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Member of

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European Technical Assessment — ETA 15/0702 of 03/07/2023

Technical Assessment Body issuing the ETA: Technical and Test Institute for Construction Prague	
Trade name of the construction product	WCF-EASF WCF-EASF-C WCF-EASF-E
Product family to which the construction product belongs	Product area code: 33 Bonded injection type anchor for use in cracked and uncracked concrete
Manufacturer	KLIMAS sp. z o.o. ul.Wincentego Witosa 135/137 Kuźnica Kiedrzyńska 42-233 Mykanów, Poland
Manufacturing plant	KLIMAS sp. z o.o. Manufacturing plant no. 3
This European Technical Assessment contains	24 pages including 21 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 Bonded fasteners for use in concrete
This version replaces	ETA 15/0702 issued on 02/12/2020

1. Technical description of the product

The WCF-EASF, WCF-EASF-C (faster curing time) and WCF-EASF-E (extended processing time) with steel elements is bonded anchor (injection type).

Steel elements can be galvanized or stainless steel threaded rod or rebar.

Steel element is placed into a drilled hole filled with injection mortar. The steel element is anchored via the bond between metal part, injection mortar and concrete. The anchor is intended to be used with embedment depth from 8 diameters to 20 diameters.

The illustration and the description of the product are given in Annex A.

2. Specification of the intended use in accordance with the applicable EAD

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 provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 50 years and 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 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 9
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 10, C 11
Displacements under short-term and long-term loading	See Annex C 12
Characteristic resistance for seismic performance categories C1	See Annex C 13

3.2 Hygiene, health and environment (BWR 3)

No performance determined.

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if the specifications of intended use according to Annex B 1 are kept.

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

According to the Decision 96/582/EC of the European Commission[1] the system of assessment verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table apply.

Product	Intended use	Level or class	System
Metal anchors for use in concrete	For fixing and/or supporting to concrete, structural elements (which contributes to the stability of the works) or heavy units	-	1

[1] Official Journal of the European Communities L 254 of 08.10.1996

5. Technical details necessary for the implementation of the AVCP system, as provided in the applicable EAD

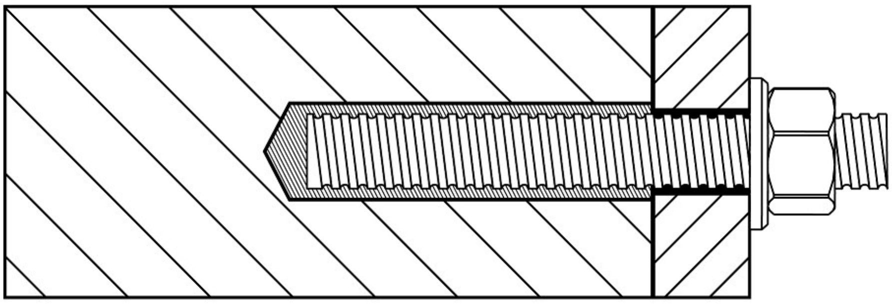
The factory production control shall be in accordance with the control plan which is a part of the technical documentation of this European Technical Assessment. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Technical and Test Institute for Construction Prague.[2] The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

Issued in Prague on 03.07.2023

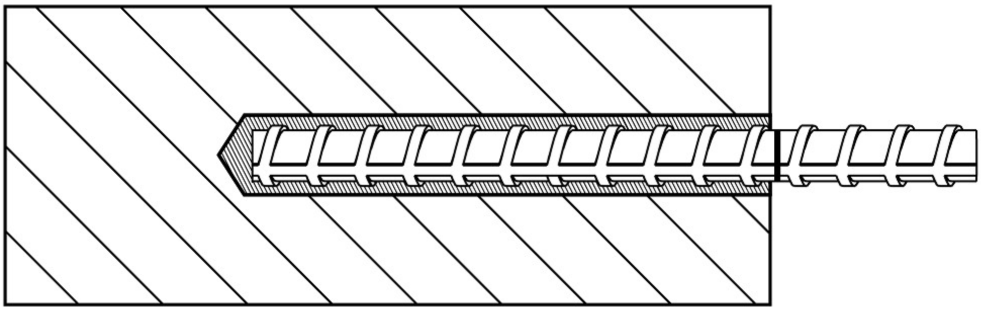
By
Ing. Jiří Studnička, Ph.D.
Head of the Technical Assessment Body

[2] The control plan is a confidential part of the documentation of the European Technical Assessment, but not published together with the ETA and only handed over to the approved body involved in the procedure of AVCP.

Threaded rod



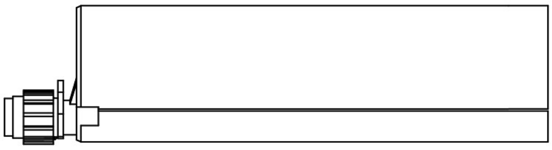
Reinforcing bar



WCF-EASF, WCF-EASF-C, WCF-EASF-E	**Annex A 1**
Product description Installed conditions	

Coaxial cartridge
WCF-EASF, WCF-EASF-C, WCF-EASF-E 150 ml
380 ml
400 ml
410 ml

Side by side cartridge
WCF-EASF, WCF-EASF-C, WCF-EASF-E 350 ml
825 ml



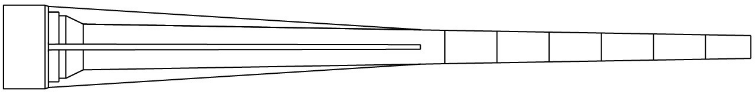
Two part foil in a single piston component cartridge
WCF-EASF, WCF-EASF-C, WCF-EASF-E 170 ml
300 ml
850 ml

