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-15/0440 of 6 July 2015

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	fischer injection system FIS EB
Product family to which the construction product belongs	Bonded anchor for use in concrete
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	Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 5: "Bonded anchors", April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

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Specific Part

1 Technical description of the product

The fischer injection system FIS EM is a bonded anchor consisting of a cartridge with injection mortar fischer FIS EM and a steel element. The steel element consist of

- a threaded rod with washer and hexagon nut of sizes M8 to M30 or
- a reinforcing bar of sizes ϕ = 8 to 40 mm or

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

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 anchor of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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 values under static and quasi-static action for design according to TR 029 or CEN/TS 1992-4:2009, Displacements	See Annex C 1 to C 8
Characteristic values for seismic performance categories C1 and C2 for design according to Technical Report TR 045, Displacements	See Annex C 9 to C 12

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	No performance assessed

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not applicable.

3.6 Energy economy and heat retention (BWR 6)

Not applicable.

3.7 Sustainable use of natural resources (BWR 7)

The sustainable use of natural resources was not investigated.

3.8 General aspects

The verification of durability is part of testing the essential characteristics. Durability is only ensured if the specifications of intended use according to Annex B are taken into account.

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

According to Decision of the Commission of 24 June 1996 (96/582/EC) (OJ L 254 of 08.10.96 p. 62-65), the system of assessment and verification of constancy of performance (see Annex V and Article 65 Paragraph 2 to Regulation (EU) No 305/2011) given in the following table applies.

Product	Intended use	Level or class	System
Metal anchors for use in concrete (heavy-duty type)	For fixing and/or supporting concrete structural elements or heavy units such as cladding and suspended ceilings	—	1

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

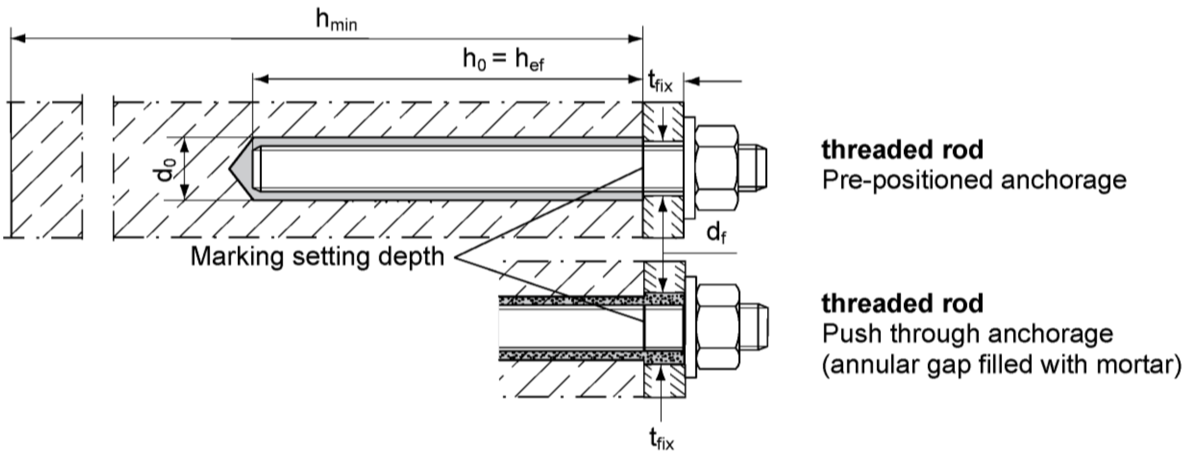
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

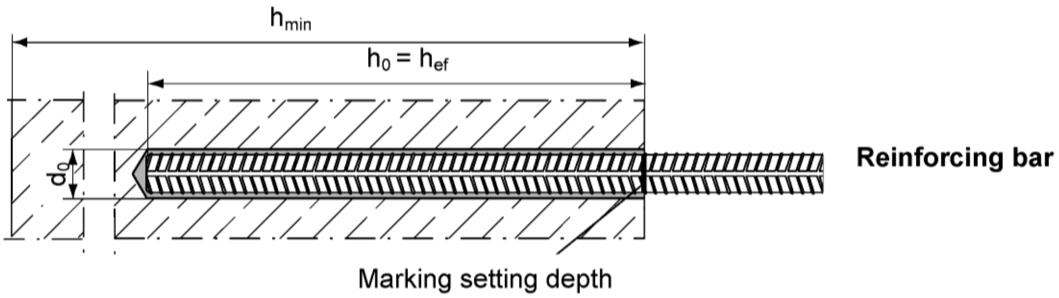
Issued in Berlin on 6 July 2015 by Deutsches Institut für Bautechnik

