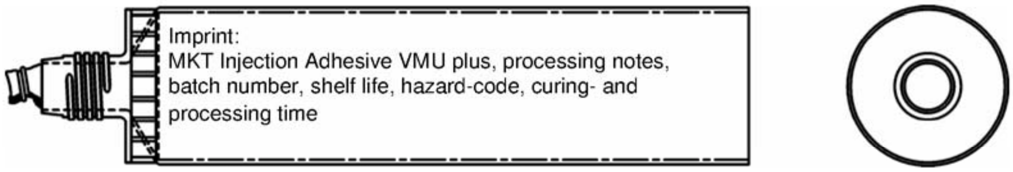
Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28, ∅ 32 according to Annex 4



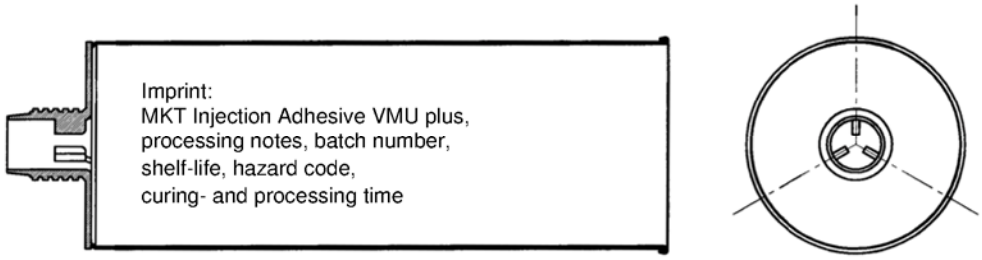
MKT Injection System VMU plus for concrete	**Annex 1**
Product (Steel) and Installation	

Cartridge: MKT Injection Adhesive VMU plus

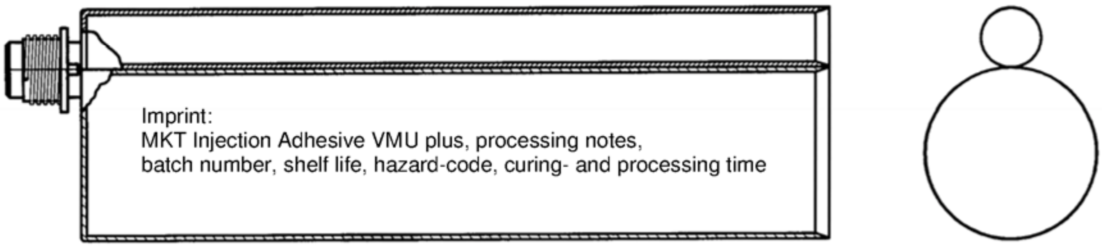
Type: „foil-tube"



Type: coaxial

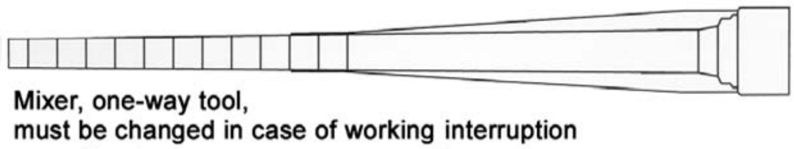


Type: „side-by-side"



Sealing cap

Static mixer



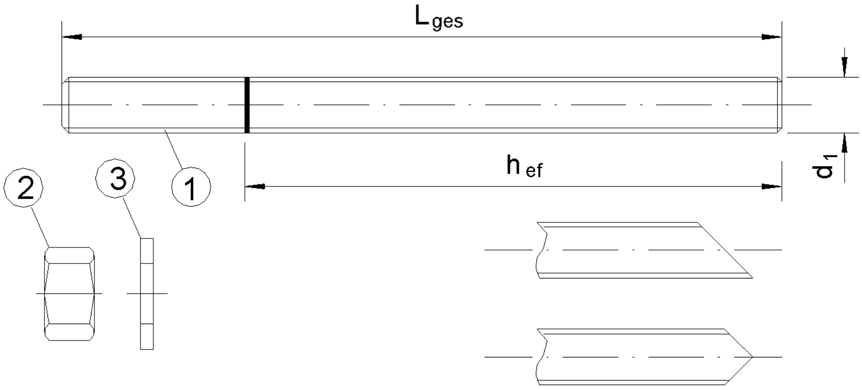
Use category:
- Installation in dry, wet concrete (all sizes) or flooded holes (only M8 to M16 and rebar ∅8 to ∅16)
- Application in non-cracked concrete: M8 to M30, rebar ∅8 to ∅32
- Application in cracked concrete and seismic C1: M12 to M30, rebar ∅12 to ∅32
- Overhead installation

Temperature range:

-40°C to +40°C (max. short term temperature +40°C and max. long term temperature +24°C)
-40°C to +80°C (max. short term temperature +80°C and max. long term temperature +50°C)
-40°C to +120°C (max. short term temperature +120°C and max. long term temperature +72°C)

MKT Injection System VMU plus for concrete	**Annex 2**
Product (Injection mortar) and Intended use	

