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ACCREDITED Inspection Agency

DAkkS Deutsche Akkreditierungsstelle D-ZE-18571-01-00

VALID FOR ACTIVITIES ACCORDING TO THE SCOPE OF ACCREDITATION.

Independent Technical Evaluation

FIS EM Plus
in
uncracked and cracked concrete
for a service life of
up to 120 years

Name of the product:
FIS EM Plus

Type of product:
Mortar injection system

Product owner:
fischerwerke GmbH & Co. KG
Validity:
5 years

Production plant:
Denzlingen

Technical Assessment bases on:
Based on EAD 330232-01-0601, EAD DP17-33-2077-06.01 and additional independent tests

Date: 20.3.2019
Number of pages: 9

Stuttgart, March 20, 2019
Prof. Dr.-Ing. Jan Hofmann

1 Introduction and scope

The "Fischer FIS EM Plus Injection resin with anchor rod for concrete of company fischerwerke GmbH & Co. KG is an adhesive anchor consisting of a cartridge with injection mortar fischer FIS EM Plus and a steel element.

This adhesive anchor is already approved for threaded rods made from different steel types M8 to M30 (threaded rods) and ∅8 to ∅40 (deformed rebars) have been assessed based on EAD 330232.

The company fischerwerke GmbH & Co. KG has commissioned the Engineering Office IEA to derive the characteristic resistances and admissible service conditions of the system Fischer FIS EM Plus as approved in [G6] and assessed in [R5] for a design service life of 100 years and 120 years respectively based on EAD 330232-02-0601 and EAD DP 17-33-2077-06.01 respectively.

For the assessment of the behaviour for a design service life of 120 years the

- sustained load tests,
- the freeze-thaw tests,
- the durability slice tests and
- the tests in opening and closing cracks

are performed with an increased duration or increased number of cycles and re-evaluated in respect of a working life of 120 years.

2 Literature

[1] Test report Nr. 875-17-008, Versuche am fischer Verbundanker FIS EM mit Gewindestangen und Betonstahl nach ETAG 001, Teil 5 und Annex A, 17.11.2017, Institut für Konstruktiven Ingenieurbau Akkreditierte Prüfstelle.

[2] Fi 472/01-19/06; Test report Versuche zur Ermittlung der Tragfähigkeit des fischer FIS EM Plus Mörtel für 120 Jahre Lebensdauer, Institut für Werkstoffe im Bauwesen, IWB in preparation, 2019

[3] Prüfbericht-Nr.: E-C 1695-2019, Risswechselversuche mit FIS EM Plus für "Service life time 120 years" mit den Größen M8 und M12, Entwicklung Chemie 15.03.2019.

[4] Prüfbericht Nr. 875-19-004, Versuche am fischer Verbundanker FIS EM PLUS mit Gewindestangen M10 und M16 nach EAD 330499-00-0601 inkl. TR 048 unter Berücksichtigung von EAD 332077-00-0601, Institut für Konstruktiven Ingenieurbau Akkreditierte Prüfstelle, 14.03.2019.

[5] 17_053-1: Evaluation Report on the upgrade of the fischer FIS EM plus adhesive anchors using additional tests for the assessment according to draft EAD 330499-00-0601 and ETAG 001, Part 5, IEA GmbH & Co. KG, Stuttgart 10.10.2017

[6] Eligehausen, R.; Mallée, R., Silva J.: Anchorage in Concrete Construction, Wilhelm Ernst & Sohn, Berlin, 2006.

[7] Owen, D.: Handbook of Statistical Tables, Addison/Wesley Publishing

[8] ETA-17/0979 vom 6. April 2018, Europäische Technische Bewertung fischer Injektionssystem FIS EM Plus nach EAD 330499-00-0601.

[9] AC308: Acceptance criteria for post installed adhesive anchors in concrete approved June 2013 (editorially revised October 2013).

[10] ACI 355.4-11: Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary.

[11] EOTA Technical Report 029: Design of Bonded Anchors, June 2007, Amended September 2010.

[12] EOTA EAD 330499-00-0601: Bonded fasteners for use in concrete,

[13] EOTA EAD 330499-02-0601: 2019-01-16 adoptEAD

[14] Prüfbericht-Nr.: E-C 1692-2019, Dauerstandversuche mit FIS EM Plus für "Service life time 120 years", Entwicklung Chemie 15.03.2019.