Uwe Bender
Head of Department

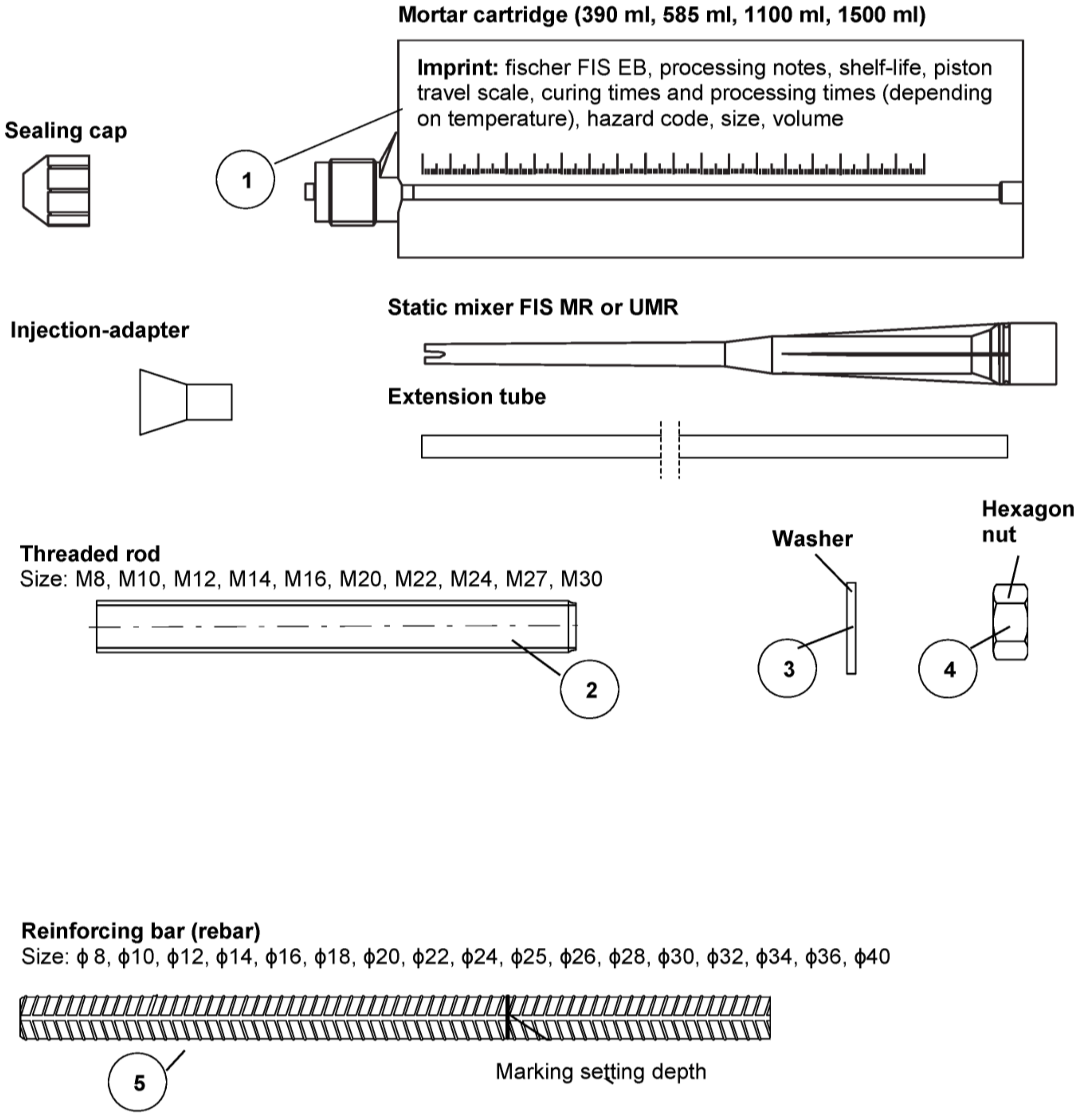
beglaubigt:
Baderschneider

Installation conditions





fischer injection system FIS EB	**Annex A 1**
Product description Installation conditions	



fischer injection system FIS EB	Annex A 2
Product description Cartridges/Static mixer/ Steel elements	

Table A1: Materials

Part	Designation	Material	
1	Mortar cartridge	Mortar, hardener, filler	
		Steel, zinc plated	Stainless steel A4
2	Threaded rod	Property class 5.8 or 8.8; EN ISO 898-1: 2013 zinc plated ≥ 5µm, EN ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004 $f_{uk} \leq 1000$ N/mm^2 $A_5 > 12\%$ fracture elongation	Property class 50, 70 or 80 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; 1.4062 EN 10088-1:2014 $f_{uk} \leq 1000$ N/mm^2 $A_5 > 12\%$ fracture elongation
3	Washer ISO 7089:2000	zinc plated ≥ 5µm, EN ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004	1.4401; 1.4404; 1.4578;1.4571; 1.4439; 1.4362 EN 10088-1:2014
4	Hexagon nut	Property class 5 or 8; EN ISO 898-2:2013 zinc plated ≥ 5µm, ISO 4042:1999 A2K or hot-dip galvanised EN ISO 10684:2004	Property class 50, 70 or 80 EN ISO 3506:2009 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362 EN 10088-1:2014
5	Reinforcing bar EN 1992-1-1:2004 and AC:2010, Annex C	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:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$	

fischer injection system FIS EB

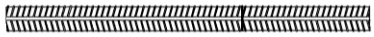
Product description
Materials

Annex A 3

Deutsches Institut für Bautechnik DIBt

Specifications of intended use (part 1)

Table B1: Overview use categories and performance categories

Anchorages subject to		FIS EB with …			
		Threaded rod 		Reinforcing bar 	
Hammer drilling		all sizes			
Diamond drilling		all sizes			
Static and quasi static load, in	uncracked concrete cracked concrete	all sizes	Tables: C1, C2, C5, C6	all sizes	Tables: C3, C4, C7, C8
Seismic performance category (only hammer drilling)	C1	M10 – M30	Table C9	ϕ 10 - ϕ 32	Table C10
	C2	M12, M16, M20, M24	Table C11	--	--
Use category	Dry or wet concrete	all sizes			
	Flooded hole	all sizes			
Installation temperature		+5°C to +40°C			
In-service temperature	Temperature range	-40°C to +72°C		(max. long term temperature +50°C and max. short term temperature +72°C)	

Base materials:
- Reinforced or unreinforced normal weight concrete according to EN 206-1:2013
- Strength classes C20/25 to C50/60 according to EN 206-1:2013

Use conditions (Environmental conditions):
- Structures subject to dry internal conditions (zinc coated steel, stainless steel)
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel)
  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

fischer injection system FIS EB

Intended Use
Specifications (part 1)

Annex B 1

Specifications of intended use (part 2)

Design:

- Anchorages have to be designed under the responsibility of an engineer experienced in anchorages and concrete work
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.)
- Anchorages under static or quasi-static actions are designed in accordance with EOTA Technical Report TR 029 "Design of bonded anchors" Edition September 2010 or CEN/TS 1992-4:2009
- Anchorages under seismic actions (cracked concrete) have to be designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure.
  - Fastenings in stand-off installation or with a grout layer are not allowed.