Table 1: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461		
1	Anchor rod	Steel acc. to EN 10087 or EN 10263 Property class 4.6, 5.8, 8.8 acc. to EN ISO 898-1:1999
2	Hexagon nut, DIN 934	Property class 4 (for class 4.6 rod) EN ISO 898-2, Property class 5 (for class 5.8 rod) EN ISO 898-2, Property class 8 (for class 8.8 rod) EN ISO 898-2
3	Washer, EN ISO 7089, EN ISO 7093 or EN ISO 7094	Steel, zinc plated or hot-dip galvanised
Stainless steel A4		
1	Anchor rod	Material 1.4401, 1.4404, 1.4571, 1.4362, EN 10088, ≤ M24: Property class 70, EN ISO 3506 > M24: Property class 50, EN ISO 3506
2	Hexagon nut, DIN 934	Material 1.4401, 1.4404, 1.4571, 1.4362, EN 10088, ≤ M24: Property class 70, EN ISO 3506 > M24: Property class 50, EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093 or EN ISO 7094	Material 1.4401, 1.4404, 1.4571, 1.4362, EN 10088
High corrosion resistance steel (HCR)		
1	Anchor rod	Material 1.4529 or 1.4565, EN 10088, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, DIN 934	Material 1.4529 or 1.4565, EN 10088, > M24: Property class 50, EN ISO 3506 ≤ M24: Property class 70, EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093 or EN ISO 7094	Material 1.4529 or 1.4565, EN 10088

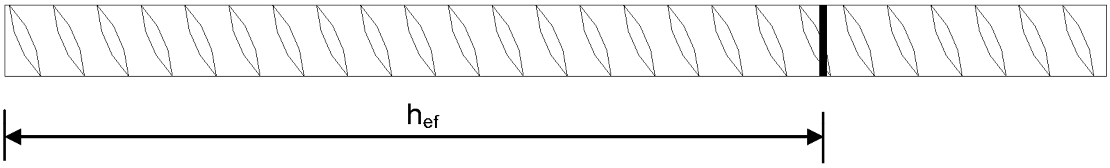
Commercial standard rod with:
- Material, dimensions and mechanical properties Table 1
- Inspection certificate 3.1 acc. to EN 10204
- Marking of embedment depth

MKT Injection System VMU plus for concrete

Materials (Threaded rod)

Annex 3

Table 2: Materials (Rebar)



Abstract of EN 1992-1-1 Annex C, Table C.1, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Characteristic yield strength f_{yk} or $f_{0,2k}$ (N/mm²)		400 to 600	
Minimum value of $k = (f_t / f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	± 6,0 ± 4,5	

Abstract of EN 1992-1-1 Annex C, Table C.2N, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Minimum value of related rip area $f_{R,min}$	Nominal diameter of the rebar (mm) 8 to 12 > 12	0,040 0,056	

Rip height of the bar shall be in the range $0{,}05d \leq h \leq 0{,}07d$.
(d: Nominal diameter of the bar; h: Rip height of the bar)

Regarding design of post-installed rebar as anschor see chapter 4.2.

MKT Injection System VMU plus for concrete

Materials (Reinforcing bar)

Annex 4

Table 3: Installation parameters for threaded rod

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Nominal drill hole diameter	d_0 [mm] =	10	12	14	18	24	28	32	35
Embedment depth and bore hole depth	$h_{ef,min}$ [mm] =	60	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm] =	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d_f [mm] ≤	9	12	14	18	22	26	30	33
Diameter of steel brush	d_b [mm] ≥	12	14	16	20	26	30	34	37
Installation torque	T_{inst} [Nm]	10	20	40	80	120	160	180	200
Thickness of fixture	$t_{fix,min}$ [mm] >	0							
	$t_{fix,max}$ [mm] <	1500							
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm			$h_{ef} + 2d_0$				
Minimum spacing	s_{min} [mm]	40	50	60	80	100	120	135	150
Minimum edge distance	c_{min} [mm]	40	50	60	80	100	120	135	150

Table 4: Installation parameters for reinforcing bar

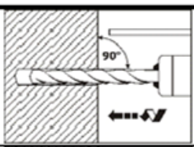
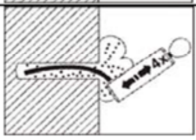
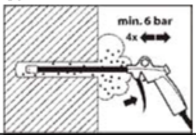
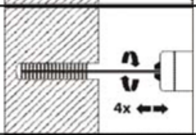
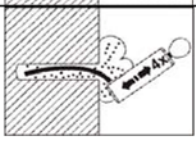
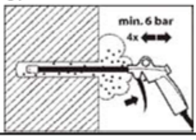
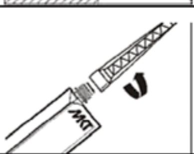
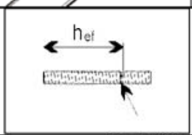
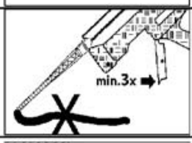
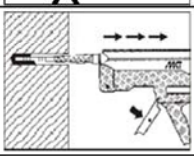
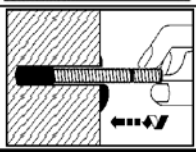
Rebar size		**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 25**	**∅ 28**	**∅ 32**
Nominal drill hole diameter	d_0 [mm] =	12	14	16	18	20	24	32	35	40
Embedment depth and bore hole depth	$h_{ef,min}$ [mm] =	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm] =	160	200	240	280	320	400	480	540	640
Diameter of steel brush	d_b [mm] ≥	14	16	18	20	22	26	34	37	41,5
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$						
Minimum spacing	s_{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	125	140	160

