Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment ETA-08/0383 of 11 December 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	Friulsider Injection system KEM-UP + Vinylester / KEM-UP + Vinylester Winter 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., Plant1 Germany
This European Technical Assessment contains	31 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
This version replaces	ETA-08/0383 issued on 16 May 2018

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Specific Part

1 Technical description of the product

The "Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete" is a bonded anchor consisting of a cartridge with injection KEM-UP + Vinylester or KEM-UP + Vinylester Winter and a steel element. The steel element consists of a commercial threaded rod with washer and hexagon nut in the range of M8 to M30 or reinforcing bar in the range of ∅ 8 to ∅ 32 mm or an internal threaded anchor 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 to C 3, C 5, C 7
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C1, C 4, C 6, C 8
Displacements (static and quasi-static loading)	See Anne C 9 to C 11
Characteristic resistance and displacements for seismic performance categories C1	See Anne C 12 to C 16
Characteristic resistance and displacements for seismic performance categories C2	No performance assessed
Durability	See Annex B 1

3.2 Hygiene, health and the environment (BWR 3)

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

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

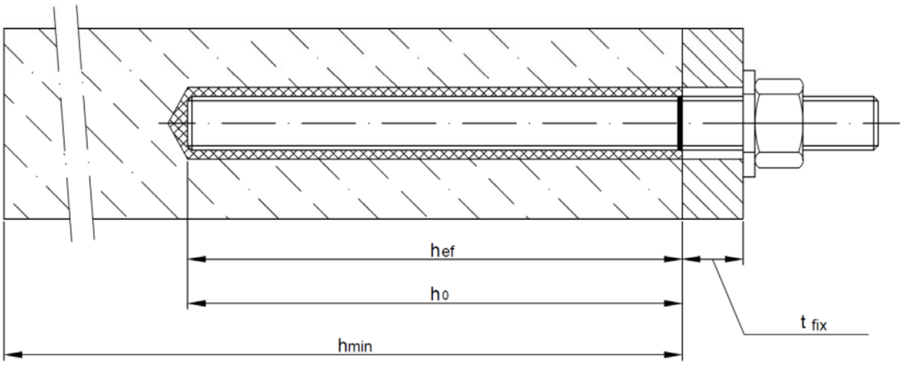
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 11 December 2019 by Deutsches Institut für Bautechnik

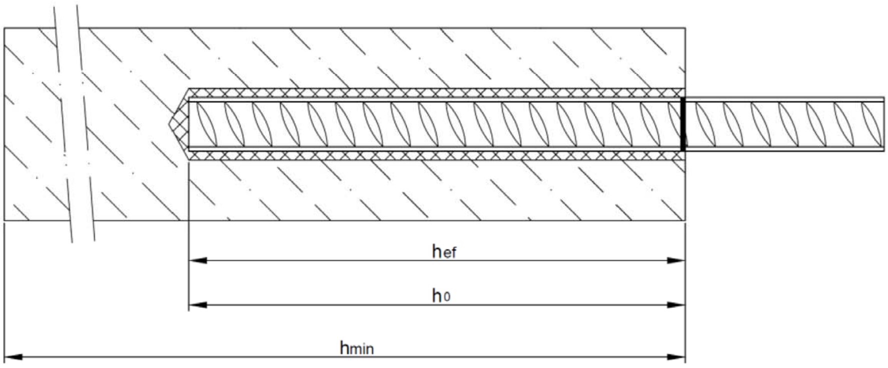
Dr.-Ing. Lars Eckfeldt
p.p. Head of Department

