Deutsches Institut für Bautechnik DIBt

Public-law institution jointly founded by the federal states and the Federation

European Technical Assessment Body for construction products

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European Technical Assessment

ETA-17/1056 of 11 April 2025

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	Systems for post-installed rebar connections with mortar
Manufacturer	fischerwerke GmbH & Co. KG Otto-Hahn-Straße 15 79211 Denzlingen DEUTSCHLAND
Manufacturing plant	fischerwerke
This European Technical Assessment contains	27 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 06/2021
This version replaces	ETA-17/1056 issued on 1 November 2024

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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 "Rebar connection with fischer injection mortar FIS EM Plus" in accordance with the regulations for reinforced concrete construction.

Reinforcing bars with a diameter ϕ 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 rebar connection 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 C2
Characteristic resistance under seismic loading	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 11 April 2025 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

Installation conditions and application examples reinforcing bars, part 1

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

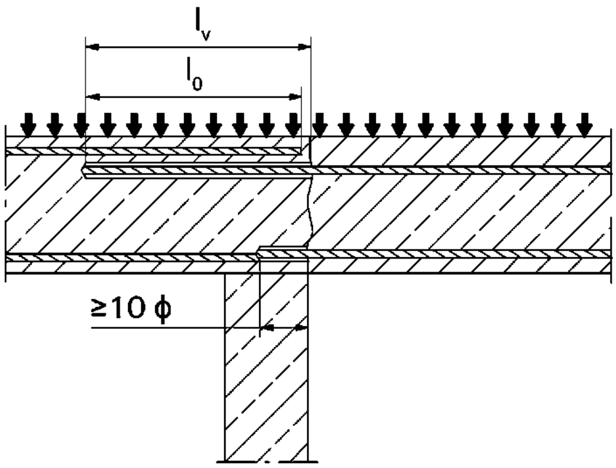


Figure A1.2:
Overlap joint with existing reinforcement at a foundation of a column or wall where the rebars are stressed

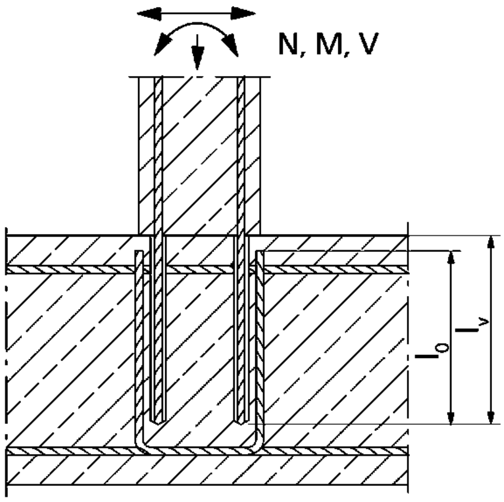
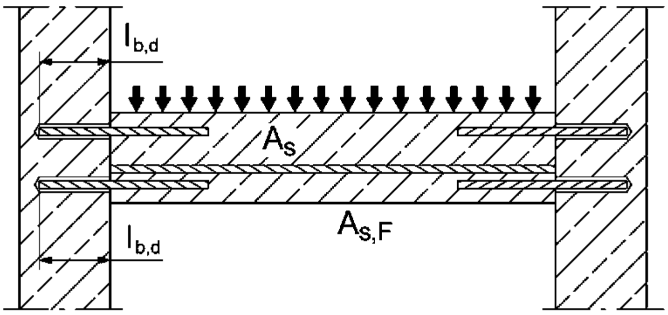


Figure A1.3:
End anchoring of slabs or beams (e.g. designed as simply supported)



Figures not to scale

Rebar connection with fischer injection mortar FIS EM Plus	Annex A1
Product description 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

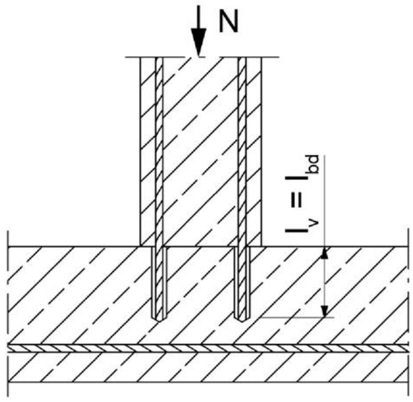
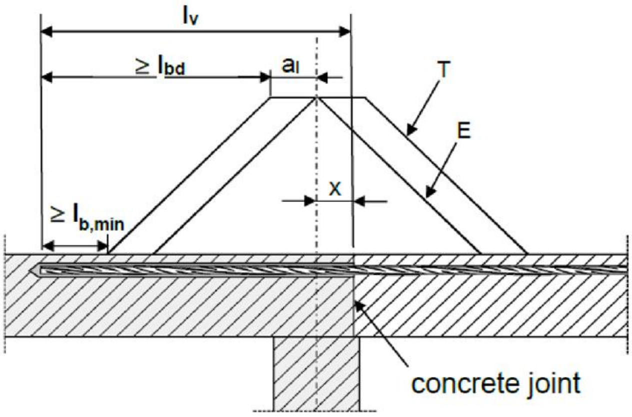


Figure A2.2:
Anchoring of reinforcement to cover the enveloped line of acting tensile force in the bending member



(only post-installed rebar is plotted)

Key to Figure
- T Acting tensile force
- E Envelope of $M_{ed} / z + N_{ed}$ (see EN 1992-1-1:2011)
- x Distance between the theoretical point of support and concrete joint

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 as required by EN 1992-1-1:2011 shall be present.

The shear transfer between old and new concrete shall be designed according to EN 1992-1-1:2011. Preparation of joints according to **Annex B3** of this document.