MKT Injection System VMU plus for concrete

Installation parameters

Annex 5

Installation instructions

1.		Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table 3 or Table 4). **Drill hole must be cleaned directly prior to installation of the anchor.**
2a.	 or 	**Attention! Standing water in the bore hole must be removed before cleaning.** Starting from the bottom or back of the bore hole, blow the hole clean with compressed air or a blow out pump (Annex 8) a minimum of four times. If the bore hole ground is not reaches an extension shall be used. The blow-out pump can be used for anchor size up to bore hole diameter 20 mm. For bore holes larger then 20 mm or deeper 240 mm, compressed air (min. 6 bar) **<u>must</u>** be used.
2b.		Check brush diameter acc. Table 6 and attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table 6) a minimum of four times. If the bore hole ground is not reached with the brush, a brush extension shall be used (Table 6).
2c.	 or 	Finally blow out the hole again with compressed air or a blow-out pump acc. Annex 8 a minimum of four times. If the bore hole ground is not reached an extension shall be used. The blow-out pump can be used for anchor sizes up to bore hole diameter 20 mm. For bore holes larger then 20 mm or deeper 240 mm, compressed air (min. 6 bar) **<u>must</u>** be used.
3.		Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table 5) as well as for new cartridges, a new static-mixer shall be used.
4.		Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.
5.		Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour.
6.		Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. For overhead and horizontal installation in bore holes larger than ∅ 20 mm a piston plug and extension nozzle (Annex 8) shall be used. Observe the gel-/ working times given in Table 5.
7.		Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The anchor should be free of dirt, grease, oil or other foreign material.

MKT Injection System VMU plus for concrete	**Annex 6**
Installation instructions	

Installation instructions (continuation)

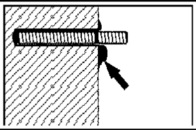
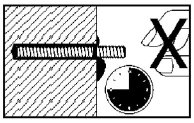
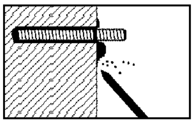
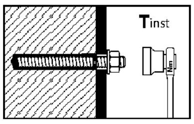
8.		Be sure that the anchor is fully seated up to the full embedment depth and that excess mortar is visible at the top of the hole. If the hole is not completely filled, pull out anchor rod and start again from step no. 6. For overhead installation fix embedded part (e.g. wedges).
9.		Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table 5).
10.		Remove excess mortar.
11.		After full curing, the add-on part can be installed with the max. torque (Table 3) by using a calibrated torque wrench.

Table 5: Maximum processing time and minimum curing time

Temperature in the drill hole	Maximum processing time	Minimum curing time in dry concrete [2)]
≥ - 10°C[1)]	90 min	24 h
≥ - 5°C	90 min	14 h
≥ 0°C	45 min	7 h
≥ + 5°C	25 min	2 h
≥ + 10°C	15 min	80 min
≥ + 20°C	6 min	45 min
≥ + 30°C	4 min	25 min
≥ + 35°C	2 min	20 min
≥ + 40°C	1,5 min	15 min

[1)] The cartridge temperature **must** be min. + 15°C.
[2)] In wet concrete the curing time **must** be doubled.

MKT Injection System VMU plus for concrete

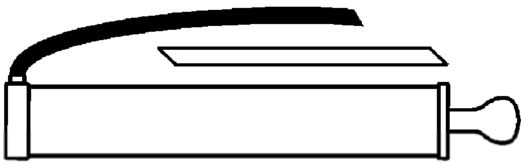
Installation instructions (continuation)
Processing time and curing time

Annex 7

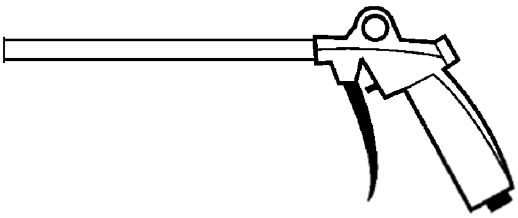
Steel brush

Table 6: Parameter cleaning and setting tools

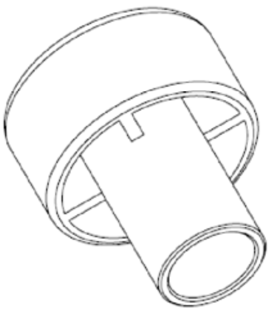
Threaded rod	Rebar	d_0 drill bit - ∅	d_b brush - ∅	$d_{b,min}$ min. brush - ∅	Retraining washer
[mm]	[mm]	[mm]	[mm]	[mm]	[-]
M8		10	12	10,5	-
M10	8	12	14	12,5	-
M12	10	14	16	14,5	-
	12	16	18	16,5	-
M16	14	18	20	18,5	-
	16	20	22	20,5	-
M20	20	24	26	24,5	VM-IA 24
M24		28	30	28,5	VM-IA 28
M27	25	32	34	32,5	VM-IA 32
M30	28	35	37	35,5	VM-IA 35
	32	40	42	40,5	VM-IA 40



