

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-20/1285
of 22 March 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Rotho Blaas Injection system HYB - FIX for concrete

Product family
to which the construction product belongs

Bonded fastener for use in concrete

Manufacturer

Rotho Blaas s.r.l
Via dell'Adige 2/1
39040 CORTACCIA (BZ)
ITALIEN

Manufacturing plant

Plant C2

This European Technical Assessment
contains

35 pages including 3 annexes which form an integral part
of this assessment

This European Technical Assessment is
issued in accordance with Regulation (EU)
No 305/2011, on the basis of

EAD 330499-01-0601, Edition 4/2020

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Specific Part

1 Technical description of the product

The "Rotho Blaas Injection system HYB - FIX for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar HYB - FIX and a steel element according to Annex A3 and A5.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

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

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance to tension load (static and quasi-static loading)	See Annex B 3, C 1 to C 4, C 6 to C 7, C 9 to C 10
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 5, C 8, C 11
Displacements under short-term and long-term loading	See Annex C 12 to C 14
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 15 to C 18

3.2 Hygiene, health and the environment (BWR 3)

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

English translation prepared by DIBt

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

In accordance with the European Assessment Document EAD 330499-01-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

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

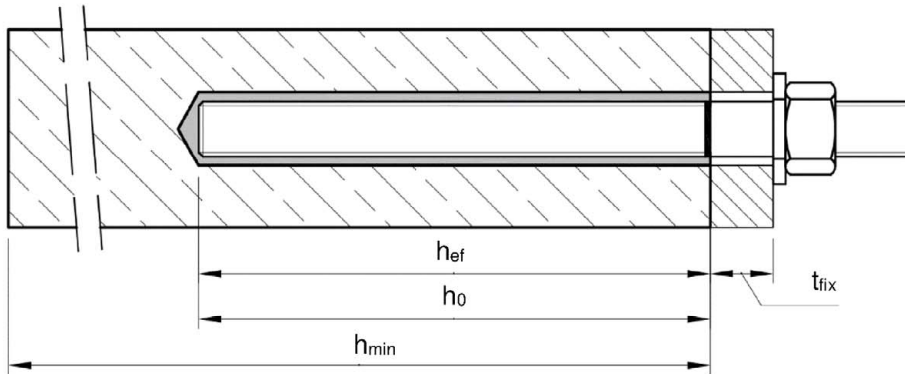
Issued in Berlin on 22 March 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

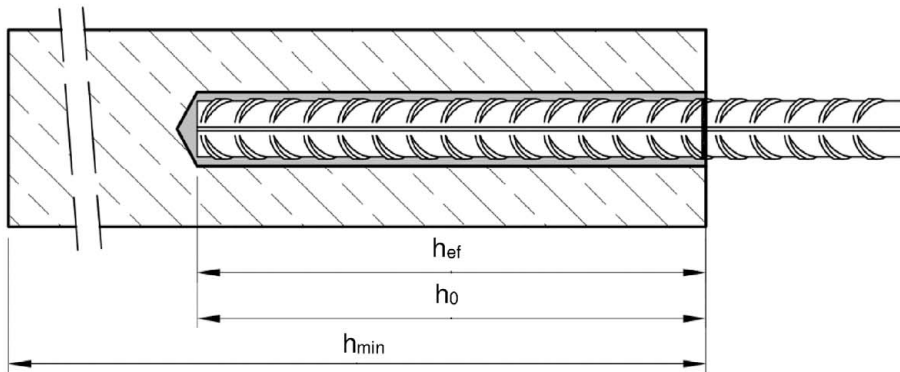
beglaubigt:
Baderschneider

Installation threaded rod M8 up to M30

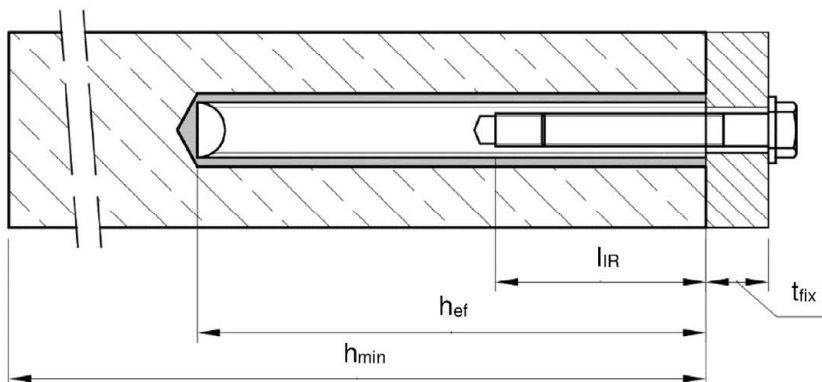
prepositioned installation or
push through installation (annular gap filled with mortar)



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



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



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

Rotho Blas Injection system HYB - FIX for concrete

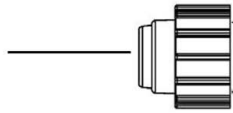
Product description
Installed condition

Annex A 1

Cartridge: HYB - FIX

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

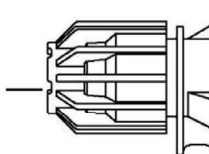
Sealing/Screw cap



Imprint: HYB - FIX, processing notes, charge-code, shelf life, storage temperature, hazard-code, curing- and processing time (depending on the temperature), with as well as without travel scale

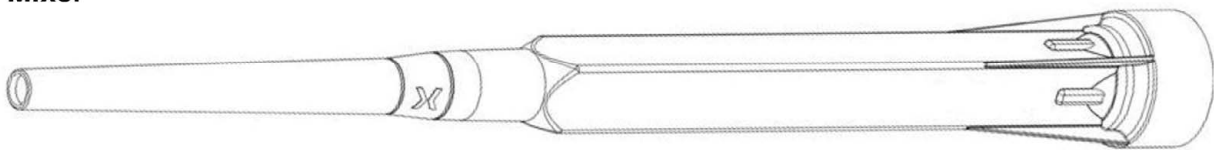
235 ml, 345 ml up to 360 ml and 825 ml cartridge (Type: "side-by-side")