Figures not to scale

Rebar connection with fischer injection mortar FIS EM Plus

Product description
Installation conditions and application examples reinforcing bars, part 2

Annex A2

Installation conditions and application examples fischer rebar anchor FRA

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

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

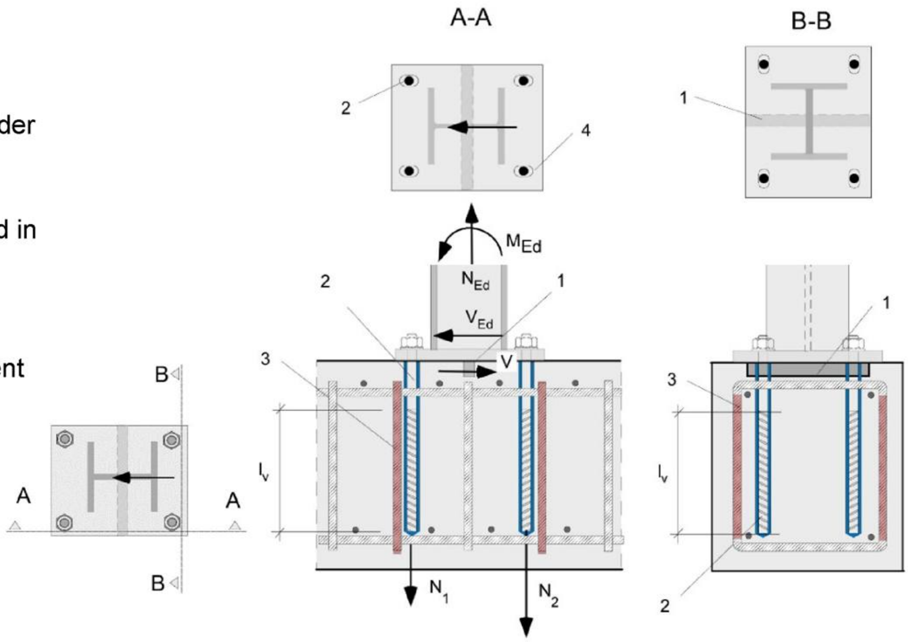
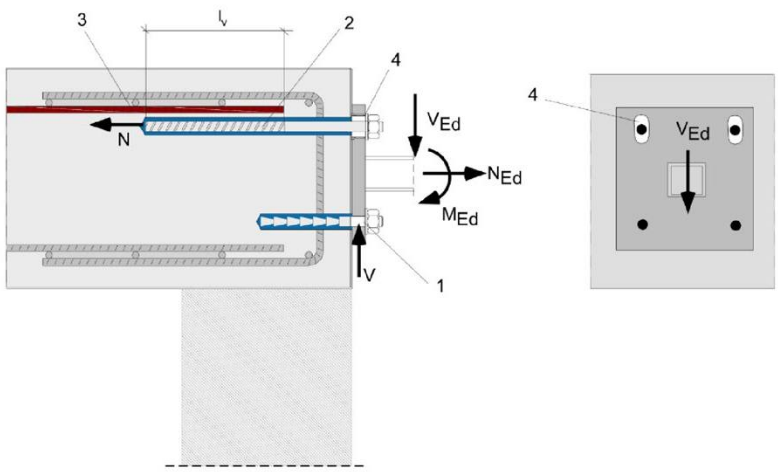


Figure A3.2:
Lap of the anchoring of guardrail posts or anchoring of cantilevered building components.
In the anchor plate, the drill holes for the fischer rebar anchors FRA have to be designed as slotted holes with axial direction to the shear force.

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



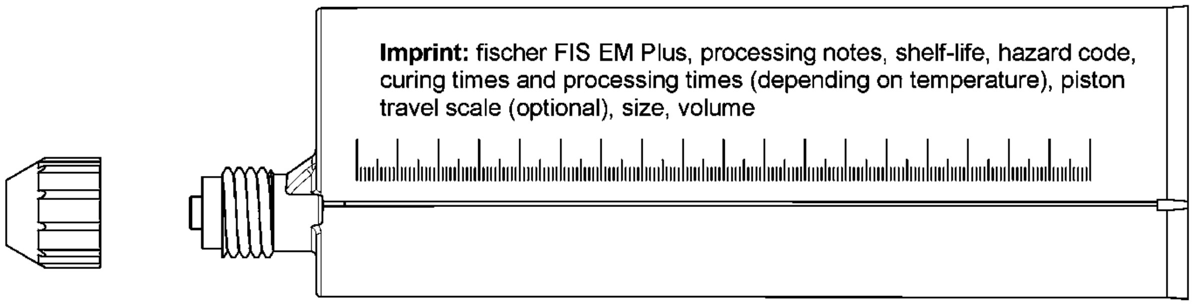
The required transverse reinforcement acc. to EN 1992-1-1:2011 is not shown in the figures. **The fischer rebar anchor FRA may be only used for axial tensile force.** The tensile force must transfered by lap to the existing reinforcement of the building. The transfer of the shear force has to be ensured by suitable measure, e.g. by means of shear force or anchors with European Technical Assessment (ETA).

Figures not to scale

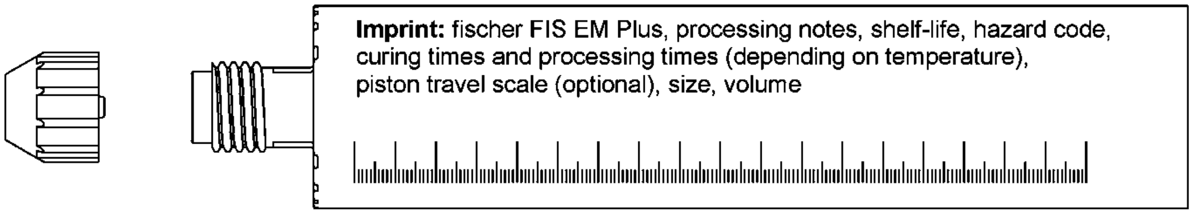
Rebar connection with fischer injection mortar FIS EM Plus	Annex A3
Product description Installation conditions and application examples fischer rebar anchors FRA	

