Technical and Test Institute for Construction Prague
Prosecká 811/76a
190 00 Prague
Czech Republic
eota@tzus.cz

Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
www.eota.eu

European Technical Assessment

ETA 18/0994 of 29/10/2019

Technical Assessment Body issuing the ETA: Technical and Test Institute for Construction Prague	
Trade name of the construction product	R-KEX-I
Product family to which the construction product belongs	Product area code: 33 Bonded injection type anchor for use in concrete
Manufacturer	Rawlplug S.A. Ul. Kwidzyńska 6 51-416 Wrocław Poland
Manufacturing plant	Manufacturing Plant No. 3
This European Technical Assessment contains	22 pages including 19 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 18/0994 issued on 08/03/2019

Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

1. Technical description of the product

The R-KEX-I is bonded anchor (injection type) consisting of an injection mortar cartridge using an applicator gun equipped with a special nozzle and steel element.

The steel element consists of threaded rod sizes M8 to M30 with hexagon nut and washer or rebar sizes Ø8 to Ø32. The threaded rod can be made of galvanized carbon steel, stainless steel or high corrosion resistant steel.

The steel element is placed into a drilled hole previously injected (using an applicator gun) with a mortar with a slow and slight twisting motion. The rod is anchored by the bond between steel element and concrete.

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. 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 and shear load for static and quasi-static loading	See Annex C 1 to C 6
Displacements under short term and long term loading	See Annex C 7

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 Technický a zkušební ústav stavební Praha, s.p.[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 29.10.2019