Sealing/Screw cap



Imprint: HYB - FIX, processing notes, charge-code, shelf life, storage temperature, hazard-code, curing- and processing time (depending on the temperature), with as well as without travel scale

Static Mixer



Piston plug and mixer extension

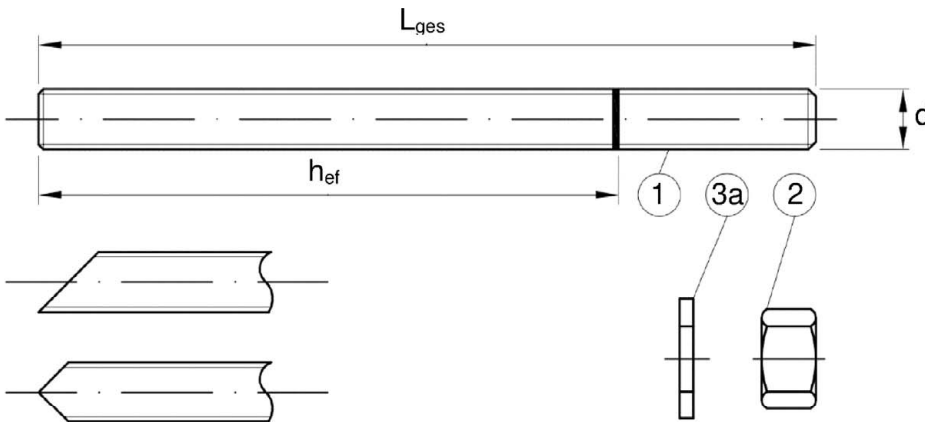


Rotho Blaas Injection system HYB - FIX for concrete

Product description
Injection system

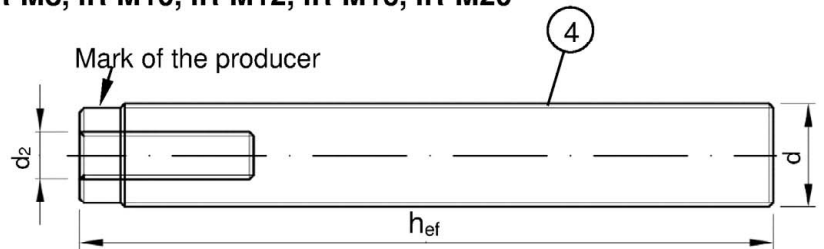
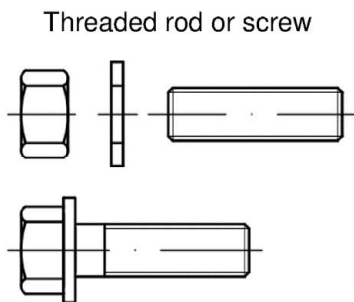
Annex A 2

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





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

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

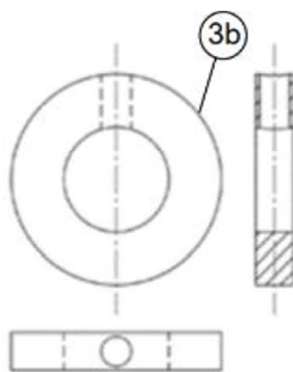


Marking: e.g.  M8

 Marking Internal thread
 Mark

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

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



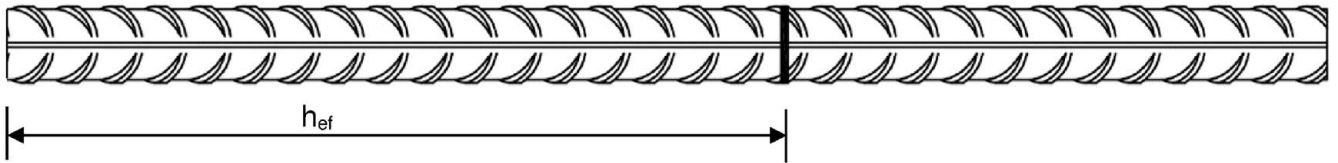
Rotho Blaas Injection system HYB - FIX for concrete

Product description
Threaded rod, internal threaded rod and filling washer

Annex A 3

Table A1: Materials						
Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN 10087:1998 or EN 10263:2001)						
- zinc plated $\geq 5 \mu\text{m}$ acc. to EN ISO 4042:1999 or						
- hot-dip galvanised $\geq 40 \mu\text{m}$ acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or						
- sherardized $\geq 45 \mu\text{m}$ acc. to EN ISO 17668:2016						
1	Threaded rod	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	4.6	$f_{uk} = 400 \text{ N/mm}^2$	$f_{yk} = 240 \text{ N/mm}^2$	$A_5 > 8\%$
			4.8	$f_{uk} = 400 \text{ N/mm}^2$	$f_{yk} = 320 \text{ N/mm}^2$	$A_5 > 8\%$
			5.6	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 300 \text{ N/mm}^2$	$A_5 > 8\%$
			5.8	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 400 \text{ N/mm}^2$	$A_5 > 8\%$
8.8	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 \geq 12\%$ ³⁾			
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 steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	5.8	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 400 \text{ N/mm}^2$	$A_5 > 8\%$
			8.8	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 > 8\%$
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⁾⁴⁾	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2009	50	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 210 \text{ N/mm}^2$	$A_5 \geq 8\%$
			70	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 \geq 12\%$ ³⁾
80	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 600 \text{ N/mm}^2$	$A_5 \geq 12\%$ ³⁾			
2	Hexagon nut ¹⁾⁴⁾	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				
4	Internal threaded anchor rod ¹⁾²⁾	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2009	50	$f_{uk} = 500 \text{ N/mm}^2$	$f_{yk} = 210 \text{ N/mm}^2$	$A_5 > 8\%$
			70	$f_{uk} = 700 \text{ N/mm}^2$	$f_{yk} = 450 \text{ N/mm}^2$	$A_5 > 8\%$
¹⁾ Property class 70 or 80 for threaded rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IR-M16 ²⁾ for IR-M20 only property class 50 ³⁾ $A_5 > 8\%$ fracture elongation if <u>no</u> use for seismic performance category C2 ⁴⁾ Property class 80 only for stainless steel A4 and high corrosion resistance steel HCR						
Rotho Blaas Injection system HYB - FIX for concrete					Annex A 4	
Product description Materials threaded rod and internal threaded rod						