Overview system components Part 1

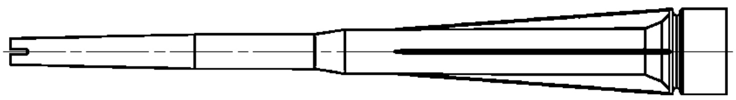
Injection cartridge (shuttle cartridge) FIS EM Plus with sealing cap
Sizes: 390 ml, 585 ml, 1100 ml, 1500 ml



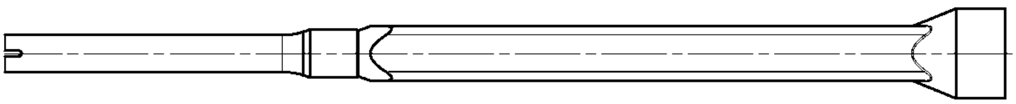
Injection cartridge (coaxial cartridge) FIS EM Plus with sealing cap
Sizes: 300 ml



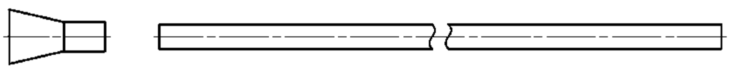
Static mixer FIS MR Plus for injection cartridge 300 ml and 390 ml



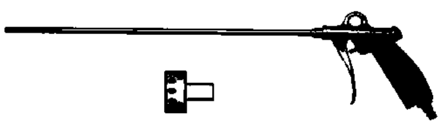
Static mixer FIS UMR for injection cartridge 585 ml to 1500 ml



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



Compressed-air cleaning tool ABP with fischer compressed-air nozzle



Figures not to scale

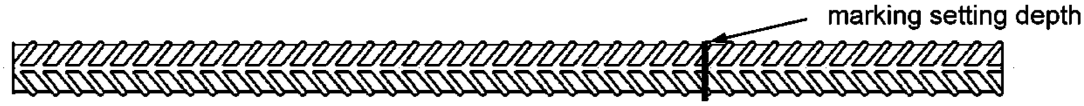
Rebar connection with fischer injection mortar FIS EM Plus

Product description
Overview system components Part 1;
Injection mortar, Blow out pump

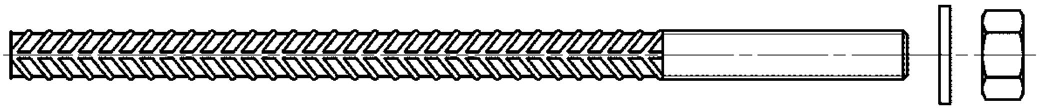
Annex A4

Overview system components Part 2

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



Figures not to scale

Rebar connection with fischer injection mortar FIS EM Plus

Product description
Overview system components Part 2;
Reinforcing bar, fischer rebar anchor

Annex A5

Properties of reinforcing bars (rebar)

Figure A6.1:

- The minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2011
- The maximum outer rebar diameter over the rips shall be:
  - The nominal diameter of the rip $\phi + 2 \cdot h$ ($h \leq 0{,}07 \cdot \phi$)
  - (ϕ: Nominal diameter of the bar; h_{rip} = rip height of the bar)

Table A6.1: 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		$h_0 = l_v$										
Effective embedment depth	l_v		acc. to static calculation										
Minimum thickness of concrete member	h_{min}		$l_v + 30$ (≥ 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		$h_0 = l_v$								
Effective embedment depth	l_v		acc. to static calculation								
Minimum thickness of concrete member	h_{min}		$l_v + 2d_0$								

[1)] Both drill hole diameters can be used

Table A6.2: Materials of rebars

Designation	**Reinforcing bar (rebar)**
Reinforcing bar EN 1992-1-1:2011, Annex C	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCI of EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Figures not to scale

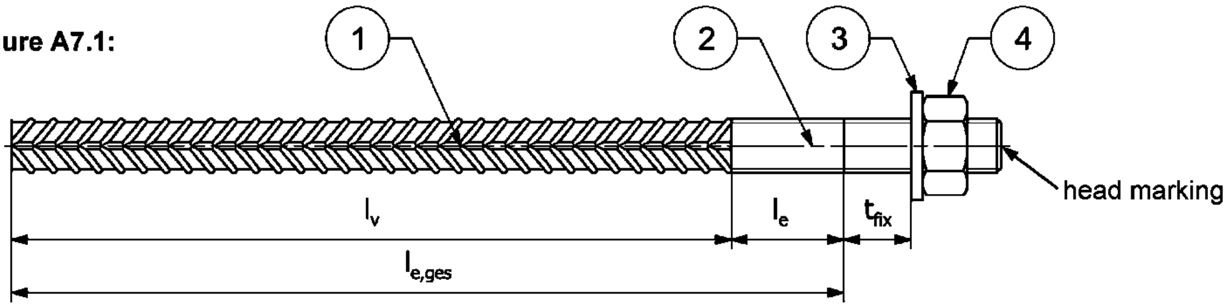
Rebar connection with fischer injection mortar FIS EM Plus

Product description
Properties and materials of reinforcing bars (rebar)

Annex A6

Properties of fischer rebar anchor FRA

Figure A7.1:



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

FRA HCR (for high corrosion-resistant steel)

Table A7.1: Installation conditions for fischer rebar anchors FRA

Threaded diameter				M12 [2)]		M16	M20	M24 [2)]	
Nominal diameter		ϕ	[mm]	12		16	20	25	
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	d_f	[mm]	14		18	22	26	
	Push through	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_{inst}	[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 A7.2: Materials of fischer rebar anchors FRA