beglaubigt:
Baderschneider

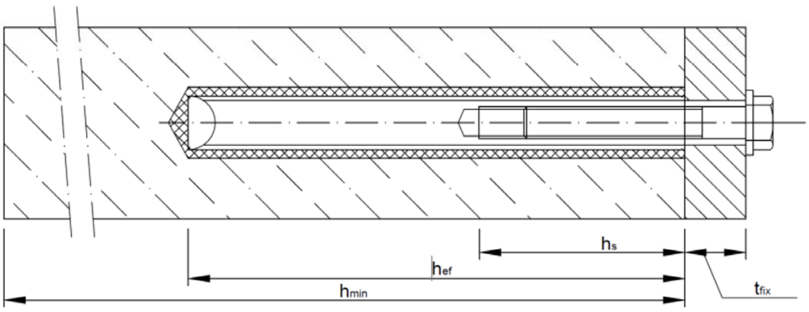
Installation threaded rod M8 up to M30



Installation reinforcing bar Ø8 up to Ø32



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

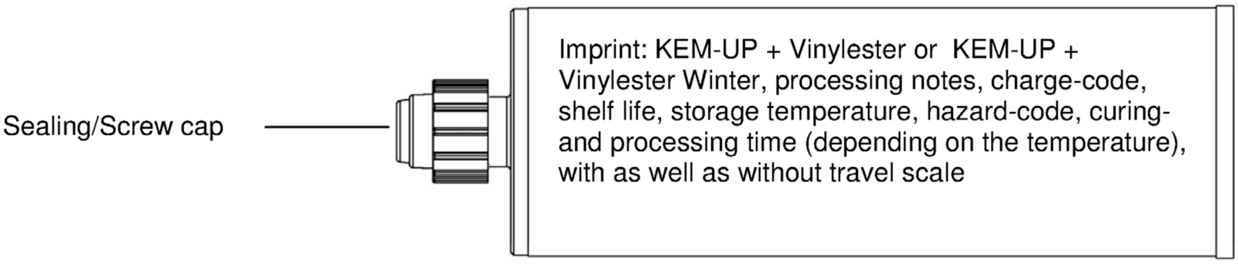


t_{fix} = thickness of fixture
h_{ef} = effective anchorage depth
h_0 = depth of drill hole
h_{min} = minimum thickness of member

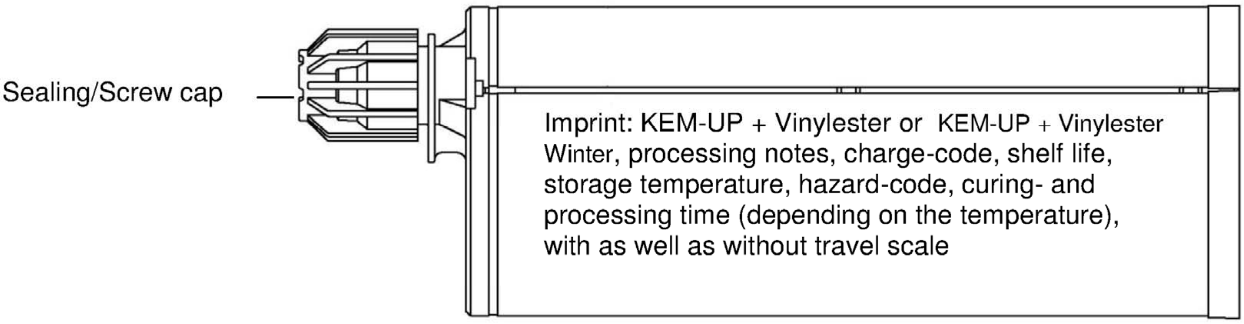
Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex A 1**
Product description Installed condition	

Cartridge: KEM-UP + Vinylester or KEM-UP + Vinylester Winter

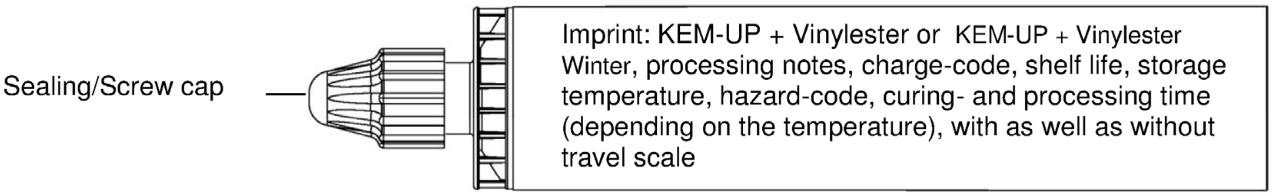
150 ml, 280 ml, 300 ml up to 333 ml and 380 ml up to 420 ml cartridge (Type: coaxial)



