Deutsches Institut für Bautechnik
DIBt

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

# European Technical Assessment

# ETA-17/1056 of 22 January 2021

English translation prepared by DIBt - Original version in German language

**General Part**

| | |
|---|---|
| Technical Assessment Body issuing the European Technical Assessment: | Deutsches Institut für Bautechnik |
| Trade name of the construction product | Rebar connection with fischer injection system FIS EM Plus |
| Product family to which the construction product belongs | Injection system for post-installed rebar connections |
| Manufacturer | fischerwerke GmbH & Co. KG<br>Otto-Hahn-Straße 15<br>79211 Denzlingen<br>DEUTSCHLAND |
| Manufacturing plant | fischerwerke |
| This European Technical Assessment contains | 26 pages including 3 annexes which form an integral part of this assessment |
| This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of | EAD 330087-01-0601 Edition 01/2021 |
| This version replaces | ETA-17/1056 issued on 17 June 2020 |

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## Specific Part

## 1 Technical description of the product

The subject of this European technical assessment 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 FIS EM Plus in accordance with the regulations for reinforced concrete construction.

Reinforcing bars with a diameter $\phi$ from 8 to 40 mm or the fischer rebar anchor FRA of sizes M12 to M24 according to Annex A and the fischer injection mortar FIS EM Plus are used for the post-installed rebar connection. The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between embedded reinforcing bar, injection mortar and concrete.

The product description is given in Annex A.

## 2 Specification of the intended use in accordance with the applicable European assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the rebar connections of at least 50 and/or 100 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.

## 3 Performance of the product and references to the methods used for its assessment

### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic | Performance |
|---|---|
| Characteristic resistance under static and quasi-static loading | See Annex C 1 and C 2 |
| Characteristic resistance under seismic action | See Annex B 5 and C 3 |

### 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Class A1 |
| Resistance to fire | See Annex C 4 and C 5 |

## 4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 330087-01-0601, the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

## 5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 22 January 2020 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

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## Installation conditions and application examples reinforcing bars, part 1

**Figure A1.1:**
Overlap joint with existing reinforcement for rebar connections of slabs and beams

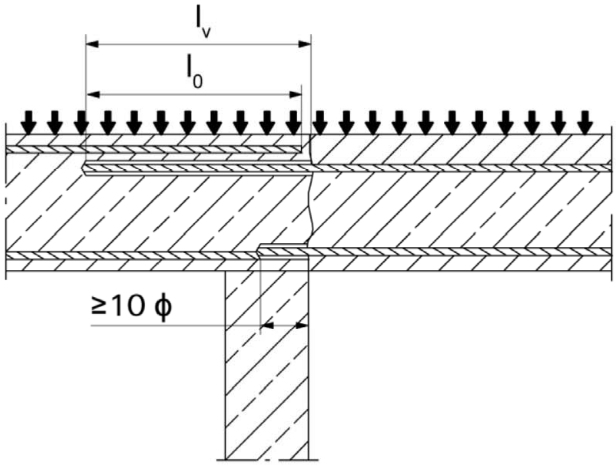



**Figure A1.2:**
Overlap joint with existing reinforcement at a foundation of a column or wall where the rebars are stressed

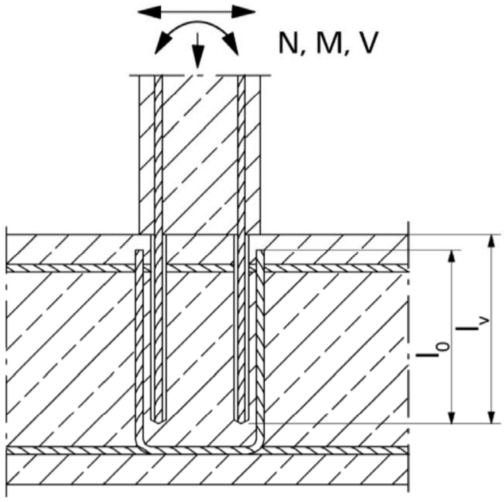
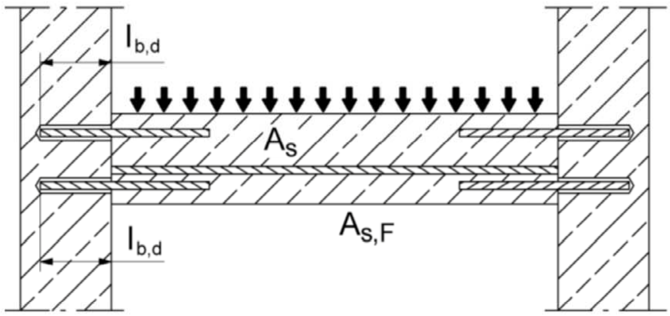



**Figure A1.3:**
End anchoring of slabs or beams (e.g. designed as simply supported)




Figures not to scale

| Rebar connection with fischer injection mortar FIS EM Plus | **Annex A 1** |
|---|---|
| **Product description**<br>Installation conditions and application examples reinforcing bars, part 1 | |

## Installation conditions and application examples reinforcing bars, part 2

**Figure A2.1:**
Rebar connection for stressed primarily in compression

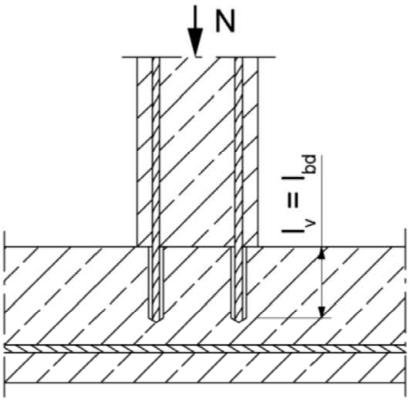
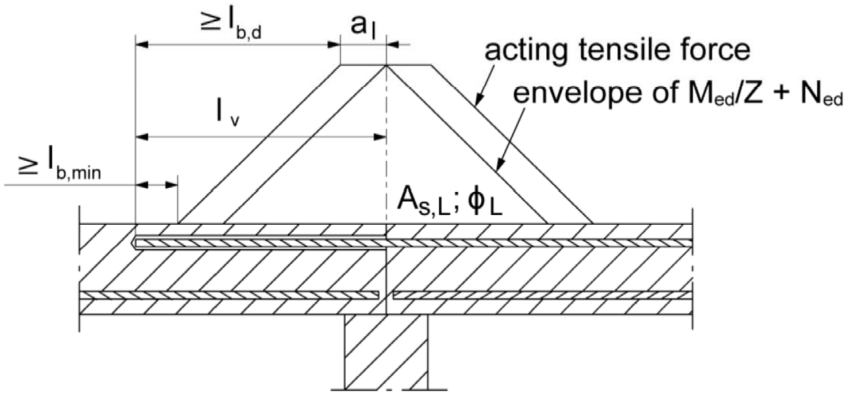



**Figure A2.2:**
Anchoring of reinforcement to cover the enveloped line of acting tensile force in the bending member




Note to **figure A1.1** to **A1.3** and **figure A2.1** to **A2.2**

In the figures no traverse reinforcement is plotted, the transverse reinforcement shall comply with EN 1992-1-1: 2004+AC:2010.

