

# **European Technical Approval ETA-12/0164**

English translation prepared by DIBt - Original version in German language Handelsbezeichnung Würth Injektionssystem WIT-VM 250 für Beton

Trade name	Würth Injection system WIT-VM 250 for concrete
Zulassungsinhaber Holder of approval	Adolf Würth GmbH & Co. KG Reinhold-Würth-Straße 12-17 74653 Künzelsau DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck	Verbunddübel mit Ankerstange zur Verankerung im Beton
Generic type and use of construction product	Bonded Anchor with Anchor rod for use in concrete
Geltungsdauer: vom Validity: from	20 June 2013
bis to	15 May 2018
Herstellwerk Manufacturing plant	Adolf Würth GmbH & Co KG, Plant 3, Germany

Diese Zulassung umfasst	33 Seiten einschließlich 24 Anhänge
This Approval contains	33 pages including 24 annexes
Diese Zulassung ersetzt	ETA-12/0164 mit Geltungsdauer vom
This Approval replaces	ETA-12/0164 with validity from 26.03.201

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Europäische Organisation für Technische Zulassungen European Organisation for Technical Approvals



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### 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<sup>1</sup>, modified by Council Directive 93/68/EEC<sup>2</sup> and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council<sup>3</sup>;
  - 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<sup>4</sup>, as amended by Article 2 of the law of 8 November 2011<sup>5</sup>;
  - Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC<sup>6</sup>;
  - 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.
- <sup>1</sup> Official Journal of the European Communities L 40, 11 February 1989, p. 12

- <sup>3</sup> Official Journal of the European Union L 284, 31 October 2003, p. 25
- Bundesgesetzblatt Teil I 1998, p. 812
- Bundesgesetzblatt Teil I 2011, p. 2178

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Official Journal of the European Communities L 220, 30 August 1993, p. 1

Official Journal of the European Communities L 17, 20 January 1994, p. 34



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### II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

### 1 Definition of product and intended use

### **1.1 Definition of the construction product**

The "Würth Injection system WIT-VM 250 for concrete" is a bonded anchor consisting of a cartridge with Würth injection mortar WIT-VM 250 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)

### Elements made of zinc coated steel:

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

### Elements made of stainless steel:

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<sup>7</sup> 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 "WIT-VM 250", 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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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.



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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<sup>8</sup> 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.<sup>9</sup>

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

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.



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### 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"<sup>10</sup>

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,

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



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- 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

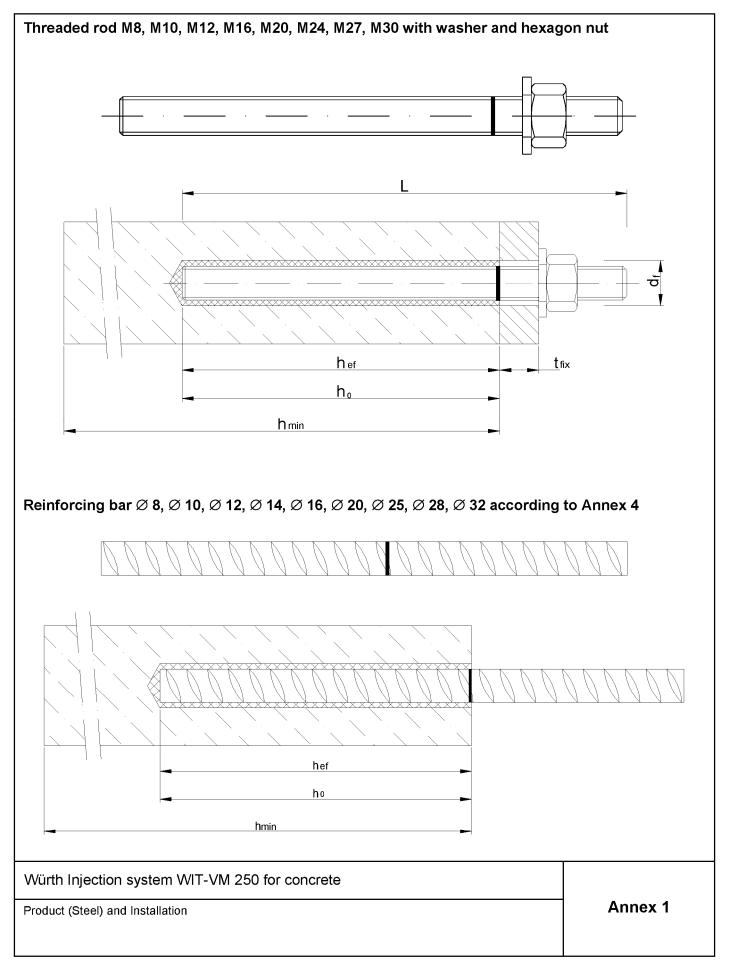
The cartridges shall be protected against sun radiation and shall be stored according to the manufacturer's installation instructions in dry condition at temperatures of at least +5 °C to not more than +25 °C.

Cartridges with expired shelf life must no longer be used.

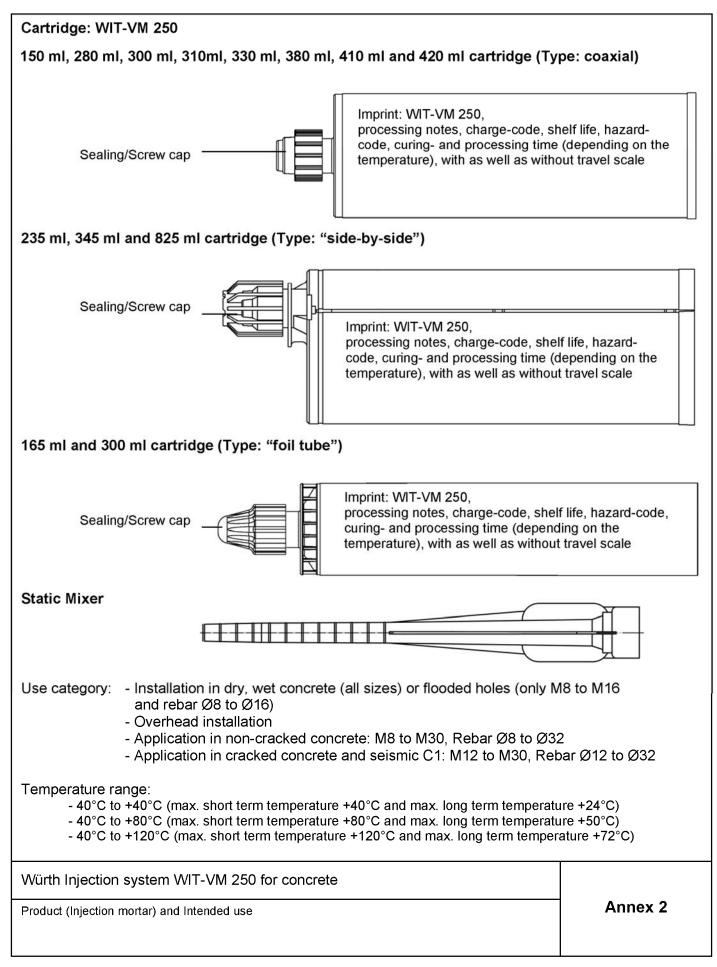
The anchor shall only be packaged and supplied as a complete unit. Cartridges may be packed separately from metal parts.

Andreas Kummerow p.p. Head of Department *beglaubigt:* Baderschneider











Tak	ole 1a: Materials (Threaded roc	1)	
		Lges	
Part	0	Material	
	l, zinc plated ≥ 5 μm acc. to EN ISO 404 dip galvanised ≥ 40 μm acc. to EN ISO 1		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 4.6, 5.8, 8.8, EN ISO 898-1: <sup>-</sup> Property class 4 (for class 4.6 rod) EN ISO	
2	Hexagon nut, EN ISO 4032	Property class 5 (for class 5.8 rod) EN ISO 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	
Stair	nless steel		
1	Anchor rod	Material 1.4401 / 1.4404 / 1.4571, EN 1008 > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506	
2	Hexagon nut, EN ISO 4032	Material 1.4401 / 1.4404 / 1.4571 EN 10088 > M24: Property class 50 (for class 50 rod) $\leq$ 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 100	
High	corrosion resistance steel		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005 > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506	,
2	Hexagon nut, EN ISO 4032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) $\leq$ M24: Property class 70 (for class 70 rod)	
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088	
Cor - - -	nmercial standard rod with: Materials, dimensions and mechanica Inspection certificate 3.1 acc. to EN 10 Marking of embedment depth		
	rth Injection system WIT-VM 250 for co rials (Threaded rod)	oncrete	Annex 3



Table 1b: Mate	erials (Rebar)					
Abstract of EN 19	h <sub>ef</sub> 92-1-1 Annex C, Table C. <sup>2</sup>	1, Properties of reinforcemer	nt:			
Product form		Bars and de	-coiled rods			
Class		В	С			
Characteristic yield str	rength f <sub>yk</sub> or f <sub>0,2k</sub> (N/mm²)	400 to	0 600			
Minimum value of k =	(f <sub>t</sub> / f <sub>y</sub> ) <sub>k</sub>	≥ 1,08	≥ 1,15 < 1,35			
Characteristic strain at $\epsilon_{uk}$ (%)	t maximum force	≥ 5,0	≥ 7,5			
Bendability	pend test					
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	± 6,0 ± 4,5				
	92-1-1 Annex C, Table C.2	2N, Properties of reinforceme				
Product form		Bars and de				
Class Min. value of related rip area f <sub>R,min</sub>	nominal diameter of the rebar (mm) 8 to 12 > 12	B 0,0				
(d: Nominal diameter	shall be in the range 0,05d ≤ h of the bar; h: Rip height of the post-installed rebar as anchor	e bar)				
Würth Injection sys	tem WIT-VM 250 for concre	ete				
Materials (Reinforcing b	ar)		Annex 4			

#### Deutsches Institut für Bautechnik

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 <sub>0</sub> [mm] =	10	12	14	18	24	28	32	35
Effective encharge denth	h <sub>ef,min</sub> [mm] =	60	60	70	80	90	96	108	120
Effective anchorage depth	h <sub>ef,max</sub> [mm] =	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d <sub>f</sub> [mm] ≤	9	12	14	18	22	26	30	33
Diameter of steel brush	d <sub>b</sub> [mm] ≥	12	14	16	20	26	30	34	37
Torque moment	T <sub>inst</sub> [Nm] ≤	10	20	40	80	120	160	180	200
Thickness of future	t <sub>fix,min</sub> [mm] >	0							
Thickness of fixture	t <sub>fix,max</sub> [mm] <	1500							
Minimum thickness of member	h <sub>min</sub> [mm]	h <sub>ef</sub> + 30 mm ≥ 100 mm h <sub>ef</sub> + 2d₀							
Minimum spacing	s <sub>min</sub> [mm]	40	50	60	80	100	120	135	150
Minimum edge distance	c <sub>min</sub> [mm]	40	50	60	80	100	120	135	150

# Table 3: Installation parameters for rebar

Rebar size		Ø <b>8</b>	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Nominal drill hole diameter	d <sub>0</sub> [mm] =	12	14	16	18	20	24	32	35	40
Effective encharage denth	h <sub>ef,min</sub> [mm] =	60	60	70	75	80	90	100	112	128
Effective anchorage depth	h <sub>ef,max</sub> [mm] =	160	200	240	280	320	400	480	540	640
Diameter of steel brush d <sub>b</sub> [mm] ≥		14	16	18	20	22	26	34	37	41,5
Minimum thickness of member	h <sub>min</sub> [mm]	h <sub>ef</sub> + 30 mm ≥ 100 mm		h <sub>ef</sub> + 2d <sub>0</sub>						
Minimum spacing	s <sub>min</sub> [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c <sub>min</sub> [mm]	40	50	60	70	80	100	125	140	160

