**Deutsches Institut für Bautechnik**
**Zulassungsstelle für Bauprodukte und Bauarten**
**Bautechnisches Prüfamt**
Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

Kolonnenstraße 30 B
D-10829 Berlin
Tel.: +49 30 78730-0
Fax: +49 30 78730-320
E-Mail: dibt@dibt.de
www.dibt.de

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-11/0449

*English translation prepared by DIBt - Original version in German language*

| | |
|---|---|
| Handelsbezeichnung<br>*Trade name* | Mapei Injektionssystem Mapefix VE SF für Beton<br>*Mapei Injection system Mapefix VE SF for concrete* |
| Zulassungsinhaber<br>*Holder of approval* | Mapei S.p.A.<br>via Cafiero, 22<br>20158 MILANO (MI)<br>ITALIEN |
| Zulassungsgegenstand und Verwendungszweck<br>*Generic type and use of construction product* | Verbunddübel mit Ankerstange zur Verankerung im Beton<br>*Bonded Anchor with Anchor rod for use in concrete* |
| Geltungsdauer: vom<br>*Validity: from* | 20 June 2013 |
| bis<br>*to* | 15 May 2018 |
| Herstellwerk<br>*Manufacturing plant* | Mapei spa, Plant L4 |

| | |
|---|---|
| Diese Zulassung umfasst<br>*This Approval contains* | 33 Seiten einschließlich 24 Anhänge<br>*33 pages including 24 annexes* |
| Diese Zulassung ersetzt<br>*This Approval replaces* | ETA-11/0449 mit Geltungsdauer vom 31.10.2011 bis 13.11.2013<br>*ETA-11/0449 with validity from 31.10.2011 to 13.11.2013* |

Electronic copy of the ETA by DIBt: ETA-11/0449

# 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.

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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 "Mapei Injection system Mapefix VE SF for concrete" is a bonded anchor consisting of a cartridge with Mapei injection mortar Mapefix VE SF 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).

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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 "Mapefix VE SF", 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".

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[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.

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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.

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## 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,

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[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.

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## 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