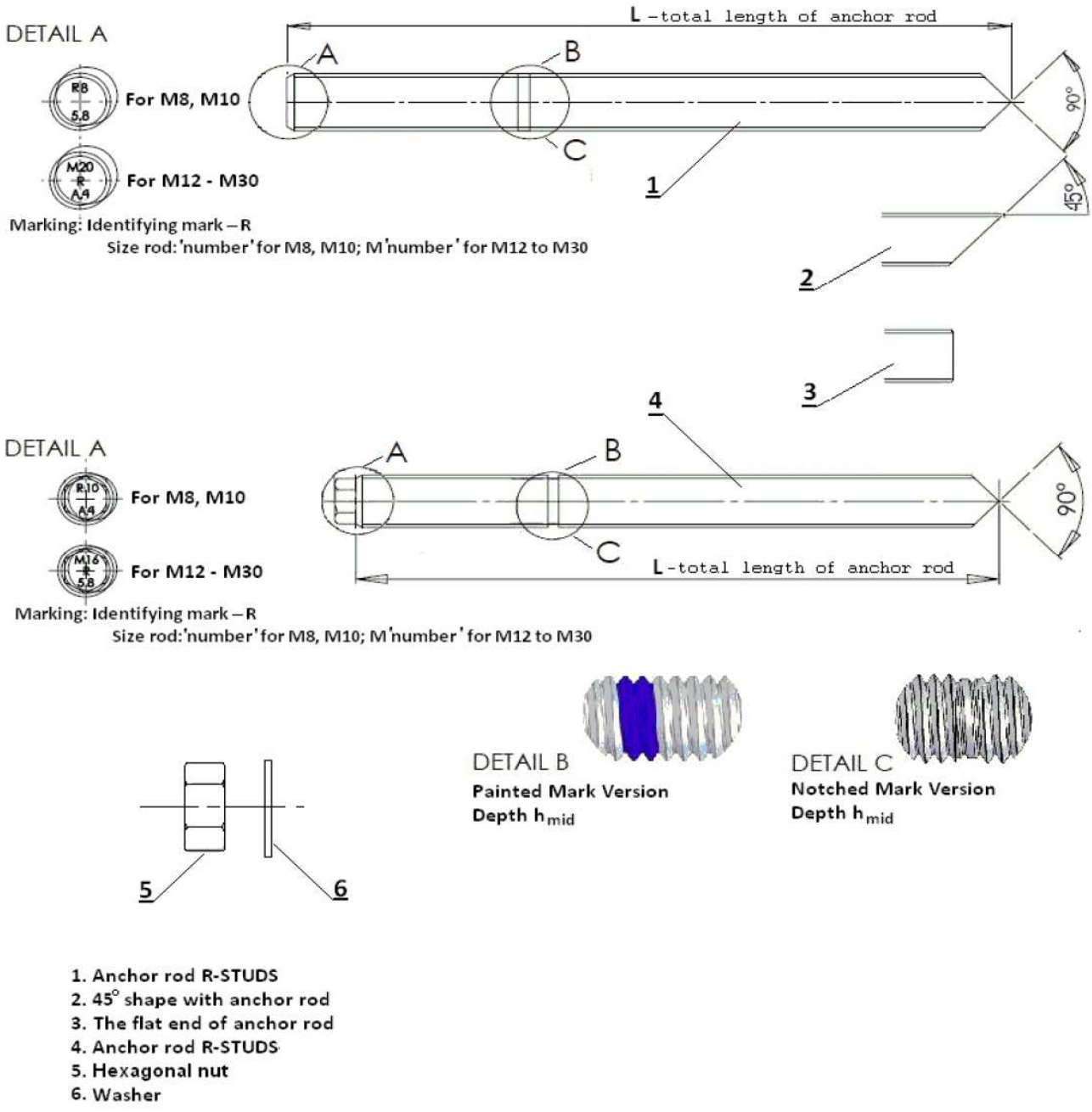
By

Ing. Maria Schaan

Head of the Technical Assessment Body

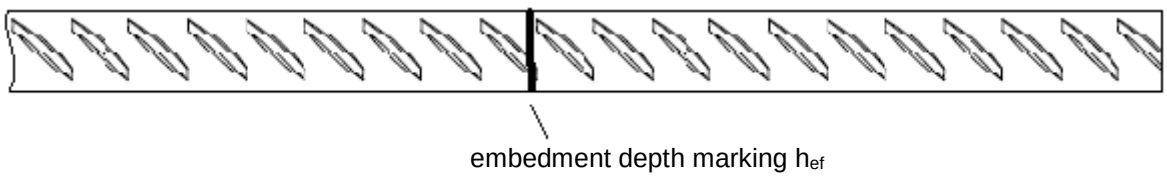
[2] The control plan is a confidential part of the documentation of the European Technical Assessment, but not published together with the ETA and only handed over to the approved body involved in the procedure of AVCP.

Threaded anchor rods



1. Anchor rod R-STUDS
2. 45° shape with anchor rod
3. The flat end of anchor rod
4. Anchor rod R-STUDS
5. Hexagonal nut
6. Washer

Rebar



R-KEX-I	**Annex A 1**
Product description Threaded rods and rebars	

Table A1: Threaded rods

Part	Designation		
	Steel, zinc plated	**Stainless steel**	**High corrosion resistance stainless steel**
Threaded rod	Steel, property class 5.8 to 12.9 acc. to EN ISO 898-1 electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coatings ≥ 8 µm acc. EN ISO 10683	Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088; property class 70 and 80 (A4-70 and A4-80) acc. to EN ISO 3506	Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088; property class 70 acc. to EN ISO 3506
Hexagon nut	Steel, property class 5 to 12, acc. to EN ISO 898-2; electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coatings ≥ 8 µm acc. EN ISO 10683	Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088; property class 70 and 80 (A4-70 and A4-80) acc. to EN ISO 3506	Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088; property class 70 acc. to EN ISO 3506
Washer	Steel, acc. to EN ISO 7089; electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coatings ≥ 8 µm acc. EN ISO 10683	Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088	Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088

Commercial standard threaded rods (in the case of rods made of galvanized steel – standard rods with property class ≤ 8.8 only), with:

- material and mechanical properties according to Table A1,
- confirmation of material and mechanical properties by inspection certificate; the documents shall be stored,
- marking of the threaded rod with the embedment depth.

Table A2: Rebars

Product form		**Bars and de-coiled rods**	
Class		B	C
Characteristic yield strength f_{yk} or $f_{0,2k}$ [N/mm²]		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	

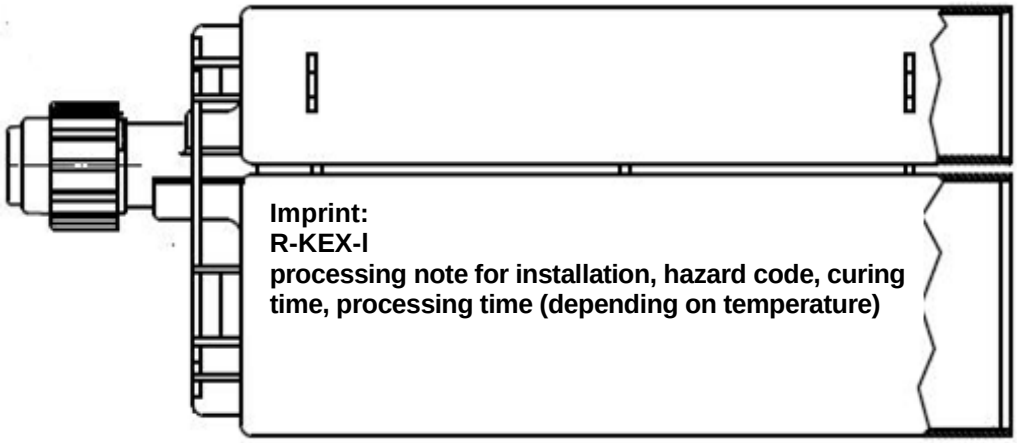
R-KEX-I

Product description
Materials

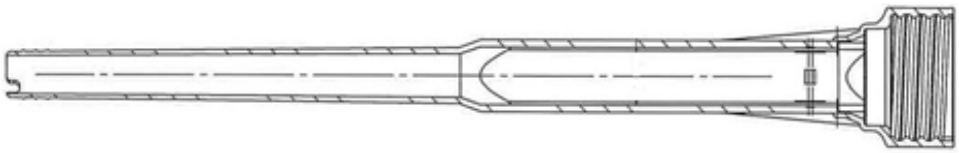
Annex A 2

Cartridge

Side by side cartridge – 385 to 1100 ml



Mixer for cartridge



R-KEX-I	**Annex A 3**
Product description Cartridge	

Specifications of intended use

Anchorages subject to:

- Static and quasi-static load.

Base materials

- Cracked and uncracked concrete.
- Reinforced or unreinforced normal weight concrete of strength class C20/25 at minimum and C50/60 at maximum according EN 206-1.

Temperature range:

- -40°C to +40°C (max. short. term temperature +40°C and max. long term temperature +24°C)
- -40°C to +80°C (max. short. term temperature +80°C and max. long term temperature +50°C)

Use conditions (Environmental conditions)

- Use in structures subject to dry, internal conditions
  (zinc coated steel, stainless steel, high corrosion resistant steel)
- For all other conditions according EN 1993-1-4, Annex A
  (stainless steel according EN 1993-1-4, Annex A for the corresponding Corrosion Resistance Class (CRC))

Installation:

- Dry or wet concrete (use category I1)
- Flooded holes (use category I2)
- Installation direction D3 (downward and horizontal and upwards installation).
- The anchors are suitable for hammer drilled holes
- Anchor installation carried out by trained personnel and under the supervision of the person responsible for technical matters of the site.

