

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

ETA-20/1284  
of 9 March 2021

English translation prepared by DIBt - Original version in German language

### General Part

Technical Assessment Body issuing the  
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Friulsider injection system KEM EP for concrete

Product family  
to which the construction product belongs

Bonded fastener for use in concrete

Manufacturer

Friulsider S.p.A.  
Via Trieste 1  
33048 SAN. GIOVANNI AL NATISONE  
ITALIEN

Manufacturing plant

Friulsider S.p.A., Plant 1 Germany

This European Technical Assessment  
contains

39 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, Edition 04/2020

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## Specific Part

### 1 Technical description of the product

The "Friulsider Injection system KEM EP for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar KEM EP and a steel element according to Annex A3 and A5.

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 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

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

Essential characteristic	Performance
Characteristic resistance to tension load (static and quasi-static loading)	See Annex B 3, C 1 to C 5, C 7 to C 9, C 11 to C13
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 6, C 10, C 14
Displacements under short-term and long-term loading	See Annex C 15 to C 17
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 18 to C 21

#### 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.

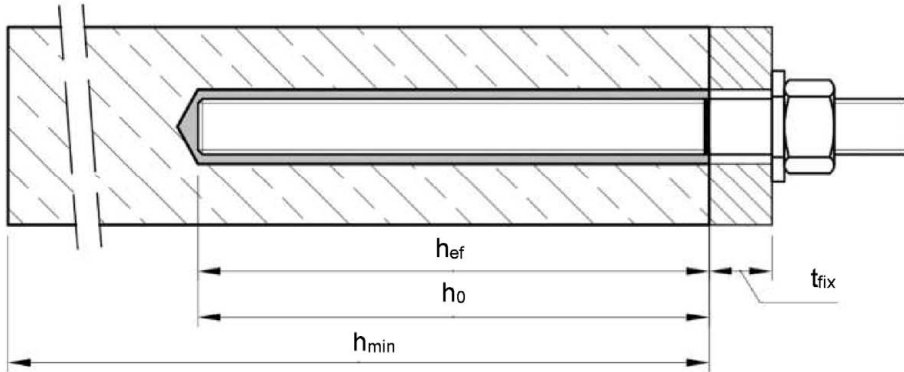
Issued in Berlin on 9 March 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock  
Head of Section

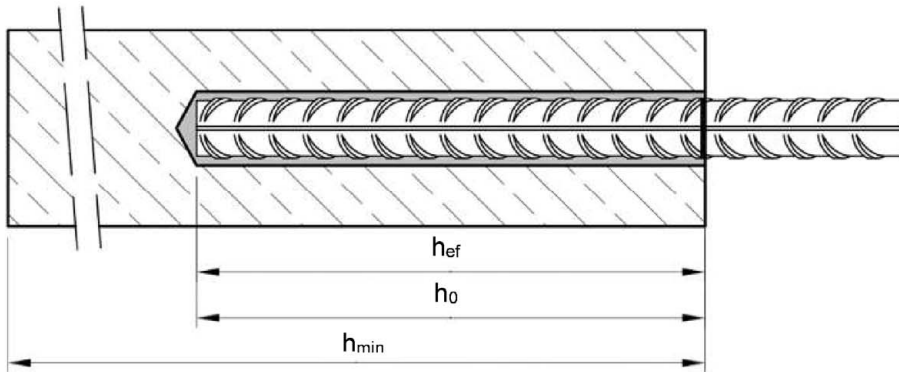
*beglaubigt:*  
Baderschneider

### Installation threaded rod M8 up to M30

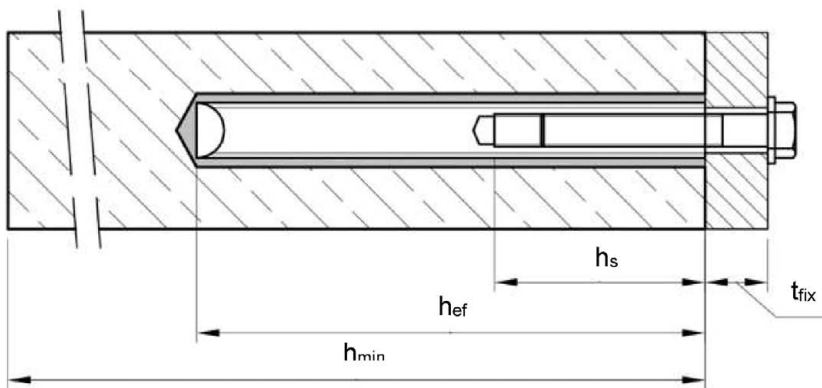
prepositioned installation or  
push through installation (annular gap filled with mortar)



### 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

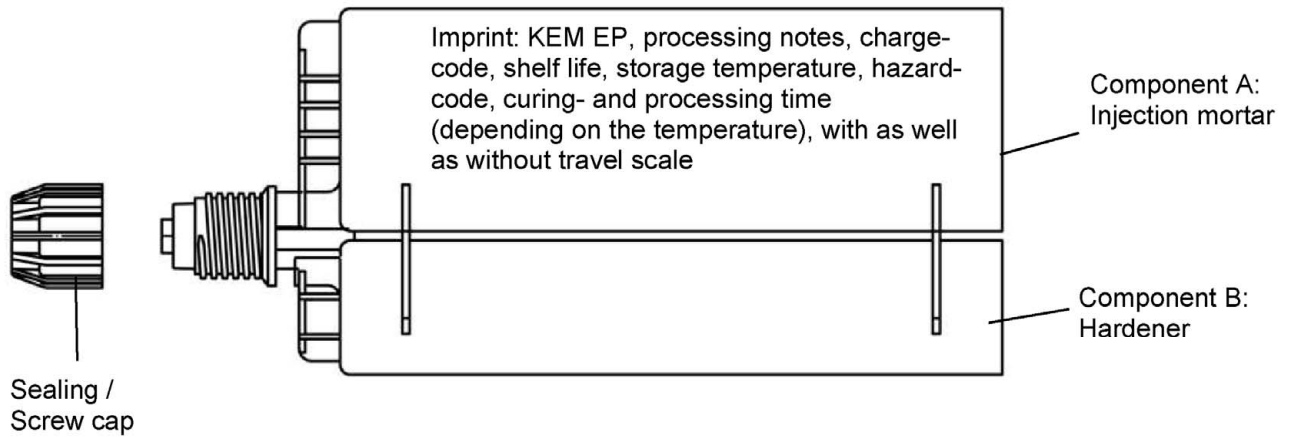
**Friulsideer injection system KEM EP for concrete**

**Product description**  
Installed condition

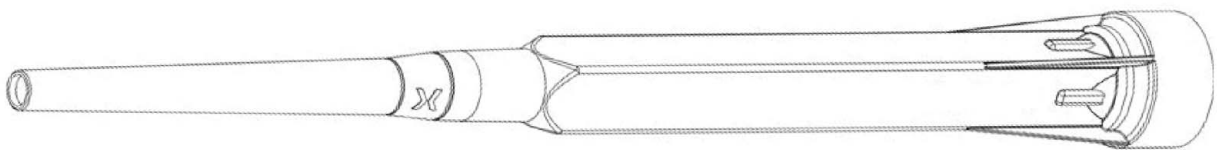
**Annex A 1**

**Cartridge: KEM EP**

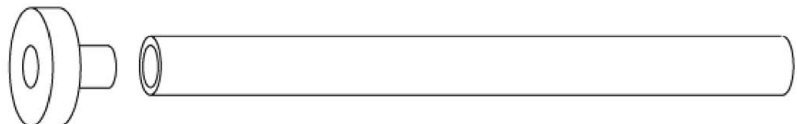
440ml, 585ml and 1400ml cartridge (Type: "side-by-side")