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- In case of aborted hole: The hole shall be filled with mortar
- Marking and keeping the effective anchorage depth
- Overhead installation is allowed

Commercial standard threaded rods, washers and hexagon nuts may also be used if the following requirements are fulfilled:

- Materials, dimensions and mechanical properties according to Annex A 3, Table A1
- Inspection certificate 3.1 according to EN 10204:2004, the documents should be stored
- Marking of embedment depth

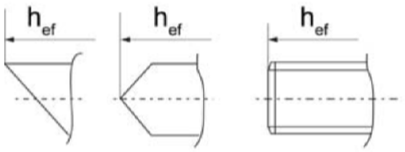
Table B2: Installation parameters for threaded rods

Size			**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Width across flat	SW		13	17	19	22	24	30	32	36	41	46
Nominal drill bit diameter	d_0	[mm]	12	14	14	16	18	24	25	28	30	35
Depth of drill hole	h_0	[mm]	$h_0 = h_{ef}$									
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	93	96	108	120
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	440	480	540	600
Minimum spacing and minimum edge distance	$s_{min} = c_{min}$	[mm]	40	45	55	60	65	85	95	105	120	140
Diameter of clearance hole in the fixture[1)] – pre-positioned anchorage	d_f	[mm]	9	12	14	16	18	22	24	26	30	33
Diameter of clearance hole in the fixture[1)] – push through anchorage	d_f	[mm]	14	16	16	18	20	26	28	30	33	40
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30 \geq 100$			$h_{ef} + 2d_0$						
Maximum torque moment	$T_{inst,max}$	[Nm]	10	20	40	50	60	120	135	150	200	300

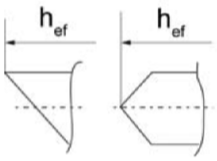
[1)] For larger clearance holes in the fixture see TR 029, 4.2.2.1 or CEN/TS 1992-4-1:2009, 5.2.3.1

fischer threaded rod:

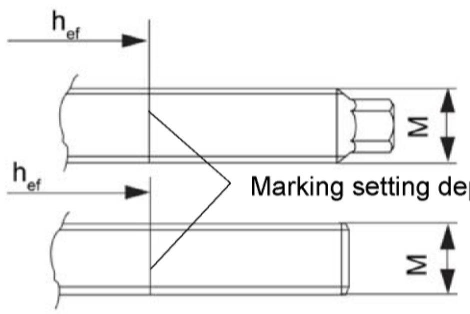
Alternative point geometry threaded rod FIS A



Alternative point geometry threaded rod RGM



Alternative head geometry threaded rod FIS A and RGM



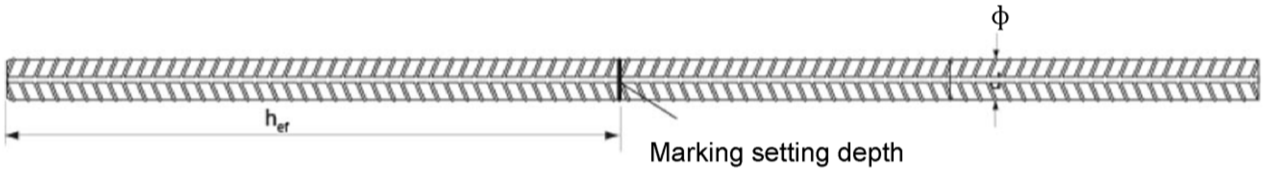
Marking (on random place):
Property class 8.8, property class 80: •
Stainless steel A4, property class 50: ••

Table B3: Installation parameters reinforcing bars

Reinforcing bar		ϕ	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Nominal drill bit diameter	d_0	[mm]	12	14	16	18	20	25	25	30	30
Drill hole depth	h_0	[mm]	$h_0 = h_{ef}$								
Effective anchorage depth	$h_{ef,min}$	[mm]	60	60	70	75	80	85	90	94	98
	$h_{ef,max}$	[mm]	160	200	240	280	320	360	400	440	480
Minimum spacing and minimum edge distance	$s_{min} = c_{min}$	[mm]	40	45	55	60	65	75	85	95	105
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 30$ ≥ 100		$h_{ef} + 2d_0$						

Reinforcing bar		ϕ	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**
Nominal drill bit diameter	d_0	[mm]	30	35	35	40	40	40	45	55
Drill hole depth	h_0	[mm]	$h_0 = h_{ef}$							
Effective anchorage depth	$h_{ef,min}$	[mm]	100	104	112	120	128	136	144	160
	$h_{ef,max}$	[mm]	500	520	560	600	640	680	720	800
Minimum spacing and minimum edge distance	$s_{min} = c_{min}$	[mm]	110	120	130	140	160	170	180	200
Minimum thickness of concrete member	h_{min}	[mm]	$h_{ef} + 2d_0$							