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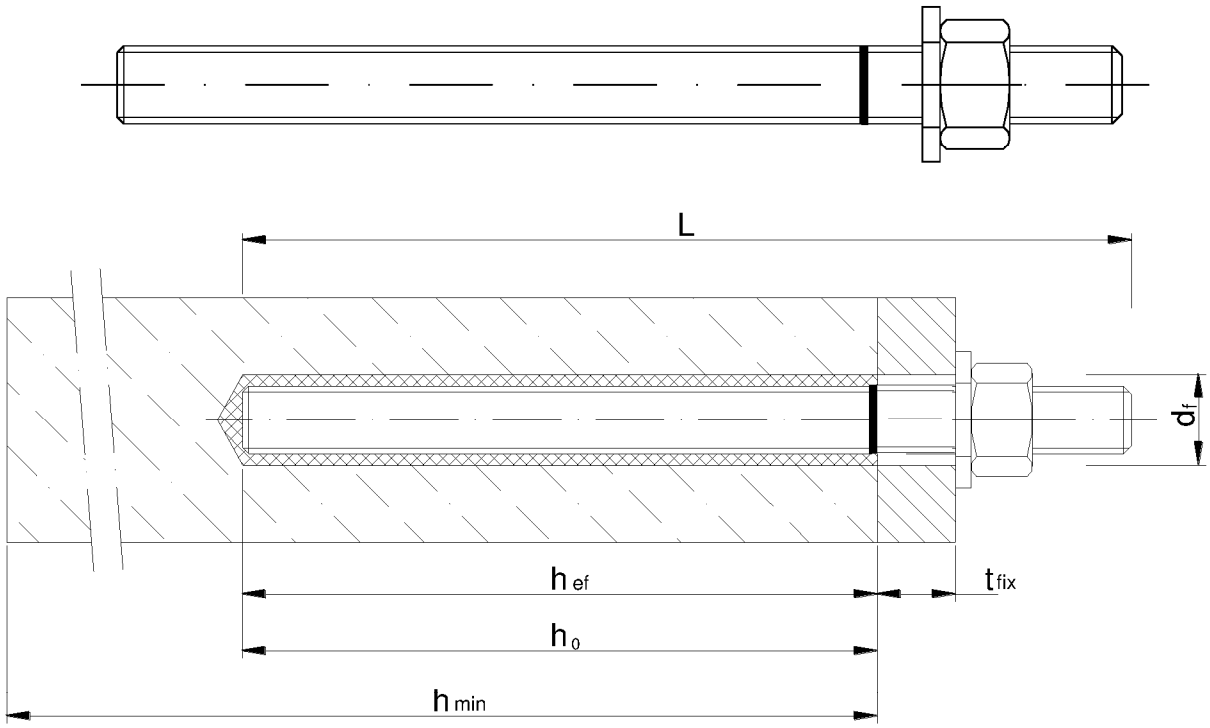
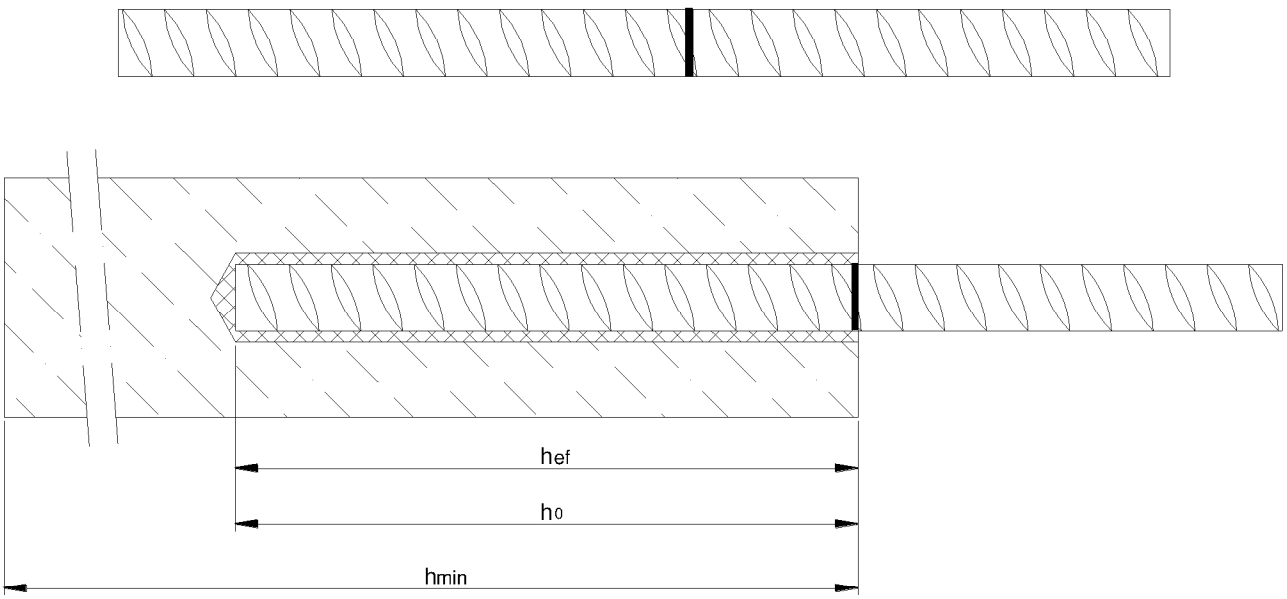
**Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut**