**Static Mixer**



**Piston Plug and Mixer Extension**

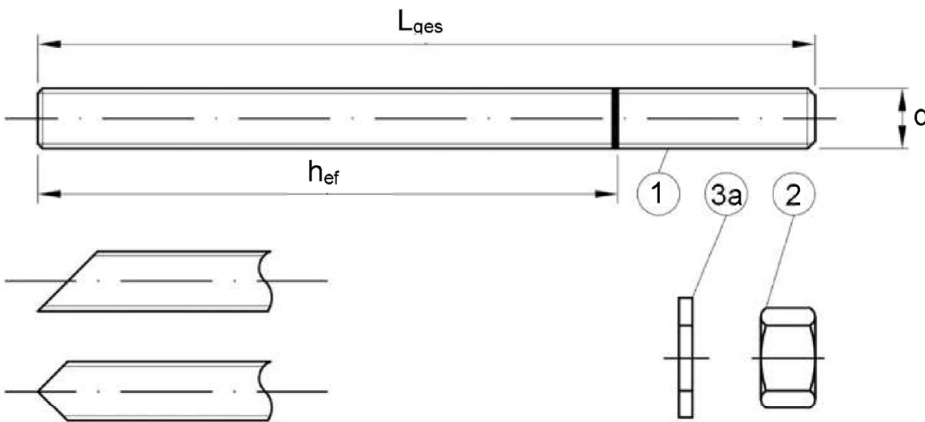


**Friulsider injection system KEM EP for concrete**

**Product description**  
Injection system

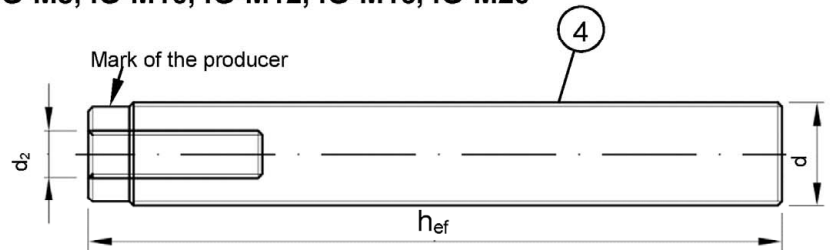
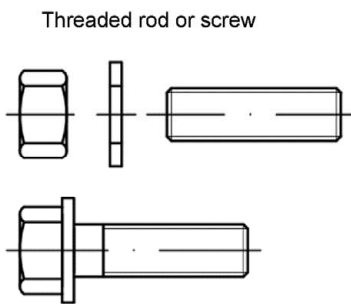
**Annex A 2**




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



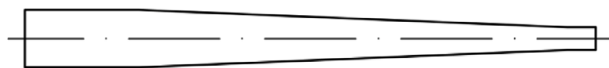
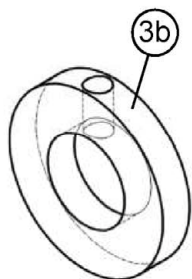
- Commercial standard threaded rod with:
- Materials, dimensions and mechanical properties acc. Table A1
  - Inspection certificate 3.1 acc. to EN 10204:2004
  - Marking of embedment depth

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



- Marking: e.g.  M8
-  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**



**Friulsideer injection system KEM EP for concrete**

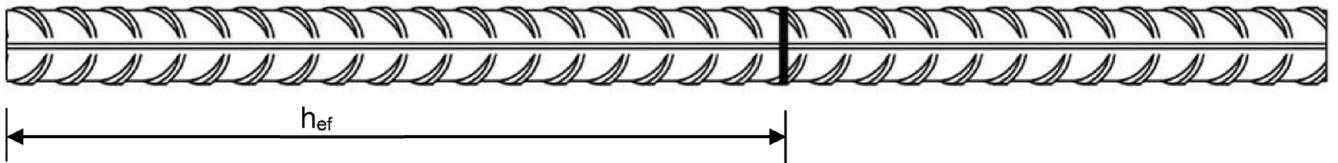
**Product description**  
Threaded rod, internal threaded rod and filling washer

**Annex A 3**

<b>Table A1: Materials</b>						
Part	Designation	Material				
<b>Steel, zinc plated</b> (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 steel ultimate tensile strength	Characteristic steel 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	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 \geq 12\%$ <sup>3)</sup>			
2	Hexagon nut	acc. to EN ISO 898-2:2012	4	for anchor rod class 4.6 or 4.8		
			5	for anchor rod class 5.6 or 5.8		
			8	for anchor 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 steel ultimate tensile strength	Characteristic steel 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	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 > 8\%$
<b>Stainless steel A2</b> (Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014)						
<b>Stainless steel A4</b> (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014)						
<b>High corrosion resistance steel</b> (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)						
1	Threaded rod <sup>1)4)</sup>	Property class	Characteristic steel ultimate tensile strength	Characteristic steel 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	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 \geq 12\%$ <sup>3)</sup>
2	Hexagon nut <sup>1)4)</sup>	acc. to EN ISO 3506-1:2009	50	for anchor rod class 50		
			70	for anchor rod class 70		
			80	for anchor rod class 80		
3a	Washer	A2: Material 1.4301 / 1.4307 / 1.4311 / 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 <sup>1)2)</sup>	Property class	Characteristic steel ultimate tensile strength	Characteristic steel 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	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 > 8\%$
<sup>1)</sup> Property class 70 or 80 for anchor rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IG-M16 <sup>2)</sup> for IG-M20 only property class 50 <sup>3)</sup> $A_5 > 8\%$ fracture elongation if <u>no</u> use for seismic performance category C2 <sup>4)</sup> Property class 80 only for stainless steel A4 and HCR						
<b>Friulsider injection system KEM EP for concrete</b>						
<b>Product description</b> Materials threaded rod and internal threaded rod						
<b>Annex A 4</b>						



Reinforcing bar  $\varnothing 8, \varnothing 10, \varnothing 12, \varnothing 14, \varnothing 16, \varnothing 20, \varnothing 24, \varnothing 25, \varnothing 28, \varnothing 32$



- 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
<b>Reinforcing bars</b>		
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 $f_{uk} = f_{tk} = k \cdot f_{yk}$
<b>Friulsider injection system KEM EP for concrete</b>		<b>Annex A 5</b>
<b>Product description</b> Materials reinforcing bar		

<b>Specifications of intended use</b>				
<b>Anchorage subject to (Static and quasi-static loads):</b>				
	for a working life of 50 years		for a working life of 100 years	
Base material	Non-cracked concrete	cracked concrete	Non-cracked concrete	cracked concrete
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20		M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	
Diamond drilling (DD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed
Temperature Range:	I: - 40 °C to +40 °C <sup>1)</sup> II: - 40 °C to +72 °C <sup>2)</sup>		I: - 40 °C to +40 °C <sup>1)</sup> II: - 40 °C to +72 °C <sup>2)</sup>	
<b>Anchorage subject to (Seismic action):</b>				
	for Performance Category C1		for Performance Category C2	
Base material	Cracked and non-cracked concrete			
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32		M12 to M24	
Diamond drilling (DD)	No performance assessed		No performance assessed	
Temperature Range:	I: - 40 °C to +40 °C <sup>1)</sup> II: - 40 °C to +72 °C <sup>2)</sup>		I: - 40 °C to +40 °C <sup>1)</sup> II: - 40 °C to +72 °C <sup>2)</sup>	
<sup>1)</sup> (max long term temperature +24 °C and max short term temperature +40 °C) <sup>2)</sup> (max long term temperature +50 °C and max short term temperature +72 °C)				
<b>Base materials:</b>				
<ul style="list-style-type: none"> <li>• Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016.</li> <li>• Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016.</li> </ul>				
<b>Use conditions (Environmental conditions):</b>				
<ul style="list-style-type: none"> <li>• Structures subject to dry internal conditions (all materials).</li> <li>• For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance class:               <ul style="list-style-type: none"> <li>- Stainless steel Stahl A2 according to Annex A 4, Table A1: CRC II</li> <li>- Stainless steel Stahl A4 according to Annex A 4, Table A1: CRC III</li> <li>- High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V</li> </ul> </li> </ul>				
<b>Friulside injection system KEM EP for concrete</b>				<b>Annex B 1</b>
<b>Intended Use Specifications</b>				

**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 TR 055, Edition February 2018

**Installation:**

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB), compressed air (CD) or diamond drill mode (DD).
- 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.

