

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-19/0263
of 21 May 2019

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

GCP EPFI VA Injection system for concrete

Product family
to which the construction product belongs

Bonded fastener for use in concrete

Manufacturer

General Construction Products, LLC
Sheridan Rd. STE 910
CHICAGO IL60657 .
USA

Manufacturing plant

Plant 2

This European Technical Assessment
contains

30 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 330499-01-0601

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Specific Part

1 Technical description of the product

The "GCP EPFI VA Injection system for concrete" is a bonded anchor consisting of a cartridge with injection mortar GCP EPFI VA and a steel element. The steel element consist of a commercial threaded rod with washer and hexagon nut in the range of M8 to M30, reinforcing bar in the range of diameter Ø8 to Ø32 mm or internal threaded rod IG-M6 to IG-M20.

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 resistance to tension load (static and quasi-static loading)	See Annex C 1, C 2, C 4, C 6
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 3, C 5, C 7
Displacements (static and quasi-static loading)	See Annex C 8 to C 10
Characteristic resistance for seismic performance category C1	See Annex C 11 to C 15
Characteristic resistance and displacements for seismic performance category C2	No performance assessed

3.2 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release of dangerous substances	No performance assessed

English translation prepared by DIBt

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

In accordance with the European Assessment Document EAD 330499-01-0601 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

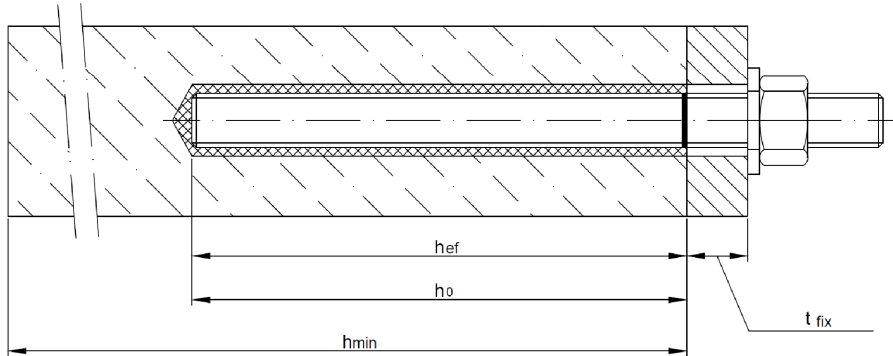
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 21 May 2019 by Deutsches Institut für Bautechnik

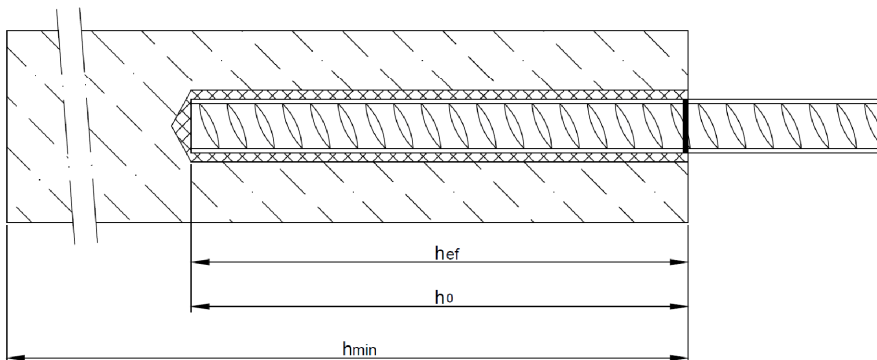
BD Dipl.-Ing. Andreas Kummerow
Head of Department

beglaubigt:
Baderschneider

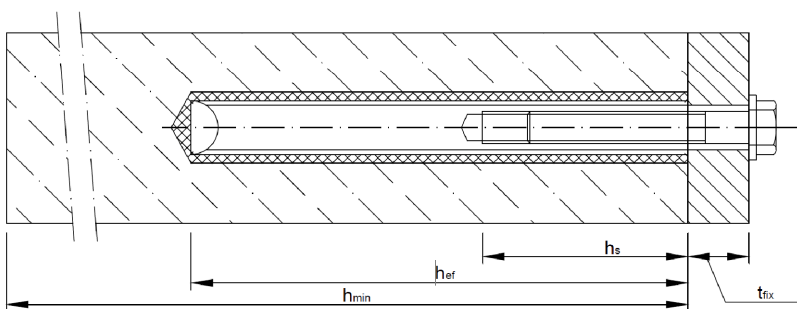
Installation threaded rod M8 up to M30



Installation reinforcing bar $\varnothing 8$ up to $\varnothing 32$



Installation internal threaded anchor rod IG-M6 up to IG-M20



- t_{fix} = thickness of fixture
- h_{ef} = effective anchorage depth
- h_0 = depth of drill hole
- h_{min} = minimum thickness of member

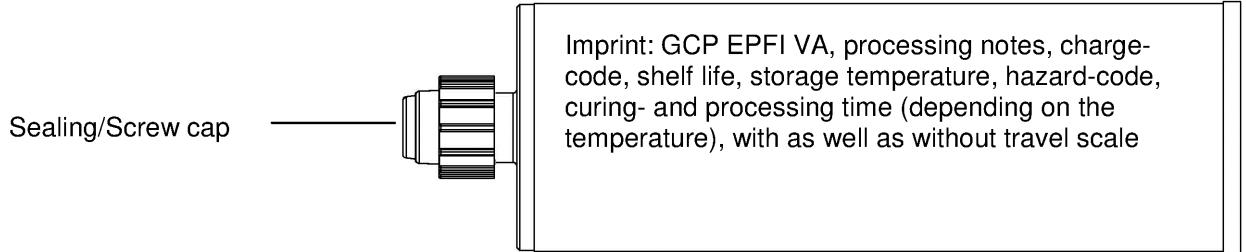
GCP EPFI VA Injection System for concrete