Design:

- The anchorages are designed in accordance with the EN 1992-4 or EOTA Technical Report TR 055 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.

R-KEX-I	**Annex B 1**
Intended use Specifications	

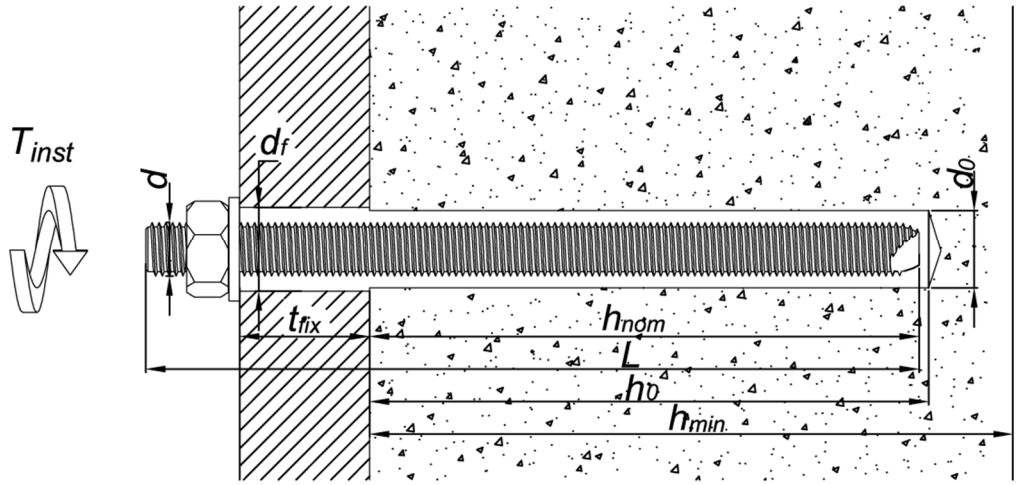


Table B1: Installation data – threaded anchor rod

Size		**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M30**
Nominal drilling diameter	d_0 [mm]	10	12	14	18	24	28	35
Maximum diameter hole in the fixture	d_f [mm]	9	12	14	18	22	26	32
Effective embedment depth	$h_{ef,min}$ [mm]	60	60	70	80	90	96	120
	$h_{ef,max}$ [mm]	160	200	240	320	400	480	600
Depth of the drilling hole	h_0 [mm]	h_{ef} + 5 mm						
Minimum thickness of the concrete slab	h_{min} [mm]	h_{ef} + 30 mm; ≥ 100 mm			h_{ef} + $2d_0$			
Torque moment	T_{inst} [N·m]	10	20	40	80	120	160	200
Minimum spacing	s_{min} [mm]	40	40	40	40	50	50	60
Minimum edge distance	c_{min} [mm]	40	40	40	40	50	50	60

R-KEX-I	**Annex B 2**
Intended use Installation data	

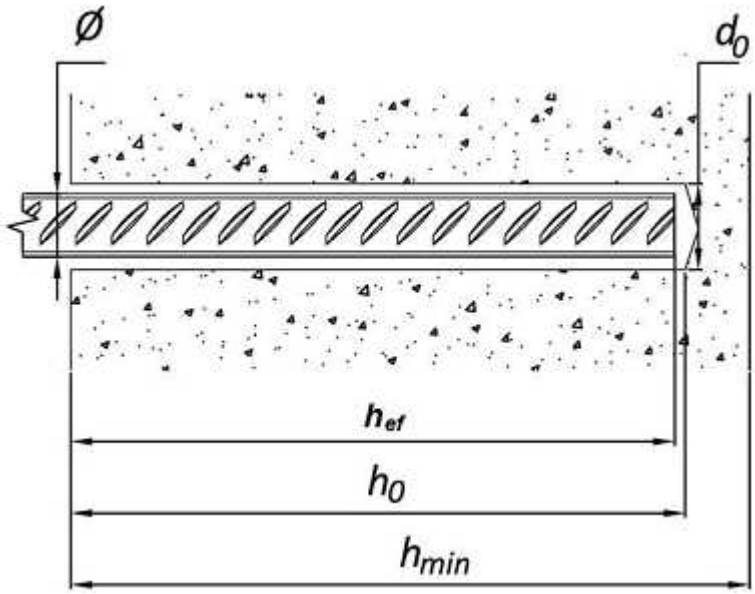


Table B2: Installation data - rebar

Size		**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Nominal drilling diameter	d_0 [mm]	10/12	12/14	18	22	26	35	40
Maximum diameter hole in the fixture	d_f [mm]	12	14	16	22	26	32	40
Effective embedment depth	$h_{ef,min}$ [mm]	60	60	70	80	90	100	128
	$h_{ef,max}$ [mm]	160	200	240	320	400	500	640
Depth of the drilling hole	h_0 [mm]	h_{ef} + 5 mm						
Minimum thickness of the concrete slab	h_{min} [mm]	h_{ef} + 30 mm; ≥ 100 mm			h_{ef} + $2d_0$			
Minimum spacing	s_{min} [mm]	40	40	40	40	50	50	65
Minimum edge distance	c_{min} [mm]	40	40	40	40	50	50	65