<b>Friulsider injection system KEM EP for concrete</b>	<b>Annex B 2</b>
<b>Intended Use Specifications</b>	

**Table B1: Installation parameters for threaded rod**

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter	$d_0$	[mm]	10	12	14	18	22	28	30	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	Prepositioned installation $d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Push through installation $d_f$	[mm]	12	14	16	20	24	30	33	40
Maximum torque moment	$\max T_{inst} \leq$	[Nm]	10	20	40 <sup>1)</sup>	60	100	170	250	300
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	75	95	115	125	140
Minimum edge distance	$c_{min}$	[mm]	35	40	45	50	60	65	75	80

<sup>1)</sup> Maximum Torque moment for M12 with steel Grade 4.6 is 35 Nm

**Table B2: Installation parameters for rebar**

Anchor size			$\emptyset 8^1)$	$\emptyset 10^1)$	$\emptyset 12^1)$	$\emptyset 14$	$\emptyset 16$	$\emptyset 20$	$\emptyset 24^1)$	$\emptyset 25^1)$	$\emptyset 28$	$\emptyset 32$
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	$d_0$	[mm]	10   12	12   14	14   16	18	20	25	30   32	30   32	35	40
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640
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	75	95	120	120	130	150
Minimum edge distance	$c_{min}$	[mm]	35	40	45	50	50	60	70	70	75	85

<sup>1)</sup> both nominal drill hole diameter can be used

**Table B3: Installation parameters for Internal threaded anchor rod**

Anchor size			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Internal diameter of anchor rod	$d_2$	[mm]	6	8	10	12	16	20
Outer diameter of anchor rod <sup>1)</sup>	$d = d_{nom}$	[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	$d_f \leq$	[mm]	7	9	12	14	18	22
Maximum torque moment	$\max T_{inst} \leq$	[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	75	95	115	140
Minimum edge distance	$c_{min}$	[mm]	40	45	50	60	65	80

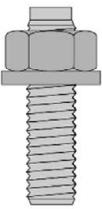
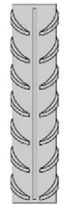



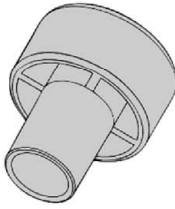



<sup>1)</sup> With metric threads according to EN 1993-1-8:2005+AC:2009

**Friulside injection system KEM EP for concrete**

**Intended Use**  
Installation parameters

**Annex B 3**

**Table B4: Parameter cleaning and setting tools**

										
Threaded Rod	Rebar	Internal threaded anchor rod	$d_0$ Drill bit - $\varnothing$ HD, HDB, CD, DD	$d_b$ Brush - $\varnothing$		$d_{b,min}$ min. Brush - $\varnothing$	Piston plug	Installation direction and use of piston plug		
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]				
M8	8		10	RB10	11,5	10,5	No plug required			
M10	8 / 10	IG-M6	12	RB12	13,5	12,5				
M12	10 / 12	IG-M8	14	RB14	15,5	14,5				
	12		16	RB16	17,5	16,5				
M16	14	IG-M10	18	RB18	20,0	18,5	VS18	$h_{ef} > 250$ mm	$h_{ef} > 250$ mm	all
	16		20	RB20	22,0	20,5	VS20			
M20		IG-M12	22	RB22	24,0	22,5	VS22			
	20		25	RB25	27,0	25,5	VS25			
M24		IG-M16	28	RB28	30,0	28,5	VS28			
M27	24 / 25		30	RB30	31,8	30,5	VS30			
	24 / 25		32	RB32	34,0	32,5	VS32			
M30	28	IG-M20	35	RB35	37,0	35,5	VS35			
	32		40	RB40	43,5	40,5	VS40			

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



**HDB – Hollow drill bit system**  
Drill bit diameter ( $d_0$ ): all diameters

The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m<sup>3</sup>/h (42 l/s).



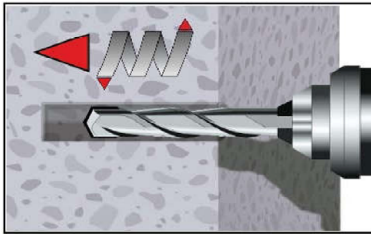
**Friulsider injection system KEM EP for concrete**

**Intended Use**  
Cleaning and setting tools

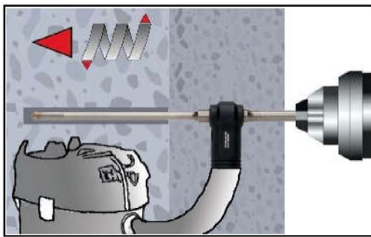
**Annex B 4**

## Installation instructions

### Drilling of the bore hole (HD, HDB, CD)



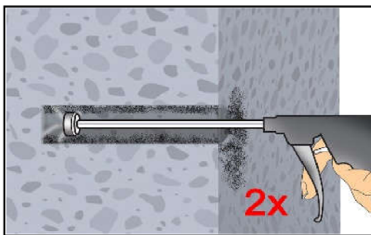
- 1a. Hammer (HD) or compressed air drilling (CD)**  
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3).  
Proceed with Step 2.  
In case of aborted drill hole, the drill hole shall be filled with mortar.



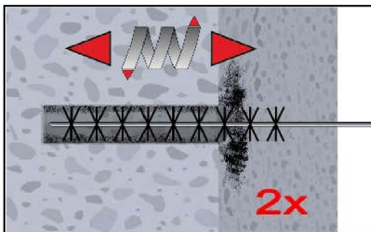
- 1b. Hollow drill bit system (HDB) (see Annex B 3)**  
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3). This drilling system removes the dust and cleans the bore hole during drilling (all conditions).  
Proceed with Step 3.  
In case of aborted drill hole, the drill hole shall be filled with mortar.

**Attention! Standing water in the bore hole must be removed before cleaning.**

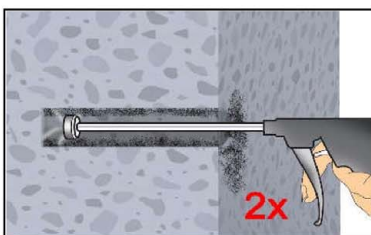
### CAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete



- 2a.** Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



- 2b.** Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) a minimum of two times.  
If the bore hole ground is not reached with the brush, a brush extension must be used.



- 2c.** Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

**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.**

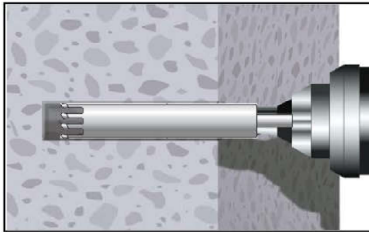
Friulsider injection system KEM EP for concrete

Intended Use  
Installation instructions

**Annex B 5**

**Installation instructions (continuation)**

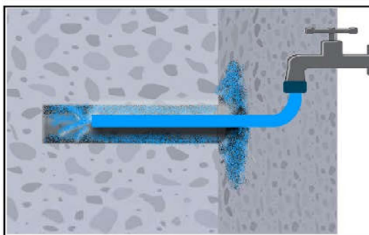
**Drilling of the bore hole (DD)**



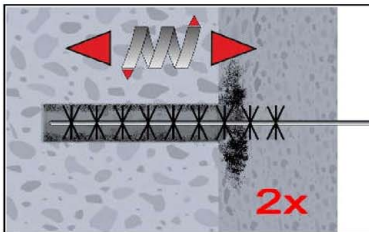
- 1a. Diamond drilling (DD)**  
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3). Proceed with Step 2.  
In case of aborted drill hole, the drill hole shall be filled with mortar.