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




Mapei Injection system Mapefix VE SF for concrete

Product (Steel) and Installation

**Annex 1**

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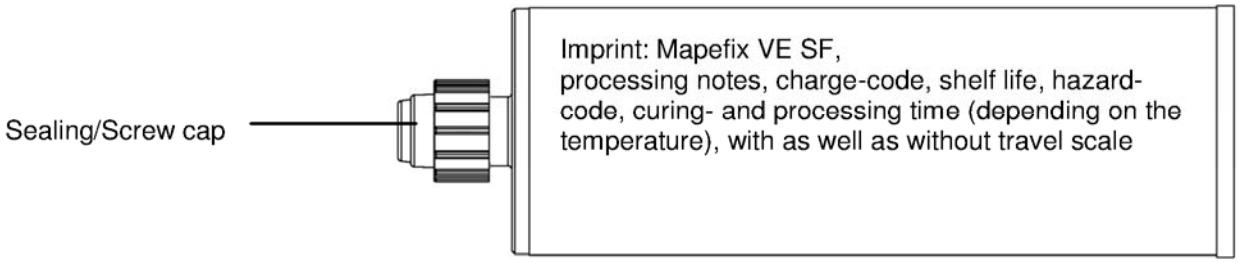
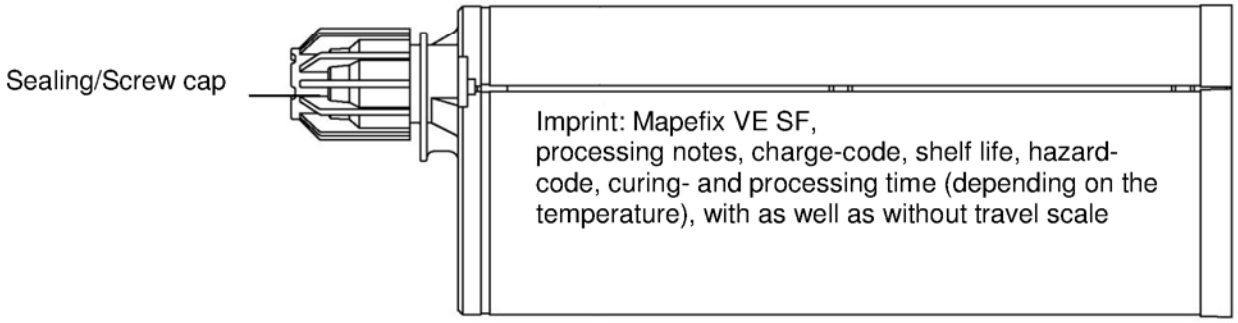
**Cartridge: Mapefix VE SF**

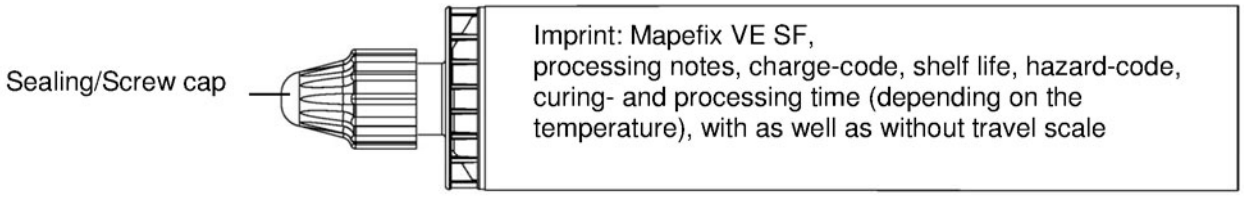
**150 ml, 280 ml, 300 ml, 310ml, 330 ml, 380 ml, 410 ml and 420 ml cartridge (Type: coaxial)**




**235 ml, 345 ml and 825 ml cartridge (Type: "side-by-side")**




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




**Static Mixer**

Use category:
- Installation in dry, wet concrete (all sizes) or flooded holes (only M8 to M16 and rebar Ø8 to Ø16)
- Overhead installation
- Application in non-cracked concrete: M8 to M30, Rebar Ø8 to Ø32
- Application in cracked concrete and seismic C1: M12 to M30, Rebar Ø12 to Ø32

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)

| | |
|---|---|
| Mapei Injection system Mapefix VE SF for concrete | **Annex 2** |
| Product (Injection mortar) and Intended use | |

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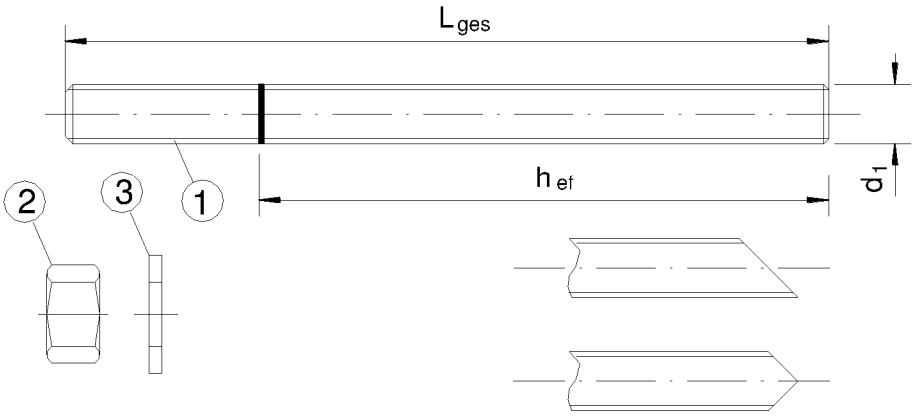
## Table 1a: Materials (Threaded rod)