# Würth Injection system WIT-VM 250 for concrete

Installation parameters

Annex 5



Installation inst	ructions	
	<ol> <li>Drill with hammer drill a hole into the base material to the size a depth required by the selected anchor (Table 2 or Table 3).</li> </ol>	nd embedment
	Attention! Standing water in the bore hole must be removed	d before cleaning.
4x	2a. Starting from the bottom or back of the bore hole, blow the hole compressed air (min. 6 bar) or a hand pump (Annex 8) a minim the bore hole ground is not reached an extension shall be used	um of four times. If
or	The hand-pump can be used for anchor sizes up to bore hole d	iameter 20 mm.
4x	For bore holes larger then 20 mm or deeper 240 mm, compress <b>must</b> be used.	ed air (min. 6 bar)
	2b. Check brush diameter (Table 5) and attach the brush to a drillin or a battery screwdriver. Brush the hole with an appropriate size	
<u>********</u> ***	> $d_{b,min}$ (Table 5) a minimum of four times. If the bore hole ground is not reached with the brush, a brush ex shall be used (Table 5).	
	2c. Finally blow the hole clean again with compressed air (min. 6 based (Annex 8) a minimum of four times. If the bore hole ground is not set to be a minimum of four times.	
4x or	extension shall be used. The hand-pump can be used for anchor sizes up to bore hole d For bore holes larger then 20 mm or deeper 240 mm, compress <u>must</u> be used.	
4x	After cleaning, the bore hole has to be protected against re an appropriate way, until dispensing the mortar in the bore the cleaning repeated has to be directly before dispensing In-flowing water must not contaminate the bore hole again.	hole. If necessary, the mortar.
	3 Attach a supplied static-mixing nozzle to the cartridge and load correct dispensing tool. Cut off the foil tube clip before use. For every working interruption longer than the recommended we as well as for new cartridges, a new static-mixer shall be used.	-
Je her	4. Prior to inserting the anchor rod into the filled bore hole, the posenbedment depth shall be marked on the anchor rods.	ition of the
min. 3 full stroke	5. Prior to dispensing into the anchor hole, squeeze out separately full strokes and discard non-uniformly mixed adhesive componer shows a consistent grey colour. For foil tube cartridges is must be minimum of six full strokes.	nts until the mortar
Würth Injection sys	tem WIT-VM 250 for concrete	
Installation instructions		Annex 6



Installation inst	ructions (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.
	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).
+20°C	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).
	<ol> <li>After full curing, the add-on part can be installed with the max. torque (Table 2) by using a calibrated torque wrench.</li> </ol>

# Table 4:Minimum curing time

Concrete temperature	Gelling- / working time	Minimum curing time in dry concrete <sup>2)</sup>		
$\geq$ -10 °C <sup>1)</sup>	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		

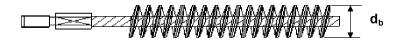
2) In wet concrete the curing time **<u>must</u>** be doubled

Würth Injection system WIT-VM 250 for concrete

Installation instructions (continuation) Curing time Annex 7



# Steel brush



# Table 5: Parameter cleaning and setting tools

Threaded Rod	Rebar	d₀ Drill bit - Ø	d <sub>⊳</sub> Brush - Ø	d <sub>⊳,min</sub> min. Brush - Ø	Piston plug	
(mm)	(mm)	(mm)	(mm)	(mm)	(No.)	
M8		10	12	10,5		
M10	8	12	14	12,5		
M12	10	14	16	14,5	No	
	12	16	18	16,5	piston plug required	
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<sub>0</sub>): 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

Würth Injection system WIT-VM 250 for concrete

Cleaning and setting tools

Annex 8



Anchor size threaded roo	k			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure				1	1		1		1	1	1
Characteristic tension resis Steel, property class 4.6	stance,	N <sub>Rk,s</sub>	[kN]	15	23	34	63	98	141	184	224
Partial safety factor		γ <sub>Ms,N</sub> 1)	1		•		2	,0	1	1	
Characteristic tension resis Steel, property class 5.8	stance,	N <sub>Rk,s</sub>	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resis Steel, property class 8.8	stance,	N <sub>Rk,s</sub>	[kN]	29	46	67	125	196	282	368	449
Partial safety factor		γ <sub>Ms,N</sub> 1)	·				1,	50			
Characteristic tension resis Stainless steel A4 and HC property class 50 (>M24) a	R,	N <sub>Rk,s</sub>	[kN]	26	41	59	110	171	247	230	281
Partial safety factor	× ,	γ <sub>Ms,N</sub> 1)			•	1,	87			2,	86
Combined pull-out and c	oncrete cone failure	1		1						1	
Characteristic bond resista	nce in non-cracked con	crete C20	/25								
Temperature range 1 <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	10	12	12	12	12	11	10	9
40°C/24°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	8,5	8,5	8,5		not adı	missible	1
Temperature range II <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	9	9	9	9	9 8,5 7		6,5
80°C/50°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5 6,5 6,5 6,5 not a				not adı	dmissible		
Temperature range III <sup>5)</sup> : 120°C/72°C	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	4,0	5,0	5,0	5,0		not admissible		
		C30/37	C30/37 1,04								
Increasing factors for conc $\Psi_c$	rete	C40/50		1,08							
		C50/60					1,	10			
Splitting failure							(	h	\		
Edge distance		C <sub>cr,sp</sub>	[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 <sub>cr,sp</sub>	[mm]	2 C <sub>cr,sp</sub>							
Partial safety factor (dry ar	nd wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$	$=\gamma_{Msp}$ <sup>1)</sup>	1,5 <sup>2)</sup>				1,8 <sup>3)</sup>			
Partial safety factor (floode	ed bore hole)	$\gamma_{Mp} = \gamma_{Mc}$	$= \gamma_{Msp}  {}^{1)}$	2,14)					not admissible		
<sup>2)</sup> The partial safet <sup>3)</sup> The partial safet	her national regulatio y factor $\gamma_2$ = 1.0 is inc y factor $\gamma_2$ = 1.2 is inc y factor $\gamma_2$ = 1.4 is inc e section 1.2	luded. luded.									
Würth Injection sys	stem WIT-VM 250	) for cor	ncrete								
Application with thread	od rod							_	An	nex 9	