Preparing of joints according to **Annex B 2**

Figures not to scale

| Rebar connection with fischer injection mortar FIS EM Plus | **Annex A 2** |
|---|---|
| **Product description**<br>Installation conditions and application examples reinforcing bars, part 2 | |

## Installation conditions and application examples fischer rebar anchor, part 3

**Figure A3.1:**
Lap to a foundation of a column under bending.

1. Shear lug (or fastener loaded in shear)
2. fischer Rebar tension anchor (tension only)
3. Existing stirrup / reinforcement for overlap (lap splice)
4. Slotted hole

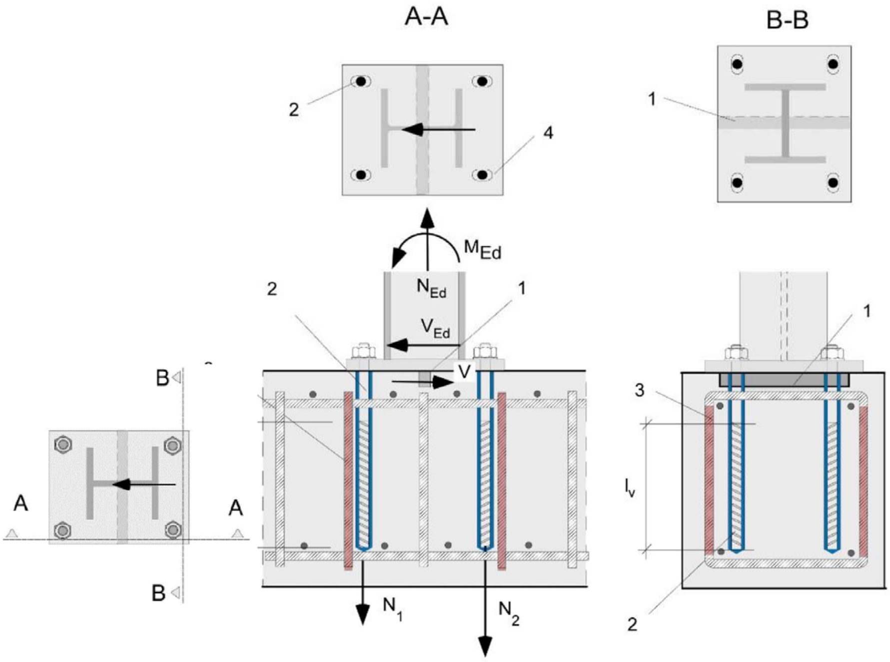
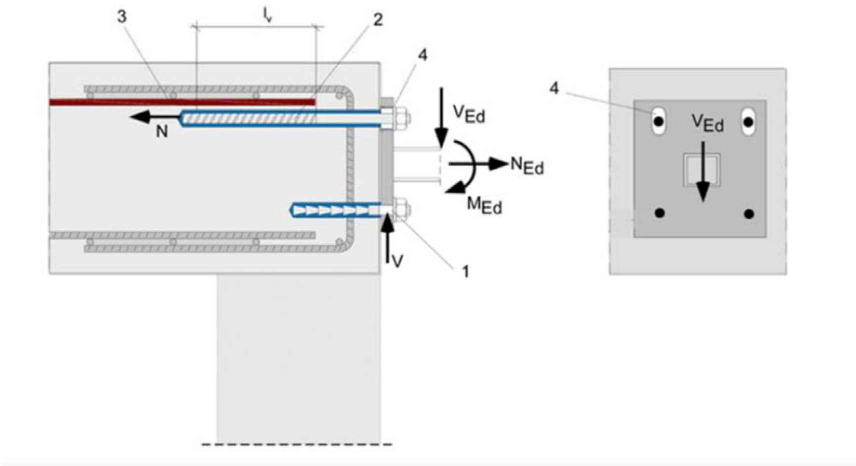



**Figure A3.2:**
Lap of the anchoring of guardrail posts or anchoring of cantilevered building components.
In the anchor plate, the drill holes for the fischer rebar anchors have to be designed as slotted holes with axial direction to the shear force.

1. Fastener for shear load transfer
2. fischer rebar tension anchor (tension only)
3. Existing stirrup / reinforcement for overlap (lap splice)
4. Slotted hole



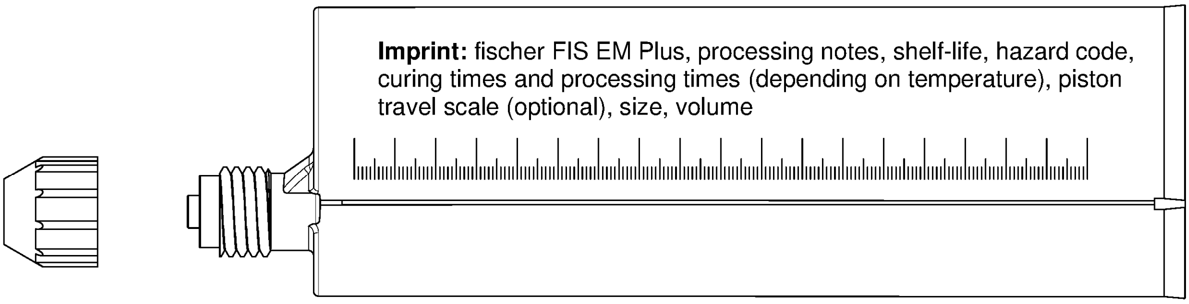

The required transverse reinforcement acc. to EN 1992-1-1:2004+AC:2010 is not shown in the figures. **The fischer rebar anchor may be only used for axial tensile force.** The tensile force must transfered by lap to the existing reinforcement of the building. The transfer of the shear force has to be ensured by suitable measure, e.g. by means of shear force or anchors with European Technical Assessment (ETA).

Figures not to scale

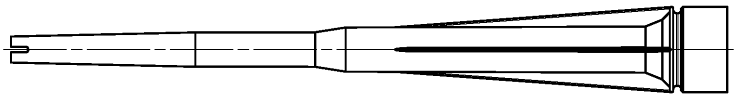
| Rebar connection with fischer injection mortar FIS EM Plus | **Annex A 3** |
|---|---|
| **Product description**<br>Installation conditions and application examples fischer rebar anchors, part 3 | |

## Overview system components

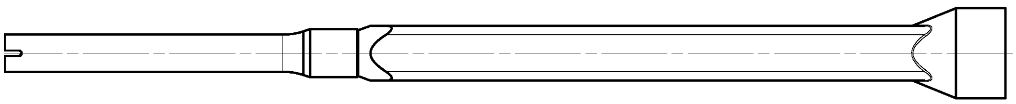
**Injection cartridge (shuttle cartridge) FIS EM Plus with sealing cap**
Sizes: 390 ml, 585 ml, 1100 ml, 1500 ml



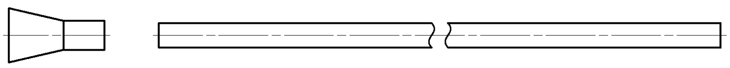

**Static mixer FIS MR Plus for injection cartridge 390 ml**



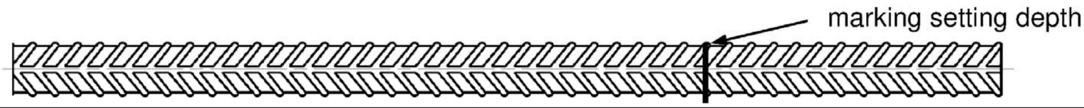
**Static mixer FIS UMR for injection cartridge 585 ml to 1500 ml**



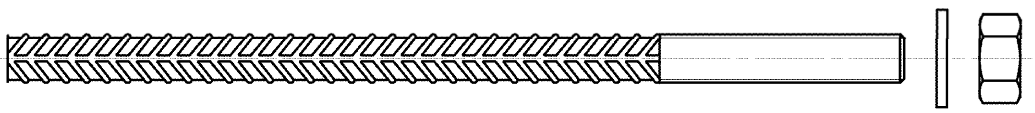
**Injection adapter and extension tube Ø 9 for static mixer FIS MR Plus;**
**Injection adapter and extension tube Ø 9 or Ø 15 for static mixer FIS UMR**



**Reinforcing bar (rebar)**
Sizes: ϕ8, ϕ10, ϕ12, ϕ14, ϕ16, ϕ20, ϕ22, ϕ24, ϕ25, ϕ26, ϕ28, ϕ30, ϕ 32, ϕ34, ϕ36, ϕ40




**fischer rebar anchor FRA, FRA HCR**
Sizes**:** M12, M16, M20, M24



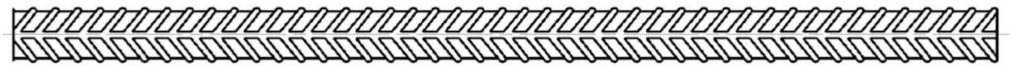
**Blow out pump ABP**

Figures not to scale

| Rebar connection with fischer injection mortar FIS EM Plus | **Annex A 4** |
|---|---|
| **Product description**<br>Overview system components;<br>Injection mortar, reinforcing bar, fischer rebar anchor, blow out pump | |

## Properties of reinforcing bars (rebar)

**Figure A5.1:**



- The minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- The maximum outer rebar diameter over the rips shall be:
  - The nominal diameter of the rip $\phi + 2 * h$ ($h \le 0{,}07 * \phi$)
  - ($\phi$: Nominal diameter of the bar; h: rip height of the bar)