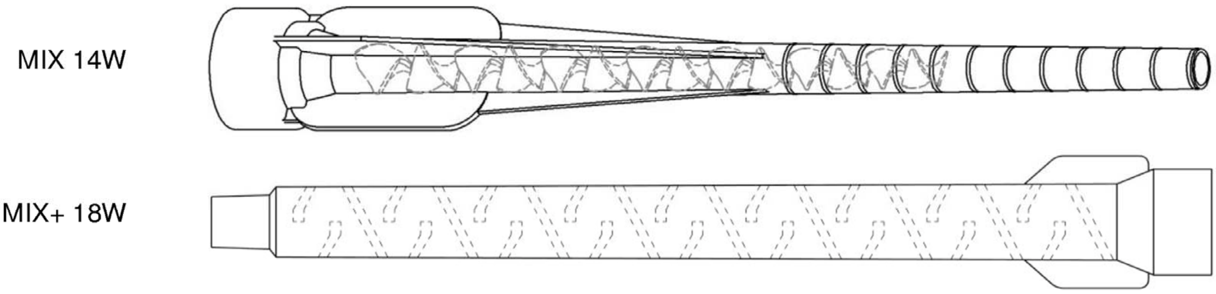
235 ml, 345 ml up to 360 ml and 825 ml cartridge (Type: “side-by-side”)



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

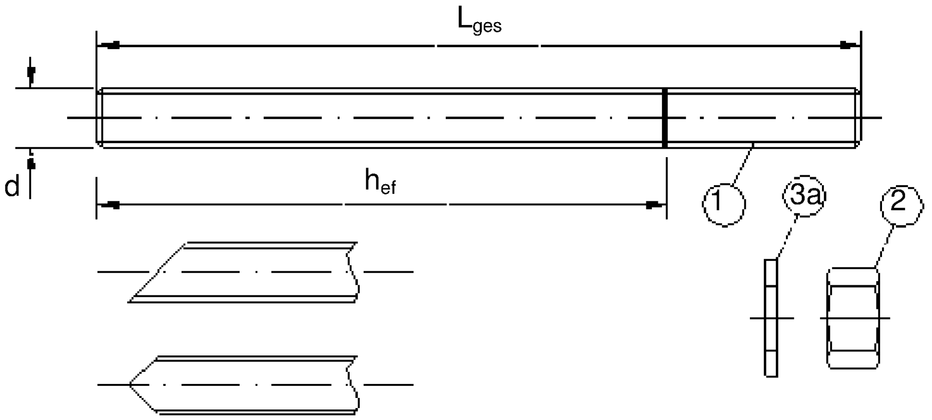


Static Mixer



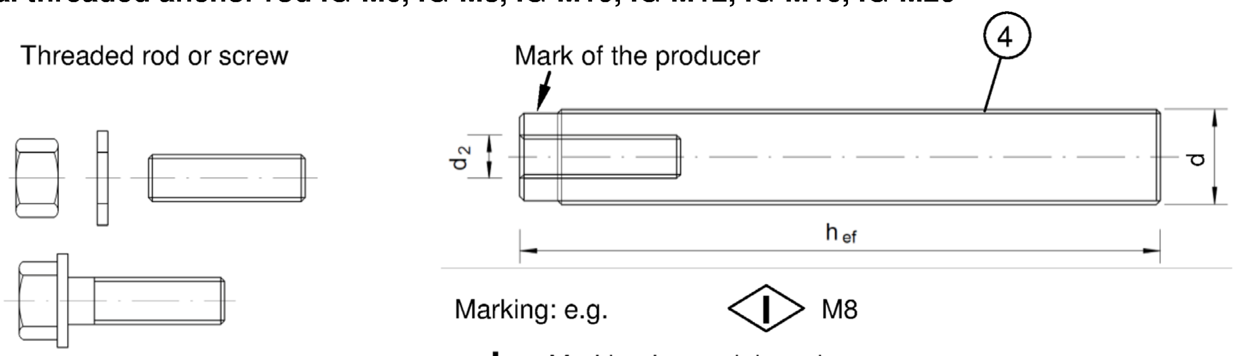
Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	Annex A 2
Product description Injection system	