Reinforcing bar



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- The rib height h must be $0{,}05 \cdot \phi \leq h \leq 0{,}07 \cdot \phi$
  (ϕ = nominal bar size, h = Rip height of the bar)

fischer injection system FIS EB

Intended Use
Installation parameters reinforcing bars

Annex B 4

Table B4: Parameters of steel brush FIS BS Ø

Drill bit diameter	[mm]	12	14	16	18	20	24	25	28	30	32	35	40	45	55
Steel brush diameter d_b	[mm]	14	16	20		25	26	27	30	40			42	47	58

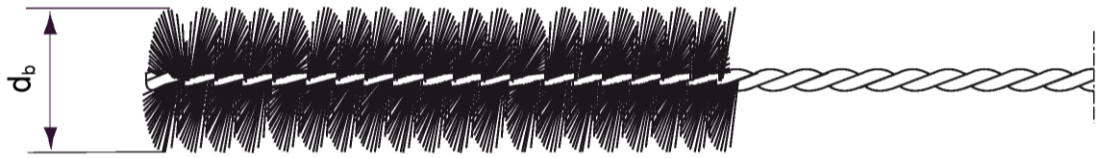
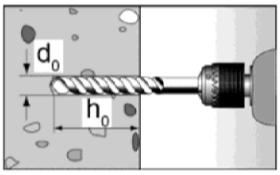
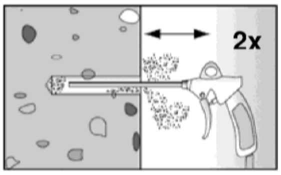
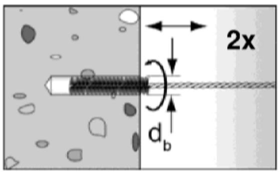
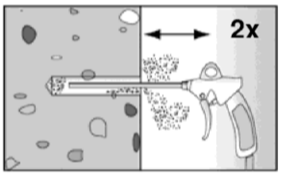


Table B5: Maximum processing time of the mortar and minimum curing time

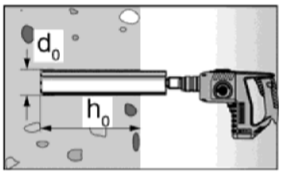
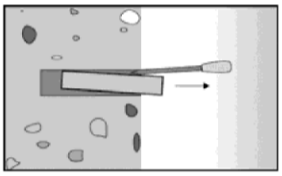
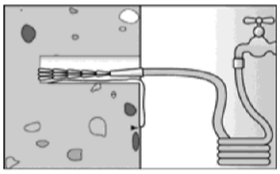
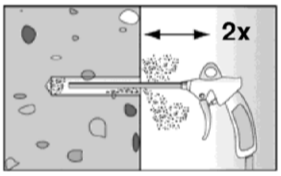
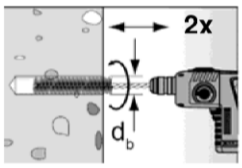
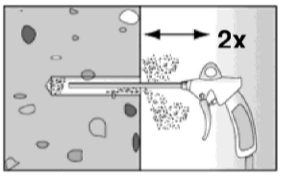
System temperature [°C]	Maximum processing time [minutes]	Minimum curing time[1)] [hours]
+5 to +10	120	45
≥ +10 to +20	30	22
≥ +20 to +30	14	12
≥ +30 to +40	7	6

1) In wet concrete or flooded holes the curing times must be doubled.

Installation instructions part 1
Drilling and cleaning the hole (hammer-drilling)

1		Drill the hole. Drill hole diameter **d_0** and drill hole depth **h_0** see **Tables B2, B3**.	
2		Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air ($p \geq 6$ bar)	
3		Brush the drill hole two times. For drill hole diameter ≥ 30 mm use a power drill. For deep holes use an extension. Corresponding brushes see **Table B4**	
4		Clean the drill hole: Blow out the drill hole two times, using oil-free compressed air ($p \geq 6$ bar)	

Drilling and cleaning the hole (diamond-drilling)

1		Drill the hole. Drill hole diameter **d_0** and drill hole depth **h_0** see **Tables B2, B3.**			Break the drill core and draw it out.
2		Flush the drill hole until the water comes clear.			
3		Blow out the drill hole two times, using oil-free compressed air ($p > 6$ bar)	4		Brush the drill hole two times using a power drill. Corresponding brushes see **Table B4**
5		Blow out the drill hole two times, using oil-free compressed air ($p > 6$ bar)			

fischer injection system FIS EB

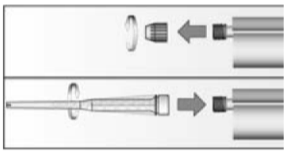
Intended use
Installation instructions part 1

Annex B 6

Installation instructions part 2

Preparing the cartridge

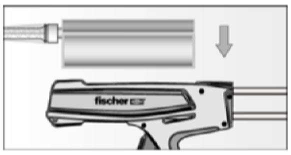
5

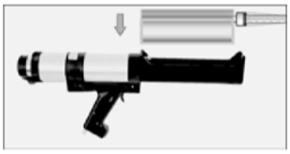


Twist off the sealing cap

Twist on the static mixer (the spiral in the static mixer must be clearly visible).

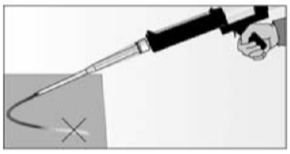
6





Place the cartridge into the dispenser.