Steel failure         Characteristic tension resistance,         Nm.s.       [kh]       34       63       98       141       184         Partial safety factor       ym.s. <sup>11</sup> 2.0       2.0       2.0       2.0         Characteristic tension resistance,       Nm.s.       [kh]       42       78       122       176       230       58         Characteristic tension resistance,       Nm.s.       [kh]       67       125       196       282       368         Characteristic tension resistance,         Stail safety factor       ym.s. <sup>1</sup> 1.50       Characteristic tension resistance,         Stail safety factor       ym.s. <sup>1</sup> 1.87       2.06         Combined pull-out and concrete cone failure         Characteristic tension resistance in cracked concrete C20/25         Temperature range 1 <sup>10</sup> :       dry and wet concrete       18.0°       [N/mm?]       5.5       5.5       5.5       6.5       10.5         Temperature range 1 <sup>10</sup> :       dry and wet concrete       18.0°       [N/mm?]       4.0       4.0       4.0       4.5       9.0         Temperature range 1 <sup>10</sup> :       dry and wet concrete       18	Anchor size threaded roo	k			M 12	M 16	M 20	M24	M 27	M 30
Steel, property class 4.6         Nme.         [KM]         34         0.3         96         141         164           Partial safety factor $\gamma_{w,w,1}^{(n)}$ 2.0            2.0           2.0          2.0          2.0          2.0          2.0          2.0 </th <th>Steel failure</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	Steel failure									
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		stance,	N <sub>Rk,s</sub>	[kN]	34	63	98	141	184	224
Steel, property class 5.8       Nex.s       [KN]       42       76       122       176       230         Characteristic tension resistance, Steel, property class 8.8       N <sub>6x.s</sub> [KN]       67       125       196       262       368         Partial safety factor $\gamma_{Ms,N}^{-1}$ 1.50       1.50       1.71       247       230         Characteristic tension resistance, Stanless steel A4 and HCR, property class 50 (-M24) and 70 (< M24)	Partial safety factor		γ <sub>Ms,N</sub> 1)				2	,0		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		stance,	N <sub>Rk,s</sub>	[kN]	42	78	122	176	230	280
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Characteristic tension resis	stance,	N <sub>Rk,s</sub>	[kN]	67	125	196	282	368	449
Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)         NRs.a         [kN]         59         110         171         247         230           Partial safety factor $\gamma_{M6,N}^{(1)}$ 1,87         2,86           Combined pull-out and concrete cone failure           1,87         2,86           Characteristic bond resistance in cracked concrete C20/25 $\gamma_{M6,N}^{(1)}$ 5,5         5,5         5,5         6,5           Temperature range II <sup>4</sup> :         dry and wet concrete $\overline{v}_{R6,cr}$ [N/mm?]         4,0         4,0         4,0         4,5         3           30°C/50°C         flooded bore hole $\overline{v}_{R6,cr}$ [N/mm?]         4,0         4,0         4,0         4,5         3           Temperature range III <sup>4</sup> :         dry and wet concrete $\overline{v}_{R6,cr}$ [N/mm?]         3,0         3,0         3,0         3,5         3           Temperature range III <sup>4</sup> :         dry and wet concrete $\overline{v}_{R6,cr}$ [N/mm?]         3,0         3,0         3,0         3,5         3           Temperature range III <sup>4</sup> :         dry and wet concrete $\overline{v}_{R6,cr}$ [N/mm?]         3,0         3,0         3,0         3,0<	Partial safety factor		γ <sub>Ms,N</sub> 1)				1,	50		
Combined pull-out and concrete cone failure         Characteristic bond resistance in cracked concrete C20/25         Temperature range If <sup>0</sup> : 40°C/24°C       dry and wet concrete       T <sub>RK,cr</sub> [N/mm²]       5,5       <	Stainless steel A4 and HC	R,	N <sub>Rk,s</sub>	[kN]	59	110	171	247	230	281
Characteristic bond resistance in cracked concrete C20/25 Temperature range I <sup>4</sup> : $ \frac{dry and wet concrete}{40^{\circ}C/24^{\circ}C} \qquad \frac{dry and wet concrete}{100 ded bore hole} \qquad TRk.cr \qquad [N/mm2] 5.5 5.5 5.5 not admissible Temperature range II4:  \frac{dry and wet concrete}{100 ded bore hole} \qquad TRk.cr \qquad [N/mm2] 4.0 4.0 4.0 4.0 4.0 4.5 \ 0.$			γ <sub>Ms,N</sub> 1)	•		1,	87	1	2,	86
$\begin{array}{c c c c c c c c } \hline \label{eq:classical} Temperature range [1^6]: \\ \hline \mbox{dor C/24°C} & \mbox{dor doe bore hole} & $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$	Combined pull-out and c	oncrete cone failure	I							
$\begin{array}{c c c c c c c } \hline \mbox{Trak,cr} & [N/mm^2] & 5,5 & 5,5 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & 4,0 & 4,0 & 4,5 \\ \hline \mbox{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & 4,0 & 4,0 & 4,5 \\ \hline \mbox{Toded bore hole} & $$^{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 4,0 & 4,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & 3,0 & 3,0 & 3,0 & 3,5 \\ \hline \mbox{Toded bore hole} & $$^{Trak,cr} & [N/mm^2] & 3,0 & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] & 3,0 & \\mbox{not admissible} \\ \hline \mbox{Trak,cr} & [N/mm^2] $	Characteristic bond resista	nce in cracked concrete C20	)/25							
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Temperature range I <sup>4)</sup> :	dry and wet concrete	τ <sub>Rk,cr</sub>	[N/mm²]	5,5	5,5	5,5	5,5	6,5	6,5
Temperature range II*1: B0°C/50°Cdry and wet concreteTenkor (N/mm²](N/mm²]4,04,04,04,04,04,04,04,04,04,04,04,04,01,0		flooded bore hole	τ <sub>Rk,cr</sub>	[N/mm²]	5,5	5,5				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Temperature range II <sup>4)</sup> :	dry and wet concrete	τ <sub>Rk,cr</sub>	[N/mm²]	4,0	4,0	4,0	4,0	4,5	4,5
Temperature range III 4):div and wet concreteTex.or[N/minr]3,03,		flooded bore hole	τ <sub>Rk,cr</sub>	[N/mm²]	4,0	4,0		not adı	missible	1
120°C/72°Cflooded bore hole $T_{Rk,cr}$ $[N/mm^2]$ 3,03,0not admissibleIncreasing factors for concrete $C30/37$ 1,04 $V_c$ $C40/50$ 1,08 $V_c$ $C50/60$ 1,10Splitting failure $C_{cr,sp}$ $[mm]$ $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left( 2,5 - \frac{h}{h_{ef}} \right) \leq 2,4 \cdot h_{ef}$ 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 $s_{cr,sp}$ $[mm]$ $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left( 2,5 - \frac{h}{h_{ef}} \right) \leq 2,4 \cdot h_{ef}$ Partial safety factor (dry and wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{1/1}$ $1,8^{2/2}$ Partial safety factor (flooded bore hole) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{1/1}$ $2,1^{3/2}$ 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.	Temperature range III <sup>4)</sup> :	dry and wet concrete	τ <sub>Rk,cr</sub>	[N/mm²]	3,0	3,0	3,0	3,0	3,5	3,5
$\frac{c_{40/50}}{c_{50/60}} = \frac{1,08}{c_{50/60}} = \frac{1,08}{c_{50/60}} = \frac{1,08}{c_{50/60}} = \frac{1,00}{c_{50/60}} = \frac{1,00}{c_{50/60}} = \frac{1,00}{c_{50/60}} = \frac{1,00}{c_{50/60}} = \frac{1,00}{c_{60/60}} = $		flooded bore hole	τ <sub>Rk,cr</sub>	[N/mm²]	3,0	3,0		not adı	missible	
$\psi_c$ $1,03$ $\psi_c$ $1,03$ $C50/60$ $1,10$ 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] $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right) \leq 2,4 \cdot h_{ef}$ Partial safety factor (dry and wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-11}$ $1,8^{21}$ Partial safety factor (flooded bore hole) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-11}$ $2,1^{31}$ not admissible $^{11}$ In absence of other national regulations $2^{2}$ The partial safety factor $\gamma_2 = 1.2$ is included. $3^{31}$ The partial safety factor $\gamma_2 = 1.4$ is included.			C30/37	,		1	1,	04		
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) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-1}$ $2,1^{3}$ 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.	-	rete	C40/50				1,	08		
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) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-1}$ $2,1^{3}$ $^{1)}$ 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.			C50/60				1,	10		
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.	Splitting failure							. )		
Partial safety factor (dry and wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-1}$ 1,8 <sup>2</sup> Partial safety factor (flooded bore hole) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-1}$ 2,1 <sup>3</sup> not admissible <sup>1)</sup> In absence of other national regulations <sup>2)</sup> The partial safety factor $\gamma_2 = 1.2$ is included. <sup>3)</sup> The partial safety factor $\gamma_2 = 1.4$ is included.	Edge distance		C <sub>cr,sp</sub>	[mm]		1,0 · h <sub>ef</sub> ≤	$\leq 2 \cdot h_{ef} \left( 2 \right)$	$5 - \frac{h}{h_{ef}}$	$\leq$ 2,4 $\cdot$ h <sub>ef</sub>	
Partial safety factor (flooded bore hole) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{-1}$ 2,13)not admissible1) In absence of other national regulations2) The partial safety factor $\gamma_2 = 1.2$ is included.3) The partial safety factor $\gamma_2 = 1.4$ is included.	Axial distance		S <sub>cr,sp</sub>	[mm]			2 c	cr,sp		
<sup>1)</sup> In absence of other national regulations <sup>2)</sup> The partial safety factor $\gamma_2 = 1.2$ is included. <sup>3)</sup> The partial safety factor $\gamma_2 = 1.4$ is included.	Partial safety factor (dry ar	nd wet concrete)	$\gamma_{Mp} = \gamma_N$	$_{\rm Hc} = \gamma_{\rm Msp}^{1)}$			1,	8 <sup>2)</sup>		
<sup>2)</sup> The partial safety factor $\gamma_2$ = 1.2 is included. <sup>3)</sup> The partial safety factor $\gamma_2$ = 1.4 is included.	Partial safety factor (floode	d bore hole)	$\gamma_{Mp} = \gamma_N$	$_{\rm Hc} = \gamma_{\rm Msp}^{1)}$	2,	,1 <sup>3)</sup>		not adı	missible	
	<sup>2)</sup> The partial safet <sup>3)</sup> The partial safet	y factor $\gamma_2 = 1.2$ is include y factor $\gamma_2 = 1.4$ is include	d. d.							
Würth Injection system WIT-VM 250 for concrete       Application with threaded rod       Annex 10	Würth Injection sys	stem WIT-VM 250 for	r concrete	9						



	esign according t acked and non-c		•								
Anchor size threaded r	od			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Steel failure without lev	ver arm										
Characteristic shear res Steel, property class 4.6	istance,	V <sub>Rk,s</sub>	[kN]	7	12	17	31	49	71	92	112
Partial safety factor		γ <sub>Ms,V</sub> 1)	-		1	1	1,	67	1	1	
Characteristic shear res Steel, property class 5.8	istance,	V <sub>Rk,s</sub>	[kN]	9	15	21	39	61	88	115	140
Characteristic shear res Steel, property class 8.8	istance,	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor		γ <sub>Ms,V</sub> <sup>1)</sup>	•				1,	25		<ul> <li>115</li> <li>184</li> <li>115</li> <li>184</li> <li>115</li> <li>2</li> <li>666</li> <li>833</li> <li>1333</li> <li>1333</li> <li>832</li> </ul>	
Characteristic shear resises Stainless steel A4 and H property class 50 (>M24)	CR,	V <sub>Rk,s</sub>	[kN]	13	20	30	55	86	124	115	140
Partial safety factor		γ <sub>Ms,V</sub> 1)				1,	56			2,	38
Steel failure with lever	arm									184 115 2. 666 833 1333 832	
Characteristic bending m Steel, property class 4.6	noment,	M <sup>0</sup> <sub>Rk,s</sub>	[Nm]	15	30	52	133	260	449	666	900
Partial safety factor		γ <sub>Ms,V</sub> <sup>1)</sup>					1,	67			
Characteristic bending m Steel, property class 5.8	noment,	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending m Steel, property class 8.8	noment,	M <sup>0</sup> <sub>Rk,s</sub>	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor		γ <sub>Ms,V</sub> <sup>1)</sup>					1,	25			
Characteristic bending m Stainless steel A4 and H property class 50 (>M24)	CR,	$\mathbf{M}^{0}_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor		γ <sub>Ms,V</sub> 1)				1,	56			2,	38
Concrete pry-out failur	e										
Factor k in equation (5.7) TR 029 for the design of							2	,0		M 27 92 115 184 115 2, 666 833 1333 832	
Partial safety factor		γ <sub>Мср</sub> <sup>1)</sup>					1,5	<b>i0</b> <sup>2)</sup>			
Concrete edge failure											
See section 5.2.3.4 of Te	echnical Report TR 029 for	the desig	n of Bond	ed Ancho	rs					Ction M 27 92 115 184 115 2,3 666 833 1333	
Partial safety factor		γ <sub>Mc</sub> <sup>1)</sup>					1,5	<b>0</b> <sup>2)</sup>			
	er national regulations factor γ <sub>2</sub> = 1.0 is include	ed.									
Würth Injection s	ystem WIT-VM 250	for cor	ncrete						_		
Application with threa Design acc. to TR 02 under static and quas	9, Characteristic values	s for shea	ar loads ir	n crackeo	d and no	n-cracke	d concre	te	An	nex 1'	



	gn according cracked conc		•						ion l	oads	in	
Anchor size reinforcing ba	ar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure				1								
Characteristic tension resistant reinforcing bar according to	,	N <sub>Rk,s</sub>	[kN]				,	$A_s \times f_{uk}^{6}$	1			
Partial safety factor		γ <sub>Ms,N</sub> <sup>1)</sup>				TR 02	9 Secti	on 3.2.2	.2, Eq. 3	3.3a <sup>6)</sup>		
Combined pull-out and co	ncrete cone failure											
Characteristic bond resistan	ce in uncracked conc	rete C20/25										
Temperature range 1 <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	10	12	12	12	12	12	11	10	8,5
40°C/24°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	8,5	8,5	8,5	8,5		not adı	missible	
Temperature range II <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
80°C/50°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5	6,5	6,5	6,5	6,5		not adı	missible	
Temperature range III <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
120°C/72°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	4,0	5,0	5,0	5,0	5,0		not adı	missible	1
		C30/37			1			1,04				
Increasing factors for concre	ete	C40/50						1,08				
		C50/60						1,10				
Splitting failure												
Edge distance		C <sub>cr,sp</sub>	[mm]		1	,0 ⋅ h <sub>ef</sub> :	≤2·h <sub>e</sub>	f (2,5 -	$\left(\frac{h}{h_{ef}}\right) \le$	2,4 · h <sub>e</sub>	f	
Axial distance		S <sub>cr,sp</sub>	[mm]					2 c <sub>cr,sp</sub>				
Partial safety factor (dry and	l wet concrete)	$\gamma_{Mp} = \gamma_{Mc} =$	γ <sub>Msp</sub> <sup>1)</sup>	1,5 <sup>2)</sup>				1,	8 <sup>3)</sup>			
Partial safety factor (flooded	bore hole)	$\gamma_{Mp} = \gamma_{Mc} =$	1)			2,1 <sup>4)</sup>				not adı	missible	
<ol> <li>In absence of oth</li> <li>The partial safety</li> <li>The partial safety</li> <li>The partial safety</li> <li>The partial safety</li> <li>Explanations see</li> <li>f<sub>uk</sub>, f<sub>yk</sub> see relevar</li> <li>Regarding design of pos</li> </ol>	factor $\gamma_2 = 1.0$ is inc factor $\gamma_2 = 1.2$ is inc factor $\gamma_2 = 1.4$ is inc section 1.2 it Technical Specific	cluded. cluded. cluded. cation for t										
Würth Injection syst Application with reinforci Design acc. to TR 029, Characteristic values for	ing bar			nder sta	tic and	quasi-s	static a	ction		Ann	ex 12	