R-KEX-I	**Annex B 3**
Intended use Installation data	

Table B3: Processing time and curing time

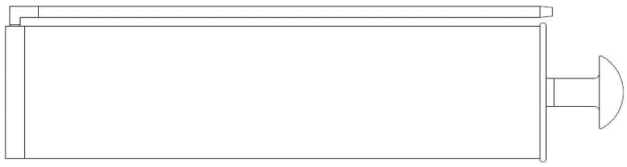
R-KEX-I			
Temperature of resin [°C]	**Temperature of substrate [°C]**	**Processing time [minutes]**	**Minimum curing time[1)] [hours]**
+5	+5	180	96
+10	+10	120	72
+20	+20	50	10
+25	+30	35	5
+25	+40	20	4

[1)] The minimum time from the end of the mixing to the time when the rebar may be loaded.
Minimum resin temperature for installation +5°C. Maximum resin temperature for installation +25°C.
For wet condition the curing time must be double.

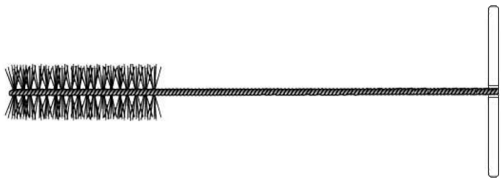
R-KEX-I	**Annex B 4**
Intended use Processing time and curing time	

Hollow drill bit RT-MAXH

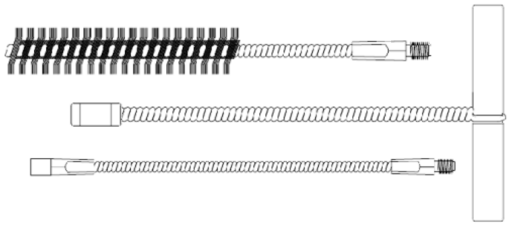
Hollow drill bit RT-SDSH



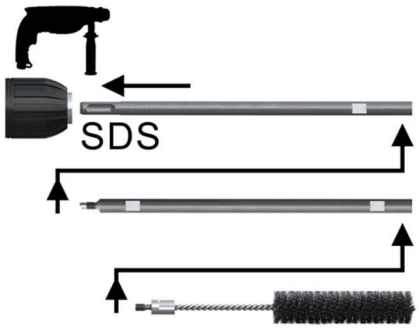
Manual blow pump R-BLOWPUMP



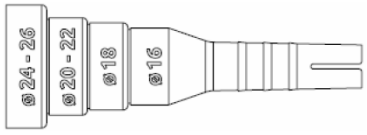
Wire brush R-BRUSH

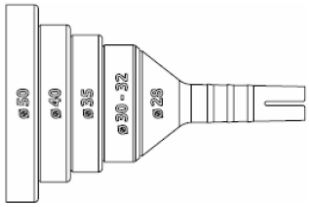


Wire brush R-BRUSH-TC,
extension with handle R-BRUSH-EXT-LT,
extension R-BRUSH-EXT-LH
for manual cleaning



Wire brush R-BRUSH-TC,
extention with SDS tit R-BRUSH-EXT-H-SDS,
extention R-BRUSH-EXT-H-TC
for automatic cleaning



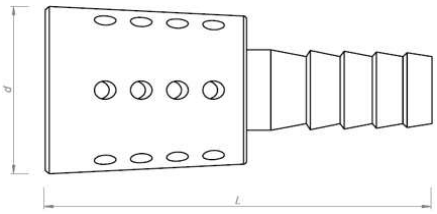


Dosing plug R-NOZ-P

Temporary centering wedge

Mixer nozzle extension SP-CE-ED-1M

Air Adapter R-NOZ-ADAPTER



Elastic hose, R-NOZ-EXT

R-KEX-I	
Intended use Tools (1)	**Annex B 5**

Dispenser	Cartridge size
 Manual gun for side by side cartridges R-GUN-385-P	385 ml
 Manual gun for side by side cartridges R-GUN-600-P	385, 600 ml
 Pneumatic dispenser gun R-GUN-KEX-600-PNEU	385, 600 ml
 Manual gun for side by side cartridges R-GUN-MULTI	385, 600 ml
 Battery Extrusion Gun with Dosing R-GUN-KEX600-AKUDOSE	385, 600 ml

R-KEX-I	**Annex B 6**
Intended use Tools (2)	

Table B4: Brush diameter for threaded rod

Threaded rod diameter		M8	M10	M12	M16	M20	M24	M30
Brush diameter	d_b [mm]	12	14	16	20	26	30	37

Table B5: Brush diameter for rebar

Rebar diameter		Ø8		Ø10		Ø12	Ø16	Ø20	Ø25	Ø32
Brush diameter	d_b [mm]	12	14	14	16	18	22	27	32	42

Table B6: Piston plug R-NOZ-P

Hole diameter d_0 [mm]	16	18	22	24	26	28	30/32	35	40
Piston plug R-NOZ-P description	Ø16	Ø18	Ø20-22	Ø24	Ø26	Ø28	Ø30-32	Ø35	Ø40

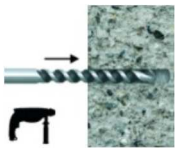
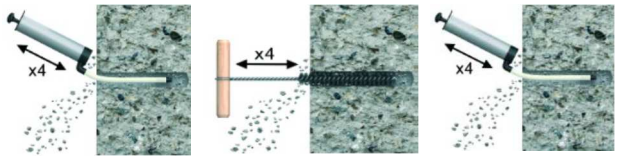
Table B7: Air Adapter, R-NOZ-ADAPTER

