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European Technical Assessment Body for construction products



European Technical Assessment

ETA-11/0418 of 4 December 2025

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the **European Technical Assessment:**

Trade name of the construction product

Product family

to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment contains

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

This version replaces

Deutsches Institut für Bautechnik

Upat Injection system UPM 55

Bonded fasteners and bonded expansion fasteners for use in concrete

Upat Vertriebs GmbH Bebelstraße 11 79108 Freiburg im Breisgau **DEUTSCHLAND**

Upat

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

EAD 330499-02-0601, Edition 12/2023

ETA-11/0418 issued on 30 September 2016

Z078709.25

European Technical Assessment ETA-11/0418

English translation prepared by DIBt



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Specific Part

1 Technical description of the product

The "Upat Injection system UPM 55" is a bonded fastener consisting of a cartridge with injection mortar UPM 55 and a steel element according to Annex 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 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 B3 to B12, C1 to C16, C19, C21, C23, C24, C25 to C34
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C1 to C4, C20, C22, C23, C24
Displacements under short-term and long-term loading	See Annex C17, C18, C35, C36
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C37 to C47

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance			
Reaction to fire	Class A1			
Resistance to fire	See Annex C48 to C51			

3.3 Hygiene, health and the environment (BWR 3)

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

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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 330499-02-0601 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 4 December 2025 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock Head of Section beglaubigt: Baderschneider

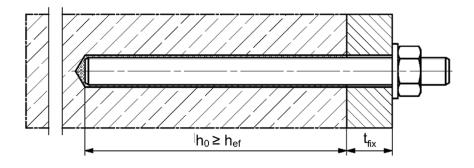
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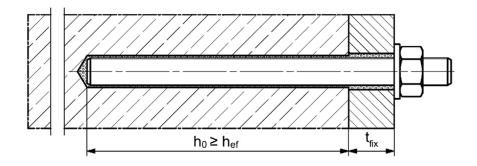
Installation conditions part 1

Upat Anchor rod UPM A / ASTA (Anchor rod) and commercial standard threaded rod (Threaded rod)

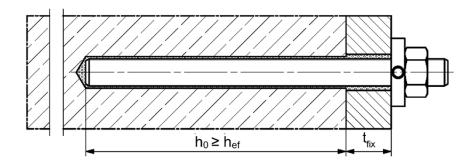
Pre-positioned installation



Push through installation (annular gap filled with mortar)



Pre-positioned or push through installation with subsequently injected filling disc (annular gap filled with mortar)



 h_0 = drill hole depth

h_{ef} = effective embedment depth

 t_{fix} = thickness of fixture

Figures not to scale

Upat Injection	system	UPM	55
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Product description

Installation conditions part 1

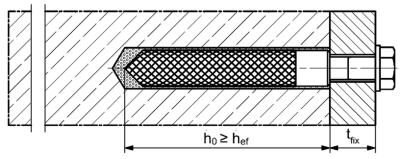
Annex A1



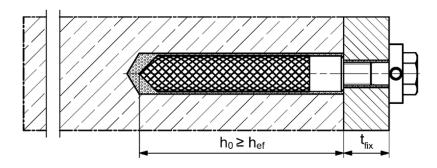
Installation conditions part 2

Upat internal threaded anchor IST (Upat IST)

Pre-positioned installation



Pre-positioned installation with subsequently injected filling disc (annular gap filled with mortar)



Figures not to scale

 h_0 = drill hole depth

hef = effective embedment depth

 t_{fix} = thickness of fixture

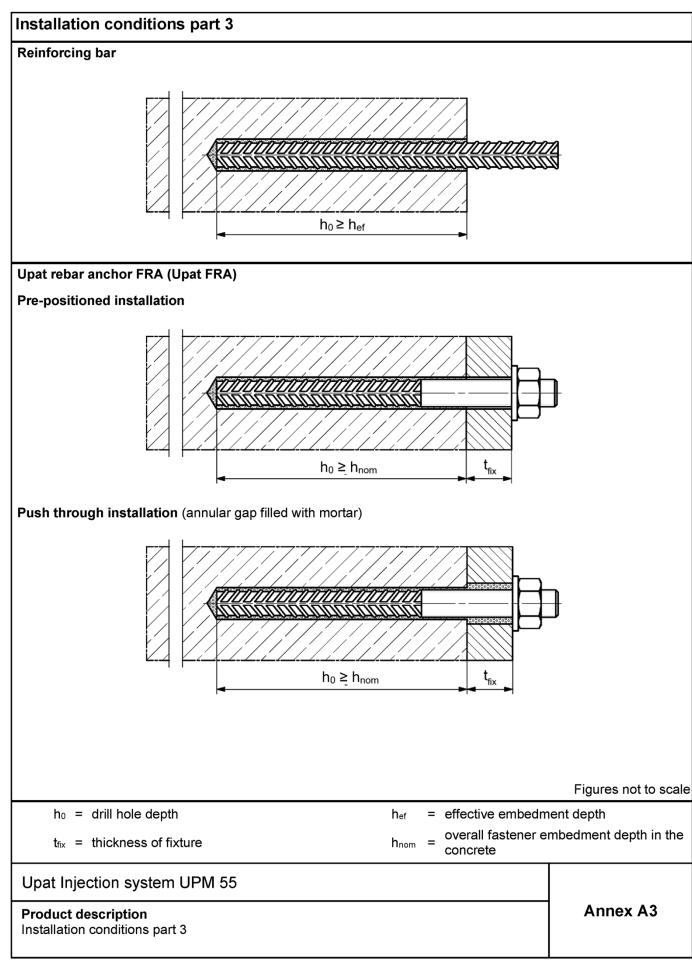
Upat Injection system UPM 55

Product description

Installation conditions part 2

Annex A2







Overview system components part 1	
Injection cartridge (shuttle cartridge) with sealing cap; Size: 390 ml, 585 ml, 1500 ml	
Imprint: UPM 55, processing notes, shelf-life, piston travel scale (optional), curing times and processing times (depending temperature), hazard code, size, volume.	on
Static mixer Upat MR Plus for injection cartridges 390 ml	
Static mixer Upat UMR for injection cartridges > 390 ml	
Injection adapter and extension tube Ø 9 for static mixer Upat MR Plus; Injection adapter and extension tube Ø 9 or Ø 15 for static mixer Upat UMR	
	∃
Cleaning brush UP BS / UP BSB	
Compressed-air cleaning tool ABP	
	Figures not to scale
Upat Injection system UPM 55	
Product description Overview system components part 1; cartridges / static mixer / accessories	Annex A4



Overview system components part 2

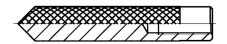
Anchor rod / Threaded rod

Metric size: M8, M10, M12, M14, M16, M20, M22, M24, M27, M30

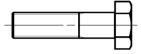
Fractional size: 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1 1/8"

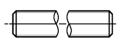
Upat IST

Metric size: M8, M10, M12, M16, M20 Fractional size: 3/8", 1/2", 5/8", 3/4"



Screw / Anchor rod / Threaded rod / washer / hexagon nut

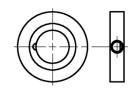








filling disc with injection adapter

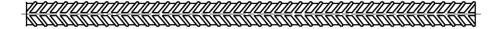




Reinforcing bar

Nominal diameter,

Metric size: $\phi 8$, $\phi 10$, $\phi 12$, $\phi 14$, $\phi 16$, $\phi 18$, $\phi 20$, $\phi 22$, $\phi 24$, $\phi 25$, $\phi 26$, $\phi 28$, $\phi 30$, $\phi 32$, $\phi 34$, $\phi 36$, $\phi 40$ Fractional size: #3 (3/8"), #4 (1/2"), #5 (5/8"), #6 (3/4"), #7 (7/8"), #8 (1"), #9 (1,128"), #10 (1,270")



Upat FRA

Metric size: M12, M16, M20, M24



Figures not to scale

Upat Injection system UPM 55

Product description

Overview system components part 2;

steel components

Annex A5



Table A6.1: Materials, metric sizes									
Part	Designation		Material						
1	Injection cartridge								
		Steel	Stainless steel R	High corrosion resistant steel HCR					
	Steel grade	zinc plated (zp, hdg)	acc. to EN 10088-1: 2023 Corrosion resistance class CRC III acc. to EN 1993-1-4: 2006+A1:2015	acc. to EN 10088-1: 2023 Corrosion resistance class CRC V acc. to EN 1993-1-4: 2006+ A1:2015					
2	Anchor rod / Threaded rod	Property class 4.8, 5.8 or 8.8; EN ISO 898-1:2013 $zp \ge 5 \mu m$, EN ISO 4042:2022 or hot dip galvanised ≥ 40 μm EN ISO 10684:2004+AC:2009 $f_{uk} \le 1000 \text{ N/mm}^2$ A ₅ > 12 % fracture elongation 1)	Property class 50, 70 or 80; EN ISO 3506-1:2020 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; 1.4062; 1.4662; 1.4462; EN 10088-1: 2023 $f_{uk} \le 1000 \text{ N/mm}^2$ A ₅ > 12 % fracture elongation 1)	Property class 50, 70 or 80; EN ISO 3506-1:2020 or property class HCR 70 with f_{yk} = 560 N/mm ² ; 1.4565;1.4529; EN 10088-1: 2023 $f_{uk} \le 1000$ N/mm ² A ₅ > 12 % fracture elongation ¹					
3	Washer ISO 7089:2000	zinc plated ≥ 5 μm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 μm EN ISO 10684:2004+AC:2009	1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1: 2023	1.4565; 1.4529; EN 10088-1: 2023					
4	Hexagon nut	Property class 5 or 8 acc. EN ISO 898-2:2022 zinc plated ≥ 5 μm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 μm EN ISO 10684:2004+AC:2009	Property class 50, 70 or 80 acc. EN ISO 3506-2:2020 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1: 2023	Property class 50, 70 or 80 acc. EN ISO 3506-2:2020 1.4565; 1.4529; EN 10088-1: 2023					
5	Upat IST	EN ISO 898-1:2013 EN ISO 3506-1:2020; EN IS zinc plated ≥ 5 µm, 1.4401; 1.4404; 1.4578; 1.4		Property class 70 EN ISO 3506-1:2020 1.4565; 1.4529; EN 10088-1: 2023					
6	Commercial standard screw or Anchor rod / Threaded rod for Upat IST	Property class 5.8 or 8.8; EN ISO 898-1:2013 zinc plated ≥ 5 µm, EN ISO 4042:2022 A₅ > 8 % fracture elongation	Property class 70 EN ISO 3506-1:2020 1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1: 2023 A ₅ > 8 % fracture elongation	Property class 70 EN ISO 3506-1:2020 1.4565; 1.4529; EN 10088-1: 2023 A ₅ > 8 % fracture elongation					
7	filling disc similar to DIN 6319-G	zinc plated ≥ 5 μm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 μm EN ISO 10684:2004+AC:2009	1.4401; 1.4404; 1.4578; 1.4571; 1.4439; 1.4362; EN 10088-1: 2023	1.4565;1.4529; EN 10088-1: 2023					
8	Rebar	EN 1992-1-1:2004 and AC:2010 Bars and de-coiled rods, class I according to EN 1992-1-1/NA; f	B or C with fyk and k according to	NDP or NCI					
Rebar part: Bars and de-coiled rods class B or C with f_{yk} and k according to NDP or NCI of EN 1992-1-1:2004+AC:2010 $f_{tuk} = f_{tk} = k \cdot f_{yk} (A_5 > 8 \%)$ Threaded part: Property class 80 EN ISO 3506-1:2020 The state of the stat									
¹⁾ F	racture elongation	A ₅ > 8 %, for applications withou	t requirements for seismic perfo	rmance category C1 or C2.					
Upat Injection system UPM 55 Product description part 1 Materials, metric sizes All									



Part	Designation	Mat	erial					
1	Injection cartridge	Mortar, har	dener, filler					
		Steel	Stainles	s steel R				
	Steel grade	zinc plated (zp, hdg)		e class CRC III acc. to : 2006+A1:2015				
2	Fractional Threaded rod	$\begin{array}{c} ASTM \ F568M-07, \ Class \ 5.8 \\ f_{uk} = 500 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ F1554-20, \ Grade \ 36 \\ f_{uk} = 400 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ F1554-20, \ Grade \ 55 \\ f_{uk} = 517 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m; \ EN \ ISO \ 4042:2022 \\ ASTM \ F1554-20, \ Grade \ 105 \\ f_{uk} = 862 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ A193/A193M-23, \ Grade \ B7 \\ f_{uk} = 862 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ S \ The \ F150 \ 4042:2022 \\ ASTM \ A193/A193M-23, \ Grade \ B7 \\ f_{uk} = 862 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ A193/A193M-23, \ Grade \ B7 \\ f_{uk} = 862 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ Zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ A193/A193M-23, \ Grade \ B7 \\ F_{uk} = 862 \ N/mm^2, A_5 > 12 \ \% \ fracture \ elongation \ ^1); \\ Zinc \ plated \ge 5 \ \mu m, \ EN \ ISO \ 4042:2022 \\ ASTM \ A193/A193M-23, \ Grade \ B7 \\ A193/A193M-23, \ Grade \ B7 \\ A293/A193M-23, \ Grade \ B7 \\ A393/A193M-23, \ Grade $	$\begin{array}{c} f_{uk} = 689 \ N/mm^2, \\ f_{uk} = 586 \ N/mm^2, \\ A_5 > 12 \ \% \ fract \\ ASTM \ A193/A193M-2 \\ f_{uk} = 517 \ N/mm^2, \ A_5 > 12 \\ ASTM \ A193/A193M-2 \\ f_{uk} = 655 \ N/mm^2, \ A_5 > 12 \\ \end{array}$	B, Grade B8M, Class 2B				
3	Washer	ASTM F436/F436M-19 zinc plated ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009	ASTM A240/A24	0M-23a Type 316				
4	Hexagon nut	ASTM A563/A563M-23, Grade DH or ASTM A194/A194M-23, Grade 2H for Threaded rod material ASTM F568M-07, Class 5.8 or ASTM F1554-20, Grade 36, 55, 105 ASTM A194/A194M-23, Grade 2H / 4 / 7 for Threaded rod material ASTM A193/A193M-23, B7 zinc plated ≥ 5 μm, EN ISO 4042:2022	for Threaded ASTM F593M-13a ASTM A193/A19 for Threaded ASTM A193/A193M-2	ae1, Alloy Group 2 I rod material: ae1, Alloy Group 2 / 3M-23, Grade 8M I rod material: 3, Grade B8M, Class 1 or 3, Grade B8M, Class 2B				
5	Upat IST	Property class 5.8 EN ISO 898-1:2013 zinc plated ≥ 5 μm, ISO 4042:2022	1.4401; 1.4404; 1.4578;	EN ISO 3506-1:2020; ; 1.4571; 1.4439; 1.4362 8-1: 2023				
6	Commercial standard screw or Threaded rod for Upat IST	See Table A7.1, line 2, steel zinc plated, EN ISO 4042:2022		A7.1, line 2, s steel R				
7	filling disc similar to DIN 6319-G	zinc plated ≥ 5 µm, EN ISO 4042:2022 or hot dip galvanised ≥ 40 µm EN ISO 10684:2004+AC:2009	1.4571; 1.4	404; 1.4578; 439; 1.4362; 88-1:2023				
8 Reinforcing bar								
¹⁾ F	racture elongat	ion A ₅ > 8 %, for applications without requirement	s for seismic performanc	e category C1 or C2.				
	-	ystem UPM 55		A				
	duct descripti erials, fractiona			Annex A7				



Specifications of intended use part 1 Overview use and performance categories Anchorages subject to **UPM 55 with ...** Anchor rod / Upat IST Reinforcing bar Upat FRA Threaded rod KKKKKKKKKKKK Hammer drilling with standard drill all sizes bit Nominal drill bit diameter (d₀) Hammer drilling 12 mm to 35 mm; 7/16" to 1 3/8" with hollow drill bit (fischer "FHD", Heller "Duster Expert"; Bosch "Speed Clean"; Hilti "TE-CD, TE-YD", DreBo "D-Plus", DreBo "D-Max") Diamond drilling all sizes Annexes: Annexes: Annexes: M12 **M8** M8 Annexes: ф8 C3, C4, C3, C4, Metric C1. to C2, C4, C7, to to to C4 - C6. C9 - C13 C14 - C16sizes M30 M20 C8, C17 φ40 M24 Static and quasi C17 C18 C18 static load, in Annexes: uncracked / Annexes: Annexes: 3/8" 3/8" C21, C22, #3 cracked concrete Fractional C19, C20, C23, C24, _1) to to C24, to C24 - C28. C32 - C34. sizes 1 1/8 3/4" C29 - C31#10 C35 C36 C35 M10 Annexes: φ10 Annexes: C37, C39, C38, C39, to to Seismic M30 C40 C41 ф32 performance C1 3/8" Annexes: #3 Annexes: category to C43, C45, to C44, C45, (only hammer _1) _1) 1 1/8" C46 #10 C47 drilling with M12 standard / hollow Annexes: M16 _1) drill bits) C2 C38, C39, M20 C42 M24 dry or wet all sizes 11 concrete Use all sizes category water filled 12 (not permitted for diamond drilling in combination hole with cracked concrete and working life 100 years) Installation direction D3 (downward and horizontal and upwards (e.g. overhead) installation) $T_{i,min} = -5 \,^{\circ}C \text{ to } T_{i,max} = +40 \,^{\circ}C$ Installation temperature for the standard variation of temperature after installation Annexes: _1) Resistance to fire C48 - C51 Temperature (max. short term temperature +40 °C; -40 °C to +40 °C max. long term temperature +24 °C) range I (max. short term temperature +60 °C; Temperature In-service -40 °C to +60 °C max. long term temperature +35 °C) temperature range II Temperature (max. short term temperature +72 °C; -40 °C to +72 °C max. long term temperature +50 °C) range III 1) no performance assessed. Upat Injection system UPM 55 Annex B1 Intended use Specifications part 1



Specifications of intended use part 2

Base materials:

Compacted reinforced or unreinforced normal weight concrete without fibres of strength classes C20/25 to C50/60 according to EN 206:2013+A2:2021.

Use conditions (Environmental conditions):

- Fastener intended for use in 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 classes to Annex A6 table A6.1 (metric sizes) or Annex A7 Table A7.1 (fractional sizes).

Design:

- Fastenings are designed under the responsibility of an engineer experienced in fastenings and concrete work.
- Verifiable calculation notes and drawings are to be prepared taking account of the loads to be anchored. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fastenings are designed in accordance with: EN 1992-4:2018 and EOTA TR 082 from June 2023.

Installation:

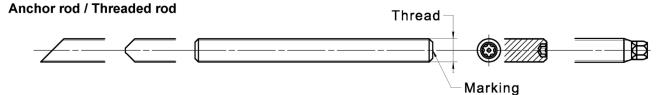
- Fastener installation is to be carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Fastening depth should be marked and adhered to installation.
- Overhead installation is allowed (necessary equipment see installation instruction).

Upat Injection system UPM 55	
Intended use Specifications part 2	Annex B2
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Table B3.1: Installation parameters for metric Anchor rods / Threaded rods													
Anchor rods / Threaded rods M8 M10 M						M12	M14	M16	M20	M22	M24	M27	M30
Nominal drill hole	diameter	d ₀		10	12	14	16	18	22 24 ¹⁾	25	28	30	35
Drill hole depth		h_0						h ₀ ≥	h _{ef}				
Effective		h _{ef, min}		60	60	70	75	80	90	93	96	108	120
embedment depth	า	h _{ef, max}		160	200	240	280	320	400	440	480	540	600
Diameter of the	pre-positioned installation	d _f	[mm]	9	12	14	16	18	22	24	26	30	33
clearance hole of the fixture	push through installation	d _f		12	14	16	18	20	26	28	30	33	40
Minimum thickness of concrete hember		h _{min}		ŀ	า _{ef} + 3()			h	1 _{ef} + 20	l o		
Maximum installa	tion torque	max T _{inst}	[Nm]	10	20	40	50	60	120	135	150	200	300

¹⁾ Both drill hole diameters can be used.