	gn according to TR ked concrete under	•					ensior	$ \begin{array}{c c c c c c c c c } \hline $ 20 & \emptyset 25 & \emptyset 28 & \emptyset \\ \hline $ x \ f_{uk} \ ^{5)} \\ \hline $ 3.2.2.2, Eq. \ 3.3a \ ^{5)} \\ \hline $ 5,5 & 5,5 & 6,5 & \\ \hline $ not admissible \\ \hline $ 4,0 & 4,0 & 4,5 & \\ \hline $ not admissible \\ \hline $ 4,0 & 4,0 & 4,5 & \\ \hline $ not admissible \\ \hline $ 3,0 & 3,0 & 3,5 & \\ \hline $ not admissible \\ \hline $ 3,0 & 3,0 & 3,5 & \\ \hline $ not admissible \\ \hline $ 04 & \\ \hline $ ,08 & \\ \hline $ ,10 & \\ \hline $ 2,5 - \frac{h}{h_{ef}} \\ \hline $ \leq 2,4 \cdot h_{ef} \\ \hline $ C_{cr,sp} \\ \hline \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$		
Anchor size reinforcing ba	ar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure						•				
Characteristic tension resist reinforcing bar according to		N <sub>Rk,s</sub>	[kN]				$A_s \times f_{uk}$ <sup>5)</sup>			
Partial safety factor		γ <sub>Ms,N</sub> 1)			TR	029 Sect	tion 3.2.2.	2, Eq. 3.3	3a <sup>5)</sup>	
Combined pull-out and co	ncrete cone failure	-1		1						
Characteristic bond resistan	ice in cracked concrete C20/25									
Temperature range I <sup>4)</sup> :	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
40°Ċ/24°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	5,5	5,5	5,5		not adr	nissible	
Temperature range II <sup>4)</sup> :	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
80°Ċ/50°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0		not adr	nissible	
Temperature range III <sup>4)</sup> :	dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
120°C/72°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0		not adr	nissible	
		C30/37			1	1	1,04			
Increasing factors for concre $\psi_c$	ete	C40/50	I				1,08	3.2.2.2, Eq. 3.3a <sup>5)</sup> 5,5 5,5 6,5 not admissible 4,0 4,0 4,5 not admissible 3,0 3,0 3,5 not admissible 1,04 1,08 1,10 2,5 $-\frac{h}{h_{ef}} \le 2,4 \cdot h_{ef}$ $c_{cr,sp}$		
		C50/60	I				1,10			
Splitting failure				•						
Edge distance		C <sub>cr,sp</sub>	[mm]		1,0 · h <sub>€</sub>	$h_{\rm f} \leq 2 \cdot h_{\rm c}$	ef (2,5 -	$\frac{h}{h_{ef}} \le 2$	c,4 · h <sub>ef</sub>	
Axial distance		S <sub>cr,sp</sub>	[mm]				2 c <sub>cr,sp</sub>			
Partial safety factor (dry and	d wet concrete)		$_{\rm Mc} = \gamma_{\rm Msp}^{1)}$				1,8 <sup>2)</sup>			
Partial safety factor (floodec	l bore hole)	$\gamma_{Mp}=\gamma_N$	$_{\rm Mc} = \gamma_{\rm Msp}^{1)}$		2,1 <sup>3)</sup>			not adr	nissible	
<sup>2)</sup> The partial safety <sup>3)</sup> The partial safety <sup>4)</sup> Explanations see <sup>5)</sup> f <sub>uk</sub> , f <sub>yk</sub> see relevar	er national regulations factor $\gamma_2 = 1.2$ is included. factor $\gamma_2 = 1.4$ is included. section 1.2 nt Technical Specification for st-installed rebar as anchor s									
Würth Injection syst Application with reinford Design acc. to TR 029,	tem WIT-VM 250 for co ing bar	ncrete						An	nex 13	3



-	-		Characteristic values for shear loads in cracked nder 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]	$0,50 \times A_{s} \times f_{uk}^{3)}$
Partial safety factor	γ <sub>Ms,V</sub> 1)		TR 029 Section 3.2.2.2, Eq. 3.3 b+c <sup>3)</sup>
Steel failure with lever arm			
Characteristic bending moment, reinforcing bar according to Annex 4	$\mathbf{M}^{0}_{\mathrm{Rk,s}}$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}^{3)}$
Partial safety factor	γ̃Ms,V <sup>1)</sup>		TR 029 Section 3.2.2.2, Eq. 3.3 b+c <sup>3)</sup>
Concrete pry-out failure			
Factor k in equation (5.7) of Technical Repor TR 029 for the design of bonded anchors	t		2,0
Partial safety factor	γ <sub>Mcp</sub> <sup>1)</sup>		1,50 <sup>2)</sup>
Concrete edge failure			
See section 5.2.3.4 of Technical Report TR 0	29 for the de	sign of B	onded Anchors
Partial safety factor <sup>1)</sup> In absence of other national regulat <sup>2)</sup> The partial safety factor γ <sub>2</sub> = 1.0 is in <sup>3)</sup> f <sub>uk</sub> , f <sub>yk</sub> see relevant Technical Spec Regarding design of post-installed rel			
Würth Injection system WIT-VM	250 for c	oncrete	e Annex 14
Application with reinforcing bar Design acc. to TR 029, Characteristic v under static and quasi-static action	alues for sh	iear load	ds in cracked and non-cracked concrete



Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M 27	М 30
Steel failure											
Characteristic tension resist Steel, property class 4.6	ance,	N <sub>Rk,s</sub>	[kN]	15	23	34	63	98	141	184	224
Partial safety factor		γ <sub>Ms,N</sub> 1)					2	,0	122       176       230         196       282       368         196       282       368         171       247       230         171       247       230         171       247       230         171       247       230         171       247       230         12       11       10         not admissible       9         9       8,5       7,5         not admissible       6,5       6,5         6,5       6,5       5,5         not admissible       9         1       10       10         1       10       10         12       11       10         not admissible       10         1       10       10         1       10       10         1       10       10         1       10       10         10       10       10         10       10       10         11       10       10         12       11       10         13       10       10         14       10		
Characteristic tension resist	ance,	N <sub>Rk.s</sub>	[kN]	18	29	42	78	122		280	
Steel, property class 5.8 Characteristic tension resist	ance.										
Steel, property class 8.8		N <sub>Rk,s</sub>	[kN]	29	46	67	125			449	
Partial safety factor		γ <sub>Ms,N</sub> 1)			1	1	1,	50	1		
Characteristic tension resist Stainless steel A4 and HCR property class 50 (>M24) ar		N <sub>Rk,s</sub>	[kN]	26	41	59	110	171	247	230	281
Partial safety factor	· ·	γ <sub>Ms,N</sub> 1)				1,	87			2,	86
Combined pull-out and co	ncrete failure	•								•	
Characteristic bond resistan	ce in non-cracked concret	e C20/25						not admissible 9 8,5 7,5 not admissible 6,5 6,5 5,5 not admissible 04			
Temperature range 1 <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	10	12	12	12		9		
40°C/24°C	flooded bore hole	T <sub>Rk,ucr</sub>	[N/mm²]	7,5	8,5	8,5	8,5		122       176       230         196       282       368         196       282       368         171       247       230         171       247       230         171       247       230         171       247       230         171       247       230         171       247       230         12       11       10         not admissible       9         9       8,5       7,5         not admissible       6,5       6,5         6,5       6,5       5,5         not admissible       4         3       3       3		
Temperature range II <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm <sup>2</sup> ]	7,5	9	9	9	9		6,5	
80°C/50°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5			1	
Temperature range III <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5	6,5	6,5	6,5	6,5		5,0	
120°C/72°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm <sup>2</sup> ]	4,0	5,0	5,0	5,0		not adr	nissible	1
		C30/37					1,	04			
Increasing factors for concre	ete	C40/50					1,	08			
Ψα		C50/60					1,	10			
Factor according to CEN/TS 1992-4-5 Section 6	.2.2.3	k <sub>8</sub>	[-]				10	),1			
Concrete cone failure											
Factor according to CEN/TS 1992-4-5 Section 6	231	<b>k</b> <sub>ucr</sub>	[-]				10	),1			
Edge distance		C <sub>cr,N</sub>	[mm]				1,5	h <sub>ef</sub>			
Axial distance		S <sub>cr,N</sub>	[mm]				3,0	h <sub>ef</sub>			
Splitting failure		I									
Edge distance		C <sub>cr,sp</sub>	[mm]		1	l,0 · h <sub>ef</sub> ≤	$2 \cdot h_{ef} \left( 2 \right)$	$5 - \frac{h}{h_{ef}}$	$\leq$ 2,4 $\cdot$ h <sub>e</sub>	əf	
Axial distance		S <sub>cr,sp</sub>	[mm]					cr,sp			
Partial safety factor (dry and	l wet concrete)	$\gamma_{Mp} = \gamma_{Mq}$	$c = \gamma_{Msp}^{1)}$	1,5 <sup>2)</sup>				1,8 <sup>3)</sup>			
Partial safety factor (flooded	l bore hole)				2,	1 <sup>4)</sup>			not adr	nissible	
Partial safety factor (dry and Partial safety factor (flooded <sup>1)</sup> In absence of oth <sup>2)</sup> The partial safety	l bore hole) er national regulations factor $\gamma_2$ = 1.0 is include	$\gamma_{Mp} = \gamma_{Mc}$ $\gamma_{Mp} = \gamma_{Mc}$	$[mm]$ $c = \gamma_{Msp}^{(1)}$ $c = \gamma_{Msp}^{(1)}$	1,5 <sup>2)</sup>				cr,sp			
<sup>3)</sup> The partial safety	factor $\gamma_2 = 1.2$ is include factor $\gamma_2 = 1.4$ is include section 1.2	ed. ed.	te								
										ex 15	



#### 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 20 M30 M 16 M24 M27 Steel failure Characteristic tension resistance, $\mathbf{N}_{\mathsf{Rk},\mathsf{s}}$ [kN] 63 98 141 184 224 34 Steel, property class 4.6 γ<sub>Ms,N</sub> 1) Partial safety factor 2,0 Characteristic tension resistance, N<sub>Rk,s</sub> [kN] 42 78 122 176 230 280 Steel, property class 5.8 Characteristic tension resistance, 67 125 282 368 449 N<sub>Rk,s</sub> [kN] 196 Steel, property class 8.8 γ<sub>Ms,N</sub> 1) Partial safety factor 1,50 Characteristic tension resistance, Stainless steel A4 and HCR, N<sub>Rk.s</sub> [kN] 59 110 171 247 230 281 property class 50 (>M24) and 70 (≤ M24) γ<sub>Ms,N</sub> <sup>1)</sup> Partial safety factor 1,87 2,86 Combined pull-out and concrete failure Characteristic bond resistance in cracked concrete C20/25 dry and wet concrete [N/mm<sup>2</sup>] 5,5 5,5 5,5 5,5 6,5 6,5 Temperature range I<sup>4)</sup>: $\tau_{Rk,cr}$ 40°C/24°C flooded bore hole $\tau_{\text{Rk,cr}}$ [N/mm<sup>2</sup>] 5.5 5,5 not admissible dry and wet concrete τ<sub>Rk,cr</sub> [N/mm<sup>2</sup>] 4.0 4,0 4,0 4.0 4.5 4,5 Temperature range II<sup>4)</sup>: 80°C/50°C not admissible flooded bore hole [N/mm<sup>2</sup>] 4,0 4,0 τ<sub>Rk.cr</sub> 3,5 dry and wet concrete 3,0 3,0 3,0 3.0 3,5 $\tau_{Rk,cr}$ [N/mm<sup>2</sup>] Temperature range III<sup>4)</sup>: 120°C/72°C $\tau_{\mathsf{Rk},\mathsf{cr}}$ flooded bore hole [N/mm<sup>2</sup>] 3,0 3,0 not admissible C30/37 1,04 Increasing factors for concrete C40/50 1,08 Ψc C50/60 1,10 Factor according to k<sub>8</sub> [-] 7,2 CEN/TS 1992-4-5 Section 6.2.2.3 Concrete cone failure Factor according to k<sub>cr</sub> [-] 7,2 CEN/TS 1992-4-5 Section 6.2.3.1 Edge distance C<sub>cr,N</sub> [mm] $1,5 h_{ef}$ Axial distance S<sub>cr,N</sub> [mm] $3,0 h_{ef}$ Splitting failure h $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef}$ 2,5 ≤ 2,4 · h<sub>ef</sub> Edge distance [mm] C<sub>cr,sp</sub> h<sub>ef</sub> Axial distance [mm] 2 c<sub>cr,sp</sub> S<sub>cr,sp</sub> 1.8 2) 1) Partial safety factor (dry and wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}$ Partial safety factor (flooded bore hole) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp} \ ^{1)}$ 2,1<sup>3)</sup> not admissible <sup>1)</sup> In absence of other national regulations <sup>2)</sup> The partial safety factor $\gamma_2 = 1.2$ is included. <sup>3)</sup> The partial safety factor $\gamma_2 = 1.4$ is included. <sup>4)</sup> Explanations see section 1.2 Würth Injection system WIT-VM 250 for concrete Annex 16 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