Peeler cartridge
WCF-EASF, WCF-EASF-C, WCF-EASF-E 280 ml

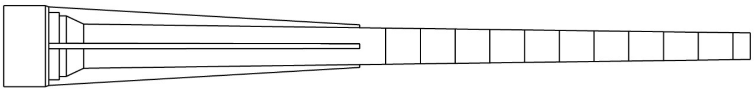
Marking of the mortar cartridges
Identifying mark of the producer, Trade name, Charge code number, Storage life, Curing and processing time

Mixing nozzle

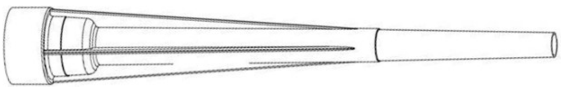
NN



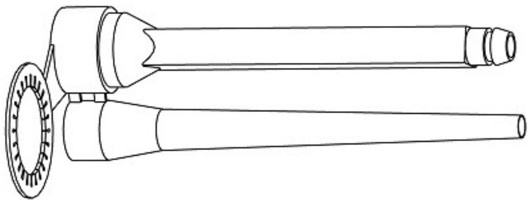
WN



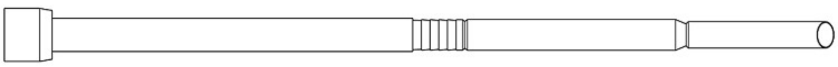
EZ-Flow



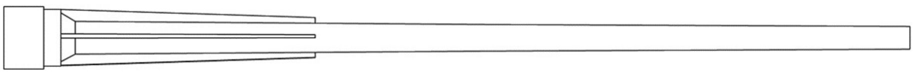
SN



LN

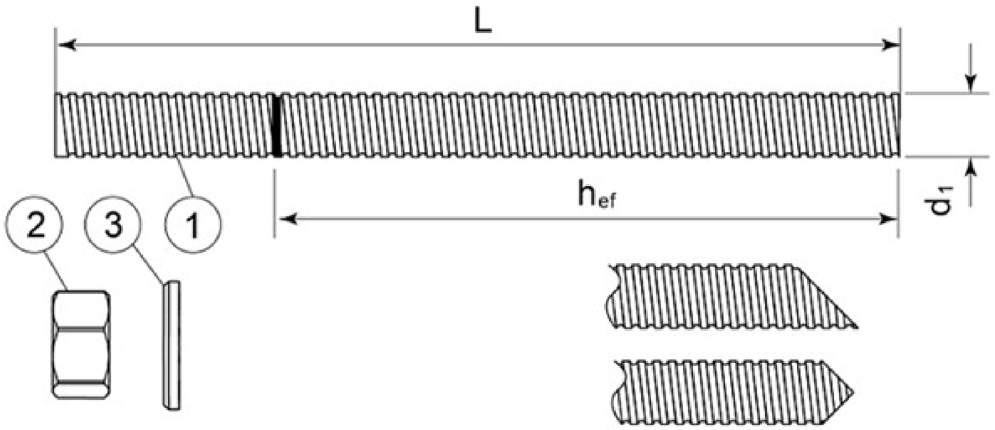


KN for 850 ml



WCF-EASF, WCF-EASF-C, WCF-EASF-E	**Annex A 2**
Product description Injection system	

Threaded rod M8, M10, M12, M16, M20, M24, M27, M30



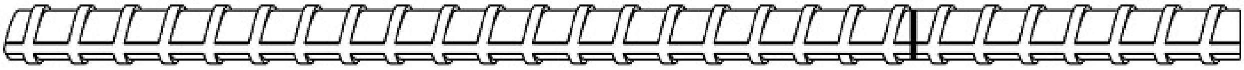
Standard commercial threaded rod with marked embedment depth

Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042 or Steel, Hot-dip galvanized ≥ 40 µm acc. to EN ISO 1461 and EN ISO 10684 or Steel, zinc diffusion coating ≥ 15 µm acc. to EN 13811 or Steel, zinc flake ≥ 8 µm acc. to EN ISO 2178:2016		
1	Anchor rod	Steel, EN 10087 or EN 10263 KPG 4.6, KPG 5.8, KPG 8.8, KPG 10.9* EN ISO 898-1
2	Hexagon nut EN ISO 4032	According to threaded rod, EN 20898-2
3	Washer EN ISO 887, EN ISO 7089, EN ISO 7093 or EN ISO 7094	According to threaded rod
Stainless steel		
1	Anchor rod	KPG A2-70, KPG A4-70, KPG A4-80 EN ISO 3506
2	Hexagon nut EN ISO 4032	According to threaded rod
3	Washer EN ISO 887, EN ISO 7089, EN ISO 7093 or EN ISO 7094	According to threaded rod
High corrosion resistant steel		
1	Anchor rod	KPG HCR, KPG UHCR EN 10088-1
2	Hexagon nut EN ISO 4032	According to threaded rod
3	Washer EN ISO 887, EN ISO 7089, EN ISO 7093 or EN ISO 7094	According to threaded rod

*Galvanized rod of high strength are sensitive to hydrogen induced brittle failure

WCF-EASF, WCF-EASF-C, WCF-EASF-E	**Annex A 3**
Product description Threaded rod and materials	

Rebar Ø8, Ø10, Ø12, Ø16, Ø20, Ø25, Ø32



Standard commercial reinforcing bar with marked embedment depth

Product form		**Bars and de-coiled rods**	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ (MPa)		400 to 600	
Minimum value of $k = (f_t/f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} (%)		≥ 5,0	≥ 7,5
Bendability		Bend/Rebend test	
Maximum deviation from nominal mass (individual bar) (%)	Nominal bar size (mm) ≤ 8 > 8	 ±6,0 ±4,5	
Bond: Minimum relative rib area, $f_{R,min}$	Nominal bar size (mm) 8 to 12 > 12	 0,040 0,056	

WCF-EASF, WCF-EASF-C, WCF-EASF-E

Product description
Rebars and materials

Annex A 4

Specifications of intended use

Anchorages subject to:
- Static and quasi-static load.
- Seismic actions category C1 (max w = 0,5 mm): threaded rod size M10, M12, M16, M20, M24

Base materials
- Uncracked concrete.
- Cracked and uncracked concrete for threaded rod size M10, M12, M16, M20, M24
- Reinforced or unreinforced normal weight concrete of strength class C20/25 at minimum and C50/60 at maximum according EN 206-1:2000-12.