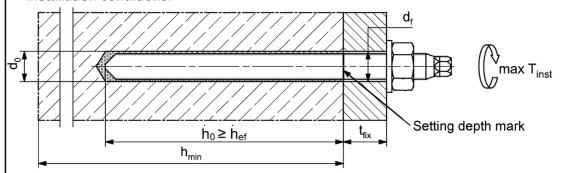
Marking (on random place) Upat anchor rod:

Steel zinc plated PC ¹⁾ 8.8	• or +	Steel hot-dip PC ¹⁾ 8.8	•
High corrosion resistant steel HCR PC 1) 50	•	High corrosion resistant steel HCR PC 1) 70	-
High corrosion resistant steel HCR PC 1) 80	(Stainless steel R property class 50	~
Stainless steel R property class 80	*		

Alternatively: Colour coding according to DIN 976-1:2016

1) PC = property class

Installation conditions:



Threaded rods, washers and hexagon nuts may also be used if the following requirements are fulfilled:

- Materials, dimensions and mechanical properties according to Annex A6, Table A6.1.
- Inspection certificate 3.1 according to EN 10204:2004, the documents have to be stored.
- Setting depth is marked.
- Steel load-bearing capacities for hot-dip galvanised parts are only valid if the threaded rod and nut are correctly paired. The strength class of the nut must be one strength class higher than that of the threaded rod (≥ M12 in combination with tolerance class 6AX in accordance with EN ISO 10684:2004+AC:2009 two strength classes higher). The pairing of undersized threaded rods (additional designation U according to EN ISO 10684) with oversized nuts (additional designation Z or X according to EN ISO 10684) is not permitted under any circumstances

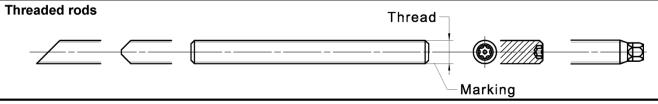
Figures not to scale

Upat Injection system UPM 55	
Intended use Installation parameters Anchor rods / Threaded rods (metric size)	Annex B3

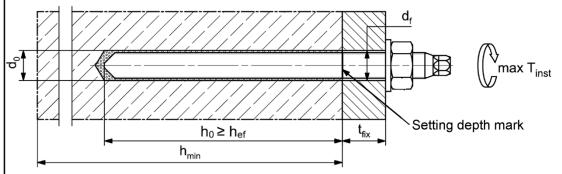


Table B4.1: Installation parameters for fractional Threaded rods										
Threaded rods		3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"		
Nominal drill hole diameter		d ο	[mm]	11,1	14,3	19,1	22,2	25,4	28,6	31,8
	e diameter	u ₀	[inch]	7/16	9/16	3/4	7/8	1	1 1/8	1 1/4
Drill hole depth		h ₀					h₀≥ h∈	ef		
Effective		$h_{\text{ef, min}}$		60,0	70,0	79,0	89,0	89,0	102,0	178,0
embedment dept	th	h _{ef, max}		191,0	254,0	318,0	381,0	445,0	508,0	572,0
Diameter of the	pre-positioned installation	d _f	[mm]	8,9	11,9	14,0	16,0	18,0	22,1	23,9
clearance hole of the fixture	push through installation	d _f		11,9	14,0	16,0	18,0	20,1	25,9	27,9
Minimum thickness of concrete h _{min}			h _{ef} -	+ 30			h _{ef} + 20	d 0		
Maximum installation torque max T _{inst} [Nm]			[Nm]	18	41	60	107	136	173	180

¹⁾ Both drill hole diameters can be used.



Installation conditions:



Additional requirements for Threaded rods, washers and hexagon nuts:

- Materials, dimensions, and mechanical properties according to Annex A7, Table A7.1.
- Inspection certificate 3.1 according to EN 10204:2004, the documents shall be stored.
- · Setting depth is marked.
- Steel load-bearing capacities for hot-dip galvanised parts are only valid if the threaded rod and nut are correctly paired. The strength class of the nut must be one strength class higher than that of the threaded rod (≥ M12 in combination with tolerance class 6AX in accordance with EN ISO 10684:2004+AC:2009 two strength classes higher). The pairing of undersized threaded rods (additional designation U according to EN ISO 10684) with oversized nuts (additional designation Z or X according to EN ISO 10684) is not permitted under any circumstances

Figures not to scale

Upat Injection system UPM 55

Intended use
Installation parameters Threaded rods (fractional size)

Annex B4



-	Minimum spacing and minimum edge distance for metric Anchor rods and metric reinforcing bars											
Metric Anchor rods			M8	M10	M12	M14	M16	-	M20	M22	M24	
Metric Reinforcing bars (nominal diameter)		ф	8	10	12	14	16	18	20	22	24	
Minimum edge distance												
Uncracked / cracked concrete	Cmin	[mm]	40	45	45	45	50	55	55	55	60	
Minimum spacing					;	accordii	ng to Ar	nnex B7	7			
Minimum spacing												
Uncracked / cracked concrete	[mm]	40	45	55	60	65	85	85	95	105		
Minimum edge distance	ן נייייון				accordii	ng to Ar	nnex B7	7				
Required projecting area												
Uncracked concrete		[1000	8,0	13,0	21,5	23,0	24,0	38,5	38,5	39,5	40,0	
Cracked concrete Asp,red		mm²]	~ -	400	40.	47.5	40.5	20.5	0	000	00.5	
Cracked concrete]	6,5	10,0	16,5	17,5	18,5	29,5	29,5	30,0	30,5	
		111111-1	6,5	10,0	·	17,5	·	29,5	29,5	30,0	30,5	
Anchor rods		-	<u>-</u>	-	M27	-	M30	-	-	-	-	
Anchor rods Reinforcing bars (nominal diam		ф	- 25	- 26	M27	- 28	·	- 32	- 34	- 36	- 40	
Anchor rods	eter)	ф	<u>-</u>	-	M27	-	M30	-	-	-	-	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance	eter)	-	- 25	- 26	M27 - 75	- 28	M30 30	- 32	- 34	- 36	- 40	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance Uncracked / cracked concrete	eter)	ф	- 25	- 26	M27 - 75	- 28	M30 30 80	- 32	- 34	- 36	- 40	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance Uncracked / cracked concrete Minimum spacing	eter)	ф [mm]	- 25	- 26	M27 - 75	- 28	M30 30 80	- 32	- 34	- 36	- 40	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance Uncracked / cracked concrete Minimum spacing Minimum spacing	eter) Cmin Smin	ф	- 25 75	- 26 75	M27 - 75	- 28 80 accordin	M30 30 80 ng to Ar	- 32 120 nnex B7	- 34 120	- 36	- 40	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance Uncracked / cracked concrete Minimum spacing Minimum spacing Uncracked / cracked concrete	eter) Cmin Smin	ф [mm]	- 25 75	- 26 75	M27 - 75	- 28 80 accordin	M30 30 80 ng to Ar	- 32 120 nnex B7	- 34 120	- 36	- 40	
Anchor rods Reinforcing bars (nominal diam Minimum edge distance Uncracked / cracked concrete Minimum spacing Minimum spacing Uncracked / cracked concrete Minimum edge distance	eter) Cmin Smin Smin Cmin	ф [mm]	- 25 75	- 26 75	M27 - 75	- 28 80 accordin	M30 30 80 ng to Ar	- 32 120 nnex B7	- 34 120	- 36	- 40	

Splitting failure for minimum edge distance and spacing in dependence of the effective embedment depth h_{ef} .

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depths and thicknesses of concrete members the following equation shall be fulfilled:

 $A_{sp,req} < A_{sp,t}$

 $A_{sp,req}$ = required projecting area,

A_{sp,t} = effective projecting area (according to **Annex B7**).

Upat Injection system UPM 55	
Intended use Minimum spacing and edge distance for Anchor rods and reinforcing bars	Annex B5



Table B6.1: Minimum spacing and minimum edge distance for fractional Threaded rods and reinforcing bars													
Fractional Threaded rods		3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	-				
Fractional Reinforcing bars	#3	#4	#5	#6	#7	#8	#9	#10					
Minimum edge distance													
Uncracked / cracked concrete	Cmin	[mm]	45	45	50	55	60	75	80	120			
Minimum spacing	Smin	[mm]	according to Annex B7										
Minimum spacing													
Uncracked / cracked concrete	Smin	[mm]	45	60	65	85	105	120	140	160			
Minimum edge distance	C _{min}	[mm]	according to Annex B7										
Required projecting area													
Uncracked concrete	. ^	[1000	12,5	21,0	24,5	36,0	39,5	43,5	40,5	64,5			
Cracked concrete	- A _{sp,req}	mm²]	9,5	16,0	18,5	27,5	30,0	33,5	31,0	49,5			

Splitting failure for minimum edge distance and spacing in dependence of the effective embedment depth h_{ef} .

For the calculation of minimum spacing and minimum edge distance of anchors in combination with different embedment depths and thicknesses of concrete members the following equation shall be fulfilled:

 $A_{sp,req} < A_{sp,t}$

 $A_{sp,req}$ = required projecting area,

A_{sp,t} = effective projecting area (according to **Annex B7**).

Upat Injection system UPM 55	
Intended use Minimum spacing and edge distance for Anchor rods and reinforcing bars	Annex B6



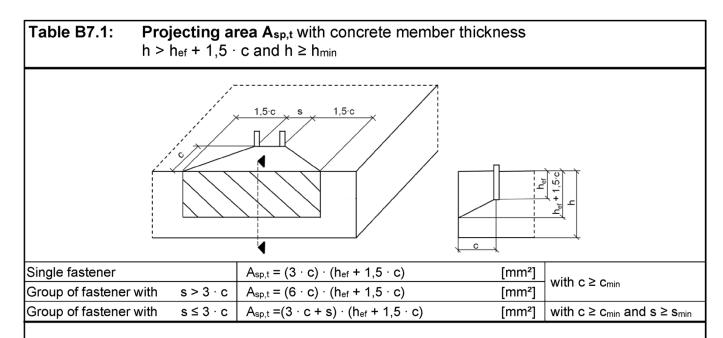
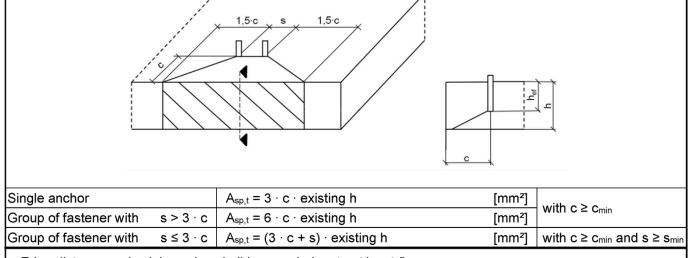


Table B7.2: Projecting area $A_{sp,t}$ with concrete member thickness $h \le h_{ef} + 1.5 \cdot c$ and $h \ge h_{min}$



Edge distance and axial spacing shall be rounded up to at least 5 mm.

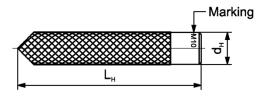
Figures not to scale

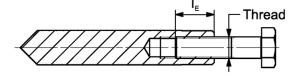
	9
Upat Injection system UPM 55	
Intended use Minimum thickness of concrete member for Anchor rods / Threaded rods, minimum spacing and edge distance	Annex B7



Table B8.1: Installation parameters for metric Upat IST													
Upat IST		Thread	М8	M10	M12	M16	M20						
Diameter of anchor	$d_{nom} = d_H$		12,0	15,7	18,0	22,0	28,0						
Nominal drill hole diameter	d ₀		14	18	20	24	32						
Drill hole depth	h_0] [$h_0 \geq h_{\text{ef}} = L_{\text{H}}$								
Effective embedment depth (hef = L _H)	h _{ef}		90	90	125	160	200						
Minimum spacing and minimum edge distance	S _{min} = C _{min}	[mm]	55	65	75	95	125						
Diameter of clearance hole in the fixture	d _f		9	12	14	18	22						
Minimum thickness of concrete member	h _{min}		120	125	165	205	260						
Maximum screw-in depth	$I_{E,max}$] [18	23	26	35	45						
Minimum screw-in depth	$I_{E,min}$	<u> </u>	8	10	12	16	20						
Maximum installation torque	max T _{inst}	[Nm]	10	20	40	80	120						

Upat IST





Marking:

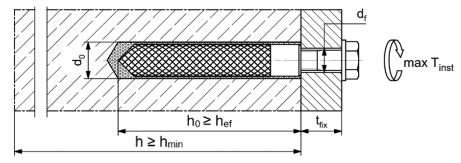
Anchor size e. g.: M10

Stainless steel → additional R; e.g.: M10 R

High corrosion resistant steel → additional HCR; e.g.: M10 HCR

Retaining screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of **Annex A6**, **Table A6.1**.

Installation conditions:



Figures not to scale

Upat Injection system UPM 55

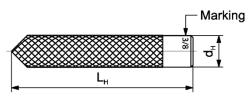
Intended use
Installation parameters internal threaded Upat IST (metric size)

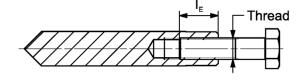
Annex B8



Table B9.1: Installation parameters for fractional Upat IST												
Upat IST		Thread	3/8"	1/2"	5/8"	3/4"						
Diameter of anchor	$d_{nom} = d_H$	[mama]	15,7	18	22	28						
Nominal drill hole	d₀	[mm]	18	20	24	32						
diameter	u ₀	[inch]	3/4	13/16	1	1 1/4						
Drill hole depth	h_0	$h_0 \ge h_{ef} = L_H$										
Effective embedment depth $(h_{ef} = L_H)$	\mathbf{h}_{ef}		90	125	160	200						
Minimum spacing and minimum edge distance	S _{min} = C _{min}		65	75	95	125						
Diameter of clearance hole in the fixture	d _f	[mm]	12	14	18	22						
Minimum thickness of concrete member	h _{min}		125	165	205	260						
Maximum screw-in depth	I _{E,max}] [23	26	35	45						
Minimum screw-in depth	$I_{E,min}$		10	12	16	20						
Maximum installation torque	max T _{inst}	[Nm]	20	40	80	120						

Upat IST



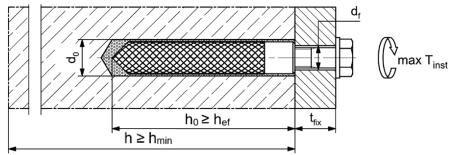


Marking: Anchor size e. g.: M 3/8

Stainless steel → additional R; e.g.: M 3/8 R

Retaining screw or threaded rods (including nut and washer) must comply with the appropriate material and strength class of **Annex A7**, **Table A7.1**.

Installation conditions:



Figures not to scale

Upat Injection system UPM 55

Intended use
Installation parameters internal threaded anchors Upat IST (fractional size)

Annex B9



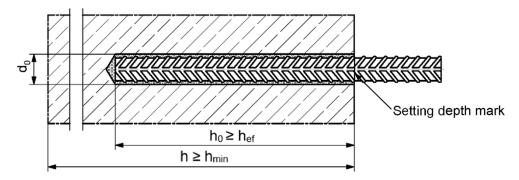
Table B10.1: Installation parameters for metric reinforcing bars 1)														
Nominal diameter of the bar		ф	8 ²⁾	10 ²⁾	12 ²⁾	14	16	18	20	22	24			
Nominal drill hole diameter	d ₀		10 12	12 14	14 16	18	20	25	25	30	30			
Drill hole depth	h ₀		h ₀ ≥ h _{ef}											
Effective	h _{ef,min}	[mm]	60	60	70	75	80	85	90	94	98			
embedment depth	h _{ef,max}	[!!!!!]	160	200	240	280	320	360	400	440	480			
Minimum thickness of concrete member	h _{min}		he	_f + 30		h _{ef} + 2d ₀								
Nominal diameter of the bar		ф	25	26	28	30	32	34	36	40				
Nominal drill hole diameter	d ₀		30	35	35	40	40	40	45	55	-			
Drill hole depth	h ₀		30	33	33	40	h ₀ ≥ h _{ef}		45	33				
Effective	h _{ef,min}	[mm]	100	104	112	120	128	136	144	160	-			
embedment depth	h _{ef,max}	[mm]	500	520	560	600	640	680	720	800	-			
Minimum thickness of concrete member	h _{min}						h _{ef} + 2d)						

¹⁾ Detailed calculation according to **Annex B7**.

Reinforcing bar

- The minimum value of related rib area f_{R,min} must fulfil the requirements of EN 1992-1-1:2004+AC:2010.
- The rib height must be within the range: $0.05 \cdot \phi \le h_{rib} \le 0.07 \cdot \phi$ (ϕ = Nominal diameter of the bar, h_{rib} = rib height).

Installation conditions:



Figures not to scale

Upat Injection system UPM 55

Intended use
Installation parameters reinforcing bars (metric size)

Annex B10

²⁾ Both drill hole diameters can be used.



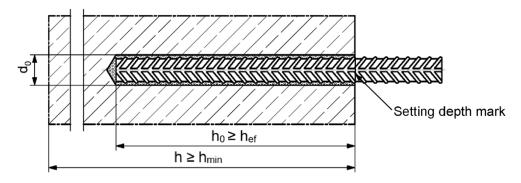
Table B11.1: Installation parameters for fractional reinforcing bars 1)													
Rebar size		#3	#4	#5	#6	#7	#8	#9	#10				
Nominal drill hole diameter	da	[mm]	12,7	15,9	19,1	22,2	28,6	31,8	34,9	38,1			
	d_0	[inch]	1/2	5/8	3/4	7/8	1 1/8	1 1/4	1 3/8	1 1/2			
Drill hole depth				h₀ ≥ h _{ef}									
Effective	$h_{\text{ef,min}}$		60	70	79	89	89	102	114	127			
embedment depth	h _{ef,max}	[mm]	191	254	318	381	445	508	572	635			
Minimum thickness h _{min}		h _{ef} -	h _{ef} + 30 h _{ef} + 2d ₀										

¹⁾ Detailed calculation according to **Annex B7**.

Reinforcing bar

Reinforcing bars, acc. to ASTM A615/A615M-22 (ASTM A767/A767M-19).
 Materials, dimensions, and mechanical properties according to Annex A7, Table A7.1.

Installation conditions:



Figures not to scale

Upat Injection system UPM 55

Intended use
Installation parameters reinforcing bars (fractional size)

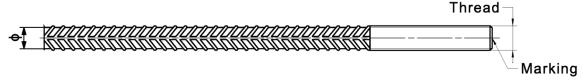
Annex B11



Upat FRA	•	Thread	M12	2 ¹⁾	M16	M20	M24	
Nominal diameter of the bar	ф		12	2	16	20	25	
Nominal drill hole diameter	d_0		14	16	20	25	30	
Drill hole depth	depth h ₀				h _{ef} + l _e	= h _{nom}		
Effective embedment death	h _{ef,min}		70)	80	90	96	
Effective embedment depth	h _{ef,max}		14	0	220	300	380	
Distance concrete surface to welded joint	le				100			
Minimum spacing and minimum edge distance	S _{min} = C _{min}	[mm]	55		65	85	105	
Diameter of anchorage	≤ d _f		14	1	18	22	26	
clearance hole push through anchorage	≤ d _f		18	3	22	26	32	
Minimum thickness of concrete member	h _{min}		h ₀ + 30			h ₀ + 2d ₀		
Maximum installation torque	max T _{inst}	[Nm]	40		60	120	150	

¹⁾ Both drill hole diameters can be used.

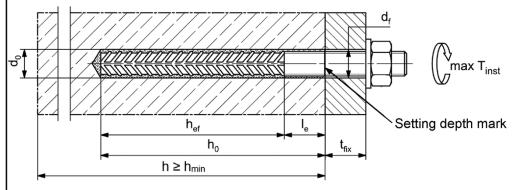
Upat FRA



Marking frontal e.g.: FRA (for stainless steel R)

FRA HCR (for high corrosion resistant steel HCR)

Installation conditions:



Figures not to scale

Upat Injection system UPM 55

Intended use

Installation parameters Upat FRA (metric size)

Annex B12



Table B13.1: Parameters of the **cleaning brush UP BS / UP BSB** (steel brush with steel bristles)

The size of the cleaning brush refers to the drill hole diameter.

Nominal drill	[mm]	10	12	14	16	18	20	22	24	25	28	30	32	35	40	45	55
hole diameter	[inch]	-	7/16	1/2	5/8	3/4	13	′16	,	1	1 1/8	1 ′	1/4	1 3/8	1 1/2	-	-
Steel brush db diameter BS	[mm]	11	14	16	2	0	2	5	26	27	30		40		-	-	-
Steel brush db	[mm]	-	-	-	-	-	-	-	-	-	-	-	-	-	42	47	58



Table B13.2: Conditions for use static mixer without an extension tube

Nominal o	llirk	[mm]	10	12	14	16	18	20	22	24	25	28	30	32	35	40	45	55
hole diameter	d ₀	[inch]	-	7/16	1/2	5/8	3/4	13/16	ı	1	-	1 1/8	1 1/4		1 3/8	1 1/2	ı	-
Drill hole	Upat MR Plus	[mm]	≤9	90	≤120	≤140	≤150	≤160	≤170	≤190				≤2	:10			
depth h₀ by using Upat UMR		[mm]		-		≤90		≤260							≤280			

Table B13.3: Maximum processing time of the mortar and minimum curing time (During the curing time of the mortar the concrete temperature may not fall below the listed minimum temperature)

Temperature at anchoring base [°C]	Maximum processing time $t_{\scriptscriptstyle work}$	Minimum curing time 1) t _{cure}
-5 to 0 ²⁾	240 min	200 h
> 0 to 5 ²⁾	150 min	90 h
> 5 to 10	120 min	40 h
> 10 to 20	30 min	18 h
> 20 to 30	14 min	10 h
> 30 to 40	7 min	5 h

¹⁾ In wet concrete or water filled holes the curing times must be doubled.

Upat Injection system UPM 55	
Intended use Cleaning brush (steel brush) Processing time and curing time	Annex B13

²⁾ Minimal cartridge temperature +5 °C.