| 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 and EN ISO 10684** | | |
| 1 | Anchor rod | Steel, EN 10087 or EN 10263<br>Property class 4.6, 5.8, 8.8, EN ISO 898-1:1999 |
| 2 | Hexagon nut, EN ISO 4032 | Property class 4 (for class 4.6 rod) EN ISO 898-2,<br>Property class 5 (for class 5.8 rod) EN ISO 898-2,<br>Property class 8 (for class 8.8 rod) EN ISO 898-2 |
| 3 | Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094 | Steel, zinc plated or hot-dip galvanised |
| **Stainless steel** | | |
| 1 | Anchor rod | Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005,<br>> M24: Property class 50 EN ISO 3506<br>≤ M24: Property class 70 EN ISO 3506 |
| 2 | Hexagon nut, EN ISO 4032 | Material 1.4401 / 1.4404 / 1.4571 EN 10088,<br>> M24: Property class 50 (for class 50 rod) EN ISO 3506<br>≤ M24: Property class 70 (for class 70 rod) EN ISO 3506 |
| 3 | Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094 | Material 1.4401, 1.4404 or 1.4571, EN 10088 |
| **High corrosion resistance steel** | | |
| 1 | Anchor rod | Material 1.4529 / 1.4565, EN 10088-1:2005,<br>> M24: Property class 50 EN ISO 3506<br>≤ M24: Property class 70 EN ISO 3506 |
| 2 | Hexagon nut, EN ISO 4032 | Material 1.4529 / 1.4565 EN 10088,<br>> M24: Property class 50 (for class 50 rod) EN ISO 3506<br>≤ M24: Property class 70 (for class 70 rod) EN ISO 3506 |
| 3 | Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094 | Material 1.4529 / 1.4565, EN 10088 |

Commercial standard rod with:
- Materials, dimensions and mechanical properties acc. Table 1a
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

| | |
|---|---|
| Mapei Injection system Mapefix VE SF for concrete | **Annex 3** |
| Materials (Threaded rod) | |

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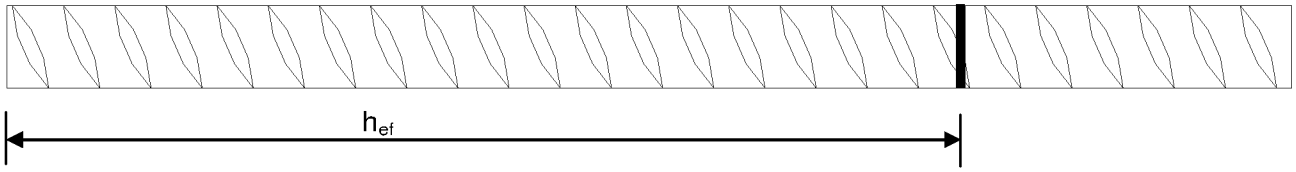
## Table 1b: Materials (Rebar)




### 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<br>< 1,35 |
| Characteristic strain at maximum force $\varepsilon_{uk}$ (%) | | ≥ 5,0 | ≥ 7,5 |
| Bendability | | Bend/Rebend test | |
| Maximum deviation from nominal mass (individual bar) (%) | Nominal bar size (mm)<br>≤ 8<br>> 8 | <br>± 6,0<br>± 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** |
| Min. value of related rip area $f_{R,min}$ | nominal diameter of the rebar (mm)<br>8 to 12<br>> 12 | <br>0,040<br>0,056 | |

Rib height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
(d: Nominal diameter of the bar; h: Rip height of the bar)

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

| Mapei Injection system Mapefix VE SF for concrete | **Annex 4** |
|---|---|
| Materials (Reinforcing bar) | |