Temperature range:
- -40°C to +80°C (max. short. term temperature +80°C and max. long term temperature +50°C)

Use conditions (Environmental conditions)
- (X1) Structures subject to dry internal conditions (zinc coated steel, stainless steel, high corrosion resistance steel).
- (X2) Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel A4, high corrosion resistant steel).
- (X3) Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist (high corrosion resistant steel).

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Concrete conditions:
- I1 – installation in dry or wet (water saturated) concrete and use in service in dry or wet concrete.
- I2 – installation in water-filled (not sea water) and use in service in dry or wet concrete

Design:
- The anchorages are designed in accordance with the EN 1992-4 under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings.
- Anchorages under seismic actions (cracked concrete) have to be designed in accordance with EN 1992-4.

Installation:
- Hole drilling by hammer drilling, dustless drilling or diamond core drilling mode.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

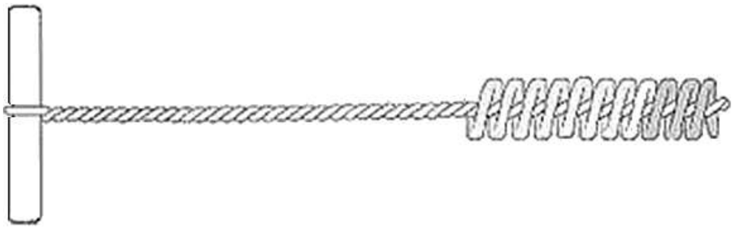
Installation direction:
- D3 – downward and horizontal and upwards (e.g. overhead) installation

HDB – Hollow Drill Bit System

Heller Duster Expert hollow drill bit
SDS-Plus ≤ 16mm
SDS-Max ≥ 16mm

Class M vacuum
Minimum flow rate 266 m3/h (74 l/s)

Cleaning brush



Applicator gun

A

B

C

D

E

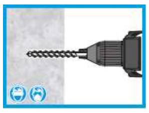
F

G

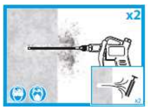
Applicator gun	A	B	C	D	E	F	G
Cartridge	Coaxial 380ml 400ml 410ml	Side by side 350ml	Foil capsule 170ml 300ml	Foil capsule 170ml 300ml Peeler 280ml	Coaxial 150ml	Side by side 825ml	Foil capsule 850ml

SOLID SUBSTRATE INSTALLATION METHOD

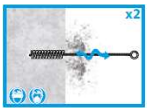
1. Using the SDS hammer drill (HD) in rotary hammer mode for drilling, with a carbide tipped drill bit of the appropriate size, drill the hole to the specified hole diameter and depth.



2. Select the correct air lance, insert to the bottom of the hole, and depress the trigger for 2 seconds. The compressed air must be clean and free from water and oil, with a minimum pressure of 90 psi (6 bar). A manual pump may be used for certain diameters and depths; check the approval document. Perform the blowing operation twice.



3. Select the correct size hole cleaning brush. Ensure that the brush is in good condition and of the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom. Withdraw with a twisting motion. There should be a positive interaction between the bristles of the brush and the sides of the drilled hole. Perform the brushing operation twice.

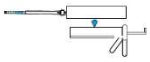


4. Repeat step 2 (blowing operation x2)

5. Repeat step 3 (brushing operation x2)

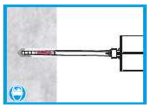
6. Repeat step 2 (blowing operation x2)

7. Select the most appropriate static mixer nozzle, checking that the mixing elements are present and t for purpose. Never modify the mixer. Attach the mixer nozzle to the cartridge. Check the dispensing tool is in good working order. Place the cartridge into the dispensing tool.



8. Extrude some resin to waste until an even coloured mixture is achieved. The cartridge is now ready for use.

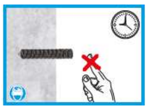
9. Insert the mixing nozzle to the bottom of the hole. Extrude the resin and slowly withdraw the nozzle from the hole. Ensure no air voids are created as the nozzle is withdrawn. Inject resin until the hole is approximately ¾ full and remove the nozzle from the hole.



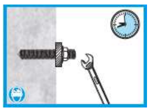
10. Select the steel anchor element ensuring it is free from oil or other contaminants, and mark with the required embedment depth. Insert the steel element into the hole using a back and forth twisting motion to ensure complete cover, until it reaches the bottom of the hole. Excess resin will be expelled from the hole evenly around the steel element and there shall be no gaps between the anchor element and the wall of the drilled hole.

11. Clean any excess resin from around the mouth of the hole.

12. Refer to the working and loading times within the tables to determine the appropriate cure time.



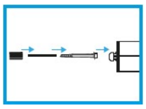
13. Position the fixture and tighten the anchor to the appropriate installation torque. Do not over-torque the anchor, as this could adversely affect its performance.



DEEP EMBEDMENT & OVERHEAD INSTALLATION METHOD

1a. Perform steps 1-8 under “solid substrate installation method”.

2a. Attach the correct diameter and length extension tube to the nozzle. Select the correct diameter resin stopper for the application, then push and screw the extension tube into the resin stopper. This is held in place with a coarse internal thread. The resin stopper is a reusable accessory.



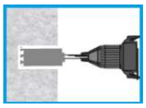
3a. Push the resin stopper and extension tube to the back of the drill hole.

4a. Ensure the extension tube is angled to allow free movement of the resin stopper as the resin is extruded.