[15] EAD DP 17-33-2077-06.01, 2018-05-30 EOTA

3 Description of the product

3.1 Description, parts and materials

The adhesive anchor system fischer FIS EM Plus [8] transfers loads into the concrete by bond stresses between anchor rod and mortar as well as by bond stresses between mortar and surface of the drilled hole. The fischerwerke GmbH & Co. KG injection adhesive anchor system consists of the fischer FIS EM Plus adhesive, threaded rods and reinforcement bars.

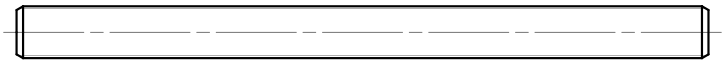
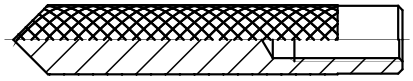
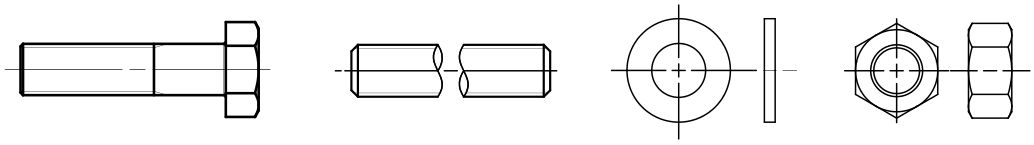
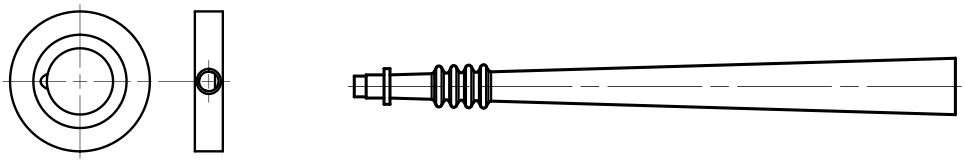
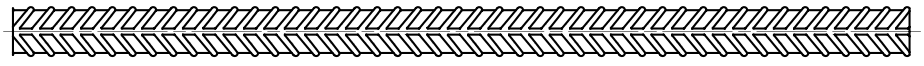
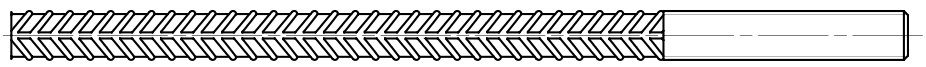
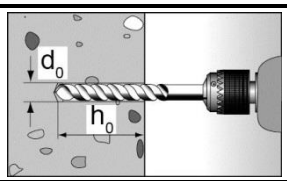
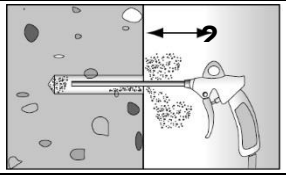
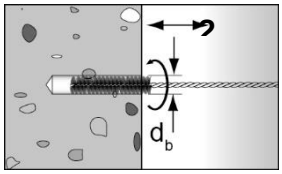
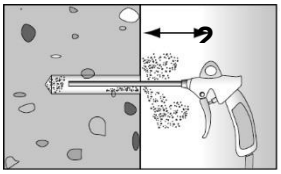
fischer anchor rod Size: M8, M10, M12, M14, M16, M20, M22, M24, M27, M30 
fischer internal threaded anchor RG MI Size: M8, M10, M12, M16, M20 
Screw / threaded rod / washer / hexagon nut 
fischer filling disk FFD with injection adapter 
Reinforcing bar Nominal diameter: ϕ8, ϕ10, ϕ12, ϕ14, ϕ16, ϕ18, ϕ20, ϕ22, ϕ24, ϕ25, ϕ26, ϕ28, ϕ30, ϕ32, ϕ34, ϕ36, ϕ40 
fischer rebar anchor FRA Size: M12, M16, M20, M24 

Table 3.1: Description of the product and different components for the fischer injection system FIS EM Plus.

3.2 Installation of the anchors

The installation parameters for threaded rods and rebars are given in the ETA and are also valid for a design live up to 120 years. The manufacturer's installation instructions (MPII) are shown in Table 3.1 and 3.2, see also [8].