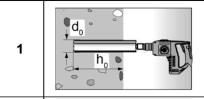


Installation instructions part 1 Drilling and cleaning the hole (hammer drilling with standard drill bit) Drill the hole. 1 Nominal drill hole diameter \textbf{d}_0 and drill hole depth \textbf{h}_0 see Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1. Cleaning the drill hole: 2 Blow out the drill hole twice, with oil-free compressed air (p ≥ 6 bar). Brush the drill hole twice. For drill hole diameter ≥ 30 mm use a power drill. 3 For deep holes use an extension. Corresponding brushes see Table B13.1. Cleaning the drill hole: Blow out the drill hole twice, with oil-free 4 compressed air ($p \ge 6$ bar). Go to step 6 Drilling and cleaning the hole (hammer drilling with hollow drill bit) Check a suitable hollow drill (see Table B1.1) 1 for correct operation of the dust extraction. Use a suitable dust extraction system, e. g. fischer FVC 35 M or a comparable dust extraction system with equivalent performance data. 2 Drill the hole with hollow drill bit. The dust extraction system has to extract the drill dust nonstop during the drilling process and must be adjusted to maximum power. Nominal drill hole diameter do and drill hole depth ho see Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1. Go to step 6 Upat Injection system UPM 55 **Annex B14** Intended use Installation instructions part 1

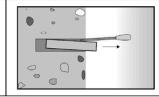


Installation instructions part 2

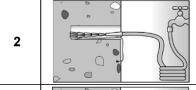
Drilling and cleaning the hole (wet drilling with diamond drill bit)



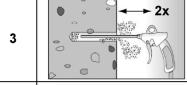
Drill the hole.
Drill hole diameter d₀ and nominal drill hole depth h₀ see Tables B3.1, B4.1, B8.1, B9.1, B10.1, B11.1, B12.1.



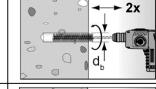
Break the drill core and remove it.



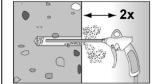
Flush the drill hole with clean water until it flows clear.



Blow out the drill hole twice, using oil-free compressed air (p > 6 bar).



Brush the drill hole twice using a power drill. Corresponding brushes see **Table B13.1**.

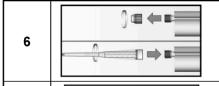


Blow out the drill hole twice, using oil-free compressed air (p > 6 bar).

Preparing the cartridge

4

5



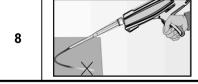
Remove the sealing cap.

Screw on the static mixer (the spiral in the static mixer must be clearly visible).





Place the cartridge into the dispenser.





Extrude approximately 10 cm of material out until the resin is evenly grey in colour.

Do not use mortar that is not uniformly grey.

Upat Injection system UPM 55

Intended use

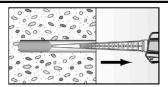
Installation instructions part 2

Annex B15



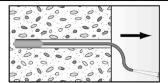
Installation instructions part 3

Injection of the mortar



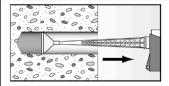
9

Fill approximately 2/3 of the drill hole with mortar. Always begin from the bottom of the hole and avoid bubbles.



The conditions for mortar injection without extension tube can be found in **Table B13.2**.

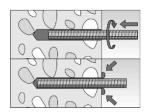
For deeper drill holes, than those mentioned in **Table B13.2**, use a suitable extension tube.

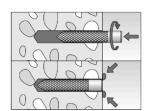


For overhead installation, deep holes ($h_0 > 250$ mm) or drill hole diameter ($d_0 \ge 30$ mm / 1 1/8") use an injection-adapter.

Installation of Anchor rods, Threaded rods or Upat IST

10

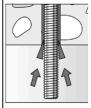




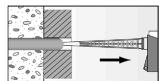
Only use clean and oil-free metal parts.

Mark the setting depth of the metal parts. Push the Anchor rod, Threaded rod or Upat IST down to the bottom of the hole, turning it slightly while doing so

After inserting the metal part, excess mortar must be emerged around the anchor element. If not, pull out the metal part immediately and reinject mortar.



For overhead installations support the metal part with wedges (e.g.centering wedges) or overhead clips.



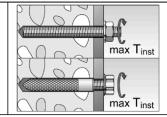
For push through installation fill the annular gap with mortar.

11



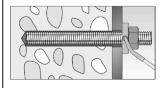
Wait for the specified curing time t_{cure} see **Table B13.3**.

12



Mounting the fixture max T_{inst} see Tables B3.1, B4.1, B8.1 and B9.1.

Option



After the minimum curing time is reached, the gap between metal part and fixture (annular clearance) may be filled with mortar via the filling disc. Compressive strength $\geq 50 \text{ N/mm}^2$

(e.g., Upat injection mortars UPM 55, UPM 44 UPM 33). ATTENTION:

Using filling disc reduces t_{fix} (usable length of the anchor).

Upat Injection system UPM 55

Intended use

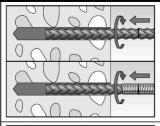
Installation instructions part 3

Annex B16



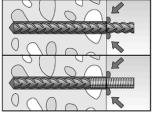
Installation instructions part 4

Installation reinforcing bars and Upat FRA



Only use clean and oil-free reinforcing bars or Upat FRA. Mark the setting depth. Turn while using force to push the reinforcement bar or the Upat FRA into the filled hole up to the setting depth mark.

10



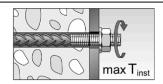
When the setting depth mark is reached, excess mortar must be emerged from the mouth of the drill hole. If not, pull out the anchor element immediately and reinject mortar.

11



Wait for the specified curing time t_{cure} see Table B13.3.

12



Mounting the fixture max T_{inst} see **Table B12.1**.

Upat Injection system UPM 55

Intended use

Installation instructions part 4

Annex B17



Tab								re un	der te	ensior	n / she	ear lo	ading	of
Anch	or rod / Threaded ro	d			М8	M10	M12	M14	M16	M20	M22	M24	M27	M30
Chara	acteristic resistance	to	stee	l failu	re under t	ension loa	ding ¹)						
, o		sistance to steel failure under tension loading "1" 14,6(13.2) 23,2(21.4) 33,7 46,0 62.8 98.0 121.2 141.2 183.6 224.4 18									224,4			
istic N _{RK} 's	Steel zinc plated	lass	5.8		18,3(16,6)	29,0(26,8)	42,1	57,5	78,5	122,5	151,5	176,5	229,5	280,5
ig seri			8.8	[FVI]	29,2(26,5)	46,4(42,8)	67,4	92,0	125,6	196,0	242,4	282,4	367,2	448,8
Characteristic esistance NRK	Stainless steel R	per	50	[KIN]	18,3	29,0	42,1	57,5	78,5	122,5	151,5	176,5	229,5	280,5
Ch	and high corrosion	Pro	70		25,6	40,6		80,5						392,7
	resistant steel HCR		80		29,2	46,4	67,4	92,0	125,6	196,0	242,4	282,4	367,2	448,8
Partia	al factors ²⁾													
١		SS												
[얼	Steel zinc plated	class												
Partial factor		Ę,		[-]										
arti	Stainless steel R	obe						07 / 11		D. 4.	-0			
۵	and high corrosion resistant steel HCR	ď					1	,87 / U		JR: 1,	50			
Char	_	to		l failu	ro undor e	hoar loadi	na 1)		1,00					
	out lever arm	ω;	siee	i iaiiu	re under S	nical Idadi	ng "							
			4 8		8 7(7 9)	13 9(12 8)	20.2	27.6	37.6	58.8	72 7	84 7	110 1	134 6
istic Vork,s	Steel zinc plated	SSE												
erisi >	otoo: Emo platou				, ,					<u> </u>	<u> </u>			
Characteristic	Stainless steel R	ert	50	[kN]		-								140,2
Chara resistar	and high corrosion	rop						-			<u> </u>	123,5		196,3
و م	resistant steel HCR	п.			14,6	23,2	33,7	46,0	62,8	98,0	121,2	141,2	183,6	224,4
Ductili	ity factor		k 7	[-]					1,0					
with I	ever arm													
k, s		S	4.8		14,9(12,9)	29,9(26,5)	52,3	83,5	132,9	259,6	357,1	448,8	665,7	899,5
it. M ^o rk,s	Steel zinc plated	las	5.8			` '		,						1124,4
aract.		₹	8.8	[Nm]										
Chaistan	Stainless steel R	per		[]	18,7									
esise	and high corrosion resistant steel HCR	Pro			,	_								
- "			80		29,9	59,8	104,6	167,0	265,9	519,3	714,2	897,6	1331,5	1799,0
Partia	al factors ²⁾		4.0						4.05					
٦	Steel zine pleted	SS	4.8											
Partial factor	Steel zinc plated													
ial fa	Ctainless start D	erty		[-]										
arti	Stainless steel R and high corrosion	go					1 !	56 / Ur		R: 1 2	5 ³⁾			
"	resistant steel HCR	ď					1,	30 / Op		11. 1,2				
2) Ir	hreaded rods according absence of other national absence of other national areas and the second in t	ng t	d for o EN	l ISO gulatio	10684:200 ons.	4+AC:2009	9.		stress	area A	∖ _s for h	ot dip	galvani	sed
Upa	at Injection system	ı UI	PM	55										
Cha	3) Only admissible for high corrosion resist. steel HCR, acc. to Table A6.1. Upat Injection system UPM 55 Performance Characteristic resistance to steel failure under tension / shear loading of metric Anchor rods / Threaded rods Annex C1													



Table C2.1:	Characteristic res metric Upat IST	sistance	to st	eel fai	lure und	der tensi	on / she	ar Ioadin	g of
Upat IST					M8	M10	M12	M16	M20
Characteristic r	esistance to steel failu	re under te	nsior	ı loadii	ng		•		
hor		s hor	5.8		18,3	29,0	42,1	78,3	122,4
aracteristii istance wit Screw or aded / Anc rod NRKS	Steel zinc plated	ty clas rew or I / Anc	8.8	[kN]	29,2	46,4	67,4	106,7	180,2
Characteristic resistance with Screw or Threaded / Anchor rod NRKS	Stainless steel R and High corrosion resistant steel HCR	Tigoria and a control of Screw or of Screw	70	[KIN]	25,6	40,6	59,0	109,6	171,3
Partial factors 1)					•		1	
_	Stool zine ploted	SS .	5.8				1,50		
acto z	Steel zinc plated	clas w or ed /	8.8				1,50		
Partial factor Yms, N	Stainless steel R and High corrosion resistant steel HCR	Property of Scre Thread Anchor	70	[-]		1,87 / (Jpat HCR	: 1,50 ²⁾	
Characteristic r	esistance to steel failu	re under s	hear I	oading					
Without lever a	rm								
ic th	Stool zine ploted	ss chor	5.8		10,9	17,4	25,2	47,1	73,5
Characteristic resistance with Screw or Threaded / Anchor rod	Steel zinc plated	clas w or And	8.8		14,6	23,2	33,7	62,8	98,0
Charact resistanc Screw Threaded / roc roc	Stainless steel R and High corrosion resistant steel HCR	B B B B B B B B B B B B B B B B B B B	70	[kN]	12,8	20,3	29,5	54,9	85,7
Ductility factor			k ₇	[-]			1,0	•	
With lever arm									
istic with or Anchor	Steel zinc plated	ss r chor	5.8		18,7	37,3	65,4	166,2	324,6
terist ce w w or / And d		y cla ew o / An d	8.8	<u></u>	29,9	59,8	104,6	265,9	519,3
Characteristic resistance with Screw or Threaded / Anchor rod M ^o Rk,s	Stainless steel R and High corrosion resistant steel HCR	Propert of Scri Threaded	70	[Nm]	26,2	52,3	91,5	232,6	454,4
Partial factors ¹)								
5	Steel zinc plated	ss - F	5.8				1,25		
factc		o we o	8.8				1,25		
Partial factor	Stainless steel R and High corrosion resistant steel HCR	Property of Scre Thread	70	[-]		1,56 / เ	Jpat HCR	:: 1,25 ²⁾	
1	f other national regulatio e for high corrosion resista		, acc.	to Table	A6.1.				
Performance	n system UPM 55	under tensi	on / s	hear lo	ading of			Annex	C2



Table C3.1:	Characteristic resistance to steel failure under tension / shear loading of
	metric reinforcing bars

Nominal diameter of the bar		ф	8 to 40
Characteristic resistance to ste	el failure	unde	er tension loading
Characteristic resistance	$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ 1)
Characteristic resistance to ste	el failure	unde	er shear loading
Without lever arm			
Characteristic resistance	$V^0_{Rk,s}$	[kN]	$k_6^{2)} \cdot A_s \cdot f_{uk}^{1)}$
Ductility factor	k 7	[-]	1,0
With lever arm			
Characteristic resistance	M^0 Rk,s	[Nm]	1,2 · W _{el} · f _{uk} ¹)

¹⁾ f_{uk} respectively shall be taken from the specifications of the reinforcing bar.

- $k_6 = 0.6$ for fasteners made of carbon steel with $f_{uk} \le 500 \text{ N/mm}^2$,
 - = 0,5 for fasteners made of carbon steel with 500 N/mm² < f_{uk} ≤ 1000 N/mm²,
 - = 0,5 for fasteners made of stainless steel.

Table C3.2: Characteristic restistance to steel failure under tension / shear loading of metric Upat FRA

Upat FRA			M12	M16	M20	M24
Characteristic resistance to	otool foilur	under			14120	1012-7
Characteristic resistance to	Steer ranure				T	T
Characteristic resistance	$N_{Rk,s}$	[kN]	62,0	110,0	173,0	236,5
Partial factor 1)						
Partial factor	γMs,N	[-]		1	,40	
Characteristic resistance to	steel failure	under	shear loading	1		
Without lever arm						
Characteristic resistance	V^0 Rk,s	[kN]	34,5	64,3	100,4	144,7
Ductility factor	k ₇	[-]		1	,0	
With lever arm						
Characteristic resistance	M^0 Rk,s	[Nm]	107,4	273,0	532,2	920,4
Partial factor ¹⁾		<u>'</u>				
Partial factor	γMs,V	[-]		1	,5	

¹⁾ In absence of other national regulations.

Upat Injection system UPM 55

Performance
Characteristic resistance to steel failure under tension / shear loading of metric reinforcing bars and metric Upat FRA

Annex C3

²⁾ In accordance with EN 1992-4:2018 section 7.2.2.3.1:



Table C4.1: Characteris tension / sł					_			fail	ure	und	der					
Size										All	sizes					
Tension loading																
Installation factor	γinst	[-]				5	See	Ann	ex C	C5 to	C16, (C40 aı	nd (C41		
Factors for the compressive str	ength of	conci	rete :	> C2	20/2	5										
C25/3	0									1	,02					
Increasing factor ψ _c forC30/3	7									1	,04					
cracked or uncracked C35/4	$\frac{5}{4}$ Ψ_c	[-]								1	,06					
concrete C40/5	0	[]								1	,07					
$\tau_{Rk(X,Y)} = \psi_c \cdot \tau_{Rk(C20/25)} \qquad C45/5$	_										,08					
C50/6	0									1	,09					
Splitting failure		1														
h / h _{ef} ≥ 2,											0 h _{ef}					
Edge distance2,0 > h / h _{ef} > 1,		[mm]							4		ef - 1,8	h				
h / h _{ef} ≤ 1,	3	-									26 h _{ef}					
Spacing	S cr,sp									2	C cr,sp					
Concrete cone failure	1.	Г	<u> </u>								4.0					
Uncracked concrete	k ucr,N	[-]									1,0					
Cracked concrete	k cr,N										7,7					
Edge distance	C _{cr,N}	[mm]									5 h _{ef}					
Spacing	Scr,N										C _{cr,N}					
Factors for sustained tension lo	pading	Ι		24.0	°C / •	40	°C			F °C	; / 60 °(<u> </u>		F0 °	C / 72	°C
Temperature range				24			<u> </u>					,		50		
Factor	ψ^0 sus	[-]			0,7),60				0,48	
Factor	ψ^0 sus,100	[-]			0,7	7				0),60				0,71	
Shear loading																
Installation factor	γ inst	[-]									1,0					
Concrete pry-out failure																
Factor for pry-out failure	k 8	[-]									2,0					
Concrete edge failure																
Effective length of fastener for shear loading	lf	[mm]									_f ; 12 d _r _f ; max		n; 3	00 m	ım))	
Effective diameter of the fasten	er d _{nom}															
Size			M8	3 [M10	١	/112	M1	14	M16	M20	M22	2	M24	M27	M30
Anchor rods and Threaded rods	d_{nom}	· · · · · · · · · · · · · · · · · · ·	8,0) /	10,0	1	2,0	14	,0	16,0	20,0	22,0		24,0	27,0	30,0
Upat IST	d_{nom}	[mm]	12,	0 -	15,7	1	8,0	_1)	22,0	28,0	_1)		_1)	_1)	_1)
Upat FRA	d_{nom}		_1)		_1)	1	2,0	_1)	16,0	20,0	_1)	1	25,0	_1)	_1)
Size (nominal diameter of the bar))	ф	8	10	12	14	16	18	20	22	24 25	26 2	8 3	30 3	2 34	36 40
Reinforcing bar	d_{nom}	[mm]	8	10	12	14	16	18	20	22	24 25	26 2	8 3	30 3	2 34	36 40
1) Anchor type not part of the as	sessmer	ıt.														
Upat Injection system UPM	1 55													A 10 11	.av C	4
Performance Characteristic resistance for con (metric size)	crete fail	ure und	der te	ensi	on /	she	ear I	oadi	ing				_	Anr	iex C	+
51783 25															8 06 0	



Table C	5.1:	Characte						-						
		metric A									iamoi	nd drii	led h	oles;
Anchorr	od / Th	uncrackereaded rod	ea or c	racked	M8 ¹⁾				e 50 <u>y</u> M16	M20	M22	M24	M27	M30
		out and concre	ete cone	failure	IVIO ''	IVITU	IVITZ	10114	INITO	IVIZU	IVIZZ	IVIZ4	IVIZI	IVISU
Calculatio			d	[mm]	8	10	12	14	16	20	22	24	27	30
Uncracke	d con	crete										•		
		ond resistanc												
		with standard d	rill bit or	<u>hollow drill</u>										1
Tem-	<u> </u>	24 °C / 40 °C		[N1/2]	20,8	19,7	18,8	18,1	17,6	16,7	16,3	16,0	15,5	15,1
perature	<u> </u>	35 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	18,0	18,0	18,0	17,0	17,0	16,0	15,0	15,0	15,0	14,0
range	:	50 °C / 72 °C with standard d	rill bit or	hollow drill	18,0	17,0	17,0	16,0	16,0	15,0	14,0	14,0	14,0	13,0
Tem-	anning I:	24 °C / 40 °C	TIII DIL OI	Tollow arill	20,8	19,7	18,8	17,9	16,9	15,3	14,4	13,8	13,2	12,3
perature	——————————————————————————————————————	35 °C / 60 °C	σ	[N/mm ²]	16,0	16,0	15,0	13,0	13,0	11,0	11,0	10,0	10,0	9,0
range	——————————————————————————————————————		$ au_{Rk,ucr}$	[[[]]	15,0	14,0	14,0	13,0	12,0	11,0	10,0	10,0	9,0	9,0
		ors; Hammer-	drilling v	/ith standa						11,0	10,0	10,0	0,0	1 0,0
Dry or we										,0				
Water fille			γinst	[-]						,4				
Diamond-	drilling	(dry or wet con	crete)	'	•					,				
Tem-	I:	24 °C / 40 °C			16,0	15,0	13,5	12,8	12,4	11,6	11,3	10,9	10,5	10,3
perature	II:	35 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	16,0	15,0	13,0	12,0	12,0	10,0	10,0	10,0	9,0	9,0
range		50 °C / 72 °C			15,0	14,0	12,0	11,0	11,0	10,0	9,0	9,0	8,0	8,0
		(water filled ho	<u>le)</u>							1				
Tem-	<u> </u>	24 °C / 40 °C			16,0	16,8	15,5	14,3	13,6	12,0	11,5	10,9	10,3	9,9
perature	<u> :</u>	35 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	16,0	15,0	13,0	12,0	12,0	10,0	10,0	10,0	9,0	9,0
range		50 °C / 72 °C	-11111		15,0	14,0	12,0	11,0	11,0	10,0	9,0	9,0	8,0	8,0
		ors; Diamond-	arilling	<u> </u>	Ι									
Dry or we Water fille		ete	γinst	[-]						<u>,0</u> ,4				
Cracked		140	·							,4				
		ond resistanc	e in crac	ked conc	rete C2	0/25								
		with standard d					t concre	ete)						
Tem-	l:	24 °C / 40 °C			7,7	9,0	10,1	9,8	9,5	8,5	8,5	8,5	8,5	8,5
perature	II:	35 °C / 60 °C	$ au_{\sf Rk,cr}$	[N/mm ²]	7,7	9,0	10,1	9,8	9,5	8,5	8,5	8,5	8,5	8,5
range	III:		Truçor		7,2	8,5	9,5	9,2	8,9	8,5	8,5	8,5	8,5	8,5
Hammer-d	drilling	with standard d	rill bit or	hollow drill	bit (wa	ter fille	d hole)							
Tem-	1:	24 °C / 40 °C			6,6	7,7	8,7	8,3	7,7	6,0	6,0	6,0	6,0	6,0
perature	H:		$ au_{Rk,cr}$	[N/mm ²]	6,6	7,7	8,7	8,3	7,7	6,0	6,0	6,0	6,0	6,0
range	III:	50 °C / 72 °C			6,2	7,3	8,1	7,9	7,3	6,0	6,0	6,0	6,0	6,0
		ors; Hammer-c	drilling v	<u>ith standa</u>	ard dri	l bit or	r hollov	w drill						
Dry or we		ete	γinst	[-]					1	,0				
Water fille			•	.,			1,2					1,4		
		(dry or wet con	crete)	1	7.0	7.0	7.0	1 7 0		0.0	7.0	1 7 0	7.0	7.0
Tem-	<u> </u>	24 °C / 40 °C		[N1/2]	7,0	7,0	7,0	7,0	6,0	6,0	7,0	7,0	7,0	7,0
perature	<u> </u>	35 °C / 60 °C 50 °C / 72 °C	. $ au_{Rk,cr}$	[N/mm ²]	7,0	7,0	7,0 7,0	7,0	6,0	6,0	7,0	7,0	7,0	7,0
range			lo)		7,0	7,0	7,0	7,0	6,0	6,0	7,0	7,0	7,0	7,0
Tem-	arılırı <u>g</u> I:	(water filled ho 24 °C / 40 °C	<u> C)</u>		6,0	7,5	7,5	7,0	6,0	6,0	6,0	6,0	6,0	6,0
perature		35 °C / 60 °C	π	[N/mm ²]	6,0	7,5	7,5	7,0	6,0	6,0	6,0	6,0	6,0	6,0
range		50 °C / 72 °C	$ au_{Rk,cr}$	[[,,,,,,,,,]	6,0	7,0	7,0	7,0	6,0	6,0	6,0	6,0	6,0	6,0
		ors; Diamond-	drillina	1		, ,,,	, ,,,	, ,,,	, 5,5	J 5,5	<u> </u>	, 5,0	_ <u>_</u>	, 5,0
Dry or we				.,					1	,0				
Water fille			γinst	[-]			1,2			,		1,4		
		for hollow drill	bit.		•		- ,=					-,-		
											\top			
Upat Ir	ijectio	on system U	PIVI 55								_			
Perforn	nance											Ann	ex C	5
		resistance to c	ombined	d pull-out a	and cor	ncrete	failure	for me	tric And	chor				
1 Onaraot											1			
		aded rods; wor	king life	50 years							ı			



