Deutsches Institut für Bautechnik

Zulassungsstelle für Bauprodukte und Bauarten

Bautechnisches Prüfamt

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

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

**Deutsches
Institut
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Bautechnik**

DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-11/0273

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	Bewehrungsanschluss mit BTI Injektionsmörtel UVT Top-Z *Rebar connection with BTI injection mortar UVT Top-Z*
Zulassungsinhaber *Holder of approval*	BTI Befestigungstechnik GmbH & Co. KG Salzstraße 51 74653 Ingelfingen DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck *Generic type and use* *of construction product*	Nachträglich eingemörtelter Bewehrungsanschluss mit BTI Injektionsmörtel UVT Top-Z *Post-installed rebar connection with* *BTI injection mortar UVT Top-Z*

Geltungsdauer: vom
Validity: *from*
   bis
   to
	26 June 2013
	
	26 June 2018

Herstellwerke *Manufacturing plants*	BTI Herstellwerk 1 BTI manufacturing plant 1

Diese Zulassung umfasst *This Approval contains*	25 Seiten einschließlich 15 Anhänge *25 pages including 15 annexes*
Diese Zulassung ersetzt *This Approval replaces*	ETA-11/0273 mit Geltungsdauer vom 08.07.2011 bis 20.05.2014 *ETA-11/0273 with validity from 08.07.2011 to 20.05.2014*

EOTA

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[1], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];

- *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998[4], as amended by Article 2 of the law of 8 November 2011[5];*

- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];

- Guideline for European technical approval of "Metal anchors for use in concrete - Part 5: Bonded anchors", ETAG 001-05.

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

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

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

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

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

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

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II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of the construction products and intended use

1.1 Definition of the product

The subject of this approval is the post-installed connection, by anchoring or overlap connection joint, of reinforcing bars (rebars) in existing structures made of normal weight concrete, using the injection mortar UVT Top-Z in accordance with the regulations for reinforced concrete construction.

Reinforcing bars made of steel with a diameter d_s from 8 to 40 mm according to Annex 6 or the rebar anchor FRA sizes 12, 16 and 20 according to Annex 7 and injection mortar UVT Top-Z are used for rebar connections. The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between embedded element, injection mortar and concrete.

1.2 Intended use

The rebar connection may be used in normal weight concrete of a minimum grade of C12/15 and maximum grade C50/60 according to EN 206-1:2000. It may be used in non-carbonated concrete with the allowable chloride content in concrete of 0.40% (CL 0.40) related to the cement content according to EN 206-1.

Rebar connections with reinforcing bars and rebar anchor FRA may be used for predominantly static loads.

The fire resistance of post-installed rebar connections is not covered by this European technical approval. Fatigue, dynamic or seismic loading of post-installed rebar connections are not covered by this European technical approval.

Rebar connections may only be carried out in a manner, which is also possible with cast-in straight reinforcing bars, e.g. those in the following applications (see Annexes 2 and 3):

- an overlap joint with existing reinforcement in a building component (Figures 1 and 2),
- anchoring of the reinforcement at a slab or beam support, (e.g. according to Figure 3: end support of a slab, designed simply supported, as well as an appropriate general reinforcement for restraint forces),
- anchoring of reinforcement of building components stressed primarily in compression (Figure 4),
- anchoring of reinforcement to cover the envelope line of tensile force in the bending member (Figure 5).

The post-installed rebar connections may be used in the temperature range of -40 °C to +80 °C (max short term temperature +80°C and max long term temperature +50 °C).

This European technical approval covers anchoring in bore holes made with hammer drilling, compressed air drilling or diamond drilling. The post-installed rebar connection may be installed in dry or wet concrete. It must not be installed in flooded holes.

The rebar may be installed downwards or in a horizontal position. Rebar sizes ≤ 25 mm and rebar anchor FRA may also be installed in upwards position.

Rebar connections with the rebar anchor FRA may be used for the transmission of tensile forces in the direction of the bar axis only. The transmission of shear forces has to be ensured by appropriate measures. Examples for the application are given in Annex 4, Figure 6 to Figure 8.

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- The rebar anchor FRA made of stainless steel 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).

- The rebar anchor FRA C made of high corrosion resistant steel 1.4529 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).

The provisions made in this European technical approval are based on an assumed working life of the post-installed rebar connection 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 post-installed rebar connection corresponds to the drawings and provisions given in the Annexes. The characteristic material values, dimensions and tolerances not indicated in the Annexes shall correspond to the respective values laid down in the technical documentation[7] of this European technical approval.

The two components of the injection mortar are delivered in unmixed condition in cartridges of sizes 390 ml, 585 ml or 1100 ml according to Annex 1. Each cartridge is marked with the identifying mark "UVT Top-Z" with the processing notes, shelf-life, hazard code, curing time (depending on temperature).

The rebar shall comply with the specifications given in Annex 6. The rebar anchor FRA shall comply with the specifications given in Annex 7. Each rebar anchor with connecting thread made of stainless steel is marked with works symbol and the letters "FRA" according to Annex 7. Each rebar anchor with connecting thread made of high corrosion resistant steel 1.4529 is marked with works symbol and the letters "FRA C" according to Annex 7.

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

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2.2 Methods of verification

The assessment of fitness of the post-installed rebar connection 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" and EOTA Technical Report TR 023 "Assessment of post-installed rebar connections"[8].

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/EC of the European Commission[9] 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 prescribed test 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.

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[8]   The Technical Report TR 023 "Assessment of post-installed rebar connections" is published on EOTA website www.EOTA.eu.

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

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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 with Deutsches Institut für Bautechnik.[10]

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

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 injection mortar. 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.

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

4.2 Drafting

Rebar connections must be designed in keeping with good engineering practice. Considering the loads to be anchored, design calculations and design drawings must be produced which can be checked. At least the following items must be stated in the design drawings:

- grade of concrete strength,
- diameter, drilling technique, concrete cover, spacing and embedment depth of the rebar,
- length ℓ_v and length for markings ℓ_m on the injection extension according to Annex 8,
- Use of a drill guide for anchorages close to the edge (see Annex 10),
- kind of preparation of the joint between building component being connected including the diameter and thickness of concrete layer that has to be removed.

4.3 Design

4.3.1 General

The actual position of the reinforcement in the existing structure shall be determined on the basis of the construction documentation and taken into account when designing.

The design of post-installed rebar connections according to Annexes 2 and 3 and determination of the internal section forces to be transferred in the construction joint shall be verified in accordance with EN 1992-1-1:2004. When ascertaining the tensile force in the rebar, allowance shall be made for the statically effective height of the bonded-in reinforcement.

The rebar anchor FRA according to Annex 7 shall be designed for the welded-on reinforcement steel B500 B. The length of the bonded-in shaft made of stainless steel may not be accounted as anchorage.

The verification of the immediate local force transfer to the concrete has been provided.

The verification of the transfer of the loads to be anchored to the building component shall be provided.

The spacing between post-installed rebars respectively rebar anchor FRA shall be greater than the minimum of 5 d_s and 50 mm (see Annex 5).

4.3.2 Determination of the basic anchorage length

The required basic anchorage length $\ell_{b,rqd}$ shall be determined in accordance with EN 1992-1-1, Section 8.4.3:

$$\ell_{b,rqd} = (d_s / 4) (\sigma_{sd} / f_{bd})$$

with: d_s = diameter of the rebar

σ_{sd} = calculated design stress of the rebar

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f_{bd} = design value of bond strength according to Annex 10, Table 7

in consideration of the coefficient related to the quality of bond conditions and of the coefficient related to the bar diameter and of the drilling technique

4.3.3   Determination of the design anchorage length

The required design anchorage length ℓ_{bd} shall be determined in accordance with EN 1992-1-1, Section 8.4.4:

$\ell_{bd} = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \cdot \alpha_5 \, \ell_{b,rqd} \geq \ell_{b,min}$

with: $\ell_{b,rqd}$ = according to section 4.3.2

α_1 = 1.0 for straight bars

α_2 = 0.7…1.0 calculated acc. to EN 1992-1-1, Table 8.2

α_3 = 1.0 because of no transverse reinforcement

α_4 = 1.0 because of no welded transverse reinforcement

α_5 = 0.7…1.0 for influence of transverse pressure acc. to EN 1992-1-1, Table 8.2

$\ell_{b,min}$ = minimum anchorage length acc. to EN 1992-1-1
= max {0.3 $\ell_{b,rqd}$; $10d_s$; 100 mm} under tension
= max {0.6 $\ell_{b,rqd}$; $10d_s$; 100 mm} under compression
In case of diamond drilling multiply the values by 1.3.