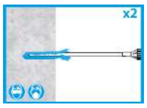
5a. Continue from step 10 under “solid substrate installation method”.

DIAMOND CORE DRILLING

1b. Using a diamond core drill (DD) and following the manufacturer’s instructions, drill the specified diameter hole to the correct embedment depth then remove the concrete core.



2b. Starting from the back of the hole, flush with pressurised water a minimum of two times and until there is only clean water.



3b. Select the correct size hole cleaning brush. Ensure that the brush is in good condition and of the correct diameter. Insert the brush to the bottom of the hole, using a brush extension if needed to reach the bottom. Withdraw with a twisting motion. There should be a positive interaction between the bristles of the brush and the sides of the drilled hole. Perform the brushing operation twice.

4b. Repeat step 2b (ushing operation x2).

5b. Repeat step 3b (brushing operation x2).

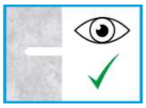
6a. Using the correct air lance and starting from the back of the hole and withdrawing, perform a minimum of two blowing operations and ensure that the hole is clear of debris and excess water.

7a. Continue from step 7 under “solid substrate installation method”.

DUSTLESS DRILLING

1c. Using the specified hollow drill bit (HDB) and vacuum system and following the manufacturer’s instructions, drill the specified diameter hole to the correct embedment depth. Ensure that the minimum vacuum specifications are met and that the vacuum is turned on.

2c. The hole should be inspected to ensure the system has worked correctly. If the hole is clear of dust and debris, no further cleaning is required.



3c. Continue from step 7 under “solid substrate installation method”.

WCF-EASF, WCF-EASF-C, WCF-EASF-E	
Intended use Installation procedure	**Annex B 3**

Table B1: Installation parameters of threaded rod

Size			M8	M10	M12	M16	M20	M24	M27	M30
Nominal drill hole diameter	$Ød_0$	[mm]	10	12	14	18	22	26	30	35
Diameter of cleaning brush	d_b	[mm]	14	14	20	20	29	29	40	40
Manual pump cleaning			h_{ef} < 300 mm							
Torque moment	max T_{fix}	[Nm]	10	20	40	80	150	200	240	275
Depth of drill hole for $h_{ef,min}$	$h_0 = h_{ef}$	[mm]	64	80	96	128	160	192	216	240
Depth of drill hole for $h_{ef,max}$	$h_0 = h_{ef}$	[mm]	160	200	240	320	400	480	540	600
Minimum edge distance	c_{min}	[mm]	35	40	50	65	80	96	110	120
Minimum spacing	s_{min}	[mm]	35	40	50	65	80	96	110	120
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm				$h_{ef} + 2d_0$			

Table B2: Installation parameters of rebar

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Nominal drill hole diameter	$Ød_0$	[mm]	12	14	16	20	25	32	40
Diameter of cleaning brush	d_b	[mm]	14	14	19	22	29	40	42
Manual pump cleaning			h_{ef} < 300 mm						
Depth of drill hole for $h_{ef,min}$	$h_0 = h_{ef}$	[mm]	64	80	96	128	160	200	256
Depth of drill hole for $h_{ef,max}$	$h_0 = h_{ef}$	[mm]	160	200	240	320	400	500	640
Minimum edge distance	c_{min}	[mm]	35	40	50	65	80	100	130
Minimum spacing	s_{min}	[mm]	35	40	50	65	80	100	130
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm				$h_{ef} + 2d_0$		

Table B3: Minimum curing time

WCF-EASF			
Resin cartridge temperature [°C]	**T Work [mins]**	**Base material Temperature [°C]**	**T Load [mins]**
+10	30 mins	-10 to -5	24 hours
+5	20 mins	-5 to 0	300 mins
0 to +5	15 mins	0 to +5	210 mins
+5 to +10	10 mins	+5 to +10	145 mins
+10 to +15	8 mins	+10 to +15	85 mins
+15 to +20	6 mins	+15 to +20	75 mins
+20 to +25	5 mins	+20 to +25	50 mins
+25 to +30	4 mins	+25 to +30	40 mins

WCF-EASF-C			
Resin cartridge temperature [°C]	**T Work [mins]**	**Base material Temperature [°C]**	**T Load [mins]**
+20	40 mins	-20 to -15[1)]	24 hours
+20	30 mins	-15 to -10[1)]	18 hours
+5	20 mins	-10 to -5	12 hours
+5	15 mins	-5 to 0	100 mins
0 to +5	10 mins	0 to +5	75 mins
+5 to +20	5 mins	+5 to +20	50 mins
+20	100 second	+20	20 mins

[1)] characteristic values of resistance see Annex C 3, C 5, C 7 and C 9

WCF-EASF-E			
Resin cartridge temperature [°C]	**T Work [mins]**	**Base material Temperature [°C]**	**T Load [mins]**
+15 to +20	15 mins	+15 to +20	5 hours
+20 to +25	10 mins	+20 to +25	145 mins
+25 to +30	7.5 mins	+25 to +30	85 mins
+30 to +35	5 mins	+30 to +35	50 mins
+35 to +40	3.5 mins	+35 to +40	40 mins

T work is typical gel time at highest temperature T load is set at the lowest temperature

Table C1: Design method EN 1992-4
Characteristic values of resistance to tension load of threaded rod

Steel failure – Characteristic resistance										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
KPG 4.6	$N_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	γ_{Ms}	[-]	2,00							
KPG 5.8	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
Partial safety factor	γ_{Ms}	[-]	1,50							
KPG 8.8	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor	γ_{Ms}	[-]	1,50							
KPG 10.9	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	459	561
Partial safety factor	γ_{Ms}	[-]	1,33							
KPG A2-70, KPG A4-70	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor	γ_{Ms}	[-]	1,87							
KPG A4-80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	367	449
Partial safety factor	γ_{Ms}	[-]	1,60							
KPG HCR	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor	γ_{Ms}	[-]	1,50							
KPG UHCR	$N_{Rk,s}$	[kN]	26	41	59	110	172	247	321	393
Partial safety factor	γ_{Ms}	[-]	1,87							