### Table A5.1: Installation conditions for rebars

| **Nominal diameter of the bar** | | **ϕ** | **8**[1)] | | **10**[1)] | | **12**[1)] | | **14** | **16** | **20** | **22** | **24** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ | [mm] | 10 | 12 | 12 | 14 | 14 | 16 | 18 | 20 | 25 | 30 | 30 |
| Drill hole depth | $h_0$ | [mm] | $h_0 = l_v$ | | | | | | | | | | |
| Effective embedment depth | $l_v$ | [mm] | acc. to static calculation | | | | | | | | | | |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $l_v + 30$ (≥ 100) | | | | $l_v + 2d_0$ | | | | | | |

| **Nominal diameter of the bar** | | **ϕ** | **25**[1)] | | **26** | **28** | **30** | **32** | **34** | **36** | **40** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ | [mm] | 30 | 35 | 35 | 35 | 40 | 40 | 40 | 45 | 55 |
| Drill hole depth | $h_0$ | [mm] | $h_0 = l_v$ | | | | | | | | |
| Effective embedment depth | $l_v$ | [mm] | acc. to static calculation | | | | | | | | |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $l_v + 2d_0$ | | | | | | | | |

[1)] Both drill hole diameters can be used

### Table A5.2: Materials of rebars

| **Designation** | **Reinforcing bar (rebar)** |
|---|---|
| Reinforcing bar<br>EN 1992-1-1:2004+AC:2010, Annex C | Bars and de-coiled rods class B or C with<br>$f_{yk}$ and k according to NDP or NCL of EN 1992-1-1/NA<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ |

Figures not to scale

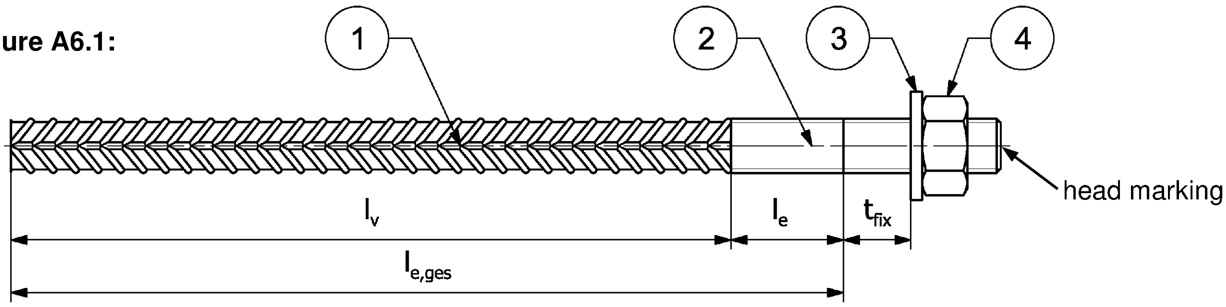
Rebar connection with fischer injection mortar FIS EM Plus

**Product description**
Properties and materials of reinforcing bars (rebar)

**Annex A 5**

## Properties of fischer rebar anchor

**Figure A6.1:**




Head marking e.g.: FRA (for stainless steel)

FRA HCR (for high corrosion-resistant steel)

### Table A6.1: Installation conditions for fischer rebar anchors

| Threaded diameter | | | M12 [2)] | | M16 | M20 | M24 [2)] | |
|---|---|---|---|---|---|---|---|---|
| Nominal diameter | $\phi$ | [mm] | 12 | | 16 | 20 | 25 | |
| Width across flat | SW | [mm] | 19 | | 24 | 30 | 36 | |
| Nominal drill bit diameter | $d_0$ | [mm] | 14 | 16 | 20 | 25 | 30 | 35 |
| Drill hole depth ($h_0 = l_{ges}$) | $l_{e,ges}$ | [mm] | $l_v + l_e$ | | | | | |
| Effective embedment depth | $l_v$ | [mm] | acc. to static calculation | | | | | |
| Distance concrete surface to welded join | $l_e$ | [mm] | 100 | | | | | |
| Diameter of clearance hole in the fixture[1)] | Pre-positioned $\leq d_f$ | [mm] | 14 | | 18 | 22 | 26 | |
| | Push through $\leq d_f$ | [mm] | 16 | 18 | 22 | 26 | 32 | 40 |
| Minimum thickness of concrete member | $h_{min}$ | [mm] | $h_0$+30 (≥ 100) | | $h_0 + 2d_0$ | | | |
| Maximum torque moment for attachment of the fixture | max $T_{fix}$ | [Nm] | 50 | | 100 | 150 | 150 | |

[1)] For bigger clearance holes in the fixture see EN 1992-4:2018
[2)] Both drill bit diameters can be used

### Table A6.2: Materials of fischer rebar anchors

| Part | Description | Materials | |
|---|---|---|---|
| | | FRA<br>Corrosion resistance class CRC III<br>acc. to EN 1993-1-4:2015 | FRA HCR<br>Corrosion resistance class CRC V<br>acc. to EN 1993-1-4:2015 |
| 1 | Reinforcing bar | Bars and de-coiled rods class B or C with $f_{yk}$ and k according to NDP or NCL of EN 1992-1-1:NA; $f_{uk} = f_{tk} = k \cdot f_{yk}$ | |
| 2 | Round bar with partial or full thread | Stainless steel, strength class 80, according to EN 10088-1:2014 | High corrosion-resistant steel, strength class 80, according to EN 10088-1:2014 |
| 3 | Washer<br>ISO 7089:2000 | Stainless steel, according to EN 10088-1:2014 | High corrosion-resistant steel, according to EN 10088-1:2014 |
| 4 | Hexagon nut | Stainless steel, strength class 80, acc. to EN ISO 3506:2009 | High corrosion-resistant steel, strength class 80, acc. to EN ISO 3506:2009 |

Figures not to scale

## Specifications of intended use (part 1)

**Table B1.1:** Overview use and performance categories

| Anchorages subject to | FIS EM Plus with … | | | |
|---|---|---|---|---|
| | Reinforcing bar  | | fischer rebar anchor  | |
| Hammer drilling with standard drill bit  | all sizes | | | |
| Hammer drilling with hollow drill bit (fischer "FHD", Heller "Duster Expert"; Bosch „Speed Clean"; Hilti "TE-CD, TE-YD")  | Nominal drill bit diameter ($d_0$) 12 mm to 35 mm | | | |
| Diamond drilling  | all sizes | | | |
| Static and quasi static load, in uncracked concrete / cracked concrete | all sizes | Tables: C1.1 C1.2 C1.3 C2.1 | all sizes | Tables: C1.1 C1.2 C1.3 C1.4 C2.1 |
| Seismic action (only hammer drilling with standard / hollow drill bits) | all sizes | Tables: C3.1 C3.2 C3.3 | no performance assessed | |
| Installation temperature | $T_{i,min}$ = -5 °C to $T_{i,max}$ = +40 °C | | | |
| Resistance to fire | all sizes | Annex C5 | all sizes | Annex C4 |

## Specifications of intended use (part 2)

**Anchorages subject to:**
- Static, quasi-static and seismic loads: reinforcing bar (rebar) size 8 mm to 40 mm
- Resistance to fire

**Base materials:**
- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A1:2016
- Strength classes C12/15 to C50/60 according to EN 206:2013+A1:2016
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2013+A1:2016
- Non-carbonated concrete
  Note: 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 ϕ + 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 in accordance with EN 1992-1-1 :2004+AC:2010. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions

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

**Installation temperature**:
- -5 °C to +40 °C

**Use conditions (Environmental conditions) for fischer rebar anchors:**
- For all conditions according to EN1993-1-4:2015 corresponding to corrosion resistance classes to Annex A 6 table A6.2