Table C6.1: Characte metric A						-						
uncrack												,,,,
Anchor rod / Threaded rod			M8 ¹⁾	M10	M12	M14	M16	M20	M22	M24	M27	M30
Combined pull-out and concre	ete cone	failure										
Calculation diameter	d	[mm]	8	10	12	14	16	20	22	24	27	30
Uncracked concrete												
Characteristic bond resistanc	e in uncr	acked co	ncrete	C20/25	5							
Hammer-drilling with standard d	rill bit or h	nollow drill	bit (dry	or wet	concre	ete)						
Tem- <u>I: 24 °C / 40 °C</u>			17,1	16,1	15,4	14,9	14,4	13,7	13,4	13,1	12,7	12,4
perature II: 35 °C / 60 °C	$ au_{ m Rk,100,ucr}$	[N/mm ²]	13,5	13,5	13,5	12,8	12,8	12,0	11,3	11,3	11,3	10,5
range III: 50 °C / 72 °C			9,9	10,2	10,2	10,4	10,4	9,8	9,1	9,1	9,1	8,5
Hammer-drilling with standard d	rill bit or i	<u>iollow drill</u>				447	40.0	40.5	44.0	1440	40.0	40.4
Tem- perature I: 24 °C / 40 °C II: 35 °C / 60 °C	_	[N/mm ²]	17,1 12,0	16,2 12,0	15,4 11,3	14,7 9,8	13,9 9,8	12,5 8,3	11,8 8,3	11,3 7,5	10,8 7,5	10,1 6,8
range III: 50 °C / 72 °C	C Rk,100,ucr	ן ווא/ווווו ן	8,3	8,4	8,4	8,5	7,8	7,2	6,5	6,5	5,9	5,9
Installation factors; Hammer-	drilling w	ith standa						1,2	1 0,0	0,0	0,0	0,0
Dry or wet concrete			4111	. ~1. 01		. 41111 k		,0				
Water filled hole	γ inst	[-]						, <u>o</u> ,4				
Diamond-drilling (dry or wet con	crete)	I						, •				
Tem- I: 24 °C / 40 °C	0.0107		12,0	12,3	11,6	11,1	10,5	10,1	9,5	9,3	8,9	8,8
perature II: 35 °C / 60 °C	TRk 100 ucr	[N/mm ²]	12,0	11,3	9,8	9,0	9,0	7,5	7,5	7,5	6,8	6,8
range III: 50 °C / 72 °C	• rax, roo, aoi		8,3	8,4	7,2	7,2	7,2	6,5	5,9	5,9	5,2	5,2
Diamond-drilling (water filled hol	<u>le)</u>											
Tem- <u>I: 24 °C / 40 °C</u>			12,0	13,8	12,7	11,7	11,2	10,0	9,4	8,9	8,4	8,1
perature II: 35 °C / 60 °C	$ au_{Rk,100,ucr}$	_{100,ucr} [N/mm²]	12,0	11,3	9,8	9,0	9,0	7,5	7,5	7,5	6,8	6,8
range III: 50 °C / 72 °C			8,3	8,4	7,2	7,2	7,2	6,5	5,9	5,9	5,2	5,2
Installation factors		ı	Ι					_				
Dry or wet concrete	· Yinst	[-]						,0				
Water filled hole		.,					1	,4				
Cracked concrete												
Characteristic bond resistanc						1 - \						
Hammer-drilling with standard d	rill bit or i	<u>iollow drill</u>					7.0	0.0			0.5	
Tem- 1: 24 °C / 40 °C	_	[N]/mm21	5,7 5,7	7,0	7,6 7,6	7,4 7,4	7,2 7,2	6,9 6,9	6,8 6,8	6,7 6,7	6,5 6,5	6,3
perature II: 35 °C / 60 °C range III: 50 °C / 72 °C	C Rk,100,cr	[N/mm ²]		7,0 6,6	7,0	7,4	6,8	6,4	6,4	6,3	6,1	6,3 6,0
Hammer-drilling with standard d	rill bit or h	nollow drill				7,0	0,0	0,4	1 0,4	0,0	0,1	0,0
Tem- I: 24 °C / 40 °C	1111 BIC 01 1	TOMOTT GIM	4,9	6,0	6,5	6,1	5,9	4,9	4,8	4,7	4,6	4,4
	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	4,9	6,0	6,5	6,1	5,9	4,9	4,8	4,7	4,6	4,4
range III: 50 °C / 72 °C	•1tk, 100,01		4,6	5,7	6,1	5,7	5,5	4,5	4,5	4,4	4,3	4,3
Installation factors; Hammer-c	drilling w	ith standa	ard dril	l bit or	hollov	v drill k	oit					
Dry or wet concrete	26	[.1					1	,0				
Water filled hole	γinst	[-]			1,2					1,4		
Diamond-drilling (dry or wet con	crete)											
Tem- <u>I: 24 °C / 40 °C</u>			4,2	6,0	5,6	4,6	3,9	3,9	4,6	4,6	4,6	4,6
	$ au_{Rk,100,cr}$	[N/mm ²]	4,2	6,0	5,6	4,6	3,9	3,9	4,6	4,6	4,6	4,6
range III: 50 °C / 72 °C			4,2	6,0	5,6	4,6	3,9	3,9	4,6	4,6	4,6	4,6
Installation factors								0				
Dry or wet concrete	γinst	[-]					1	,0				
1) Not allowed for hollow drill	bit.											
Upat Injection system U Performance Characteristic resistance to c	combined	l pull-out a	and cor	ncrete t	failure	for And	chor ro	ds and		Ann	ex C	6
Threaded rods in hammer or	diamono	d drilled ho	oles; w	orking	life 100) years						



•				bined pull- nond drilled		ncrete fail	u re for
				working life			
Upat IST			M8	M10	M12	M16	M20
Combined pull-out and con-							
Calculation diameter	<u>d</u>	[mm]	12	15,7	18	22	28
Uncracked concrete Characteristic bond resistar	nce in uno	rackad aa	norete C20/2	5			
Hammer-drilling with standard							
Tem- I: 24 °C / 40 °C	anni bil Ul	I TOTION WITH	18,8	17,6	17,0	16,2	15,3
perature II: 35 °C / 60 °C	$_{\scriptscriptstyle \perp}$ $ au_{\scriptscriptstyle Rk,ucr}$	[N/mm ²]	15,0	14,0	14,0	13,0	12,0
range III: 50 °C / 72 °C	_ URK,uci	[14,0	13,0	13,0	12,0	11,0
Hammer-drilling with standard	drill bit or	hollow drill			,	,	,
Tem- <u>I: 24 °C / 40 °C</u>	_		18,8	16,9	15,8	14,3	12,8
perature II: 35 °C / 60 °C	$_{\scriptscriptstyle \perp}$ $ au_{\scriptscriptstyle Rk,ucr}$	[N/mm ²]	14,0	12,0	12,0	11,0	10,0
range III: 50 °C / 72 °C			13,0	12,0	11,0	10,0	9,0
Installation factors; Hamme	r-drilling v	vith stand	ard drill bit o	r hollow drill b			
Dry or wet concrete	- γinst	[-]			1,0		
Water filled hole		.,			1,4		
Diamond-drilling (dry or wet c Tem- I: 24 °C / 40 °C	oncrete)		13,3	12,3	11.0	11.2	10,4
Tem- <u>I: 24 °C / 40 °C</u> perature <u>II: 35 °C / 60 °C</u>	- ~	[N/mm ²]	13,3	12,3	11,9 11,0	11,2 10,0	9,0
range III: 50 °C / 72 °C	_ $ au_{Rk,ucr}$	[[1][[]]	12,0	11,0	10,0	9,0	8,0
Diamond-drilling (water filled I	nole)		12,0	11,0	10,0	9,0	0,0
Tem- I: 24 °C / 40 °C	1010 <u>1</u>		15,1	13,6	12,6	11,4	10,2
perature II: 35 °C / 60 °C	$_{-}$ $ au_{Rk,ucr}$	[N/mm ²]	13,0	12,0	11,0	10,0	9,0
range III: 50 °C / 72 °C	_ ⊌RK,ucr	[]	12,0	11,0	10,0	9,0	8,0
Installation factors; Diamon	d-drilling	1	,-	, 5	, .	-,-	
Dry or wet concrete		r 1			1,0		
Water filled hole	— γinst	[-]			1,4		
Cracked concrete							
Characteristic bond resistar							
Hammer-drilling with standard	drill bit or	<u>hollow drill</u>			2.2	7.0	7.0
Tem- I: 24 °C / 40 °C		[N1/m=:==21	7,0	6,0	6,0	7,0	7,0
perature II: 35 °C / 60 °C range III: 50 °C / 72 °C	$_{\scriptscriptstyle \perp}$ $ au_{\scriptscriptstyle Rk,cr}$	[N/mm ²]	7,0 7,0	6,0	6,0	7,0	7,0
range III: 50 °C / 72 °C Hammer-drilling with standard	drill hit or	hollow drill		6,0	6,0	7,0	7,0
Tem- I: 24 °C / 40 °C	uiiii bit Ui		7,0	6,5	6,0	6,0	6,0
perature II: 35 °C / 60 °C	- τ-:	[N/mm ²]		6,5	6,0	6,0	6,0
range III: 50 °C / 72 °C	$_{\scriptscriptstyle \perp}$ $ au_{\scriptscriptstyle Rk,cr}$	[[[]	7,0	6,0	6,0	6,0	6,0
Installation factors; Hamme	r-drillina v	vith stand				<u> </u>	. 0,0
Dry or wet concrete					1,0		
Water filled hole	γinst	[-]		1,2	, -	1	,4
Diamond-drilling (dry or wet c	oncrete)						
Tem- I: 24 °C / 40 °C	_		7,0	6,0	6,0	7,0	7,0
perature II: 35 °C / 60 °C	$_{\scriptscriptstyle \perp}$ $ au_{\scriptscriptstyle Rk,cr}$	[N/mm ²]	7,0	6,0	6,0	7,0	7,0
range III: 50 °C / 72 °C			7,0	6,0	6,0	7,0	7,0
Diamond-drilling (water filled I	nole)			-			-
Tem- 1: 24 °C / 40 °C	_	FN.17 2-	7,0	6,5	6,0	6,0	6,0
perature II: 35 °C / 60 °C	$_{f L}$ $ au_{ m Rk,cr}$	[N/mm ²]	7,0	6,5	6,0	6,0	6,0
range III: 50 °C / 72 °C	ما ما بالله د		7,0	6,0	6,0	6,0	6,0
Installation factors; Diamon Dry or wet concrete	u-uriiing		I		1,0		
Water filled hole	— γinst	[-]		1,2	1,0	1	,4
vater filled flole			I	۱,۷		'	, ¬
Upat Injection system Performance Characteristic resistance to		d mull and	and concret-	foilure for the	nt IST:	Ann	ex C7
Characteristic resistance to working life 50 years	Compined	a pull-out a	and concrete	ialiure for Upa	at 101;		



Table C8.1: Characteristic resistance to combined pull-out and concrete failure for metric Upat IST in hammer or diamond drilled holes; uncracked or cracked concrete; working life 100 years

Upat IST			М8	M10	M12	M16	M20
combined pull-out and con	crete cone	failure					
alculation diameter	d	[mm]	12	15,7	18	22	28
Incracked concrete							
haracteristic bond resista	nce in unc	racked cor	ncrete C20/2	5			
Hammer-drilling with standard							
Tem- I: 24 °C / 40 °C			15,4	14,4	14,0	13,3	12,6
perature II: 35 °C / 60 °C	_ τ _{Rk,100,ucr}	[N/mm ²]	11,3	10,5	10,5	9,8	9,0
range III: 50 °C / 72 °C			7,7	7,8	7,8	7,8	7,2
Hammer-drilling with standard	d drill bit or	hollow drill	bit (water fille	d hole)			
Tem- <u>I: 24 °C / 40 °C</u>	_		15,4	13,9	13,0	11,7	10,5
perature II: 35 °C / 60 °C	$_{ extsf{L}}$ $ au_{ extsf{Rk},100, ext{ucr}}$	[N/mm ²]	10,5	9,0	9,0	8,3	7,5
range III: 50 °C / 72 °C			7,2	7,2	6,6	6,5	5,9
nstallation factors; Hamme	er-drilling v	vith standa	ırd drill bit oı	r hollow drill			
Dry or wet concrete	- γ _{inst}	[-]			1,0		
Nater filled hole	·	1 1			1,4		
Diamond-drilling (dry or wet c	oncrete)						
Tem- I: 24 °C / 40 °C	_		10,9	10,1	9,8	9,2	8,6
perature II: 35 °C / 60 °C	$_{ m L}$ $ au_{ m Rk,100,ucr}$	[N/mm ²]	9,8	9,0	8,3	7,5	6,8
range III: 50 °C / 72 °C	I I - \		6,6	6,6	6,0	5,9	5,2
Diamond-drilling (water filled	<u>hole)</u>		40.5	110	100		0.4
Tem- I: 24 °C / 40 °C		[N1/mama21]	12,5	11,2	10,3	9,3	8,4
perature II: 35 °C / 60 °C range III: 50 °C / 72 °C	$_{-}$ $ au_{ ext{Rk,100,ucr}}$	[N/mm ²]	9,8 6,6	9,0 6,6	8,3 6,0	7,5 5,9	6,8 5,2
nstallation factors; Diamor	d-drilling		0,0	<u> </u>	0,0	5,9	5,2
Dry or wet concrete	iu-uriiiiig				1,0		
Water filled hole	— γinst	[-]			1,4		
Cracked concrete					1,4		
Characteristic bond resista	nce in crac	ked concr	oto C20/25				
Hammer-drilling with standard				t concrete)			
Tem- I: 24 °C / 40 °C	a drill bit of	TOHOW GITT	4,2	5,1	4,8	4,6	4,6
perature II: 35 °C / 60 °C	_ τ _{Rk,100,cr}	[N/mm ²]	4,2	5,1	4,8	4,6	4,6
range III: 50 °C / 72 °C	_ U RK,100,cr	'' '' ''	4,2	5,1	4,8	4,6	4,6
Hammer-drilling with standard	d drill bit or	hollow drill			.,.	.,.	.,,,
Tem- I: 24 °C / 40 °C			4,2	5,5	4,8	3,9	3,9
perature II: 35 °C / 60 °C	_ τ _{Rk,100,cr}	[N/mm ²]	4,2	5,5	4,8	3,9	3,9
range III: 50 °C / 72 °C			4,2	5,1	4,8	3,9	3,9
Installation factors; Hamme	er-drilling v	vith standa			bit		
Dry or wet concrete		[,]			1,0		
Water filled hole	– γinst	[-]		1,2	-	1	4
Diamond-drilling (dry or wet c	oncrete)			·			
Tem- I: 24 °C / 40 °C			4,2	5,1	4,8	4,6	4,6
perature II: 35 °C / 60 °C	_ _ τ _{Rk,100,cr}	[N/mm ²]	4,2	5,1	4,8	4,6	4,6
range III: 50 °C / 72 °C			4,2	5,1	4,8	4,6	4,6
	ممالا:اا:مم		· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	
Installation factors; Diamor	ia-ariiing						

Upat Injection system UPM 55

Performance

Characteristic resistance to combined pull-out and concrete failure for Upat IST; working life 100 years