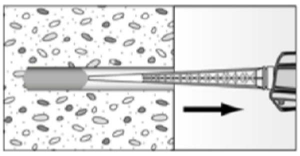
7



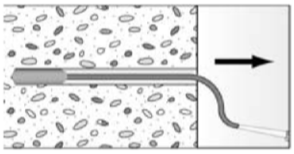
Press approx. 10 cm of material out until the resin is evenly grey in colour. Don`t use mortar that is not uniformly grey.

Injection of the mortar

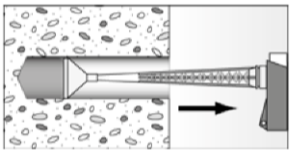
8



Fill approx. 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles.



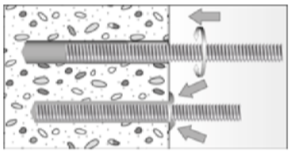
For drill hole depth ≥ 150 mm use an extension tube.



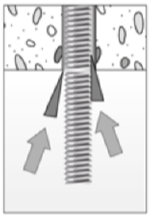
For overhead installation, deep holes h_0 > 250 mm or drill hole diameter d_0 ≥ 40 mm use an injection-adapter.

Installation threaded rods

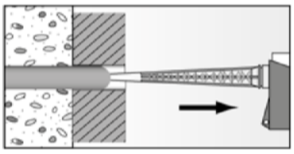
9



Only use clean and oil-free anchor elements. Mark the setting depth of the anchor. Press the threaded rod down to the bottom of the hole, turning it slightly while doing so. After inserting the anchor element, excess mortar must emerge around the anchor element.



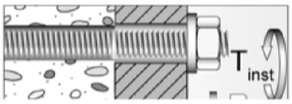
For overhead installations support the threaded rod with wedges.



For push through installation fill the annular clearance with mortar.

10

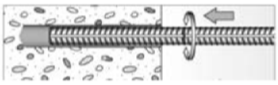
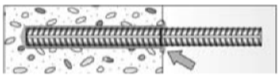
Wait for the specified curing time, t_{cure} see **Table B5**.



Mounting the fixture $T_{inst,max}$ see **Table B2.**

fischer injection system FIS EB	**Annex B 7**
Intended use Installation instructions part 2	

Installation instructions part 3
Installation reinforcing bars

9		Only use clean and oil-free reinforcing bars. Mark the setting depth of the reinforcing bar. Using a turning movement, push the reinforcement bar vigorously into the filled hole up to the insertion depth marking.
		When reaching the setting depth mark, excess mortar must emerge from the mouth of the drill hole.
10		Wait for the specified curing time t_{cure} see **Table B5**.

fischer injection system FIS EB

Intended use
Installation instructions part 3

Annex B 8

Table C1: Characteristic values of resistance for threaded rods under tension loads in un-cracked and cracked concrete

Size			**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor – dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0						1,2			
Installation safety factor – flooded hole	$\gamma_2 = \gamma_{inst}$	[-]	1,4[2)]					1,4				
Steel failure												
Characteristic resistance	$N_{Rk,s}$	[kN]	A_s x f_{uk}									
Combined pullout and concrete cone failure												
Diameter of calculation	d	[mm]	8	10	12	14	16	20	22	24	27	30
Characteristic bond resistance in un-cracked concrete C20/25												
hammer-drilling (dry and wet concrete)												
Temperature range [1)]	$\tau_{Rk,ucr}$	[N/mm²]	11	10	10	9	9	8	8	8	7,5	7,5
hammer-drilling (flooded hole)												
Temperature range [1)]	$\tau_{Rk,ucr}$	[N/mm²]	11	10	10	9	8	7,5	7	7	6	6
diamond-drilling (dry and wet concrete)												
Temperature range [1)]	$\tau_{Rk,ucr}$	[N/mm²]	11	10	8	7,5	7,5	7	6	6	5,5	5,5
diamond-drilling (flooded hole)												
Temperature range [1)]	$\tau_{Rk,ucr}$	[N/mm²]	11	10	8	7,5	7,5	7	6	6	5,5	5,5
Factor for un-cracked concrete	k_{ucr}	[-]	10,1									
Characteristic bond resistance in cracked concrete C20/25												
hammer and diamond drilling (dry and wet concrete)												
Temperature range [1)]	$\tau_{Rk,cr}$	[N/mm²]	5	5	5	5	4	4	5	5	5	5
hammer and diamond drilling (flooded hole)												
Temperature range [1)]	$\tau_{Rk,cr}$	[N/mm²]	4	5	5	5	4	4	4	4	4	4
Factor for cracked concrete	k_{cr}	[-]	7,2									
Increasing factor for τ_{Rk} – C25/30	Ψ_c	[-]	1,02									
Increasing factor for τ_{Rk} – C30/37	Ψ_c	[-]	1,04									
Increasing factor for τ_{Rk} – C35/45	Ψ_c	[-]	1,06									
Increasing factor for τ_{Rk} – C40/50	Ψ_c	[-]	1,07									
Increasing factor for τ_{Rk} – C45/55	Ψ_c	[-]	1,08									
Increasing factor for τ_{Rk} – C50/60	Ψ_c	[-]	1,09									
Splitting failure												
Edge distance – $h / h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}									
Edge distance – $2,0 > h/h_{ef} > 1,3$	$c_{cr,sp}$	[mm]	4,6 h_{ef} – 1,8 h									
Edge distance – $h / h_{ef} \leq 1,3$	$c_{cr,sp}$	[mm]	2,26 h_{ef}									
Axial distance	$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$									

[1)] See Annex B 1
[2)] For use in cracked concrete (flooded hole) the installation safety factor can be reduced to 1,2.