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

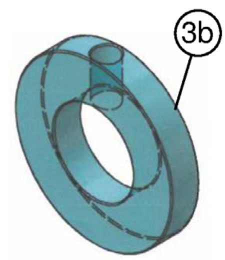
Internal threaded anchor rod IG-M6, IG-M8, IG-M10, IG-M12, IG-M16, IG-M20

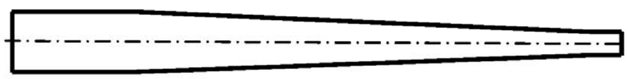


Marking: e.g. ◇I◇ M8

I	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





Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	Annex A 3
Product description Threaded rod, internal threaded rod and filling washer	

Table A1: Materials

Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN 10087:1998 or EN 10263:2001) - zinc plated ≥ 5 µm acc. to EN ISO 4042:1999 or - hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or - sherardized ≥ 45 µm 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 N/mm²	f_{yk} = 240 N/mm²	A_5 > 8%
			4.8	f_{uk} = 400 N/mm²	f_{yk} = 320 N/mm²	A_5 > 8%
			5.6	f_{uk} = 500 N/mm²	f_{yk} = 300 N/mm²	A_5 > 8%
			5.8	f_{uk} = 500 N/mm²	f_{yk} = 400 N/mm²	A_5 > 8%
			8.8	f_{uk} = 800 N/mm²	f_{yk} = 640 N/mm²	A_5 ≥ 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 N/mm²	f_{yk} = 400 N/mm²	A_5 > 8%
			8.8	f_{uk} = 800 N/mm²	f_{yk} = 640 N/mm²	A_5 > 8%
Stainless steel A2 (Material 1.4301 / 1.4307 / 1.4311 / 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 N/mm²	f_{yk} = 210 N/mm²	A_5 ≥ 8%
			70	f_{uk} = 700 N/mm²	f_{yk} = 450 N/mm²	A_5 ≥ 8%
			80	f_{uk} = 800 N/mm²	f_{yk} = 600 N/mm²	A_5 ≥ 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 / 1.4307 / 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				
		Property class		Characteristic tensile strength	Characteristic yield strength	Elongation at fracture
4	Internal threaded anchor rod[1)2)]	acc. to EN ISO 3506-1:2009	50	f_{uk} = 500 N/mm²	f_{yk} = 210 N/mm²	A_5 > 8%
			70	f_{uk} = 700 N/mm²	f_{yk} = 450 N/mm²	A_5 > 8%

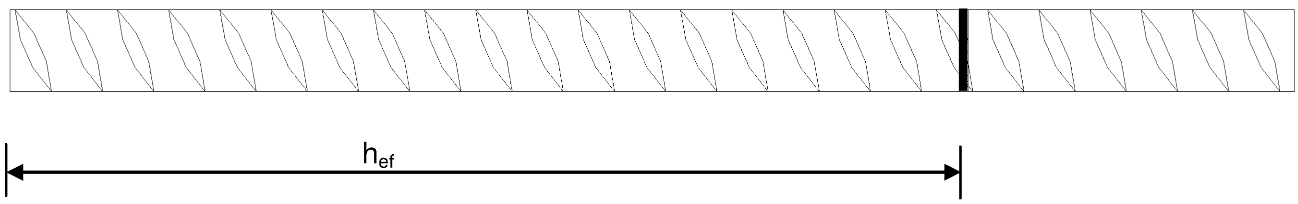
[1)] Property class 70 for threaded rods up to M24 and Internal threaded anchor rods up to IG-M16,
[2)] for IG-M20 only property class 50
[3)] Property class 80 only for stainless steel A4

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Product description
Materials threaded rod and internal threaded rod

Annex A 4

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28, ∅ 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 ≤ h ≤ 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 $f_{uk} = f_{tk} = k \cdot f_{yk}$

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Product description
Materials reinforcing bar

Annex A 5

Specifications of intended use

Anchorages 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, Rebar Ø8 to Ø32.

Base materials:

- Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016.
- Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016.
- 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 (all materials).
- For all other conditions according to EN 1993-1-4:2006+A1:2015 corresponding to corrosion resistance class:
  - Stainless steel Stahl A2 according to Annex A 4, Table A1: CRC II
  - Stainless steel Stahl A4 according to Annex A 4, Table A1: CRC III
  - High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V

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, Edition February 2018

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.
- The injection mortar is assessed for installation at minimum concrete temperature of -10°C resp. -20°C, where subsequently the temperature in the concrete does not rise at a rapid rate, i.e. from the minimum installation temperature to 24°C within a 12-hour period.