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## Table 2: Installation parameters for threaded rod

| Anchor size | | M 8 | M 10 | M 12 | M 16 | M 20 | M 24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ [mm] = | 10 | 12 | 14 | 18 | 24 | 28 | 32 | 35 |
| Effective anchorage 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 |
| Torque moment | $T_{inst}$ [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 3: Installation parameters for rebar

| Rebar size | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ [mm] = | 12 | 14 | 16 | 18 | 20 | 24 | 32 | 35 | 40 |
| Effective anchorage 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 |

Mapei Injection system Mapefix VE SF for concrete

Installation parameters

**Annex 5**

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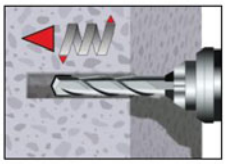
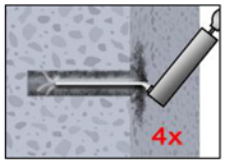
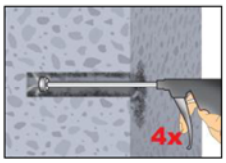
## Installation instructions



1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table 2 or Table 3).




or

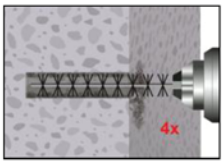



**Attention! Standing water in the bore hole must be removed before cleaning.**

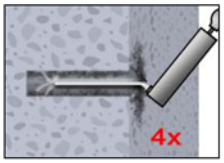
2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) or a hand pump (Annex 8) a minimum of four times. If the bore hole ground is not reached an extension shall be used.

The hand-pump can be used for anchor sizes up to bore hole diameter 20 mm.

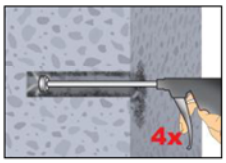
For bore holes larger then 20 mm or deeper 240 mm, compressed air (min. 6 bar) **must** be used.




2b. Check brush diameter (Table 5) 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 5) a minimum of four times.
If the bore hole ground is not reached with the brush, a brush extension shall be used (Table 5).

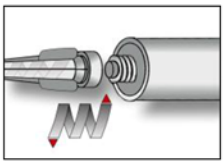



or

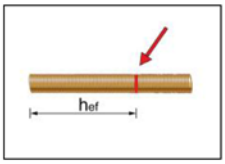



2c. Finally blow the hole clean again with compressed air (min. 6 bar) or a hand pump (Annex 8) a minimum of four times. If the bore hole ground is not reached an extension shall be used.
The hand-pump can be used for anchor sizes up to bore hole diameter 20 mm.
For bore holes larger then 20 mm or deeper 240 mm, compressed air (min. 6 bar) **must** be used.

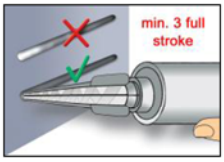
**After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning repeated has to be directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.**



3. Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. Cut off the foil tube clip before use.
For every working interruption longer than the recommended working time (Table 4) 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. For foil tube cartridges is must be discarded a minimum of six full strokes.

| Mapei Injection system Mapefix VE SF for concrete | **Annex 6** |
|---|---|
| Installation instructions | |

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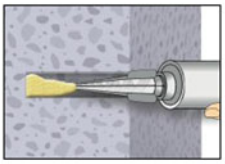
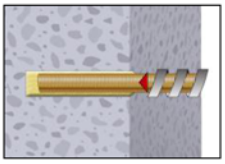
## Installation instructions (continuation)

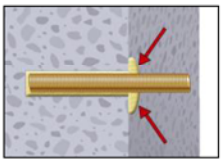


6. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. For overhead and horizontal installation a piston plug (Annex 8) and extension nozzle shall be used. Observe the gel-/ working times given in Table 4.

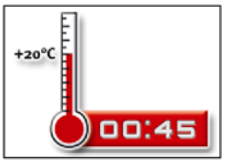


7. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

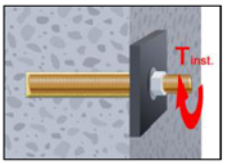
   The anchor should be free of dirt, grease, oil or other foreign material.



8. Be sure that the anchor is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod should be fixed (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 4).




10. After full curing, the add-on part can be installed with the max. torque (Table 2) by using a calibrated torque wrench.