Produkt	Description	Hole diameter [mm]
R-NOZ-ADAPTER-14	Air Adapter	14 - 20
R-NOZ-ADAPTER-22	Air Adapter	22 - 26
R-NOZ-ADAPTER-28	Air Adapter	28 - 50

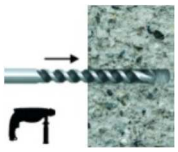
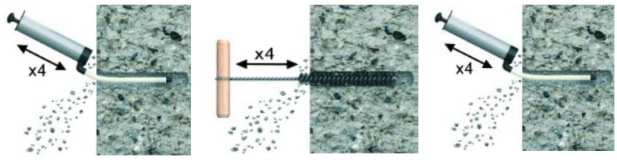
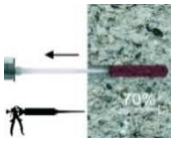
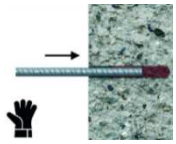
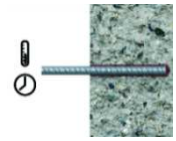
R-KEX-I

Intended use
Tools (3)

Annex B 7

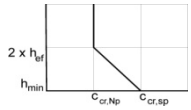
1. 1. a.  1. b. 	1. Hole drilling a. Hammer drilling. Drill hole to the required diameter and depth using a rotary hammer drilling machine. b. Hammer drilling with hollow drill bit (e.g. RT-MAXH and RT-SDSH) Drill hole to the required diameter and depth using a hollow drill bit with vacuum cleaner. After drilling is completed, proceed to step no. 3. Hole cleaning is not necessary. Hollow drill bit cleans the drill hole during drilling.
2. 2. a.  2. b. 	2. Hole cleaning a. Manual cleaning with brush and hand pump for hammer drilled hole: **Only for drilled hole depth ≤ 300 mm** - starting from the drill hole bottom blow the hole at least 4 times using the hand pump, - using the specified brush, mechanically brush out the hole at least 4 times, - starting from the drill hole bottom, blow at least 4 times with the hand pump. b. Cleaning hole, hammer drilling, with compressed air: **Must be used for drilled hole depth > 300 mm** - starting from the drill hole bottom blow the hole at least twice by compressed air 6 atm - using the specified brush, mechanically brush out the hole at least twice, - blow the hole at least twice by compressed air 6 atm - brush out the hole at least twice, - blow over the hole at least twice by compressed air 6 atm
3. 	Attach nozzle and insert cartridge into dispenser. Dispense to waste until even colour is obtained (min. 10 cm).
4. 	Insert the mixing nozzle to the far end of the hole and inject resin, slowly withdrawing the nozzle as the hole is filled to 70% of its depth.
5. 	Immediately insert the threaded rods, slowly and with slight twisting motion. Remove any excess resin around the hole before it sets.
6. 	Leave the fixing undisturbed until the curing time elapses.
7. 	Attach fixture and tighten the nut to the required torque.

R-KEX-I	**Annex B 8**
Intended use Installation instruction – threaded rod	

1. 1. a.  1. b. 	1. Hole drilling a. Hammer drilling. Drill hole to the required diameter and depth using a rotary hammer drilling machine. b. Hammer drilling with hollow drill bit (e.g. RT-MAXH and RT-SDSH) Drill hole to the required diameter and depth using a hollow drill bit with vacuum cleaner. After drilling is completed, proceed to step no. 3. Hole cleaning is not necessary. Hollow drill bit cleans the drill hole during drilling.
2. 2. a.  2. b. 	2. Hole cleaning a. Manual cleaning with brush and hand pump for hammer drilled hole: **Only for drilled hole depth ≤ 300 mm** - starting from the drill hole bottom blow the hole at least 4 times using the hand pump, - using the specified brush, mechanically brush out the hole at least 4 times, - starting from the drill hole bottom, blow at least 4 times with the hand pump. b. Cleaning hole, hammer drilling, with compressed air: **Must be used for drilled hole depth > 300 mm** - starting from the drill hole bottom blow the hole at least twice by compressed air 6 atm - using the specified brush, mechanically brush out the hole at least twice, - blow the hole at least twice by compressed air 6 atm - brush out the hole at least twice, - blow over the hole at least twice by compressed air 6 atm
3. 	Attach nozzle and insert cartridge into dispenser. Dispense to waste until even colour is obtained (min. 10 cm).
4. 	Insert the mixing nozzle to the far end of the hole and inject resin, slowly withdrawing the nozzle as the hole is filled to 70% of its depth.
5. 	Immediately insert the rebar, slowly and with slight twisting motion. Remove any excess resin around the hole before it sets.
6. 	Leave the fixing undisturbed until the curing time elapses.

R-KEX-I	**Annex B 9**
Intended use Installation instruction - rebar	

Table C1: Characteristic values for tension load for threaded rod in uncracked concrete