Product description
Installed condition

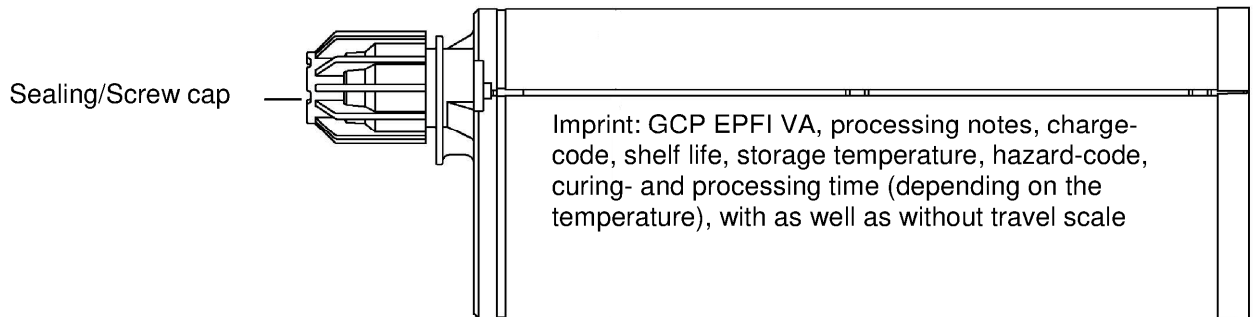
Annex A 1

Cartridge: GCP EPFI VA

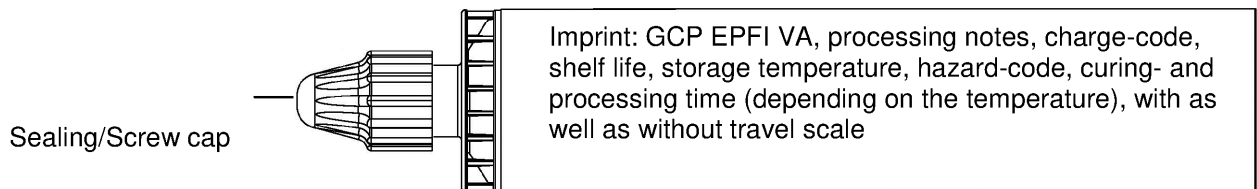
150 ml, 280 ml, 300 ml up to 333 ml and 380 ml up to 420 ml cartridge (Type: coaxial)



235 ml, 345 ml up to 360 ml and 825 ml cartridge (Type: “side-by-side”)

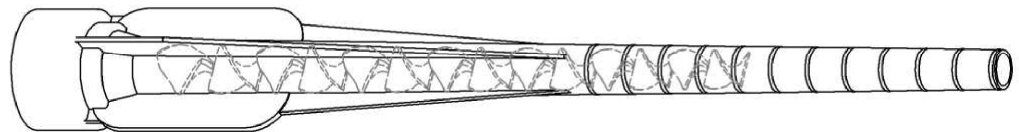


165 ml and 300 ml cartridge (Type: “foil tube”)

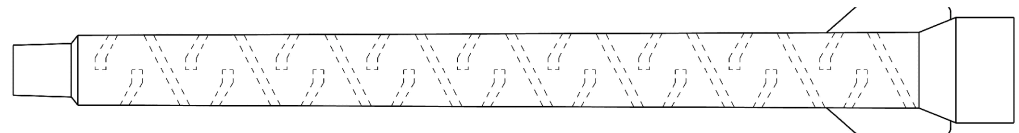


Static Mixer

CRW 14W



TAH 18W

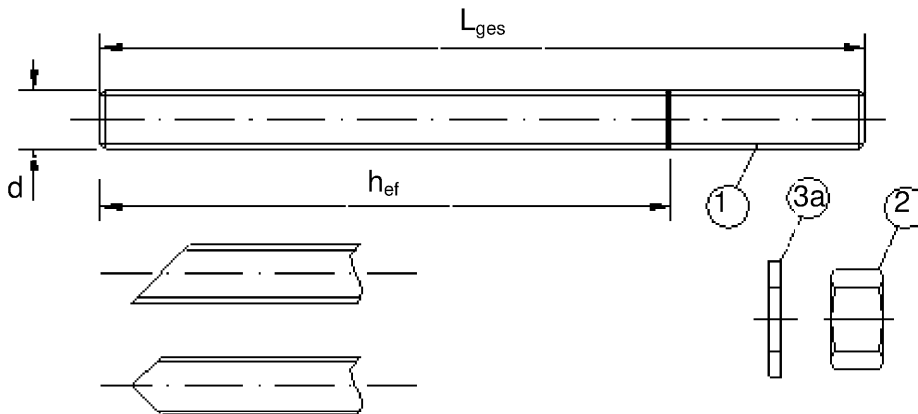


GCP EPFI VA Injection System for concrete

Product description
Injection system

Annex A 2

Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut

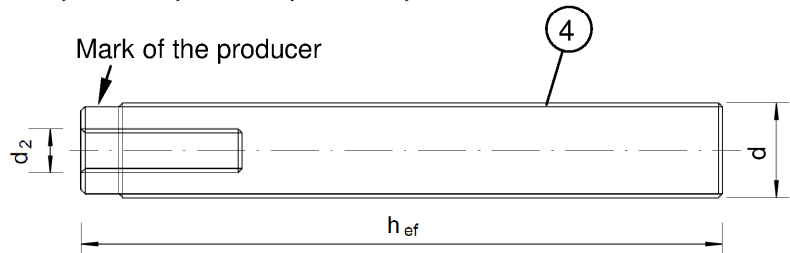
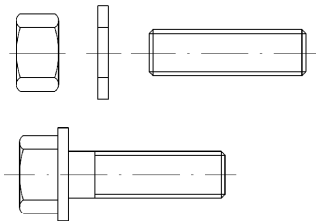


Commercial standard threaded rod with:

- Materials, dimensions and mechanical properties acc. Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

Internal threaded anchor rod IG-M6, IG-M8, IG-M10, IG-M12, IG-M16, IG-M20

Threaded rod or screw



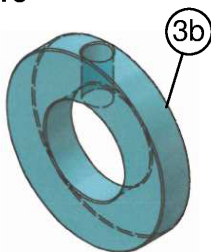
Marking: e.g.