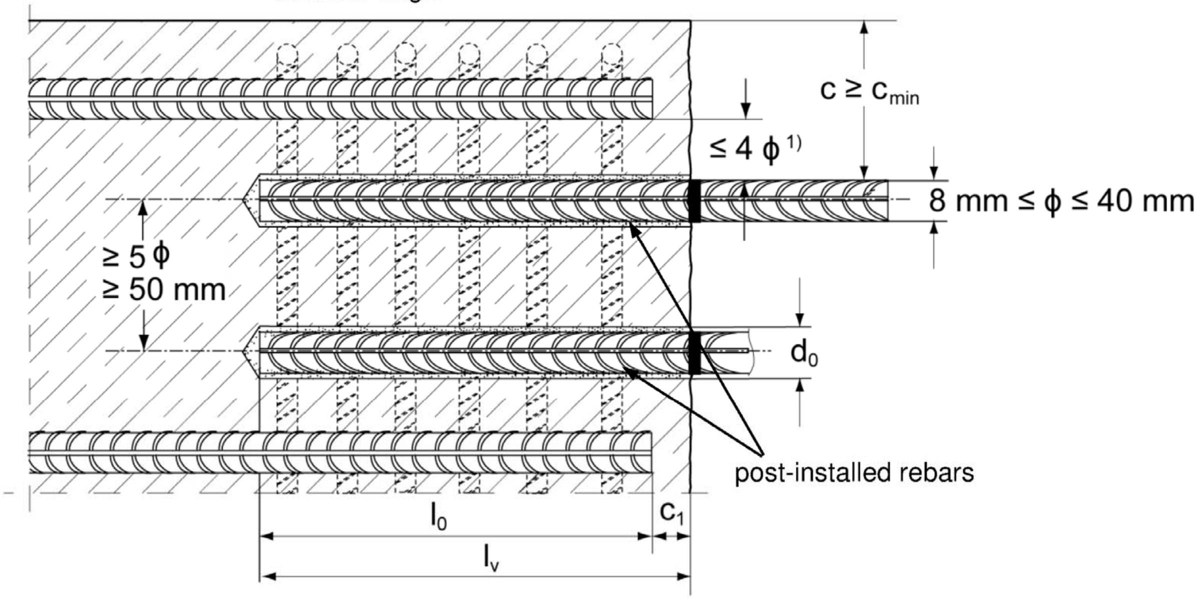
**Design:**
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- Design according to EN 1992-1-1:2004+AC:2010 and Annex B 3 and B 4.
- The 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.

**Installation:**
- Dry or wet concrete
- It must not be installed in water filled holes
- Hole drilling by hammer drill, hollow drill, compressed air drill or diamond drill mode
- Overhead installation allowed
- The installation of post-installed rebar respectively fischer rebar anchor 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.
- 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).

## General construction rules for post-installed rebars

**Figure B3.1:**

- Only tension forces in the axis of the rebar may be transmitted
- The transfer of shear forces between new concrete and existing structure shall be designed additionally according to EN 1992-1-1:2004+AC:2010.
- The joints for concreting must be roughened to at least such an extent that aggregate protrude.




[1] If the clear distance between lapped bars exceeds 4 ϕ then the lap length shall be increased by the difference between the clear bar distance and 4 ϕ

| | |
|---|---|
| c | concrete cover of post-installed rebar |
| $c_1$ | concrete cover at end-face of existing rebar |
| $c_{min}$ | minimum concrete cover according to table B5.1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2 |
| ϕ | nominal diameter of reinforcing bar |
| $l_0$ | lap length, according to EN 1992-1-1:2004+AC:2010 for static loading and according to EN 1998-1:2004, section 5.6.3 for seismic loading |
| $l_v$ | effective embedment depth, ≥: $l_0 + c_1$ |
| $d_0$ | nominal drill bit diameter, see Annex B 6 |

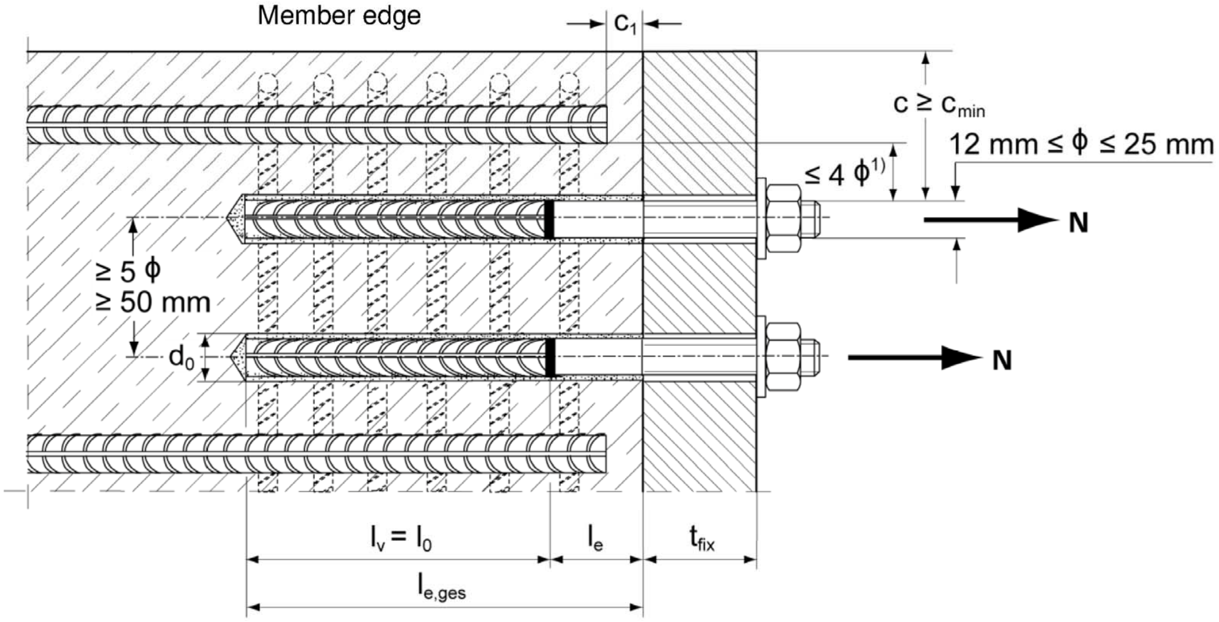
Figures not to scale

| Rebar connection with fischer injection mortar FIS EM Plus | **Annex B 3** |
|---|---|
| **Intended use**<br>General construction rules for for post-installed rebars | |

## General construction rules for post-installed fischer rebar anchors

**Figure B4.1:**

- Only tension forces in the axis of the fischer rebar anchor may be transmitted.
- The tension force must be transferred via an overlap joint to the reinforcement in the building part.
- The transmission of the shear load shall be ensured by appropriate additional measures, e.g. by shear lugs or by anchors with a European Technical Assessment (ETA).
- In the anchor plate, the holes for the tension anchor shall be executed as slotted holes with the axis in the direction of the shear force.




[1)] If the clear distance between lapped bars exceeds 4 ϕ then the lap length shall be increased by the difference between the clear bar distance and 4 ϕ.

| | |
|---|---|
| $c$ | concrete cover of post-installed fischer rebar anchor |
| $c_1$ | concrete cover at end-face of existing rebar |
| $c_{min}$ | minimum concrete cover according to table B5.1 and to EN 1992-1-1:2004+AC:2010, Section 4.4.1.2 |
| $\phi$ | nominal diameter of reinforcing bar |
| $l_0$ | lap length, according to EN 1992-1-1:2004+AC:2010, Section 8.7.3 |
| $l_{e,ges}$ | overall embedment depth, ≥ $l_0 + l_e$ |
| $d_0$ | nominal drill bit diameter, see Annex B 6 |
| $l_e$ | length of the bonded in threaded part |
| $t_{fix}$ | thickness of the fixture |
| $l_v$ | effective embedment depth |

Figures not to scale

Rebar connection with fischer injection mortar FIS EM Plus

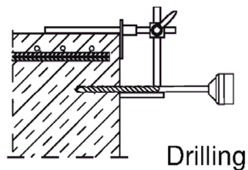
**Intended use**
General construction rules for post-installed fischer rebar anchors