Blow-out pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm



Air Blower (min. 6 bar)
Drill bit diameter (d_0): 10 mm to 40 mm



Retraining washer for overhead or horizontal installation
Drill bit diameter (d_0): 24 mm to 40 mm

MKT Injection System VMU plus for concrete	Annex 8
Cleaning and setting tools	

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Table 7: Design according to TR 029, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure										
Characteristic tension resistance, Steel, property class 4.6	$N_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,N}$ 1)	[-]	2,0							
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ 1)	[-]	1,50							
Characteristic tension resistance, Stainless steel A4 and HCR Property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ 1)	[-]	1,87						2,86	
Combined pull-out and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25										
Temperature range I 5): 40°C/24°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	11	10	9
Temperature range I 5): 40°C/24°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	not admissible			
Temperature range II 5): 80°C/50°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	8,5	7,5	6,5
Temperature range II 5): 80°C/50°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	not admissible			
Temperature range III 5): 120°C/72°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
Temperature range III 5): 120°C/72°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	not admissible			
Increasing factors for concrete	ψ_c	C30/37	1,04							
		C40/50	1,08							
		C50/60	1,10							
Splitting failure										
Edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$							
Axial distance	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ 1)	[-]	1,5 2)	1,8 3)						
Partial safety factor (flooded bore hole)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ 1)	[-]	2,1 4)				not admissible			

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,0 is included.
3) The partial safety factor γ_2 = 1,2 is included.
4) The partial safety factor γ_2 = 1,4 is included.
5) Explanations see section 1.2

MKT Injection System VMU plus for concrete

Application with threaded rod, Design acc. to TR 029, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Annex 9

Table 8: Design according to TR 029, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Anchor size threaded rod				M12	M16	M20	M24	M27	M30
Steel failure									
Characteristic tension resistance, Steel, property class 4.6		$N_{Rk,s}$	[kN]	34	63	98	141	184	224
Partial safety factor		$\gamma_{Ms,N}$ [1)]	[-]	2,0					
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1)]	[-]	1,50					
Characteristic tension resistance, Stainless steel A4 and HCR Property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ [1)]	[-]	1,87				2,86	
Combined pull-out and concrete cone failure									
Characteristic bond resistance in cracked concrete C20/25									
Temperature range I[4)]: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5	6,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible			
Temperature range II[4)]: 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5	4,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	not admissible			
Temperature range III[4)]: 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	not admissible			
Increading factors for concrete	ψ_c		C30/37	1,04					
			C40/50	1,08					
			C50/60	1,10					
Spitting failure									
Edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$					
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$					
Partial safety factor (dry and wet concrete)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1)]	[-]	1,8[2)]					
Partial safety factor (flooded bore hole)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1)]	[-]	2,1[3)]	not admissible				

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,2 is included.
3) The partial safety factor γ_2 = 1,4 is included.
4) Explanations see section 1.2

MKT Injection System VMU plus for concrete

Application with threaded rod, Design acc. to TR 029, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Annex 10

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Table 9: Design according to TR 029, Characteristic values for shear loads in cracked and non-cracked concrete under static and quasi-static action

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 4.6	$V_{Rk,s}$	[kN]	7	12	17	31	49	71	92	112
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,67							
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,25							
Characteristic shear resistance, Stainless steel A4 and HCR Property class 50 (>M24) und 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56						2,38	
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 4.6	$M^0_{Rk,s}$	[Nm]	15	30	52	133	260	449	666	900
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,67							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,25							
Characteristic bending moment, Stainless steel A4 and HCR property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	1,56						2,38	
Concrete pry-out failure										
Factor k in equation (5.7) of Technical Report TR 029 for the design of bonded anchors			2,0							
Partial safety factor	γ_{Mcp} [1)]	[-]	1,50 [2)]							
Concrete edge failure										
See section 5.2.3.4 of Technical Report TR 029 for the design of bonded anchors										
Partial safety factor	γ_{Mc} [1)]	[-]	1,50 [2)]							

[1)] In absence of other national regulations
[2)] The partial safety factor γ_2 = 1,0 is included.

MKT Injection System VMU plus for concrete	**Annex 11**
Application with threaded rod, Design acc. to TR 029, Characteristic values for shear loads in cracked and non-cracked concrete under static and quasi-static action	

Deutsches Institut für Bautechnik DIBt

Table 10: Design according to TR 029, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Anchor size reinforcing bar				∅ 8	∅ 10	∅ 12	∅ 14	∅16	∅ 20	∅ 25	∅ 28	∅ 32
Steel failure												
Characteristic tension resistance, reinforcing bar according to Annex 4		$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$ [6]								
Partial safety factor		$\gamma_{Ms,N}$ [1]	[-]	TR 029 Section 3.2.2.2, Eq. 3.3a [6]								
Combined pull-out and concrete cone failure												
Characteristic bond resistance in uncracked concrete C20/25												
Temperature range I[5]: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	12	11	10	8,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	8,5	not admissible			
Temperature range II[5]: 80°C/50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	not admissible			
Temperature range III[5]: 120°C/72°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	5,0	not admissible			
Increasing factors for concrete	ψ_c	C30/37		1,04								
		C40/50		1,08								
		C50/60		1,10								
Splitting failure												
Edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef} \cdot \left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								
Partial safety factor (dry adn wet concrete)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	1,5[2]	1,8[3]							
Partial safety factor (flooded bore hole)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	2,1[4]					not admissible			

[1] In absence of other national regulations
[2] The partial safety factor γ_2 = 1,0 is included.
[3] The partial safety factor γ_2 = 1,2 is included.
[4] The partial safety factor γ_2 = 1,4 is included.
[5] Ecplanations see section 1.2
[6] f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar.