The maximum permissible anchorage depth is given in Annex 8 in relation to the dispenser to be used.

4.3.4   Overlap joints

The required design lap length ℓ_0 shall be determined in accordance with EN 1992-1-1, Section 8.7.3:

$\ell_0 = \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_5 \cdot \alpha_6 \, \ell_{b,rqd} \geq \ell_{0,min}$

with: $\ell_{b,rqd}$ = according to Section 4.3.2

α_1 = 1.0 for straight bars

α_2 = 0.7…1.0 calculated acc. to EN 1992-1-1, Table 8.2

α_3 = 1.0 because of no transverse reinforcement

α_5 = 0.7…1.0 for influence of transverse pressure acc. to EN 1992-1-1, Table 8.2

α_6 = 1.0…1.5 for influence of percentage of lapped bars relative to the total cross-section area acc. to EN 1992-1-1, Table 8.3

$\ell_{0,min}$ = minimum lap length acc. to EN 1992-1-1
= max {0.3·α_6 $\ell_{b,rqd}$; $15d_s$; 200 mm}

In case of diamond drilling multiply the values by 1.3.

The maximum permissible anchorage depth is given in Annex 8 in relation to the dispenser and the bar diameter to be used.

4.3.5   Embedment depth for overlap joints

Overlap joint for rebars:

For calculation of the effective embedment depth of overlap joints the concrete cover at end-face of bonded-in rebar c_1 shall be considered (see Annex 5, Figure 9):

$\ell_v \geq \ell_0 + c_1$

with: ℓ_0 = required lap length acc. to Section 4.3.4 and to EN 1992-1-1

c_1 = concrete cover at end-face of bonded-in rebar (see Annex 5, Figure 9)

If the clear distance between the overlapping rebars is greater than $4\,d_s$ the lap length shall be enlarged by the difference between the clear distance and $4\,d_s$.

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<u>Overlap joint for rebar anchor FRA:</u>

The effective embedment depth is the same like the lap length $\ell_v = \ell_0$ (see Annex 5, Figure 10).

The total embedment depth $\ell_{e.ges}$ shall be determined as follows (see Annex 5, Figure 10):

$$\ell_{e.ges} \geq \ell_0 + \ell_e$$

with: ℓ_0 = required lap length acc. to Section 4.3.4 and to EN 1992-1-1

ℓ_e = length of the embedded threaded ($\ell_e > c_1$ see also Annex 7),

If the clear distance between overlapping rods exceeds $4\,d_s$, the overlap length shall be increased by the difference between the actual clear distance and $4\,d_s$.

4.3.6 Concrete cover

The concrete cover required for bonded-in rebars and rebar anchor FRA is shown in Annex 10, Table 8, in relation to the drilling method and the hole tolerance.

Furthermore the minimum concrete cover given in EN 1992-1-1, Section 4.4.1.2 shall be observed.

4.3.7 Transverse reinforcement

The requirements of transverse reinforcement in the area of the post-installed rebar connection or of the rebar anchor FRA connection shall comply with EN 1992-1-1, Section 8.7.4.

4.3.8 Connection joint

The transfer of shear forces between new concrete and existing structure shall be designed according to EN 1992-1-1. The joints for concreting must be roughened to at least such an extent that aggregate protrude.

In case of a carbonated surface of the existing concrete structure the carbonated layer shall be removed in the area of the post-installed rebar connection with a diameter of $d_s + 60$ mm prior to the installation of the new rebar.

The depth of concrete to be removed shall correspond to at least the minimum concrete cover for the respective environmental conditions in accordance with EN 1992-1-1.

The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions.

4.4 Installation

The fitness for use of the post-installed rebar connection can only be assumed if the rebar respectively the rebar anchor FRA is installed as follows:

- the installation of post-installed rebar respectively rebar anchor FRA shall be done only by suitable trained installer and under supervision on site; the conditions under which an installer may be considered as suitable trained and the conditions for supervision on site are up to the Member States in which the installation is done,

- use of the injection system only as supplied by the manufacturer without exchanging the components of the Injection system,

- installation in accordance with the manufacturer's specifications and drawings using the tools indicated in the technical documentation of this European technical approval,

- checks before rebar installation to ensure that the strength class of the concrete in which the post-installed rebar connection 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,

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- check the position of the existing rebars (if the position of existing rebars is not known, it shall be determined using a rebar detector suitable for this purpose as well as on the basis of the construction documentation and then marked on the building component for the overlap joint),
- keeping the anchorage depth as specified in the design drawings,
- keeping of concrete cover and spacing as specified in the design drawings,
- positioning of the drill holes without damaging the reinforcement,
- in case of aborted drill hole the drill hole shall be filled with mortar,
- the post-installed rebar connection must not be installed in flooded holes,
- the drilling and cleaning of the hole and the installation shall be performed only with the equipment specified by the manufacturer according to the manufacturer's installation instructions (see Annex 10), it shall be ensured that this equipment is available on site and it is used,
- during curing of the injection mortar the temperature of the building component must not be less than +5 °C and no more than +40 °C; observing the curing time given in Annex 8.

5 Recommendations concerning packaging, transport and storage

5.1 Responsibility of the manufacturer

It is in the responsibility of the manufacturer to ensure that the information on the specific conditions according to sections 1 and 2 including Annexes referred to and section 4 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,
- diameter of rebar,
- admissible service temperature range,
- curing time of the injection mortar,
- Installation instructions including cleaning of the drill hole,
- reference to any special installation equipment needed,
- identification of the manufacturing batch,

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

5.2 Packaging, transport and storage

The mortar cartridges shall be protected against sun radiation and shall be stored according to the manufacture's installation instructions in dry condition at temperatures of at least +5 °C to not more than +25 °C.
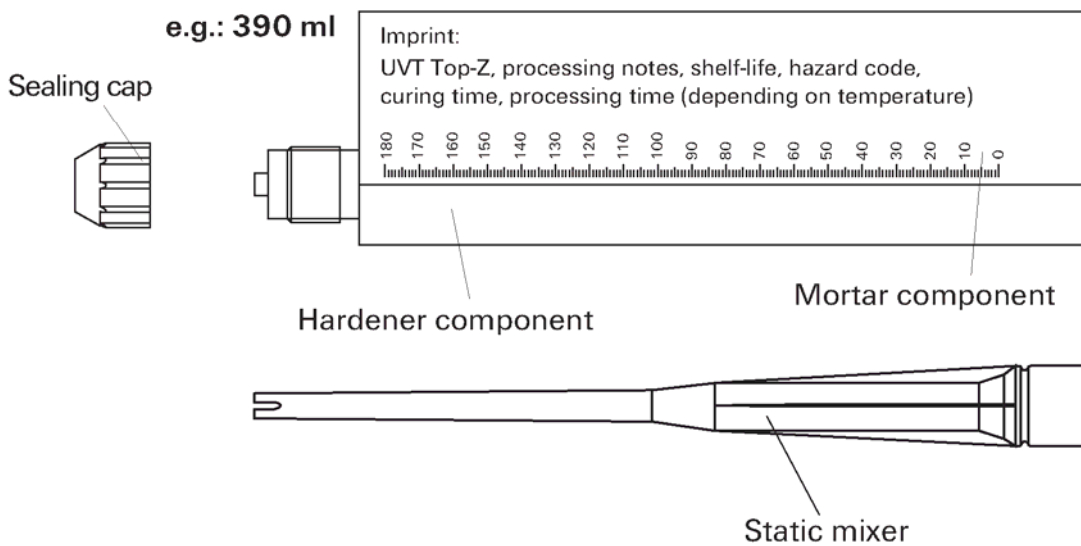
Mortar cartridges with expired shelf life must no longer be used.
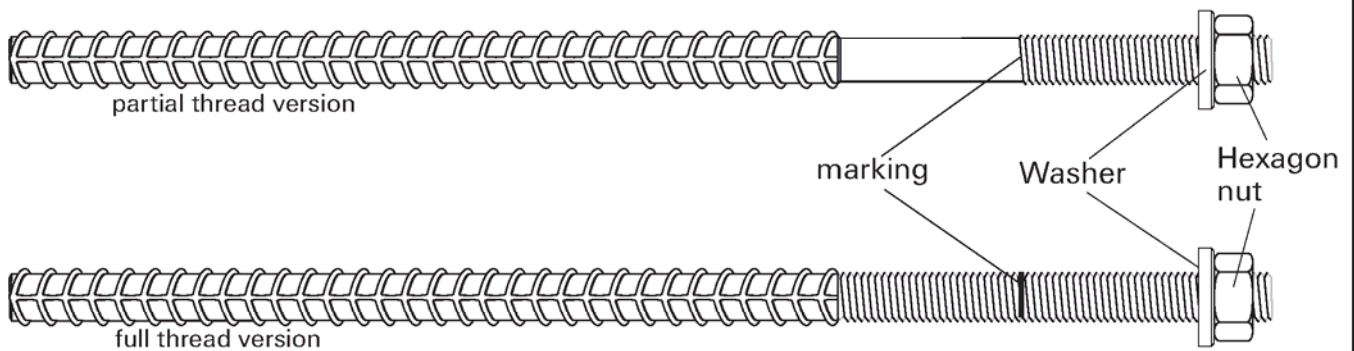
Uwe Bender
Head of Department