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



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

Table A2: Materials

Part	Designation	Material
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 $f_{uk} = f_{tk} = k \cdot f_{yk}$

Rotho Blaas Injection system HYB - FIX for concrete

Product description
Materials reinforcing bar

Annex A 5

Specifications of intended use				
Anchorage subject to static and quasi-static loads:				
	for a working life of 50 years		for a working life of 100 years	
Base material	Non-cracked concrete	cracked concrete	Non-cracked concrete	cracked concrete
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32, IR-M6 to IR-M20		M8 to M30, Ø8 to Ø32, IR-M6 to IR-M20	
Temperature Range:	I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +80 °C ²⁾ III: - 40 °C to +120 °C ³⁾ IV: - 40 °C to +160 °C ⁴⁾		I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +80 °C ²⁾	
Anchorage subject to seismic action:				
	for Performance Category C1		for Performance Category C2	
Base material	Cracked and non-cracked concrete			
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32		M12 to M24	
Temperature Range:	I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +80 °C ²⁾ III: - 40 °C to +120 °C ³⁾ IV: - 40 °C to +160 °C ⁴⁾		I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +80 °C ²⁾ III: - 40 °C to +120 °C ³⁾ IV: - 40 °C to +160 °C ⁴⁾	
<p>1) (max long-term temperature +24 °C and max short-term temperature +40 °C) 2) (max long-term temperature +50 °C and max short-term temperature +80 °C) 3) (max long-term temperature +72 °C and max short-term temperature +120 °C) 4) (max long-term temperature +100 °C and max short-term temperature +160 °C)</p> <p>Base materials:</p> <ul style="list-style-type: none"> • 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. <p>Use conditions (Environmental conditions):</p> <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> - 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 				
Rotho Blaas Injection system HYB - FIX for concrete				Annex B 1
Intended Use Specifications				

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- The anchorages are designed in accordance to EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB) 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.

Rotho Blaas Injection system HYB - FIX for concrete

Intended Use
Specifications

Annex B 2

Table B1: Installation parameters for threaded rod

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter	d_0	[mm]	10	12	14	18	22	28	30	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	80	90	96	108	120
	$h_{ef,max}$	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture ¹⁾	Prepositioned installation $d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Push through installation d_f	[mm]	12	14	16	20	24	30	33	40
Maximum torque moment	$\max T_{inst} \leq$	[Nm]	10	20	40 ²⁾	60	100	170	250	300
Minimum thickness of member	h_{min}	[mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$				
Minimum spacing	s_{min}	[mm]	40	50	60	75	95	115	125	140
Minimum edge distance	c_{min}	[mm]	35	40	45	50	60	65	75	80

¹⁾ For application under seismic loading the diameter of clearance hole in the fixture shall be at maximum $d_1 + 1 \text{ mm}$ or alternatively the annular gap between fixture and threaded rod shall be filled force-fit with mortar.

²⁾ Maximum Torque moment for M12 with steel Grade 4.6 is 35 Nm

Table B2: Installation parameters for rebar

Rebar size			$\varnothing 8$ ¹⁾	$\varnothing 10$ ¹⁾	$\varnothing 12$ ¹⁾	$\varnothing 14$	$\varnothing 16$	$\varnothing 20$	$\varnothing 24$ ¹⁾	$\varnothing 25$ ¹⁾	$\varnothing 28$	$\varnothing 32$
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	d_0	[mm]	10 12	12 14	14 16	18	20	25	30 32	30 32	35	40
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h_{min}	[mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$						
Minimum spacing	s_{min}	[mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	c_{min}	[mm]	35	40	45	50	50	60	70	70	75	85

¹⁾ both nominal drill hole diameter can be used

Table B3: Installation parameters for Internal threaded rod

Anchor size			IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20
Internal diameter of sleeve	d_2	[mm]	6	8	10	12	16	20
Outer diameter of sleeve ¹⁾	$d = d_{nom}$	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0	[mm]	12	14	18	22	28	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	70	80	90	96	120
	$h_{ef,max}$	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	7	9	12	14	18	22
Maximum torque moment	$\max T_{inst} \leq$	[Nm]	10	10	20	40	60	100
Thread engagement length min/max	l_{IR}	[mm]	8/20	8/20	10/25	12/30	16/32	20/40
Minimum thickness of member	h_{min}	[mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$		
Minimum spacing	s_{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c_{min}	[mm]	40	45	50	60	65	80