Annex C8



Table C9.1:			Table C9.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes;											
			_					drilled	nole	s;				
	uncracke	ed con	icrete; w	orking	g life 5	0 yea	rs							
Nominal diameter			ф	8 ¹⁾	10	12	14	16	18	20	22	24		
Combined pull-ou		ete cone	failure											
Calculation diamete	er	d	[mm]	8	10	12	14	16	18	20	22	24		
Uncracked concre														
Characteristic bor	nd resistance	e in unc	racked co	ncrete (220/25									
Hammer-drilling wit	<u>th standard dı</u>	rill bit or	hollow drill	bit (dry	or wet c	oncrete	<u>:)</u>							
Tem- <u>I: 24</u>	4 °C / 40 °C			16,0	16,8	16,1	15,5	15,0	14,6	14,2	14,0	13,6		
perature II: 35	5 °C / 60 °C	$ au_{\sf Rk,ucr}$	[N/mm ²]	16,0	15,0	15,0	14,0	14,0	13,0	13,0	13,0	12,0		
range III: 50	0 °C / 72 °C			15,0	14,0	14,0	13,0	13,0	12,0	12,0	12,0	12,0		
Hammer-drilling wit	h standard di	rill bit or	hollow drill	bit (wat	er filled l	hole)								
Tem- I: 24	4 °C / 40 °C			16,0	16,8	16,1	14,9	14,4	13,4	13,0	12,1	11,8		
	5 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	16,0	16,0	14,0	13,0	12,0	12,0	11,0	11,0	10,0		
range III: 50	0 °C / 72 °C	T (II, GO)		15,0	14,0	13,0	12,0	12,0	11,0	11,0	10,0	10,0		
Installation factors		irillina v	vith standa	, , , , , , , , , , , , , , , , , , ,			,	· '	1 ,			'		
Dry or wet concrete								1,0						
Water filled hole		- γinst	[-]					1,4						
Diamond-drilling (dr	rv or wet con	crete as	well as wa	ter filled	hole)			.,-						
	4 °C / 40 °C	01010 00	Tron do wa	16,0	15,0	13,0	12,0	12,0	11,0	10,0	10,0	10,0		
	5 °C / 60 °C	σ-	[N/mm ²]	16,0	15,0	13,0	12,0	12,0	11,0	_	10,0	10,0		
l'	0 °C / 72 °C	$ au_{Rk,ucr}$	[[[]]]	15,0	14,0	12,0	11,0	11,0	10,0		9,0	9,0		
Installation factors		drilling		10,0	14,0	12,0	11,0	11,0	10,0	10,0	3,0	0,0		
Dry or wet concrete		uriiiiig						1.0						
Water filled hole	•	— γ _{inst}	[-]					1,0 1,4						
	- 6 (1) - 1			0.5					201)	0.41)	0.01\	401)		
			φ	25	26	28	30	" 3	32"	34 ¹⁾	36 ¹⁾	40 ¹⁾		
(Compined null_our		Nominal diameter of the bar ϕ 25 26 28 30 ¹⁾ 32 ¹⁾ 34 ¹⁾ 36 ¹⁾ 40 ¹⁾ Combined pull-out and concrete cone failure												
			T	0.5	00			<u>. </u>	20	0.4	00	40		
Calculation diamete	er	d d	[mm]	25	26	28	30)	32	34	36	40		
Calculation diamete	er e te	d	[mm]			28	30	0	32	34	36	40		
Calculation diameter Uncracked concre Characteristic bor	er ete nd resistance	d e in unc	[mm]	ncrete (20/25			0	32	34	36	40		
Calculation diameter Uncracked concre Characteristic bor Hammer-drilling wit	er ete nd resistance h standard di	d e in unc	[mm]	ncrete (20/25 or wet c	oncrete	2)							
Calculation diameter Uncracked concrete Characteristic bort Hammer-drilling witt Tem- 1: 24	er ete nd resistance h standard di 4°C / 40°C	d e in unc rill bit or	racked co	ncrete (bit (dry 13,5	020/25 or wet c	oncrete	e) 1 12	,9 1	2,7	12,5	12,4	12,1		
Calculation diameter Uncracked concrete Characteristic born Hammer-drilling with Tem- I: 24 perature II: 35	er ete nd resistance h standard de 4 °C / 40 °C 5 °C / 60 °C	d e in unc	[mm]	ncrete (bit (dry 13,5 12,0	020/25 or wet c 13,3 12,0	oncrete 13,1 12,0	e) 1 12 0 12	,9 1 ,0 1	2,7	12,5 11,0	12,4 11,0	12,1 11,0		
Calculation diameter Uncracked concrete Characteristic born Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50	er ete nd resistance th standard dr 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C	d e in unc rill bit or $ au_{Rk,uer}$	[mm] racked co hollow drill [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0	020/25 or wet c 13,3 12,0 11,0	oncrete 13,7 12,0	e) 1 12 0 12	,9 1 ,0 1	2,7	12,5	12,4	12,1		
Calculation diameter Uncracked concrete Characteristic born Hammer-drilling witt Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling witt	er ete nd resistance th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C th standard de	d e in unc rill bit or $ au_{Rk,uer}$	[mm] racked co hollow drill [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat	020/25 or wet c 13,3 12,0 11,0 er filled	0ncrete 13,7 12,0 11,0 hole)	e) 1 12 0 12 0 11	,9 1 ,0 1 ,0 1	2,7 2,0 1,0	12,5 11,0 11,0	12,4 11,0 10,0	12,1 11,0 10,0		
Calculation diameter Uncracked concrete Characteristic born Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling wit Tem- I: 24	er end resistance th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C th standard de 4 °C / 40 °C	d e in unc rill bit or TRk,uer rill bit or	[mm] racked co hollow drill [N/mm²] hollow drill	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5	020/25 or wet c 13,3 12,0 11,0 er filled	oncrete 13,7 12,0 11,0 hole)	2) 1 12 0 12 0 11	,9 1 ,0 1 ,0 1	2,7 2,0 1,0	12,5 11,0 11,0	12,4 11,0 10,0	12,1 11,0 10,0		
Calculation diameter Uncracked concre Characteristic bor Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling wit Tem- I: 24 perature II: 35	er ete nd resistance h standard de 4 °C / 40 °C 5 °C / 60 °C ch standard de 4 °C / 40 °C 5 °C / 60 °C 6 °C / 60 °C	d e in unc rill bit or $ au_{Rk,uer}$	[mm] racked co hollow drill [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0	020/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0	13,7 12,0 11,0 hole) 10,6	2) 1 12 0 12 0 11 6 10 0 9,	,9 1 ,0 1 ,0 1	2,7 2,0 1,0 0,3	12,5 11,0 11,0 9,0 9,0	12,4 11,0 10,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0		
Calculation diameter Uncracked concre Characteristic bor Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50	er ete hd resistance h standard de 4°C / 40°C 5°C / 60°C 0°C / 72°C h standard de 4°C / 40°C 5°C / 60°C 0°C / 72°C	d e in unc rill bit or TRk,uer rill bit or	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0	oncrete 13,7 12,0 11,0 hole) 10,6 9,0	2) 1 12 0 12 0 11 6 10 0 9,	,9 1 ,0 1 ,0 1	2,7 2,0 1,0	12,5 11,0 11,0	12,4 11,0 10,0	12,1 11,0 10,0		
Calculation diameter Uncracked concre Characteristic born Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling wit Tem- I: 24 perature II: 35 range III: 50 Installation factors	er ete nd resistance th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C 5 °C / 60 °C 0 °C / 72 °C s; Hammer-de	d e in unc rill bit or TRk,uer rill bit or	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith standa	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0	oncrete 13,7 12,0 11,0 hole) 10,6 9,0	2) 1 12 0 12 0 11 6 10 0 9,	,9 1 ,0 1 ,0 1 ,5 1 0 9	2,7 2,0 1,0 0,3	12,5 11,0 11,0 9,0 9,0	12,4 11,0 10,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0		
Calculation diameter Uncracked concrete Characteristic born Hammer-drilling wit Tem- II: 35 range III: 50 Hammer-drilling wit Tem- II: 24 perature III: 35 range III: 50 Installation factors Dry or wet concrete	er ete nd resistance th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C 5 °C / 60 °C 0 °C / 72 °C s; Hammer-de	d e in unc rill bit or TRk,uer rill bit or	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0	oncrete 13,7 12,0 11,0 hole) 10,6 9,0	2) 1 12 0 12 0 11 6 10 0 9,	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8	2,7 2,0 1,0 0,3	12,5 11,0 11,0 9,0 9,0	12,4 11,0 10,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0		
Calculation diameter Uncracked concre Characteristic born Hammer-drilling wit Temperature II: 35 range III: 50 Hammer-drilling wit Temperature II: 35 range III: 50 Installation factors Uncorrected Water filled hole	er ete nd resistance th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C th standard de 4 °C / 40 °C 5 °C / 60 °C 0 °C / 72 °C cs; Hammer-de	d e in unc rill bit or TRk,uer rill bit or TRk,uer drilling v	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand:	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	oncrete 13,7 12,0 11,0 hole) 10,6 9,0	2) 1 12 0 12 0 11 6 10 0 9,	,9 1 ,0 1 ,0 1 ,5 1 0 9	2,7 2,0 1,0 0,3	12,5 11,0 11,0 9,0 9,0	12,4 11,0 10,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr	er ete nd resistance ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C cs; Hammer-de	d e in unc rill bit or TRk,uer rill bit or TRk,uer drilling v	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand:	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	oncrete 13,7 12,0 111,0 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9,	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 9,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50 Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr Tem- I: 24	er ete nd resistance th standard de 4°C / 40°C 5°C / 60°C 0°C / 72°C th standard de 4°C / 40°C 5°C / 60°C 0°C / 72°C s; Hammer-de 4°C / 40°C	d e in unc rill bit or TRK,ucr rill bit or TRK,ucr drilling v Yinst crete as	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith standa [-] well as wa	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	oncrete 13,7 12,6 11,6 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Temperature II: 35 range III: 50 Hammer-drilling with Temperature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr Temperature II: 35 Diamond-drilling (dr Temperature III: 35	er ete nd resistance th standard did 4°C / 40°C 5°C / 60°C 0°C / 72°C th standard did 4°C / 40°C 5°C / 60°C 0°C / 72°C s; Hammer-did 4°C / 40°C 6°C / 60°C	d e in unc rill bit or TRk,uer rill bit or TRk,uer drilling v	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand:	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	13,7 12,6 11,7 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8 1,0 1,4	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0 7,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Temperature II: 35 range III: 50 Hammer-drilling with Temperature II: 35 range III: 50 Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Temperature II: 35 range III: 50 Installation factors Installation factors III: 35 Installation IIII: 35 Installation IIII Installation IIII Installation IIII Installation IIII Installation III Installation II Instal	er ete nd resistance th standard did 4°C / 40°C 5°C / 60°C 0°C / 72°C th standard did 4°C / 40°C 5°C / 60°C 0°C / 72°C s; Hammer-de every or wet cond 4°C / 40°C 5°C / 60°C 0°C / 72°C	d e in unc rill bit or TRK,ucr rill bit or TRK,ucr drilling v Yinst crete as TRK,ucr	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith standa [-] well as wa	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	oncrete 13,7 12,6 11,6 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8 1,0 1,4	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Temperature II: 35 range III: 50 Hammer-drilling with Temperature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr Temperature II: 35 Diamond-drilling (dr Temperature III: 35	er ete nd resistance th standard de 4 °C / 40 °C 5 °C / 60 °C ch standard de 4 °C / 40 °C 5 °C / 60 °C 6 °C / 60 °C 72 °C 8; Hammer- 6 ry or wet cone 4 °C / 40 °C 6 °C / 60 °C 0 °C / 72 °C s; Hammer- 6 ry or wet cone 4 °C / 40 °C 6 °C / 60 °C 0 °C / 72 °C s; Diamond-	d e in unc rill bit or TRK,ucr rill bit or TRK,ucr drilling v Yinst crete as TRK,ucr	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand: [-] well as wa [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	13,7 12,6 11,7 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 1 1,0 1,4	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0 7,0		
Calculation diameter Uncracked concre Characteristic born Hammer-drilling wit Tem- II: 24 perature III: 35 range III: 50 Hammer-drilling wit Tem- II: 24 perature III: 35 range III: 50 Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- II: 24 perature III: 35 range III: 50 Installation factors III: 35 Installation factors	er ete nd resistance th standard do 4°C / 40°C 5°C / 60°C 0°C / 72°C th standard do 4°C / 40°C 5°C / 60°C 0°C / 72°C s; Hammer-do 6°C / 40°C 0°C / 60°C 0°C / 72°C s; Diamond-	d e in unc rill bit or TRK,ucr rill bit or TRK,ucr drilling v Yinst crete as TRK,ucr	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith standa [-] well as wa	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	13,7 12,6 11,7 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8 1,0 1 1,0 8 0 8	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0 7,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Temperature II: 35 range III: 50 Hammer-drilling with Temperature II: 35 range III: 50 Installation factors Uncompared III: 50 Installation factors Uncompared III: 35 Installation factors III: 35 Installation factors III: 35 Installation factors III: 35 Installation factors III: 50 Installation factors III: 50 Installation factors III: 50 Installation factors III: 50 Installation factors	erend resistance ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C s; Hammer-de ery or wet cond 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C s; Hammer-de ery or wet cond 6 ° C / 60 ° C 0 ° C / 72 ° C s; Diamond-de ery	d e in unc rill bit or TRk,ucr rill bit or TRk,ucr drilling v Yinst TRk,ucr drilling	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand: [-] well as wa [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h hole) 9,0	13,7 12,6 11,7 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 1 1,0 1,4	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Temperature II: 35 range III: 50 Hammer-drilling with Temperature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr Temperature II: 35 range III: 50 Installation factors III: 35 Installation factors III: 35 Installation factors Dry or wet concreter Water filled hole Unicolor of the section o	er ete nd resistance ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C ch standard de 4 ° C / 40 ° C 5 ° C / 60 ° C 6 ° C / 60 ° C 72 ° C 72 ° C 72 ° C 73; Hammer-ce 6 ° C / 60 ° C 74 ° C / 60 ° C 75 ° C / 60 ° C	d e in unc rill bit or TRk,uer rill bit or TRk,uer drilling v Yinst crete as TRk,uer drilling Yinst bit.	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith stand: [-] well as wa [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0	220/25 or wet c 13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h hole) 9,0	13,7 12,6 11,7 10,6 10,6 9,0 ollow c	2) 1 12 2 12 2 11 6 10 0 9, 9 9, drill bit	,9 1 ,0 1 ,0 1 ,5 1 0 9 0 8 1,0 1 1,0 8 0 8	2,7 2,0 1,0 0,3 9,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0		
Calculation diameter Uncracked concreter Characteristic born Hammer-drilling with Tem- I: 24 perature II: 35 Hammer-drilling with Tem- I: 24 perature II: 35 range III: 50 Installation factors Dry or wet concreter Water filled hole Diamond-drilling (dr Tem- I: 24 perature III: 35 Installation factors Under III: 35 Installation factors Tem- I: 24 perature III: 35 Installation factors Tem- I: 24 perature III: 35 Installation factors Dry or wet concrete Water filled hole 1) Not allowed fo	er ete nd resistance ch standard did 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C ch standard did 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C s; Hammer-d 6 ry or wet cone 4 ° C / 40 ° C 5 ° C / 60 ° C 0 ° C / 72 ° C s; Diamond-d c or hollow drill system UI sistance to c	d e in unc rill bit or TRk,uer rill bit or TRk,uer drilling v Yinst Crete as TRk,uer drilling Yinst bit.	[mm] racked co hollow drill [N/mm²] hollow drill [N/mm²] vith standa [-] well as wa [N/mm²]	ncrete (bit (dry 13,5 12,0 11,0 bit (wat 11,5 10,0 9,0 ard drill ter filled 9,0 9,0 9,0	13,3 12,0 11,0 er filled 11,4 10,0 9,0 bit or h	13,7	9) 1	,9	2,7 2,0 1,0 0,3 9,0 8,0 8,0 8,0 8,0	12,5 11,0 11,0 9,0 9,0 8,0 8,0 7,0	12,4 11,0 10,0 8,0 8,0 8,0 8,0	12,1 11,0 10,0 8,0 8,0 8,0 7,0 7,0		

working life 50 years part 1



8,1 8,1 8,1 6,1 6,1
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Table C	metric r	einforc	resistan ing bars ete; worl	in har	nmer o	r diamo	ond drill			ailure 1	or
Nominal o	diameter of the bar	•	ф	25	26	28	30 ¹⁾	32 ¹⁾	34 ¹⁾	36 ¹⁾	40 ¹⁾
Combine	d pull-out and con	crete co	ne failure								
Calculatio	n diameter	d	[mm]	25	26	28	30	32	34	36	40
Cracked o	concrete										
Characte	ristic bond resista	nce in cr	acked cor	ncrete C	20/25						
Hammer-c	drilling with standard	l drill bit o	or hollow d	rill bit (d	ry or we	t concret	<u>:e)</u>				
Tem-	I: 24 °C / 40 °C	:		8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
range	III: 50 °C / 72 °C	;		8,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
<u>Hammer-c</u>	drilling with standard	l drill bit d	or hollow d	rill bit (w	/ater fille	d hole)					
Tem-	I: 24 °C / 40 °C			6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
range	III: 50 °C / 72 °C	-		6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
Installatio	on factors; Hamme	r-drilling	with stan	dard d	rill bit or	hollow	drill bit				
Dry or wet	concrete		F 1				1	,0			
Water fille	d hole	γinst	[-]				1	,4			
Diamond-	drilling (dry or wet c	oncrete)									
Tem-	I: 24 °C / 40 °C			7,0	7,0	7,0	7,0	5,0	5,0	5,0	5,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,0	7,0	7,0	7,0	5,0	5,0	5,0	5,0
range	III: 50 °C / 72 °C	;		7,0	7,0	7,0	7,0	5,0	5,0	5,0	5,0
Diamond-	drilling (water filled l	nole)									
Tem-	l: 24 °C / 40 °C	-		6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
range	III: 50 °C / 72 °C	;		6,0	6,0	6,0	6,0	5,0	5,0	5,0	5,0
Installatio	on factors; Diamon	d-drillin	g								
Dry or wet	concrete		[]				1	,0			
Water fille	d hole	- γinst	[-]				1	,4			
1) Not al	lowed for hollow dri	ll bit.									

1) Not al	lowed fo	r hollow	drill	bit.
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Upat Injection system UPM 55 **Annex C11 Performance** Characteristic resistance to combined pull-out and concrete failure for reinforcing bars; working life 50 years part 2



Table C12.1: Characteristic resistance to combined pull-out and concrete failure for metric reinforcing bars in hammer or diamond drilled holes;												
			_					arilled	nole	s;		
		ked con	crete; w				ars					
Nominal diameter			ф	8 ¹⁾	10	12	14	16	18	20	22	24
Combined pull-ou									T			
Calculation diameter		d	[mm]	8	10	12	14	16	18	20	22	24
Uncracked concre		-										
Characteristic bor												
Hammer-drilling wit		drill bit or	hollow drill						1	1	1	
Tem- <u>I: 24 °C</u>				12,0	13,8	13,2	12,7	12,3	12,0		11,5	11,2
perature II: 35 °C		$ au_{ m Rk,100,ucr}$	[N/mm ²]	12,0	11,3	11,3	10,5	10,5	9,8	9,8	9,8	9,0
	: / 72 °C			8,3	8,4	8,4	8,5	8,5	7,8	7,8	7,8	7,8
Hammer-drilling wit		drill bit or	<u>hollow drill</u>									
Tem- <u>I: 24 °C</u>				12,0	13,8	13,2	12,2	11,8	11,0	<u> </u>	9,9	9,7
l' <u>————</u>	C / 60 °C	$ au_{ ext{Rk,100,ucr}}$	[N/mm ²]	12,0	12,0	10,5	9,8	9,0	9,0	8,3	8,3	7,5
	: / 72 °C			8,3	8,4	7,8	7,8	7,8	7,2	7,2	6,5	6,5
Installation factors		r-drilling v	vith stand	ard drill	bit or h	ollow	drill bit					
Dry or wet concrete)		[]					1,0				
Water filled hole		γinst	[-]					1,4				
Diamond-drilling (di	ry or wet co	oncrete as	well as wa	ter filled	hole)							
Tem- I: 24 °	C / 40 °C			12,0	11,3	9,8	9,0	9,0	8,3	7,5	7,5	7,5
	C / 60 °C	τ _{Rk.100.ucr}	[N/mm ²]	12,0	11,3	9,8	9,0	9,0	8,3	7,5	7,5	7,5
range III: 50 °C		• • • • • • • • • • • • • • • • • • • •		8,3	8,4	7,2	7,2	7,2	6,5	6,5	5,9	5,9
Installation factors	s: Diamon	d-drilling		,	,	,	,	· ·			,	<u> </u>
Dry or wet concrete	-	<u></u>						1,0				
Water filled hole		γinst	[-]					1,4				
Nominal diameter	of the har		Φ	25	26	28	30		32 ¹⁾	34 ¹⁾	36 ¹⁾	40 ¹⁾
Combined pull-ou							00		_			
Calculation diameter		d	[mm]	25	26	28	30	0	32	34	36	40
Uncracked concre		-1	[]						_			
	te											
		nce in unc	racked co	ncrete (C20/25							
Characteristic bor	nd resistar					concrete	;)					
Characteristic bor Hammer-drilling wit	n <mark>d resista</mark> r h standard			bit (dry	or wet o			.6 1	0.5	10.3	10.1	9.9
Characteristic bor Hammer-drilling wit Tem- I: 24 °C	nd resistar h standard C / 40 °C	drill bit or	hollow drill	bit (dry 11,1	or wet o	10,8	3 10		0,5	10,3	10,1	9,9 8,3
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C	nd resistar h standard C / 40 °C	drill bit or		bit (dry	or wet of 10,9	10,8 9,0	3 10	0 9	9,0	8,3	8,3	9,9 8,3 6,5
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C	drill bit or τ _{Rk,100,ucr}	hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2	or wet of 10,9 9,0 7,2	10,8 9,0 7,2	3 10	0 9				8,3
Characteristic bor Hammer-drilling wit Tem- 1: 24 ° 0 perature II: 35 ° 0 range III: 50 ° 0 Hammer-drilling wit Tem- 1: 24 ° 0	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C	drill bit or τ _{Rk,100,ucr}	hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2	or wet of 10,9 9,0 7,2	10,8 9,0 7,2	3 10 9,	0 9	9,0	8,3	8,3	8,3
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C	h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C	drill bit or τ _{Rk,100,ucr}	hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat	or wet c 10,9 9,0 7,2 er filled 9,3 7,5	10,8 9,0 7,2 hole)	3 10 9, 7,	0 9 2 7	9,0 7,2	8,3 7,2	8,3 6,5	8,3 6,5
Characteristic bor Hammer-drilling wit Tem- perature II: 24 °C range III: 50 °C Hammer-drilling wit Tem- perature II: 35 °C range III: 50 °C	h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C	$\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$	[N/mm²] hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9	10,8 9,0 7,2 hole) 8,7 7,5 5,9	3 10 9, 7, 8, 6, 6,	0 9 2 7 6 8 8 6	9,0 7,2 3,5	8,3 7,2 6,8	8,3 6,5 6,0	8,3 6,5 6,0
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C range III: 50 °C Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C range III: 50 °C Installation factors	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme	$\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$	[N/mm²] hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9	10,8 9,0 7,2 hole) 8,7 7,5 5,9	3 10 9, 7, 8, 6, 6,	0 9 2 7 6 8 8 6 9 9	9,0 7,2 8,5 6,8	8,3 7,2 6,8 6,8	8,3 6,5 6,0 6,0	8,3 6,5 6,0 6,0
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme	TRk,100,ucr TRk,100,ucr TRk,100,ucr	hollow drill [N/mm²] hollow drill [N/mm²] vith stand	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9	10,8 9,0 7,2 hole) 8,7 7,5 5,9	3 10 9, 7, 8, 6, 6,	0 9 2 7 6 8 8 6	9,0 7,2 8,5 6,8	8,3 7,2 6,8 6,8	8,3 6,5 6,0 6,0	8,3 6,5 6,0 6,0
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C range III: 50 °C Hammer-drilling wit Tem- I: 24 °C perature III: 35 °C range III: 50 °C Installation factors	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme	$\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$ $\tau_{Rk,100,ucr}$	[N/mm²] hollow drill [N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9	10,8 9,0 7,2 hole) 8,7 7,5 5,9	3 10 9, 7, 8, 6, 6,	0 9 2 7 6 8 8 6 9 9	9,0 7,2 8,5 6,8	8,3 7,2 6,8 6,8	8,3 6,5 6,0 6,0	8,3 6,5 6,0 6,0
Characteristic bor Hammer-drilling wit Tem- perature II: 24 °C range III: 50 °C Hammer-drilling wit Tem- perature II: 24 °C perature II: 35 °C range III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (di	h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme	drill bit or τ _{Rk,100,ucr} drill bit or τ _{Rk,100,ucr} τ _{Rk,100,ucr} r-drilling v	hollow drill [N/mm²] hollow drill [N/mm²] [N/mm²] vith stand	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9	3 10 9, 7, 8, 6, 6,	0 9 2 5 6 8 8 6 9 3	9,0 7,2 8,5 6,8	8,3 7,2 6,8 6,8	8,3 6,5 6,0 6,0	8,3 6,5 6,0 6,0
Characteristic bor Hammer-drilling wit Temperature II: 24 °C perature III: 50 °C Hammer-drilling wit Temperature II: 24 °C perature II: 35 °C range III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (d) Tem- II: 24 °C	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme	drill bit or τ _{Rk,100,ucr} drill bit or τ _{Rk,100,ucr} τ-drilling v γ _{inst}	hollow drill [N/mm²] hollow drill [N/mm²] with stand [-] well as wa	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill ter filled 6,8	or wet c 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 5 6 8 8 6 9 4 1,0 1,4	9,0 7,2 8,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2
Characteristic bor Hammer-drilling wit Tem- perature II: 35 °C Hammer-drilling wit Tem- perature II: 35 °C Hammer-drilling wit Tem- perature II: 35 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- perature II: 24 °C perature III: 35 °C Installation factors Installation factors Installation factors III: 35 °C IIII IIII IIIIIIIIIIIIIIIIIIIIIIIII	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme c C / 40 °C C / 60 °C	drill bit or τ _{Rk,100,ucr} drill bit or τ _{Rk,100,ucr} τ-drilling v γ _{inst}	hollow drill [N/mm²] hollow drill [N/mm²] [N/mm²] vith stand	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C III: 50 °C III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C range III: 50 °C	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme c C / 40 °C C / 60 °C C / 72 °C	TRk,100,ucr TRk,100,ucr TRk,100,ucr T-drilling v γinst Dncrete as TRk,100,ucr	hollow drill [N/mm²] hollow drill [N/mm²] with stand [-] well as wa	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill ter filled 6,8	or wet c 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 8,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C Installation factors Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C S; Diamon	TRk,100,ucr TRk,100,ucr TRk,100,ucr T-drilling v γinst Dncrete as TRk,100,ucr	hollow drill [N/mm²] hollow drill [N/mm²] with stand [-] well as wa	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Tem- perature II: 24 °C perature III: 50 °C Hammer-drilling wit Tem- perature II: 24 °C perature III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- perature II: 24 °C perature III: 35 °C Installation factors Diamond-drilling (dr Tem- perature III: 35 °C Installation factors Dry or wet concrete	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Diamon	TRk,100,ucr TRk,100,ucr TRk,100,ucr Trdrilling v Yinst Discrete as TRk,100,ucr TRk,100,ucr	[N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C Installation factors Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Diamon	TRk,100,ucr TRk,100,ucr TRk,100,ucr T-drilling v γinst Dncrete as TRk,100,ucr	hollow drill [N/mm²] hollow drill [N/mm²] with stand [-] well as wa	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Tem- perature II: 24 °C perature III: 50 °C Hammer-drilling wit Tem- perature II: 24 °C perature III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- perature II: 24 °C perature III: 35 °C Installation factors Diamond-drilling (dr Tem- perature III: 35 °C Installation factors Dry or wet concrete	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme c C / 40 °C C / 60 °C C / 72 °C c / 60 °C C / 72 °C s; Diamon	TRk,100,ucr TRk,100,ucr TRk,100,ucr T-drilling v γinst Dncrete as TRk,100,ucr d-drilling	[N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C Hammer-drilling wit Tem- I: 24 °C perature II: 35 °C III: 50 °C III: 50 °C III: 50 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Tem- I: 24 °C perature II: 35 °C range III: 50 °C Installation factors Dry or wet concrete Water filled hole Union of the concrete Water filled hole Water filled hole	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme c / 40 °C C / 60 °C C / 72 °C s; Diamon	TRk,100,ucr TRk,100,ucr TRk,100,ucr Trdrilling v γinst TRk,100,ucr d-drilling γinst rill bit.	[N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill 6,8 6,8	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 3,5 6,8 5,2	8,3 7,2 6,8 6,8 5,2 6,0 6,0	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 5,3
Characteristic bor Hammer-drilling wit Temperature II: 24 °C perature III: 35 °C Hammer-drilling wit Temperature II: 35 °C perature III: 35 °C perature III: 35 °C Installation factors Dry or wet concrete Water filled hole Diamond-drilling (dr Temperature II: 24 °C perature III: 35 °C Installation factors United hole Diamond-drilling (dr Temperature III: 35 °C IIII: 50 °C IIII: 50 °C Installation factors Dry or wet concrete Water filled hole 1) Not allowed for	nd resistar h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 60 °C C / 72 °C s; Hamme c C / 40 °C C / 60 °C C / 72 °C s; Diamon c sistance to	drill bit or τ _{Rk,100,ucr} drill bit or τ _{Rk,100,ucr} τ-drilling v γinst σncrete as τ _{Rk,100,ucr} d-drilling γinst rill bit.	hollow drill [N/mm²] hollow drill [N/mm²] vith stand [-] well as wa [N/mm²]	bit (dry 11,1 9,0 7,2 bit (wat 9,4 7,5 5,9 ard drill ter filled 6,8 6,8 5,9	or wet of 10,9 9,0 7,2 er filled 9,3 7,5 5,9 bit or h	10,8 9,0 7,2 hole) 8,7 7,5 5,9 nollow o	8, 10 9, 7, 8, 6, 6, 5, drill bit	0 9 2 7 6 8 8 6 9 4 1,0 1,4	9,0 7,2 3,5 3,8 5,2 6,0 6,0 5,2	6,8 6,8 5,2 6,0 6,0 4,6	8,3 6,5 6,0 6,0 5,2	8,3 6,5 6,0 6,0 5,2 5,3 4,6