Part	Description	Materials	
		FRA Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015	FRA HCR Corrosion resistance class CRC V acc. to EN 1993-1-4: 2006+A1:2015
1	Reinforcing bar	Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCI of EN 1992-1-1:NA; $f_{uk} = f_{tk} = k \cdot f_{yk}$ (f_{yk} = 500 N/mm^2)	
2	Round bar with partial or full thread	Stainless steel, strength class 80, according to EN 10088-1:2023	High corrosion-resistant steel, strength class 80, according to EN 10088-1:2023
3	Washer ISO 7089:2000	Stainless steel, according to EN 10088-1: 2023	High corrosion-resistant steel, according to EN 10088-1: 2023
4	Hexagon nut	Stainless steel, strength class 80, acc. to EN ISO 3506-2:2020, according to EN 10088-1: 2023	High corrosion-resistant steel, strength class 80, acc. to EN ISO 3506-2:2020, according to EN 10088-1: 2023

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 FRA	
Hammer drilling or compressed air 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			
Use category I1	dry or wet concrete	all sizes			
Static and quasi static load, in	uncracked 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
	cracked concrete				
Characteristic resistance under seismic loading (only hammer drilling with standard / hollow drill bits)		all sizes	Tables: C3.1 C3.2 C3.3	no performance assessed	
Installation direction		D3 (downward and horizontal and upwards (e.g. overhead))			
Installation temperature		$T_{i,min}$ = -5 °C to $T_{i,max}$ = +40 °C			
Service temperature	Temperature range	-40 °C to +80 °C	(max. short term temperature +80 °C; max long term temperature +50 °C)		
Resistance to fire		all sizes	Annex C5	all sizes	Annex C4

Specifications of intended use part 2

Anchorages subject to:

- Static and quasi-static loading: reinforcing bar (rebar) size 8 mm to 40 mm; FRA M12 to M24
- Characteristic resistance under seismic loading: reinforcing bar (rebar) size 8 mm to 40 mm
- Resistance to fire: reinforcing bar (rebar) size 8 mm to 40 mm; FRA M12 to M24.

Base materials:

- Compacted reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013+A2:2021
- Strength classes C12/15 to C50/60 according to EN 206:2013+A2:2021
- Maximum chloride content of 0,40 % (CL 0.40) related to the cement content according to EN 206:2013+A2:2021
- 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 1992-1-1:2011. The foregoing may be neglected if building components are new and not carbonated and if building components are in dry conditions

Use conditions (Environmental conditions) for fischer rebar anchors FRA:

- For all conditions according to EN1993-1-4:2006+A1:2015 corresponding to corrosion resistance classes to **Annex A7 Table A7.2**.

Design:

- The structural design according to EN 1992-1-1:2011, EN 1992-1-2:2011 and **Annex B3** and **B4** are conducted under responsibility of a designer expierenced in the field of anchorages and concrete works.
- Verifiable calculation notes and drawings are prepared taking account of the forces to be transmitted.
- 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.

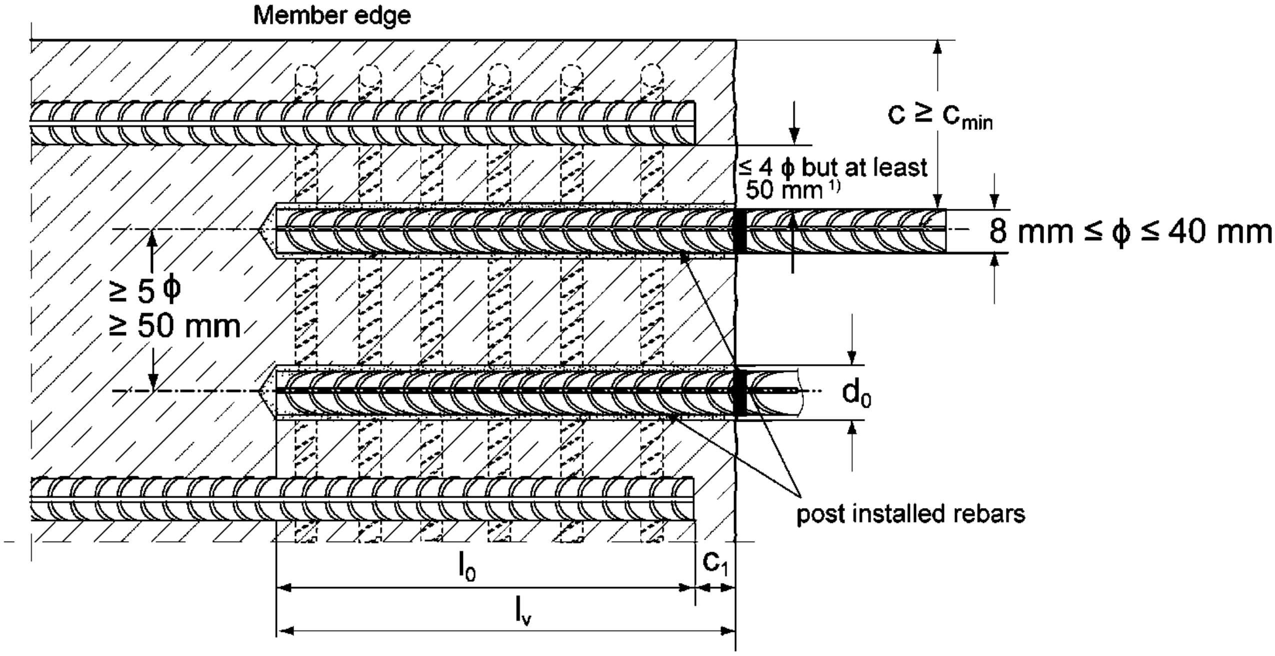
Installation:

- The installation of post-installed rebar respectively fischer 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.
- 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 1992-1-1:2011.
- 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 but at least 50 mm then the lap length shall be increased by the difference between the clear bar distance and 4 ϕ but at least 50 mm.