## Table 4: Minimum curing time

| Concrete temperature | Gelling- / working 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) Cartridge temperature **must** be at min. +15°C
2) In wet concrete the curing time **must** be doubled

Mapei Injection system Mapefix VE SF for concrete

Installation instructions (continuation)
Curing time

**Annex 7**

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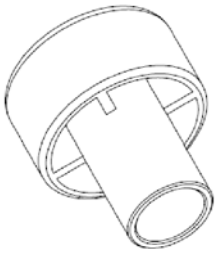
## Steel brush

## Table 5: Parameter cleaning and setting tools

| Threaded Rod | Rebar | $d_0$ Drill bit - ∅ | $d_b$ Brush - ∅ | $d_{b,min}$ min. Brush - ∅ | Piston plug |
|---|---|---|---|---|---|
| (mm) | (mm) | (mm) | (mm) | (mm) | (No.) |
| M8 | | 10 | 12 | 10,5 | No piston plug required |
| 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 | # 24 |
| M24 | | 28 | 30 | 28,5 | # 28 |
| M27 | 25 | 32 | 34 | 32,5 | # 32 |
| M30 | 28 | 35 | 37 | 35,5 | # 35 |
| | 32 | 40 | 41,5 | 40,5 | # 38 |

**Hand pump (volume 750 ml)**
Drill bit diameter ($d_0$): 10 mm to 20 mm

**Rec. compressed air tool (min 6 bar)**
Drill bit diameter ($d_0$): 10 mm to 40 mm



**Piston plug for overhead or horizontal installation**
Drill bit diameter ($d_0$): 24 mm to 40 mm

Mapei Injection system Mapefix VE SF for concrete

Cleaning and setting tools

**Annex 8**

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## Table 6a: Design according to TR 029, Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

| Anchor size threaded rod | | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| | 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 |
| | 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 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 4,0 | 5,0 | 5,0 | 5,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | C30/37 | | 1,04 | | | | | | | |
| | | C40/50 | | 1,08 | | | | | | | |
| | | C50/60 | | 1,10 | | | | | | | |
| **Splitting failure** | | | | | | | | | | | |
| Edge distance | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | $2\ c_{cr,sp}$ | | | | | | | |
| Partial safety factor (dry and wet concrete) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,5[2] | 1,8[3] | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 2,1[4] | | | | not admissible | | | |

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ is included.
[5] Explanations see section 1.2

Mapei Injection system Mapefix VE SF 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**

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## Table 6b: Design according to TR 029, Characteristic values for tension loads in cracked concrete under static and quasi-static action

| Anchor size threaded rod | | | | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|
| **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] | 5,5 | 5,5 | 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] | 4,0 | 4,0 | 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] | 3,0 | 3,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | C30/37 | | 1,04 | | | | | |
| | | C40/50 | | 1,08 | | | | | |
| | | C50/60 | | 1,10 | | | | | |
| **Splitting failure** | | | | | | | | | |
| Edge distance | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | $2\ c_{cr,sp}$ | | | | | |
| Partial safety factor (dry and wet concrete) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1)] | | 1,8[2)] | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [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

Mapei Injection system Mapefix VE SF 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 7: 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 | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | 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 | | | | | | | |
| 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) 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 | |
| **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 | $\gamma_{Mcp}$ [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 | $\gamma_{Mc}$ [1)] | | 1,50 [2)] | | | | | | | |

[1)] In absence of other national regulations
[2)] The partial safety factor $\gamma_2 = 1.0$ is included.

Mapei Injection system Mapefix VE SF for concrete

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

**Annex 11**

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## Table 8a: Design according to TR 029, 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** | **Ø 16** | **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] | | 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 $\psi_c$ | | C30/37 | | 1,04 | | | | | | | | |
| | | C40/50 | | 1,08 | | | | | | | | |
| | | C50/60 | | 1,10 | | | | | | | | |
| **Splitting failure** | | | | | | | | | | | | |
| Edge distance | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | 2 $c_{cr,sp}$ | | | | | | | | |
| Partial safety factor (dry and wet concrete) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,5[2] | 1,8[3] | | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 2,1[4] | | | | | not admissible | | | |

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ 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

Mapei Injection system Mapefix VE SF 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**