Size			M8	M10	M12	M16	M20	M24	M30
Steel failure									
Steel, property class 5.8									
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	280
Partial safety factor[1)]	γ_{Ms}	[-]	1,50						
Steel, property class 8.8									
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	449
Partial safety factor[1)]	γ_{Ms}	[-]	1,50						
Steel, property class 10.9									
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	561
Partial safety factor[1)]	γ_{Ms}	[-]	1,40						
Steel, property class 12.9									
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	673
Partial safety factor[1)]	γ_{Ms}	[-]	1,40						
Stainless steel, property class A4-70									
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	393
Partial safety factor[1)]	γ_{Ms}	[-]	1,87						
Stainless steel, property class A4-80									
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	448
Partial safety factor[1)]	γ_{Ms}	[-]	1,60						
High corrosion resistant steel, property class 70									
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	59	110	171	247	393
Partial safety factor[1)]	γ_{Ms}	[-]	1,87						
Combined pull-out and concrete cone failure in uncracked concrete C20/25									
Characteristic bond resistance temperature range -40°C / +40°C [2)]	$\tau_{Rk,ucr}$	[N/mm²]	16,0	15,0	16,0	13,0	12,0	12,0	10,0
Characteristic bond resistance temperature range -40°C / +80°C [2)]	$\tau_{Rk,ucr}$	[N/mm²]	16,0	15,0	16,0	13,0	12,0	12,0	10,0
Increasing factor for C30/37	ψ_c	[-]	1,0				1,04		
Increasing factor for C40/50			1,0				1,07		
Increasing factor for C50/60			1,0				1,09		
Concrete cone failure in uncracked concrete									
Factor for uncracked concrete	k_{ucr}[3)]	[-]	10,1						
	$k_{ucr,N}$[4)]	[-]	11,0						
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$						
Spacing	$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$						
Splitting failure									
Edge distance	$c_{cr,sp}$ for h_{min}	[mm]	$2,0 \cdot h_{ef}$						
	$c_{cr,sp}$ for $h_{min} < h$[5)] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation)								
	$c_{cr,sp}$ for h[5)] $\geq 2 \cdot h_{ef}$		$c_{cr,N}$						
Spacing	$s_{cr,sp}$	[mm]	$2,0 \cdot c_{cr,sp}$						
Installation sensitivity factors for combined pull-out, concrete cone and splitting failure									
Installation sensitivity factor for in use category I1[1)]	γ_{inst}	[-]	1,0						
Installation sensitivity factor for in use category I2[1)]			1,2						

Note: Design method according to TR 055 and EN 1992-4

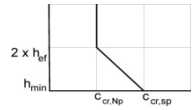
[1)] In the absence of other national regulation.
[2)] See: Annex B1.
[3)] Design according EOTA Technical Report TR 055
[4)] Design according EN 1992-4
[5)] h = concrete member thickness

R-KEX-I

Performances
Characteristic resistance under tension loads for threaded rod in uncracked concrete

Annex C 1

Table C2: Characteristic values under tension load for threaded rod in cracked concrete

Size			M8	M10	M12	M16	M20	M24	M30
Steel failure									
Steel, property class 5.8									
Characteristic resistance	$N_{Rk,s}$	[kN]	18	29	42	78	122	176	280
Partial safety factor[1)]	γ_{Ms}	[-]	1,50						
Steel, property class 8.8									
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	449
Partial safety factor[1)]	γ_{Ms}	[-]	1,50						
Steel, property class 10.9									
Characteristic resistance	$N_{Rk,s}$	[kN]	37	58	84	157	245	353	561
Partial safety factor[1)]	γ_{Ms}	[-]	1,40						
Steel, property class 12.9									
Characteristic resistance	$N_{Rk,s}$	[kN]	44	70	101	188	294	424	673
Partial safety factor[1)]	γ_{Ms}	[-]	1,40						
Stainless steel, property class A4-70									
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	393
Partial safety factor[1)]	γ_{Ms}	[-]	1,87						
Stainless steel, property class A4-80									
Characteristic resistance	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	448
Partial safety factor[1)]	γ_{Ms}	[-]	1,60						
High corrosion resistant steel, property class 70									
Characteristic resistance	$N_{Rk,s}$	[kN]	25	40	59	110	171	247	393
Partial safety factor[1)]	γ_{Ms}	[-]	1,87						
Combined pull-out and concrete cone failure in cracked concrete C20/25									
Characteristic bond resistance temperature range -40°C / +40°C [2)]	$\tau_{Rk,cr}$	[N/mm²]	7,5	7,5	7,5	7,5	7,5	6,5	6,0
Characteristic bond resistance temperature range -40°C / +80°C [2)]	$\tau_{Rk,cr}$	[N/mm²]	7,5	7,5	7,5	7,5	7,5	6,5	6,0
Increasing factor for C30/37	ψ_c	[-]	1,04						
Increasing factor for C40/50			1,07						
Increasing factor for C50/60			1,09						
Concrete cone failure in cracked concrete									
Factor for cracked concrete	$k_{cr,N}$[3)]	[-]	7,2						
	$k_{cr,N}$[4)]	[-]	7,7						
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$						
Spacing	$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$						
Splitting failure									
Edge distance	$c_{cr,sp}$ for h_{min}	[mm]	$2,0 \cdot h_{ef}$						
	$c_{cr,sp}$ for $h_{min} < h$[5)] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation)								
	$c_{cr,sp}$ for h[5)] $\geq 2 \cdot h_{ef}$		$c_{cr,N}$						
Spacing	$s_{cr,sp}$	[mm]	$2,0 \cdot c_{cr,sp}$						
Installation sensitivity factors for combined pull-out, concrete cone and splitting failure									
Installation sensitivity factor for in use category I1[1)]	γ_{inst}	[-]	1,0						
Installation sensitivity factor for in use category I2[1)]			1,2						

Note: Design method according to TR 055 and EN 1992-4

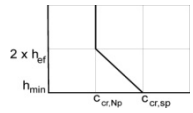
[1)] In the absence of other national regulation.
[2)] See: Annex B1.
[3)] Design according EOTA Technical Report TR 055
[4)] Design according EN 1992-4
[5)] h = concrete member thickness