		resistan			-					ailure f	or
1		ing bars					arillea	noie	s;		
	a concre	ete; wor			_		- 10	1 10			
Nominal diameter of the bar		φ	8 ¹⁾	10	12	14	16	18	20	22	24
Combined pull-out and cond		T		10	10	4.4	4.0	10	1 20	100	24
Calculation diameter	d	[mm]	8	10	12	14	16	18	20	22	24
Cracked concrete		dead as as		2/05							
Characteristic bond resistan											
Hammer-drilling with standard	arili bit or	nollow arili					E 2	F 0		F 2	F 2
Tem- <u>I: 24 °C / 40 °C</u>		[N1/21	4,2	6,0	6,4	5,2	5,2	5,2	5,2	5,2	5,2
perature II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	4,2	6,0	6,4	5,2	5,2	5,2	5,2	5,2	5,2
range III: 50 °C / 72 °C	-1	 	4,2	6,0	6,4	5,2	5,2	5,2	5,2	5,2	5,2
Hammer-drilling with standard	arill bit or	hollow arill				4.0	4.0	1 0 0	100	100	100
Tem- <u>I: 24 °C / 40 °C</u>		FN1/ 21	3,6	6,4	5,2	4,2	4,2	3,9	3,9	3,9	3,9
perature II: 35 °C / 60 °C	$ au_{Rk,100,cr}$	[N/mm ²]	3,6	6,4	5,2	4,2	4,2	3,9	3,9	3,9	3,9
range III: 50 °C / 72 °C			3,6	5,5	5,2	3,9	3,9	3,9	3,9	3,9	3,9
Installation factors; Hammer	r-drilling v	vith standa	ard drill	bit or h	ollow (drill bit					
Dry or wet concrete	γinst	[-]					1,0				
Water filled hole		.,			1	,2				1,4	
Diamond-drilling (dry or wet co	ncrete)	T	40	6.0	F 0	40			1 00	1.0	1.0
Tem- 1: 24 °C / 40 °C			4,2	6,0	5,6	4,6	3,9	3,9	3,9	4,6	4,6
perature II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	4,2	6,0	5,6	4,6	3,9	3,9	3,9	4,6	4,6
range III: 50 °C / 72 °C			4,2	6,0	5,6	4,6	3,9	3,9	3,9	4,6	4,6
Installation factor; Diamond	-drilling										
Dry or wet concrete	γinst	[-]					1,0	- 40		1	
Nominal diameter of the bar		ф	25	26	28	30	1) 3	32 ¹⁾	34 ¹⁾	36 ¹⁾	40 ¹⁾
Combined pull-out and cond		I		T 00	1 00			00	0.4		
Calculation diameter	d	[mm]	25	26	28	30)	32	34	36	40
Cracked concrete		lead as as)/2 <i>E</i>							
Characteristic bond resistan											
Hammer-drilling with standard	arili bit or	nollow arili			_		2	5 2	5.2	5.2	5,2
Tem- 1: 24 °C / 40 °C	_	[N1/mamma21	5,2	5,2	5,2			5,2	5,2	5,2	
perature II: 35 °C / 60 °C	$ au_{\text{Rk,100,cr}}$	[N/mm ²]	5,2	5,2	5,2			5,2	5,2	5,2	5,2
range III: 50 °C / 72 °C	-1-11 1-14	 	5,2	5,2	5,2	5,	2 :	5,2	5,2	5,2	5,2
Hammer-drilling with standard	arili bit or	nollow arill					<u> </u>	2 2	20	20	2.0
Tem- <u>I: 24 °C / 40 °C</u>		FN1/21	3,9	3,9	3,9			3,3	3,8	3,8	3,8
perature II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	3,9	3,9	3,9			3,3	3,8	3,8	3,8
range III: 50 °C / 72 °C	- مالالسلم	 	3,9	3,9	3,9		9 ·	3,3	3,3	3,3	3,3
Installation factors; Hammer	-arilling v	vitn standa	ara arill	DIT OF h	OHOW	ariii bit	1.0				
Dry or wet concrete Water filled hole	γinst	[-]					1,0				
	Ť						1,4				
Diamond-drilling (dry or wet co	nicrete)	Ι	16	16	10	1 4	6 7	3 2	22	22	3,3
Tem- 1: 24 °C / 40 °C	_	[N]/mm ²¹	4,6	4,6	4,6			3,3	3,3	3,3	
perature II: 35 °C / 60 °C range III: 50 °C / 72 °C	$ au_{Rk,100,cr}$	[N/mm ²]	4,6	4,6	4,6			3,3	3,3	3,3	3,3
	duillin		4,6	4,6	4,6	4,	U	3,3	3,3	3,3	3,3
Installation factor; Diamond- Dry or wet concrete		r 1					4.0				
-	γinst	[-]					1,0				
1) Not allowed for hollow dr	ill bit.							Ī			
Upat Injection system t	JPM 55								_		40
Performance Characteristic resistance fo working life 100 years	r combine	d pull-out	and cor	ncrete fa	ailure fo	or reinfo	rcing b	ars;	Ar	nnex C	13



Table C14.1: Characteristic resistance to combined pull-out and concrete failure for metric Upat FRA in hammer or diamond drilled holes; uncracked concrete; working life 50 years

Upat FRA	<u> </u>			M12	M16	M20	M24
Combine	d pull-out and cond	crete cor	ne failure				
Calculation	on diameter	d	[mm]	12	16	20	25
Uncracke	ed concrete						
Characte	ristic bond resistar	nce in ur	cracked o	concrete C20/25	5		
<u> Hammer-</u>	drilling with standard	drill bit c	r hollow d	rill bit (dry or wet	t concrete)		
Tem-	I: 24 °C / 40 °C			16,1	15,0	14,2	13,5
perature	II: 35 °C / 60 °C	$ au_{\sf Rk,ucr}$	[N/mm ²]	15,0	14,0	13,0	12,0
range	III: 50 °C / 72 °C			14,0	13,0	12,0	11,0
<u> Hammer-</u>	drilling with standard	drill bit o	r hollow d	rill bit (water fille	d hole)		
Tem-	I: 24 °C / 40 °C			16,1	14,4	13,0	11,5
perature	II: 35 °C / 60 °C	$ au_{\sf Rk,ucr}$	[N/mm ²]	14,0	12,0	11,0	10,0
range	III: 50 °C / 72 °C			13,0	12,0	11,0	9,0
Installati	on factors; Hamme	r-drilling	with stan	ndard drill bit or	hollow drill bit		
Dry or we	t concrete				1	,0	
Water fille	ed hole	γinst	[-]		1	,4	
Diamond-	-drilling (dry or wet co	oncrete a	s well as v	water filled hole)			
Tem-	I: 24 °C / 40 °C			13,0	12,0	10,0	9,0
perature	II: 35 °C / 60 °C	$ au_{\sf Rk,ucr}$	[N/mm ²]	13,0	12,0	10,0	9,0
range	III: 50 °C / 72 °C	-		12,0	11,0	10,0	9,0
Installati	on factors; Diamon	d-drilling	9				
Dry or we	t concrete		r 1		1	,0	
Water fille	ed hole	γinst	[-]		1	,4	

Upat Injection system UPM 55

Performance
Characteristic resistance to combined pull-out and concrete failure for Upat FRA; working life 50 years

Annex C14



Table C15.1: Characteristic resistance to combined pull-out and concrete failure for metric Upat FRA in hammer or diamond drilled holes; cracked concrete; working life 50 years

		,	9 , .			
Upat FRA			M12	M16	M20	M24
Combined pull-out and con	crete cor	ne failure				
Calculation diameter	d	[mm]	12	16	20	25
Cracked concrete						
Characteristic bond resista	nce in cr	acked co	ncrete C20/25			
Hammer-drilling with standard	d drill bit c	r hollow d	rill bit (dry or wet	t concrete)		
Tem- <u>I: 24 °C / 40 °C</u>			8,0	8,0	8,0	8,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	8,0	8,0	8,0	8,0
range III: 50 °C / 72 °C			8,0	8,0	8,0	8,0
Hammer-drilling with standard	d drill bit c	r hollow d	rill bit (water fille	d hole)		
Tem- <u>I: 24 °C / 40 °C</u>			6,5	6,5	6,0	6,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,5	6,5	6,0	6,0
range III: 50 °C / 72 °C			6,5	6,0	6,0	6,0
Installation factors; Hamme	er-drilling	with star	ndard drill bit or	hollow drill bit		
Dry or wet concrete	04 .	[-]		1	,0	
Water filled hole	γinst	[-]	1,	,2	1	,4
Diamond-drilling (dry or wet o	oncrete)					
Tem- <u>I: 24 °C / 40 °C</u>			7,0	6,0	6,0	7,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,0	6,0	6,0	7,0
range III: 50 °C / 72 °C			7,0	6,0	6,0	7,0
Diamond-drilling (water filled he	ole)					
Tem- <u>I: 24 °C / 40 °C</u>			6,5	6,5	6,0	6,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,5	6,5	6,0	6,0
range III: 50 °C / 72 °C			6,5	6,0	6,0	6,0
Installation factors; Diamor	nd-drilling	9				
Dry or wet concrete	24	[]		1	,0	
Water filled hole	γinst	[-]	1	,2	1	,4

Upat Injection system UPM 55	
Performance Characteristic resistance to combined pull-out and concrete failure for Upat FRA; working life 50 years	Annex C15



Table C16.1: Charac	teristic	resistan	ce to combin	ed pull-out ar	nd concrete	failure for
	•			ond drilled hole	•	
	ked or c	racked c		rking life 100		
Upat FRA			M12	M16	M20	M24
Combined pull-out and cond	crete cone	failure				
Calculation diameter	d	[mm]	12	16	20	25
Uncracked concrete						
Characteristic bond resistar						
Hammer-drilling with standard	drill bit or	<u>hollow drill l</u>				
Tem- <u>I: 24 °C / 40 °C</u>			13,2	12,3	11,6	11,1
	$ au_{ ext{Rk,100,ucr}}$	[N/mm ²]	11,3	10,5	9,8	9,0
range III: 50 °C / 72 °C			8,4	8,5	7,8	7,2
-lammer-drilling with standard	drill bit or	hollow drill l	oit (water filled he	<u>ole)</u>		
Tem- <u>I: 24 °C / 40 °C</u>			13,2	11,8	10,7	9,4
perature II: 35 °C / 60 °C	$ au_{Rk,100,ucr}$	[N/mm ²]	10,5	9,0	8,3	7,5
range III: 50 °C / 72 °C	, , ,		7,8	7,8	7,2	5,9
nstallation factors; Hamme	r-drilling v	vith standa	rd drill bit or ho	llow drill bit		
Dry or wet concrete	_			1,	0	
Water filled hole	- γinst	[-] -		1,	4	
Diamond-drilling (dry or wet co	oncrete as	well as wate	er filled hole)	,		
Tem- I: 24 °C / 40 °C			9,8	9,0	7,5	6,8
perature II: 35 °C / 60 °C	$ au_{ ext{Rk,100,ucr}}$	[N/mm ²]	9,8	9,0	7,5	6,8
range III: 50 °C / 72 °C	CRK, 100,uci	[]	7,2	7,2	6,5	5,9
nstallation factors; Diamon	d-drillina		. ,_	. ,_		
Ory or wet concrete	a arming			1,	0	
Nater filled hole	γinst	[-]		1,		
Upat FRA			M12	M16	т М20	M24
Combined pull-out and cond	crata cona	failuro	IVIIZ	IVITO	IVIZU	IVIZ4
Calculation diameter	d	[mm]	12	16	20	25
Cracked concrete	u	[111111]	12	10	20	20
Characteristic bond resistar	oce in crac	ked concr	oto C20/25			
Hammer-drilling with standard				ncrete)		
1 0100 11000	unii bit oi		6,4	5,2	5,2	5,2
	_	[NI/mm ²]				_
perature II: 35 °C / 60 °C range III: 50 °C / 72 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	6,4	5,2	5,2	5,2
	م عاماً النسام	ا المالية	6,4	5,2	5,2	5,2
Hammer-drilling with standard	arili bit or	nollow arill I	•		0.0	0.0
Tem- I: 24 °C / 40 °C		27	5,2	4,2	3,9	3,9
perature II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	5,2	4,2	3,9	3,9
range III: 50 °C / 72 °C			5,2	3,9	3,9	3,9
nstallation factors; Hamme	r-drilling v	vith standa	rd drill bit or ho			
Dry or wet concrete	Yinst	[-]		1,	0	
Nater filled hole	·	11	1,	,2		1,4
Diamond-drilling (dry or wet co	oncrete)					
Tem- <u>I: 24 °C / 40 °C</u>			5,6	3,9	3,9	4,6
perature II: 35 °C / 60 °C	$ au_{Rk,100,cr}$	[N/mm ²]	5,6	3,9	3,9	4,6
range III: 50 °C / 72 °C			5,6	3,9	3,9	4,6
nstallation factors; Diamon	d-drilling					
Ory or wet concrete	γinst	[-]		1,	0	
Upat Injection system	UPM 55					
Performance Characteristic resistance to working life 100 years	combined	d pull-out a	nd concrete failu	ure for Upat FRA;		Annex C16

English translation prepared by DIBt



Table (Table C17.1: Displacements for metric Anchor rods / Threaded rods													
Anchor Threade		M8	M10	M12	M14	M16	M20	M22	M24	M27	M30			
Displace	ment-Factors	for tensi	on loadi	ng ¹⁾										
Uncrack	Uncracked or cracked concrete; Temperature range I, II, III													
$\delta_{ extsf{N0-Factor}}$	[mm/(N/mm²)]	0,07	0,08	0,09	0,09	0,10	0,11	0,11	0,12	0,12	0,13			
δ _{N∞-} Factor	[[mm/(N/mm-)]	0,11	0,12	0,13	0,14	0,15	0,16	0,17	0,18	0,19	0,19			
Displace	ment-Factors	for shea	r loading	2)										
Uncrack	ed or cracked	concrete	; Tempe	rature ra	nge I, II,	III								
δ _{V0-Factor}	[mm/kN]	0,18	0,15	0,12	0,10	0,09	0,07	0,07	0,06	0,05	0,05			
δ∨∞-Factor	[mm/kN]	0,27	0,22	0,18	0,16	0,14	0,11	0,10	0,09	0,08	0,07			

¹⁾ Calculation of effective displacement:

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \, \cdot \, \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

Table C17.2: Displacements for metric Upat IST

Upat IST	•	M8 M10 M12 M16								
Displace	Displacement-Factors for tension loading ¹⁾									
Uncrack	ed or cracked	concrete; Tempe	rature range I, II,	III						
δ N0-Factor	[mm/(N/mm ²)]	0,09	0,10	0,10	0,11	0,13				
$\delta_{\text{N}\infty ext{-} ext{Factor}}$	[[[]]]]	0,13	0,15	0,16	0,17	0,19				
Displace	ment-Factors	for shear loading	2)							
Uncrack	ed or cracked	concrete; Tempe	rature range I, II,	III						
δ V0-Factor	[mm/kN]	0,12	0,09	0,08	0,07	0,05				
δ∨∞-Factor	[IIIII/KN]	0,18	0,14	0,12	0,10	0,08				

1) Calculation of	effective dis	placement:
-------------------	---------------	------------

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \, \cdot \, \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

Unat	Injection	evetem	HIDM	55
UDAL	ппеспоп	System	UPIN	:::::