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

Rotho Blaas Injection system HYB - FIX for concrete

Intended Use
Installation parameters

Annex B 3

Table B4: Parameter cleaning and setting tools

Threaded Rod	Rebar	Internal threaded rod	d_0 Drill bit - Ø HD, HDB, CD	d_b Brush - Ø		$d_{b,min}$ min. Brush - Ø	Piston plug	Installation direction and use of piston plug			
				BRU	[mm]			[mm]	↓	→	↑
[mm]	[mm]	[mm]	[mm]								
M8	8		10	H10	11,5	10,5	No plug required				
M10	8 / 10	IR-M6	12	H12	13,5	12,5					
M12	10 / 12	IR-M8	14	H14	15,5	14,5					
	12		16	H16	17,5	16,5					
M16	14	IR-M10	18	H18	20,0	18,5	PL18	$h_{ef} > 250$ mm	$h_{ef} > 250$ mm	all	
	16		20	H20	22,0	20,5	PL20				
M20		IR-M12	22	H22	24,0	22,5	PL22				
	20		25	H25	27,0	25,5	PL25				
M24		IR-M16	28	H28	30,0	28,5	PL28				
M27	24 / 25		30	H30	31,8	30,5	PL30				
	24 / 25		32	H32	34,0	32,5	PL32				
M30	28	IR-M20	35	H35	37,0	35,5	PL35				
	32		40	H40	43,5	40,5	PL40				



HP - Hand pump (volume 750 ml)

Drill bit diameter (d_0): 10 mm to 20 mm

Drill hole depth (h_0): $< 10 d_s$

Only in non-cracked concrete

CAT - Rec. compressed air tool (min 6 bar)

Drill bit diameter (d_0): all diameters



HDB – Hollow drill bit system

Drill bit diameter (d_0): all diameters

The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m³/h (42 l/s).

Rotho Blaas Injection system HYB - FIX for concrete

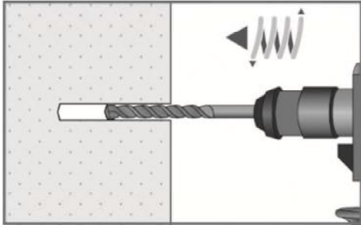
Intended Use

Cleaning and setting tools

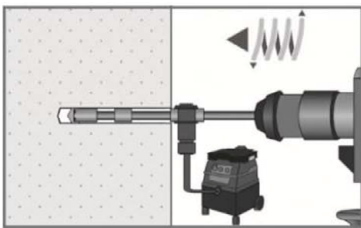
Annex B 4

Installation instructions

Drilling of the bore hole



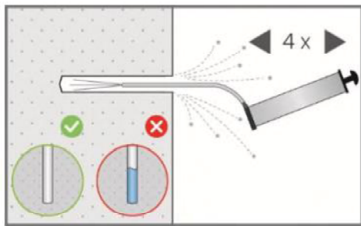
- 1a. Hammer (HD) or compressed air drilling (CD)**
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3).
Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.



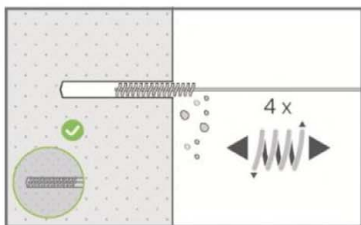
- 1b. Hollow drill bit system (HDB) (see Annex B 3)**
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3). This drilling system removes the dust and cleans the bore hole during drilling (all conditions).
Proceed with Step 3.
In case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

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

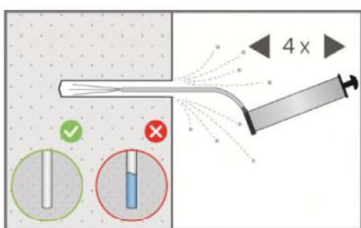
HP: Cleaning for dry and wet bore hole with diameter $d_0 \leq 20\text{mm}$ and bore hole depth $h_0 \leq 10d_{\text{nom}}$ (uncracked concrete only!)



- 2a.** Starting from the bottom or back of the bore hole, blow the hole clean with handpump (Annex B 4) a minimum of four times until return air stream is free of noticeable dust.



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



- 2c.** Finally blow the hole clean again with handpump (Annex B 4) a minimum of four times until return air stream is free of noticeable dust.

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.

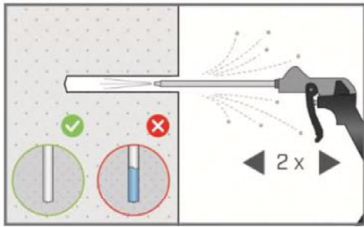
Rotho Blaas Injection system HYB - FIX for concrete

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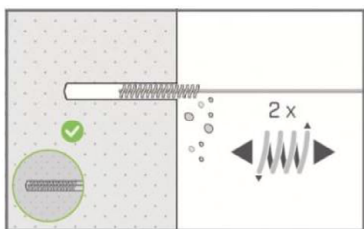
Annex B 5

Installation instructions (continuation)

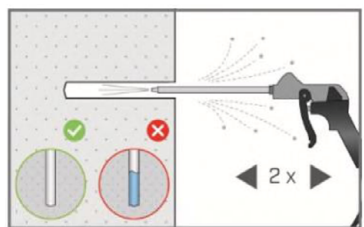
CAT: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete



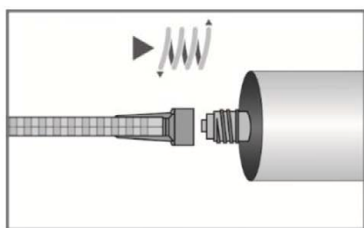
2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



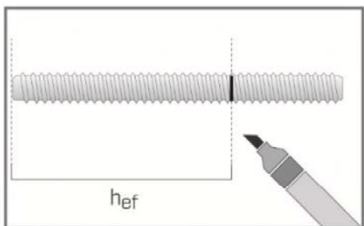
2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B5) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension shall be used (Table B5).