**Annex B 4**

Deutsches Institut für Bautechnik DIBt

**Table B5.1:** Minimum concrete cover $c_{min} = c_{min,seis}$ [1)] depending of the drilling method and the drilling tolerance

| Drilling method | nominal diameter of reinforcing bar ϕ [mm] | Minimum concrete cover $c_{min} = c_{min,seis}$ Without drilling aid [mm] | Without drilling aid [mm] |
|---|---|---|---|
| Hammer drilling with standard drill bit | < 25 | 30 mm + 0,06 $l_v \geq 2\phi$ | 30 mm + 0,02 $l_v \geq 2\phi$ |
| | ≥ 25 | 40 mm + 0,06 $l_v \geq 2\phi$ | 40 mm + 0,02 $l_v \geq 2\phi$ |
| Hammer drilling with hollow drill bit (fischer “FHD”, Heller "Duster Expert"; Bosch „Speed Clean“; Hilti "TE-CD, TE-YD") | < 25 | 30 mm + 0,06 $l_v \geq 2\phi$ | 30 mm + 0,02 $l_v \geq 2\phi$ |
| | ≥ 25 | 40 mm + 0,06 $l_v \geq 2\phi$ | 40 mm + 0,02 $l_v \geq 2\phi$ |
| Compressed air drilling | < 25 | 50 mm + 0,08 $l_v$ | 50 mm + 0,02 $l_v$ |
| | ≥ 25 | 60 mm + 0,08 $l_v \geq 2\phi$ | 60 mm + 0,02 $l_v \geq 2\phi$ |
| Diamond drilling | < 25 | 30 mm + 0,06 $l_v \geq 2\phi$ | 30 mm + 0,02 $l_v \geq 2\phi$ |
| | ≥ 25 | 40 mm + 0,06 $l_v \geq 2\phi$ | 40 mm + 0,02 $l_v \geq 2\phi$ |



Drilling aid

[1)] See Annex B3, figure B3.1and Annex B4, figure B4.1
Note: The minimum concrete cover as specified in EN 1992-1-1:2004+AC:2010 must be observed.

**Table B5.2:** Dispensers and cartride sizes corresponding to maximum embedment depth $l_{v,max}$

| reinforcing bars (rebar) | fischer rebar anchor | Manual dispenser | Accu and pneumatic dispenser (small) | Pneumatic dispenser (large) |
|---|---|---|---|---|
| | | Cartridge size 390 ml, 585 ml | Cartridge size 390 ml, 585 ml | Cartridge size 1500 ml |
| ϕ [mm] | [-] | $l_{v,max}$ / $l_{e,ges,max}$ [mm] | $l_{v,max}$ / $l_{e,ges,max}$ [mm] | $l_{v,max}$ / $l_{e,ges,max}$ [mm] |
| 8 | --- | 1000 | 1000 | 1800 |
| 10 | --- | | | |
| 12 | FRA M12<br>FRA HCR M12 | | 1200 | |
| 14 | --- | | | |
| 16 | FRA M16<br>FRA HCR M16 | | 1500 | |
| 20 | FRA M20<br>FRA HCR M20 | 700 | 1300 | |
| 22 / 24 / 25 | FRA M24<br>FRA HCR M24 | | 1000 | 2000 |
| 26 / 28 | --- | 500 | 700 | |
| 30 / 32 / 34 | --- | no performance assessed | 500 | |
| 36 | --- | | | |
| 40 | --- | | | |

Rebar connection with fischer injection mortar FIS EM Plus

**Intended use**
Minimum concrete cover;
dispenser and cartridge sizes corresponding to maximum embedment depth

**Annex B 5**

**Table B6.1:** Working times $t_{work}$ and curing times $t_{cure}$

| Temperature in the anchorage base [°C] | Maximum working time[1) ] $t_{work}$ **FIS EM Plus** | Minimum curing time[2)] $t_{cure}$ **FIS EM Plus** |
|---|---|---|
| -5 to 0 | 240 min [3)] | 200 h |
| >0 to 5 | 150 min [3)] | 90 h |
| >5 to 10 | 120 min [3)] | 40 h |
| >10 to 20 | 30 min | 18 h |
| >20 to 30 | 14 min | 10 h |
| >30 to 40 | 7 min [4)] | 5 h |

[1)] Maximum time from the beginning of the injection to rebar / fischer rebar anchor setting and positioning
[2)] For wet concrete the curing time must be doubled
[3)] If the temperature in the concrete falls below 10°C the cartridge has to be warmed up to +15°C.
[4)] If the temperature in the concrete exceeds 30 °C the cartridge has to be cooled down to +15°C up to 20°C

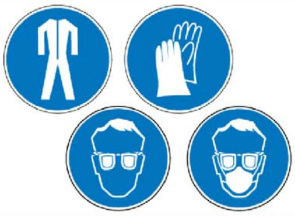
**Table B6.2:** Installation tools for drilling and cleaning the bore hole and injection of the mortar

| reinforcing bars (rebar) | fischer rebar anchor | Drilling and cleaning | | | | Injection | |
|---|---|---|---|---|---|---|---|
| | | Nominal drill bit diameter | Diameter of cutting edge | Steel brush diameter | Diameter of cleaning nozzle | Diameter of extension tube | Injection adapter |
| $\phi$ [mm] | [-] | $d_0$ [mm] | $d_{cut}$ [mm] | $d_b$ [mm] | [mm] | [mm] | [colour] |
| 8[1)] | --- | 10 | ≤ 10,50 | 11,0 | --- | 9 | --- |
| | | 12 | ≤ 12,50 | 12,5 | 11 | | nature |
| 10[1)] | --- | 12 | ≤ 12,50 | 12,5 | | | |
| | | 14 | ≤ 14,50 | 15 | | | blue |
| 12[1)] | FRA M12[1)] FRA HCR M12[1)] | 14 | ≤ 14,50 | 15 | 15 | | |
| | | 16 | ≤ 16,50 | 17 | | | red |
| 14 | --- | 18 | ≤ 18,50 | 19 | | 9 or 15 | yellow |
| 16 | FRA M16 FRA HCR M16 | 20 | ≤ 20,55 | 21,5 | 19 | | green |
| 20 | FRA M20 FRA HCR M20 | 25 | ≤ 25,55 | 26,5 | | | black |
| 22 / 24 | --- | 30 | ≤ 30,55 | 32 | 28 | | grey |
| 25 | FRA M24[1)] FRA HCR M24[1)] | 30 | ≤ 30,55 | 32 | | | grey |
| | | 35 | ≤ 35,70 | 37 | | | brown |
| 26 / 28 | --- | 35 | ≤ 35,70 | 37 | | | brown |
| 30 / 32 / 34 | --- | 40 | ≤ 40,70 | 42 | 38 | | red |
| 36 | --- | 45 | ≤ 45,70 | 47 | | | yellow |
| 40 | --- | 55 | ≤ 55,70 | 58 | | | nature |

[1)] Both drill bit diameters can be used

| Rebar connection with fischer injection mortar FIS EM Plus | Annex B 6 |
|---|---|
| **Intended use** Working times and curing times; Installation tools for drilling and cleaning the bore hole and injection of the mortar | |

## Safety regulations



Review the Material Safety Data Sheet (SDS) before use for proper and safe handling!

Wear well-fitting protective goggles and protective gloves when working with mortar FIS EM Plus

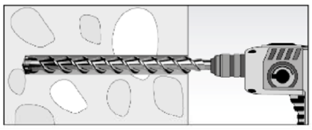
Important: Observe the instructions for use provided with each cartridge.

## Installation instruction part 1; Installation with FIS EM Plus

### Hole drilling

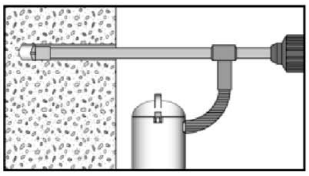
Note: Before drilling, remove carbonized concrete; clean contact areas (see Annex B 2)
In case of aborted drill holes the drill hole shall be filled with mortar.