Performance

Displacements for metric Anchor rods / Threaded rods and Upat IST

Annex C17

English translation prepared by DIBt



Nominal of the ba	diameter ar	ф	8	10	12	14	16	18	20	22	24	25	26	28	30	32	34	36	40
Displacement-Factors for tension loading ¹⁾																			
Uncrack	ed or crack	ced	conc	rete;	Tem	perat	ure ra	ange	I, II, I	II									
$\delta_{ extsf{N0-Factor}}$	[mm/(N/mr	-2\1	0,07	0,08	0,09	0,09	0,10	0,10	0,11	0,11	0,12	0,12	0,12	0,13	0,13	0,13	0,14	0,14	0,1
δ _{N∞-} Factor	[mm/(N/mm²)] 	n-)]	0,11	0,12	0,13	0,14	0,15	0,16	0,16	0,17	0,18	0,18	0,18	0,19	0,19	0,20	0,20	0,21	0,22
Displace	Displacement-Factors for shear loading ²⁾																		
Uncrack	ed or crack	ced	conc	rete;	Tem	perat	ure ra	ange	I, II, I	II									
δ V0-Factor	F (I-N1)		0,18	0,15	0,12	0,10	0,09	0,08	0,07	0,07	0,06	0,06	0,06	0,05	0,05	0,05	0,04	0,04	0,04
δ∨∞-Factor	[mm/kN]	J	0,27	0,22	0,18	0,16	0,14	0,12	0,11	0,10	0,09	0,09	0,08	0,08	0,07	0,07	0,06	0,06	0.05

1) Calculation of effective displacement:

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \, \cdot \, \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

Table C18.2: Displacements for metric Upat FRA

Upat FR	A	M12 M16 M20						
Displace	Displacement-Factors for tension loading ¹⁾							
Uncrack	ed or cracked	concrete; Temperatu	re range I, II, III					
$\delta_{ extsf{N0-Factor}}$	[mm/(N/mm ²)]	0,09	0,10	0,11	0,12			
$\delta_{\text{N}\infty ext{-} ext{Factor}}$	[[[[[[]]	0,13	0,15	0,16	0,18			
Displacement-Factors for shear loading ²⁾								
Uncrack	ed or cracked	concrete; Temperatu	re range I, II, III					
$\delta_{ extsf{V0-Factor}}$	[mm/kN]	0,12	0,09	0,07	0,06			
δ∨∞-Factor	[mm/kN]	0,18	0,14	0,11	0,09			

1) Calculation of effective displaceme	nt:
--	-----

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \, \cdot \, \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

Upat I	njection	system	UPM	55

Performance

Displacements for reinforcing bars and Upat FRA

Annex C18



Tab	Table C19.1: Characteristic resistance to steel failure under tension loading for fractional Threaded rods part 1										
Threa	aded rod				3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Char	acteristic resist	ance	to steel failure under ten	sion lo	ading						
			F568M, Class 5.8		25,0	45,7	72,9	107,9	148,9	195,4	246,0
ဥ	.		F1554, Grade 36		19,9	36,5	58,3	86,2	119,1	156,2	196,7
star	Steel zinc plated	က္က	F1554, Grade 55]	25,8	47,3	75,3	111,5	154,0	202,0	254,4
resi	•	class	F1554, Grade 105		43,0	78,8	125,6	185,9	256,7	336,8	424,0
stic Kr.s	지	ا ين	A193, B7	[kN]	43,0	78,8	125,6	185,9	256,7	336,8	424,0
teris		Property	F593, Alloy Group 2]	34,4	63,0	100,5	126,4	174,5	229,0	288,3
Characteristic resistance NRKS	Stainless steel R	P.	A193, Grade B8M, Class 1		25,8	47,3	75,3	111,5	154,0	202,0	254,4
0		_	A193, Grade B8M, Class 2B		32,7	59,9	95,4	141,3	195,1	255,9	322,2
Partia	al factors 1)										
			F568M, Class 5.8					1,50			
			F1554, Grade 36		1,94						
_	Steel zinc plated	ဟ	F1554, Grade 55					1,64			
Partial factor	•	class	F1554, Grade 105					1,43			
ial fa			A193, B7	[-]				1,43			
arti⊱ √	•	Property	F593, Alloy Group 2			1,85			2,	27	
Δ.	Stainless steel R	۔ م	A193, Grade B8M, Class 1					3,00			
	Steel K		A193, Grade B8M, Class 2B					1,52			

¹⁾ In absence of other national regulations.

Upat Injection system UPM 55	
Performance Characteristic resistance to steel failure under tension / shear loading for fractional Threaded rods part 1	Annex C19



Steel zinc plated Stainless steel R Stainless st	[kN]	15,0 11,9 12,9 21,5 21,5 17,2 12,9 16,3	27,4 21,9 23,6 39,4 31,5 23,6 29,9	43,7 34,9 37,6 62,8 62,8 50,2 37,6 47,7	64,7 51,7 55,7 92,9 92,9 63,2 55,7 70,6	89,3 71,4 77,0 128,3 128,3 87,2 77,0 97,5	117,2 93,7 101,0 168,4 168,4 114,5 101,0	147,6 118,0 127,2 212,0 212,0 144,1 127,2
Steel zinc plated Zinc p		11,9 12,9 21,5 21,5 17,2 12,9 16,3	21,9 23,6 39,4 39,4 31,5 23,6 29,9	34,9 37,6 62,8 62,8 50,2 37,6 47,7	51,7 55,7 92,9 92,9 63,2 55,7 70,6	71,4 77,0 128,3 128,3 87,2 77,0	93,7 101,0 168,4 168,4 114,5 101,0	118,0 127,2 212,0 212,0 144,7 127,2
Steel zinc plated Zinc plated Steel Zinc plated Zinc plate		11,9 12,9 21,5 21,5 17,2 12,9 16,3	21,9 23,6 39,4 39,4 31,5 23,6 29,9	34,9 37,6 62,8 62,8 50,2 37,6 47,7	51,7 55,7 92,9 92,9 63,2 55,7 70,6	71,4 77,0 128,3 128,3 87,2 77,0	93,7 101,0 168,4 168,4 114,5 101,0	118,0 127,2 212,0 212,0 144,1 127,2
Class 2B Ductility factor k6 with lever arm F568M, Class 5.8		12,9 21,5 21,5 17,2 12,9 16,3	23,6 39,4 39,4 31,5 23,6 29,9	37,6 62,8 62,8 50,2 37,6 47,7	55,7 92,9 92,9 63,2 55,7 70,6	77,0 128,3 128,3 87,2 77,0	101,0 168,4 168,4 114,5 101,0	127,2 212,0 212,0 144,1 127,2
Class 2B Ductility factor k ₆ with lever arm F568M, Class 5.8		21,5 21,5 17,2 12,9 16,3 29,9 23,9	39,4 39,4 31,5 23,6 29,9	62,8 62,8 50,2 37,6 47,7	92,9 92,9 63,2 55,7 70,6	128,3 128,3 87,2 77,0	168,4 168,4 114,5 101,0	212, 212, 144, 127,
Class 2B Ductility factor k ₆ with lever arm F568M, Class 5.8		21,5 17,2 12,9 16,3 29,9 23,9	39,4 31,5 23,6 29,9	62,8 50,2 37,6 47,7	92,9 63,2 55,7 70,6 1,0	128,3 87,2 77,0	168,4 114,5 101,0	212, 144, 127,
Class 2B Ductility factor k ₆ with lever arm F568M, Class 5.8		17,2 12,9 16,3 29,9 23,9	31,5 23,6 29,9 74,0	50,2 37,6 47,7	63,2 55,7 70,6 1,0	87,2 77,0	114,5 101,0	144, 127,
Class 2B Ductility factor k ₆ with lever arm F568M, Class 5.8		12,9 16,3 29,9 23,9	23,6 29,9 74,0	37,6 47,7	55,7 70,6 1,0	77,0	101,0	127,
Class 2B Ductility factor k ₆ with lever arm F568M, Class 5.8	[-]	16,3 29,9 23,9	29,9	47,7	70,6 1,0		·	
Class 2B Ductility factor k6 with lever arm F568M, Class 5.8	[-]	29,9	74,0		1,0	97,5	127,9	161,
with lever arm F568M, Class 5.8	[-]	23,9		148 9				
F568M, Class 5.8		23,9		148 9	.			
Steel zinc plated Steel Zinc p		23,9		148 9				
Steel zinc plated F1554, Grade 36 F1554, Grade 55 F1554, Grade 105 F1593, Alloy Group 2 A193, Grade B8M, Glass 1			59,2	140,5	268,2	435,1	653,8	923,
Steel F1554, Grade 55 F1554, Grade 105 F193, Alloy Group 2 Stainless Stainless Steel F1554, Grade 105 F1593, Alloy Group 2 F193, Grade B8M, Glass 1		30.9		119,1	214,5	348,0	522,9	738,
Stainless Stai		,-	76,6	154,0	277,4	450,0	676,1	955,
Stainless A193, B7 F593, Alloy Group 2 A193, Grade B8M,	I	51,5	127,6	256,8	462,4	750,0	1126,9	1591
Stainless F593, Alloy Group 2 A193, Grade B8M, Class 1	[Nm]	51,5	127,6	256,8	462,4	750,0	1126,9	1591
Stainless A193, Grade B8M,		41,2	102,1	205,4	314,4	510,0	766,3	1082
g steel R		30,9	76,6	154,0	277,4	450,0	676,1	955,
A193, Grade B8M, Class 2B		39,1	97,0	195,1	351,4	570,0	856,4	1209
Partial factors 1)	·		•					
F568M, Class 5.8	F568M, Class 5.8 1,25							
F1554, Grade 36		1,61						
Steel F1554, Grade 55					1,36			
Sinc plated		1,50						
		1,50						
F593, Alloy Group 2	<u></u> [-]		1,54	1,	89			
Stainless steel R Stainless steel R		2,50						
A193, Grade B8M, Class 2B					1,27			



Table C21.1:	Characteristic resistance to steel failure under tension loading for
	fractional Upat IST part 1

Upat IST			IST	Screw		3/8"	1/2"	5/8"	3/4"
Characteristic	resist	ance to s	teel fail	ure under tension loa	ding				
		Property		F568M, Class 5.8		25,0	45,7	72,9	107,9
		class,		F1554, Grade 36		20,0	36,6	58,3	86,3
		Steel	5.8	F1554, Grade 55		25,8	47,3	75,3	111,5
Charactaristic		zinc		F1554, Grade 105		43,1	76,4	110,8	186,0
Characteristic resistance with	Neks	plated		A193, B7	[kN]	43,1	76,4	110,8	186,0
screw	i vick,s			F593, Alloy Group 2	[[34,4	63,0	100,4	126,4
		Property class, Stainless	70	A193, Grade B8M, Class 1		25,8	47,3	75,3	111,5
		steel R		A193, Grade B8M, Class 2B		32,7	59,9	95,4	141,3
Partial factors	1)								
		Droporty		F568M, Class 5.8			1,	50	
		Property class,		F1554, Grade 36			1,9	94	
		Steel	5.8	F1554, Grade 55			1,0	64	
		zinc		F1554, Grade 105] [1,43		1,50	
Partial factors	plated γ _{Ms,N}			A193, B7	[-]	1,43		1,50	
T Grada Table 10	/IVIS,IV			F593, Alloy Group 2] ' ' [1,85		2,27
		Property class,	70	A193, Grade B8M, Class 1			3,	00	
		Stainless steel R		A193, Grade B8M, Class 2B		1,52			

¹⁾ In absence of other national regulations.

Upat Injection system UPM 55	
Performance Characteristic resistance to steel failure under tension loading for fractional Upat IST part 1	Annex C21



Characteristic resistand Without lever arm	ce to st				3/8"	1/2"	5/8''	3/4"		
		eel fail	ure under shear load	ing						
Pro						<u> </u>	T			
1 10	operty		F568M, Class 5.8		15,0	27,4	43,7	64,7		
cla	ass,		F1554, Grade 36		11,9	21,9	34,9	51,7		
	eel	5.8	F1554, Grade 55		12,9	23,6	37,6	55,7		
zin Characteristic pla	ated		F1554, Grade 105		21,5	39,4	62,8	92,9		
resistance with V ⁰ Rk,s			A193, B7	[kN]	21,5	39,4	62,8	92,9		
screw	conorty		F593, Alloy Group 2		17,2	31,5	50,2	63,2		
cla	roperty ass, ainless	70	A193, Grade B8M, Class 1		12,9	23,6	37,6	55,7		
	eel R		A193, Grade B8M, Class 2B		16,3	29,9	47,7	70,6		
With lever arm	Т	1					·			
Pro	operty		F568M, Class 5.8		29,9	74,0	148,9	268,2		
cla	ass,		F1554, Grade 36		23,9	59,2	119,1	214,5		
Ste zin	eel	5.8	F1554, Grade 55		30,9	76,6	154,0	277,4		
	ated		F1554, Grade 105		51,5	127,6	256,8	462,4		
resistance with M ⁰ Rk,s			A193, B7	[Nm]	51,5	127,6	256,8	462,4		
screw Pro	operty		F593, Alloy Group 2		41,2	102,1	205,4	314,4		
cla	ass, ainless	70	A193, Grade B8M, Class 1		30,9	76,6	154,0	277,4		
	eel R		A193, Grade B8M, Class 2B		39,1	97,0	195,1	351,4		
Partial factors 1)										
Pro	Property		F568M, Class 5.8				1,25			
cla	ass,		F1554, Grade 36		1,61					
Ste zin	eel	5.8	F1554, Grade 55		1,36					
	ated		F1554, Grade 105		1,50					
Partial factors γ _{Ms,V}			A193, B7	[-]	1,50					
Pro	operty		F593, Alloy Group 2	-		1,54		1,89		
cla	ass, ainless	70	A193, Grade B8M, Class 1			50				
ste	eel R		A193, Grade B8M, Class 2B			1,	27			

English translation prepared by DIBt



Table C23.1: Character fractional				steel fa	ailure ι	ınder te	ension <i>i</i>	/ shear	loadin	g for
Rebar size			#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Characteristic resistance to s	teel failure	unde	r tensio	n loadi	ng					
Characteristic resistance	sistance N _{Rk,s} [kN] A _s · f _{uk} ²⁾									
Characteristic resistance to s	teel failure	unde	r shear	loading	3					
Without lever arm										
Characteristic resistance	$V^0_{Rk,s}$	[kN]				k ₆ ³⁾ · A	$\lambda_{s} \cdot f_{uk}^{2)}$			
Ductility factor	k ₇	[-]				1	,0			
With lever arm										
Characteristic resistance	M^0 _{Rk,s}	[Nm]				1,2 · V	√ _{el} · f _{uk} ²⁾			

Not allowed for hollow drill bit.

3) In accordance with EN 1992-4:2018 section 7.2.2.3.1:

 $k_6 = 0.6$ for fasteners made of carbon steel with $f_{uk} \le 500 \text{ N/mm}^2$,

= 0,5 for fasteners made of stainless steel.

Upat Injection system UPM 55	
Performance Characteristic resistance to steel failure under tension / shear loading for reinforcing bars	Annex C23

²⁾ f_{uk} respectively shall be taken from the specifications of the reinforcing bar.

^{= 0,5} for fasteners made of carbon steel with 500 N/mm² < f_{uk} ≤ 1000 N/mm²,



Size									All si	izes					
Characteristic resistance t	o concr	ete fa	ilure ui	nder ten	sion loa	adi	ng								
Installation factor		γinst	[-]		Se	e A	Annex	C2	5 to (C34, C	46 and (C47			
Factors for the compressiv	e stren	gth of	concr	ete > C2	0/25										
(C25/30								1,0)2					
Increasing factor ψ_c for $\frac{1}{2}$	230/37								1,0)4					
	235/45	Ψ_{c}	[-]						1,0)6					
	C40/50	Ic	[-]						1,0)7					
$\tau_{Rk(X,Y)} = \psi_c \cdot \tau_{Rk(C20/25)} \qquad ($	C45/55								1,0	8					
	C50/60			1,09											
Splitting failure															
	_{ef} ≥ 2,0								1,0						
Edge distance 2,0 > h / h		C cr,sp	[mm]					4,0		- 1,8 h					
	_{ef} ≤ 1,3				2,26 h _{ef} 2 c _{cr,sp}										
Spacing		S cr,sp							2 C c	r,sp					
Concrete cone failure		ı.							44.0	1)					
Uncracked concrete		Kucr,N	[-]		11,0 ¹⁾ 7,7 ¹⁾										
Cracked concrete Edge distance		K _{cr,N}							7,7 1,5						
Spacing		C _{cr,N}	[mm]						2 c						
Factors for sustained tens	ion load								2 00	cr,N					
Temperature range	ion ioac	anig		24 °	C / 40 °(35	°C /	60 °C		50 °C / 7	72 °C		
Factor		Ψ^0 sus			0,77 0,60				0,48						
Factor	21			0,77 0,60					0,71						
Characteristic resistance to	<u> </u>	0 _{sus,100}				ine	-		0,0	,,,		3,71			
Installation factor	o conci			iluer Sile	ai ioau	ıιιί	<u> </u>		1,0	<u> </u>					
Concrete pry-out failure		γinst	[-]						١,٠	<u> </u>					
Factor for pry-out failure		k ₈	[-]						2,	n					
Concrete edge failure		100	[L J]						۷,						
Effective length of fastener in shear loading	า	l _f	[mm]		r d _{nom} ≤ r d _{nom} >						n) d _{nom} ; 30	00 mm))			
Calculation diameters															
Size				3/8"	1/2"	Т	5/8	"	3/4	1"	7/8"	1"	1 1/8		
Anchor rods and Threaded re	ods	d _{nom}		9,5	12,7		15,9	9	19	,1	22,2	25,4	28,6		
Upat IST		d _{nom}	[mm]	15,7	18,0	\dashv	22,0	_	28		_2)	_2)	_2)		
Rebar size				#3	#4		#5	#	:6	#7	#8	#9	#10		
Reinforcing bar		d_{nom}	[mm]	9,5	12,7	1	5,9	19	9,1	22,2	25,4	28,7	32,3		
¹⁾ Values only valid when ²⁾ Anchor type not part of															
Upat Injection system	UPM 5	5													
Performance Characteristic resistance for	or concre	ete fail	ure und	der tensi	on / shea	ar I	oadin	g fo	r		A	nnex (224		



[h we = e' = -'	ا سم دا	uncracke	u con	CIELE, W				2/4"	7/0"	411	4.4101
Threaded					3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8'
		out and conc					T				I
Calculatio			d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,6
Jncracke											
		ond resistan									
Hammer-d		vith standard	drill bit c	r hollow d		1	1				T
Гет-		24 °C / 40 °C			20,0	18,6	17,7	16,8	16,2	15,8	15,3
erature ange		35 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	18,0	18,0	17,0	16,0	15,0	15,0	14,0
		50 °C / 72 °C			17,0	17,0	16,0	15,0	14,0	14,0	13,0
Hammer-c		with standard	drill bit c	r hollow d				Г			
Гет-		24 °C / 40 °C			20,0	18,6	17,0	15,4	14,3	13,7	12,8
perature		35 °C / 60 °C	$\tau_{\text{Rk},\text{ucr}}$	[N/mm ²]	16,0	15,0	13,0	11,0	11,0	10,0	9,0
ange		50 °C / 72 °C			14,0	14,0	12,0	11,0	10,0	9,0	9,0
nstallatio	on facto	ors; Hammer	drilling	with star	ndard dri	ll bit or h	ollow dri	l bit			
Dry or wet		ete	γinst	[-]				1,0			
Nater fille	d hole		fillst					1,4			
Diamond-	drilling	(dry or wet co	ncrete)								
Гет-	l: _2	24 °C / 40 °C			14,4	13,3	12,3	11,8	11,3	10,8	10,3
perature	II: 3	35 °C / 60 °C	$\tau_{\text{Rk},\text{ucr}}$	[N/mm ²]	15,0	13,0	12,0	10,0	10,0	9,0	9,0
ange	III: 5	50 °C / 72 °C			14,0	12,0	11,0	10,0	9,0	8,0	8,0
Diamond-	drilling	(water filled ho	ole)								
Гет-	l: 2	24 °C / 40 °C			17,3	15,0	13,6	12,4	11,5	10,8	10,1
erature	II: 3	35 °C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	15,0	13,0	12,0	10,0	10,0	9,0	9,0
ange	III: 5	50 °C / 72 °C			14,0	12,0	11,0	10,0	9,0	8,0	8,0
nstallatio	on facto	ors; Diamond	-drilling	3							
Ory or wet	t concre	ete						1,0			
Nater fille	d hole		γinst	[-]				1,4			
Perform	nance	n system UF		1 null-out s	and concr	ete failure	a for			Annex	C25