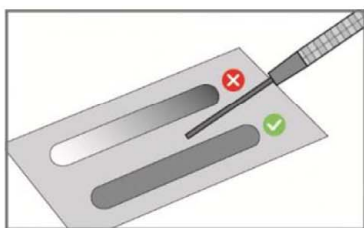
2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



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



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



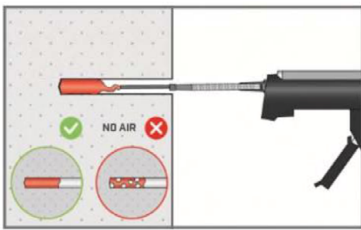
5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour.

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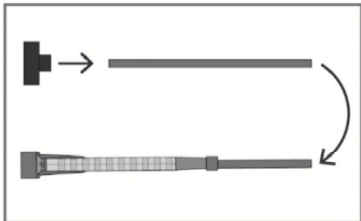
Intended Use
Installation instructions (continuation)

Annex B 6

Installation instructions (continuation)



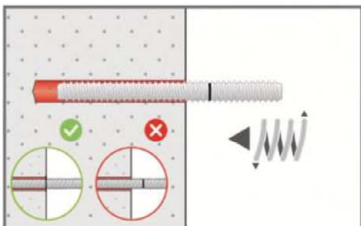
6. Starting from the bottom or back of the cleaned anchor hole, fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. Observe the gel-/ working times given in Table B5.



7. Piston plugs shall be used according to Table B4 for the following applications:
 - Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit- $\varnothing d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$ mm
 - Overhead assembly (vertical upwards direction): Drill bit- $\varnothing d_0 \geq 18$ mm
 Assemble mixing nozzle, extension and piston plug before injecting mortar.

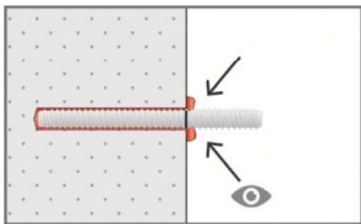


8. Insert piston plug to back of the hole and inject adhesive. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. During injection the piston plug is naturally pushed out of the borehole by the back pressure of the mortar. Observe the gel-/ working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

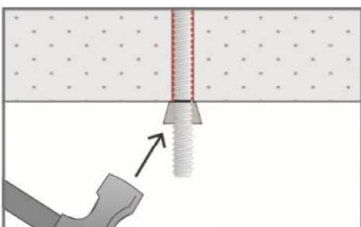


9. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment mark has reached the surface level.

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



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



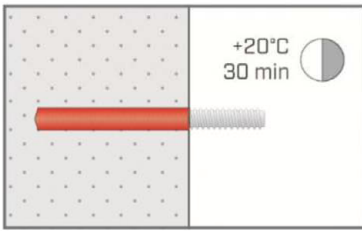
11. For overhead application the anchor rod shall be fixed (e.g. wedges) until the mortar has started to harden.

Rotho Blaas Injection system HYB - FIX for concrete

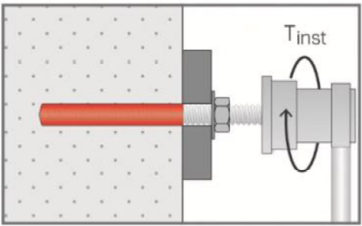
Intended Use
Installation instructions (continuation)

Annex B 7

Installation instructions (continuation)



12. Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B5).



13. After full curing, the add-on part can be installed with up to the max. torque (Table B1 or B3) by using a calibrated torque wrench. In case of prepositioned installation the annular gap between anchor and fixture can be optional filled with mortar. 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

Concrete temperature	Gelling working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
- 5 °C to - 1 °C	50 min	5 h	10 h
0 °C to + 4 °C	25 min	3,5 h	7 h
+ 5 °C to + 9 °C	15 min	2 h	4 h
+ 10 °C to + 14 °C	10 min	1 h	2 h
+ 15 °C to + 19 °C	6 min	40 min	80 min
+ 20 °C to + 29 °C	3 min	30 min	60 min
+ 30 °C to + 40 °C	2 min	30 min	60 min
Cartridge temperature	+5°C to +40°C		

Rotho Blaas Injection system HYB - FIX for concrete

Intended Use
Installation instructions (continuation)
Curing time

Annex B 8

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

Size			M8	M10	M12	M16	M20	M24	M27	M30	
Cross section area	A_s	[mm ²]	36,6	58	84,3	157	245	353	459	561	
Characteristic tension resistance, Steel failure ¹⁾											
Steel, Property class 4.6 and 4.8	$N_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224	
Steel, Property class 5.6 and 5.8	$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280	
Steel, Property class 8.8	$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449	
Stainless steel A2, A4 and HCR, class 50	$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281	
Stainless steel A2, A4 and HCR, class 70	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	_{3)}	_{3)}	
Stainless steel A4 and HCR, class 80	$N_{Rk,s}$	[kN]	29	46	67	126	196	282	_{3)}	_{3)}	
Characteristic tension resistance, Partial factor ²⁾											
Steel, Property class 4.6 and 5.6	$\gamma_{Ms,N}$	[-]	2,0								
Steel, Property class 4.8, 5.8 and 8.8	$\gamma_{Ms,N}$	[-]	1,5								
Stainless steel A2, A4 and HCR, class 50	$\gamma_{Ms,N}$	[-]	2,86								
Stainless steel A2, A4 and HCR, class 70	$\gamma_{Ms,N}$	[-]	1,87								
Stainless steel A4 and HCR, class 80	$\gamma_{Ms,N}$	[-]	1,6								
Characteristic shear resistance, Steel failure ¹⁾											
Without lever arm	Steel, Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Stainless steel A2, A4 and HCR, class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Stainless steel A2, A4 and HCR, class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	_{3)}	_{3)}
	Stainless steel A4 and HCR, class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	_{3)}	_{3)}
With lever arm	Steel, Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
	Stainless steel A2, A4 and HCR, class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
	Stainless steel A2, A4 and HCR, class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	_{3)}	_{3)}
	Stainless steel A4 and HCR, class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	_{3)}	_{3)}
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 ³⁾ Anchor type not part of the ETA											
Rotho Blas Injection system HYB - FIX for concrete									Annex C 1		
Performances Characteristic values for steel tension resistance and steel shear resistance of threaded rods											