**Attention! Standing water in the bore hole must be removed before cleaning.**

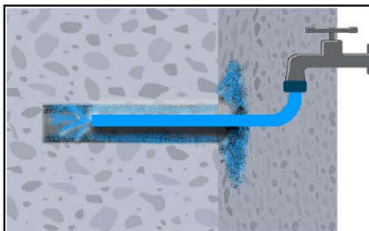
**SPCAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete**



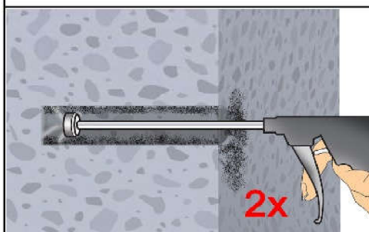
- 2a.** Rinsing with water until clear water comes out.



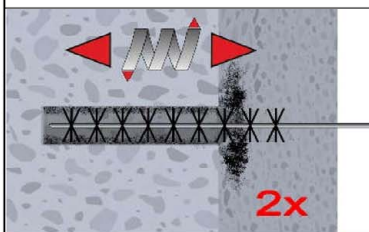
- 2b.** Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) a minimum of two times.  
If the bore hole ground is not reached with the brush, a brush extension must be used.



- 2c.** Rinsing again with water until clear water comes out.



- 2d.** Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used



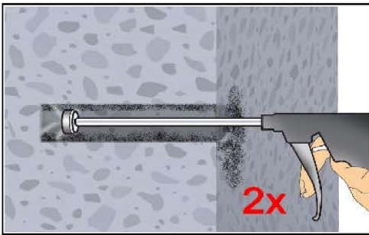
- 2e.** Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush  $> d_{b,min}$  (Table B4) a minimum of two times.  
If the bore hole ground is not reached with the brush, a brush extension must be used.

**Friulside injection system KEM EP for concrete**

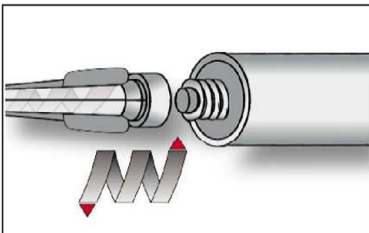
**Intended Use**  
Installation instructions (continuation)

**Annex B 6**

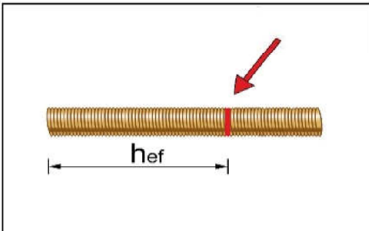
**Installation instructions (continuation)**



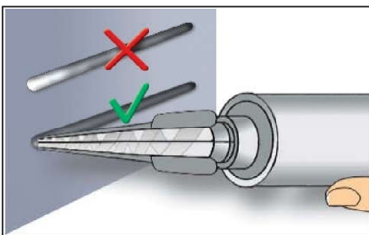
2f. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



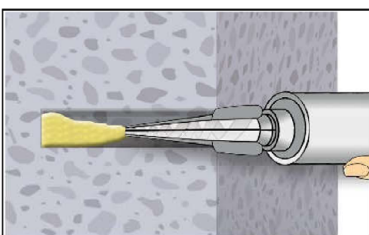
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used.



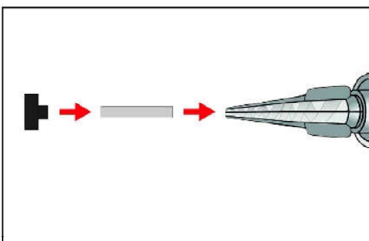
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



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 or red colour.



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 Table B5.



7. Piston plugs 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

Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.

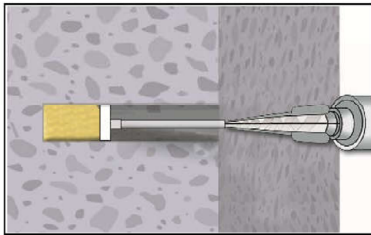
**Friulsideer injection system KEM EP for concrete**

**Intended Use**  
Installation instructions (continuation)

**Annex B 7**



**Installation instructions (continuation)**

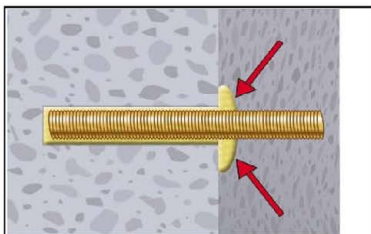


8. Insert piston plug to back of the hole and inject adhesive. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used.  
During injection the piston plug is naturally pushed out of the borehole by the back pressure of the mortar. Observe the gel-/ working times given in Table B5.

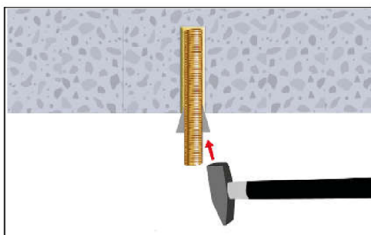


9. Push the fixing element into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment mark has reached the surface level.

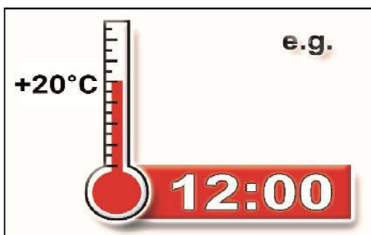
The anchor shall be free of dirt, grease, oil or other foreign material.



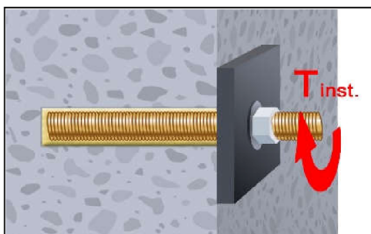
10. After inserting the anchor, the annular gap between anchor rod and concrete, in case of a push through installation additionally also the fixture, must be completely filled with mortar. If excess mortar is not visible at the top of the hole, the requirement is not fulfilled and the application has to be renewed.



11. For overhead application the anchor rod shall be fixed (e.g. wedges) until the mortar has started to harden.



12. 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 Table B5).



13. 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. In case of prepositioned installation the annular gap between anchor and fixture can be optional filled with mortar. Therefore 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.

**Friulsider injection system KEM EP for concrete**

**Intended Use**  
Installation instructions (continuation)

**Annex B 8**

**Table B5: Maximum working time and minimum curing time**

Concrete temperature	Gelling working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
0 °C to + 4 °C	90 min	144 h	288 h
+ 5 °C to + 9 °C	80 min	48 h	96 h
+ 10 °C to + 14 °C	60 min	28 h	56 h
+ 15 °C to + 19 °C	40 min	18 h	36 h
+ 20 °C to + 24 °C	30 min	12 h	24 h
+ 25 °C to + 34 °C	12 min	9 h	18 h
+ 35 °C to + 39 °C	8 min	6 h	12 h
+40 °C	8 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		

**Friulside injection system KEM EP for concrete**

**Intended Use**  
Curing time

**Annex B 9**

**Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods**

Size			M8	M10	M12	M16	M20	M24	M27	M30	
Cross section area	$A_s$	[mm <sup>2</sup> ]	36,6	58	84,3	157	245	353	459	561	
<b>Characteristic tension resistance, Steel failure <sup>1)</sup></b>											
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	– <sup>3)</sup>	– <sup>3)</sup>	
Stainless steel A4 and HCR, class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	– <sup>3)</sup>	– <sup>3)</sup>	
<b>Characteristic tension resistance, Partial factor <sup>2)</sup></b>											
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								
<b>Characteristic shear resistance, Steel failure <sup>1)</sup></b>											
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]	11 (10)	17 (16)	25	47	74	106	138	168
	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	– <sup>3)</sup>	– <sup>3)</sup>
	Stainless steel A4 and HCR, class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	– <sup>3)</sup>	– <sup>3)</sup>
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	– <sup>3)</sup>	– <sup>3)</sup>
	Stainless steel A4 and HCR, class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	– <sup>3)</sup>	– <sup>3)</sup>
<b>Characteristic shear resistance, Partial factor <sup>2)</sup></b>											
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								
<sup>1)</sup> 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. <sup>2)</sup> in absence of national regulation <sup>3)</sup> Anchor type not part of the ETA											
<b>Friulsideer injection system KEM EP for concrete</b>									<b>Annex C 1</b>		
<b>Performances</b> Characteristic values for steel tension resistance and steel shear resistance of threaded rods											