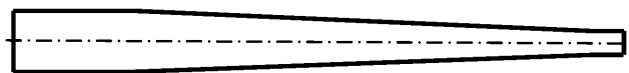
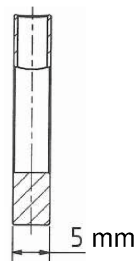
- ┆ Marking Internal thread
- ◊ Mark

- M8 Thread size (Internal thread)
- A4 additional mark for stainless steel
- HCR additional mark for high-corrosion resistance steel

Filling washer and mixer reduction nozzle for filling the annular gap between anchor rod and fixture



3b



GCP EPFI VA Injection System for concrete

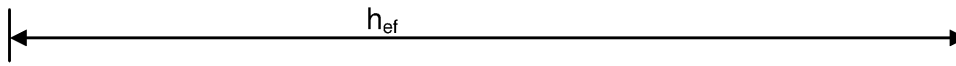
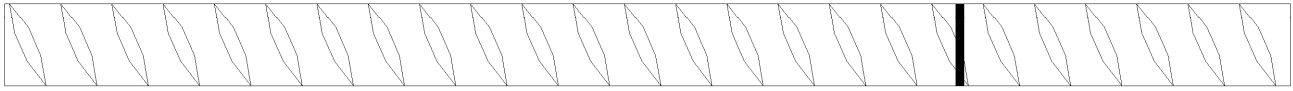
Product description

Threaded rod, internal threaded rod and filling washer

Annex A 3

Table A1: Materials						
Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN 10087:1998 or EN 10263:2001)						
- zinc plated $\geq 5 \mu\text{m}$ acc. to EN ISO 4042:1999 or						
- hot-dip galvanised $\geq 40 \mu\text{m}$ acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or						
- sherardized $\geq 45 \mu\text{m}$ acc. to EN ISO 17668:2016						
1	Threaded rod	Property class	Characteristic tensile strength	Characteristic yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	4.6	$f_{uk} = 400 \text{ N/mm}^2$	$f_{yk} = 240 \text{ N/mm}^2$	$A_5 > 8\%$
			4.8	$f_{uk} = 400 \text{ N/mm}^2$	$f_{yk} = 320 \text{ N/mm}^2$	$A_5 > 8\%$
			5.6	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 300 \text{ N/mm}^2$	$A_5 > 8\%$
			5.8	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 400 \text{ N/mm}^2$	$A_5 > 8\%$
8.8	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 \geq 8\%$			
2	Hexagon nut	acc. to EN ISO 898-2:2012	4	for threaded rod class 4.6 or 4.8		
			5	for threaded rod class 5.6 or 5.8		
			8	for threaded rod class 8.8		
3a	Washer	Steel, zinc plated, hot-dip galvanised or sherardized (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Steel, zinc plated, hot-dip galvanised or sherardized				
4	Internal threaded anchor rod	Property class	Characteristic tensile strength	Characteristic yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	5.8	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 400 \text{ N/mm}^2$	$A_5 > 8\%$
			8.8	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 > 8\%$
Stainless steel A2 (Material 1.4301 / 1.4303 / 1.4307 / 1.4567 or 1.4541, acc. to EN 10088-1:2014)						
Stainless steel A4 (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014)						
High corrosion resistance steel (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)						
1	Threaded rod ¹⁾³⁾	Property class	Characteristic tensile strength	Characteristic yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2009	50	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 210 \text{ N/mm}^2$	$A_5 \geq 8\%$
			70	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 \geq 8\%$
80	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 600 \text{ N/mm}^2$	$A_5 \geq 8\%$			
2	Hexagon nut ¹⁾³⁾	acc. to EN ISO 3506-1:2009	50	for threaded rod class 50		
			70	for threaded rod class 70		
			80	for threaded rod class 80		
3a	Washer	A2: Material 1.4301 / 1.4303 / 1.4307 / 1.4567 or 1.4541, acc. to EN 10088-1:2014 A4: Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014 HCR: Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014 (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Stainless steel A4, High corrosion resistance steel				
4	Internal threaded anchor rod ¹⁾²⁾	Property class	Characteristic tensile strength	Characteristic yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2009	50	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 210 \text{ N/mm}^2$	$A_5 > 8\%$
			70	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 > 8\%$
¹⁾ Property class 70 for threaded rods up to M24 and Internal threaded anchor rods up to IG-M16, ²⁾ for IG-M20 only property class 50 ³⁾ Property class 80 only for stainless steel A4						
GCP EPFI VA Injection System for concrete					Annex A 4	
Product description Materials threaded rod and internal threaded rod						

Reinforcing bar $\varnothing 8, \varnothing 10, \varnothing 12, \varnothing 14, \varnothing 16, \varnothing 20, \varnothing 25, \varnothing 28, \varnothing 32$



- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rib height of the bar shall be in the range $0,05d \leq h \leq 0,07d$
(d: Nominal diameter of the bar; h: Rip height of the bar)

Table A2: Materials

Part	Designation	Material
Reinforcing bars		
1	Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA $f_{tk} = f_{tk} = k \cdot f_{yk}$

GCP EPFI VA Injection System for concrete

Product description
Materials reinforcing bar

Annex A 5

Specifications of intended use

Anchorage subject to:

- Static and quasi-static loads: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.
- Seismic action for Performance Category C1: M8 to M30 (except hot-dip galvanised rods), Rebar Ø8 to Ø32.

Base materials:

- Reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013.
- Strength classes C20/25 to C50/60 according to EN 206:2013.
- Non-cracked concrete: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.
- Cracked concrete: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.

Temperature Range:

- I: - 40 °C to +40 °C (max long term temperature +24 °C and max short term temperature +40 °C)
- II: - 40 °C to +80 °C (max long term temperature +50 °C and max short term temperature +80 °C)
- III: - 40 °C to +120 °C (max long term temperature +72 °C and max short term temperature +120 °C)

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc coated steel, stainless steel A2 resp. A4 or high corrosion resistant 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 A4 or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant 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).

Design:

- 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 are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- The anchorages are designed in accordance to EN 1992-4:2018 and Technical Report TR055

Installation:

- Dry or wet concrete: M8 to M30, Rebar Ø8 to Ø32, IG-M6 to IG-M20.
- Flooded holes (not sea water): M8 to M16, Rebar Ø8 to Ø16, IG-M6 to IG-M10.
- Hole drilling by hammer (HD), hollow (HDB) or compressed air drill mode (CD).
- Overhead installation allowed.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

GCP EPFI VA Injection System for concrete

Intended Use
Specifications

Annex B 1

Anchor size		M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30	
Outer diameter of anchor	d_{nom} [mm] =	8	10	12	16	20	24	27	30	
Nominal drill hole diameter	d_0 [mm] =	10	12	14	18	24	28	32	35	
Effective embedment depth	$h_{ef,min}$ [mm] =	60	60	70	80	90	96	108	120	
	$h_{ef,max}$ [mm] =	160	200	240	320	400	480	540	600	
Diameter of clearance hole in the fixture	d_f [mm] ≤	9	12	14	18	22	26	30	33	
Diameter of steel brush	d_b [mm] ≥	12	14	16	20	26	30	34	37	
Maximum torque moment	T_{inst} [Nm] ≤	10	20	40	80	120	160	180	200	
Minimum thickness of member	h_{min} [mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$					
Minimum spacing	s_{min} [mm]	40	50	60	80	100	120	135	150	
Minimum edge distance	c_{min} [mm]	40	50	60	80	100	120	135	150	