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 $c_{cr,sp}$
Rotho Blaas Injection system HYB - FIX for concrete				Annex C 2
Performances Characteristic values for Concrete cone failure and Splitting with all kind of action				

Table C3: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years												
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 and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm ²]	17	17	16	15	14	13	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr}$	[N/mm ²]	17	17	16	15	14	13	13	13
	III: 120°C/72°C		$\tau_{Rk,ucr}$	[N/mm ²]	15	14	14	13	12	12	11	11
	IV: 160°C/100°C		$\tau_{Rk,ucr}$	[N/mm ²]	12	11	11	10	9,5	9,0	9,0	9,0
Characteristic bond resistance in cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	II: 80°C/50°C		$\tau_{Rk,cr}$	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	III: 120°C/72°C		$\tau_{Rk,cr}$	[N/mm ²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	IV: 160°C/100°C		$\tau_{Rk,cr}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Reduktion factor ψ_{sus}^0 in cracked and non-cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ_{sus}^0	[-]	0,90							
	II: 80°C/50°C				0,87							
	III: 120°C/72°C				0,75							
	IV: 160°C/100°C				0,66							
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	HP	γ_{inst}	[-]	1,2					No Performance assessed			
	CAT			1,0								
	HDB			1,2								
for flooded bore hole	CAT	1,4										
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 3		
Performances Characteristic values of tension loads under static and quasi-static action												

Table C4: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years												
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 and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm ²]	17	17	16	15	14	13	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	17	17	16	15	14	13	13	13
Characteristic bond resistance in cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm ²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
	II: 80°C/50°C		$\tau_{Rk,cr,100}$	[N/mm ²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
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	HP	γ_{inst}	[-]	1,2					No Performance assessed			
	CAT			1,0								
	HDB			1,2								
for flooded bore hole	CAT			1,4								
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 4		
Performances Characteristic values of tension loads under static and quasi-static action												

Table C5: Characteristic values of shear loads under static and quasi-static action											
Anchor size 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 and 5.6, 5.8	$V_{Rk,s}^0$	[kN]	0,6 · A _s · f _{uk} (or see Table C1)								
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A2, A4 and HCR, all strength classes	$V_{Rk,s}^0$	[kN]	0,5 · A _s · f _{uk} (or see Table C1)								
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1								
Ductility factor	k ₇	[-]	1,0								
Steel failure with lever arm											
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	1,2 · W _{el} · f _{uk} (or see Table C1)								
Elastic section modulus	W _{el}	[mm ³]	31	62	109	277	541	935	1387	1874	
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1								
Concrete pry-out failure											
Factor	k ₈	[-]	2,0								
Installation factor	γ_{inst}	[-]	1,0								
Concrete edge failure											
Effective length of fastener	l _f	[mm]	min(h _{ef} ; 12 · 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								
Rotho Blaas Injection system HYB - FIX for concrete									Annex C 5		
Performances Characteristic values of shear loads under static and quasi-static action											

Table C6: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years

Anchor size internal threaded anchor rods				IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20	
Steel failure¹⁾										
Characteristic tension resistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123	
Steel, strength class	8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196	
Partial factor, strength class 5.8 and 8.8	$\gamma_{Ms,N}$		[-]	1,5						
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		$N_{Rk,s}$	[kN]	14	26	41	59	110	124	
Partial factor	$\gamma_{Ms,N}$		[-]	1,87						
Combined pull-out and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm ²]	17	16	15	14	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr}$	[N/mm ²]	17	16	15	14	13	13
	III: 120°C/72°C		$\tau_{Rk,ucr}$	[N/mm ²]	14	14	13	12	12	11
	IV: 160°C/100°C		$\tau_{Rk,ucr}$	[N/mm ²]	11	11	10	9,5	9,0	9,0
Characteristic bond resistance in cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0
	II: 80°C/50°C		$\tau_{Rk,cr}$	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0
	III: 120°C/72°C		$\tau_{Rk,cr}$	[N/mm ²]	6,5	7,0	7,5	7,0	6,0	6,0
	IV: 160°C/100°C		$\tau_{Rk,cr}$	[N/mm ²]	5,5	6,0	6,5	6,0	5,5	5,5
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}	[-]	0,90					
	II: 80°C/50°C				0,87					
	III: 120°C/72°C				0,75					
	IV: 160°C/100°C				0,66					
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	HP	γ_{inst}	[-]	1,2		No Performance assessed				
	CAT			1,0						
	HDB			1,2						
for flooded bore hole	CAT			1,4						
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 IR-M20 strength class 50 is valid										
Rotho Blaas Injection system HYB - FIX for concrete								Annex C 6		
Performances Characteristic values of tension loads under static and quasi-static action										