Table C2: Design method EN 1992-4
Steel failure - Characteristic values of resistance to tension load of rebar

Steel failure – Characteristic resistance									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Rebar BSt 500 S	$N_{Rk,s}$	[kN]	28	43	62	111	173	270	442
Partial safety factor	γ_{Ms}	[-]	1,4						

WCF-EASF, WCF-EASF-C, WCF-EASF-E

Performances
Steel failure characteristic resistance

Annex C 1

Table C3: Design method EN 1992-4
Characteristic values of resistance to tension load of threaded rod

Combined pullout and concrete cone failure in concrete C20/25

Hammer drilling

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years										
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,5	9,5	9,0	8,5	8,0	6,5	5,5
Installation safety factor	γ_{inst}	[-]	1,2						1,4	
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	8,5	7,5	7,0	7,0	6,5	5,5		
Installation safety factor	γ_{inst}	[-]	1,4							

Size			**M10**	**M12**	**M16**	**M20**	**M24**
Characteristic bond resistance in cracked concrete for a working life of 50 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0
Installation safety factor	γ_{inst}	[-]	1,4				
Characteristic bond resistance in cracked concrete for a working life of 100 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	2,5	2,5
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	2,5	2,5
Installation safety factor	γ_{inst}	[-]	1,4				

Dustless drilling

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years										
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,5	9,5	9,0	8,5	8,0	6,5	5,5
Installation safety factor	γ_{inst}	[-]	1,2							
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	8,5	7,5	7,0	7,0	6,5	5,5	4,5	4,0
Installation safety factor	γ_{inst}	[-]	1,4							

Size			**M10**	**M12**	**M16**	**M20**	**M24**
Characteristic bond resistance in cracked concrete for a working life of 50 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	4,5	4,5	4,5	4,0	4,0
Installation safety factor	γ_{inst}	[-]	1,4				
Characteristic bond resistance in cracked concrete for a working life of 100 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	2,5	2,5
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	3,0	3,0	3,0	2,5	2,5
Installation safety factor	γ_{inst}	[-]	1,4				

Factor for uncracked concrete	C50/60	ψ_c	[-]	1
Factor for cracked concrete	C30/37	ψ_c	[-]	1,12
	C40/50			1,23
	C50/60			1,30
Factor for influence of sustained load for a working life 50 years	T1: 24°C / 40°C	ψ^0_{sus}	[-]	0,75
	T2: 50°C / 80°C			0,73

Concrete cone failure

Factor for concrete cone failure for uncracked concrete	$k_{ucr,N}$	[-]	11
Factor for concrete cone failure for cracked concrete	$k_{cr,N}$	[-]	7,7
Edge distance	$c_{cr,N}$	[mm]	$1,5h_{ef}$

Splitting failure

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Edge distance	$c_{cr,sp}$	[mm]	$1,5h_{ef}$							
Spacing	$s_{cr,sp}$	[mm]	$3,0h_{ef}$							

WCF-EASF, WCF-EASF-C, WCF-EASF-E

Performances
Hammer drilling, Dustless drilling
Characteristic resistance for tension loads - threaded rod

Annex C 2

Table C4: Design method EN 1992-4
Characteristic values of resistance to tension load of threaded rod for WCF-EASF-C with installation temperature < -10°C

Combined pullout and concrete cone failure in concrete C20/25

Hammer drilling

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years										
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,0	9,0	8,5	8,0	7,5	6,0	5,0
Installation safety factor	γ_{inst}	[-]	1,2						1,4	
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	8,0	7,0	6,5	6,5	6,0	5,0		
Installation safety factor	γ_{inst}	[-]	1,4							

Size			**M10**	**M12**	**M16**	**M20**	**M24**
Characteristic bond resistance in cracked concrete for a working life of 50 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5
Installation safety factor	γ_{inst}	[-]	1,4				
Characteristic bond resistance in cracked concrete for a working life of 100 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,5	2,5	2,5	2,0	2,0
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	2,5	2,5	2,0	2,0
Installation safety factor	γ_{inst}	[-]	1,4				

Dustless drilling

Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years										
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9,5	9,0	9,0	8,5	8,0	7,5	6,0	5,0
Installation safety factor	γ_{inst}	[-]	1,2							
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	8,0	7,0	6,5	6,5	6,0	5,0	4,0	3,5
Installation safety factor	γ_{inst}	[-]	1,4							

Size			**M10**	**M12**	**M16**	**M20**	**M24**
Characteristic bond resistance in cracked concrete for a working life of 50 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	4,0	3,5	3,5
Installation safety factor	γ_{inst}	[-]	1,4				
Characteristic bond resistance in cracked concrete for a working life of 100 years							
Dry and wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,5	2,5	2,5	2,0	2,0
Installation safety factor	γ_{inst}	[-]	1,2				
Flooded hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	2,5	2,5	2,0	2,0
Installation safety factor	γ_{inst}	[-]	1,4				

Factor for uncracked concrete	C50/60	ψ_c	[-]	1
Factor for cracked concrete	C30/37 C40/50 C50/60	ψ_c	[-]	1,12 1,23 1,30
Factor for influence of sustained load for a working life 50 years	T1: 24°C / 40°C T2: 50°C / 80°C	ψ^0_{sus}	[-]	0,75 0,73

Concrete cone failure
See Annex C 2

Splitting failure
See Annex C 2

Table C5: Design method EN 1992-4
Characteristic values of resistance to tension load of rebar