Z53794.13



# 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

31				M 30
31		<b>_</b>	-	<b>_</b>
	49	71	92	112
1,	,67			
39	61	88	115	140
63	98	141	184	224
1,	,25			
55	86	124	115	140
1,56		-	2,	,38
0	),8		-	
133	260	449	666	900
1,	,67			
166	324	560	833	112
266	519	896	1333	179
1,	,25			
232	454	784	832	112
1,56	•	<b>.</b>	2,	,38
2	2,0			
1,5	50 <sup>2)</sup>			
l <sub>f</sub> = min(h	n <sub>ef</sub> ; 8 d <sub>nom</sub> )	)		
16	20	24	27	30
1,5	50 <sup>2)</sup>			
	16		16 20 24	16 20 24 27

### Würth Injection system WIT-VM 250 for concrete

Application with threaded rod

Design according to CEN/TS 1992-4, Characteristic values for shear loads in cracked and noncracked concrete under static and quasi-static action Annex 17



	ign according to Is in non-cracke										'n	
Anchor size reinforcing ba	ar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure					I	I						
Characteristic tension resist reinforcing bar according to	-	N <sub>Rk,s</sub>	[kN]					A <sub>s</sub> x f <sub>uk</sub> <sup>6</sup>	)			
Partial safety factor		γ <sub>Ms,N</sub> <sup>1)</sup>			С	EN/TS 1	992-4-1	Section	4.4.3.1	.1, Eq. <b>4</b>	6)	
Combined pull-out and co	ncrete failure	1		1								
Characteristic bond resistan	ice in non-cracked concre	te C20/2	:5									
Temperature range I <sup>5)</sup> :	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	10	12	12	12	12	12	11	10	8,5
40°C/24°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	8,5	8,5	8,5	8,5		not adr	nissible	
	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
Temperature range II <sup>5)</sup> : 80°C/50°C	flooded bore hole	τ <sub>Rk,ucr</sub>	[N/mm²]	5,5	6,5	6,5	6,5	6,5		not adr	nissible	
	dry and wet concrete	τ <sub>Rk,ucr</sub>	[N/mm <sup>2</sup> ]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
Temperature range III <sup>5)</sup> : 120°C/72°C	flooded bore hole	, ,	[N/mm <sup>2</sup> ]	4,0	5,0	5,0	5,0	5,0	-,-	ŕ	nissible	-1-
		τ <sub>Rk,ucr</sub> C30/37		7,0	5,0	5,0	5,0	1,04		not adi		
Increasing factors for concre	ete	C30/37						1,04				
Ψc		C50/60						1,10				
Factor according to CEN/TS 1992-4-5 Section 6	5.2.2.3	k <sub>8</sub>	[-]					10,1				
Concrete cone failure												
Factor according to CEN/TS 1992-4-5 Section 6	5.2.3.1	k <sub>ucr</sub>	[-]					10,1				
Edge distance		C <sub>cr,N</sub>	[mm]					1,5 h <sub>ef</sub>				
Axial distance		S <sub>cr,N</sub>	[mm]					3,0 $h_{\text{ef}}$				
Splitting failure												
Edge distance		C <sub>cr,sp</sub>	[mm]			1,0 · h <sub>e</sub>	$_{ m ef} \leq 2 \cdot h_{ m e}$	ef (2,5	$\left(\frac{h}{h_{ef}}\right) \le 2$	2,4 · h <sub>ef</sub>		
Axial distance		S <sub>cr,sp</sub>	[mm]					2 c <sub>cr,sp</sub>				
Partial safety factor (dry and	d wet concrete)	$\gamma_{Mp} = \gamma_N$	$_{\rm Ac} = \gamma_{\rm Msp}^{1)}$	1,5 <sup>2)</sup>				1,	8 <sup>3)</sup>			
Partial safety factor (floodec	l bore hole)		$_{Mc} = \gamma_{Msp}^{1)}$			2,1 <sup>4)</sup>				not adr	nissible	
<sup>2)</sup> The partial safety <sup>3)</sup> The partial safety <sup>4)</sup> The partial safety <sup>5)</sup> Explanations see	ter national regulations factor $\gamma_2 = 1.0$ is incluc factor $\gamma_2 = 1.2$ is incluc factor $\gamma_2 = 1.4$ is incluc section 1.2 nt Technical Specificati	led. led. led.	he reinforc	ing bar								
Regarding design of po	st-installed rebar as an	chor se	e chapter 4	.2					1			
Würth Injection syst	tem WIT-VM 250 f	or con	crete									
Application with reinforc Design according to C Characteristic values for	N/TS 1992-4,	cracked	concrete u	nder sta	atic and	quasi-	static a	ction		Anne	ex 18	



acked concrete	under stat			tatic a			tensio		
ar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
						I			
tance, reinforcing bar	N <sub>Rk,s</sub>	[kN]				$A_s \times f_{uk}$ <sup>5)</sup>			
	γms,n <sup>1)</sup>			CEN/TS	1992- <b>4</b> -1	1 Section	4.4.3.1.1,	Eq. 4 5)	
oncrete failure									
nce in cracked concrete	C20/25								
dry and wet concrete	τ <sub>Rk,cr</sub>	[N/mm²]	5,5	5,5	5,5	5,5	5,5	6,5	6,5
flooded bore hole	τ <sub>Rk,cr</sub>	[N/mm²]	5,5	5,5	5,5		not adn	nissible	
dry and wet concrete	τ <sub>Rk,cr</sub>	[N/mm²]	4,0	4,0	4,0	4,0	4,0	4,5	4,5
flooded bore hole	τ <sub>Rk.cr</sub>	[N/mm²]	4,0	4,0	4,0		not adn	nissible	
dry and wet concrete	τ <sub>Rk.cr</sub>	[N/mm²]	3,0	3,0	3,0	3,0	3,0	3,5	3,5
flooded bore hole		IN/mm²]	3.0	3.0	3.0		not adr	nissible	
	C30/37	[]	- 1 -	-,-	-,-	1.04			
rete	C40/50					1,08			
	C50/60					1,10			
6.2.2.3	k <sub>8</sub>	[-]				7,2			
		•							
6.2.3.1	k <sub>cr</sub>	[-]				7,2			
	C <sub>cr,N</sub>	[mm]				1,5 h <sub>ef</sub>			
	S <sub>cr,N</sub>	[mm]				3,0 h <sub>ef</sub>			
	C <sub>cr,sp</sub>	[mm]		1,0 ·	h <sub>ef</sub> ≤2 ⋅ h	$h_{ef}\left(2,5-\frac{1}{h}\right)$	$\left(\frac{h}{h_{ef}}\right) \le 2,4$	∙ h <sub>ef</sub>	
	S <sub>cr,sp</sub>	[mm]				2 c <sub>cr,sp</sub>			
d wet concrete)	$\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp} {}^{1)}$	•				1,8 <sup>2)</sup>			
d bore hole)	$\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp} {}^{1)}$			<b>2</b> ,1 <sup>3)</sup>			not adn	nissible	
y factor $\gamma_2 = 1.2$ is incl y factor $\gamma_2 = 1.4$ is incl e section 1.2 nt Technical Specific	uded. uded. ation for the rei								
cing bar EN/TS 1992-4,			and quas	si-static a	action		An	nex 19	)
	ar tance, reinforcing bar concrete failure nce in cracked concrete dry and wet concrete flooded bore hole dry and wet concrete flooded bore hole dry and wet concrete flooded bore hole at y and wet concrete at y and	ar         tance, reinforcing bar       N <sub>Rk.s</sub> $\gamma_{Ms,N}^{(1)}$ $\gamma_{Ms,N}^{(1)}$ porcrete failure         nce in cracked concrete C20/25         dry and wet concrete $T_{Rk,cr}$ flooded bore hole $T_{Rk,cr}$ ete       C30/37         ctal $C_{40/50$ C50/60 $5.2.2.3$ s.2.2.3       ks         s.2.3.1       kcr         c.3.2.3.1       kcr         c.3.2.3.1       kcr         s.2.3.1       kcr         s.2.3.1       kcr         s.2.3.1       kcr         flooded bore hole $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{(1)}$ d wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{(1)}$ d wet concrete) $\gamma_{Mp} = \gamma_{Mc} = \gamma_{Msp}^{(1)}$ re rational regu	tance, reinforcing bar $N_{Rk,s}$ $[kN]$ $7_{Mb,N}$ <sup>(1)</sup> concrete failure note in cracked concrete C20/25 dry and wet concrete $\tau_{Rk,cr}$ $[N/mm^2]$ flooded bore hole $\tau_{Rk,cr}$ $[nmm]$ $s_{cr,N}$ $[mm]$ $s_{cr,N}$ $[mm]$ d wet concrete) $\gamma_{Mp} = \gamma_{Mb} = \gamma_{Mbp}^{(1)}$ ther national regulations $\gamma_{factor \gamma_2} = 1.2$ is included. $\gamma_{factor \gamma_2} = 1.4$ is included. $\gamma_{factor \gamma_2} = 1.2$ is included. $\gamma_{factor \gamma_2} = 1.4$ is included. $\gamma_{factor \gamma_2} = 1.2$ is included. $\gamma_{factor \gamma_2} = 1.2$ is included. $\gamma_{factor \gamma_2} = 1.4$ is included. $\gamma$	ar       Ø 12         tance, reinforcing bar       N <sub>Rk,s</sub> [kN]	ar $0 12 0 14$ tance, reinforcing bar $N_{RK,s}$ $[KN]$ $\gamma_{Mn,N}^{(1)}$ CEN/TS concrete failure the in cracked concrete C20/25 $dry and wet concrete T_{RK,ar}$ $[N/rmn^2] 5.5 5.5$ flooded bore hole $T_{RK,ar}$ $[N/rmn^2] 4.0 4.0$ flooded bore hole $T_{RK,ar}$ $[N/rmn^2] 4.0 4.0$ flooded bore hole $T_{RK,ar}$ $[N/rmn^2] 3.0 3.0$ flooded bore hole $T_{RK,ar}$ $[nmn]$ $S_{ar,N}$ $[mmn]$ flooded bore hole $T_{RK,ar}$ $[nmn]$ $10^{-1}$ flooded bore hole $\gamma_{MP} = \gamma_{MR} = \gamma_{MRP}^{-1}$ $2.1^{3^{-1}}$ ther national regulations $r_{MD} = \gamma_{MR} = \gamma_{MRP}^{-1}$ $2.1^{3^{-1}}$ ther national regulations $r_{2} = 1.4$ is included. $r_{2}$ section 1.2 int Technical Specification for the reinforcing bar st-installed rebar as anchor see chapter 4.2 term V/IT-VM 250 for concrete bing bar N/rTS 19224,	tance, reinforcing bar       N <sub>Rs.s</sub> [kN] $\gamma_{Me,N}^{(1)}$ CEN/TS 1992-4-         concrete failure $\gamma_{Me,n'}$ [N/mm <sup>2</sup> ]       5,5       5,5       5,5         flooded bore hole $\gamma_{Re,\alpha'}$ [N/mm <sup>2</sup> ]       5,5       5,5       5,5         dry and wet concrete $\gamma_{Re,\alpha'}$ [N/mm <sup>2</sup> ]       4,0       4,0       4,0         flooded bore hole $\gamma_{Re,\alpha'}$ [N/mm <sup>2</sup> ]       3,0       3,0       3,0         flooded bore hole $\gamma_{Re,\alpha'}$ [N/mm <sup>2</sup> ]       3,0       3,0       3,0         flooded bore hole $\gamma_{Re,\alpha''}$ [N/mm <sup>2</sup> ]       3,0       3,0       3,0         ete       C30/37       C40/50	ar       Ø 12       Ø 14       Ø 16       Ø 20         tance, reinforcing bar       N <sub>Res</sub> [kN]       A, x f <sub>uk</sub> %         Tance, reinforcing bar       N <sub>Res</sub> [kN]       A, x f <sub>uk</sub> %         Tance, reinforcing bar       N <sub>Res</sub> [N/mm7]       5,5	ar       Ø 12       Ø 14       Ø 16       Ø 20       Ø 25         tance, reinforcing bar       N <sub>R,x</sub> [KN]       A <sub>x</sub> x f <sub>u</sub> . <sup>3</sup> Image: CEN/TS 1992-4-1 Section 4.4.3.1.1, concrete failure         nce in cracked concrete       C20/25       CEN/TS 1992-4-1 Section 4.4.3.1.1, concrete failure       Image: CEN/TS 1992-4-1 Section 4.4.3.1.1, concrete failure         nce in cracked concrete       T <sub>Re,x</sub> [N/mm²]       5,5       5,5       5,5       5,5         flooded bore hole       T <sub>Re,x</sub> [N/mm²]       4,0       4,0       4,0       4,0         dy and wet concrete       T <sub>Re,x</sub> [N/mm²]       3,0       3,0       3,0       3,0         flooded bore hole       T <sub>Re,x</sub> [N/mm²]       3,0       3,0       3,0       3,0         doded bore hole       T <sub>Re,x</sub> [N/mm²]       3,0       3,0       3,0       3,0         ete       C30/37       1,04       1,10       1,10       1,10       1,10         3,2,2,3       Ks       [-]       T,2       1,20       1,20       1,20       1,20         3,2,3,1       Ks       [-]       T,2       1,00       h <sub>eff</sub> ≤ 2 - h <sub>eff</sub> (25 - h <sub>bf</sub> ) ≤ 2,4       1,20       1,20       1,20       1,20       1,20<	ar       Ø 12       Ø 14       Ø 16       Ø 20       Ø 25       Ø 28         tance, reinforcing bar yw.n <sup>10</sup> $A_n \ge t_n^n$ $  N  $ $A_n \ge t_n^n$ $A_n \ge t_n^n$ $A_n \ge t_n^n$ tance, reinforcing bar yw.n <sup>10</sup> $A_n \ge t_n^n$ $  N  $ $A_n \ge t_n^n$ $  A  $ $A_n \ge t_n^n$ tance, reinforcing bar yw.n <sup>10</sup> $CENTS$ 1992-4-1 Section 4.4.3.1.1. Eq. 4 <sup>19</sup> $A_n \ge t_n^n$ $  A   $ $A_n \ge t_n^n$ tance in cracked concrete $\nabla B_{0,ar}$ $  N mm ^2 $ 5.5       5.5       5.5       5.5       6.5         flooded bore hole $\nabla B_{0,ar}$ $  N mm ^2 $ 3.0       3.0       3.0       3.5       100 ded bore hole $\nabla B_{0,ar}$ $  N mm ^2 $ 3.0       3.0       3.0       3.0       3.5       100 ded bore hole $\nabla B_{0,ar}$ $  N mm ^2 $ 3.0       3.0       3.0       3.0       3.5       100 ded bore hole $\nabla B_{0,ar}$ $  N                                  $