R-KEX-I

Performances
Characteristic resistance under tension loads for threaded rod in cracked concrete

Annex C 2

Table C3: Characteristic values for tension load for rebar in uncracked concrete

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	A_s[6] · f_{uk}						
Partial safety factor[1]	γ_{Ms}	[-]	1,4						
Combined pull-out and concrete cone failure in uncracked concrete C20/25									
Characteristic bond resistance temperature range -40°C / +40°C [2]	$\tau_{Rk,ucr}$	[N/mm²]	15,0	14,0	14,0	10,0	10,0	10,0	9,0
Characteristic bond resistance temperature range -40°C / +80°C [2]	$\tau_{Rk,ucr}$	[N/mm²]	15,0	14,0	14,0	10,0	10,0	10,0	9,0
Increasing factor for C30/37	ψ_c	[-]	1,0				1,04		
Increasing factor for C40/50			1,0				1,07		
Increasing factor for C50/60			1,0				1,09		
Concrete cone failure in uncracked concrete									
Factor for uncracked concrete	k_{ucr}[3]	[-]	10,1						
	$k_{ucr,N}$[4]	[-]	11,0						
Edge distance	$c_{cr,N}$	[mm]	1,5 · h_{ef}						
Spacing	$s_{cr,N}$	[mm]	3,0 · h_{ef}						
Splitting failure									
Edge distance	$c_{cr,sp}$ for h_{min}	[mm]	2,0 · h_{ef}						
	$c_{cr,sp}$ for $h_{min} < h$[5] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation)								
	$c_{cr,sp}$ for h[5] $\geq 2 \cdot h_{ef}$		$c_{cr,N}$						
Spacing	$s_{cr,sp}$	[mm]	2,0 · $c_{cr,sp}$						
Installation sensitivity factors for combined pull-out, concrete cone and splitting failure									
Installation sensitivity factor for in use category I1[1]	γ_{inst}	[-]	1,0						
Installation sensitivity factor for in use category I2[1]			1,2						

Note: Design method according to TR 055 and EN 1992-4

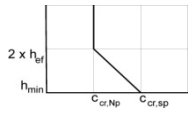
[1] In the absence of other national regulation.
[2] See: Annex B1.
[3] Design according EOTA Technical Report TR 055
[4] Design according EN 1992-4
[5] h = concrete member thickness
[6] Stressed cross section of the steel element

R-KEX-I

Performances
Characteristic resistance under tension loads for rebar in uncracked concrete

Annex C 3

Table C4: Characteristic values for tension load for rebar in cracked concrete

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	A_s[6] · f_{uk}						
Partial safety factor[1]	γ_{Ms}	[-]	1,4						
Combined pull-out and concrete cone failure in cracked concrete C20/25									
Characteristic bond resistance temperature range -40°C / +40°C [2]	$\tau_{Rk,cr}$	[N/mm²]	6,5	6,5	7,0	7,0	7,0	5,0	4,5
Characteristic bond resistance temperature range -40°C / +80°C [2]	$\tau_{Rk,cr}$	[N/mm²]	6,5	6,5	7,0	7,0	7,0	5,0	4,5
Increasing factor for C30/37	ψ_c	[-]	1,04						
Increasing factor for C40/50			1,07						
Increasing factor for C50/60			1,09						
Concrete cone failure in cracked concrete									
Factor for uncracked concrete	$k_{cr,N}$[3]	[-]	7,2						
	$k_{cr,N}$[4]	[-]	7,7						
Edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$						
Spacing	$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$						
Splitting failure									
Edge distance	$c_{cr,sp}$ for h_{min}	[mm]	$2,0 \cdot h_{ef}$						
	$c_{cr,sp}$ for $h_{min} < h$[5] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation)								
	$c_{cr,sp}$ for h[5] $\geq 2 \cdot h_{ef}$		$c_{cr,N}$						
Spacing	$s_{cr,sp}$	[mm]	$2,0 \cdot c_{cr,sp}$						
Installation sensitivity factors for combined pull-out, concrete cone and splitting failure									
Installation sensitivity factor for in use category I1[1]	γ_{inst}	[-]	1,0						
Installation sensitivity factor for in use category I2[1]			1,2						

Note: Design method according to TR 055 and EN 1992-4

[1] In the absence of other national regulation.
[2] See: Annex B1.
[3] Design according EOTA Technical Report TR 055
[4] Design according EN 1992-4
[5] h = concrete member thickness
[6] Stressed cross section of the steel element

R-KEX-I

Performances
Characteristic resistance under tension loads for rebar in cracked concrete

Annex C 4

Table C5: Characteristic values under shear loads for threaded rod – steel failure without lever arm

Size			M8	M10	M12	M16	M20	M24	M30
Steel, property class 5.8									
Characteristic resistance	$V_{Rk,s}$	[kN]	9	14	21	39	61	88	140
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,25						
Steel, property class 8.8									
Characteristic resistance	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	224
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,25						
Steel, property class 10.9									
Characteristic resistance	$V_{Rk,s}$	[kN]	18	29	42	78	122	176	280
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,50						
Steel, property class 12.9									
Characteristic resistance	$V_{Rk,s}$	[kN]	22	35	51	94	147	212	336
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,50						
Stainless steel, property class A4-70									
Characteristic resistance	$V_{Rk,s}$	[kN]	13	20	29	55	86	124	196
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,56						
Stainless steel, property class A4-80									
Characteristic resistance	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	224
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,33						
High corrosion resistant steel, property class 70									
Characteristic resistance	$V_{Rk,s}$	[kN]	13	20	29	55	86	124	196
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,56						