Rebar size		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Outer diameter of anchor	d_{nom} [mm] =	8	10	12	14	16	20	25	28	32
Nominal drill hole diameter	d_0 [mm] =	12	14	16	18	20	24	32	35	40
Effective embedment depth	$h_{ef,min}$ [mm] =	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm] =	160	200	240	280	320	400	500	580	640
Diameter of steel brush	d_b [mm] ≥	14	16	18	20	22	26	34	37	41,5
Minimum thickness of member	h_{min} [mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$					
Minimum spacing	s_{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	125	140	160

Size internal threaded anchor rod		IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Internal diameter of anchor	d_2 [mm] =	6	8	10	12	16	20
Outer diameter of anchor ¹⁾	d_{nom} [mm] =	10	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm] =	12	14	18	22	28	35
Effective embedment depth	$h_{ef,min}$ [mm] =	60	70	80	90	96	120
	$h_{ef,max}$ [mm] =	200	240	320	400	480	600
Diameter of clearance hole in the fixture	d_f [mm] =	7	9	12	14	18	22
Maximum torque moment	T_{inst} [Nm] ≤	10	10	20	40	60	100
Thread engagement length min/max	l_{IG} [mm] =	8/20	8/20	10/25	12/30	16/32	20/40
Minimum thickness of member	h_{min} [mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$		
Minimum spacing	s_{min} [mm]	50	60	80	100	120	150
Minimum edge distance	c_{min} [mm]	50	60	80	100	120	150

¹⁾ With metric threads according to EN 1993-1-8:2005+AC:2009

GCP EPFI VA Injection System for concrete	Annex B 2
Intended Use Installation parameters	

Table B4: Parameter cleaning and setting tools

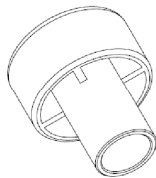
Threaded Rod	Rebar	Internal threaded Anchor rod	d_0 Drill bit - \emptyset HD, HDB, CA	d_b Brush - \emptyset		$d_{b,min}$ min. Brush - \emptyset	Piston plug	Installation direction and use of piston plug		
					[mm]			[mm]		
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]				
M8			10	RBT10	12	10,5	No piston plug required			
M10	8	IG-M6	12	RBT12	14	12,5				
M12	10	IG-M8	14	RBT14	16	14,5				
	12		16	RBT16	18	16,5				
M16	14	IG-M10	18	RBT18	20	18,5	VS18	$h_{ef} > 250$ mm	$h_{ef} > 250$ mm	all
	16		20	RBT20	22	20,5	VS20			
M20	20	IG-M12	24	RBT24	26	24,5	VS24			
M24		IG-M16	28	RBT28	30	28,5	VS28			
M27	25		32	RBT32	34	32,5	VS32			
M30	28	IG-M20	35	RBT35	37	35,5	VS35			
	32		40	RBT40	41,5	40,5	VS40			



MAC - Hand pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm
Drill hole depth (h_0): $< 10 d_{nom}$
Only in non-cracked concrete



CAC - Rec. compressed air tool (min 6 bar)
Drill bit diameter (d_0): all diameters



Piston plug for overhead or horizontal installation VS
Drill bit diameter (d_0): 18 mm to 40 mm

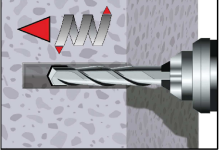
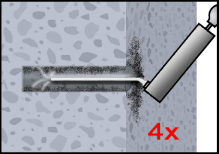
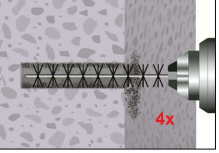
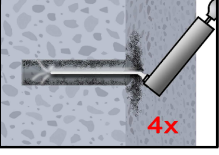
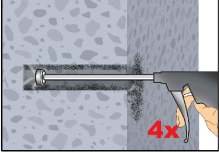
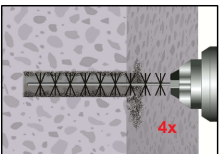
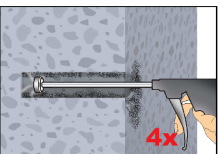


Steel brush RBT
Drill bit diameter (d_0): all diameters

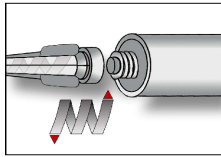
GCP EPFI VA Injection System for concrete

Intended Use
Cleaning and setting tools

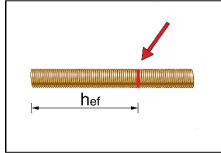
Annex B 3

Installation instructions	
Drilling of the bore hole	
	<p>1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3), with hammer (HD), hollow (HDB) or compressed air (CD) drilling. The use of a hollow drill bit is only in combination with a sufficient vacuum permitted. In case of aborted drill hole: The drill hole shall be filled with mortar</p>
Attention! Standing water in the bore hole must be removed before cleaning.	
MAC: Cleaning for bore hole diameter $d_0 \leq 20\text{mm}$ and bore hole depth $h_0 \leq 10d_{\text{nom}}$ (uncracked concrete only!)	
	<p>2a. Starting from the bottom or back of the bore hole, blow the hole clean by a hand pump ¹⁾ (Annex B 3) a minimum of four times.</p>
	<p>2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,\text{min}}$ (Table B4) a minimum of four times in a twisting motion. If the bore hole ground is not reached with the brush, a brush extension must be used.</p>
	<p>2c. Finally blow the hole clean again with a hand pump (Annex B 3) a minimum of four times.</p> <p>¹⁾ It is permitted to blow bore holes with diameter between 14 mm and 20 mm and an embedment depth up to $10d_{\text{nom}}$ also in cracked concrete with hand-pump.</p>
CAC: Cleaning for all bore hole diameter in uncracked and cracked concrete	
	<p>2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 3) a minimum of four times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension must be used.</p>
	<p>2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,\text{min}}$ (Table B4) a minimum of four times in a twisting motion. If the bore hole ground is not reached with the brush, a brush extension must be used.</p>
	<p>2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 3) a minimum of four times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension must be used.</p>
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.	
GCP EPFI VA Injection System for concrete	Annex B 4
Intended Use Installation instructions	

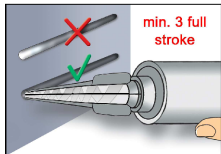
Installation instructions (continuation)



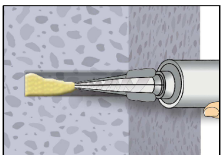
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. Cut off the foil tube clip before use. For every working interruption longer than the recommended working time (Annex B 6) as well as for new cartridges, a new static-mixer shall be used.