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## Table 8b: 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** | **Ø 16** | **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 $f_{uk}$ [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] | 5,5 | 5,5 | 5,5 | 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] | 4,0 | 4,0 | 4,0 | 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] | 3,0 | 3,0 | 3,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | C30/37 | | 1,04 | | | | | | |
| | | C40/50 | | 1,08 | | | | | | |
| | | C50/60 | | 1,10 | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Edge distance | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | 2 $c_{cr,sp}$ | | | | | | |
| Partial safety factor (dry and wet concrete) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,8[2] | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [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

Mapei Injection system Mapefix VE SF 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**

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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 reinforcing bar** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | |
| Characteristic shear resistance, reinforcing bar according to Annex 4 | $V_{Rk,s}$ | [kN] | 0,50 x $A_s$ x $f_{uk}$ [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 | $M^0_{Rk,s}$ | [Nm] | 1.2 ·$W_{el}$ · $f_{uk}$ [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 | $\gamma_{Mcp}$ [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 | $\gamma_{Mc}$ [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 10a: Design according to CEN/TS 1992-4: Characteristic values for tension loads in non-cracked concrete under static and quasi-static action

| Anchor size threaded rod | | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 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 |
| | 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 |
| | 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 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 4,0 | 5,0 | 5,0 | 5,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | 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] | 3,0 $h_{ef}$ | | | | | | | |
| **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) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,5[2] | 1,8[3] | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 2,1[4] | | | | not admissible | | | |

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ is included.
[5] Explanations see section 1.2

Mapei Injection system Mapefix VE SF for concrete

Application with threaded rod
Design according 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 10b: 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 | | | | M 12 | M 16 | M 20 | 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 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] | 5,5 | 5,5 | 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] | 4,0 | 4,0 | 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] | 3,0 | 3,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | 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 $h_{ef}$ | | | | | |
| **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) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,8 [2] | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [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

Mapei Injection system Mapefix VE SF for concrete

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

**Annex 16**

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## Table 11: 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 | M24 | 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 | | | | | | | |
| 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) 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 | $\gamma_{Mcp}$ [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 | $\gamma_{Mc}$ [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

Mapei Injection system Mapefix VE SF for concrete

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

**Annex 17**

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## Table 12a: 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** | **Ø 16** | **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 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 | 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 $\psi_c$ | | 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] | 3,0 $h_{ef}$ | | | | | | | | |
| **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) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,5[2] | 1,8[3] | | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 2,1[4] | | | | | not admissible | | | |

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1.0$ is included.
[3] The partial safety factor $\gamma_2 = 1.2$ is included.
[4] The partial safety factor $\gamma_2 = 1.4$ 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

Mapei Injection system Mapefix VE SF for concrete

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

**Annex 18**

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## Table 12b: 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 | Ø 16 | 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 $f_{uk}$ [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] | 5,5 | 5,5 | 5,5 | 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] | 4,0 | 4,0 | 4,0 | 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] | 3,0 | 3,0 | 3,0 | not admissible | | | |
| Increasing factors for concrete $\psi_c$ | | 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 $h_{ef}$ | | | | | | |
| **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) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [1] | | 1,8[2] | | | | | | |
| Partial safety factor (flooded bore hole) | | $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ [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

| Mapei Injection system Mapefix VE SF for concrete | **Annex 19** |
|---|---|
| Application with reinforcing bar<br>Design according to CEN/TS 1992-4,<br>Characteristic values for tension loads in cracked concrete under static and quasi-static action | |

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## Table 13: 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** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | |
| Characteristic shear resistance, reinforcing bar according to Annex 4 | $V_{Rk,s}$ | [kN] | 0,50 x $A_s$ x $f_{uk}$ [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** | | | | | | | | | | | |
| Characteristic bending moment, reinforcing bar according to Annex 4 | $M^0_{Rk,s}$ | [Nm] | 1.2 ·$W_{el}$ · $f_{uk}$ [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 | $\gamma_{Mcp}$ [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 | $\gamma_{Mc}$ [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