beglaubigt:

Baderschneider

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- Standard concrete C12/15 - C50/60 according to EN 206-1
- Reinforcement bar, d_s = 8 mm - 40 mm (properties see Annex 6).
- Rebar anchor FRA 12, FRA 16, FRA 20 (properties see Annex 7).
- Injection mortar UVT Top-Z
- Method for drilling and cleaning the drill holes and the injection of the mortar.

UVT Top-Z, mortar cartridge 390 ml, 585 ml, 1500 ml

e.g.: 390 ml

Sealing cap

Imprint:
UVT Top-Z, processing notes, shelf-life, hazard code,
curing time, processing time (depending on temperature)

Hardener component

Mortar component

Static mixer

Rebar anchor FRA 12, 16, 20

partial thread version

marking   Washer   Hexagon nut

full thread version

Intended use
Installation in dry and wet concrete. The rebar may be installed downwards or in horizontal position. Rebar sizes ≤ 25 mm may also be installed in upward position.

Temperature range:
-40°C to + 80°C (max. long term temperature +50°C and
                 max. short term temperature +80°C)

Rebar connection with BTI Injection mortar UVT Top-Z	
Product and intended use	**Annex 1**

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Figure 1

ℓ_v
ℓ_0

$\geq 10\,d_s$

Reinforcement lap for rebar
connections of slabs and beams

Roughen joint
according to 4.3.8 of this approval

Figure 2

N, M, V

Roughen joint
according to 4.3.8 of this approval

ℓ_0 ℓ_v

Reinforcement lap of a column
or a wall under bending stress
to a foundation.

The required transverse reinforcement according to EN 1992-1-1
is not shown in the figures.

Rebar connection with BTI Injection mortar UVT Top-Z	
Examples of use for reinforcement bars Laps	**Annex 2**

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Figure 3

$\ell_{b,d}$

A_s

$\ell_{b,d}$ $A_{s,F}$

Roughen joint
according to 4.3.8
of this approval

End anchoring of slabs or beams
which have been designed as
simply supported

Figure 4

N

$\ell_v = \ell_0$

Rebar connection of building
members under predominant
pressure

Figure 5

$\geq \ell_{b,d}$ a_l

Envelope of the tensile force

ℓ_v

$\geq \ell_{b,min}$

$A_{s,L}$; $d_{s,L}$

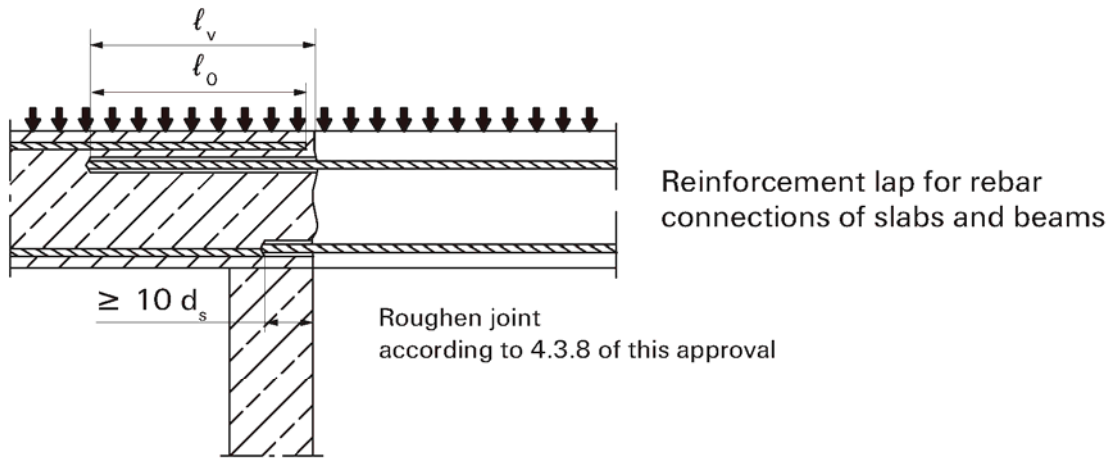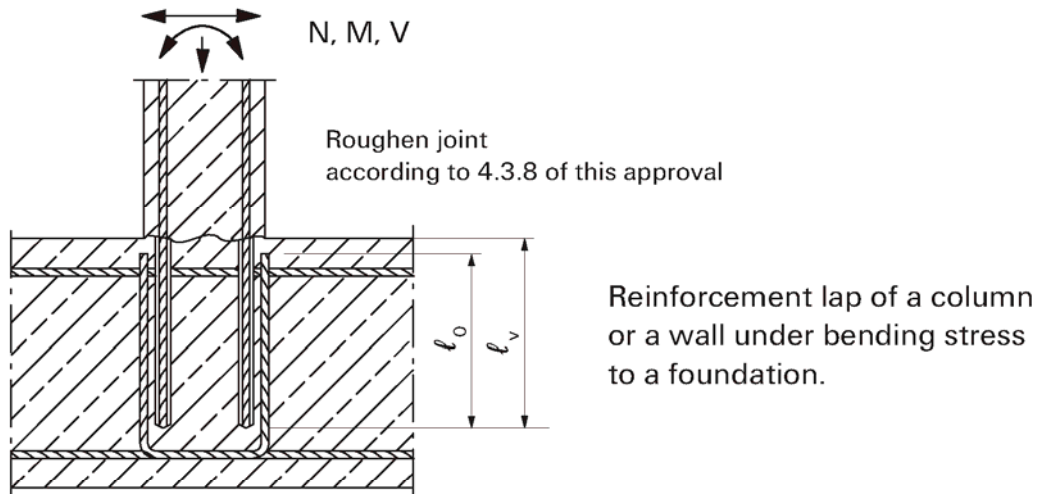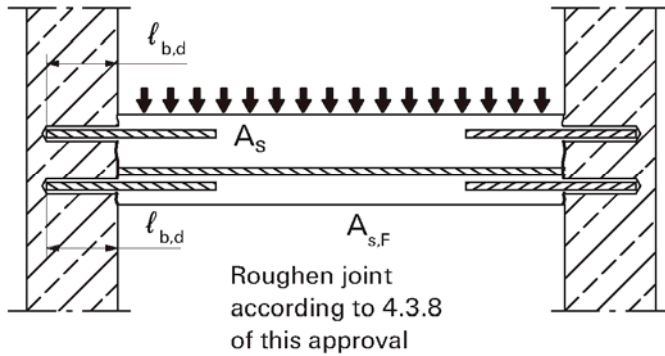Anchoring of reinforcement to
cover the envelope of the tensile
force

The required transverse reinforcement according to EN 1992-1-1
is not shown in the figures.