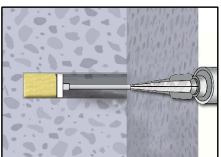
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour. For foil tube cartridges it must be discarded a minimum of six full strokes.

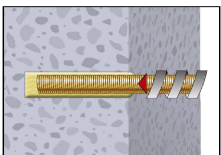


6. Starting from the bottom or back of the cleaned anchor hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. Observe the gel-/ working times given in Annex B 6.



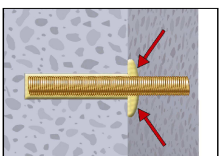
7. Piston plugs and mixer nozzle extensions shall be used according to Table B4 for the following applications:

- Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit- $\varnothing d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$ mm
- Overhead assembly (vertical upwards direction): Drill bit- $\varnothing d_0 \geq 18$ mm

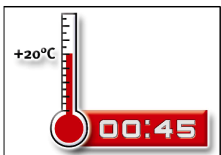


8. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

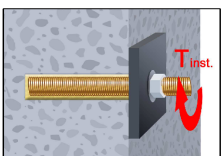
The anchor shall be free of dirt, grease, oil or other foreign material.



9. Be sure that the anchor is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod shall be fixed (e.g. wedges).



10. Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Annex B 6).



11. After full curing, the add-on part can be installed with up to the max. torque (Table B1 or B3) by using a calibrated torque wrench. It can be optional filled the annular gap between anchor and fixture with mortar. Therefor substitute the washer by the filling washer and connect the mixer reduction nozzle to the tip of the mixer. The annular gap is filled with mortar, when mortar oozes out of the washer.

GCP EPFI VA Injection System for concrete

Intended Use

Installation instructions (continuation)

Annex B 5

**Table B5: Maximum working time and minimum curing time
GCP EPFI VA**

Concrete temperature	Gelling- / working time	Minimum curing time in dry concrete ¹⁾
-10 °C to -6°C	90 min ²⁾	24 h ²⁾
-5 °C to -1°C	90 min	14 h
0 °C to +4°C	45 min	7 h
+5 °C to +9°C	25 min	2 h
+ 10 °C to +19°C	15 min	80 min
+ 20 °C to +29°C	6 min	45 min
+ 30 °C to +34°C	4 min	25 min
+ 35 °C to +39°C	2 min	20 min
+ 40 °C	1,5 min	15 min
Cartridge temperature	+5°C to +40°C	

¹⁾ In wet concrete the curing time must be doubled.

²⁾ Cartridge temperature must be at min. +15°C.

GCP EPFI VA Injection System for concrete

Intended Use
Curing time

Annex B 6

Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods											
Size			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Cross section area	A_s	[mm ²]	36,6	58	84,3	157	245	353	459	561	
Characteristic tension resistance, Steel failure ¹⁾											
Steel, Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224	
Steel, Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280	
Steel, Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449	
Stainless steel A2, A4 and HCR, class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281	
Stainless steel A2, A4 and HCR, class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-	-	
Stainless steel A4 and HCR, class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-	
Characteristic tension resistance, Partial factor ²⁾											
Steel, Property class 4.6 and 5.6	$\gamma_{Ms,N}$	[-]	2,0								
Steel, Property class 4.8, 5.8 and 8.8	$\gamma_{Ms,N}$	[-]	1,5								
Stainless steel A2, A4 and HCR, class 50	$\gamma_{Ms,N}$	[-]	2,86								
Stainless steel A2, A4 and HCR, class 70	$\gamma_{Ms,N}$	[-]	1,87								
Stainless steel A4 and HCR, class 80	$\gamma_{Ms,N}$	[-]	1,6								
Characteristic shear resistance, Steel failure ¹⁾											
Without lever arm	Steel, Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	9 (8)	15 (13)	21	39	61	88	115	140
	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Stainless steel A2, A4 and HCR, class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Stainless steel A2, A4 and HCR, class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	-	-
	Stainless steel A4 and HCR, class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-	-
With lever arm	Steel, Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
	Stainless steel A2, A4 and HCR, class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
	Stainless steel A2, A4 and HCR, class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
	Stainless steel A4 and HCR, class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-	-
Characteristic shear resistance, Partial factor ²⁾											
Steel, Property class 4.6 and 5.6	$\gamma_{Ms,V}$	[-]	1,67								
Steel, Property class 4.8, 5.8 and 8.8	$\gamma_{Ms,V}$	[-]	1,25								
Stainless steel A2, A4 and HCR, class 50	$\gamma_{Ms,V}$	[-]	2,38								
Stainless steel A2, A4 and HCR, class 70	$\gamma_{Ms,V}$	[-]	1,56								
Stainless steel A4 and HCR, class 80	$\gamma_{Ms,V}$	[-]	1,33								
¹⁾ Values are only valid for the given stress area A_s . Values in brackets are valid for undersized threaded rods with smaller stress area A_s for hot-dip galvanised threaded rods according to EN ISO 10684:2004+AC:2009. ²⁾ in absence of national regulation											
GCP EPFI VA Injection System for concrete									Annex C 1		
Performances Characteristic values for steel tension resistance and steel shear resistance of threaded rods											

Table C2: Characteristic values of tension loads under static and quasi-static action													
Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M27	M30		
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)									
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1									
Combined pull-out and concrete failure													
Characteristic bond resistance in non-cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm ²]	10	12	12	12	12	11	10	9	
	II: 80°C/50°C				7,5	9	9	9	9	8,5	7,5	6,5	
	III: 120°C/72°C				5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0	
	I: 40°C/24°C	flooded bore hole			7,5	8,5	8,5	8,5	No Performance Assessed (NPA)				
	II: 80°C/50°C				5,5	6,5	6,5	6,5					
	III: 120°C/72°C				4,0	5,0	5,0	5,0					
Characteristic bond resistance in cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm ²]	4,0	5,0	5,5	5,5	5,5	5,5	6,5	6,5	
	II: 80°C/50°C				2,5	3,5	4,0	4,0	4,0	4,0	4,5	4,5	
	III: 120°C/72°C				2,0	2,5	3,0	3,0	3,0	3,0	3,5	3,5	
	I: 40°C/24°C	flooded bore hole			4,0	4,0	5,5	5,5	No Performance Assessed (NPA)				
	II: 80°C/50°C				2,5	3,0	4,0	4,0					
	III: 120°C/72°C				2,0	2,5	3,0	3,0					
Increasing factors for concrete ψ_c		C25/30		1,02									
		C30/37		1,04									
		C35/45		1,07									
		C40/50		1,08									
		C45/55		1,09									
		C50/60		1,10									
Concrete cone failure													
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0									
Cracked concrete		$k_{cr,N}$	[-]	7,7									
Edge distance		$c_{cr,N}$	[mm]	$1,5 h_{ef}$									
Axial distance		$s_{cr,N}$	[mm]	$2 c_{cr,N}$									
Splitting													
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$									
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$									
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$									
Axial distance		$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$									
Installation factor													
for dry and wet concrete		γ_{inst}	[-]	1,0	1,2								
for flooded bore hole				1,4				NPA					
GCP EPFI VA Injection System for concrete											Annex C 2		
Performances Characteristic values of tension loads under static and quasi-static action													