Drilling and cleaning the hole (hammer drilling with standard drill bit)

1		Drill the hole. Nominal drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$ see [8]
2		Cleaning the drill hole: Blow out the drill hole twice, with oil free compressed air (p ≥ 6 bar) 
3		Brush the drill hole twice. For drill hole diameter ≥ 30 mm use a power drill. For deep holes use an extension. Corresponding brushes see [8]
4		Cleaning the drill hole: Blow out the drill hole twice, with oil free compressed air (p ≥ 6 bar) 

Drilling and cleaning the hole (hammer drilling with hollow drill bit)

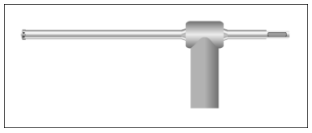
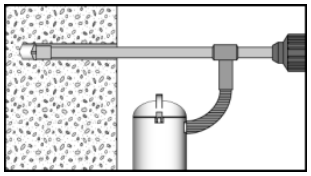
1		Check a suitable hollow drill (see [8]) for correct operation of the dust extraction
2		Use a suitable dust extraction system, e. g. Bosch GAS 35 M AFC or a comparable dust extraction system with equivalent performance data Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process and must be adjusted to maximum power. Nominal drill hole diameter $\mathbf{d_0}$ and drill hole depth $\mathbf{h_0}$ see [8]

Table 3.2: Installation of the drop in anchors FIS EM Plus (Part 1).

Detailed requirements for cleaning the holes and injecting the mortar are given in the relevant ETA 17/0979 [8]. Therefore, the description of the adhesive system is not repeated in the current report.

Drilling and cleaning the hole (wet drilling with diamond drill bit)

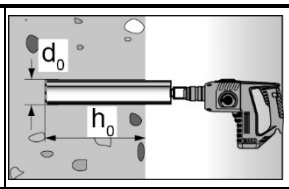
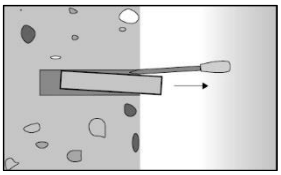
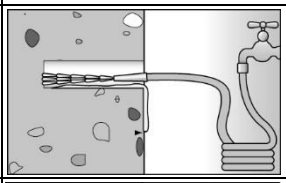
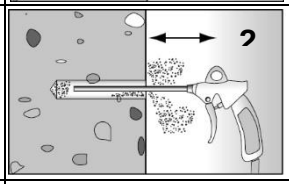
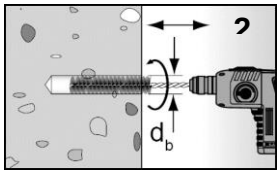
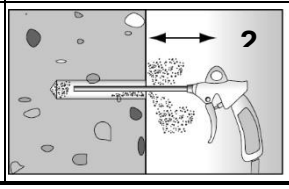
1		Drill the hole. Drill hole diameter **d_0** and nominal drill hole depth **h_0** see [8].		Break the drill core and remove it
2		Flush the drill hole with clean water until it flows clear		
3		Blow out the drill hole twice, using oil-free compressed air (p > 6 bar)		
4		Brush the drill hole twice using a power drill. Corresponding brushes see [8]		
5		Blow out the drill hole twice, using oil-free compressed air (p > 6 bar)		

Table 3.3: Installation parameters for the drop in anchors FIS EM Plus (Part 2).

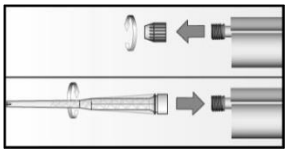
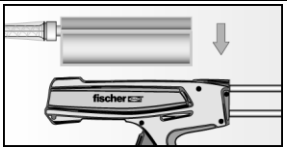
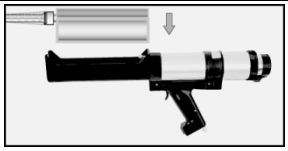
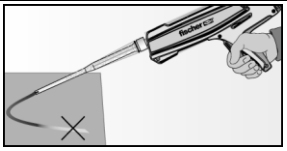
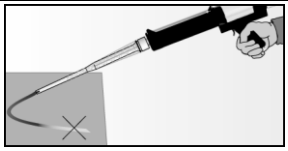
6		Remove the sealing cap Screw on the static mixer (the spiral in the static mixer must be clearly visible)	
7			Place the cartridge into the dispenser
8			Extrude approximately 10 cm of material out until the resin is evenly grey in colour. Do not use mortar that is not uniformly grey

Table 3.4: Installation parameters for the drop in anchors FIS EM Plus (Preparing the cartridge).