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 1992-1-1:2011, Section 4.4.1.2
ϕ	nominal diameter of reinforcing bar
l_0	lap length, according to EN 1992-1-1:2011 for static loading and according to EN 1998-1:2004+AC:2009, section 5.6.3 for seismic action.
l_v	effective embedment depth, $\geq l_0 + c_1$
d_0	nominal drill bit diameter, see **Annex B6**

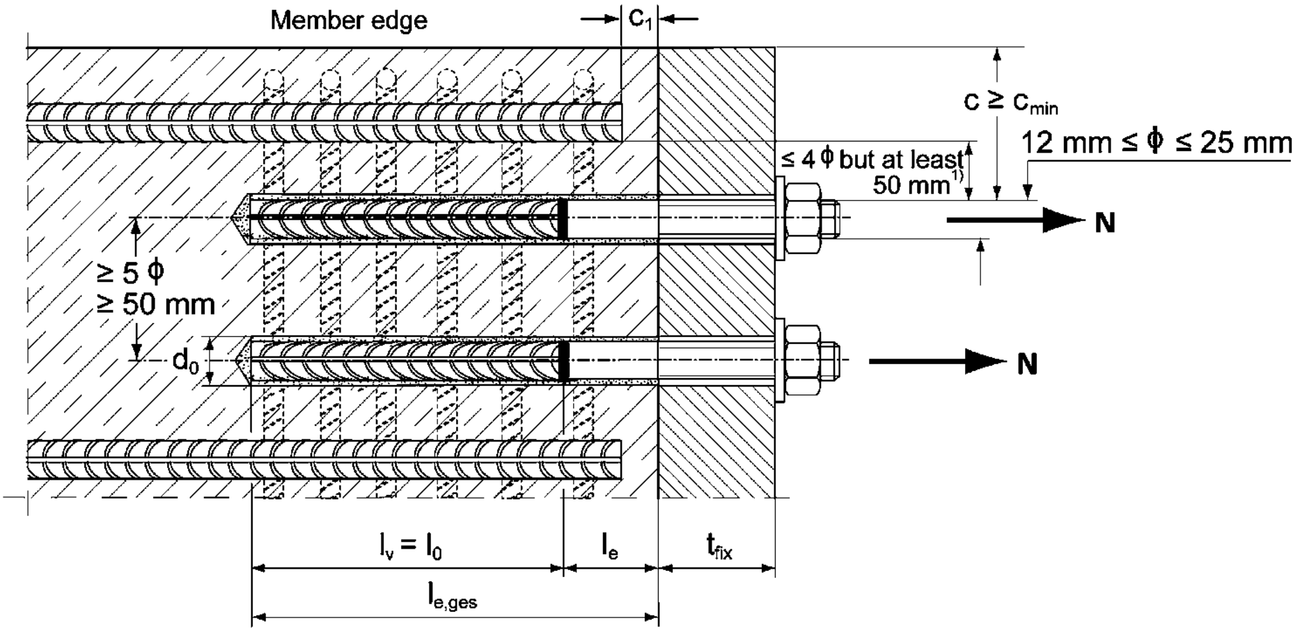
Figures not to scale

Rebar connection with fischer injection mortar FIS EM Plus	**Annex B3**
Intended use General construction rules for for post-installed rebars	

General construction rules for post-installed fischer rebar anchors FRA

Figure B4.1:

- Only tension forces in the axis of the fischer rebar anchor FRA 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.
- The length of the bonded-in thread may not be accounted as anchorage.



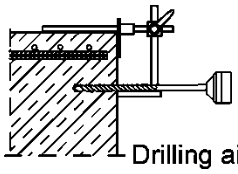
[1)] If the clear distance between lapped bars exceeds 4 ϕ but at least 50 mm then the lap length shall be increased by the difference between the clear bar distance and 4 ϕ but at least 50 mm.

c	concrete cover of post-installed fischer rebar anchor FRA
c_1	concrete cover at end-face of existing rebar
c_{min}	minimum concrete cover according to **Table B5.1** and to EN 1992-1-1:2011, Section 4.4.1.2
ϕ	nominal diameter of reinforcing bar
l_0	lap length, according to EN 1992-1-1:2011, Section 8.7.3
$l_{e,ges}$	overall embedment depth, $\geq l_0 + l_e$
d_0	nominal drill bit diameter, see **Annex B6**
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	**Annex B4**
Intended use General construction rules for post-installed fischer rebar anchors	

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] [2)]	With drilling aid [mm] [2)]	
Hammer drilling with standard drill bit	< 25	30 mm + 0,06 $l_v \geq 2\,\phi$	30 mm + 0,02 $l_v \geq 2\,\phi$	 Drilling aid
	≥ 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	< 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 $l_v \geq 2\,\phi$	

[1)] See **Annex B3**, figure B3.1 and **Annex B4**, figure B4.1
Note: The minimum concrete cover as specified in EN 1992-1-1:2011 must be observed. The same minimum concrete covers apply to rebar elements in case of seismic loading. $c_{min,seis} = 2\,\phi$.
[2)] For FRA (HCR) $l_{e,ges}$ instead of l_v.