<b>Table C2: Characteristic values for Concrete cone failure and Splitting with all kind of action</b>				
<b>Anchor</b>		<b>All Anchor type and sizes</b>		
<b>Concrete cone failure</b>				
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 $c_{cr,N}$	
<b>Splitting</b>				
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 $c_{cr,sp}$	
<b>Friulsider injection system KEM EP for concrete</b>			<b>Annex C 2</b>	
<b>Performances</b> Characteristic values for Concrete cone failure and Splitting with all kind of action				

<b>Table C3: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years</b>												
<b>Anchor size threaded rod</b>					<b>M8</b>	<b>M10</b>	<b>M12</b>	<b>M16</b>	<b>M20</b>	<b>M24</b>	<b>M27</b>	<b>M30</b>
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								
<b>Combined pull-out and concrete failure</b>												
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	20	20	19	19	18	17	16	16
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	17	16	16	16	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
	I: 40°C/24°C	flooded bore hole			16	16	16	15	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor $\psi_{sus}^0$ in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi_{sus}^0$	[-]	0,80							
	II: 72°C/50°C				0,68							
Increasing factors for concrete $\psi_c$			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
<b>Concrete cone failure</b>												
Relevant parameter					see Table C2							
<b>Splitting</b>												
Relevant parameter					see Table C2							
<b>Installation factor</b>												
for dry and wet concrete (HD; HDB, CD)		$\gamma_{inst}$	[-]	1,0								
for flooded bore hole (HD; HDB, CD)				1,2								
<b>Friulsider injection system KEM EP for concrete</b>										<b>Annex C 3</b>		
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action												

<b>Table C4: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years</b>												
<b>Anchor size threaded rod</b>					<b>M8</b>	<b>M10</b>	<b>M12</b>	<b>M16</b>	<b>M20</b>	<b>M24</b>	<b>M27</b>	<b>M30</b>
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								
<b>Combined pull-out and concrete failure</b>												
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	20	20	19	19	18	17	16	16
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	17	16	16	16	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
	I: 40°C/24°C	flooded bore hole			16	16	16	15	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm <sup>2</sup> ]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete $\psi_c$			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
<b>Concrete cone failure</b>												
Relevant parameter					see Table C2							
<b>Splitting</b>												
Relevant parameter					see Table C2							
<b>Installation factor</b>												
for dry and wet concrete (HD; HDB, CD)		$\gamma_{inst}$	[-]	1,0								
for flooded bore hole (HD; HDB, CD)				1,2								
<b>Friulsider injection system KEM EP for concrete</b>										<b>Annex C 4</b>		
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action												

<b>Table C5: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years</b>												
<b>Anchor size threaded rod</b>					<b>M8</b>	<b>M10</b>	<b>M12</b>	<b>M16</b>	<b>M20</b>	<b>M24</b>	<b>M27</b>	<b>M30</b>
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								
<b>Combined pull-out and concrete failure for a working life of 50 years</b>												
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	15	14	14	13	12	12	11	11
	II: 72°C/50°C				12	12	11	10	9,5	9,5	9,0	9,0
Reduction factor $\psi_{sus}^0$ in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi_{sus}^0$	[-]	0,77							
	II: 72°C/50°C				0,72							
Increasing factors for concrete $\psi_c$		C25/30		1,04								
		C30/37		1,08								
		C35/45		1,12								
		C40/50		1,15								
		C45/55		1,17								
		C50/60		1,19								
<b>Combined pull-out and concrete failure for a working life of 100 years</b>												
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	15	14	14	13	12	12	11	11
	II: 72°C/50°C				11	11	10	10	9,5	9,0	8,5	8,5
Increasing factors for concrete $\psi_c$		C25/30		1,04								
		C30/37		1,08								
		C35/45		1,12								
		C40/50		1,15								
		C45/55		1,17								
		C50/60		1,19								
<b>Concrete cone failure</b>												
Relevant parameter					see Table C2							
<b>Splitting</b>												
Relevant parameter					see Table C2							
<b>Installation factor</b>												
for dry and wet concrete (DD)		$\gamma_{inst}$	[-]	1,0								
for flooded bore hole (DD)				1,2			1,4					
<b>Friulside injection system KEM EP for concrete</b>										<b>Annex C 5</b>		
Performances Characteristic values of tension loads under static and quasi-static action												

<b>Table C6: Characteristic values of shear loads under static and quasi-static action</b>											
<b>Anchor size threaded rod</b>			<b>M8</b>	<b>M10</b>	<b>M12</b>	<b>M16</b>	<b>M20</b>	<b>M24</b>	<b>M27</b>	<b>M30</b>	
<b>Steel failure without lever arm</b>											
Characteristic shear resistance Steel, strength class 4.6, 4.8 and 5.6, 5.8	$V_{Rk,s}^0$	[kN]	$0,6 \cdot A_s \cdot f_{uk}$ (or see Table C1)								
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A2, A4 and HCR, all strength 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								
<b>Steel failure with lever arm</b>											
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 <sup>3</sup> ]	31	62	109	277	541	935	1387	1874	
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1								
<b>Concrete pry-out failure</b>											
Factor	$k_8$	[-]	2,0								
Installation factor	$\gamma_{inst}$	[-]	1,0								
<b>Concrete edge failure</b>											
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	$\gamma_{inst}$	[-]	1,0								
<b>Friulsider injection system KEM EP for concrete</b>									<b>Annex C 6</b>		
<b>Performances</b> Characteristic values of shear loads under static and quasi-static action											



<b>Table C7: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years</b>										
<b>Anchor size internal threaded anchor rods</b>				<b>IG-M6</b>	<b>IG-M8</b>	<b>IG-M10</b>	<b>IG-M12</b>	<b>IG-M16</b>	<b>IG-M20</b>	
<b>Steel failure<sup>1)</sup></b>										
Characteristic tension resistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123	
Steel, strength class	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 <sup>2)</sup>		$N_{Rk,s}$	[kN]	14	26	41	59	110	124	
Partial factor	$\gamma_{Ms,N}$		[-]	1,87						
<b>Combined pull-out and concrete cone failure</b>										
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	20	19	19	18	17	16
	II: 72°C/50°C				15	15	14	13	13	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	16	16	16	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole			16	16	15	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,0	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	7,0	7,0	7,0	7,0	7,0
Reduction factor $\psi^0_{sus}$ in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus}$	[-]	0,80					
	II: 72°C/50°C				0,68					
Increasing factors for concrete $\psi_c$			C25/30		1,02					
			C30/37		1,04					
			C35/45		1,07					
			C40/50		1,08					
			C45/55		1,09					
			C50/60		1,10					
<b>Concrete cone failure</b>										
Relevant parameter				see Table C2						
<b>Splitting failure</b>										
Relevant parameter				see Table C2						
<b>Installation factor</b>										
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0					
for flooded bore hole (HD; HDB, CD)					1,2					
<sup>1)</sup> 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. <sup>2)</sup> For IG-M20 strength class 50 is valid										
<b>Friulside injection system KEM EP for concrete</b>								<b>Annex C 7</b>		
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action										