Regarding design of post-installed rebar as anchor see chapter 4.2.

MKT Injection System VMU plus for concrete

Application with reinforcing bar, Design acc. to TR 029, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Annex 12

Table 11: Design according to TR 029, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Anchor size reinforcing bar				**Ø 12**	**Ø 14**	**Ø16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure										
Characteristic tension resistance, reinforcing bar according to Annex 4		$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$ 5)						
Partial safety factor		$\gamma_{Ms,N}$ 1)	[-]	TR 029 Section 3.2.2.2, Eq. 3.3a 5)						
Combined pull-out and concrete cone failure										
Characteristic bond resistance in cracked concrete C20/25										
Temperature range I 4): 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	6,0	not admissible			
Temperature range II 4): 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	not admissible			
Temperature range III 4): 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	3,5	not admissible			
Increasing factors for concrete	ψ_c	C30/37		1,04						
		C40/50		1,08						
		C50/60		1,10						
Splitting failure										
Edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef} \cdot \left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$						
Axial distance		$s_{cr,sp}$	[mm]	$2\, c_{cr,sp}$						
Partial safety factor (dry and wet concrete)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ 1)	[-]	1,8 2)						
Partial safety factor (flooded bore hole)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ 1)	[-]	2,1 3)			not admissible			

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,2 is included.
3) The partial safety factor γ_2 = 1,4 is included.
4) Expananations see section 1.2
5) f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar.

Regarding design of post-installed rebar as anchor see chapter 4.2.

MKT Injection System VMU plus for concrete

Application with reinforcing bar, Design acc. to TR 029, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Annex 13

Table 12: Design according to TR 029, Characteristic values for shear loads in cracked and non-cracked concrete under static and quasi-static action

Anchor size reinforcing bar			**∅ 8**	**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 25**	**∅ 28**	**∅ 32**
Steel failure without lever arm											
Characteristic shear resistance, reinforcing bar according to Annex 4	$\mathbf{V_{Rk,s}}$	[kN]	$0,5 \times A_s \times f_{uk}$ 3)								
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	TR 029 Section 3.2.2.2, Eq. 3.3 b+c 3)								
Steel failure with lever arm											
Characteristic bending moment, reinforcing bar according to Annex 4	$\mathbf{M^0_{Rk,s}}$	[Nm]	$1,2 \times W_{el} \times f_{uk}$ 3)								
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	TR 029 Section 3.2.2.2, Eq. 3.3 b+c 3)								
Concrete pry-out failure											
Factor k in equation (5.7) of Technical Report TR 029 for the design of bonded anchors			2,0								
Partial safety factor	γ_{Mcp} 1)	[-]	1,50 2)								
Concrete edge failure											
See section 5.2.3.4 of Technical Report TR 029 for the design of bonded anchors											
Partial safety factor	γ_{Mc} 1)	[-]	1,50 2)								

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1,0$ is included.
3) f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar

Regarding design of post-installed rebar as anchor see chapter 4.2.

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Table 13: Design according to CEN/TS 1992-4, Characteristic values for tension loads in non-cracked conrete under static and quasi-static action

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure										
Characteristic tension resistance, Steel, property class 4.6	$N_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,N}$ [1)]	[-]	2,0							
Characterustic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1)]	[-]	1,50							
Characteristic tension resistance, Stainless steel A4 and HCR poperty class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ [1)]	[-]	1,87						2,86	
Combined pull-out and concrete failure										
Characteristic bond resistance in non-cracked concrete C20/25										
Temperature range I[5)]: 40°C/24°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	11	10	9
Temperature range I[5)]: 40°C/24°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	not admissible			
Temperature range II[5)]: 80°C/50°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	8,5	7,5	6,5
Temperature range II[5)]: 80°C/50°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	not admissible			
Temperature range III[5)]: 120°C/72°C – dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
Temperature range III[5)]: 120°C/72°C – flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	not admissible			
Increasing factors for concrete	ψ_c	C30/37	1,04							
		C40/50	1,08							
		C50/60	1,10							
Factor acc. to CEN/TS 1992-4-5, Section 6.2.2.3	k_8	[-]	10,1							
Concrete cone failure										
Factor acc. to CEN/TS 1992-4-5, Section 6.2.3.1	k_{ucr}	[-]	10,1							
Edge distance	$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$							
Axial distance	$s_{cr,N}$	[mm]	$3\ h_{ef}$							
Splitting failure										
Edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \le 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \le 2{,}4 \cdot h_{ef}$							
Axial distance	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1)]	[-]	1,5[2)]	1,8[3)]						
Partial safety factor (flooded bore hole)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1)]	[-]	2,1[4)]				not admissible			