Table C6: Characteristic values for shear loads for threaded rod – steel failure with lever arm

Size			M8	M10	M12	M16	M20	M24	M30
Steel, property class 5.8									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	561	1124
Partial safety factor [1)]	γ_{Ms}	[-]	1,25						
Steel, property class 8.8									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	1799
Partial safety factor [1)]	γ_{Ms}	[-]	1,25						
Steel, property class 10.9									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	37	75	131	333	649	1123	2249
Partial safety factor [1)]	γ_{Ms}	[-]	1,50						
Steel, property class 12.9									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	45	90	157	400	779	1347	2698
Partial safety factor [1)]	γ_{Ms}	[-]	1,50						
Stainless steel, property class A4-70									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1574
Partial safety factor [1)]	γ_{Ms}	[-]	1,56						
Stainless steel, property class A4-80									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	898	1799
Partial safety factor [1)]	γ_{Ms}	[-]	1,33						
High corrosion resistant steel, property class 70									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	233	454	786	1574
Partial safety factor [1)]	γ_{Ms}	[-]	1,56						

Table C7: Characteristic values for shear loads – pry out and concrete edge failure for threaded rod

Size			M8	M10	M12	M16	M20	M24	M30
Pry out failure									
Factor	k_8	[-]	2						
Concrete edge failure									
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	30
Effective length of anchor under shear loading	l_f	[mm]	min (h_{ef}; $8d_{nom}$)						

[1)] In the absence of other national regulation.

R-KEX-I

Performances
Characteristic resistance under shear loads for threaded rod

Annex C 5

Table C8: Characteristic values under shear loads for rebar – steel failure without lever arm

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Rebar									
Characteristic resistance	$V_{Rk,s}$	[kN]	$0,5 \cdot A_s$[2)] $\cdot f_{uk}$						
Factor considering ductility	k_7	[-]	0,8						
Partial safety factor [1)]	γ_{Ms}	[-]	1,5						

Table C9: Characteristic values for shear loads for rebar – steel failure with lever arm

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Rebar									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	$1,2 \cdot W_{el}$[3)] $\cdot f_{uk}$						
Partial safety factor [1)]	γ_{Ms}	[-]	1,5						

Table C10: Characteristic values for shear loads – pry out and concrete edge failure for rebar

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Pry out failure									
Factor	k_8	[-]	2						
Concrete edge failure									
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	25	32
Effective length of anchor under shear loading	l_f	[mm]	min (h_{ef}; $8d_{nom}$)						

[1)] In the absence of other national regulation
[2)] Stressed cross section of the steel element
[3)] Elastic section modulus calculated from the stressed cross section of steel element

R-KEX-I

Performances
Characteristic resistance for shear loads for rebar

Annex C 6

Table C11: Displacement under tension loads – threaded rod

Size			M8	M10	M12	M16	M20	M24	M30
Characteristic displacement in uncracked concrete C20/25 to C50/60 under tension loads									
Admissible service load[1)]	N	[kN]	11,9	13,5	17,5	20,1	28,2	43,0	54,3
Displacement	δ_{N0}	[mm]	0,30	0,35	0,40	0,48	0,50	0,52	0,65
	$\delta_{N\infty}$	[mm]	0,78	0,78	0,78	0,78	0,78	0,78	0,78
Characteristic displacement in cracked concrete C20/25 to C50/60 under tension loads									
Admissible service load[1)]	N	[kN]	5,39	6,73	9,42	13,4	18,9	22,4	32,3
Displacement	δ_{N0}	[mm]	0,20	0,21	0,25	0,30	0,40	0,42	0,45
	$\delta_{N\infty}$	[mm]	3	3	3	3	3	3	3

[1)] These values are suitable for each temperature range and categories specified in Annex B1

Table C12: Displacement under tension loads – rebar

Size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Characteristic displacement in uncracked concrete C20/25 to C50/60 under tension loads									
Admissible service load[1)]	N	[kN]	10,77	12,57	17,59	19,15	26,93	37,40	55,15
Displacement	δ_{N0}	[mm]	0,29	0,33	0,38	0,40	0,45	0,47	0,50
	$\delta_{N\infty}$	[mm]	0,78	0,78	0,78	0,78	0,78	0,78	0,78
Characteristic displacement in cracked concrete C20/25 to C50/60 under tension loads									
Admissible service load[1)]	N	[kN]	5,0	6,3	8,8	13,4	18,9	18,7	30,6
Displacement	δ_{N0}	[mm]	0,21	0,23	0,24	0,30	0,30	0,35	0,46
	$\delta_{N\infty}$	[mm]	3	3	3	3	3	3	3

[1)] These values are suitable for each temperature range and categories specified in Annex B1

Table C13: Displacement under shear loads – threaded rod and rebar

Size			M8/ Ø8	M10/ Ø10	M12/ Ø12	M16/ Ø16	M20/ Ø20	M24/ Ø25	M30/ Ø32
Characteristic displacement in concrete C20/25 to C50/60 under shear loads									
Admissible service load[1)]	V	[kN]	3,7	5,8	8,4	15,7	24,5	35,3	55,6
Displacement	δ_{V0}	[mm]	2,5	2,5	2,5	2,5	2,5	2,5	2,5
	$\delta_{V\infty}$	[mm]	3,7	3,7	3,7	3,7	3,7	3,7	3,7

[1)] These values are suitable for each temperature range and categories specified in Annex B1.

R-KEX-I

Performances
Displacement

Annex C 7