Combined pullout and concrete cone failure in uncracked concrete C20/25										
Hammer drilling										
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	11,0	9,5	9,5	9,0	8,5	8,5	5,5
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	11,0	9,5	9,5	9,0	8,5	8,5	5,5
Installation safety factor	γ_{inst}	[-]	1,4						
Factor for influence of sustained load for a working life 50 years T1: 24°C / 40°C	ψ^0_{sus}	[-]	0,75						
Factor for influence of sustained load for a working life 50 years T2: 50°C / 80°C	ψ^0_{sus}	[-]	0,73						
Dustless drilling									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	11,0	9,5	9,5	9,0	8,5	8,5	5,5
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	11,0	9,5	9,5	9,0	8,5	8,5	5,5
Installation safety factor	γ_{inst}	[-]	1,4						
Factor for concrete C50/60	ψ_c	[-]	1						
Factor for influence of sustained load for a working life 50 years T1: 24°C / 40°C	ψ^0_{sus}	[-]	0,75						
Factor for influence of sustained load for a working life 50 years T2: 50°C / 80°C	ψ^0_{sus}	[-]	0,73						

Concrete cone failure			
Factor for concrete cone failure	$k_{ucr,N}$	[-]	11
Edge distance	$c_{cr,N}$	[mm]	$1,5h_{ef}$

Splitting failure									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Edge distance	$c_{cr,sp}$	[mm]	$1,5h_{ef}$						
Spacing	$s_{cr,sp}$	[mm]	$3,0h_{ef}$						

WCF-EASF, WCF-EASF-C, WCF-EASF-E

Performances
Hammer drilling, Dustless drilling
Characteristic resistance for tension loads - rebar

Annex C 4

Table C6: Design method EN 1992-4
Characteristic values of resistance to tension load of rebar for WCF-EASF-C with installation temperature < -10°C

Combined pullout and concrete cone failure in uncracked concrete C20/25									
Hammer drilling									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,0	9,0	8,5	8,0	8,0	5,0
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,0	9,0	8,5	8,0	8,0	5,0
Installation safety factor	γ_{inst}	[-]	1,4						
Dustless drilling									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,0	9,0	8,5	8,0	8,0	5,0
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	10,0	9,0	9,0	8,5	8,0	8,0	5,0
Installation safety factor	γ_{inst}	[-]	1,4						
Factor for concrete C50/60	ψ_c	[-]	1						
Factor for influence of sustained load for a working life 50 years T1: 24°C / 40°C	ψ^0_{sus}	[-]	0,75						
T2: 50°C / 80°C			0,73						

Concrete cone failure
See Annex C 4

Splitting failure
See Annex C 4

Table C7: Design method EN 1992-4
Characteristic values of resistance to tension load of threaded rod

Combined pullout and concrete cone failure in concrete C20/25											
Diamond core drilling											
Size				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years											
Dry and wet concrete		$\tau_{Rk,ucr}$	[N/mm²]	9,0	8,5	8,5	8,0	7,5	7,0	5,5	4,5
Installation safety factor		γ_{inst}	[-]	1,0							
Flooded hole		$\tau_{Rk,ucr}$	[N/mm²]	8,0	7,0	6,5	6,5	6,0	5,0	4,0	3,5
Installation safety factor		γ_{inst}	[-]	1,4							

Factor for uncracked concrete	C30/37	ψ_c	[-]	1,04
	C40/50			1,07
	C50/60			1,09
Factor for influence of sustained load for a working life 50 years		ψ^0_{sus}	[-]	0,77

Concrete cone failure			
Factor for concrete cone failure for uncracked concrete	$k_{ucr,N}$	[-]	11
Edge distance	$c_{cr,N}$	[mm]	$1{,}5h_{ef}$

Splitting failure										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Edge distance	$c_{cr,sp}$	[mm]	$1{,}5h_{ef}$							
Spacing	$s_{cr,sp}$	[mm]	$3{,}0h_{ef}$							

Table C8: Design method EN 1992-4
Characteristic values of resistance to tension load of threaded rod for WCF-EASF-C with installation temperature < -10°C

Combined pullout and concrete cone failure in concrete C20/25										
Diamond core drilling										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years										
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,0	8,0	7,5	7,0	6,5	5,0	4,0
Installation safety factor	γ_{inst}	[-]	1,0							
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	6,5	6,0	6,0	5,5	4,5	3,5	3,0
Installation safety factor	γ_{inst}	[-]	1,4							

Factor for uncracked concrete	C30/37 C40/50 C50/60	ψ_c	[-]	1,04 1,07 1,09
Factor for influence of sustained load for a working life 50 years		ψ^0_{sus}	[-]	0,77

Concrete cone failure
See Annex C 6

Splitting failure
See Annex C 6

Table C9: Design method EN 1992-4
Characteristic values of resistance to tension load of rebar

Combined pullout and concrete cone failure in uncracked concrete C20/25

Diamond core drilling										
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9,0	8,5	8,0	7,5	7,0	6,0	3,0
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	9,0	8,5	8,0	7,5	7,0	5,5	2,5
Installation safety factor	γ_{inst}	[-]	1,4						

Factor for uncracked concrete	C30/37 C40/50 C50/60	ψ_c	[-]	1,04 1,07 1,09
Factor for influence of sustained load for a working life 50 years		ψ^0_{sus}	[-]	0,77

Concrete cone failure			
Factor for concrete cone failure	$k_{ucr,N}$	[-]	11
Edge distance	$c_{cr,N}$	[mm]	$1{,}5h_{ef}$

Splitting failure									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Edge distance	$c_{cr,sp}$	[mm]	$1{,}5h_{ef}$						
Spacing	$s_{cr,sp}$	[mm]	$3{,}0h_{ef}$						

Table C10: Design method EN 1992-4
Characteristic values of resistance to tension load of rebar for
WCF-EASF-C with installation temperature < -10°C