Table C3: Characteristic values of shear loads under static and quasi-static action											
Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Steel failure without lever arm											
Characteristic shear resistance Steel, strength class 4.6 and 4.8	$V_{Rk,s}^0$	[kN]	$0,6 \cdot A_s \cdot f_{uk}$ (or see Table C1)								
Characteristic shear resistance Steel, strength class 5.6, 5.8 and 8.8 Stainless Steel A2, A4 and HCR, all classes	$V_{Rk,s}^0$	[kN]	$0,5 \cdot A_s \cdot f_{uk}$ (or see Table C1)								
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1								
Ductility factor	k_7	[-]	1,0								
Steel failure with lever arm											
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}$ (or see Table C1)								
Elastic section modulus	W_{el}	[mm ³]	31	62	109	277	541	935	1387	1874	
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1								
Concrete pry-out failure											
Factor	k_8	[-]	2,0								
Installation factor	γ_{inst}	[-]	1,0								
Concrete edge failure											
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300\text{mm})$		
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30	
Installation factor	γ_{inst}	[-]	1,0								
GCP EPFI VA Injection System for concrete									Annex C 3		
Performances Characteristic values of shear loads under static and quasi-static action											

Table C4: Characteristic values of tension loads under static and quasi-static action											
Anchor size internal threaded anchor rods				IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20		
Steel failure¹⁾											
Characteristic tension resistance, Steel, strength class	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123		
	8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196		
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,N}$	[-]	1,5							
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		$N_{Rk,s}$	[kN]	14	26	41	59	110	124		
Partial factor		$\gamma_{Ms,N}$	[-]	1,87							
Combined pull-out and concrete cone failure											
Characteristic bond resistance in non-cracked concrete C20/25											
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm ²]	12	12	12	12	11	9	
	II: 80°C/50°C				9	9	9	9	8,5	6,5	
	III: 120°C/72°C				6,5	6,5	6,5	6,5	6,5	5,0	
	I: 40°C/24°C	flooded bore hole			8,5	8,5	8,5	No Performance Assessed (NPA)			
	II: 80°C/50°C				6,5	6,5	6,5				
	III: 120°C/72°C				5,0	5,0	5,0				
Characteristic bond resistance in cracked concrete C20/25											
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm ²]	5,0	5,5	5,5	5,5	5,5	6,5	
	II: 80°C/50°C				3,5	4,0	4,0	4,0	4,0	4,5	
	III: 120°C/72°C				2,5	3,0	3,0	3,0	3,0	3,5	
	I: 40°C/24°C	flooded bore hole			4,0	5,5	5,5	No Performance Assessed (NPA)			
	II: 80°C/50°C				3,0	4,0	4,0				
	III: 120°C/72°C				2,5	3,0	3,0				
Increasing factors for concrete ψ_c				C25/30	1,02						
				C30/37	1,04						
				C35/45	1,07						
				C40/50	1,08						
				C45/55	1,09						
				C50/60	1,10						
Concrete cone failure											
Non-cracked concrete			$k_{ucr,N}$	[-]	11,0						
Cracked concrete			$k_{cr,N}$	[-]	7,7						
Edge distance			$c_{cr,N}$	[mm]	1,5 h_{ef}						
Axial distance			$s_{cr,N}$	[mm]	2 $c_{cr,N}$						
Splitting failure											
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}							
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$							
	$h/h_{ef} \leq 1,3$			2,4 h_{ef}							
Axial distance			$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$						
Installation factor											
for dry and wet concrete			γ_{inst}	[-]	1,2						
for flooded bore hole					1,4			NPA			
¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element. ²⁾ For IG-M20 strength class 50 is valid											
GCP EPFI VA Injection System for concrete								Annex C 4			
Performances Characteristic values of tension loads under static and quasi-static action											

Table C5: Characteristic values of shear loads under static and quasi-static action											
Anchor size for internal threaded anchor rods				IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20		
Steel failure without lever arm¹⁾											
Characteristic shear resistance, Steel, strength class	5.8	$V_{Rk,s}^0$	[kN]	5	9	15	21	38	61		
	8.8	$V_{Rk,s}^0$	[kN]	8	14	23	34	60	98		
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25							
Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		$V_{Rk,s}^0$	[kN]	7	13	20	30	55	40		
		$\gamma_{Ms,V}$	[-]	1,56						2,38	
Ductility factor		k_7	[-]	1,0							
Steel failure with lever arm¹⁾											
Characteristic bending moment, Steel, strength class	5.8	$M_{Rk,s}^0$	[Nm]	8	19	37	66	167	325		
	8.8	$M_{Rk,s}^0$	[Nm]	12	30	60	105	267	519		
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25							
Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70 ²⁾		$M_{Rk,s}^0$	[Nm]	11	26	52	92	233	456		
		$\gamma_{Ms,V}$	[-]	1,56						2,38	
Concrete pry-out failure											
Factor		k_8	[-]	2,0							
Installation factor		γ_{inst}	[-]	1,0							
Concrete edge failure											
Effective length of fastener		l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$					$\min(h_{ef}; 300\text{mm})$		
Outside diameter of fastener		d_{nom}	[mm]	10	12	16	20	24	30		
Installation factor		γ_{inst}	[-]	1,0							
¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element. ²⁾ For IG-M20 strength class 50 is valid											
GCP EPFI VA Injection System for concrete								Annex C 5			
Performances Characteristic values of shear loads under static and quasi-static action											