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1.0 is included.
3) The partial safety factor γ_2 = 1.2 is included.
4) The partial safety factor γ_2 = 1.4 is included.
5) Explanations see section 1.2

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Application with threaded rod, Design acc. to CEN/TS 1992-4, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Annex 15

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Table 14: Design according to CEN/TS 1992-4, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Anchor size threaded rod			M12	M16	M20	M24	M27	M30
Steel failure								
Characteristic tension resistance, Steel, property class 4.6	$N_{Rk,s}$	[kN]	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,N}$ [1]	[-]	2,0					
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1]	[-]	1,50					
Chracteristic tension resistance, Stainless steel A4 and HCR property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ [1]	[-]	1,87				2,86	
Combined pull-out and concrete failure								
Characteristic bond resistance in cracked concrete C20/25								
Temperature range I[4]: 40°C/24°C — dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	6,5	6,5
Temperature range I[4]: 40°C/24°C — flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	not admissible			
Temperature range II[4]: 80°C/50°C — dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,5	4,5
Temperature range II[4]: 80°C/50°C — flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	not admissible			
Temperature range III[4]: 120°C/72°C — dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,5	3,5
Temperature range III[4]: 120°C/72°C — flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	not admissible			
Increasing factors for concrete	ψ_c	C30/37	1,04					
		C40/50	1,08					
		C50/60	1,10					
Factor acc. to CEN/TS 1992-4-5, Section 6.2.2.3	k_8	[-]	7,2					
Concrete cone failure								
Factor acc. to CEN/TS 1992-4-5, Section 6.2.3.1	k_{cr}	[-]	7,2					
Edge distance	$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$					
Axial distance	$s_{cr,N}$	[mm]	$3{,}0\ h_{ef}$					
Splitting failure								
Edge distance	$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$					
Axial distance	$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$					
Partial safety factor (dry and wet concrete)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	1,8[2]					
Partial safety factor (flooded bore hole)	$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	2,1[3]	not admissible				

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.2$ is included.
[3] The partial safety factor $\gamma_2 = 1.4$ is included.
[4] Explanations see section 1.2

MKT Injection System VMU plus for concrete

Application with threaded rod, Design acc. to CEN/TS 1992-4, Characteristic tension loads in cracked concrete under static and quasi-static action

Annex 16

Table 15: Design according to CEN/TS 1992-4, Characteristic values for shear loads in cracked and non-cracked concrete under static and quasi-static action

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 4.6	$V_{Rk,s}$	[kN]	7	12	17	31	49	71	92	112
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,67							
Charactertistic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,25							
Characteristic shear resistance, Stainless steel A4 and HCR Property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,56						2,38	
Ductility factor according to CEN/TS 1992-4-5, Section 6.3.2.1	k_2	[-]	0,8							
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 4.6	$M^0_{Rk,s}$	[Nm]	15	30	52	133	260	449	666	900
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,67							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,25							
Characteristic bending moment, Stainless steel A4 and HCR property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ 1)	[-]	1,56						2,38	
Concrete pry-out failure										
Factor in equation (27) of CEN/TS 1992-4-5, Section 6.3.3	k_3	[-]	2,0							
Partial safety factor	γ_{Mcp} 1)	[-]	1,50 2)							
Concrete edge failure 3)										
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\, d_{nom})$							
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Partial safety factor	γ_{Mc} 1)	[-]	1,50 2)							

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1.0 is included.
3) See CEN/TS 1992-4-5 Section 6.3.4

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Table 16: Design according to CEN/TS 1992-4, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure												
Characteristic tension resistance, reinforcing bar according to Annex 4		$N_{Rk,s}$	[kN]	A_s x f_{uk} [6]								
Partial safety factor		$\gamma_{Ms,N}$ [1]	[-]	CEN/TS 1992-4-1, Section 4.4.3.1.1, Eq. (4) [6]								
Combined pull-out concrete failure												
Chracteristic bond restistance in non-cracked concretet C20/25												
Temperature range I[5]: 40°C/24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	12	11	10	8,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	8,5	not admissible			
Temperature range II[5]: 80°C/50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	not admissible			
Temperature range III[5]: 120°C/72°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	5,0	not admissible			
Increasing factors for concrete		ψ_c	C30/37	1,04								
			C40/50	1,08								
			C50/60	1,10								
Factor according to CEN/TS 1992-4-5, Section 6.2.2.3		k_8	[-]	10,1								
Concrete cone failure												
Factor according to CEN/TS 1992-4-5, Section 6.2.3.1		k_{ucr}	[-]	10,1								
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}								
Axial distance		$s_{cr,N}$	[mm]	3 h_{ef}								
Splitting failure												
Edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$								
Partial safety factor (dry and wet concrete)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	1,5[2]	1,8[3]							
Partial safety factor (flooded bore hole)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	2,1[4]					not admissible			

[1] In absence of other national regulations
[2] The partial safety factor γ_2 = 1.0 is included.
[3] The partial safety factor γ_2 = 1.2 is included.
[4] The partial safety factor γ_2 = 1.4 is included.
[5] Explanations see section 1.2
[6] f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar