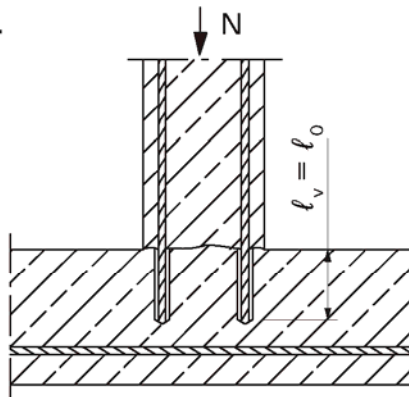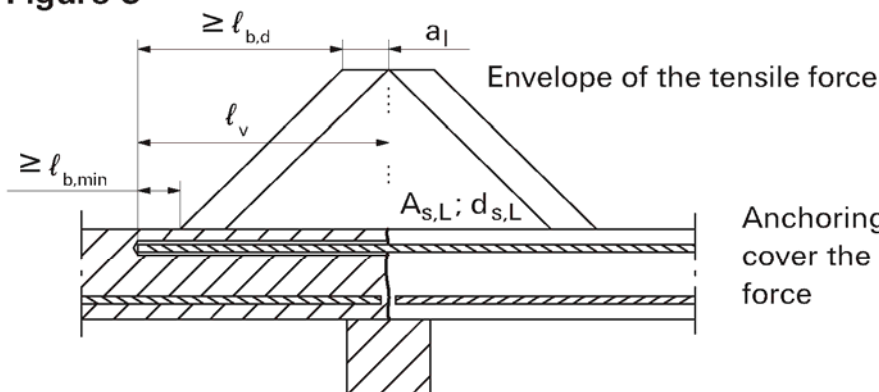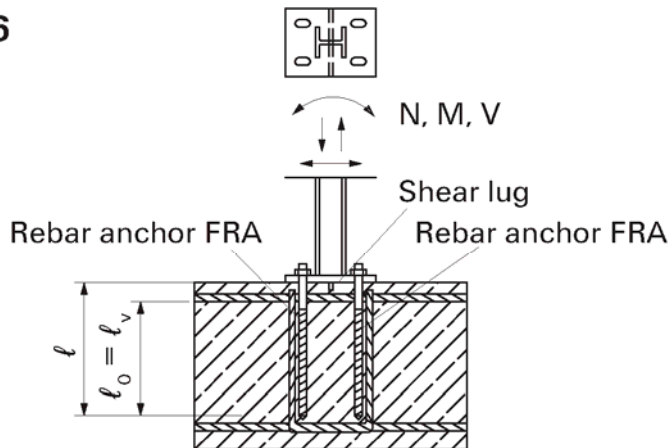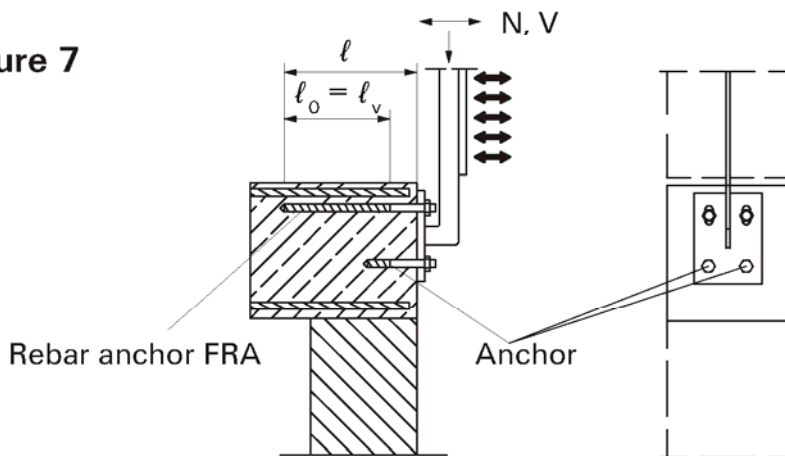| Rebar connection with BTI Injection mortar UVT Top-Z	
Examples of use for reinforcement bars Anchorages	**Annex 3**

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Figure 6

N, M, V

Shear lug

Rebar anchor FRA   Rebar anchor FRA

ℓ
$\ell_0 = \ell_v$

Lap to a foundation of
a column under bending

Figure 7

N, V

ℓ
$\ell_0 = \ell_v$

Rebar anchor FRA   Anchor

Lap for the anchoring of
guardrail posts

In the anchor plate, the drill holes
for the rebar anchors FRA have to be
designed as elongated holes with
axial direction to the shear force.

Figure 8

Rebar anchor FRA   Shear lug

ℓ
$\ell_0 = \ell_v$

N, V
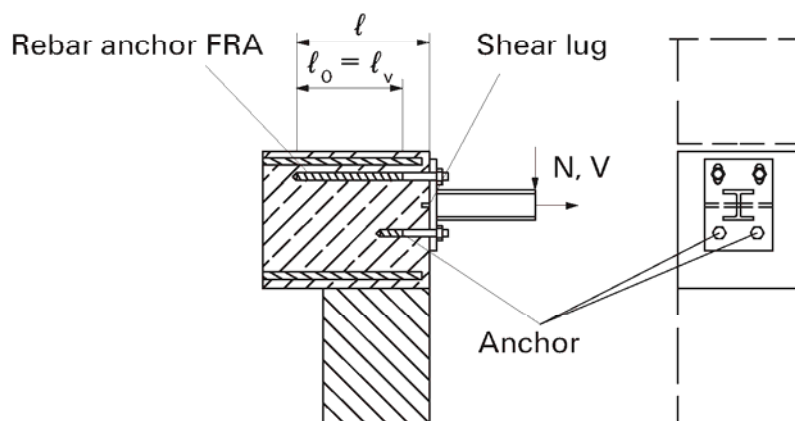
Anchor

Lap of the anchoring of
cantilevered building
components

In the anchor plate, the drill holes
for the rebar anchors FRA have to be
designed as elongated holes with
axial direction to the shear force.

The required transverse reinforcement according to EN 1992-1-1 is not shown in the figures. **The rebar anchor FRA may be only used for axial tensile loads.** The tensile force must been transferred by a lap to the existing reinforcement of the building. The transfer of the shear loads has to be ensured by suitable measure, e.g. by means of shear lugs or anchors with an European technical approval (ETA).

Rebar connection with BTI Injection mortar UVT Top-Z	
Examples of use for rebar anchors FRA Laps	**Annex 4**

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Figure 9: Setting instruction rebar

Member edge

$c \geq \min c$

$\leq 4 d_s^{1)}$

$8 \text{ mm} \leq d_s \leq 40 \text{ mm}$

$\geq 5 d_s$
$\geq 50 \text{ mm}$

d_0

Insertion depth marking

ℓ_0 c_1

ℓ_v
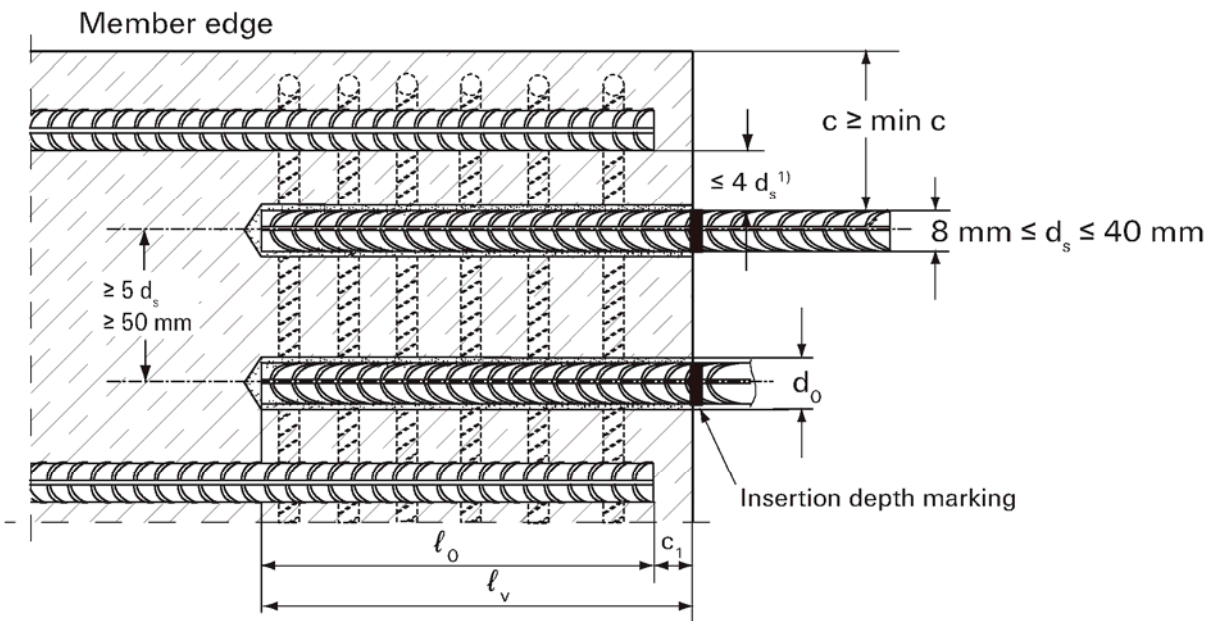
Figure 10: Setting instruction FRA (e.g.: Version with smooth shaft)