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex B 1**
Intended Use Specifications	

Table B1: Installation parameters for threaded rod

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
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 mm ≥ 100 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

Table B2: Installation parameters for rebar

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 mm ≥ 100 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

Table B3: Installation parameters for internal threaded anchor rod

Size internal threaded anchor rod		**IG-M6**	**IG-M8**	**IG-M10**	**IG-M12**	**IG-M16**	**IG-M20**
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 mm ≥ 100 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

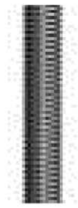
[1)] With metric threads according to EN 1993-1-8:2005+AC:2009

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Intended Use
Installation parameters

Annex B 2

Table B4: Parameter cleaning and setting tools

										
Threaded Rod	**Rebar**	**Internal threaded Anchor rod**	**d_0 Drill bit - Ø HD, HDB, CA**	**d_b Brush - Ø**		**$d_{b,min}$ min. Brush - Ø**	**Piston plug**	**Installation direction and use of piston plug**		
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]		↓	→	↑
M8			10	SCO10	12	10,5	No piston plug required			
M10	8	IG-M6	12	SCO12	14	12,5				
M12	10	IG-M8	14	SCO14	16	14,5				
	12		16	SCO16	18	16,5				
M16	14	IG-M10	18	SCO18	20	18,5	VS18	h_{ef} > 250 mm	h_{ef} > 250 mm	all
	16		20	SCO20	22	20,5	VS20			
M20	20	IG-M12	24	SCO24	26	24,5	VS24			
M24		IG-M16	28	SCO28	30	28,5	VS28			
M27	25		32	SCO32	34	32,5	VS32			
M30	28	IG-M20	35	SCO35	37	35,5	VS35			
	32		40	SCO40	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

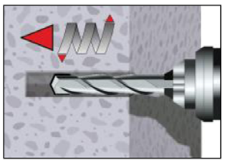
Piston plug for overhead or horizontal installation VS
Drill bit diameter (d_0): 18 mm to 40 mm

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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex B 3**
Intended Use Cleaning and setting tools	

Installation instructions

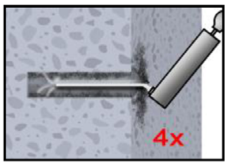
Drilling of the bore hole



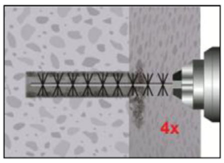
1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3), with hammer (HD), hollow (HDB) or compressed air (CD) drilling. The use of a hollow drill bit is only in combination with a sufficient vacuum permitted.
In case of aborted drill hole: The drill hole shall be filled with mortar

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

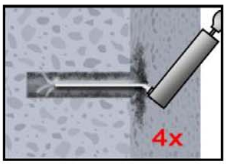
MAC: Cleaning for bore hole diameter $d_0 \leq$ 20mm and bore hole depth $h_0 \leq 10d_{nom}$ (uncracked concrete only!)



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.



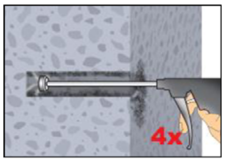
2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of four times in a twisting motion.
If the bore hole ground is not reached with the brush, a brush extension must be used.



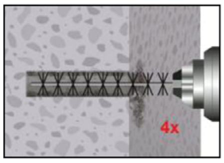
2c. Finally blow the hole clean again with a hand pump (Annex B 3) a minimum of four times.

[1)] It is permitted to blow bore holes with diameter between 14 mm and 20 mm and an embedment depth up to $10d_{nom}$ also in cracked concrete with hand-pump.

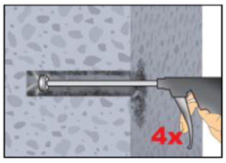
CAC: Cleaning for all bore hole diameter in uncracked and cracked concrete



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 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.



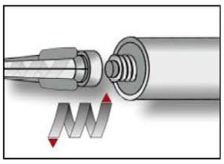
2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) a minimum of four times in a twisting motion.
If the bore hole ground is not reached with the brush, a brush extension must be used.