**1a** **Hammer drilling or compressed air drilling**



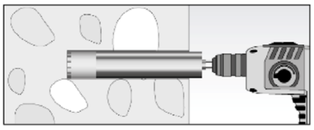
Drill the hole to the required embedment depth using a hammer drill with carbide drill bit set in rotation hammer mode or a pneumatic drill.
Drill bit sizes see table B6.2

**1b** **Hammer drilling with hollow drill bit**

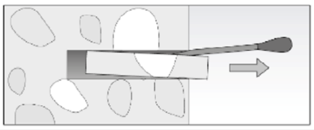


Drill the hole to the required embedment depth using a hammer drill with hollow drill bit in rotation hammer mode.
Dust extraction conditions see drill hole cleaning annex B 8.
Drill bit sizes see table B6.2

**1c** **Diamond drilling**

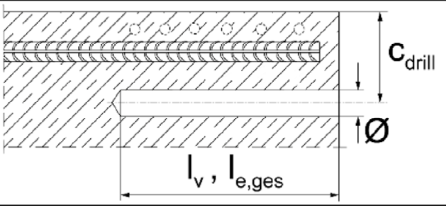


Drill the hole to the required embedment depth using a diamond drill in rotation mode.
Drill bit sizes see table B6.2

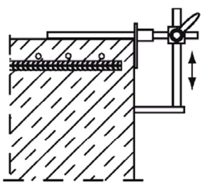


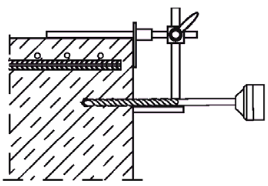
Break away the drill core and remove it

**2**




Measure and control concrete cover c
($c_{drill}$ = c + Ø / 2)
Drill parallel to surface edge and to existing rebar.
Where applicable use fischer drilling aid.





For holes $l_v$ > 20 cm use drilling aid.
Three different options can be considered:

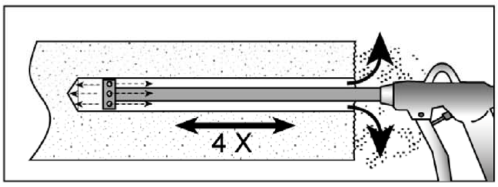
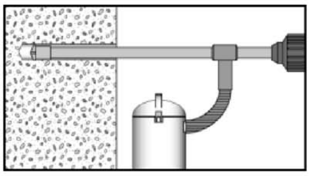
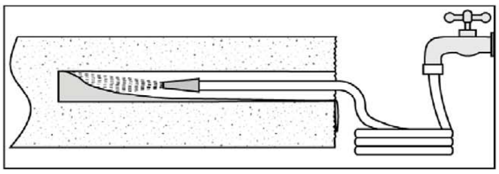
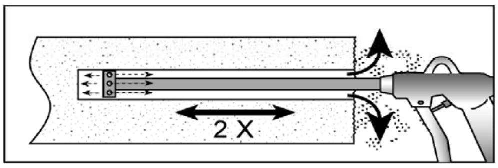
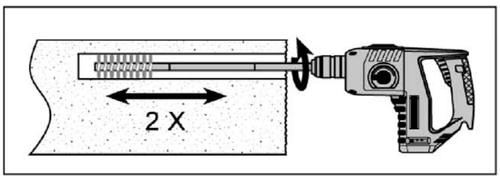
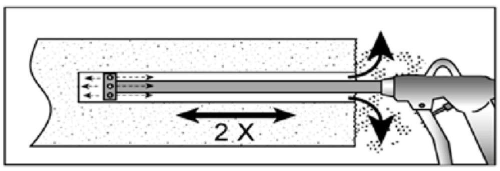
A) fischer drilling aid
B) Slat or spirit level
C) Visual check

Minimum concrete cover $c_{min}$ see table B5.1

| Rebar connection with fischer injection mortar FIS EM Plus | **Annex B 7** |
|---|---|
| **Intended use**<br>Safety regulations; Installation instruction part 1, hole drilling | |

## Installation instruction part 2; Installation with FIS EM Plus

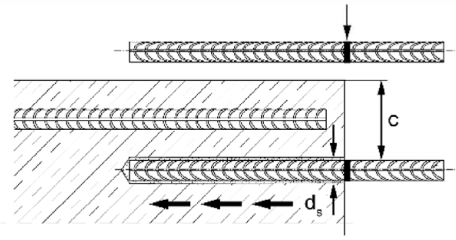
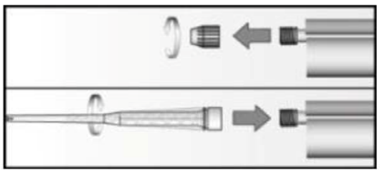
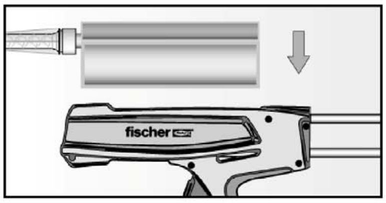
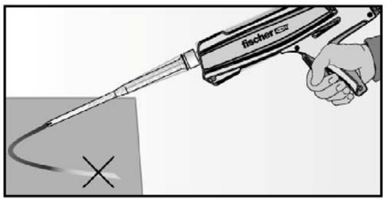
Drill hole cleaning

| | | |
|---|---|---|
| **3a** | **Hammer or compressed air drilling** |  |
| |   | Blowing<br>four times from the back of the hole with the appropriate nozzle (oil-free compressed air ≥ 6 bar) until return air stream is free of noticeable dust.<br>Personal protective equipment must be used (see regulations Annex B 7). |
| **3b** | **Hammer drilling with hollow drill bit** |  |
| |  | Use a suitable dust extraction system, e. g. fischer FVC 35 M or a comparable dust extraction system with equivalent performance data.<br>Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process and must be adjusted to maximum power.<br>No further drill hole cleaning necessary |
| **3c** | **Diamond drilling** |  |
| |  | Flush the bore hole until the water comes clear |
| |   | Blowing<br>twice from the back of the hole with the appropriate nozzle (oil-free compressed air ≥ 6 bar) until return air stream is free of noticeable dust.<br>Personal protective equipment must be used (see regulations Annex B 7). |
| |   | Check steel brush with brush control template.<br>Fix an adequate steel brush with an extension into a drilling machine and brush the bore hole twice |
| |   | Blowing<br>twice from the back of the hole with the appropriate nozzle (oil-free compressed air ≥ 6 bar) until return air stream is free of noticeable dust.<br>Personal protective equipment must be used<br>(see regulations Annex B 7). |

| | |
|---|---|
| Rebar connection with fischer injection mortar FIS EM Plus | **Annex B 8** |
| **Intended use**<br>Installation instruction part 2, hole cleaning | |

## Installation instruction part 3; Installation with FIS EM Plus

reinforcing bars (rebar) / fischer rebar anchor and cartridge preparation

| | | |
|---|---|---|
| **4** |   | Before use, make asure that the rebar or the fischer rebar anchor is dry and free of oil or other residue.<br>Mark the embedment depth $l_v$ on the rebar (e.g. with tape)<br>Insert rebar in borehole, to verify drill hole depth and setting depth $l_v$ resp. $l_{e,ges}$ |
| **5** |  | Twist off the sealing cap<br>Twist on the static mixer (the spiral in the static mixer must be clearly visible). |
| **6** |   | Place the cartridge into a suitable dispenser. |
| **7** |   | Press out approximately 10 cm of mortar until the resin is permanently grey in colour. Mortar which is not grey in colour will not cure and must be disposed. |

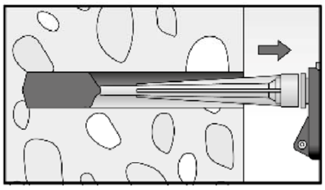


| | |
|---|---|
| Rebar connection with fischer injection mortar FIS EM Plus | **Annex B 9** |
| **Intended use**<br>Installation instruction part 3,<br>reinforcing bars (rebar) / fischer rebar anchor and cartridge preparation | |

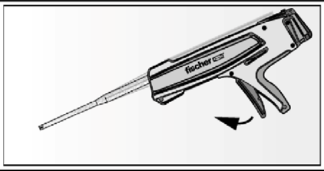
## Installation instruction part 4; Installation with FIS EM Plus

### Injection of the mortar; borehole depth ≤ 250 mm

**8a**



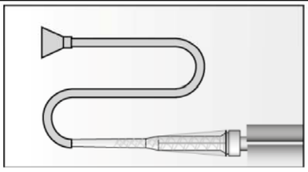
Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step with each trigger pull.
Avoid bubbles.
Fill holes approximately 2/3 full, to ensure that the annular gap between the rebar and the concrete will be completely filled with adhesive over the entire embedment length.