Regarding design of post-installed rebar as anchor see chapter 4.2

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Application with reinforcing bar, Design according to CEN/TS 1992-4, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

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Table 17: Design according to CEN/TS 1992-4, Characteristic values for tension loads in cracked concrete under static and quasi-static action

Anchor size reinforcing bar				Ø 12	Ø 14	Ø16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure										
Characteristic tension resistance, reinforcing bar according to Annex 4		$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$ [5]						
Partial safety factor		$\gamma_{Ms,N}$ [1]	[-]	CEN/TS 1992-4-1 Section 4.4.3.1.1, Eq. 4 [5]						
Combined pull-out and concrete failure										
Characteristic bond resistance in cracked concrete C20/25										
Temperature range I[4]: 40°C/24°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	6,0	6,0	6,0	not admissible			
Temperature range II[4]: 80°C/50°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	not admissible			
Temperature range III[4]: 120°C/72°C	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	3,5	3,5	3,5	not admissible			
Increasing factors for concrete	ψ_c	C30/37		1,04						
		C40/50		1,08						
		C50/60		1,10						
Factor according to CEN/TS 1992-4-5, Section 6.2.2.3		k_8	[-]	7,2						
Concrete cone failure										
Factor according to CEN/TS 1992-4-5, Section 6.2.3.1		k_{cr}	[-]	7,2						
Edge distance		$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$						
Axial distance		$s_{cr,N}$	[mm]	$3{,}0\ h_{er}$						
Splitting failure										
Edge distance		$c_{cr,sp}$	[mm]	$1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$						
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	1,8[2]						
Partial safety factor (flooded bore hole)		$\gamma_{Msp} = \gamma_{Mc} = \gamma_{Mp}$ [1]	[-]	2,1[3]			not admissible			

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.2$ is included.
[3] The partial safety factor $\gamma_2 = 1.4$ is included.
[4] Explanations see section 1.2
[5] f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar

Regarding design of post-installed rebar as anchor see chapter 4.2

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Application with reinforcing bar, Design acc. to CEN/TS 1992-4, Characteristic values for tension loads in cracked concrete under static and quasi-static action	

Table 18: Design according to CEN/TS 1992-4, Characteristic values for shear loads in cracked and non-cracked concrete under static and quasi-static action

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Steel failure without lever arm (Properties acc. to Annex 4)											
Characteristic shear resistance, reinforcing bar according to Annex 4	$V_{Rk,s}$	[kN]	$0{,}5 \times A_s \times f_{uk}$ [4)]								
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	CEN/TS 1992-4-1, Section 4.4.3.1.1, Eq. 5 + 6 [4)]								
Ductility factor according to CEN/TS 1992-4-5, Section 6.3.2.1	k_2	[-]	0,8								
Steel failure with lever arm (Properties acc. to Annex 4)											
Characteristic bending moment, reinforcing bar acc. to Annex 4	$M^0_{Rk,s}$	[Nm]	$1{,}2 \times W_{el} \times f_{uk}$ [4)]								
Partial safety factor	$\gamma_{Ms,V}$ [1)]	[-]	CEN/TS 1992-4-1, Section 4.4.3.1.1, Eq. 5 + 6 [4)]								
Concrete pry-out failure											
Factor in equation (27) of CEN/TS 1992-4-5, Section 6.3.3	k_3	[-]	2,0								
Partial safety factor	γ_{Mcp} [1)]	[-]	1,50 [2)]								
Concrete edge failure [3)]											
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$								
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	14	16	20	24	27	30
Partial safety factor	γ_{Mc} [1)]	[-]	1,50 [2)]								

[1)] In absence of other national regulations
[2)] The partial safety factor $\gamma_2 = 1.0$ is included.
[3)] See CEN/TS 1992-4-5 Section 6.3.4
[4)] f_{uk}, f_{yk}: see relevant Technical Specification for the reinforcing bar

Regarding design of post-installed rebar as anchor see chapter 4.2

Table 19: Displacements for tension loads threaded rod [1)]

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Non-cracked concrete C20/25										
40°C/24°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,030	0,033	0,037	0,045	0,052	0,060	0,065	0,071
80°C/50°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
120°C/72°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Cracked concrete C20/25										
40°C/24°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,070					
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,105					
80°C/50°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,170					
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,245					
120°C/72°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,170					
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,245					

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)
[2)] Explanations see section 1.2

Table 20: Displacements for shear loads threaded rod [3)]

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Non-cracked concrete C20/25										
All temperatures	δ_{V0}	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Cracked concrete C20/25										
All temperatures	δ_{V0}	[mm/(kN)]	-		0,11	0,10	0,09	0,08	0,08	0,07
	$\delta_{V\infty}$	[mm/(kN)]			0,17	0,15	0,14	0,13	0,12	0,10

[3)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

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Application with threaded rod
Verschiebungen

Annex 21

Table 21: Displacements for tension loads reinforcing bar [1)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Non-cracked concrete C20/25											
40°C/24°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,030	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
80°C/50°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
120°C/72°C [2)]	δ_{N0}	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Cracked concrete C20/25											
40°C/24°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,070						
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,105						
80°C/50°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,170						
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,245						
120°C/72°C [2)]	δ_{N0}	[mm/(N/mm²)]	-		0,170						
	$\delta_{N\infty}$	[mm/(N/mm²)]			0,245						