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

reinforcing bars (rebar)	fischer rebar anchor	Manual dispenser	Accu and pneumatic dispenser (small)	Pneumatic dispenser (large)
		Cartridge size 300 ml, 390 ml, 585 ml	Cartridge size 300 ml, 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 FRA HCR M12		1200	
14	---			
16	FRA M16 FRA HCR M16		1500	
20	FRA M20 FRA HCR M20	700	1300[1)]	
22 / 24 / 25	FRA M24 FRA HCR M24		1000[1)]	2000
26 / 28	---	500	700[1)]	
30 / 32 / 34	---	no performance assessed	500[1)]	
36	---			
40	---			

[1)] Not possible with the 300 ml cartridge

Table B5.3: Conditions for use **static mixer** without an **extension tube**

Nominal drill hole diameter	d_0	[mm]	10	12	14	16	18	20	25	30	35	40	45	55
Drill hole depth h_0 by using	FIS MR Plus		≤ 90		≤ 120	≤ 140	≤ 150	≤ 160	≤ 210					
	FIS UMR		-	-	≤ 90	≤ 160	≤ 180	≤ 190	≤ 220	≤ 250				

Rebar connection with fischer injection mortar FIS EM Plus

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

Annex B5

Table B6.1: Working times t_{work}, initial curing time $t_{cure,ini}$ and curing times t_{cure}

Temperature in the anchorage base [°C]	Maximum working time [1)] t_{work} **FIS EM Plus**	Initial curing time [2)] $t_{cure,ini}$ **FIS EM Plus**	Minimum curing time [3)] t_{cure} **FIS EM Plus**
-5 to 0	240 min [4)]	62 h	200 h
>0 to 5	150 min [4)]	39 h	90 h
>5 to 10	120 min [4)]	25 h	40 h
>10 to 15	30 min	16 h	18 h
>15 to 20	23 min	11 h	18 h
>20 to 25	14 min	7 h	10 h
>25 to 30	10 min	5 h	10 h
>30 to 35	7 min [5)]	3,5 h	5 h
>35 to 40	5 min [5)]	2,5 h	5 h

[1)] Maximum time from the beginning of the injection to rebar / fischer rebar anchor FRA setting and positioning
[2)] After the initial curing time $t_{cure,ini}$ is reached, the initial bond strength is achieved and allows further processing.
[3)] For wet concrete the curing time must be doubled.
[4)] If the temperature in the concrete falls below 10°C the cartridge has to be warmed up to +15°C.
[5)] 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 fischer compressed air nozzle	Diameter of extension tube	Injection adapter
ϕ [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

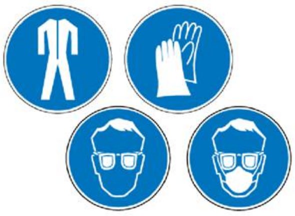
[1)] Both drill bit diameters can be used

Rebar connection with fischer injection mortar FIS EM Plus

Intended use
Working times and curing times;
Installation tools for drilling and cleaning the bore hole and injection of the mortar

Annex B6

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

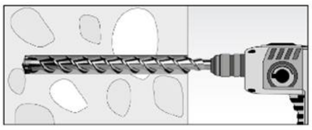
Important: Observe the instructions for use provided with each cartridge.

Installation instruction part 1; Installation with FIS EM Plus

Hole drilling

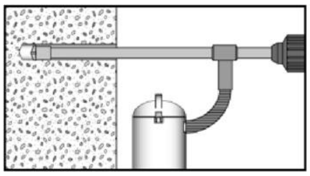
Note: Before drilling, remove carbonized concrete; clean contact areas (see **Annex B2**)
In case of aborted drill holes the drill hole shall be filled with mortar.

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



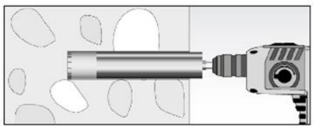
Drill the hole to the required embedment depth using a hammer drill with carbide drill bit set in rotation hammer mode or a pneumatic drill.
Drill bit sizes see **Table B6.2**.

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

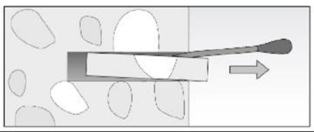


Drill the hole to the required embedment depth using a hammer drill with hollow drill bit in rotation hammer mode.
Dust extraction conditions see drill hole cleaning annex B8.
Drill bit sizes see **Table B6.2**.

1c **Diamond drilling**

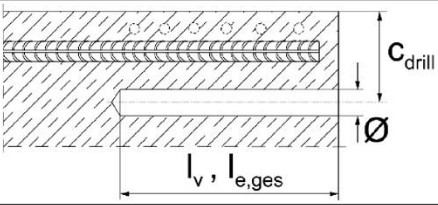


Drill the hole to the required embedment depth using a diamond drill in rotation mode.
Drill bit sizes see **Table B6.2**.
.

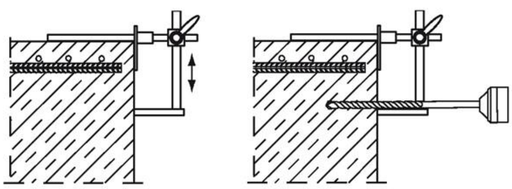


Break away the drill core and remove it

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**.

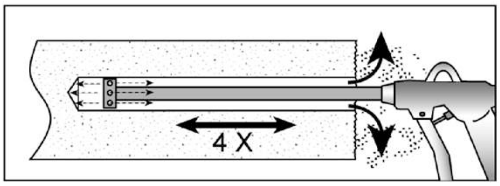
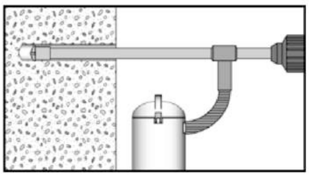
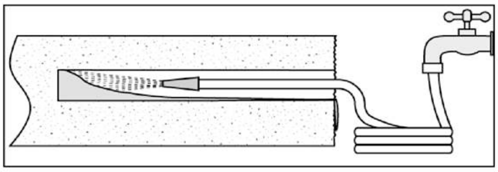
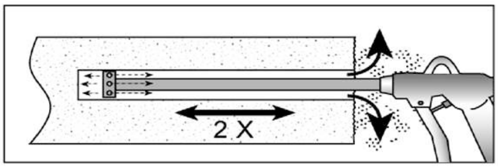
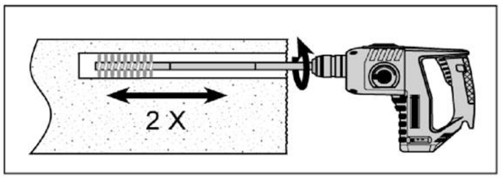
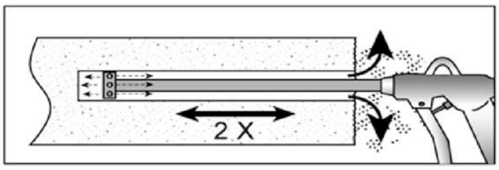
Rebar connection with fischer injection mortar FIS EM Plus