<b>Table C8: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years</b>									
<b>Anchor size internal threaded anchor rods</b>				<b>IG-M6</b>	<b>IG-M8</b>	<b>IG-M10</b>	<b>IG-M12</b>	<b>IG-M16</b>	<b>IG-M20</b>
<b>Steel failure<sup>1)</sup></b>									
Characteristic tension resistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123
Steel, strength class	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 <sup>2)</sup>		$N_{Rk,s}$	[kN]	14	26	41	59	110	124
Partial factor	$\gamma_{Ms,N}$		[-]	1,87					2,86
<b>Combined pull-out and concrete cone failure</b>									
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)									
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$ [N/mm <sup>2</sup> ]	20	19	19	18	17	16
	II: 72°C/50°C			15	15	14	13	13	12
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)									
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$ [N/mm <sup>2</sup> ]	16	16	16	15	14	13
	II: 72°C/50°C			14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole		16	16	15	15	14	13
	II: 72°C/50°C			14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)									
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$ [N/mm <sup>2</sup> ]	6,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C			5,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete $\psi_c$	C25/30			1,02					
	C30/37			1,04					
	C35/45			1,07					
	C40/50			1,08					
	C45/55			1,09					
	C50/60			1,10					
<b>Concrete cone failure</b>									
Relevant parameter				see Table C2					
<b>Splitting failure</b>									
Relevant parameter				see Table C2					
<b>Installation factor</b>									
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0				
for flooded bore hole (HD; HDB, CD)					1,2				
<sup>3)</sup> 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. <sup>4)</sup> For IG-M20 strength class 50 is valid									
<b>Friulsider injection system KEM EP for concrete</b>								<b>Annex C 8</b>	
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action									

<b>Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years</b>										
<b>Anchor size internal threaded anchor rods</b>				<b>IG-M6</b>	<b>IG-M8</b>	<b>IG-M10</b>	<b>IG-M12</b>	<b>IG-M16</b>	<b>IG-M20</b>	
<b>Steel failure<sup>1)</sup></b>										
Characteristic tension resistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123	
Steel, strength class	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 <sup>2)</sup>		$N_{Rk,s}$	[kN]	14	26	41	59	110	124	
Partial factor	$\gamma_{Ms,N}$		[-]	1,87						
<b>Combined pull-out and concrete cone failure for a working life of 50 years</b>										
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	13	12	12	11
	II: 72°C/50°C				12	11	10	9,5	9,5	9,0
Reduction factor $\psi_{sus}^0$ in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi_{sus}^0$	[-]	0,77					
	II: 72°C/50°C				0,72					
Increasing factors for concrete $\psi_c$	C25/30			1,04						
	C30/37			1,08						
	C35/45			1,12						
	C40/50			1,15						
	C45/55			1,17						
	C50/60			1,19						
<b>Combined pull-out and concrete cone failure for a working life of 100 years</b>										
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	14	14	13	12	12	11
	II: 72°C/50°C				11	10	10	9,5	9,0	8,5
Increasing factors for concrete $\psi_c$	C25/30			1,04						
	C30/37			1,08						
	C35/45			1,12						
	C40/50			1,15						
	C45/55			1,17						
	C50/60			1,19						
<b>Concrete cone failure</b>										
Relevant parameter				see Table C2						
<b>Splitting failure</b>										
Relevant parameter				see Table C2						
<b>Installation factor</b>										
for dry and wet concrete (DD)			$\gamma_{inst}$	[-]	1,0					
for flooded bore hole (DD)					1,2		1,4			
<sup>1)</sup> 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. <sup>2)</sup> For IG-M20 strength class 50 is valid										
<b>Friulsider injection system KEM EP for concrete</b>								<b>Annex C 9</b>		
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action										

<b>Table C10: Characteristic values of shear loads under static and quasi-static action</b>										
<b>Anchor size for internal threaded anchor rods</b>				<b>IG-M6</b>	<b>IG-M8</b>	<b>IG-M10</b>	<b>IG-M12</b>	<b>IG-M16</b>	<b>IG-M20</b>	
<b>Steel failure without lever arm<sup>1)</sup></b>										
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 <sup>2)</sup>		$V_{Rk,s}^0$	[kN]	7	13	20	30	55	40	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56					2,38	
Ductility factor	$k_7$	[-]	1,0							
<b>Steel failure with lever arm<sup>1)</sup></b>										
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 <sup>2)</sup>		$M_{Rk,s}^0$	[Nm]	11	26	52	92	233	456	
	Partial factor	$\gamma_{Ms,V}$	[-]	1,56					2,38	
<b>Concrete pry-out failure</b>										
Factor	$k_8$	[-]	2,0							
Installation factor	$\gamma_{inst}$	[-]	1,0							
<b>Concrete edge failure</b>										
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	$\gamma_{inst}$	[-]	1,0							
<sup>1)</sup> 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. <sup>2)</sup> For IG-M20 strength class 50 is valid										
<b>Friulsider injection system KEM EP for concrete</b>								<b>Annex C 10</b>		
<b>Performances</b> Characteristic values of shear loads under static and quasi-static action										

<b>Table C11: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years</b>															
<b>Anchor size reinforcing bar</b>			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32			
<b>Steel failure</b>															
Characteristic tension resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$												
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804			
Partial factor	$\gamma_{Ms,N}$	[-]	1,4 <sup>2)</sup>												
<b>Combined pull-out and concrete failure</b>															
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)															
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	16	16	16	16	16	16	15	15	15	15	
	II: 72°C/50°C				12	12	12	12	12	12	12	12	11	11	
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)															
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	14	13	13	13	13	13	13	13	13	
	II: 72°C/50°C				12	12	12	11	11	11	11	11	11	11	
	I: 40°C/24°C	flooded bore hole			13	13	13	13	13	13	13	13	13	13	13
	II: 72°C/50°C				11	11	11	11	11	11	11	11	11	11	
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)															
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm <sup>2</sup> ]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5	
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	
Reduction factor $\psi_{sus}^0$ in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)															
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi_{sus}^0$	[-]	0,80										
	II: 72°C/50°C				0,68										
Increasing factors for concrete $\psi_c$				C25/30	1,02										
				C30/37	1,04										
				C35/45	1,07										
				C40/50	1,08										
				C45/55	1,09										
				C50/60	1,10										
<b>Concrete cone failure</b>															
Relevant parameter			see Table C2												
<b>Splitting</b>															
Relevant parameter			see Table C2												
<b>Installation factor</b>															
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0										
for flooded bore hole (HD; HDB, CD)					1,2										
<sup>1)</sup> $f_{uk}$ shall be taken from the specifications of reinforcing bars <sup>2)</sup> in absence of national regulation															
<b>Friulsider injection system KEM EP for concrete</b>											<b>Annex C 11</b>				
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action															

<b>Table C12: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years</b>															
<b>Anchor size reinforcing bar</b>			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32			
<b>Steel failure</b>															
Characteristic tension resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$												
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804			
Partial factor	$\gamma_{Ms,N}$	[-]	1,4 <sup>2)</sup>												
<b>Combined pull-out and concrete failure</b>															
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)															
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	16	16	16	16	16	16	15	15	15	15	
	II: 72°C/50°C				12	12	12	12	12	12	12	12	11	11	
Characteristic bond resistance in non-cracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)															
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	14	14	13	13	13	13	13	13	13	13	
	II: 72°C/50°C				12	12	12	11	11	11	11	11	11	11	
	I: 40°C/24°C	flooded bore hole			13	13	13	13	13	13	13	13	13	13	13
	II: 72°C/50°C				11	11	11	11	11	11	11	11	11	11	
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)															
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm <sup>2</sup> ]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	
	II: 72°C/50°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	
Increasing factors for concrete $\psi_c$			C25/30		1,02										
			C30/37		1,04										
			C35/45		1,07										
			C40/50		1,08										
			C45/55		1,09										
			C50/60		1,10										
<b>Concrete cone failure</b>															
Relevant parameter			see Table C2												
<b>Splitting</b>															
Relevant parameter			see Table C2												
<b>Installation factor</b>															
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0										
for flooded bore hole (HD; HDB, CD)					1,2										
<sup>1)</sup> $f_{uk}$ shall be taken from the specifications of reinforcing bars <sup>2)</sup> in absence of national regulation															
<b>Friulside injection system KEM EP for concrete</b>											<b>Annex C 12</b>				
<b>Performances</b> Characteristic values of tension loads under static and quasi-static action															