Combined pullout and concrete cone failure in uncracked concrete C20/25									
Diamond core drilling									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Characteristic bond resistance in uncracked concrete for a working life of 50 years and 100 years									
Dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,0	7,5	7,0	6,5	5,5	2,5
Installation safety factor	γ_{inst}	[-]	1,2						
Flooded hole	$\tau_{Rk,ucr}$	[N/mm²]	8,5	8,0	7,5	7,0	6,5	5,0	2,0
Installation safety factor	γ_{inst}	[-]	1,4						
Factor for uncracked concrete C30/37	ψ_c	[-]	1,04						
Factor for uncracked concrete C40/50	ψ_c	[-]	1,07						
Factor for uncracked concrete C50/60	ψ_c	[-]	1,09						
Factor for influence of sustained load for a working life 50 years	ψ^0_{sus}	[-]	0,77						

Concrete cone failure
See Annex C 8

Splitting failure
See Annex C 8

Table C11: Design method EN 1992-4
Characteristic values of resistance to shear load of threaded rod

Steel failure without lever arm										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
KPG 4.6	$V_{Rk,s}$	[kN]	7	12	17	31	49	71	92	112
Partial safety factor	γ_{Ms}	[-]	1,67							
KPG 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG 10.9	$V_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
Partial safety factor	γ_{Ms}	[-]	1,5							
KPG A2-70, KPG A4-70	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
Partial safety factor	γ_{Ms}	[-]	1,56							
KPG A4-80	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	γ_{Ms}	[-]	1,33							
KPG HCR	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG UHCR	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	161	196
Partial safety factor	γ_{Ms}	[-]	1,56							
Characteristic resistance of group of fasteners										
Ductility factor k_7 = 1,0 for steel with rupture elongation A_5 > 8%										

Steel failure with lever arm										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
KPG 4.6	$M^o_{Rk,s}$	[N.m]	15	30	52	133	260	449	666	900
Partial safety factor	γ_{Ms}	[-]	1,67							
KPG 5.8	$M^o_{Rk,s}$	[N.m]	19	37	66	166	325	561	832	1125
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG 8.8	$M^o_{Rk,s}$	[N.m]	30	60	105	266	519	898	1332	1799
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG 10.9	$M^o_{Rk,s}$	[N.m]	37	75	131	333	649	1123	1664	2249
Partial safety factor	γ_{Ms}	[-]	1,50							
KPG A2-70, KPG A4-70	$M^o_{Rk,s}$	[N.m]	26	52	92	233	454	786	1165	1574
Partial safety factor	γ_{Ms}	[-]	1,56							
KPG A4-80	$M^o_{Rk,s}$	[N.m]	30	60	105	266	519	898	1332	1799
Partial safety factor	γ_{Ms}	[-]	1,33							
KPG HCR	$M^o_{Rk,s}$	[N.m]	26	52	92	233	454	786	1165	1574
Partial safety factor	γ_{Ms}	[-]	1,25							
KPG UHCR	$M^o_{Rk,s}$	[N.m]	26	52	92	233	454	786	1165	1574
Partial safety factor	γ_{Ms}	[-]	1,56							
Concrete pry-out failure										
Factor for resistance to pry-out failure	k_8	[-]	2							

Concrete edge failure										
Size			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Effective length of fastener	ℓ_f	[mm]	min (h_{ef}, 8 d_{nom})							

Table C12: Design method EN 1992-4
Characteristic values of resistance to shear load of rebar

Steel failure without lever arm									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Rebar BSt 500 S	$V_{Rk,s}$	[kN]	14	22	31	55	86	135	221
Partial safety factor	γ_{Ms}	[-]	1,5						
Characteristic resistance of group of fasteners									
Ductility factor k_7 = 1,0 for steel with rupture elongation A_5 > 8%									

Steel failure with lever arm									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Rebar BSt 500 S	$M^{o}_{Rk,s}$	[N.m]	33	65	112	265	518	1013	2122
Partial safety factor	γ_{Ms}	[-]	1,5						
Concrete pry-out failure									
Factor for resistance to pry-out failure	k_8	[-]	2						

Concrete edge failure									
Size			**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	25	32
Effective length of fastener	ℓ_f	[mm]	min (h_{ef}, 8 d_{nom})						

Table C13: Displacement of threaded rod under tension and shear load
Hammer drilling, dustless drilling

Size		M8	M10	M12	M16	M20	M24	M27	M30
Tension load									
Uncracked concrete									
δ_{N0}	[mm/kN]	0,05	0,04	0,03	0,02	0,02	0,02	0,01	0,01
$\delta_{N\infty}$	[mm/kN]	0,11	0,09	0,06	0,04	0,03	0,02	0,02	0,02
Cracked concrete									
δ_{N0}	[mm/kN]		0,08	0,09	0,05	0,03	0,02		
$\delta_{N\infty}$	[mm/kN]		0,51	0,32	0,18	0,13	0,11		
Shear load									
δ_{V0}	[mm/kN]	0,48	0,30	0,20	0,11	0,10	0,08	0,06	0,05
$\delta_{V\infty}$	[mm/kN]	0,72	0,45	0,30	0,17	0,14	0,12	0,10	0,08

Table C14: Displacement of threaded rod under tension and shear load
Diamond core drilling

Size		M8	M10	M12	M16	M20	M24	M27	M30
Tension load									
Uncracked concrete									
δ_{N0}	[mm/kN]	0,02	0,02	0,03	0,02	0,01	0,01	0,02	0,02
$\delta_{N\infty}$	[mm/kN]	0,11	0,07	0,05	0,03	0,02	0,02	0,02	0,02
Cracked concrete									
δ_{N0}	[mm/kN]		0,07	0,05	0,05	0,03	0,03		
$\delta_{N\infty}$	[mm/kN]		0,37	0,23	0,16	0,10	0,07		
Shear load									
δ_{V0}	[mm/kN]	0,48	0,30	0,20	0,11	0,10	0,08	0,06	0,05
$\delta_{V\infty}$	[mm/kN]	0,72	0,45	0,30	0,17	0,14	0,12	0,10	0,08