Member edge c_1

$c \geq \min c$

$12 \text{ mm} \leq d_s \leq 20 \text{ mm}$

$\leq 4 d_s^{1)}$

N

$\geq 5 d_s$
$\geq 50 \text{ mm}$

N

$\ell_v = \ell_0$ ℓ_e t_{fix}
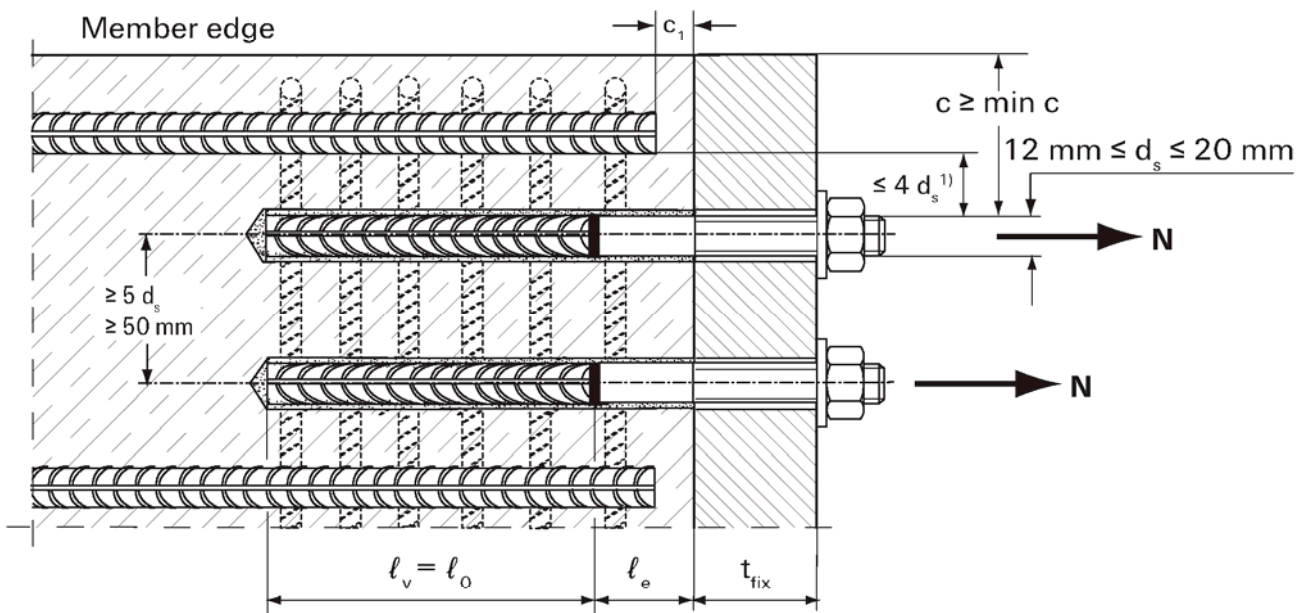
[1] If the clear distance between lapped bars exeeds $4d_s$, then the lap length shall be increased by the difference between the clear bar distance and $4d_s$.

c	concrete cover of bonded-in bar	ℓ_v	effective embedment depth
min c	minimum concrete cover according to Section 4.3.6 of this approval	ℓ_e	length of the smooth shaft
c_1	concrete cover at end-face of bonded-in bar	d_0	nominal drill bit diameter, see table 4, annex 8
d_s	diameter of bonded-in bar	t_{fix}	minimum thickness of fixture
ℓ_0	lap length		

Rebar connection with BTI Injection mortar UVT Top-Z	
General instruction rules	**Annex 5**

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Figure 11: Properties of reinforcing bars „rebars"

marking setting depth
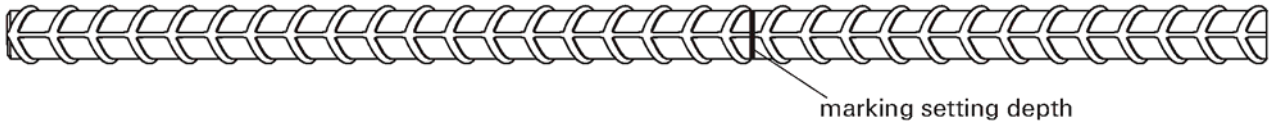
Refer to EN 1992-1-1 Annex C, Table C.1 and C.2N,
properties of reinforcement:

Produkt form		Non-zinc-plated bars and de-coiled rod	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ [MPa]		400 to 600	
Minimum value of $k = (f_t/f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force, ε_{uk} [%]		≥ 5,0	≥ 7,5
Bendability		Bend / Rebend test	
Maximum deviation from nominal mass (individual bar) [%]	Nominal bar size [mm] ≤ 8 > 8	± 6,0 ± 4,5	
Bond: Minimum relative rib area, $f_{R,min}$ (determination according to EN 15630)	Nominal bar size [mm] 8 to 12 > 12	0,040 0,056	

Rib height h:

The rib height h must be: $0,05 \cdot d \leq h \leq 0,07 \cdot d$

d = nominal bar size

Rebar connection with BTI Injection mortar UVT Top-Z	
Properties of rebars	**Annex 6**

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Figure 12: Properties of rebar anchor FRA / FRA C

Head marking e.g.: **FRA** (for stainless steel)
FRA C
(for high corrosion-resistant
steel C)
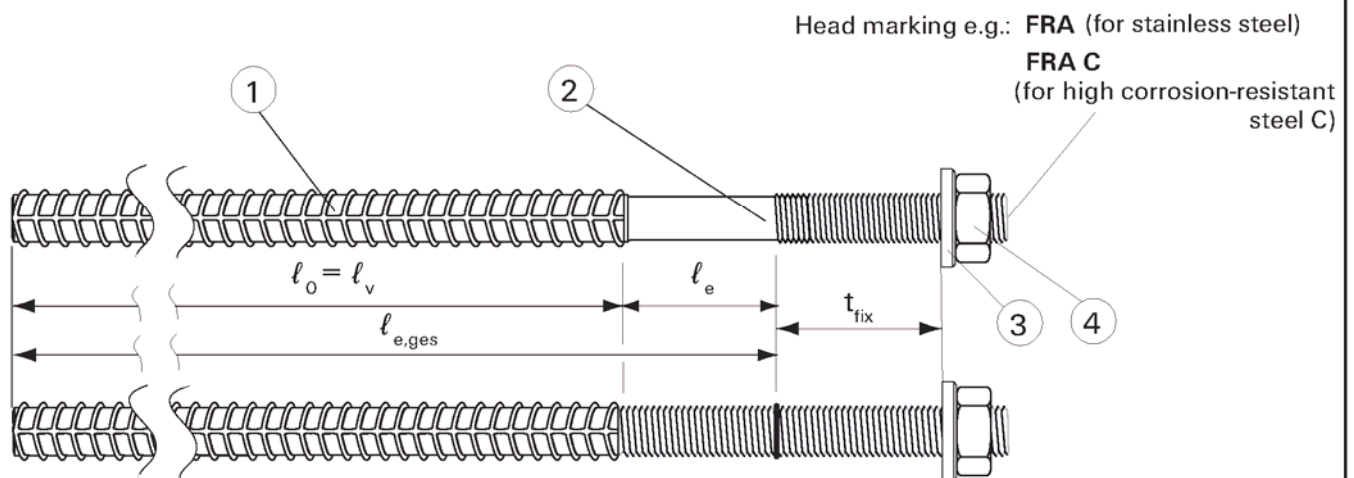
Table 1: Dimensions of rebar anchor FRA and FRA C