Table C7: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years										
Anchor size internal threaded anchor rods				IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20	
Steel failure¹⁾										
Characteristic tension resistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123	
Steel, strength class	8.8	$N_{Rk,s}$	[kN]	16	27	46	67	121	196	
Partial factor, strength class 5.8 and 8.8	$\gamma_{Ms,N}$		[-]	1,5						
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 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 and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm ²]	17	16	15	14	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	17	16	15	14	13	13
Characteristic bond resistance in cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm ²]	6,0	6,5	6,5	6,5	6,5	6,5
	II: 80°C/50°C		$\tau_{Rk,cr,100}$	[N/mm ²]	6,0	6,5	6,5	6,5	6,5	6,5
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	HP	γ_{inst}	[-]	1,2			No Performance assessed			
	CAT			1,0						
	HDB			1,2						
for flooded bore hole	CAT	1,4								
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 IR-M20 strength class 50 is valid										
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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 for internal threaded anchor rods				IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20
Steel failure without lever arm¹⁾									
Characteristic shear resistance, Steel, strength class	5.8	$V_{Rk,s}^0$	[kN]	5	9	15	21	38	61
	8.8	$V_{Rk,s}^0$	[kN]	8	14	23	34	60	98
Partial factor, strength class 5.8 and 8.8	$\gamma_{Ms,V}$		[-]	1,25					
Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾	$V_{Rk,s}^0$		[kN]	7	13	20	30	55	40
	$\gamma_{Ms,V}$		[-]	1,56					
Ductility factor	k_7		[-]	1,0					
Steel failure with lever arm¹⁾									
Characteristic bending moment, Steel, strength class	5.8	$M_{Rk,s}^0$	[Nm]	8	19	37	66	167	325
	8.8	$M_{Rk,s}^0$	[Nm]	12	30	60	105	267	519
Partial factor, strength class 5.8 and 8.8	$\gamma_{Ms,V}$		[-]	1,25					
Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70 ²⁾	$M_{Rk,s}^0$		[Nm]	11	26	52	92	233	456
	$\gamma_{Ms,V}$		[-]	1,56					
Concrete pry-out failure									
Factor	k_8		[-]	2,0					
Installation factor	γ_{inst}		[-]	1,0					
Concrete edge failure									
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300\text{mm})$
Outside diameter of fastener	d_{nom}	[mm]	10	12	16	20	24	30	
Installation factor	γ_{inst}		[-]	1,0					
¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element. ²⁾ For IR-M20 strength class 50 is valid									
Rotho Blaas Injection system HYB - FIX for concrete								Annex C 8	
Performances Characteristic values of shear loads under static and quasi-static action									

Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years													
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$									
Cross section area		A_s	[mm ²]	50	79	113	154	201	314	452	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 and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm ²]	14	14	14	14	13	13	13	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr}$	[N/mm ²]	14	14	14	14	13	13	13	13	13
	III: 120°C/72°C		$\tau_{Rk,ucr}$	[N/mm ²]	13	12	12	12	12	11	11	11	11
	IV: 160°C/100°C		$\tau_{Rk,ucr}$	[N/mm ²]	9,5	9,5	9,5	9,0	9,0	9,0	9,0	8,5	8,5
Characteristic bond resistance in cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0
	II: 80°C/50°C		$\tau_{Rk,cr}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0
	III: 120°C/72°C		$\tau_{Rk,cr}$	[N/mm ²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0
	IV: 160°C/100°C		$\tau_{Rk,cr}$	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0
Reduktion factor ψ_{sus}^0 in cracked and non-cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ_{sus}^0	[-]	0,90								
	II: 80°C/50°C				0,87								
	III: 120°C/72°C				0,75								
	IV: 160°C/100°C				0,66								
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	HP	γ_{inst}	[-]	1,2					No Performance assessed				
	CAT			1,0									
	HDB			1,2									
for flooded bore hole	CAT	1,4											
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation													
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Performances			Characteristic values of tension loads under static and quasi-static action										

Table C10: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size reinforcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Steel failure													
Characteristic tension resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}^{1)}$										
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	452	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 and flooded bore hole	$\tau_{Rk,ucr,100}$	[N/mm ²]	14	14	14	14	13	13	13	13	13
	II: 80°C/50°C		$\tau_{Rk,ucr,100}$	[N/mm ²]	14	14	14	14	13	13	13	13	13
Characteristic bond resistance in cracked concrete C20/25													
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr,100}$	[N/mm ²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0
	II: 80°C/50°C		$\tau_{Rk,cr,100}$	[N/mm ²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0
Increasing factors for concrete ψ_c		C25/30		1,02									
		C30/37		1,04									
		C35/45		1,07									
		C40/50		1,08									
		C45/55		1,09									
		C50/60		1,10									
Concrete cone failure													
Relevant parameter		see Table C2											
Splitting													
Relevant parameter		see Table C2											
Installation factor													
for dry and wet concrete	HP	γ_{inst}	[-]	1,2				No Performance assessed					
	CAT			1,0									
	HDB			1,2									
for flooded bore hole	CAT	1,4											
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation													
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 10			
Performances Characteristic values of tension loads under static and quasi-static action													

Table C11: Characteristic values of shear loads under static and quasi-static action														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Steel failure without lever arm														
Characteristic shear resistance	$V_{Rk,s}^0$	[kN]	$0,50 \cdot A_s \cdot f_{uk}^{1)}$											
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾											
Ductility factor	k_7	[-]	1,0											
Steel failure with lever arm														
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	$1,2 \cdot W_{el} \cdot f_{uk}^{1)}$											
Elastic section modulus	W_{el}	[mm ³]	50	98	170	269	402	785	1357	1534	2155	3217		
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾											
Concrete pry-out failure														
Factor	k_8	[-]	2,0											
Installation factor	γ_{inst}	[-]	1,0											
Concrete edge failure														
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300\text{mm})$					
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	24	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														
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 11				
Performances			Characteristic values of shear loads under static and quasi-static action											

Table C12: Displacements under tension load¹⁾ (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 for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424

¹⁾ Calculation of the displacement

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

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

Table C13: Displacements under shear load²⁾ (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Non-cracked and cracked concrete 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