Table 13:Design according to in cracked and nor											
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							1	1			
Characteristic shear resistance, reinforcing bar according to Annex 4	V <sub>Rk,s</sub>	[kN]				0,5	0 x A <sub>s</sub> x <sup>-</sup>	f <sub>uk</sub> <sup>4)</sup>			
Partial safety factor	γ <sub>Ms,V</sub> <sup>1)</sup>			CEI	N/TS 199	92-4-1 S	Section 4	.4.3.1.1	, Eq. 5 +	· 6 <sup>4)</sup>	
Ductility factor according to CEN/TS 1992-4-5 Section 6.3.2.1	k <sub>2</sub>						0,8				
Steel failure with lever arm											
Characteristic bending moment, reinforcing bar according to Annex 4	$M^0_{Rk,s}$	[ <b>N</b> m]				1.2	2 ·W <sub>el</sub> · f <sub>u</sub>	4) uk			
Partial safety factor	Ύмs,v <sup>1)</sup>			CEI	N/TS 199	92-4-1 S	Section 4	.4.3.1.1	, Eq. 5 +	· 6 <sup>4)</sup>	
Concrete pry-out failure											
Factor in equation (27) of CEN/TS 1992-4-5 Section 6.3.3	k <sub>3</sub>						2,0				
Partial safety factor	γмср <sup>1)</sup>						1,50 <sup>2)</sup>				
Concrete edge failure <sup>3)</sup>	1										
Effective length of anchor	l <sub>f</sub>	[mm]				l <sub>f</sub> = m	nin(h <sub>ef</sub> ; 8	d <sub>nom</sub> )			
Outside diameter of anchor	d <sub>nom</sub>	[mm]	8	10	12	14	16	4.4.3.1.1, Eq. 5 + 6 <sup>4)</sup> 3 d <sub>nom</sub> ) 20 24 27	30		
Partial safety factor	γ <sub>Mc</sub> <sup>1)</sup>						1,50 <sup>2)</sup>				
<ol> <li><sup>1)</sup> In absence of other national reg</li> <li><sup>2)</sup> The partial safety factor γ<sub>2</sub> = 1.0</li> <li><sup>3)</sup> See CEN/TS 1992-4-5 Section 6</li> <li><sup>4)</sup> f<sub>uk</sub>, f<sub>yk</sub> see relevant Technical Sp</li> <li>Regarding design of post-installed</li> </ol>	is included. 5.3.4 pecification for										
Würth Injection system WIT-VM 250	for concrete	e									
Application with reinforcing bar Design according to CEN/TS 1992-4, Charac cracked concrete under static and quasi-stat		s for she	ear loac	ls in cra	acked a	nd non	-		Anne	ex 20	



Anchor size threa	aded rod		M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Non-cracked con	crete C20	/25			•					
40°C/24°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
40°C/24°C	δ <sub>N∞</sub>	[mm/(N/mm²)]	0,030	0,033	0,037	0,045	0,052	0,060	0,065	0,07
80°C/50°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
80 C/50 C	δ <sub>N∞</sub>	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
120°C/72°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
120 0/12 0 /	δ <sub>N∞</sub>	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Cracked concrete	e C20/25				•					
10°0 (01°0 <sup>2</sup> )	δ <sub>N0</sub>	[mm/(N/mm²)]					0,0	)70		
40°C/24°C <sup>2)</sup>	δ <sub>N∞</sub>	[mm/(N/mm <sup>2</sup> )]		-			0,1	05		
80°C/50°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm <sup>2</sup> )]					0,1	70		
80.0/20.0	δ <sub>N∞</sub>	[mm/(N/mm <sup>2</sup> )]		-			0,2	245		
120°C/72°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm²)]					0,1	70		
120°C/72°C -	$\delta_{N\infty}$	[mm/(N/mm <sup>2</sup> )]		-			0,2	245		

<sup>1)</sup> Calculation of the displacement for design load Displacement for short term load =  $\delta_{N0} \cdot \tau_{Sd}$  / 1,4; Displacement for long term load =  $\delta_{N_{\infty}} \cdot \tau_{Sd} / 1,4;$ 

 $(\tau_{Sd}: design bond strength)$ <sup>2)</sup> Explanations see section 1.2

#### Displacement for shear load threaded rod <sup>3)</sup> Table 15:

	aded rod		M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
For non-cracked	concrete	C20/25	I.		•	1	1		•	
All tomporatures	δ <sub>V0</sub>	[mm/(kN)]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
All temperatures	$\delta_{V\infty}$	[mm/(kN)]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
For cracked con	crete C20/	25	·							
All tomporatures	δ <sub>V0</sub>	[mm/(kN)]			0,11	0,10	0,09	0,08	0,08	0,07
All temperatures	δν∞	[mm/(kN)]		-	0,17	0,15	0,14	0,13	0,12	0,10
	for long term	m load = $\delta_{Vo} \cdot V_d / 1,4;$ n load = $\delta_{V\infty} \cdot V_d / 1,4;$								
Displacement	for long term									
Displacement (V <sub>d</sub> : design sh	for long tern ear load)		crete						nnex 2	



Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Non-cracked	concret	e C20/25		I						•	•
(2) (2) (2)	δ <sub>N0</sub>	[mm/(N/mm <sup>2</sup> )]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
40°C/24°C <sup>2)</sup>	$\delta_{N\infty}$	[mm/(N/mm <sup>2</sup> )]	0,030	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,07
80°C/50°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,12
	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,18
120°C/72°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm <sup>2</sup> )]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,12
120 0/12 0	$\delta_{N\infty}$	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,18
Cracked con	crete C2	0/25									
40°C/24°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm <sup>2</sup> )]						0,070			
40°C/24°C ->	δ <sub>N∞</sub>	[mm/(N/mm <sup>2</sup> )]		-				0,105			
80°C/50°C <sup>2)</sup>	δ <sub>N0</sub>	[mm/(N/mm²)]						0,170			
80 C/50 C /	$\delta_{N\infty}$	[mm/(N/mm²)]		-				0,245			
2)								0.170			
120°C (72°C <sup>2)</sup>	$\delta_{N0}$	[mm/(N/mm²)]						0,170			
Displacem Displacem (τ <sub>Sd</sub> : desig <sup>2)</sup> Explanatio	$\delta_{N\infty}$ n of the di ent for sh ent for lo n bond st ns see se	[mm/(N/mm <sup>2</sup> )] splacement for design out term load = $\delta_{No} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) action 1.2	<sub>Sd</sub> / 1,4; <sub>Sd</sub> / 1,4;	- nds reiu	nforcin	g bar <sup>3</sup>	3)	0,245			
<ol> <li><sup>1)</sup> Calculation Displacem (τ<sub>Sd</sub>: desig</li> <li><sup>2)</sup> Explanatio</li> <li>Table 17:</li> </ol>	δ <sub>N∞</sub> n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b>	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) action 1.2	<sub>Sd</sub> / 1,4; <sub>Sd</sub> / 1,4; <b>near lo</b> a			-		0,245	Ø <b>25</b>	Ø 28	Ø3
<sup>1)</sup> Calculation Displacem (τ <sub>Sd</sub> : desig <sup>2)</sup> Explanatio Table 17: Anchor size r	δ <sub>N∞</sub> n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{No} \cdot \tau$ ing term load = $\delta_{No} \cdot \tau_s$ rength) ection 1.2	<sub>Sd</sub> / 1,4; <sub>Sd</sub> / 1,4;	nds rein Ø10	nforcin Ø 12	i <b>g bar</b> <sup>3</sup> ∅ 14	3) Ø 16		Ø 25	Ø 28	Ø 32
<sup>1)</sup> Calculation Displacem (τ <sub>Sd</sub> : desig <sup>2)</sup> Explanatio Table 17: Anchor size r	δ <sub>N∞</sub> n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci concret	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) ection 1.2 ilacement for sl ing bar e C20/25	s <sub>d</sub> / 1,4; <sub>5d</sub> / 1,4; near loa	Ø 10	Ø 12	Ø 14	Ø 16	0,245 Ø <b>20</b>			Ø 32
<sup>1)</sup> Calculation Displacem (τ <sub>Sd</sub> : desig <sup>2)</sup> Explanatio Table 17: Anchor size r	δ <sub>N∞</sub> n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci concret	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) action 1.2 blacement for sl ng bar e C20/25 [mm/(kN)]	sd / 1,4; sd / 1,4; near loa Ø 8	Ø 10 0,05	Ø 12 0,05	Ø <b>14</b> 0,04	Ø <b>16</b> 0,04	0,245 Ø <b>20</b> 0,04	0,03	0,03	0,03
<ol> <li><sup>1)</sup> Calculation Displacem (τ<sub>Sd</sub>: desig</li> <li><sup>2)</sup> Explanatio</li> <li>Table 17:</li> <li>Anchor size r</li> <li>Non-cracked</li> <li>All emperatures</li> </ol>	$\frac{\delta_{N\infty}}{\Delta N_{\infty}}$ a of the direct for sheet for log n bond st ns see see Dispendent for circle the second state of the sec	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{No} \cdot \tau$ ing term load = $\delta_{No} \cdot \tau$ rength) ection 1.2 <b>placement for sl</b> ing bar e C20/25 [mm/(kN)] [mm/(kN)]	s <sub>d</sub> / 1,4; <sub>5d</sub> / 1,4; near loa	Ø 10	Ø 12	Ø 14	Ø 16	0,245 Ø <b>20</b>			
<ol> <li><sup>1)</sup> Calculation Displacem (t<sub>Sd</sub>: desig</li> <li><sup>2)</sup> Explanatio</li> <li><b>Table 17:</b></li> <li><b>Anchor size n</b></li> <li><b>Non-cracked</b></li> <li>All emperatures</li> <li><b>Cracked cond</b></li> </ol>	$δ_{N∞}$ n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci concret $δ_{V₀}$ $δ_{V∞}$ crete C2	$[mm/(N/mm^2)]$ splacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) ection 1.2 <b>placement for sl</b> ng bar e C20/25 [mm/(kN)] [mm/(kN)]	sd / 1,4; sd / 1,4; near loa Ø 8	Ø 10 0,05 0,08	Ø 12 0,05 0,08	Ø <b>14</b> 0,04 0,06	Ø <b>16</b> 0,04 0,06	0,245 Ø <b>20</b> 0,04 0,05	0,03 0,05	0,03	0,03
<sup>1)</sup> Calculation Displacem (τ <sub>Sd</sub> : desig <sup>2)</sup> Explanatio Table 17: Anchor size r	δ <sub>N∞</sub> n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci	$[mm/(N/mm^2)]$ isplacement for design ort term load = $\delta_{No} \cdot \tau$ ing term load = $\delta_{No} \cdot \tau_s$ rength) ection 1.2	<sub>Sd</sub> / 1,4; <sub>Sd</sub> / 1,4; <b>near lo</b> a			-		0,245	Ø 25	Ø 28	
<ol> <li><sup>1)</sup> Calculation Displacem (τ<sub>Sd</sub>: desig <sup>2)</sup> Explanatio</li> <li>Table 17: Anchor size r Non-cracked</li> <li>Mon-cracked</li> <li>Cracked cond</li> </ol>	$δ_{N∞}$ n of the di ent for sh ent for loi n bond st ns see se <b>Disp</b> reinforci concret $δ_{V₀}$ $δ_{V∞}$ crete C2	$[mm/(N/mm^2)]$ splacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) ection 1.2 <b>placement for sl</b> ng bar e C20/25 [mm/(kN)] [mm/(kN)]	sd / 1,4; sd / 1,4; near loa Ø 8 0,06 0,09	Ø 10 0,05 0,08	Ø 12 0,05 0,08	Ø <b>14</b> 0,04 0,06	Ø <b>16</b> 0,04 0,06	0,245 Ø <b>20</b> 0,04 0,05	0,03 0,05	0,03	0,0 0,0
<ol> <li><sup>1)</sup> Calculation Displacem (τ<sub>Sd</sub>: desig <sup>2)</sup> Explanatio</li> <li>Table 17:</li> <li>Anchor size r Non-cracked</li> <li>Memperatures</li> <li>Cracked cond</li> </ol>	$δ_{N∞}$ n of the dial ent for shared for shared for log n bond st ns see se <b>Disp</b> reinforci <b>concret</b> $δ_{V0}$ $δ_{V∞}$ crete C2 $δ_{V0}$	$[mm/(N/mm^2)]$ splacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) ection 1.2 <b>blacement for sl</b> <b>ng bar</b> <b>e C20/25</b> [mm/(kN)] <b>0/25</b> [mm/(kN)]	sd / 1,4; sd / 1,4; near loa Ø 8 0,06 0,09	Ø 10 0,05 0,08	Ø 12 0,05 0,08 0,11	Ø <b>14</b> 0,04 0,06 0,11	Ø 16 0,04 0,06 0,10	0,245 Ø <b>20</b> 0,04 0,05 0,09	0,03 0,05 0,08	0,03 0,04 0,07	0,0 0,0 0,0
<ol> <li><sup>1)</sup> Calculation Displacem Displacem <sup>2)</sup> Explanatio</li> <li>Table 17:</li> <li>Anchor size r</li> <li>Non-cracked</li> <li>All emperatures</li> <li>Cracked cond All emperatures</li> <li><sup>3)</sup> Calculation Displacem</li> </ol>	$\frac{\delta_{N\infty}}{\Delta_{N\infty}}$ n of the diamet for shares for long the set of the diamet for long the set of the set of the diamet for shares for for share	$[mm/(N/mm^2)]$ splacement for design ort term load = $\delta_{N0} \cdot \tau$ ing term load = $\delta_{N\infty} \cdot \tau_s$ rength) ection 1.2 <b>placement for sl</b> ng bar e C20/25 [mm/(kN)] [mm/(kN)]	sd / 1,4; sd / 1,4; near loa Ø 8 0,06 0,09	Ø 10 0,05 0,08	Ø 12 0,05 0,08	Ø <b>14</b> 0,04 0,06	Ø <b>16</b> 0,04 0,06	0,245 Ø <b>20</b> 0,04 0,05	0,03 0,05	0,03	0,0

Application with reinforcing bar Displacements



# 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 <sup>a)</sup>		Importance Class acc. to EN 1998-1:2004, 4.2.5						
	a <sub>g</sub> ⋅ S <sup>c)</sup>	I	П	ш	IV			
Very low <sup>b)</sup>	a <sub>g</sub> ·S ≤ 0,05 g		No additional requirement					
Low <sup>b)</sup>	0,05 g < a <sub>g</sub> ·S ≤ 0,1 g	C1	C1 <sup>d)</sup> or C2 <sup>e)</sup>		C2			
< Low <sup>b)</sup>	a <sub>g</sub> ·S > 0,1 g	C1	C2					

<sup>a)</sup> The values defining the seismicity levels may be found in the National Annex of EN 1998-1.

<sup>b)</sup> Definition according to EN 1998-1:2004, 3.2.1.

 $^{\rm c)}$   $~~a_{g}~$  = 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).

<sup>d)</sup> 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<sub>k,seis</sub>

Tension load:	$R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot \alpha_{N,seis} \cdot R_{k}^{0}$
	with $R_{k}^{0} = N_{Rk,s}$ , $N_{Rk,p}$ , $N_{Rk,c}$ , $N_{Rk,sp}$ (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 $R_{k}^{0} = V_{Rk,s}$ , $V_{Rk,c}$ , $V_{Rk,cp}$ (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