Table C15: Displacement of rebar under tension and shear load
Hammer drilling, dustless drilling

Size		Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Tension load								
Uncracked concrete								
δ_{N0}	[mm/kN]	0,04	0,03	0,02	0,02	0,01	0,01	0,01
$\delta_{N\infty}$	[mm/kN]	0,09	0,07	0,05	0,03	0,02	0,01	0,01
Shear load								
δ_{V0}	[mm/kN]	0,05	0,04	0,03	0,02	0,01	0,01	0,01
$\delta_{V\infty}$	[mm/kN]	0,08	0,06	0,05	0,03	0,02	0,01	0,01

Table C16: Displacement of rebar under tension and shear load
Diamond core drilling

Size		Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Tension load								
Uncracked concrete								
δ_{N0}	[mm/kN]	0,04	0,04	0,03	0,02	0,02	0,02	0,02
$\delta_{N\infty}$	[mm/kN]	0,10	0,07	0,05	0,03	0,02	0,02	0,02
Shear load								
δ_{V0}	[mm/kN]	0,05	0,04	0,03	0,02	0,01	0,01	0,01
$\delta_{V\infty}$	[mm/kN]	0,08	0,06	0,05	0,03	0,02	0,01	0,01

Table C17: Seismic performance category C1 - Hammer drilling, Dustless drilling

Size			M10	M12	M16	M20	M24
Tension load							
Steel failure							
Characteristic resistance KPG 4.6	$N_{Rk,s,eq}$	[kN]	23	34	63	98	141
Partial safety factor	γ_{Ms}	[-]			2,00		
Characteristic resistance KPG 5.8	$N_{Rk,s,eq}$	[kN]	29	42	79	123	177
Partial safety factor	γ_{Ms}	[-]			1,50		
Characteristic resistance KPG 8.8	$N_{Rk,s,eq}$	[kN]	46	67	126	196	282
Partial safety factor	γ_{Ms}	[-]			1,50		
Characteristic resistance KPG 10.9	$N_{Rk,s,eq}$	[kN]	58	84	157	245	353
Partial safety factor	γ_{Ms}	[-]			1,33		
Characteristic resistance KPG A2-70, KPG A4-70	$N_{Rk,s,eq}$	[kN]	41	59	110	172	247
Partial safety factor	γ_{Ms}	[-]			1,87		
Characteristic resistance KPG A4-80	$N_{Rk,s,eq}$	[kN]	46	67	126	196	282
Partial safety factor	γ_{Ms}	[-]			1,60		
Characteristic resistance KPG HCR	$N_{Rk,s,eq}$	[kN]	41	59	110	172	247
Partial safety factor	γ_{Ms}	[-]			1,50		
Characteristic resistance KPG UHCR	$N_{Rk,s,eq}$	[kN]	41	59	110	172	247
Partial safety factor	γ_{Ms}	[-]			1,87		
Characteristic resistance to pull-out for a working life of 50 years							
Dry, wet concrete and flooded hole	$\tau_{Rk,C1}$	[N/mm²]	3,5	3,5	3,5	3,5	3,5
WCF-EASF-C with installation temperature < -10°C							
Dry, wet concrete and flooded hole	$\tau_{Rk,C1}$	[N/mm²]	3,3	3,3	3,3	3,3	3,3
Characteristic resistance to pull-out for a working life of 100 years							
Dry, wet concrete and flooded hole	$\tau_{Rk,C1}$	[N/mm²]	3,0	3,0	3,0	2,2	2,2
WCF-EASF-C with installation temperature < -10°C							
Dry, wet concrete and flooded hole	$\tau_{Rk,C1}$	[N/mm²]	2,8	2,8	2,8	2,1	2,1
Installation safety factor – Dry and wet concrete	γ_{inst}	[-]			1,2		
Installation safety factor – Flooded hole	γ_{inst}	[-]			1,4		

Size			M10	M12	M16	M20	M24
Shear load							
Steel failure without lever arm							
Characteristic resistance KPG 4.6	$V_{Rk,s,eq}$	[kN]	7	10	23	30	40
Partial safety factor	γ_{Ms}	[-]			1,67		
Characteristic resistance KPG 5.8	$V_{Rk,s,eq}$	[kN]	9	13	28	38	51
Partial safety factor	γ_{Ms}	[-]			1,25		
Characteristic resistance KPG 8.8	$V_{Rk,s,eq}$	[kN]	14	21	45	61	81
Partial safety factor	γ_{Ms}	[-]			1,25		
Characteristic resistance KPG 10.9	$V_{Rk,s,eq}$	[kN]	18	26	56	76	101
Partial safety factor	γ_{Ms}	[-]			1,50		
Characteristic resistance KPG A2-70, KPG A4-70	$V_{Rk,s,eq}$	[kN]	12	18	39	53	71
Partial safety factor	γ_{Ms}	[-]			1,56		
Characteristic resistance KPG A4-80	$V_{Rk,s,eq}$	[kN]	14	21	45	61	81
Partial safety factor	γ_{Ms}	[-]			1,33		
Characteristic resistance KPG HCR	$V_{Rk,s,eq}$	[kN]	12	18	39	53	71
Partial safety factor	γ_{Ms}	[-]			1,25		
Characteristic resistance KPG UHCR	$V_{Rk,s,eq}$	[kN]	12	18	39	53	71
Partial safety factor	γ_{Ms}	[-]			1,56		
Factor for annular gap	α_{gap}	[-]			0,5		

Note: Rebars are not qualified for seismic design

WCF-EASF, WCF-EASF-C, WCF-EASF-E

Performances
Hammer drilling, Dustless drilling
Seismic performance category C1

Annex C 13