After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

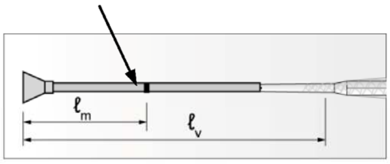
### Injection of the mortar; borehole depth > 250 mm

**8b**



Assemble mixing nozzle FIS MR Plus or FIS UMR, extension tube and appropriate injection adapter (see table B 6.2)

Mortar level mark



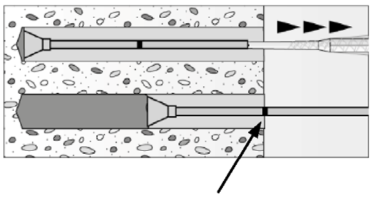

Mark the required mortar level $l_m$ and embedment depth $l_v$ resp. $l_{e,ges}$ with tape or marker on the injection extension tube.

a) Estimation:

$$l_m = \frac{1}{3} * l_v \; resp. \; l_m = \frac{1}{3} * l_{e,ges} \text{ [mm]}$$

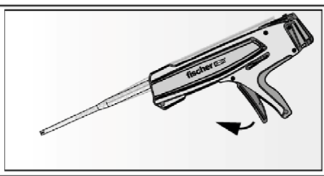
b) Precise equation for optimum mortar volume:

$$l_m = l_v \; resp. \; l_{e,ges} \left(1{,}2 * \frac{d_s^2}{d_0^2} - 0{,}2\right) \text{ [mm]}$$



Mortar level mark

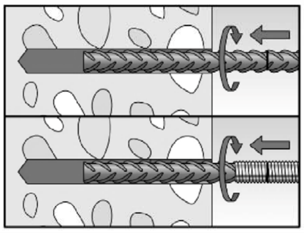
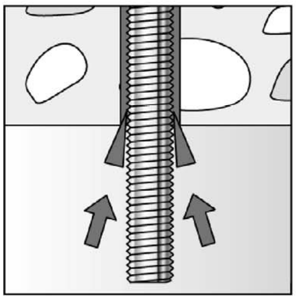
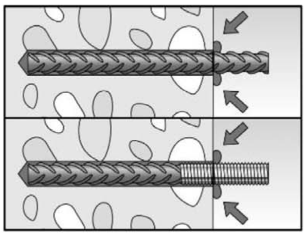
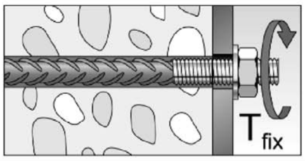
Insert injection adapter to back of the hole. Begin injection allowing the pressure of the injected adhesive mortar to push the injection adapter towards the front of the hole. Do not actively pull out!
Fill holes approximately 2/3 full, to ensure that the annular gap between the rebar and the concrete will be completely filled with adhesive over the embedment length.
When using an injection adapter continue injection until the mortar level mark $l_m$ becomes visible.
Maximum embedment depth see table B5.2



After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

## Installation instruction part 5; Installation with FIS EM Plus

Insert rebar / fischer rebar anchor

| | | |
|---|---|---|
| **9** |  | Insert the rebar / fischer rebar anchor slowly twisted into the borehole until the embedment mark is reached. |
| **10** |  | For overhead installation, support the rebar / fischer rebar anchor and secure it from falling till mortar started to harden, e.g. using wedges. |
| **11** |  | After installing the rebar or fischer rebar anchor the annular gap must be completely filled with mortar.<br><br>Proper installation<br>• Desired embedment depth is reached $l_v$: embedment mark at concrete surface.<br>• Excess mortar flows out of the borehole after the rebar has been fully inserted up to the embedment mark. |
| **12** |  | Observe the working time "$t_{work}$" (see table B6.1), which varies according to temperature of base material. Minor adjustments to the rebar / fischer rebar anchor position may be performed during the working time<br><br>Full load may be applied only after the curing time "$t_{cure}$" has elapsed (see table B 6.1) |
| **13** |   | Mounting the fixture,<br>max $T_{fix}$ see table A6.1 |

| | |
|---|---|
| Rebar connection with fischer injection mortar FIS EM Plus | **Annex B 11** |
| **Intended use**<br>Installation instruction part 5, insert rebar / fischer rebar anchor | |

## Minimum anchorage length and minimum lap length

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1: 2004+AC:2010 shall be multiply by the relevant amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ according to table C1.1.

**Table C1.1:** Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ related to concrete strength class and drilling method with a service life of 50 or 100 years

| Rebar / fischer rebar anchor ϕ [mm] | Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ – Concrete strength class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| **Hammer drilling, hollow drilling and compressed air drilling** | | | | | | | | | |
| 8 to 25 | 1,0 | | | | | | | | |
| 26 to 40 | 1,0 | | | | | | | | |
| **Diamond drilling** | | | | | | | | | |
| 8 to 12 | 1,0 | | | 1,04 | 1,08 | 1,13 | 1,17 | 1,21 | 1,25 |
| 14 to 25 | 1,0 | | | 1,04 | 1,08 | 1,13 | 1,17 | 1,21 | 1,25 |
| 26 to 40 | 1,0 | | | 1,08 | 1,17 | 1,25 | 1,33 | 1,42 | 1,50 |

**Table C1.2:** Bond efficiency factor $k_b = k_{b,100y}$ for hammer drilling, hollow drilling and compressed air drilling with a service life of 50 or 100 years

| Rebar / fischer rebar anchor ϕ [mm] | Bond efficiency factor $k_b = k_{b,100y}$ – Concrete strength class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| **Hammer drilling, hollow drilling and compressed air drilling** | | | | | | | | | |
| 8 to 25 | 1,0 | | | | | | | | 0,98 |
| 26 to 40 | 1,0 | | | | | | | | 0,98 |

**Table C1.3:** Bond efficiency factor $k_b = k_{b,100y}$ for diamond drilling with a service life of 50 or 100 years

| Rebar / fischer rebar anchor ϕ [mm] | Bond efficiency factor $k_b = k_{b,100y}$ – Concrete strength class | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| **Diamond drilling** | | | | | | | | | |
| 8 to 12 | 1,0 | | | | | | | | 0,95 |
| 14 to 25 | 1,0 | | | | | | | | 0,95 |
| 26 to 40 | 1,0 | | | | | 0,96 | 0,87 | 0,81 | 0,76 |

**Table C1.4:** Characteristic values for **steel failure** under tension load of **fischer rebar anchors**

| fischer rebar anchor FRA / FRA HCR | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Bearing capacity under tension load, steel failure** | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 63 | 111 | 173 | 270 |
| **Partial factor** | | | | | | |
| Partial factor | $\gamma_{Ms,N}$ | [-] | 1,4 | | | |

Rebar connection with fischer injection mortar FIS EM Plus

**Performance**
Amplification factor $\alpha_{lb} = \alpha_{lb,100y}$ bond efficiency factor $k_b = k_{b,100y}$

**Annex C 1**

Deutsches Institut für Bautechnik DIBt

**Table C2.1:** Design values of the bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ in N/mm² for hammer drilling, hollow drilling, compressed air drilling and diamond drilling with a service life of 50 or 100 years

$$f_{bd,PIR} = k_b \bullet f_{bd}$$
$$f_{bd,PIR,100y} = k_{b,100y} \bullet f_{bd}$$

$f_{bd}$ : Design value of the bond strength in N/mm² considering the concrete strength classes and the rebar diameter for good bond condition (for all other bond conditions multiply the values by $\eta_1 = 0{,}7$) and recommended partial factor $\gamma_c = 1{,}5$ according to EN 1992-1-1: 2004+AC:2010

$k_b$ Bond efficiency factor according to table C1.2 and C1.3

$k_{b,100y}$ Bond efficiency factor according to table C1.2 and C1.3

**Hammer drilling, hollow drilling and compressed air drilling**

| **Rebar / fischer rebar anchor** ϕ [mm] | **bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Concrete strength class | | | | | | | | |
| | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8-32 | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,2 |
| 34 | 1,6 | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 | 4,1 |
| 36 | 1,5 | 1,9 | 2,2 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 | 4,0 |
| 40 | 1,5 | 1,8 | 2,1 | 2,5 | 2,8 | 3,1 | 3,4 | 3,7 | 3,9 |

**Diamond drilling**

| **Rebar / fischer rebar anchor** ϕ [mm] | **bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Concrete strength class | | | | | | | | |
| | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8-12 | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,1 |
| 14-25 | | | | | | 3,4 | 3,7 | 4,0 | 4,1 |
| 26-32 | | | | | | 3,2 | 3,2 | 3,2 | 3,2 |
| 34 | 1,6 | 2,0 | 2,3 | 2,6 | 2,9 | 3,1 | 3,1 | 3,1 | 3,1 |
| 36 | 1,5 | 1,9 | 2,2 | 2,6 | 2,9 | 3,1 | 3,1 | 3,1 | 3,1 |
| 40 | 1,5 | 1,8 | 2,1 | 2,5 | 2,8 | 2,9 | 2,9 | 2,9 | 2,9 |

## Minimum anchorage length and minimum lap length under seismic conditions

The minimum anchorage length $l_{b,min}$ and the minimum lap length $l_{0,min}$ according to EN 1992-1-1: 2004+AC:2010 shall be multiply by the relevant amplification factor $\alpha_{lb,seis}$ according to table C3.1.