<b>Table C13: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years</b>														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
<b>Steel failure</b>														
Characteristic tension resistance		$N_{Rk,s}$	[kN]		$A_s \cdot f_{uk}^{1)}$									
Cross section area		$A_s$	[mm <sup>2</sup> ]		50	79	113	154	201	314	452	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]		1,4 <sup>2)</sup>									
<b>Combined pull-out and concrete failure for a working life of 50 years</b>														
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm <sup>2</sup> ]	14	13	13	13	12	12	11	11	11	11
	II: 72°C/50°C				11	11	10	10	10	9,5	9,5	9,5	9,0	9,0
Reduction factor $\psi^0_{sus}$ in non-cracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\psi^0_{sus}$	[-]	0,77									
	II: 72°C/50°C				0,72									
Increasing factors for concrete $\psi_c$		C25/30		1,04										
		C30/37		1,08										
		C35/45		1,12										
		C40/50		1,15										
		C45/55		1,17										
		C50/60		1,19										
<b>Combined pull-out and concrete failure for a working life of 100 years</b>														
Characteristic bond resistance in non-cracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm <sup>2</sup> ]	14	13	13	13	12	12	11	11	11	11
	II: 72°C/50°C				11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5
Increasing factors for concrete $\psi_c$		C25/30		1,04										
		C30/37		1,08										
		C35/45		1,12										
		C40/50		1,15										
		C45/55		1,17										
		C50/60		1,19										
<b>Concrete cone failure</b>														
Relevant parameter			see Table C2											
<b>Splitting</b>														
Relevant parameter			see Table C2											
<b>Installation factor</b>														
for dry and wet concrete (DD)		$\gamma_{inst}$	[-]	1,0										
for flooded bore hole (DD)				1,2					1,4					
<sup>1)</sup> $f_{uk}$ shall be taken from the specifications of reinforcing bars <sup>2)</sup> in absence of national regulation														
<b>Friulside injection system KEM EP for concrete</b>											<b>Annex C 13</b>			
<b>Performances</b>		Characteristic values of tension loads under static and quasi-static action												

Table C14: 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 24	Ø 25	Ø 28	Ø 32		
<b>Steel failure without lever arm</b>														
Characteristic shear resistance	$V_{RK,s}^0$	[kN]	$0,5 \cdot A_s \cdot f_{uk}^{1)}$											
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 <sup>2)</sup>											
Ductility factor	$k_7$	[-]	1,0											
<b>Steel failure with lever arm</b>														
Characteristic bending moment	$M_{RK,s}^0$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$											
Elastic section modulus	$W_{el}$	[mm <sup>3</sup> ]	50	98	170	269	402	785	1357	1534	2155	3217		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 <sup>2)</sup>											
<b>Concrete pry-out failure</b>														
Factor	$k_8$	[-]	2,0											
Installation factor	$\gamma_{inst}$	[-]	1,0											
<b>Concrete edge failure</b>														
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	24	25	28	32		
Installation factor	$\gamma_{inst}$	[-]	1,0											
<sup>1)</sup> $f_{uk}$ shall be taken from the specifications of reinforcing bars <sup>2)</sup> in absence of national regulation														
<b>Friulsider injection system KEM EP for concrete</b>										<b>Annex C 14</b>				
<b>Performances</b> Characteristic values of shear loads under static and quasi-static action														



**Table C15: Displacements under tension load<sup>1)</sup> in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)**

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,038	0,039	0,040	0,044	0,047	0,051	0,052	0,055
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,047	0,049	0,051	0,055	0,059	0,064	0,067	0,070
<b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,069	0,071	0,072	0,074	0,076	0,079	0,081	0,082
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,100	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,092	0,095	0,096	0,099	0,102	0,106	0,109	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,134	0,154	0,163	0,172	0,181	0,189	0,207	0,229

<sup>1)</sup> Calculation of the displacement

$$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$$

$\tau$ : action bond stress for tension

$$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau;$$

**Table C16: Displacements under tension load<sup>1)</sup> in diamond drilled holes (DD)**

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 years</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,018	0,019	0,019	0,020	0,022	0,023	0,024	0,025
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,052	0,053	0,055	0,058	0,062	0,065	0,068	0,070
<b>Non-cracked concrete under static and quasi-static action for a working life of 100 years</b>										
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,020	0,021	0,021	0,023	0,024	0,025	0,026	0,027
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,038	0,039	0,040	0,043	0,045	0,047	0,049	0,051

<sup>1)</sup> Calculation of the displacement

$$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$$

$\tau$ : action bond stress for tension

$$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau;$$

**Table C17: Displacements under shear load<sup>1)</sup> for all drilling methods**

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
<b>Non-cracked and cracked concrete under static and quasi-static action</b>										
All temperature ranges	$\delta_{V0}$ -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

<sup>1)</sup> Calculation of the displacement

$$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V;$$

V: action shear load

$$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V;$$

**Friulside injection system KEM EP for concrete**

**Performances**

Displacements under static and quasi-static action (threaded rods)

**Annex C 15**

<b>Table C18: Displacements under tension load<sup>1)</sup> in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)</b>								
Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>								
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,029	0,030	0,033	0,035	0,038	0,041
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,029	0,030	0,033	0,035	0,038	0,041
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,039	0,040	0,044	0,047	0,051	0,055
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,049	0,051	0,055	0,059	0,064	0,070
<b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>								
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,071	0,072	0,074	0,076	0,079	0,082
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,115	0,122	0,128	0,135	0,142	0,171
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,095	0,096	0,099	0,102	0,106	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,154	0,163	0,172	0,181	0,189	0,229
<sup>1)</sup> Calculation of the displacement $\delta_{N0} = \delta_{N0}$ -factor $\cdot \tau$ ; $\tau$ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty}$ -factor $\cdot \tau$ ;								
<b>Table C19: Displacements under tension load<sup>1)</sup> in diamond drilled holes (DD)</b>								
Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 years</b>								
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,019	0,019	0,020	0,022	0,023	0,025
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,053	0,055	0,058	0,062	0,065	0,070
<b>Non-cracked concrete under static and quasi-static action for a working life of 100 years</b>								
Temperature range I: 40°C/24°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,021	0,021	0,023	0,024	0,025	0,027
Temperature range II: 72°C/50°C	$\delta_{N0}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm <sup>2</sup> )]	0,039	0,040	0,043	0,045	0,047	0,051
<sup>1)</sup> Calculation of the displacement $\delta_{N0} = \delta_{N0}$ -factor $\cdot \tau$ ; $\tau$ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty}$ -factor $\cdot \tau$ ;								
<b>Table C20: Displacements under shear load<sup>1)</sup> for all drilling methods</b>								
Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
<b>Non-cracked and cracked concrete under static and quasi-static action</b>								
All temperature ranges	$\delta_{V0}$ -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
<sup>1)</sup> Calculation of the displacement $\delta_{V0} = \delta_{V0}$ -factor $\cdot V$ ; $V$ : action shear load $\delta_{V\infty} = \delta_{V\infty}$ -factor $\cdot V$ ;								
<b>Friulsider injection system KEM EP for concrete</b>							<b>Annex C 16</b>	
<b>Performances</b> Displacements under static and quasi-static action (Internal threaded anchor rod)								