Size	FRA 12/l$_{e,ges}$ M12-t$_{fix}$	FRA 16/l$_{e,ges}$ M16-t$_{fix}$	FRA 20/l$_{e,ges}$ M20-t$_{fix}$
Threaded diameter [mm]	12	16	20
Wrench size [mm]	19	24	30
Total embedment depth $\ell_{e,ges}$ [mm]	$\ell_o + \ell_e$		
Effective embedment depth ℓ_v [mm]	according to statical calculation		
Lenght of smooth shaft or cast-in thread ℓ_e [mm]	100		
Minimum thickness of fixture t$_{fix}$ [mm]	5		
Maximum thickness of fixture t$_{fix}$ [mm]	3000		

Table 2: Materials of rebar anchor FRA and FRA C

Part	Description	Materials	
		FRA	FRA C
1	Reinforcing bar	Non-zinc-plated reinforcement bar acc. to EN 1992-1-1	
2	Round bar with partial or full thread	stainless steel according to EN 10088	high corrosion-resistant steel
3	Washer		
4	Hexagon nut	stainless steel according to EN 10088 strength class 80 EN ISO 3506	high corrosion-resistant steel strength class 80 EN ISO 3506

Rebar connection with BTI Injection mortar UVT Top-Z	
Properties of FRA Materials FRA	**Annex 7**

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Table 3: Maximum permissible processing times and minimum curing times

System temperature [°C]	Max. processing time[2] [minutes]	Minimum curing time[3] [hours]
+5 to +10[1]	120	40
>+10 to +20	30	18
>+20 to +30	14	10
>+30 to +40	7	5

[1] For installation temperature lower than 10° C the mortar UVT Top-Z must be tempered to 20°C.

[2] Maximum time from the beginning of injection to rebar setting and positioning.

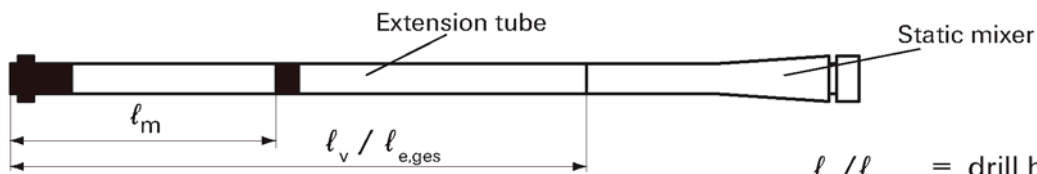[3] For wet concrete the curing time must be doubled

Table 4: Maximum permissible setting depths

Bar diameter d_s [mm]	Nominal drill diameter d_0 [mm]	Diameter of cutting edge d_{cut} [mm]	maximum permissible setting depth I_v [mm]		
			cartridge 390 ml, 585 ml		1500 ml
			manual dispenser	Accu and pneumatic dispenser (small)	pneumatic dispenser (large)
8	12	≤ 12,50	1000	1000	1800
10	14	≤ 14,50			
12/FRA 12	16	≤ 16,50		1200	
14	18	≤ 18,50			
16/FRA 16	20	≤ 20,55		1500	
20/FRA 20	25	≤ 25,55	700	1300	
22 / 24 / 25	30	≤ 30,55		1000	2000
26 / 28	35	≤ 35,70	500	700	
30 / 32 / 34	40	≤ 40,70	—	500	
36	45	≤ 45,70			
40	55	≤ 55,70			

Table 5: Maximum installation torque for rebar anchor FRA

Rebar anchor	Installation torque T_{inst} [Nm]
FRA 12/$l_{e,ges}$ M12 - t_{fix}	50
FRA 16/$l_{e,ges}$ M16 - t_{fix}	100
FRA 20/$l_{e,ges}$ M20 - t_{fix}	150

Marking length ℓ_m as factor of the setting depth ℓ_v

Empirical formula: $\ell_m = \frac{1}{3}\,\ell_v \ \text{ or } \ \ell_m = \frac{1}{3}\,\ell_{e,ges} \ [mm]$

Accurate formula: $\ell_m = \ell_v \ \text{ or } \ \ell_{e,ges}\left(1{,}2\,\dfrac{d_s^2}{d_0^2} - 0{,}2\right) [mm]$

$\ell_v / \ell_{e,ges}$ = drill hole depth
= minimum length of the extension tube

ℓ_m = length from the end of the injection adapter to the marking on the extension tube

Rebar connection with BTI Injection mortar UVT Top-Z	
Processing times and curing times Setting depths; Installation torque FRA Marking length	**Annex 8**

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Installing instructions

Using hammer drill bit or pneumatic drill bit
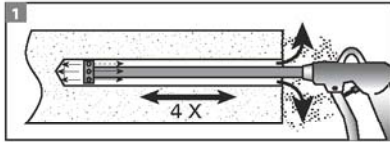
Blow out the drill hole 4 times from the base of the hole with the corresponding cleaning nozzle (oil-free compressed air ≥ 6 bar).

Using diamond core bit

Remove the drill core
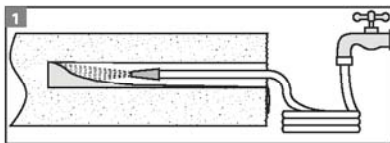
Flush the drill hole with tap water until water runs clear.
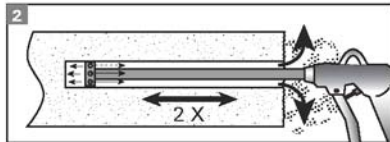
Blow out the drill hole 2 times from the base of the hole with the corresponding cleaning nozzle (oil-free compressed air ≥ 6 bar).
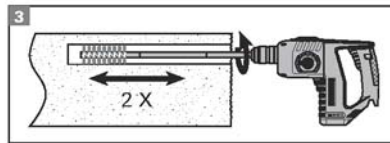
Attach the extension with corresponding stainless steel brush to the power drill. Brush out the drill hole 2 times.
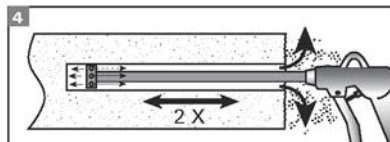
Blow out the drill hole 2 times from the base of the hole with the corresponding cleaning nozzle (oil-free compressed air ≥ 6 bar).

Filling the drill hole
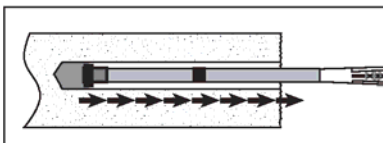
Place mortar cartridge in dispenser. Attach static mixer, extension tube and injection adapter. Slowly withdraw the dispenser - following the pressure build-up - during filling.

Inserting rebar or rebar anchor FRA
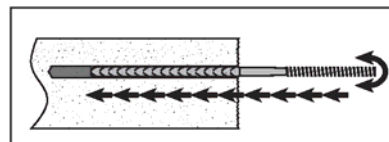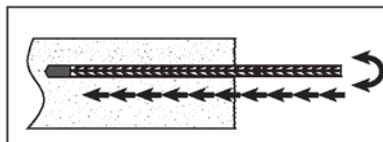
Using a turning movement, push the reinforcement bar vigorously into the filled hole up to the insertion depth marking. Excess mortar has to exit from the drill hole surface. Wait for the specified curing time.

The rebar may only be loaded after full curing!

Rebar connection with BTI Injection mortar UVT Top-Z	
Installing instructions	**Annex 9**

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Table 6: Installing equipment

Rebar diameter	d_s [mm]	8	10	12	14	16	18 20	22 24 25	26 28	30 32 34	36	40
Drill hole diameter	d_0 [mm]	12	14	16	18	20	25	30	35	40	45	55
Brush diameter	[mm]	12,5	15	17	19	21,5	26,5	32	37	42	47	58
Cleaning nozzle diameter	[mm]	11	11	11	15	15	19	19	28	28	38	38
Extension tube diameter	[mm]	9[1]	9[1]	9[1]	9[1] or 15							
Colour of injection adapter and brush		white	blue	red	yellow	green	black	grey	brown	nature		

[1] Observe the max. filling depth for the 9 mm extension tube.