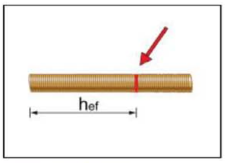
2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 3) a minimum of four times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension must be used.

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.

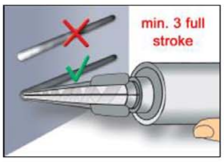
Installation instructions (continuation)



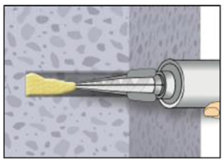
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. Cut off the foil tube clip before use.
For every working interruption longer than the recommended working time (Annex B 6) as well as for new cartridges, a new static-mixer shall be used.



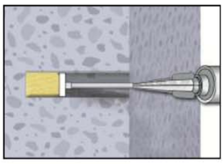
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



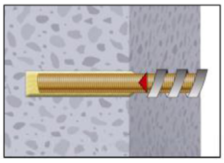
5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour. For foil tube cartridges it must be discarded a minimum of six full strokes.



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.

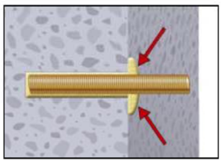


7. Piston plugs and mixer nozzle extensions shall be used according to Table B4 for the following applications:
   - Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$mm
   - Overhead assembly (vertical upwards direction): Drill bit-Ø $d_0 \geq 18$ mm

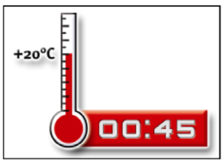


8. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

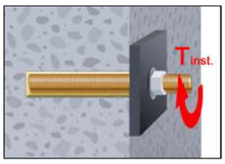
   The anchor shall be free of dirt, grease, oil or other foreign material.



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.

Table B5: Maximum working time and minimum curing time KEM-UP + Vinylester

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.

Table B6: Maximum working time and minimum curing time KEM-UP + Vinylester Winter

Concrete temperature			Gelling- / working time	Minimum curing time in dry concrete [1)]
-20 °C	to	-16°C	75 min	24 h
-15 °C	to	-11°C	55 min	16 h
-10 °C	to	-6°C	35 min	10 h
-5 °C	to	-1°C	20 min	5 h
0 °C	to	+4°C	10 min	2,5 h
+5 °C	to	+9°C	6 min	80 Min
+ 10 °C			6 min	60 Min
Cartridge temperature			-20°C to +10°C	

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

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	[mm²]	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
Without lever arm	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
Without lever arm	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Without lever arm	Stainless steel A2, A4 and HCR, class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Without lever arm	Stainless steel A2, A4 and HCR, class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	-	-
Without lever arm	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
With lever arm	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
With lever arm	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
With lever arm	Stainless steel A2, A4 and HCR, class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
With lever arm	Stainless steel A2, A4 and HCR, class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
With lever arm	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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Performances
Characteristic values for steel tension resistance and steel shear resistance of threaded rods

Annex C 1

Table C2: Characteristic values for Concrete cone failure and Splitting with all kind of action

Anchor size				**All Anchor types and sizes**
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 $c_{cr,sp}$

Table C3: Characteristic values of tension loads under static and quasi-static action

Anchor size threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**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/mm²]	10	12	12	12	12	11	10	9
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	8,5	7,5	6,5
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	No Performance Assessed (NPA)			
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	No Performance Assessed (NPA)			
Characteristic bond resistance in cracked concrete C20/25											
Temperature range I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	5,0	5,5	5,5	5,5	5,5	6,5	6,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,5	4,0	4,0	4,0	4,0	4,5	4,5
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	3,0	3,0	3,5	3,5
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	5,5	5,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,0	4,0	4,0	No Performance Assessed (NPA)			
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	No Performance Assessed (NPA)			
Reduktion factor ψ^0_{sus} in cracked and non-cracked concrete C20/25											
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,73							
Temperature range II: 80°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,65							
Temperature range III: 120°C/72°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,57							
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											
Relevant parameter				see Table C2							
Splitting											
Relevant parameter				see Table C2							
Installation factor											
for dry and wet concrete		γ_{inst}	[-]	1,0	1,2						
for flooded bore hole		γ_{inst}	[-]	1,4				NPA			