Table C6: Characteristic values of tension loads under static and quasi-static action														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32			
Steel failure														
Characteristic tension resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$											
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	491	616	804			
Partial factor	$\gamma_{Ms,N}$	[-]	1,4 ²⁾											
Combined pull-out and concrete failure														
Characteristic bond resistance in non-cracked concrete C20/25														
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm ²]	10	12	12	12	12	12	11	10	8,5	
	II: 80°C/50°C				7,5	9	9	9	9	9	8,0	7,0	6,0	
	III: 120°C/72°C				5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5	
	I: 40°C/24°C	flooded bore hole			7,5	8,5	8,5	8,5	8,5	No Performance Assessed (NPA)				
	II: 80°C/50°C				5,5	6,5	6,5	6,5	6,5					
	III: 120°C/72°C				4,0	5,0	5,0	5,0	5,0					
Characteristic bond resistance in cracked concrete C20/25														
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm ²]	4,0	5,0	5,5	5,5	5,5	5,5	5,5	6,5	6,5	
	II: 80°C/50°C				2,5	3,5	4,0	4,0	4,0	4,0	4,0	4,5	4,5	
	III: 120°C/72°C				2,0	2,5	3,0	3,0	3,0	3,0	3,0	3,5	3,5	
	I: 40°C/24°C	flooded bore hole			4,0	4,0	5,5	5,5	5,5	No Performance Assessed (NPA)				
	II: 80°C/50°C				2,5	3,0	4,0	4,0	4,0					
	III: 120°C/72°C				2,0	2,5	3,0	3,0	3,0					
Increasing factors for concrete ψ_c			C25/30		1,02									
			C30/37		1,04									
			C35/45		1,07									
			C40/50		1,08									
			C45/55		1,09									
			C50/60		1,10									
Concrete cone failure														
Non-cracked concrete	$k_{ucr,N}$	[-]	11,0											
Cracked concrete	$k_{cr,N}$	[-]	7,7											
Edge distance	$c_{cr,N}$	[mm]	$1,5 h_{ef}$											
Axial distance	$s_{cr,N}$	[mm]	$2 c_{cr,N}$											
Splitting														
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$										
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$										
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$										
Axial distance	$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$											
Installation factor														
for dry and wet concrete	γ_{inst}	[-]	1,2	1,2										
for flooded bore hole			1,4	NPA										
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation														
GCP EPFI VA Injection System for concrete										Annex C 6				
Performances Characteristic values of tension loads under static and quasi-static action														

Table C7: Characteristic values of shear loads under static and quasi-static action													
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32		
Steel failure without lever arm													
Characteristic shear resistance	$V_{Rk,s}^0$	[kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$										
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	491	616	804		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾										
Ductility factor	k_7	[-]	1,0										
Steel failure with lever arm													
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$										
Elastic section modulus	W_{el}	[mm ³]	50	98	170	269	402	785	1534	2155	3217		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾										
Concrete pry-out failure													
Factor	k_8	[-]	2,0										
Installation factor	γ_{inst}	[-]	1,0										
Concrete edge failure													
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300\text{mm})$				
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	25	28	32		
Installation factor	γ_{inst}	[-]	1,0										
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation													
GCP EPFI VA Injection System for concrete									Annex C 7				
Performances Characteristic values of shear loads under static and quasi-static action													

Table C8: Displacements under tension load¹⁾ (threaded rod)											
Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Non-cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049	
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,030	0,033	0,037	0,045	0,052	0,060	0,065	0,071	
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119	
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172	
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119	
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172	
Cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,090				0,070				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,105				0,105				
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
¹⁾ Calculation of the displacement $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;											
Table C9: Displacements under shear load¹⁾ (threaded rod)											
Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Non-cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03	
	$\delta_{V\infty}$ -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	
Cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07	
	$\delta_{V\infty}$ -factor	[mm/kN]	0,18	0,18	0,17	0,15	0,14	0,13	0,12	0,10	
¹⁾ Calculation of the displacement $\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V : action shear load $\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;											
GCP EPFI VA Injection System for concrete								Annex C 8			
Performances Displacements (threaded rods)											

Table C10: Displacements under tension load¹⁾ (Internal threaded anchor rod)								
Anchor size Internal threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,023	0,026	0,031	0,036	0,041	0,049
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,033	0,037	0,045	0,052	0,060	0,071
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,081	0,090	0,108	0,127	0,145	0,172
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,081	0,090	0,108	0,127	0,145	0,172
Cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,090	0,070				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,105	0,105				
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219	0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255	0,245				
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219	0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255	0,245				
¹⁾ Calculation of the displacement $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;								
Table C11: Displacements under shear load¹⁾ (Internal threaded anchor rod)								
Anchor size Internal threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked and cracked concrete C20/25 under static and quasi-static action								
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$ -factor	[mm/kN]	0,10	0,09	0,08	0,08	0,06	0,06
¹⁾ Calculation of the displacement $\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V : action shear load $\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;								
GCP EPFI VA Injection System for concrete							Annex C 9	
Performances Displacements (Internal threaded anchor rod)								

Table C12: Displacements under tension load¹⁾ (rebar)											
Anchor size reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32	
Non-cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,030	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
Temperature range II: 80°C/50°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Temperature range III: 120°C/72°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,090			0,070					
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,105			0,105					
Temperature range II: 80°C/50°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,219			0,170					
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,255			0,245					
Temperature range III: 120°C/72°C	δ _{N0} -factor	[mm/(N/mm ²)]	0,219			0,170					
	δ _{N∞} -factor	[mm/(N/mm ²)]	0,255			0,245					
¹⁾ Calculation of the displacement δ _{N0} = δ _{N0} -factor · τ; τ: action bond stress for tension δ _{N∞} = δ _{N∞} -factor · τ;											
Table C13: Displacement under shear load¹⁾ (rebar)											
Anchor size reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32	
Non-cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ _{V0} -factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
	δ _{V∞} -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
Cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ _{V0} -factor	[mm/kN]	0,12	0,12	0,11	0,11	0,10	0,09	0,08	0,07	0,06
	δ _{V∞} -factor	[mm/kN]	0,18	0,18	0,17	0,16	0,15	0,14	0,12	0,11	0,10
¹⁾ Calculation of the displacement δ _{V0} = δ _{V0} -factor · V; V: action shear load δ _{V∞} = δ _{V∞} -factor · V;											
GCP EPFI VA Injection System for concrete									Annex C 10		
Performances Displacements (rebar)											