Table 7: Design values of the ultimate bond resistance

Hammer drill or pneumatic drill[1]

	Rebar	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
f_{bd} [N/mm²]	8-25	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
	26-40									4,0

Diamond drill[2]

	Rebar	C12/15	C16/20	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
f_{bd} [N/mm²]	8-12	1,6	2,0	2,3	2,7	3,0	3,4	3,7	4,0	4,3
	14-25	1,6	2,0	2,3	2,7	3,0	3,4	3,7	3,7	3,7
	26-40						3,0	3,0	3,0	3,0

[1] Minimum anchorage length and lap length $l_{b,min}$ and $l_{0,min}$ according to EN 1992-1-1

[2] In case of diamond drilling multiply the values for $l_{b,min}$ and $l_{0,min}$ by 1,3.

Note: The values given in Table 7 are valid for „good bond conditions" as described in EN 1992-1-1. For all other conditions multiply the values by 0,7.

Table 8: Minimum concrete cover min c[1] depending of the drilling method and the drilling tolerance

Drilling method	Bar diameter d_s [mm]	Minimum concrete cover min c	
		without drill guide [mm]	with drill guide [mm]
Hammer drilling/ Diamond drilling	≤ 20 mm	30 mm + 0.06 l_v	30 mm + 0.02 l_v ≥ 2 d_s
	> 20 mm	40 mm + 0.06 l_v	40 mm + 0.02 l_v ≥ 2 d_s
Pneumatic hammer drilling	≤ 20 mm	50 mm + 0.08 l_v	50 mm + 0.02 l_v
	> 20 mm	60 mm + 0.08 l_v	60 mm + 0.02 l_v

[1] see Annex 5, Figures 9 and 10

Note: The minimum concrete cover as specified in EN 1992-1-1 must be observed.

Drill guide

Rebar connection with BTI Injection mortar UVT Top-Z	
Installing equipment Design values Concrete cover	**Annex 10**

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Table 9.1: Values for pre-calculation of anchoring with UVT Top-Z.
Example for C20/25, good bond conditions, Rebar yield strength 500 N/mm².

| Rebar Ø [mm] | $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 1,0$ | | | α_2 or $\alpha_5 = 0,7$ $\alpha_1 = \alpha_3 = \alpha_4 = 1,0$ | | |
	Anchorage length $l_{b,D}$ [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]	Anchorage length $l_{b,D}$ [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]
8	113	6,6	9	113	9,4	9
8	113	6,6	9	200	16,5	15
8	200	11,6	15	–	–	–
8	320	18,5	24	–	–	–
8	378	21,9	29	265	21,9	20
10	142	10,2	18	142	14,6	13
10	200	14,5	18	200	20,6	18
10	300	21,7	27	300	31,0	27
10	400	28,9	36	–	–	–
10	473	34,2	43	331	34,2	30
12	170	14,8	18	170	21.1	18
12	240	20,8	25	240	29,7	25
12	360	31,2	38	360	44,6	38
12	480	41,6	51	–	–	–
12	567	49,2	60	397	49,2	42
14	198	20,1	24	198	28,6	24
14	280	28,3	34	280	40,5	34
14	420	42,5	51	420	50,7	51
14	560	56,7	68	–	–	–
14	662	66,9	80	463	66,9	56
16	227	26,2	31	227	37,5	31
16	320	37,0	43	320	52,9	43
16	480	55,5	65	480	79,3	65
16	640	74,0	87	–	–	–
16	756	87,4	103	529	87,4	72
18	255	33,2	72	255	47,4	72
18	366	46,8	102	360	66,9	102
18	540	70,2	153	540	100,3	153
18	720	93,6	204	–	–	–
18	851	110,6	241	595	110,6	169
20	284	41,0	60	284	58,5	60
20	400	57,8	85	400	82,6	85
20	600	86,7	127	600	123,9	127
20	800	115,6	170	–	–	–
20	945	136,6	200	662	136,6	140
22	312	49,6	122	312	70,8	122
22	440	69,9	173	440	99,9	173
22	660	104,9	259	660	149,9	259
22	880	139,9	345	–	–	–
22	1040	165,3	408	728	165,3	285
24	340	59,0	104	340	84,3	104
24	480	83,2	147	480	118,9	147
24	720	124,9	220	720	178,4	220
24	960	166,5	293	–	–	–
24	1134	196,7	346	794	196,7	242

The design value is valid for „good bond conditions" as described in EN 1992-1-1. For all other conditions multiply the value by 0,7.

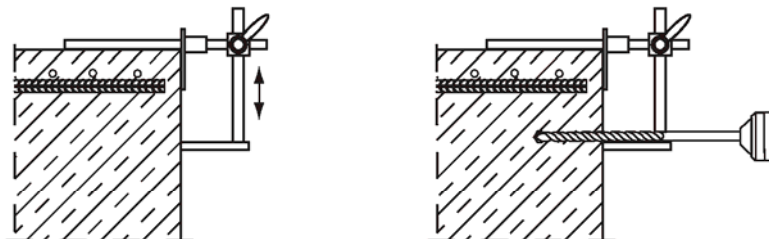Rebar connection with BTI Injection mortar UVT Top-Z

Values for pre-calculation of anchoring with UVT Top-Z
Example for C20/25 ($f_{b,d}$ = 2,3 N/mm²), good bond conditions,
Rebar yield strength 500 N/mm²

Annex 11

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Table 9.2: Values for pre-calculation of anchoring with UVT Top-Z.
Example for C20/25, good bond conditions, Rebar yield strength 500 N/mm².

Rebar Ø [mm]	$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 1,0$			α_2 or $\alpha_5 = 0,7$ $\alpha_1 = \alpha_3 = \alpha_4 = 1,0$		
	Anchorage length $l_{b,D}$ [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]	Anchorage length $l_{b,D}$ [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]
25	354	64,0	92	354	91,5	92
25	500	90,3	130	500	129,0	130
25	750	135,5	194	750	193,5	194
25	1000	180,6	259	–	–	–
25	1181	213,4	306	827	213,4	214
26	369	69,3	191	369	98,9	191
26	520	97,7	269	520	139,6	269
26	780	146,5	404	780	209,3	404
26	1040	195,4	538	–	–	–
26	1229	230,8	636	860	230,8	445
28	397	80,3	165	397	114,4	165
28	600	121,4	249	600	173,2	249
28	840	170,0	349	840	242,8	349
28	1120	226,6	466	–	–	–
28	1323	267,7	550	926	267,7	385
30	425	92,2	281	425	131,7	281
30	600	130,1	396	600	185,8	396
30	900	195,1	594	900	278,7	594
30	1200	260,1	792	–	–	–
30	1418	307,3	935	992	307,3	655
32	454	104,9	246	454	149,9	246
32	640	148,0	347	640	211,4	347
32	960	222,0	521	960	317,1	521
32	1280	296,0	695	–	–	–
32	1512	349,7	821	1059	349,7	575
34	492	118,4	206	492	169,2	206
34	680	163,7	285	680	233,9	285
34	1020	245,6	427	1020	350,8	427
34	1360	327,4	569	-	-	-
34	1640	394,8	686	1148	394,8	480
36	532	132,8	365	532	189,7	365
36	720	179,8	495	720	256,9	495
36	1080	269,7	742	1080	385,3	742
36	1440	359,6	989	-	-	-
36	1772	442,6	1218	1241	442,6	852
40	616	163,9	828	616	234,2	828
40	800	212,7	1074	800	303,9	1074
40	1200	319,1	1612	1200	455,8	1612
40	1600	425,5	2149	-	-	-
40	2055	546,4	2760	1438	546,4	1932

The design value is valid for „good bond conditions" as described in EN 1992-1-1. For all other conditions multiply the value by 0,7.

Rebar connection with BTI Injection mortar UVT Top-Z	
Values for pre-calculation of anchoring with UVT Top-Z Example for C20/25 ($f_{b,d}$ = 2,3 N/mm²), good bond conditions, Rebar yield strength 500 N/mm²	**Annex 12**

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Table 10.1: Values for pre-calculation of overlap joins with UVT Top-Z.
Example for C20/25, good bond conditions, Rebar yield strength 500 N/mm².