Mapei Injection system Mapefix VE SF for concrete

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

**Annex 20**

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## Table 14: Displacements for tension loads threaded rod [1)]

| Anchor size threaded rod | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Non-cracked concrete C20/25** | | | | | | | | | | |
| 40°C/24°C [2)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [mm/(N/mm²)] | - | | 0,070 | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | | | 0,105 | | | | | |
| 80°C/50°C [2)] | $\delta_{N0}$ | [mm/(N/mm²)] | - | | 0,170 | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | | | 0,245 | | | | | |
| 120°C/72°C [2)] | $\delta_{N0}$ | [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 = $\delta_{N\infty} \cdot \tau_{Sd} / 1{,}4$;
($\tau_{Sd}$: design bond strength)
[2)] Explanations see section 1.2

## Table 15: Displacement for shear load threaded rod [3)]

| Anchor size threaded rod | | | M 8 | M 10 | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|
| **For non-cracked concrete C20/25** | | | | | | | | | | |
| All temperatures | $\delta_{V0}$ | [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 |
| **For cracked concrete C20/25** | | | | | | | | | | |
| All temperatures | $\delta_{V0}$ | [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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## Table 16: Displacements for tension loads reinforcing bar [1)]

| Anchor size reinforcing bar | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Non-cracked concrete C20/25** | | | | | | | | | | | |
| 40°C/24°C [2)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [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)] | $\delta_{N0}$ | [mm/(N/mm²)] | - | 0,070 | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | | 0,105 | | | | | | | |
| 80°C/50°C [2)] | $\delta_{N0}$ | [mm/(N/mm²)] | - | 0,170 | | | | | | | |
| | $\delta_{N\infty}$ | [mm/(N/mm²)] | | 0,245 | | | | | | | |
| 120°C/72°C [2)] | $\delta_{N0}$ | [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 = $\delta_{N\infty} \cdot \tau_{Sd} / 1{,}4$;
($\tau_{Sd}$: design bond strength)
[2)] Explanations see section 1.2

## Table 17: Displacement for shear loads reinforcing bar [3)]

| Anchor size reinforcing bar | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Non-cracked concrete C20/25** | | | | | | | | | | | |
| All temperatures | $\delta_{V0}$ | [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 | $\delta_{V0}$ | [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)

Mapei Injection system Mapefix VE SF for concrete

Application with reinforcing bar
Displacements

**Annex 22**

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## Design according to TR 045; Design under seismic action

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

Furthermore, the values of $a_g \cdot S$ assigned to the seismicity levels may be different in the National Annexes to EN 1998-1:2004 (EC8) compared to the 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 18: Recommended seismic performance categories for anchors

| Seismicity level [a)] | | Importance 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 19 or Table 20 for $N_{Rk,s}$ and $N_{Rk,p}$
$\alpha_{N,seis}$ = 1,0 for $N_{Rk,c}$ and $N_{Rk,sp}$
$\alpha_{gap}$ = see Table 21
$\alpha_{seis}$ = see Table 21

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 19 or Table 20 for $V_{Rk,s}$
$\alpha_{V,seis}$ = 1,0 for $V_{Rk,c}$ and $V_{Rk,cp}$
$\alpha_{gap}$ = see Table 21
$\alpha_{seis}$ = see Table 21

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## Table 19: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for threaded rods

| Anchor size threaded rods | | | M 12 | M 16 | M 20 | M24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|
| **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 | 0,68 | 0,68 | 0,69 | 0,69 | 0,69 |
| **Shear load** | | | | | | | | |
| Steel failure without lever arm ($V_{Rk,s}$) | $\alpha_{V,seis}$ | [-] | 0,70 | | | | | |

## Table 20: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for reinforcing bar

| Anchor size reinforcing bar | | | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 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 | 0,68 | 0,68 | 0,68 | 0,69 | 0,69 | 0,69 |
| **Shear load** | | | | | | | | | |
| Steel failure without lever arm ($V_{Rk,s}$) | $\alpha_{V,seis}$ | [-] | 0,70 | | | | | | |

## Table 21: Reduction factors $\alpha_{gap}$ and $\alpha_{seis}$ for resistance under seismic actions

| Loading | Failure modes | $\alpha_{gap}$ | $\alpha_{seis}$ - Single fastener | $\alpha_{seis}$ - Fastener group |
|---|---|---|---|---|
| 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, $\alpha_{gap}$ = 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

**Annex 24**

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