<b>Table C21: Displacements under tension load<sup>1)</sup> in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)</b>												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>												
Temp.- range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
Temp.- range II: 72°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	0,058
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	0,072
<b>Cracked concrete under static and quasi-static action for a working life of 50 and 100 years</b>												
Temp.- range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	0,084
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	0,194
Temp.- range II: 72°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,092	0,095	0,096	0,098	0,099	0,102	0,106	0,106	0,109	0,113
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,154	0,163	0,172	0,181	0,189	0,207	0,229	0,229	0,242	0,260
<sup>1)</sup> Calculation of the displacement $\delta_{N0} = \delta_{N0\text{-factor}} \cdot \tau;$ $\tau$ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty\text{-factor}} \cdot \tau;$												
<b>Table C22: Displacements under tension load<sup>1)</sup> in diamond drilled holes (DD)</b>												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Non-cracked concrete under static and quasi-static action for a working life of 50 years</b>												
Temp.- range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,008	0,009	0,009	0,01	0,011	0,012	0,013	0,013	0,014	0,015
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,018	0,018	0,019	0,020	0,021	0,024	0,027	0,027	0,028	0,031
Temp.- range II: 72°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,048	0,051	0,054	0,058	0,061	0,068	0,076	0,076	0,081	0,088
<b>Non-cracked concrete under static and quasi-static action for a working life of 100 years</b>												
Temp.- range I: 40°C/24°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	0,015
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,018	0,020	0,021	0,022	0,024	0,026	0,029	0,029	0,031	0,034
Temp.- range II: 72°C/50°C	δ <sub>N0</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	δ <sub>N∞</sub> -factor	[mm/(N/mm <sup>2</sup> )]	0,035	0,037	0,040	0,042	0,045	0,049	0,055	0,055	0,059	0,064
<sup>1)</sup> Calculation of the displacement $\delta_{N0} = \delta_{N0\text{-factor}} \cdot \tau;$ $\tau$ : action bond stress for tension $\delta_{N\infty} = \delta_{N\infty\text{-factor}} \cdot \tau;$												
<b>Table C23: Displacements under shear load<sup>1)</sup> for all drilling methods</b>												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
<b>Non-cracked and cracked concrete under static and quasi-static action</b>												
All temperature ranges	δ <sub>V0</sub> -factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
	δ <sub>V∞</sub> -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04
<sup>1)</sup> Calculation of the displacement $\delta_{V0} = \delta_{V0\text{-factor}} \cdot V;$ V: action shear load $\delta_{V\infty} = \delta_{V\infty\text{-factor}} \cdot V;$												
<b>Friulsider injection system KEM EP for concrete</b>										<b>Annex C 17</b>		
<b>Performances</b> Displacements under static and quasi-static action (rebar)												

<b>Table C24: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years</b>													
Anchor size threaded rod				M8	M10	M12	M16	M20	M24	M27	M30		
<b>Steel failure</b>													
Characteristic tension resistance		$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$									
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1									
<b>Combined pull-out and concrete failure</b>													
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)													
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete $\psi_c$			C25/30 to C50/60				1,0						
<b>Installation factor</b>													
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0								
for flooded bore hole (HD; HDB, CD)					1,2								
<b>Table C25: Characteristic values of shear loads under seismic action (performance category C1)</b>													
Anchor size threaded rod				M8	M10	M12	M16	M20	M24	M27	M30		
<b>Steel failure</b>													
Characteristic shear resistance (Seismic C1)		$V_{Rk,s,eq,C1}$	[kN]	$0,70 \cdot V^0_{Rk,s}$									
Partial factor		$\gamma_{Ms,V}$	[-]	see Table C1									
<b>Factor for annular gap</b>		$\alpha_{gap}$	[-]	$0,5 (1,0)^1$									
<sup>1)</sup> 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 recommended.													
<b>Friulside injection system KEM EP for concrete</b>											<b>Annex C 18</b>		
<b>Performances</b> Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (threaded rod)													

**Table C26: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years**

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
<b>Steel failure</b>													
Characteristic tension resistance	$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot A_s \cdot f_{uk}^{1)}$										
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804	
Partial factor	$\gamma_{Ms,N}$	[-]	1,4 <sup>2)</sup>										
<b>Combined pull-out and concrete failure</b>													
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)													
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm <sup>2</sup> ]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete $\psi_C$		C25/30 to C50/60	1,0										
<b>Installation factor</b>													
for dry and wet concrete (HD; HDB, CD)		$\gamma_{inst}$	[-]	1,0									
for flooded bore hole (HD; HDB, CD)				1,2									

<sup>1)</sup>  $f_{uk}$  shall be taken from the specifications of reinforcing bars  
<sup>2)</sup> in absence of national regulation

**Table C27: 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 24	Ø 25	Ø 28	Ø 32
<b>Steel failure</b>												
Characteristic shear resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$									
Cross section area	$A_s$	[mm <sup>2</sup> ]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 <sup>2)</sup>									
<b>Factor for annular gap</b>	$\alpha_{gap}$	[-]	0,5 (1,0) <sup>3)</sup>									

<sup>1)</sup>  $f_{uk}$  shall be taken from the specifications of reinforcing bars  
<sup>2)</sup> in absence of national regulation  
<sup>3)</sup> 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 recommended.

**Friulsider injection system KEM EP for concrete**

**Performances**

Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (rebar)

**Annex C 19**

<b>Table C28: Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 and 100 years</b>								
Anchor size threaded rod			M12	M16	M20	M24		
<b>Steel failure</b>								
Characteristic tension resistance, Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class $\geq 70$			$N_{Rk,s,eq,C2}$	[kN]	$1,0 \cdot N_{Rk,s}$			
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1			
<b>Combined pull-out and concrete failure</b>								
Characteristic bond resistance in cracked and non-cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and with hollow drill bit (HDB)								
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C2}$	[N/mm <sup>2</sup> ]	5,8	4,8	5,0	5,1
	II: 72°C/50°C		$\tau_{Rk,eq,C2}$	[N/mm <sup>2</sup> ]	5,0	4,1	4,3	4,4
Increasing factors for concrete $\psi_c$			C25/30 to C50/60		1,0			
<b>Installation factor</b>								
for dry and wet concrete (HD; HDB, CD)			$\gamma_{inst}$	[-]	1,0			
for flooded bore hole (HD; HDB, CD)					1,2			
<b>Table C29: Characteristic values of shear loads under seismic action (performance category C2)</b>								
Anchor size threaded rod			M12	M16	M20	M24		
<b>Steel failure</b>								
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class $\geq 70$			$V_{Rk,s,eq,C2}$	[kN]	$0,70 \cdot V_{Rk,s}^0$			
Partial factor			$\gamma_{Ms,V}$	[-]	see Table C1			
<b>Factor for annular gap</b>			$\alpha_{gap}$	[-]	$0,5 (1,0)^1$			
<sup>1)</sup> 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 recommended.								
<b>Friulside injection system KEM EP for concrete</b>						<b>Annex C 20</b>		
<b>Performances</b> Characteristic values of tension and shear loads under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)								

**Table C30: Displacements under tension load (threaded rod)**

Anchor size threaded rod			M12	M16	M20	M24
<b>Non-cracked and cracked concrete under seismic action (performance category C2)</b>						
All temperature ranges	$\delta_{N,eq,C2}(DLS)$	[mm]	0,21	0,24	0,27	0,36
	$\delta_{N,eq,C2}(ULS)$	[mm]	0,54	0,51	0,54	0,63

**Table C31: Displacements under shear load (threaded rod)**

Anchor size threaded rod			M12	M16	M20	M24
<b>Non-cracked and cracked concrete under seismic action (performance category C2)</b>						
All temperature ranges	$\delta_{V,eq,C2}(DLS)$	[mm]	3,1	3,4	3,5	4,2
	$\delta_{V,eq,C2}(ULS)$	[mm]	6,0	7,6	7,3	10,9

**Friulsider injection system KEM EP for concrete**

**Performances**

Displacements under seismic action (performance category C2) (threaded rods)

**Annex C 21**