Würth Injection system WIT-VM 250 for concrete

Design according to TR 045; Design under seismic action

Annex 23



$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Table 19: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for threaded rods												
Steel failure (NRLL) $\alpha_{M,sels}$ [-]       1,0         Combined pull-out and concrete failure (NRLL) $\alpha_{M,sels}$ [-]       0,68       0,68       0,69       0,69       0,69         Shear load       Steel failure without lever arm (ValL2) $\alpha_{V,sels}$ [-]       0,70         Table 20: Reduction factors $\alpha_{M,sels}$ and $\alpha_{V,sels}$ for seismic design category C1 for reinforcing bar       Anchor size reinforcing bar $0.12$ $0.14$ $0.16$ $0.20$ $0.23$ $0.28$ $0.28$ $0.69$ <	Anchor si	ze threaded rods			M 12	2 M 1	6	M 20	M24	M 27	M 30		
Combined pull-out and concrete failure (Na <sub>k,p</sub> )         α <sub>N,pels</sub> [-]         0,68         0,68         0,68         0,69         0,69         0,61           Steel failure without lever arm (V <sub>Rx,s</sub> )         α <sub>V,pels</sub> [-]         0,70           Table 20: Reduction factors α <sub>M,sels</sub> and α <sub>V,sels</sub> for seismic design category C1 for reinforcing bar           Anchor size reinforcing bar         0.12         0.14         0.16         0.20         0.25         0.28         0.1           Combined pull-out and concrete failure (N <sub>Rx,p</sub> )         α <sub>M,sels</sub> [-]         1.0         0.68         0,68         0,69	Tension le	oad			<b>I</b>	I				1	1		
Combined pull-out and concrete failure (Na <sub>k,p</sub> )         α <sub>N,pels</sub> [-]         0,68         0,68         0,68         0,69         0,69         0,61           Steel failure without lever arm (V <sub>Rx,s</sub> )         α <sub>V,pels</sub> [-]         0,70           Table 20: Reduction factors α <sub>M,sels</sub> and α <sub>V,sels</sub> for seismic design category C1 for reinforcing bar           Anchor size reinforcing bar         0.12         0.14         0.16         0.20         0.25         0.28         0.1           Combined pull-out and concrete failure (N <sub>Rx,p</sub> )         α <sub>M,sels</sub> [-]         1.0         0.68         0,68         0,69	Steel failure	e (N <sub>Rk.s</sub> )	α <sub>N seis</sub>	[-]				1,	0				
Shear load       Image: Steel failure without lever arm (Vex.s) $\alpha_{V,sels}$ [-]       0,70         Table 20: Reduction factors $\alpha_{M,sels}$ and $\alpha_{V,sels}$ for seismic design category C1 for reinforcing bar       Image: Comparison of the selection of the selectin selectin all the selection of the selection of the	Combined p	oull-out and concrete failure (N <sub>Rk.p</sub> )			0,68	3 0,6	88	0,68	0,69	0,69	0,69		
Table 20: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for reinforcing bar         Anchor size reinforcing bar $\emptyset$ 12 $\emptyset$ 14 $\emptyset$ 16 $\emptyset$ 20 $\emptyset$ 28 $\emptyset$ 28 $\emptyset$ 27         Tension load       Steef failure $(N_{N,s,0})$ $\alpha_{N,sois}$ $[-]$ $1,0$ $0.68$ $0.68$ $0.69$	·		11,0010						•				
Table 20: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$ for seismic design category C1 for reinforcing bar         Anchor size reinforcing bar $\emptyset$ 12 $\emptyset$ 14 $\emptyset$ 16 $\emptyset$ 20 $\emptyset$ 28 $\emptyset$ 28 $\emptyset$ 27         Tension load       Steef failure $(N_{N,s,0})$ $\alpha_{N,sois}$ $[-]$ $1,0$ $0.68$ $0.68$ $0.69$	Steel failure								'0				
Tension load         Steel failure (N <sub>PK,k</sub> )       (N <sub>R,k</sub> )       (N <sub>R,k</sub> )         Combined pull-out and concrete failure (N <sub>PK,g</sub> )       (N <sub>R,k</sub> )       (N <sub>R,k</sub> )       (N <sub>R,k</sub> )         Table 21: Reduction factors $\alpha_{gap}$ and $\alpha_{seis}$ for resistance under seismic actions         Loading       Failure modes $\alpha_{seis} - Single fastener         Steel failure       1,0       1,0       1,0         Pull-out failure       1,0       1,0       1,0       0,85         Steel failure       1,0       1,0       0,85         Steel failure       1,0       1,0       0,85$	Table 2	Table 20: Reduction factors $\alpha_{N,seis}$ and $\alpha_{V,seis}$											
Steel failure (N <sub>Rk,s</sub> ) $\alpha_{N,selis}$ [-]       1,0         Combined pull-out and concrete failure (N <sub>Rk,s</sub> ) $\alpha_{N,selis}$ [-]       0,68       0,68       0,68       0,69       0,69       0,69         Steel failure without lever arm (V <sub>Rk,s</sub> ) $\alpha_{V,selis}$ [-]       0,70         Table 21: Reduction factors $\alpha_{gap}$ and $\alpha_{selis}$ for resistance under seismic actions         Loading       Failure modes $\alpha_{gap}$ $\alpha_{selis}$ - Single fastener group         Steel failure       1,0       1,0       1,0         Pull-out failure       1,0       1,0       0,85         Concrete cone failure       1,0       1,0       0,85         Concrete cone failure       0,5 <sup>10</sup> 1,0       0,85         Steel failure without lever arm       0,5 <sup>10</sup> 1,0       0,85         Concrete cone failure       0,5 <sup>10</sup> 1,0       0,85         Concrete deg failure       0,5 <sup>10</sup> 1,0       0,85         Concrete pry-out failure       0,5 <sup>10</sup> 1,0       0,85         Concrete deg failure       0,5 <sup>10</sup> 1,0       0,85         Concrete deg failure       0,5 <sup>10</sup> 1,0       0,85         Concrete deg failure       0,5 <sup>10</sup> <td>Anchor si</td> <td>ze reinforcing bar</td> <td></td> <td></td> <td>Ø 12</td> <td>Ø 14</td> <td>Ø 16</td> <td>5 Ø 20</td> <td>) Ø 25</td> <td>j Ø 28</td> <td>Ø 32</td>	Anchor si	ze reinforcing bar			Ø 12	Ø 14	Ø 16	5 Ø 20	) Ø 25	j Ø 28	Ø 32		
Combined pull-out and concrete failure (N <sub>Rk,D</sub> )         α <sub>kk,defi</sub> [-]         0,68         0,68         0,68         0,69							1	1	<b>I</b>	I	<b>I</b>		
Combined pull-out and concrete failure (N <sub>Rk,D</sub> )         α <sub>kk,defi</sub> [-]         0,68         0,68         0,68         0,69	Steel failure	e (N <sub>Rk,s</sub> )	an seis	[-]				1.0					
Shear load         Steel failure without lever arm (V <sub>Rk.2</sub> ) $\alpha_{v,seis}$ I       0,70         Table 21: Reduction factors $\alpha_{gap}$ and $\alpha_{seis}$ for resistance under seismic actions         Loading       Failure modes         Steel failure       1,0       1,0       0,70         Tension       Combined pull-out and concrete failure       1,0       1,0       0,85         Oncrete cone failure       1,0       1,0       0,85       0,5 <sup>17</sup> 1,0       0,85       0,75         Splitting failure with lever arm       0,5 <sup>17</sup> 1,0       0,85       0,75         Shear       NPD <sup>2</sup> NPD <sup>2</sup> NPD <sup>2</sup> 1       The limitation for size of the clearance hole is given in TR 029 Table 4.1,       concrete pry-out failure       0,5 <sup>17</sup> 1,0       0,85       0,75       NPD <sup>29</sup> NPD <sup>29</sup> NPD <sup>29</sup> No Performance Determined       Würth Inject					0.68	0.68	0.68			0.69	0,69		
Steel failure without lever arm (V <sub>Rk.s</sub> ) $\alpha_{V,Sels}$ [-]       0,70         Table 21: Reduction factors $\alpha_{gap}$ and $\alpha_{sels}$ for resistance under seismic actions         Loading       Failure modes $\alpha_{gap}$ $\alpha_{sels}$ - Single fastener group         Steel failure       1,0       1,0       1,0       1,0         Pull-out failure       1,0       1,0       0,85       0,75         Concrete cone failure       1,0       1,0       0,85       0,75         Shear       Steel failure with out lever arm       0,5 <sup>1</sup> 1,0       0,85         Shear       Steel failure       0,5 <sup>1</sup> 1,0       0,85         Ocncrete edge failure       0,5 <sup>1</sup> 1,0       0,85       0,75         Concrete dege failure       0,5 <sup>1</sup> 1,0       0,85       0,75         Ocncrete edge failure       0,5 <sup>1</sup> 1,0       0,85       0,75         Concrete pry-out failure       0,5 <sup>1</sup> 0,0       0,85       0,75         Order       Out case of no clearance hole is given in TR 029 Table 4.1, $\alpha_{gap}$ $\alpha_{gap}$ 1,0       0,85       0,75         On Performance Determined       Würth Injection system WIT-VM 250 for concrete       0,0       0,0       0,0 <td></td> <td></td> <td>11,000</td> <td></td> <td>, -</td> <td>, -</td> <td>,</td> <td>,</td> <td>,</td> <td>,</td> <td>1 1 1</td>			11,000		, -	, -	,	,	,	,	1 1 1		
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         Steel failure       1,0       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       1,0       0.85         Splitting failure       1,0       1,0       0.85         Steel failure with lever arm       0,5 <sup>10</sup> 1,0       0.85         Concrete edge failure       0,5 <sup>10</sup> 1,0       0.85         Concrete edge failure       0,5 <sup>10</sup> 1,0       0.85         Concrete pry-out failure       0,5 <sup>10</sup> 1,0       0.85         Concrete pry-out failure       0,5 <sup>10</sup> 0,85       0,75         1 <sup>o</sup> 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       Würth Injection system WIT-VM 250 for concrete       UWürth Injection system WIT-VM 250 for concrete			Quesis	[-]				0.70	)				
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         1.0         0.85           Splitting failure         1.0         1.0         0.85           Steel failure without lever arm         0.5 <sup>10</sup> 1.0         0.85           Steel failure with lever arm         0.5 <sup>10</sup> 1.0         0.85           Concrete edge failure         0.5 <sup>10</sup> 1.0         0.85           Concrete pry-out failure         0.5 <sup>10</sup> 1.0         0.85           Concrete pry-out failure         0.5 <sup>10</sup> 0.0         0.85           Concrete pry-out failure         0.5 <sup>10</sup> 0.0         0.85           Concrete pry-out failure         0.5 <sup>10</sup> 0.85         0.75           1 <sup>10</sup> The limitation for size of no clearance hole is given in TR 029 Table 4.1,         0.85         0.75           2 <sup>10</sup> No Performance Determined         No Performance Determined         No Performance Determined			and $\alpha_{sei}$	s for r	esistan			α <sub>seis</sub> - S	Single	α <sub>seis</sub> - Fa			
TensionCombined pull-out and concrete failure1.01.00.85Concrete cone failure1.01.00.850.75Splitting failure1.01.00.850.75ShearSteel failure without lever arm0.5 $^{10}$ 1.00.85ShearSteel failure with lever arm0.5 $^{10}$ 1.00.85Concrete edge failure0.5 $^{10}$ 1.00.85Concrete edge failure0.5 $^{10}$ 1.00.85Concrete pry-out failure0.5 $^{10}$ 0.850.751)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 fixture2)2)No Performance DeterminedNo Performance Determined0.5 $^{10}$		Steel failure				1,0	)			-	-		
Concrete cone failure         1,0         0,85         0,75           Splitting failure         1,0         1,0         0,85         0,75           Shear         Steel failure without lever arm         0,5 <sup>1)</sup> 1,0         0,85           Shear         Steel failure with lever arm         0,5 <sup>1)</sup> 1,0         0,85           Concrete edge failure         0,5 <sup>1)</sup> 1,0         0,85           Concrete pry-out failure         0,5 <sup>1)</sup> 0,85         0,75           1         The limitation for size of the clearance hole is given in TR 029 Table 4.1,         crasp = 1,0 in case of no clearance between fastener and fixture         2           No Performance Determined         No Performance Determined         9         No Performance Determined         9		Pull-out failure				1,0	)	1,	0	0,85			
Splitting failure         1,0         1,0         0,85           Shear         Steel failure without lever arm         0,5 <sup>-17</sup> 1,0         0,85           Shear         Steel failure with lever arm         NPD <sup>-27</sup> NPD <sup>-27</sup> NPD <sup>-27</sup> Concrete edge failure         0,5 <sup>-17</sup> 1,0         0,85           Concrete pry-out failure         0,5 <sup>-17</sup> 1,0         0,85           1         The limitation for size of the clearance hole is given in TR 029 Table 4.1,         0,5 <sup>-17</sup> 0,85         0,75           1         The limitation for size of no clearance between fastener and fixture         No Performance Determined         0         0,5 <sup>-17</sup> 0,85         0,75           1         No Performance Determined         Steel failure         0,5 <sup>-17</sup> 0,85         0,75	Tension	Combined pull-out and concrete fa	ailure			1,0	)				85		
Shear     Steel failure without lever arm     0,5 <sup>1</sup> )     1,0     0,85       Steel failure with lever arm     NPD <sup>2</sup> )     NPD <sup>2</sup> )     NPD <sup>2</sup> )       Concrete edge failure     0,5 <sup>1</sup> )     1,0     0,85       Concrete pry-out failure     0,5 <sup>1</sup> )     1,0     0,85       Concrete pry-out failure     0,5 <sup>1</sup> )     1,0     0,85       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)       2)     No Performance Determined     No Performance Determined						1,0	1,0 0,85		35	0,75			
Shear         Steel failure with lever arm         NPD <sup>2</sup> )         NPD <sup>2</sup> )         NPD <sup>2</sup> )           Concrete edge failure         0,5 <sup>1</sup> )         1,0         0,85           Concrete pry-out failure         0,5 <sup>1</sup> )         1,0         0,85           1)         The limitation for size of the clearance hole is given in TR 029 Table 4.1,		Splitting failure									85		
Shear       Concrete edge failure       0,5 <sup>-1</sup> )       1,0       0,85         Concrete pry-out failure       0,5 <sup>-1</sup> )       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         Würth Injection system WIT-VM 250 for concrete													
Concrete pry-out failure     0,5 <sup>1</sup> )     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     0	Shear												
<ul> <li><sup>1)</sup> The limitation for size of the clearance hole is given in TR 029 Table 4.1, α<sub>gap</sub> = 1,0 in case of no clearance between fastener and fixture No Performance Determined</li> <li>Würth Injection system WIT-VM 250 for concrete</li> </ul>		_											
Agep = 1,0 in case of no clearance between fastener and fixture       2) No Performance Determined       Würth Injection system WIT-VM 250 for concrete		Concrete pry-out failure				0,5	.,	0,8	35	0,	/5		
	$\alpha_{gap} =$	1,0 in case of no clearance between				,							
									Annex 24				