**Table C3.1:** Amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis100y}$ related to concrete strength class and drilling method

**Hammer drilling, hollow drilling and compressed air drilling**

| Rebar ϕ [mm] | **Amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis,100y}$** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Concrete strength class | | | | | | | |
| | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8 to 25 | 1,0 | | | | | | | |
| 26 to 40 | 1,0 | | | | | | | |

**Table C3.2:** Bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$ for hammer drilling, hollow drilling and compressed air drilling with a service life of 50 or 100 years

**Hammer drilling, hollow drilling and compressed air drilling**

| Rebar ϕ [mm] | **Bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Concrete strength class | | | | | | | |
| | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8 to 25 | 1,00 | | | | | | | 0,98 |
| 26 to 40 | 1,00 | | | | | | | 0,98 |

**Table C3.3:** Design values of the bond strength $f_{bd,PIR,seis} = f_{bd,PIR,seis,100y}$ in N/mm² for hammer drilling, hollow drilling and compressed air drilling **under seismic action** and for good bond conditions with a service life of 50 or 100 years

$$\mathbf{f_{bd,PIR,seis} = k_{b,seis} \cdot f_{bd}}$$
$$\mathbf{f_{bd,PIR,seis,100y} = k_{b,seis,100y} \cdot f_{bd}}$$

**Hammer drilling, hollow drilling and compressed air drilling**

| Rebar ϕ [mm] | **bond strength $f_{bd,PIR,seis} = f_{bd,PIR,seis,100y}$ [N/mm²]** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Concrete strength class | | | | | | | |
| | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
| 8-32 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,2 |
| 34 | 1,6 | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 |
| 36 | 1,5 | 1,9 | 2,2 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 |
| 40 | 1,5 | 1,8 | 2,1 | 2,5 | 2,8 | 3,1 | 3,4 | 3,7 |



Rebar connection with fischer injection mortar FIS EM Plus

**Performance**
Amplification factor $\alpha_{lb,seis} = \alpha_{lb,seis,100y}$, bond efficiency factor $k_{b,seis} = k_{b,seis,100y}$, Design values of the bond strength $f_{bd,PIR,seis} = f_{bd,PIR,seis,100y}$

**Annex C 3**

**Table C4.1:** Essential characteristics to **steel failure** for **fischer rebar anchors** under fire exposure

concrete strength classes C12/C15 to C50/60, according to EN 1992-4:2018

| **fischer rebar anchor FRA / FRA HCR** | | | | **M12** | **M16** | **M20** | **M24** |
|---|---|---|---|---|---|---|---|
| Characteristic resistance to steel failure | R30 | $N_{Rk,s,fi}$ | [kN] | 1,7 | 2,5 | 4,7 | 7,4 |
| | R60 | | | 1,5 | 2,1 | 3,9 | 6,1 |
| | R90 | | | 1,2 | 1,7 | 3,1 | 4,9 |
| | R120 | | | 0,9 | 1,3 | 2,5 | 3,9 |

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## Bond strength $f_{bk,fi} = f_{bk,fi,100y}$ at increased temperature for concrete strength classes C12/15 to C50/60 (all drilling methods)

The bond strength $f_{bk,fi} = f_{bk,fi,100y}$ at increased temperature has to be calculated by the following equation:

$$f_{bk,fi} = f_{bk,fi,100y} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \frac{\gamma_c}{\gamma_{M,fi}}$$

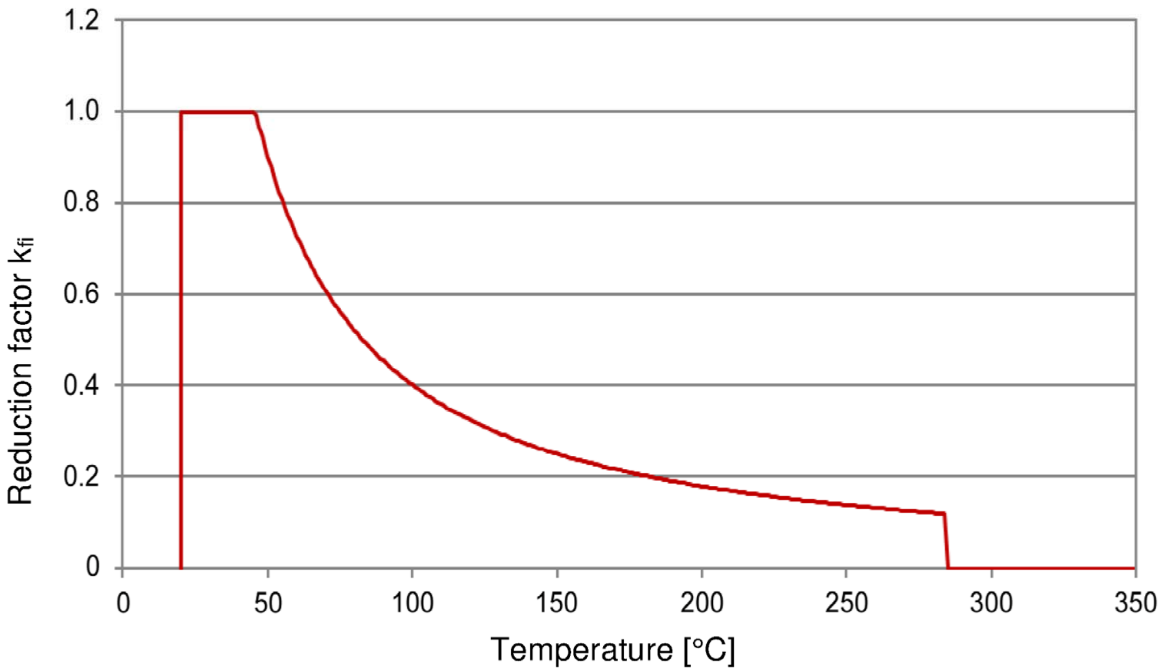
If: θ > 46 °C $\qquad k_{fi}(\theta) = \frac{862{,}3 \cdot \theta^{-1{,}166}}{f_{bd,PIR} \cdot 4{,}3} \leq 1{,}0$

If: θ > $\theta_{max}$ (284 °C) $\qquad k_{fi}(\theta) = 0$

| | | |
|---|---|---|
| $f_{bk,fi}$ = | = | Bond strength at increased temperature in N/mm² for service life 50 years |
| $f_{bk,fi,100y}$ | = | Bond strength at increased temperature in N/mm² for service life 100 years |
| (θ) | = | Temperature in °C in the mortar layer |
| $k_{fi}(\theta)$ = $k_{fi,100y}(\theta)$ | = | Reduction factor at increased temperature |
| $f_{bd,PIR}$= | = | Design value of the bond strength in N/mm² in cold condition according to table C2.1 considering the concrete classes, the rebar diameter, the drilling method and the bond conditions according to EN 1992-1-1:2004+AC:2010 |
| $\gamma_C$ | = | Partial factor according to EN 1992-1-1:2004+AC:2010 |
| $\gamma_{M,fi}$ | = | Partial factor according to EN 1992-1-2:2004+AC:2008 |

For evidence at increased temperature the anchorage length shall be calculated according to EN 1992-1-1:2004+AC:2010 Equation 8.3 using the temperature-dependent ultimate bond strength $f_{bk,fi}$.

**Figure C5.1:** Example graph of reduction factor $k_{fi}$ (θ) for concrete class C20/25 for good bond conditions




| Rebar connection with fischer injection mortar FIS EM Plus | Annex C 5 |
|---|---|
| **Performance**<br>Bond strength $f_{bk,fi} = f_{bk,fi,100y}$ at increased temperature | |