²⁾ Calculation of the displacement

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

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

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

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Table C14: Displacements under tension load¹⁾ (Internal threaded rod)								
Anchor size Internal threaded rod			IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20
Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,037	0,039	0,042	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,047	0,051	0,054	0,060
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,034	0,035	0,038	0,041	0,044	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,044	0,045	0,049	0,053	0,056	0,062
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,126	0,131	0,142	0,153	0,163	0,179
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,129	0,135	0,146	0,157	0,168	0,184
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,083	0,085	0,090	0,095	0,099	0,106
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,170	0,110	0,116	0,122	0,128	0,137
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,086	0,088	0,093	0,098	0,103	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,111	0,114	0,121	0,127	0,133	0,143
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,321	0,330	0,349	0,367	0,385	0,412
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,330	0,340	0,358	0,377	0,396	0,424
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 C15: Displacements under shear load²⁾ (Internal threaded rod)								
Anchor size Internal threaded rod			IR-M6	IR-M8	IR-M10	IR-M12	IR-M16	IR-M20
Non-cracked and cracked concrete 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
²⁾ Calculation of the displacement $\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load $\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;								
Rotho Blaas Injection system HYB - FIX for concrete							Annex C 13	
Performances Displacements under static and quasi-static action (Internal threaded anchor rod)								

Table C16: Displacements under tension load¹⁾ (rebar)												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Non-cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temperature range I: 40°C/24°C II: 80°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,108
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature range III: 120°C/72°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature range IV: 160°C/100°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,321	0,330	0,340	0,349	0,358	0,377	0,396	0,396	0,410	0,449
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 C17: Displacements under shear load²⁾ (rebar)												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Non-cracked and cracked concrete 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	0,03
	$\delta_{V\infty}$ -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04
²⁾ Calculation of the displacement $\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V : action shear load $\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;												
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 14		
Performances Displacements under static and quasi-static action (rebar)												

Table C18: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years												
Anchor size threaded rod				M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure												
Characteristic tension resistance		$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$								
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1								
Combined pull-out and concrete failure												
Characteristic bond resistance in cracked and non-cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	II: 80°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
	III: 120°C/72°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
	IV: 160°C/100°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0								
Installation factor												
for dry and wet concrete		CAT	γ_{inst}	[-]	1,0							
		HDB			1,2							
for flooded bore hole		CAT			1,4							
Table C19: 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												
Characteristic shear resistance (Seismic C1)		$V_{Rk,s,eq,C1}$	[kN]	$0,70 \cdot V^0_{Rk,s}$								
Partial factor		$\gamma_{Ms,V}$	[-]	see Table C1								
Factor for annular gap		α_{gap}	[-]	$0,5 (1,0)^{1)}$								
¹⁾ Value in brackets valid for filled annular gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended												
Rotho Blaas Injection system HYB - FIX for concrete										Annex C 15		
Performances Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (threaded rod)												

Table C20: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Steel failure														
Characteristic tension resistance		$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot A_s \cdot f_{uk}^{1)}$										
Cross section area		A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 ²⁾										
Combined pull-out and concrete failure														
Characteristic bond resistance in cracked and non-cracked concrete C20/25														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	II: 80°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
	III: 120°C/72°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
	IV: 160°C/100°C		$\tau_{Rk,eq,C1}$	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0										
Installation factor														
for dry and wet concrete		CAT	γ_{inst}	[-]	1,0									
		HDB			1,2									
for flooded bore hole		CAT			1,4									
¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars ²⁾ in absence of national regulation														
Table C21: Characteristic values of shear loads under seismic action (performance category C1)														
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Steel failure														
Characteristic shear resistance		$V_{Rk,s,eq}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$										
Cross section area		A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor		$\gamma_{Ms,V}$	[-]	1,5 ²⁾										
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 gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended														
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Performances Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (rebar)														

**Table C22: Characteristic values of tension loads under seismic action
(performance category C2) for a working life of 50 and 100 years**

Anchor size threaded rod		M12	M16	M20	M24			
Steel failure								
Characteristic tension resistance, Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥ 70	$N_{Rk,s,eq,C2}$	[kN]	$1,0 \cdot N_{Rk,s}$					
Partial factor	$\gamma_{Ms,N}$	[-]	see Table C1					
Combined pull-out and concrete failure								
Characteristic bond resistance in cracked and non-cracked concrete C20/25								
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C2}$	[N/mm ²]	3,6	3,5	3,3	2,3
	II: 80°C/50°C		$\tau_{Rk,eq,C2}$	[N/mm ²]	3,6	3,5	3,3	2,3
	III: 120°C/72°C		$\tau_{Rk,eq,C2}$	[N/mm ²]	3,1	3,0	2,8	2,0
	IV: 160°C/100°C		$\tau_{Rk,eq,C2}$	[N/mm ²]	2,5	2,7	2,5	1,8
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0				
Installation factor								
for dry and wet concrete	CAT	γ_{inst}	[-]	1,0				
	HDB			1,2				
for flooded bore hole	CAT			1,4				

**Table C23: Characteristic values of shear loads under seismic action
(performance category C2)**

Anchor size threaded rod		M12	M16	M20	M24
Steel failure					
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥ 70	$V_{Rk,s,eq,C2}$	[kN]	$0,70 \cdot V^0_{Rk,s}$		
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1		
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) ¹⁾		

¹⁾ Value in brackets valid for filled annular gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended

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Characteristic values of tension and shear loads under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)

Annex C 17

Table C24: Displacements under tension load¹⁾ (threaded rod)						
Anchor size threaded rod			M12	M16	M20	M24
Cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{N,eq,C2(DLS)}$	[mm]	0,24	0,27	0,29	0,27
	$\delta_{N,eq,C2(ULS)}$	[mm]	0,55	0,51	0,50	0,58
Table C25: Displacements under shear load (threaded rod)						
Anchor size threaded rod			M12	M16	M20	M24
Cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{V,eq,C2(DLS)}$	[mm]	3,6	3,0	3,1	3,5
	$\delta_{V,eq,C2(ULS)}$	[mm]	7,0	6,6	7,0	9,3
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Performances Displacements under seismic action (performance category C2) (threaded rods)						