Intended use
Safety regulations; Installation instruction part 1, hole drilling

Annex B7

Installation instruction part 2; Installation with FIS EM Plus

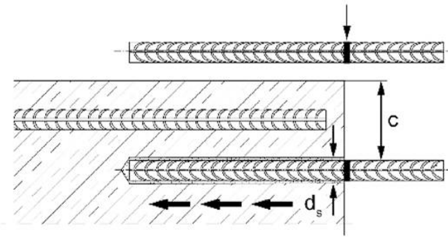
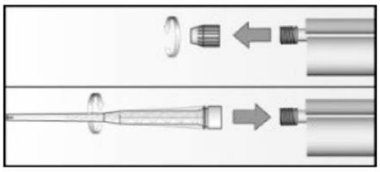
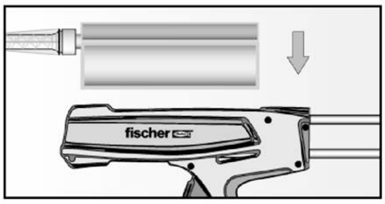
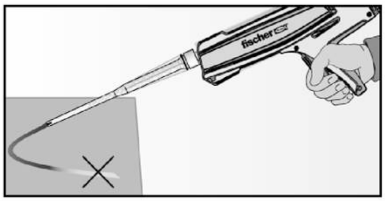
Drill hole cleaning

3a	**Hammer or compressed air drilling**	
		Blowing 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. Personal protective equipment must be used (see regulations **Annex B7**).
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. 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. No further drill hole cleaning necessary.
3c	**Diamond drilling**	
		Flush the bore hole until the water comes clear.
		Blowing 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. Personal protective equipment must be used (see regulations **Annex B7**).
		Check steel brush with brush control template. Fix an adequate steel brush with an extension into a drilling machine and brush the bore hole twice
		Blowing 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. Personal protective equipment must be used (see regulations **Annex B7**).

Rebar connection with fischer injection mortar FIS EM Plus	**Annex B8**
Intended use Installation instruction part 2, hole cleaning	

Installation instruction part 3; Installation with FIS EM Plus

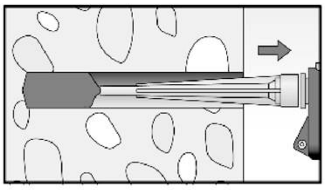
reinforcing bars (rebar) / fischer rebar anchor FRA and cartridge preparation

4		Before use, make asure that the rebar or the fischer rebar anchor FRA is dry and free of oil or other residue. Mark the embedment depth l_v on the rebar (e.g. with tape) Insert rebar in borehole, to verify drill hole depth and setting depth l_v resp. $l_{e,ges}$
5		Twist off the sealing cap 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.

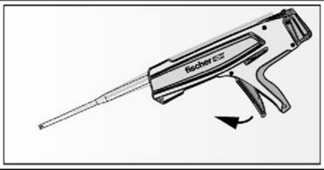
Installation instruction part 4; Installation with FIS EM Plus

Injection of the mortar; borehole depth ≤ 250 mm

8a



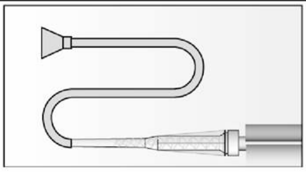
Inject the mortar from the back of the hole towards the front and slowly withdraw the mixing nozzle step by step with each trigger pull.
Avoid bubbles.
Fill holes approximately 2/3 full, to ensure that the annular gap between the rebar and the concrete will be completely filled with adhesive over the entire embedment length.
The conditions for mortar injection without extension tube can be found in **Table B5.3.**



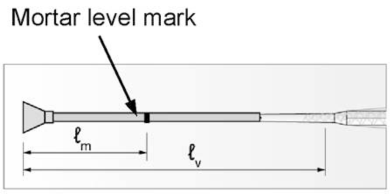
After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

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**).



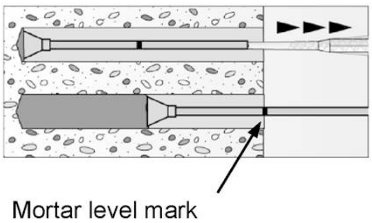
Mark the required mortar level l_m and embedment depth l_v resp. $l_{e,ges}$ with tape or marker on the injection extension tube.

a) Estimation:

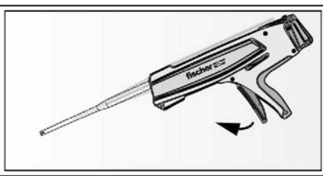
$$l_m = \frac{1}{3} * l_v \ resp. \ l_m = \frac{1}{3} * l_{e,ges} \text{ [mm]}$$

b) Precise equation for optimum mortar volume:

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



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**.

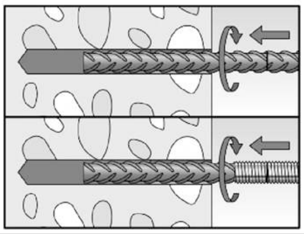
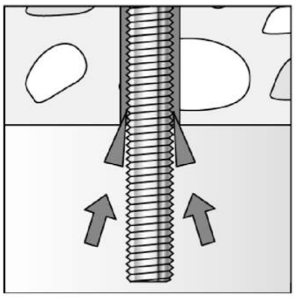
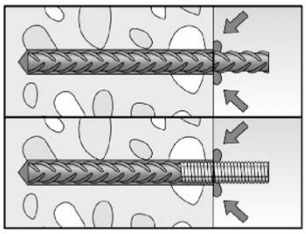
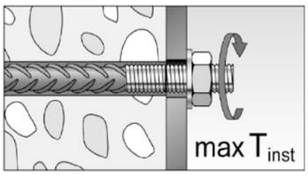


After injecting, release the dispenser. This will prevent further mortar discharge from the mixing nozzle.