Table C14: Characteristic values of tension loads under seismic action (performance category C1)													
Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30		
Steel failure													
Characteristic tension resistance		$N_{Rk,s,eq}$	[kN]	$1,0 \cdot N_{Rk,s}$									
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1									
Combined pull-out and concrete failure													
Characteristic bond resistance in non-cracked and cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm ²]	2,5	3,1	3,7	3,7	3,7	3,8	4,5	4,5	
	II: 80°C/50°C				1,6	2,2	2,7	2,7	2,7	2,8	3,1	3,1	
	III: 120°C/72°C				1,3	1,6	2,0	2,0	2,0	2,1	2,4	2,4	
	I: 40°C/24°C	flooded bore hole			2,5	2,5	3,7	3,7	No Performance Assessed (NPA)				
	II: 80°C/50°C				1,6	1,9	2,7	2,7					
	III: 120°C/72°C				1,3	1,6	2,0	2,0					
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0									
Concrete cone failure													
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0									
Cracked concrete		$k_{cr,N}$	[-]	7,7									
Edge distance		$c_{cr,N}$	[mm]	$1,5 h_{ef}$									
Axial distance		$s_{cr,N}$	[mm]	$2 c_{cr,N}$									
Splitting													
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$									
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$									
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$									
Axial distance		$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$									
Installation factor													
for dry and wet concrete		γ_{inst}	[-]	1,0	1,2								
for flooded bore hole				1,4				NPA					
GCP EPFI VA Injection System for concrete											Annex C 11		
Performances Characteristic values of tension loads under seismic action (performance category C1)													

Table C15: Characteristic values of shear loads under seismic action (performance category C1)										
Anchor size threaded rod		M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Steel failure without lever arm										
Characteristic shear resistance (Seismic C1)	$V_{Rk,s,eq}$	[kN]	$0,70 \cdot V_{Rk,s}^0$							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M_{Rk,s,eq}^0$	[Nm]	No Performance Assessed (NPA)							
Concrete pry-out failure										
Factor	k_8	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$					$\min(h_{ef}; 300\text{mm})$		
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							
Factor for annular gap	α_{gap}	[-]	$0,5 (1,0)^{1)}$							
¹⁾ Value in brackets valid for filled annular gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required										
GCP EPFI VA Injection System for concrete								Annex C 12		
Performances Characteristic values of shear loads under seismic action (performance category C1)										

Table C16: Characteristic values of tension loads under seismic action (performance category C1)														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32			
Steel failure														
Characteristic tension resistance	$N_{Rk,s,eq}$	[kN]	$1,0 \cdot A_s \cdot f_{uk}^{1)}$											
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	491	616	804			
Partial factor	$\gamma_{Ms,N}$	[-]	$1,4^{2)}$											
Combined pull-out and concrete failure														
Characteristic bond resistance in non-cracked and cracked concrete C20/25														
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm ²]	2,5	3,1	3,7	3,7	3,7	3,7	3,8	4,5	4,5	
	II: 80°C/50°C				1,6	2,2	2,7	2,7	2,7	2,7	2,8	3,1	3,1	
	III: 120°C/72°C				1,3	1,6	2,0	2,0	2,0	2,0	2,1	2,4	2,4	
	I: 40°C/24°C	flooded bore hole			2,5	2,5	3,7	3,7	3,7	No Performance Assessed (NPA)				
	II: 80°C/50°C				1,6	1,9	2,7	2,7	2,7					
	III: 120°C/72°C				1,3	1,6	2,0	2,0	2,0					
Increasing factors for concrete ψ_c		C25/30 to C50/60	1,0											
Concrete cone failure														
Non-cracked concrete	$k_{ucr,N}$	[-]	11,0											
Cracked concrete	$k_{cr,N}$	[-]	7,7											
Edge distance	$c_{cr,N}$	[mm]	$1,5 h_{ef}$											
Axial distance	$s_{cr,N}$	[mm]	$2 c_{cr,N}$											
Splitting														
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	$1,0 h_{ef}$										
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$										
	$h/h_{ef} \leq 1,3$			$2,4 h_{ef}$										
Axial distance	$s_{cr,sp}$	[mm]	$2 c_{cr,sp}$											
Installation factor														
for dry and wet concrete	γ_{inst}	[-]	1,2	1,2										
for flooded bore hole			1,4	NPA										
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation														
GCP EPFI VA Injection System for concrete										Annex C 13				
Performances Characteristic values of tension loads under seismic action (performance category C1)														

Table C17: Characteristic values of shear loads under seismic action (performance category C1)													
Anchor size reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32			
Steel failure without lever arm													
Characteristic shear resistance	$V_{Rk,s,eq}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{2)}$										
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	491	616	804		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾										
Ductility factor	k_7	[-]	1,0										
Steel failure with lever arm													
Characteristic bending moment	$M^0_{Rk,s,eq}$	[Nm]	No Performance Assessed (NPA)										
Concrete pry-out failure													
Factor	k_8	[-]	2,0										
Installation factor	γ_{inst}	[-]	1,0										
Concrete edge failure													
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300\text{mm})$				
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	25	28	32		
Installation factor	γ_{inst}	[-]	1,0										
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) ³⁾										
<p>¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars</p> <p>²⁾ in absence of national regulation</p> <p>³⁾ Value in brackets valid for filled annular gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required</p>													
GCP EPFI VA Injection System for concrete										Annex C 14			
Performances Characteristic values of shear loads under seismic action (performance category C1)													

Table C18: Displacements under tension load¹⁾ (threaded rod)											
Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Cracked and non-cracked concrete C20/25 under seismic C1 action											
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,090				0,070				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,105				0,105				
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
Table C19: Displacements under tension load¹⁾ (rebar)											
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Cracked and non-cracked concrete C20/25 under seismic C1 action											
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,090				0,070				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,105				0,105				
Temperature range II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,219				0,170				
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,255				0,245				
¹⁾ Calculation of the displacement $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;											
Table C20: Displacements under shear load²⁾ (threaded rod)											
Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30	
Cracked and non-cracked concrete C20/25 under seismic C1 action											
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07	
	$\delta_{V\infty}$ -factor	[mm/kN]	0,18	0,18	0,17	0,15	0,14	0,13	0,12	0,10	
Table C21: Displacement under shear load¹⁾ (rebar)											
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Cracked and non-cracked concrete C20/25 under seismic C1 action											
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,12	0,12	0,11	0,11	0,10	0,09	0,08	0,07	0,06
	$\delta_{V\infty}$ -factor	[mm/kN]	0,18	0,18	0,17	0,16	0,15	0,14	0,12	0,11	0,10
¹⁾ Calculation of the displacement $\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V : action shear load $\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;											
GCP EPFI VA Injection System for concrete									Annex C 15		
Performances Displacements under seismic C1 action (threaded rods and rebar)											