fischer injection system FIS EB

Performances
Design of bonded anchors
Static or quasi-static action in tensions

Annex C 1

Table C2: Characteristic values of resistance for threaded rods under shear loads

Size			**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0									
Steel failure without lever arm												
Characteristic resistance	$V_{Rk,s}$	[kN]	$0{,}5\ A_s \times f_{uk}$									
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]	0,8									
Steel failure with lever arm												
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1{,}2 \times W_{el} \times f_{uk}$									
Concrete pryout failure												
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]	2,0									
Concrete edge failure												
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d)$									
Diameter of calculation	d	[mm]	8	10	12	14	16	20	22	24	27	30

fischer injection system FIS EB

Performances
Design of bonded anchors
Static or quasi-static action under shear loads

Annex C 2

Table C3: Characteristic values of resistance for reinforcing bars under tension loads in un-cracked concrete / Hammer-drilling

Reinforcing bar			ϕ	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0							1,2	
	flooded hole		[-]	1,4								
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	8	10	12	14	16	18	20	22	24
Characteristic bond resistance in un-cracked concrete												
hammer-drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	11	10	10	9	9	9	8	8	8
hammer-drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	11	10	9	8	7,5	8	7,5	7	7

Reinforcing bar			ϕ	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**	**-**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,2								-
	flooded hole		[-]	1,4								-
Combined pullout and concrete cone failure												
Diameter of calculation		d	[mm]	25	26	28	30	32	34	36	40	-
Characteristic bond resistance in un-cracked concrete												
hammer-drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	8	7,5	7,5	7,5	7,5	7,5	7,5	7	-
hammer-drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	6	6	6	6	5,5	5,5	5,5	5,5	-

[1)] See Annex B 1

Table C3.1: Characteristic values of resistance for reinforcing bars under tension loads in un-cracked concrete / Diamond-drilling

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	γ_2 =	[-]	1,0							1,2	
	flooded hole	γ_{inst}	[-]	1,4								
Characteristic bond resistance in un-cracked concrete C20/25												
diamond-drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	11	10	8	7,5	7,5	7	7	6	6
diamond-drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	11	10	8	7,5	7,5	7	7	6	6
Reinforcing bar			**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**	**-**
Installation safety factor	dry and wet concrete	γ_2 =	[-]	1,2								-
	flooded hole	γ_{inst}	[-]	1,4								-
Characteristic bond resistance in un-cracked concrete C20/25												
diamond-drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	6	5,5	5,5	5,5	5,5	5	5	5	-
diamond-drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,ucr}$	[N/mm²]	6	5,5	5,5	5,5	5,5	5	5	5	-
Factor for un-cracked concrete		k_{ucr}	[-]	10,1								

[1)] See Annex B 1

fischer injection system FIS EB

Performances
Design of bonded anchors
Static or quasi-static action in tension

Annex C 4

Table C3.2: Characteristic values of resistance for reinforcing bars under tension loads in cracked concrete / Hammer- and Diamond-drilling

Reinforcing bar			ϕ	8	10	12	14	16	18	20	22	24
Installation safety factor	dry and wet concrete	γ_2 =	[-]	-	1,0						1,2	
	flooded hole	γ_{inst}	[-]	-	1,2					1,4		
Characteristic bond resistance in cracked concrete C20/25												
hammer and diamond drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,cr}$	[N/mm²]	5	5	5	5	4	4	4	5	5
hammer and diamond drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,cr}$	[N/mm²]	4	4,5	4,5	4	4	4	4	4	4

Reinforcing bar			ϕ	25	26	28	30	32	34	36	40	
Installation safety factor	dry and wet concrete	γ_2 =	[-]	1,2								-
	flooded hole	γ_{inst}	[-]	1,4								-
Characteristic bond resistance in cracked concrete C20/25												
hammer and diamond drilling (dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,cr}$	[N/mm²]	5	5	5	5	3,5	3,5	3,5	3,5	-
hammer and diamond drilling (flooded hole)												
Temperature range [1)]		$\tau_{Rk,cr}$	[N/mm²]	4	4	4	4	3,5	3,5	3,5	3,5	-
Factor for cracked concrete		k_{cr}	[-]	7,2								
Increasing factor for τ_{Rk}	Ψ_c	C25/30	[-]	1,02								
		C30/37	[-]	1,04								
		C35/45	[-]	1,06								
		C40/50	[-]	1,07								
		C45/55	[-]	1,08								
		C50/60	[-]	1,09								
Splitting failure												
Edge distance $c_{cr,sp}$		$h/h_{ef} \geq 2{,}0$	[mm]	$1{,}0\ h_{ef}$								
		$2{,}0 > h/h_{ef} > 1{,}3$	[mm]	$4{,}6\ h_{ef} - 1{,}8\ h$								
		$h/h_{ef} \leq 1{,}3$	[mm]	$2{,}26\ h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								

[1)] See Annex B 1

fischer injection system FIS EB

Performances
Design of bonded anchors
Static or quasi-static in tension

Annex C 5

Table C4: Characteristic values of resistance for reinforcing bars under shear loads