Rebar connection with fischer injection mortar FIS EM Plus	**Annex B10**
Intended use Installation instruction part 4, mortar injection	

Installation instruction part 5; Installation with FIS EM Plus

Insert rebar / fischer rebar anchor FRA

9		Insert the rebar / fischer rebar anchor FRA slowly twisted into the borehole until the embedment mark is reached. Recommendation: Rotation back and forth of the reinforcement bar or the fischer rebar anchor FRA makes pushing easy.
10		For overhead installation, support the rebar / fischer rebar anchor FRA and secure it from falling till mortar started to harden, e.g. using wedges.
11		After installing the rebar or fischer rebar anchor FRA the annular gap must be completely filled with mortar. Proper installation • Desired embedment depth is reached l_v: embedment mark at concrete surface. • 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 After the initial curing time $t_{cure,ini}$ (see **Table B6.1**) is reached, the initial bond strength is achieved and allows further processing. Full load may be applied only after the curing time "t_{cure}" has elapsed (see **Table B 6.1**)
13		Mounting the fixture for fischer rebar anchor FRA, max T_{inst} see **Table A7.1**.

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 1992-1-1:2011 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 FRA 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 FRA 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 FRA 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 resistance to **steel failure** under tension loading of **fischer rebar anchors FRA**

fischer rebar anchor FRA / FRA HCR			M12	M16	M20	M24
Characteristic resistance to steel failure under tension loading						
Characteristic resistance	$N_{Rk,s}$	[kN]	62,0	111,0	173,0	236,5
Partial factor						
Partial factor	$\gamma_{Ms,N}$ 1)	[-]	1,4			

1) In absence of national regulations

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 C1

Table C2.1: Design values of the bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ in N/mm² related to concrete strength class and drilling metod for good bond conditions; service life 50 or 100 years

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

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 η_1 = 0,7) and recommended partial factor γ_c = 1,5 according to EN 1992-1-1:2011

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 FRA	**bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]**								
	Concrete strength class								
ϕ [mm]	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 FRA	**bond strength $f_{bd,PIR} = f_{bd,PIR,100y}$ [N/mm²]**								
	Concrete strength class								
ϕ [mm]	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 1992-1-1:2011 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

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

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

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

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

fischer rebar anchor FRA / FRA HCR				**M12**	**M16**	**M20**	**M24**
Characteristic resistance to steel failure	R30	$N_{Rk,s,fi}$	[kN]	2,5	4,7	7,3	10,5
	R60			2,1	3,9	6,1	8,8
	R90			1,6	3,1	4,9	7,1
	R120			1,3	2,5	3,9	5,6

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:

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

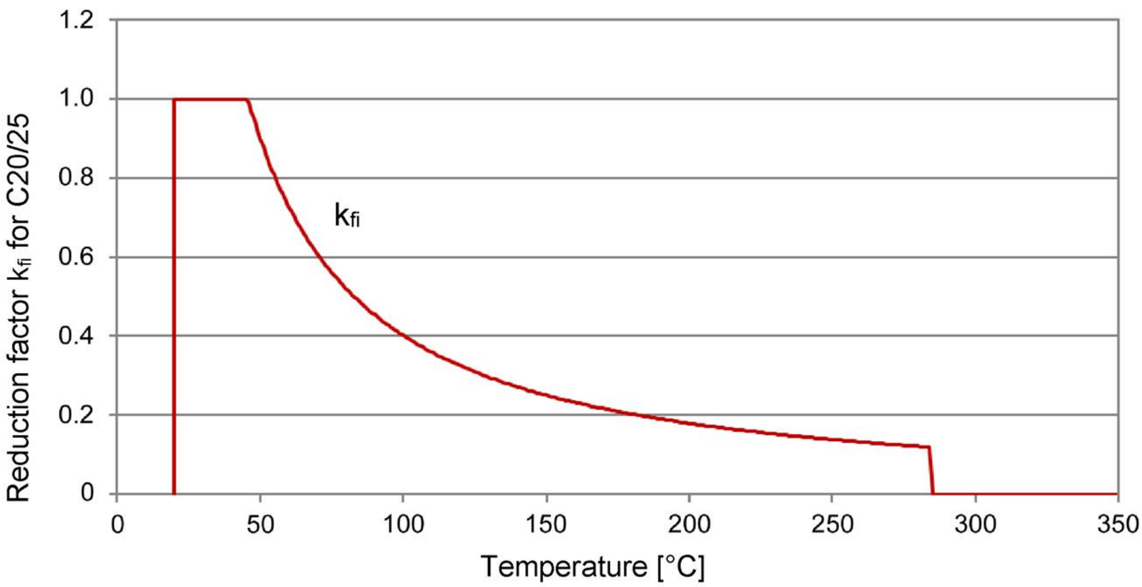
If: θ > 46 °C $\quad k_{fi}(\theta) = \frac{862{,}3 \cdot \theta^{-1{,}166}}{f_{bd,PIR} \cdot 4{,}3} \leq 1{,}0$

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

$f_{bk,fi}$ =	=	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 1992-1-1:2011
γ_C	=	1,5 recommended partial factor according to EN 1992-1-1:2011
$\gamma_{M,fi}$	=	1,0 recommended partial factor according to EN 1992-1-2:2011

For evidence at increased temperature the anchorage length shall be calculated according to EN 1992-1-1:2011 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 C5
Performance Bond strength $f_{bk,fi} = f_{bk,fi,100y}$ at increased temperature	