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd}$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd}$ / 1,4;
(τ_{Sd}: design bond strength)
[2)] Explanations see section 1.2

Table 22: Displacements for shear loads reinforcing bar [3)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Non-cracked concrete C20/25											
All temperatures	δ_{V0}	[mm/(kN)]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
Cracked concrete C20/25											
All temperatures	δ_{V0}	[mm/(kN)]	-		0,11	0,11	0,10	0,09	0,08	0,07	0,06
	$\delta_{V\infty}$	[mm/(kN)]			0,17	0,16	0,15	0,14	0,12	0,11	0,10

[3)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{V\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

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Annex 22

Design according to TR 045; Design under seismic action

The decision of the selection of the seismic performance category is in the responsability of each individual Member State.

Furthermore, the values $a_g \cdot S$ assigned to the seismicity levels may be different in the National Annexes to EN 1998-1:2004 (EC8) compared tot he values given in Table 18.

The recommended category C1 and C2 given in Table 18 are given in the case that no National requirements are defined.

Table 23: Recommended seismic performance categories for anchors

Seismicity level [a)]		Importace Class acc. to EN 1998-1:2004, 4.2.5			
	$a_g \cdot S$ [c)]	I	II	III	IV
Very low [b)]	$a_g \cdot S \leq 0{,}05$ g	No additional requirement			
Low [b)]	$0{,}05$ g $< a_g \cdot S \leq 0{,}1$ g	C1	C1 [d)] or C2 [e)]		C2
> Low [b)]	$a_g \cdot S > 0{,}1$ g	C1	C2		

a) The values defining the seismicity levels may be found in the National Annex of EN 1998-1.
b) Definition according to EN 1998-1:2004, 3.2.1.
c) a_g = Design ground acceleration on Type A ground (EN 1998-1: 2004, 3.2.1),
S = Soil factor (see e.g. EN 1998-1: 2004, 3.2.2).
d) C1 attachments of non-structural elements
e) C2 for connections between structural elements of primary and/or secondary seismic members

Calculation of characteristic seismic resistance $R_{k,seis}$

Tension load: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot \alpha_{N,seis} \cdot R^0_k$

with $R^0_k = N_{Rk,s}, N_{Rk,p}, N_{Rk,c}, N_{Rk,sp}$ (calculation according to CEN/TS 1992-4 or TR029)
$\alpha_{N,seis}$ = see Table 24 or Table 25 for $N_{Rk,s}$ and $N_{Rk,p}$
$\alpha_{N,seis}$ = 1,0 for $N_{Rk,c}$ and $N_{Rk,sp}$
α_{gap} = see Table 26
α_{seis} = see Table 26

Shear load: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot \alpha_{V,seis} \cdot R^0_k$

with $R^0_k = V_{Rk,s}, V_{Rk,c}, V_{Rk,cp}$ (calculation according to CEN/TS 1992-4 or TR029)
$\alpha_{V,seis}$ = see Table 24 or Table 25 for $V_{Rk,s}$
$\alpha_{V,seis}$ = 1,0 for $V_{Rk,c}$ and $V_{Rk,cp}$
α_{gap} = see Table 26
α_{seis} = see Table 26

Table 24: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design categorie C1 for threaded rods

Anchor size threaded rods			M12	M16	M20	M24	M27	M30
Tension load								
Steel failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	1,0					
Combined pull-out and concrete failure ($N_{Rk,p}$)	$\alpha_{N,seis}$	[-]	0,68			0,69		
Shear load								
Steel failure without lever arm ($V_{Rk,s}$)	$\alpha_{V,seis}$	[-]	0,70					

Table 25: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for reinforcing bar

Anchor size reinforcing bar			∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Tension load									
Steel failure ($N_{Rk,s}$)	$\alpha_{N,seis}$	[-]	1,0						
Combined pull-out and concrete failure ($N_{Rk,p}$)	$\alpha_{N,seis}$	[-]	0,68				0,69		
Shear load									
Steel failure without lever arm ($V_{Rk,s}$)	$\alpha_{V,seis}$	[-]	0,70						

Table 26: Reduction factors α_{gap} and α_{seis} for resistance under seismic actions

Loading	Versagensart	α_{gap}	α_{seis} – Einzelbefestigung	α_{seis} – Gruppenbefestigung
Tension	Steel failure	1,0	1,0	1,0
	Pull-out failure	1,0	1,0	0,85
	Combined pull-out and concrete failure	1,0	1,0	0,85
	Concrete cone failure	1,0	0,85	0,75
	Splitting failure	1,0	1,0	0,85
Shear	Steel failure without lever arm	0,5 [1]	1,0	0,85
	Steel failure with lever arm	NPD [2]	NPD [2]	NPD [2]
	Concrete edge failure	0,5 [1]	1,0	0,85
	Concrete pry-out failure	0,5 [1]	0,85	0,75

1) The limitation for size of the clearance hole is given in TR 029 Table 4.1, α_{gap} = 1,0 in case of no clearance between fastener and fixture
2) No Performance Determined

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Design according to TR 045; Reduction factors	