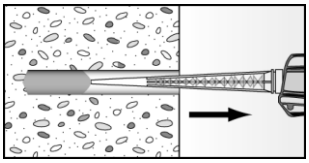
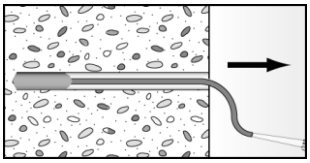
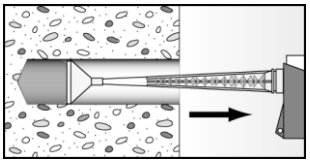
9	 Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles	 For drill hole depth ≥ 150 mm use an extension tube	 For overhead installation, deep holes (h_0 > 250 mm) or drill hole diameter (d_0 ≥ 40 mm) use an injection-adapter

Table 3.5: Installation parameters for the drop in anchors FIS EM Plus (injection of the mortar).

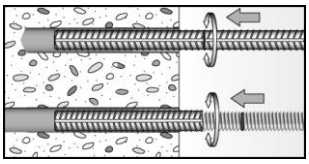
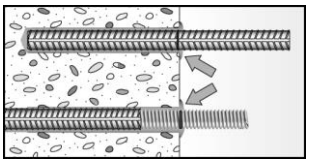
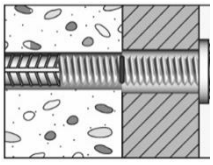
10		Only use clean and oil-free reinforcing bars or fischer FRA. Mark the setting depth. Turn while using force to push the reinforcement bar or the fischer FRA into the filled hole up to the setting depth mark
		When the setting depth mark is reached, excess mortar must be emerged from the mouth of the drill hole.
11		Wait for the specified curing time t_{cure} see [8]
12		Mounting the fixture Max T_{fix} see [8]

Table 3.6: Installation parameters for the drop in anchors FIS EM Plus (Installation reinforcing bars and fischer rebar anchor FRA).

4 Performance of the product

4.1 Characteristic resistances

The characteristic resistances given in ETA-17/0979 [8] are valid for a service lifetime of 50 years. To cover a service lifetime of 120 years the values given in ETA-17/0979 shall be reduced with the factor $\alpha_{120\ years}$ given in the following table.

Reduction factor	Cracked concrete							
	35°C / 60°C				50°C / 72°C			
	M8	M10	M12	M16 and larger	M8	M10	M12	M16 and larger
$\tau_{Rk,50years}$ =	see ETA -17/0979 (except flooded holes applications)							
$\alpha_{120\ years}$ =	0,60	0,85	0,80	0,65	0,60	0,85	0,80	0,65
Reduction factor	**Non-cracked concrete**							
	35°C / 60°C				50°C / 72°C			
	M8	M10	M12	M16 and larger	M8	M10	M12	M16 and larger
$\tau_{Rk,50years}$ =	see ETA -17/0979 (except flooded holes applications)							
$\alpha_{120\ years}$ =	0,74	0,74	0,74	0,77	0,57	0,58	0,60	0,65

Table 4.1: Reduction factors for the characteristic resistances given in the ETA - 17/0979 to cover a service lifetime of 120 years.

The reduction factors do no cover applications with flooded hole conditions.

4.2 Displacements

The long term displacements $\delta_{N,\infty}$ and $\delta_{V,\infty}$ for a lifetime of 120 years are calculated using the short term displacements $\delta_{N,0}$ and $\delta_{V,0}$ multiplied with a factor of 3.6 instead of 1,5. The short term displacements are given in ETA-17/0979 [8].

4.3 Characteristic resistances under fire conditions

The characteristic resistances are not dependent on the service lifetime, since fire condition is an exceptional loading case. The characteristic resistances under fire however shall be limited to the values under ambient conditions (see 4.1).

4.4 Characteristic resistances under seismic conditions

The characteristic resistances are not dependent on the service lifetime, since seismic condition is an exceptional loading case. The characteristic resistances under seismic actions however shall be limited to the values under ambient conditions (see 4.1).

5 Summary and conclusion

the adhesive anchor system fischer FIS EM Plus is already assessed according to EAD 330499-02-0601 or for threaded rods, rebars and FRA anchor rods made from different steel types and deformed reinforcing bars. The mortar system is assessed for the use in cracked and non-cracked concrete under different temperatures.

The results of the additional short-term tests with the adhesive anchors fischer FIS EM Plus were evaluated to judge the suitability for a service lifetime of 120 years. In an experts report it is shown that the adhesive anchor system fischer FIS EM Plus is suitable for applications in non-cracked and cracked concrete for a service lifetime up to 120 years, if the characteristic resistances assessed for 50 years are reduced with the factor $\alpha_{120years}$ given in section 4.1. The reduction are not valid for flooded hole applications.

For the design, the partial safety factors for the material and loading must be adapted to a service life of or 120 years respectively.