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Performances
Characteristic values of tension loads under static and quasi-static action

Annex C 3

Table C4: Characteristic values of shear loads under static and quasi-static action

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic shear resistance Steel, strength class 4.6, 4.8, 5.6 and 5.8	$V^0_{Rk,s}$	[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 classes	$V^0_{Rk,s}$	[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	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$ (or see Table C1)							
Elastic section modulus	W_{el}	[mm³]	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							

Table C5: Characteristic values of tension loads under static and quasi-static action

Anchor size internal threaded anchor rods					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure[1]										
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					2,86
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/mm²]	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/mm²]	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			
Reduktion factor ψ^0_{sus} in cracked and non-cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,73					
	II: 80°C/50°C				0,65					
	III: 120°C/72°C				0,57					
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										
Relevant parameter					see Table C2					
Splitting failure										
Relevant parameter					see Table C2					
Installation factor										
for dry and wet concrete			γ_{inst}	[-]	1,2					
for flooded bore hole			γ_{inst}	[-]	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

Table C6: Characteristic values of shear loads under static and quasi-static action

Anchor size for internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure without lever arm[1)]									
Characteristic shear resistance, Steel, strength class	5.8	$V^0_{Rk,s}$	[kN]	5	9	15	21	38	61
	8.8	$V^0_{Rk,s}$	[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)]		$V^0_{Rk,s}$	[kN]	7	13	20	30	55	40
Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Ductility factor		k_7	[-]	1,0					
Steel failure with lever arm[1)]									
Characteristic bending moment, Steel, strength class	5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
	8.8	$M^0_{Rk,s}$	[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)]		$M^0_{Rk,s}$	[Nm]	11	26	52	92	233	456
Partial factor		$\gamma_{Ms,V}$	[-]	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]	$\min(h_{ef}; 12 \cdot d_{nom})$					$\min(h_{ef}; 300mm)$
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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	Annex C 6
Performances Characteristic values of shear loads under static and quasi-static action	

Table C7: 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	[mm²]	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/mm²]	10	12	12	12	12	12	11	10	8,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	8,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5				
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	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/mm²]	4,0	5,0	5,5	5,5	5,5	5,5	5,5	6,5	6,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,5	4,0	4,0	4,0	4,0	4,0	4,5	4,5
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	3,0	3,0	3,0	3,5	3,5
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	5,5	5,5	5,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,0	4,0	4,0	4,0				
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	3,0				
Reduktion factor ψ^0_{sus} in cracked and non-cracked concrete C20/25												
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,73								
Temperature range II: 80°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,65								
Temperature range III: 120°C/72°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,57								
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												
Relevant parameter				see Table C2								
Splitting												
Relevant parameter				see Table C2								
Installation factor												
for dry and wet concrete		γ_{inst}	[-]	1,2	1,2							
for flooded bore hole		γ_{inst}	[-]	1,4					NPA			

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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 7**
Performances Characteristic values of tension loads under static and quasi-static action	

Table C8: 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	$V^0_{Rk,s}$	[kN]	$0{,}50 \cdot A_s \cdot f_{uk}$ [1]								
Cross section area	A_s	[mm²]	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	$M^0_{Rk,s}$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}$ [1]								
Elastic section modulus	W_{el}	[mm³]	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]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$		
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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 8**
Performances Characteristic values of shear loads under static and quasi-static action	

Table C9: Displacements under tension load[1)] (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Non-cracked concrete C20/25 under static and quasi-static action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,090		0,070					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105		0,105					
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255		0,245					
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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 C10: Displacements under shear load[1)] (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 9**
Performances Displacements (threaded rods)	

Table C11: Displacements under tension load[1] (Internal threaded anchor rod)

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Non-cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,023	0,026	0,031	0,036	0,041	0,049
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,033	0,037	0,045	0,052	0,060	0,071
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,081	0,090	0,108	0,127	0,145	0,172
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,090	0,070				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105				
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245				
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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 C12: Displacements under shear load[1] (Internal threaded anchor rod)

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Performances
Displacements (Internal threaded anchor rod)

Annex C 10

Table C13: Displacements under tension load[1] (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/mm²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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/mm²)]	0,090		0,070						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105		0,105						
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255		0,245						
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255		0,245						