Reinforcing bar			**φ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Diameter of calculation	d	[mm]		8	10	12	14	16	18	20	22	24
Reinforcing bar			**φ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**	
Diameter of calculation	d	[mm]		25	26	28	30	32	34	36	40	-
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]		1,0								
Steel failure without lever arm												
Characteristic resistance	$V_{Rk,s}$	[kN]		$0{,}5\ A_s \times f_{uk}$								
Ductility factor acc. to CEN/TS 1992-4-5:2009 Section 6.3.2.1	k_2	[-]		0,8								
Steel failure with lever arm												
Characteristic resistance	$M^0_{Rk,s}$	[Nm]		$1{,}2 \times W_{el} \times f_{uk}$								
Concrete pryout failure												
Factor k acc. to TR029 Section 5.2.3.3 resp. k_3 acc. to CEN/TS 1992-4-5:2009 Section 6.3.3	$k_{(3)}$	[-]		2,0								
Concrete edge failure												
Effective length of anchor	l_f	[mm]		$l_f = \min(h_{ef};\ 8\ d)$								

fischer injection system FIS EB

Performances
Design of bonded anchors
Static or quasi-static action under shear loads

Annex C 6

Table C5: Displacements under tension load for threaded rods[1)]

Size		M8	M10	M12	M16	M20	M24	M27	M30
Un-cracked and cracked concrete; temperature range									
Displacement δ_{N0} - Factor	[mm/(N/mm^2)]	0,07	0,08	0,09	0,10	0,11	0,12	0,13	0,13
Displacement $\delta_{N\infty}$ - Factor	[mm/(N/mm^2)]	0,13	0,14	0,15	0,17	0,17	0,18	0,19	0,19

1) Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor$\cdot\ \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor$\cdot\ \tau$
(τ: design bond strength)

Table C6: Displacements under shear load for threaded rods[1)]

Size		M8	M10	M12	M16	M20	M24	M27	M30
Un-cracked and cracked concrete; temperature range									
Displacement δ_{V0} - Factor	[mm/kN]	0,18	0,15	0,12	0,09	0,07	0,06	0,05	0,05
Displacement $\delta_{V\infty}$ - Factor	[mm/kN]	0,27	0,22	0,18	0,14	0,11	0,09	0,08	0,07

1) Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot$ V
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot$ V
(V: design shear resistance)

Table C7: Displacements under tension load for reinforcing bars [1)]

Size		**ϕ**	**8**	**10**	**12**	**14**	**16**	**20**	**25**	**28**	**32**
Un-cracked and cracked concrete											
Displacement	δ_{N0} - Factor	[mm/(N/mm^2)]	0,07	0,08	0,09	0,09	0,10	0,11	0,12	0,13	0,13
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm^2)]	0,12	0,13	0,13	0,15	0,16	0,16	0,18	0,20	0,20

[1)] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor$\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor$\cdot \tau$
(τ: design bond strength)

Table C8: Displacements under shear load for reinforcing bars [1)]

Size		**ϕ**	**8**	**10**	**12**	**14**	**16**	**20**	**25**	**28**	**32**
Un-cracked and cracked concrete											
Displacement	δ_{V0} - Factor	[mm/kN]	0,18	0,15	0,12	0,10	0,09	0,07	0,06	0,05	0,05
Displacement	$\delta_{V\infty}$ - Factor	[mm/kN]	0,27	0,22	0,18	0,16	0,14	0,11	0,09	0,08	0,06

[1)] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot$ V
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot$ V
(V: design shear resistance)

Table C9A: Characteristic values of resistance for fischer threaded rods FIS A and RGM under seismic action performance category C1 in hammer drilled hole

Size				**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,0						1,2			
	flooded hole		[-]	1,2					1,4				
Characteristic resistance tension load, steel failure													
$N_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	-	29	43	58	79	123	152	177	230	281
			8.8	-	47	68	92	126	196	243	282	368	449
	Stainless steel A4	Property class	50	-	29	43	58	79	123	152	177	230	281
			70	-	41	59	81	110	172	212	247	322	393
			80	-	47	68	92	126	196	243	282	368	449
Characteristic bond resistance, combined pullout and concrete cone failure													
(dry and wet concrete)													
Temperature range [2)]		$\tau_{Rk,C1}$	[N/mm²]	-	4,9	4,9	4,6	4,0	4,0	4,6	4,6	4,6	4,6
(flooded hole)													
Temperature range [2)]		$\tau_{Rk,C1}$	[N/mm²]	-	4,7	4,7	4,5	4,0	4,0	4,0	4,0	4,0	4,0
Characteristic resistance shear load, steel failure without lever arm													
$V_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	-	15	21	29	39	61	76	89	115	141
			8.8	-	23	34	46	63	98	122	141	184	225
	Stainless steel A4	Property class	50	-	15	21	29	39	61	76	89	115	141
			70	-	20	30	40	55	86	107	124	161	197
			80	-	23	34	46	63	98	122	141	184	225
Installation safety factor		$\gamma_2 = \gamma_{inst}$	[-]	1,0									

1) For fischer threaded rods FIS A / RGM the factor for steel ductility is 1,0
2) See Annex B 1

Table C9B: Characteristic values of resistance for standard threaded rods under seismic action performance category C1 in hammer drilled hole

Size				**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor				See Table C9A									
Characteristic resistance tension load, steel failure				See Table C9A									
Characteristic bond resistance, combined pullout and concrete cone failure				See Table C9A									
Characteristic resistance shear load, steel failure without lever arm													
$V_{Rk,s,C1}$ [kN]	Zinc plated steel	Property class	5.8	-	11	15	20	27	43	53	62	81	99
			8.8	-	16	24	32	44	69	85	99	129	158
	Stainless steel A4	Property class	50	-	11	15	20	27	43	53	62	81	99
			70	-	14	21	28	39	60	75	87	113	138
			80	-	16	24	32	44	69	85	99	129	158
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	-	1,0								

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Annex C 10

Table C10: Characteristic values of resistance for reinforcing bars under seismic action performance category C1 in hammer drilled hole