Rebar Ø [mm]	$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_5 = \alpha_6 = 1{,}0$			α_2 or $\alpha_5 = 0{,}7$ $\alpha_1 = \alpha_3 = \alpha_6 = 1{,}0$		
	Lap length l_0 [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]	Lap length l_0 [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]
8	200	11,6	15	200	16,5	15
8	320	18,5	24	-	-	-
8	-	-	-	-	-	-
8	-	-	-	-	-	-
8	378	21,9	29	265	21,9	20
10	200	14,5	18	200	20,6	18
10	300	21,7	27	300	31,0	27
10	400	28,9	36	-	-	-
10	-	-	-	-	-	-
10	473	34,2	43	331	34,2	30
12	200	17,3	21	200	24,8	21
12	240	20,8	25	240	29,7	25
12	360	31,2	38	360	44,6	38
12	480	41,6	51	-	-	-
12	567	49,2	60	397	49,2	42
14	210	21,2	25	210	30,4	25
14	280	28,3	34	280	40,5	34
14	420	42,5	51	420	60,7	51
14	560	56,7	68	-	-	-
14	662	67,0	80	463	66,9	56
16	240	27,8	33	240	39,6	33
16	320	37,0	43	320	52,9	43
16	480	55,5	65	480	79,3	65
16	640	74,0	87	-	-	-
16	756	87,4	103	529	87,4	72
18	270	35,1	77	270	50,2	77
18	360	46,8	102	360	66,9	102
18	540	70,2	153	540	100,3	153
18	720	93,6	204	-	-	-
18	851	110,6	241	596	110,6	169
20	300	43,4	64	300	61,9	64
20	400	57,8	85	400	82,6	85
20	600	86,7	127	600	123,9	127
20	800	115,6	170	-	-	-
20	945	136,6	200	662	136,6	140
22	330	52,5	129	330	74,9	129
22	440	70,0	173	440	99,9	173
22	660	105,0	259	660	149,9	259
22	880	140,0	345	-	-	-
22	1040	165,3	408	728	165,3	285
24	360	62,4	110	360	89,2	110
24	480	83,2	147	480	118,9	147
24	720	124,9	220	720	178,4	220
24	960	166,5	293	-	-	-
24	1134	196,7	346	794	196,7	242

The design value is valid for „good bond conditions" as described in EN 1992-1-1. For all other conditions multiply the value by 0,7.

Rebar connection with BTI Injection mortar UVT Top-Z	
Values for pre-calculation of overlap joins with UVT Top-Z Example for C20/25 ($f_{b,d}$ = 2,3 N/mm²), good bond conditions, Rebar yield strength 500 N/mm²	**Annex 13**

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Table 10.2: Values for pre-calculation of overlap joins with UVT Top-Z.
Example for C20/25, good bond conditions, Rebar yield strength 500 N/mm².

Rebar Ø [mm]	$\alpha_1 = \alpha_2 = \alpha_3 = \alpha_5 = \alpha_6 = 1,0$			α_2 or $\alpha_5 = 0,7$ $\alpha_1 = \alpha_3 = \alpha_6 = 1,0$		
	Lap length l_0 [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]	Lap length l_0 [mm]	Design value N_{Rd} [kN]	Mortar volume [ml]
25	375	67,7	97	375	96,8	97
25	500	90,3	130	500	129,0	130
25	750	135,5	194	750	193,5	194
25	1000	180,6	259	-	-	-
25	1181	213,4	306	827	213,4	214
26	390	73,3	202	390	104,7	202
26	520	97,7	269	520	139,6	269
26	780	146,5	404	780	209,3	404
26	1040	195,4	538	-	-	-
26	1229	230,8	636	860	230,8	445
28	420	85,0	175	420	121,4	175
28	600	121,4	249	600	173,4	249
28	840	170,0	349	840	242,8	349
28	1120	226,6	466	-	-	-
28	1323	267,7	550	926	267,7	385
30	450	97,6	297	450	139,4	297
30	600	130,1	396	600	185,8	396
30	900	196,0	594	900	278,7	594
30	1200	260,1	792	-	-	-
30	1418	307,3	935	992	307,3	655
32	480	111,0	261	480	158,6	261
32	640	148,0	347	640	211,4	347
32	960	222,0	521	960	317,1	521
32	1280	296,0	695	-	-	-
32	1512	350,0	821	1059	349,7	575
34	510	122,8	213	510	175,4	213
34	680	163,7	285	680	233,9	285
34	1020	245,6	427	1020	350,8	427
34	1360	327,4	569	-	-	-
34	1640	394,8	686	1148	394,8	480
36	540	134,9	371	540	192,6	371
36	720	179,8	495	720	256,9	495
36	1080	269,7	742	1080	385,3	742
36	1440	359,6	989	-	-	-
36	1772	442,6	1218	1241	442,6	852
40	616	163,9	828	616	234,2	828
40	800	212,7	1074	800	303,9	1074
40	1200	319,1	1612	1200	455,8	1612
40	1600	425,5	2149	-	-	-
40	2055	546,4	2760	1438	546,4	1932

The design value is valid for „good bond conditions" as described in EN 1992-1-1. For all other conditions multiply the value by 0,7.

Rebar connection with BTI Injection mortar UVT Top-Z	
Values for pre-calculation of overlap joins with UVT Top-Z Example for C20/25 ($f_{b,d} = 2,3$ N/mm²), good bond conditions, Rebar yield strength 500 N/mm²	**Annex 14**

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Table 11: Marking length ℓ_m as factor of setting depth ℓ_v resp. $\ell_{e.ges}$

Drill hole depth = setting depth ℓ_v [mm]	Marking length ℓ_m [mm] — Bar diameter d_s [mm]										
	8	10	12/ FRA12	14	16/ FRA16	20/ FRA20	22/24/ 25	26/28	30/32/ 34	36	40
	Nominal drill diameter d_0 [mm]										
	12	14	16	18	20	25	30	35	40	45	55
80	25										
100	35	40									
120	40	50	55								
140	45	60	65	75							
160	55	65	75	85	90						
180	60	75	85	95	100						
200	65	80	95	105	115	115					
220	75	90	105	115	125	125					
240	80	100	115	125	135	135					
250	85	105	120	130	140	140	160				
260	85	105	125	135	150	150	165				
280	95	115	135	145	160	160	175	160			
300	100	125	140	160	170	170	190	170			
320	105	130	150	170	180	180	205	180			
340	115	140	160	180	195	195	215	195	225		
350	115	145	165	185	200	200	220	200	235		
360	120	150	170	190	205	205	230	205	240	205	
380	125	155	180	200	215	215	240	215	255	215	
400	135	165	190	210	225	225	255	225	265	225	175
420	140	175	200	220	240	240	265	240	280	240	185
450	150	185	215	235	255	255	285	255	300	255	195
500	165	205	235	265	285	285	315	285	335	285	215
550	185	225	260	290	310	310	350	310	365	310	240
600	200	245	285	315	340	340	380	340	400	340	260
650	215	270	310	340	370	370	410	370	435	370	285
700	235	290	330	370	400	400	445	400	465	400	305
750	250	310	355	395	425	425	475	425	500	425	325
800	265	330	380	420	455	455	505	455	535	455	350
850	285	350	405	445	485	485	540	485	565	485	370
900	300	370	425	475	510	510	570	510	600	510	390
950	315	390	450	500	540	540	600	540	635	540	415
1000	335	410	475	525	570	570	635	570	665	570	435
1100	365	455	520	580	625	625	695	625	735	625	480
1200	400	495	570	630	680	680	760	680	800	680	520
1300	435	535	615	685	740	740	825	740	865	740	565
1400	465	575	665	735	795	795	885	795	935	795	610
1500	500	620	710	790	850	850	950	850	1000	850	650
1600	535	660	760	840	910	910	1015	910	1065	910	695
1700	565	700	805	895	965	965	1075	965	1135	965	740
1800	600	740	855	945	1020	1020	1140	1020	1200	1020	780
1900							1205	1080	1265	1080	825
2000							1265	1135	1335	1135	870

Rebar connection with BTI Injection mortar UVT Top-Z

Marking length

Annex 15