[1] Calculation of the displacement

$\delta_{N0} = \delta_{N0}$-factor $\cdot \tau$; τ: action bond stress for tension

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

Table C14: Displacement under shear load[1] (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
	$\delta_{V\infty}$-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
	$\delta_{V\infty}$-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

$\delta_{V0} = \delta_{V0}$-factor $\cdot V$; V: action shear load

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

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 11**
Performances Displacements (rebar)	

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Table C15: Characteristic values of tension loads under seismic action (performance category C1)

Anchor size threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure											
Characteristic tension resistance		$N_{Rk,s,eq}$	[kN]	1,0 • $N_{Rk,s}$							
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/mm²]	2,5	3,1	3,7	3,7	3,7	3,8	4,5	4,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,6	2,2	2,7	2,7	2,7	2,8	3,1	3,1
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	2,0	2,1	2,4	2,4
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	2,5	2,5	3,7	3,7	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,6	1,9	2,7	2,7	No Performance Assessed (NPA)			
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	No Performance Assessed (NPA)			
Reduktion factor ψ^0_{sus} in cracked and non-cracked concrete C20/25											
Temperature range I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,73							
Temperature range II: 80°C/50°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,65							
Temperature range III: 120°C/72°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,57							
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0							
Concrete cone failure											
Relevant parameter				see Table C2							
Splitting											
Relevant parameter				see Table C2							
Installation factor											
for dry and wet concrete		γ_{inst}	[-]	1,0	1,2						
for flooded bore hole		γ_{inst}	[-]	1,4				NPA			

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete

Performances
Characteristic values of tension loads under seismic action (performance category C1)

Annex C 12

Table C16: Characteristic values of shear loads under seismic action (performance category C1)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure without lever arm										
Characteristic shear resistance (Seismic C1)	$V_{Rk,s,eq}$	[kN]	$0,70 \cdot V^0_{Rk,s}$							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
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]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$	
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 gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required

Table C17: 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	[mm²]	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/mm²]	2,5	3,1	3,7	3,7	3,7	3,7	3,8	4,5	4,5
Temperature range II: 80°C/50°C; Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,6	2,2	2,7	2,7	2,7	2,7	2,8	3,1	3,1
Temperature range III: 120°C/72°C; Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	2,0	2,0	2,1	2,4	2,4
Temperature range I: 40°C/24°C; flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	2,5	2,5	3,7	3,7	3,7	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C; flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,6	1,9	2,7	2,7	2,7				
Temperature range III: 120°C/72°C; flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	2,0				
Reduktion factor ψ^0_{sus} in cracked and non-cracked concrete C20/25											
Temperature range I: 40°C/24°C; Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,73								
Temperature range II: 80°C/50°C; Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,65								
Temperature range III: 120°C/72°C; Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,57								
Increasing factors for concrete ψ_c	C25/30 to C50/60		1,0								
Concrete cone failure											
Relevant parameter			see Table C2								
Splitting											
Relevant parameter			see Table C2								
Installation factor											
for dry and wet concrete	γ_{inst}	[-]	1,2	1,2							
for flooded bore hole	γ_{inst}	[-]	1,4					NPA			

[1)] f_{uk} shall be taken from the specifications of reinforcing bars
[2)] in absence of national regulation

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 14**
Performances Characteristic values of tension loads under seismic action (performance category C1)	

Table C18: 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	[mm²]	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]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$		
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]								

[1] f_{uk} shall be taken from the specifications of reinforcing bars
[2] in absence of national regulation
[3] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is required

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	**Annex C 15**
Performances Characteristic values of shear loads under seismic action (performance category C1)	

Table C19: Displacements under tension load[1] (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Cracked and non-cracked concrete C20/25 under seismic C1 action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090	0,070						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105						
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245						
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245						

Table C20: Displacements under tension load[1] (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/mm²)]	0,090	0,070							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105							
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245							
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	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 C21: Displacements under shear load[2] (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
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 C22: Displacement under shear load[1] (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
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V;$

Friulsider Injection System KEM-UP + Vinylester / KEM-UP + Vinylester Winter for concrete	Annex C 16
Performances Displacements under seismic C1 action (threaded rods and rebar)	