Reinforcing bar			**ϕ**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	-	1,0						1,2	
	flooded hole	$\gamma_2 = \gamma_{inst}$	[-]	-	1,2					1,4		
Characteristic resistance tension load, steel failure												
$N_{Rk,s,C1}$			[kN]	-	44	63	85	111	140	173	209	249
Characteristic bond resistance, combined pullout and concrete cone failure												
(dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,C1}$	[N/mm²]	-	4,9	4,9	4,6	4,0	4,0	4,0	4,6	4,6
(flooded hole)												
Temperature range [1)]		$\tau_{Rk,C1}$	[N/mm²]	-	4,7	4,7	4,1	4,1	4,0	4,0	4,0	4,0
Characteristic resistance shear load, steel failure without lever arm												
$V_{Rk,s,C1}$			[kN]	-	15	22	30	39	49	61	74	88
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0								
Reinforcing bar			**ϕ**	**25**	**26**	**28**	**30**	**32**	**34**	**36**	**40**	**-**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	1,2								-
	flooded hole	$\gamma_2 = \gamma_{inst}$	[-]	1,4								-
Characteristic resistance tension load, steel failure												
$N_{Rk,s,C1}$			[kN]	270	292	339	389	443	-	-	-	-
Characteristic bond resistance, combined pullout and concrete cone failure												
(dry and wet concrete)												
Temperature range [1)]		$\tau_{Rk,C1}$	[N/mm²]	4,6	4,6	4,6	4,6	3,4	-	-	-	-
(flooded hole)												
Temperature range [1)]		$\tau_{Rk,C1}$	[N/mm²]	4,0	4,0	4,0	4,0	3,4	-	-	-	-
Characteristic resistance shear load, steel failure without lever arm												
$V_{Rk,s,C1}$			[kN]	95	102	119	137	155	-	-	-	-
Installation safety factor		$\gamma_2=\gamma_{inst}$	[-]	1,0								

[1)] See Annex B 1

fischer injection system FIS EB	**Annex C 11**
Performances Design of bonded anchors Seismic performances C1	

Table C11: Characteristic values of resistance for fischer threaded rods FIS A, RGM and standard threaded rods under seismic action performance category C2 in hammer drilled hole

Size				**M8**	**M10**	**M12**	**M14**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**
Installation safety factor	dry and wet concrete	$\gamma_2 = \gamma_{inst}$	[-]	-	-	1,0	-	1,0	1,0	-	1,2	-	-
	flooded hole		[-]	-	-	1,2	-	1,2	1,4	-	1,4	-	-
Characteristic resistance tension load, steel failure													
$N_{Rk,s,C2}$ [kN]	Zinc plated steel	Property class	5.8	-	-	39	--	72	108	-	177	-	-
			8.8	-	-	61	-	116	173	-	282	-	-
	Stainless steel A4	Property class	50	-	-	39	-	72	108	-	177	-	-
			70	-	-	53	-	101	152	-	247	-	-
			80	-	-	61	-	116	173	-	282	-	-
Characteristic bond resistance, combined pullout and concrete cone failure (dry and wet concrete)													
Temperature range [1)]		$\tau_{Rk,C2}$	[N/mm²]	-	-	1,5	-	2,5	1,3	-	1,7	-	-
Characteristic bond resistance, combined pullout and concrete cone failure (flooded hole)													
Temperature range [1)]		$\tau_{Rk,C2}$	[N/mm²]	-	-	1,6	-	2,5	1,3	-	1,4	-	-
Displacements													
$\delta_{N,(DLS)}$ - Factor [3)]			[mm/(N/mm²)]	-	-	0,09	-	0,10	0,11	-	0,12	-	-
$\delta_{N,(ULS)}$ - Factor [3)]			[mm/(N/mm²)]	-	-	0,15	-	0,17	0,17	-	0,18	-	-
Characteristic resistance shear load, steel failure without lever arm													
$V_{Rk,s,C2}$ [2)] [kN]	Zinc plated steel	Property class	5.8	-	-	14	-	27	43	-	62	-	-
			8.8	-	-	22	-	44	69	-	99	-	-
	Stainless steel A4	Property class	50	-	-	14	-	27	43	-	62	-	-
			70	-	-	20	-	39	60	-	87	-	-
			80	-	-	22	-	44	69	-	99	-	-
Installation safety factor		$\gamma_2 = \gamma_{inst}$	[-]	-	-	1,0	-	1,0	1,0	-	1,0	-	-
Displacements													
$\delta_{V,(DLS)}$ - Factor [4)]			[mm/kN]	-	-	0,18	-	0,10	0,07	-	0,06	-	-
$\delta_{V,(ULS)}$ - Factor [4)]			[mm/kN]	-	-	0,25	-	0,14	0,11	-	0,09	-	-

[1)] See Annex B 1
[2)] For fischer threaded rods FIS A / RGM the factor for steel ductility is 1,0

[3)] Calculation for displacement

$\delta_{N(DLS)} = \delta_{N(DLS)}$-Factor $\cdot\ \tau$;
$\delta_{N(ULS)} = \delta_{N(ULS)}$-Factor $\cdot\ \tau$;
(τ: design bond strength)

[4)] Calculation for displacement

$\delta_{V(DLS)} = \delta_{V(DLS)}$-Factor $\cdot$ V;
$\delta_{V(ULS)} = \delta_{V(ULS)}$-Factor $\cdot$ V;
(V: design shear resistance)

fischer injection system FIS EB

Performances
Design of bonded anchors
Seismic performances C2

Annex C 12