Table C	fraction	al Thre	resistan aded roc ete; worl	d s in ha	ımmer o	r diamor			e failure	for
Threaded	rod			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Combine	d pull-out and cor	crete co	ne failure							
Calculatio	n diameter	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,6
Cracked (concrete									
Characte	ristic bond resista	nce in cr	acked co	ncrete C	20/25					
Hammer-d	<u>drilling with standar</u>	d drill bit o	or hollow d	rill bit (dr	y or wet c	oncrete)				
Tem-	I: 24 °C / 40 °C	2		8,7	9,9	9,5	8,5	8,5	8,5	8,5
perature	II: 35 °C / 60 °C	Σ $ au_{Rk,cr}$	[N/mm ²]	8,7	9,9	9,5	8,5	8,5	8,5	8,5
range	III: 50 °C / 72 °C			8,2	9,3	8,9	8,5	8,5	8,5	8,5
Hammer-d	<u>drilling with standar</u>	d drill bit o	or hollow d	rill bit (wa	ater filled h	nole)				
Tem-	I: 24 °C / 40 °C	2		7,5	8,5	7,8	6,0	6,0	6,0	6,0
perature	II: 35 °C / 60 °C	Σ $ au_{ m Rk,cr}$	[N/mm ²]	7,5	8,5	7,8	6,0	6,0	6,0	6,0
range	III: 50 °C / 72 °C		- • • • • • • • • • • • • • • • • • • •	7,0	8,0	7,3	6,0	6,0	6,0	6,0
Installatio	on factors; Hamme	er-drilling	with star	ndard dri	II bit or h	ollow dri	ll bit			
Dry or we	t concrete	_ ^.	[-]				1,0			
Water fille	d hole	— γinst	[-]		1,2		1,4			
Diamond-	drilling (dry or wet o	concrete)								
Tem-	I: 24 °C / 40 °C			7,0	7,0	6,0	6,0	7,0	7,0	7,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,0	7,0	6,0	6,0	7,0	7,0	7,0
range	III: 50 °C / 72 °C			7,0	7,0	6,0	6,0	7,0	7,0	7,0
Diamond-	drilling (water filled	hole)								
Tem-	I: 24 °C / 40 °C	2		7,5	7,5	6,0	6,0	6,0	6,0	6,0
perature	II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,5	7,5	6,0	6,0	6,0	6,0	6,0
range	III: 50 °C / 72 °C			7,0	7,0	6,0	6,0	6,0	6,0	6,0
Installatio	on factors; Diamo	nd-drillin	g							
Dry or we	t concrete	_ 24 .	[-]				1,0			
Water fille	d hole	— γinst	[-]		1,2			1	,4	

Upat Injection system UPM 55	
Performance Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods; working life 50 years	Annex C26



Table (fraction	nal Threa	resistan aded roc crete; w	ds in ha	mmer o	r diamor			failure	for
Threade	d rod			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Combine	ed pull-out and con	crete cor	ie failure							
Calculation	on diameter	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,6
Uncrack	ed concrete									
Characte	eristic bond resista	nce in un	cracked o	concrete	C20/25					
Hammer-	-drilling with standar	d drill bit o	r hollow d	rill bit (dry	or wet co	oncrete)				
Tem-	I: 24 °C / 40 °C			16,4	15,3	14,5	13,8	13,3	12,9	12,6
perature	II: 35 °C / 60 °C	τ _{Rk,100,ucr}	[N/mm ²]	13,5	13,5	12,8	12,0	11,3	11,3	10,5
range	III: 50 °C / 72 °C			10,2	10,2	10,4	9,8	9,1	9,1	8,5
Hammer-	-drilling with standar	<u>d drill bit o</u>	r hollow d	rill bit (wa	ter filled h	<u>role)</u>				
Tem-	I: 24 °C / 40 °C	_		16,4	15,3	13,9	12,6	11,7	11,2	10,5
perature	II: 35 °C / 60 °C	$_{ extstyle au} au_{ extstyle extstyle au_{ extstyle extstyle au_{ extstyle extstyle au_{ extstyle au$	[N/mm ²]	12,0	11,3	9,8	8,3	8,3	7,5	6,8
range	III: 50 °C / 72 °C			8,4	8,4	7,8	7,2	6,5	5,9	5,9
Installati	ion factors; Hamme	ər-drilling	with stan	idard dril	ll bit or h	ollow dril	l bit			
Dry or we	et concrete	— Vinet	[-]				1,0			
Water fille	ed hole	— γinst	[-]				1,4			
Diamond	I-drilling (dry or wet o	concrete)								
Tem-	I: 24 °C / 40 °C	_		11,8	10,8	10,1	9,7	9,3	8,8	8,5
perature	II: 35 °C / 60 °C	$_{ extstyle } au_{ extstyle extst$	[N/mm ²]	11,3	9,8	9,0	7,5	7,5	6,8	6,8
range	III: 50 °C / 72 °C			8,4	7,2	7,2	6,5	5,9	5,2	5,2
Diamond	l-drilling (water filled	hole)								
Tem-	I: 24 °C / 40 °C	_		14,2	12,3	11,2	10,2	9,4	8,9	8,3
perature	II: 35 °C / 60 °C	$_{ extstyle au_{ extstyle extsty$	[N/mm ²]	11,3	9,8	9,0	7,5	7,5	6,8	6,8
range	III: 50 °C / 72 °C			8,4	7,2	7,2	6,5	5,9	5,2	5,2
Installati	ion factors; Diamoi	nd-drillinç	j							
Dry or we	et concrete	— ^6 4	[-]				1,0			
Water fille	ed hole	— γinst	[-]				1,4			

Upat Injection system UPM 55	
Performance	Annex C27
Characteristic resistance to combined pull-out and concrete failure for	
fractional Threaded rods in hammer or diamond drilled holes; working life 100 years	



Table C28.1:	Characteristic resistance to combined pull-out and concrete failure for
	fractional Threaded rods in hammer or diamond drilled holes;
	cracked concrete; working life 100 years

	cracked	d concre	ete; worl	king life	e 100 ye	ars				
Threaded	rod			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Combined	l pull-out and con	crete cor	ne failure		•				•	
Calculation	n diameter	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,6
Cracked c	oncrete									
Character	istic bond resista	nce in cr	acked cor	ncrete C2	20/25					
<u>Hammer-d</u>	rilling with standard	d drill bit o	r hollow d	rill bit (dn	y or wet c	oncrete)				
Tem	I: 24 °C / 40 °C			7,0	7,5	7,2	6,9	6,8	6,5	6,3
perature I	II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	7,0	7,5	7,2	6,9	6,8	6,5	6,3
range II	II: 50 °C / 72 °C			6,6	7,1	6,8	6,4	6,4	6,1	6,0
<u>Hammer-d</u>	rilling with standard	d drill bit o	r hollow d	rill bit (wa	ater filled h	nole)				
Tem	I: 24 °C / 40 °C		τ _{Rk,100,cr} [N/mm²]	6,0	6,5	5,9	4,9	4,8	4,6	4,4
	II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$		6,0	6,5	5,9	4,9	4,8	4,6	4,4
range II	II: 50 °C / 72 °C			5,6	6,1	5,5	4,5	4,5	4,3	4,3
Installatio	n factors; Hamme	er-drilling	with star	dard dri	ll bit or h	ollow dril	l bit			
Dry or wet	concrete	_ ^ .	[-]				1,0			
Water filled	d hole	— γinst	[-]	1,2 1,4		,4				
Diamond-d	drilling (dry or wet c	oncrete)								
Tem	I: 24 °C / 40 °C			6,0	5,6	3,9	3,9	4,6	4,6	4,6
perature	II: 35 °C / 60 °C	$ au_{ ext{Rk,100,cr}}$	[N/mm ²]	6,0	5,6	3,9	3,9	4,6	4,6	4,6
range I	II: 50 °C / 72 °C			6,0	5,6	3,9	3,9	4,6	4,6	4,6
Installatio	n factors; Diamor	nd-drilling	J							
Dry or wet	concrete	γinst	[-]				1,0			

Upat Injection system UPM 55

Performance

Characteristic resistance to combined pull-out and concrete failure for fractional Threaded rods in hammer or diamond drilled holes; working life 100 years

Annex C28



	ed con		orking life 50	mond drilled h	nd concrete oles;	ianure ioi				
			3/8"	1/2"	5/8"	3/4"				
t and conc	rete cor	ne failure								
er	d	[mm]	15,7	18,0	22,0	28,0				
ete										
nd resistan	ce in un	cracked c	oncrete C20/25	,						
h standard	drill bit c	r hollow dr	ill bit (dry or wet	concrete)						
C / 40 °C			17,6	17,0	16,2	15,3				
C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	14,0	14,0	13,0	12,0				
C / 72 °C	,		13,0	13,0	12,0	11,0				
h standard	drill bit c	r hollow dr	ill bit (water fille	d hole)						
C / 40 °C			16,9	15,8	14,3	12,8				
C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	12,0	12,0	11,0	10,0				
C / 72 °C	•		12,0	11,0	10,0	9,0				
s; Hammer	-drilling	with stan	dard drill bit or	hollow drill bit		'				
•		F 3		1,	0					
	γinst	[-]	1,4							
ry or wet co	ncrete)									
C / 40 °C			12,3	11,9	11,2	10,4				
C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	12,0	11,0	10,0	9,0				
C / 72 °C	,	1	11,0	10,0	9,0	8,0				
ater filled he	ole)					'				
C / 40 °C			13,6	12,6	11,4	10,2				
C / 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	12,0	11,0	10,0	9,0				
C / 72 °C			11,0	10,0	9,0	8,0				
s; Diamond	l-drillinç	3				•				
•		r 1		1,	0					
	Yinst	[-]		1,	4					
	nd resistande h standard C / 40 °C C / 60 °C C / 72 °C h standard C / 40 °C C / 72 °C s; Hammer C / 40 °C C / 60 °C C / 72 °C ater filled he C / 40 °C C / 60 °C C / 72 °C ater filled he C / 40 °C C / 60 °C C / 72 °C s; Diamond	nd resistance in until h standard drill bit of C / 40 °C C / 60 °C C / 72 °C ch standard drill bit of C / 40 °C C / 60 °C C / 72 °C s; Hammer-drilling γinst ry or wet concrete) C / 40 °C C / 60 °C C / 72 °C atter filled hole) C / 40 °C C / 40 °C C / 72 °C atter filled hole) C / 40 °C C / 72 °C s; Diamond-drilling	th standard drill bit or hollow drill bit or h	And resistance in uncracked concrete C20/25 And resistance in uncrease in unc	The standard drill bit or hollow drill bit (dry or wet concrete) C / 40 ° C C / 60 ° C T_{Rk,ucr} [N/mm²] 14,0 14,0	And resistance in uncracked concrete C20/25 And resistance in uncracked concrete C20/25				

fractional Upat IST; working life 50 years



Table C30.1:	Characteristic resistance to combined pull-out and concrete failure for
	fractional Upat IST in hammer or diamond drilled holes;
	cracked concrete; working life 50 years

				,	king life 50 ye	_			
Upat IST					3/8"	1/2"	5/8"	3/4"	
Combine	d pu	II-out and conc	rete cor	ne failure					
Calculatio	n dia	ameter	d	[mm]	15,7	18,0	22,0	28,0	
Cracked	cond	rete							
Characte	ristic	bond resistan	ce in cr	acked cor	ncrete C20/25				
Hammer-	drillir	<u>ig with standard</u>	drill bit c	r hollow d	rill bit (dry or wet	t concrete)			
Tem	I:	24 °C / 40 °C			6,0	6,0	7,0	7,0	
oerature _	II:	35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,0	6,0	7,0	7,0	
range	III:	50 °C / 72 °C			6,0	6,0	7,0	7,0	
Hammer-	drillir	ng with standard	drill bit c	r hollow d	rill bit (water fille	<u>d hole)</u>			
Tem	I:	24 °C / 40 °C			6,5	6,0	6,0	6,0	
oerature	II:	35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,5	6,0	6,0	6,0	
range	III:	50 °C / 72 °C			6,0	6,0	6,0	6,0	
nstallati	on fa	ctors; Hammer	-drilling	with star	dard drill bit or	hollow drill bit			
Dry or we	t con	crete	24 .	[-]		1	,0		
Water fille	ed ho	le	γinst	[-]	1,	,2	1,4		
<u>Diamond-</u>	drillir	ng (dry or wet co	ncrete)						
Tem	l:	24 °C / 40 °C			6,0	6,0	7,0	7,0	
oerature	II:	35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,0	6,0	7,0	7,0	
range	III:	50 °C / 72 °C			6,0	6,0	7,0	7,0	
Diamond-	drillir	ng (water filled h	ole)						
Tem	l:	24 °C / 40 °C	,		6,5	6,0	6,0	6,0	
oerature	II:	35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	6,5	6,0	6,0	6,0	
range	III:	50 °C / 72 °C			6,0	6,0	6,0	6,0	
nstallati	on fa	ctors; Diamon	d-drilling	3					
Dry or we	t con	crete	26	[-]		1	,0		
Water fille	ed ho	le	γinst	[-]	1,	,2	1	,4	

Upat Injection system UPM 55	
Performance	

Characteristic resistance to combined pull-out and concrete failure for fractional Upat IST; working life 50 years

Annex C30



frac	tional Upat	IST in h	ce to combin ammer or diar concrete; wo	nond drilled h	oles;	rete failure for
Upat IST			3/8"	1/2"	5/8"	3/4"
Combined pull-out and	concrete cone	failure				
Calculation diameter	d	[mm]	15,7	18,0	22,0	28,0
Uncracked concrete						
Characteristic bond res	istance in unc	racked co	ncrete C20/25			
Hammer-drilling with stan	dard drill bit or	hollow drill	bit (dry or wet co	ncrete)		
Tem- <u>I: 24 °C / 40 °</u>	°C		14,4	14,0	13,3	12,6
perature II: 35 °C / 60 °		[N/mm ²]	10,5	10,5	9,8	9,0
range III: 50 °C / 72			7,8	7,8	7,8	7,2
Hammer-drilling with stan		hollow drill				
Tem- <u>I: 24 °C / 40 °</u>			13,9	13,0	11,7	
perature II: 35 °C / 60 °	•rak,100,001	[N/mm ²]	9,0	9,0	8,3	7,5
range III: 50 °C / 72			7,2	6,6	6,5	5,9
nstallation factors; Har	nmer-drilling v	vith standa	ırd drill bit or ho		•	
Dry or wet concrete	——— γinst	[-]			,0	
Water filled hole	•			1	,4	
<u>Diamond-drilling (dry or w</u> Tem- I: 24 °C / 40 °			10,1	9,8	9,2	8,6
Tem- <u>I: 24 °C / 40 °</u> perature II: 35 °C / 60 °		[N/mm ²]	9,0	8,3	7,5	6,8
range III: 50 °C / 72		ן ווווווון	6,6	6,0	5,9	5,2
Diamond-drilling (water fi			0,0	0,0	5,9	5,2
Tem- I: 24 °C / 40 °			11,2	10,3	9,3	8,4
perature II: 35 °C / 60		[N/mm ²]	9,0	8,3	7,5	6,8
range III: 50 °C / 72		[, 4,]	6,6	6,0	5,9	5,2
Installation factors; Dia			0,0	0,0	0,0	, C,2
Dry or wet concrete	<u>g</u>			1	,0	
Water filled hole	γinst	[-]			,4	
Cracked concrete						
Characteristic bond res						
<u>Hammer-drilling with stan</u>		hollow drill				
Tem- <u>I: 24 °C / 40 °</u>			5,1	4,8	4,6	4,6
perature <u>II: 35 °C / 60 °</u>		[N/mm ²]	5,1	4,8	4,6	4,6
range III: 50 °C / 72			5,1	4,8	4,6	4,6
Hammer-drilling with stan		hollow drill			1	
Tem- I: 24 °C / 40 °			5,5	4,8	3,9	3,9
perature II: 35 °C / 60		[N/mm ²]	5,5	4,8	3,9	3,9
range III: 50 °C / 72			5,1	4,8	3,9	3,9
nstallation factors; Har	nmer-drilling v	vith standa	ird drill bit or ho		^	
Dry or wet concrete Water filled hole	γinst	[-]	1,		,0 	1,4
Diamond-drilling (dry or w	et concrete)			<u> </u>	<u>I</u>	1,7
Tem- I: 24 °C / 40 °			5,1	4,8	4,6	4,6
perature II: 35 °C / 60		[N/mm ²]	5,1	4,8	4,6	4,6
range III: 50 °C / 72		[[[]]	5,1	4,8	4,6	4,6
Installation factors; Dia			٥, ١	1,0	1 7,0	1 7,0
Ory or wet concrete	γinst	[-]		1	,0	
Upat Injection system	em UPM 55					
Performance Characteristic resistan fractional Upat IST; wo			nd concrete failu	re for		Annex C31



1,0

1,4

	fraction	al reinf	resistan orcing b crete; w	ars in	hamme	er or dia	amond			ailure 1	for
Rebar size				#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Combined pull-out	and con	crete con	e failure								
Calculation diamete	r ·	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,7	32,3
Uncracked concre	te										
Characteristic bon	d resista	nce in un	cracked o	concrete	C20/25	5					
<u>Hammer-drilling witl</u>	<u>n standar</u>	d drill bit o	r hollow d	rill bit (d	ry or wet	concret	<u>e)</u>				
Tem- I: 24 °C	/ 40 °C			17,0	15,9	15,1	14,4	13,9	13,4	13,1	12,7
perature II: 35 °C	/ 60 °C	$ au_{Rk,ucr}$		15,0	15,0	14,0	13,0	13,0	12,0	12,0	12,0
range III 50 °C	/ 72 °C			14,0	14,0	13,0	12,0	12,0	11,0	11,0	11,0
Hammer-drilling witl	n standard	d drill bit o	r hollow d	rill bit (w	ater fille	d hole)					
Tem- l: 24 °C	/ 40 °C			17,0	15,9	14,5	13,2	12,3	11,6	10,5	10,2
perature II: 35 °C	/ 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	16,0	14,0	12,0	11,0	11,0	10,0	10,0	9,0
range III 50 °C	/ 72 °C			14,0	13,0	12,0	11,0	10,0	9,0	9,0	8,0
Installation factors	; Hamme	er-drilling	with stan	dard dr	ill bit or	hollow	drill bit				
Dry or wet concrete		24	[-]				1	0			
Water filled hole		γinst	[-]				1,	4			
Diamond-drilling (dr	y or wet c	concrete a	s well as v	vater fille	ed hole)						
Tem- I: 24 °C	/ 40 °C			15,0	13,0	12,0	10,0	10,0	9,0	9,0	8,0
perature II: 35 °C	/ 60 °C	$ au_{Rk,ucr}$	[N/mm ²]	15,0	13,0	12,0	10,0	10,0	9,0	9,0	8,0
range III 50 °C	/ 72 °C			14,0	12,0	11,0	10,0	9,0	9,0	8,0	8,0
Installation factors	; Diamor	nd-drilling]								· · ·

¹⁾ Not allowed for drilling with hollow drill bit.

[-]

 γ_{inst}

Dry or wet concrete

Water filled hole

Upat Injection system UPM 55	
Performance Characteristic resistance to combined pull-out and concrete failure for fractional reinforcing bars; working life 50 years	Annex C32



Table C33.1:	Characteristic resistant fractional reinforcing to cracked concrete; wor	oars in	hamme	er or dia				ailure 1	for
Rehar size		#3	#4	#5	#6	#7	#2	#9	#1

Clack	eu conci	ete, wor	Killig III	ie so y	cai 5					
Rebar size			#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Combined pull-out and c	oncrete co	ne failure								
Calculation diameter	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,7	32,3
Cracked concrete					-					
Characteristic bond resis	tance in cr	racked cor	ncrete C	20/25						
Hammer-drilling with stand	ard drill bit	or hollow d	rill bit (d	ry or we	t concret	<u>:e)</u>				
Tem- l: 24 °C / 40 °C			7,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
range III 50 °C / 72 °C	_		7,0	8,0	8,0	8,0	8,0	8,0	8,0	8,0
Hammer-drilling with stand	ard drill bit	or hollow d	rill bit (w	ater fille	d hole)				•	
Tem- l: 24 °C / 40 °C			7,5	6,5	6,5	6,0	6,0	6,0	6,0	5,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,5	6,5	6,5	6,0	6,0	6,0	6,0	5,0
range III 50 °C / 72 °C	_		6,5	6,5	6,0	6,0	6,0	6,0	6,0	5,0
Installation factors; Hami	mer-drilling	with star	dard d	rill bit or	hollow	drill bit		•	•	
Dry or wet concrete		[]				1	,0			
Water filled hole	— γinst	[-]		1,2				1,4		
Diamond-drilling (dry or we	t concrete)									
Tem- I: 24 °C / 40 °C			7,0	7,0	6,0	6,0	7,0	7,0	7,0	5,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,0	7,0	6,0	6,0	7,0	7,0	7,0	5,0
range III 50 °C / 72 °C			7,0	7,0	6,0	6,0	7,0	7,0	7,0	5,0
Diamond-drilling (water fille	ed hole)									
Tem- I: 24 °C / 40 °C			7,5	6,5	6,5	6,0	6,0	6,0	6,0	5,0
perature II: 35 °C / 60 °C	$ au_{Rk,cr}$	[N/mm ²]	7,5	6,5	6,5	6,0	6,0	6,0	6,0	5,0
range III 50 °C / 72 °C			6,5	6,5	6,0	6,0	6,0	6,0	6,0	5,0
Installation factors; Diam	ond-drillin	g								
Dry or wet concrete		[]				1	,0			
Water filled hole		[-]		1,2				1,4		

¹⁾ Not allowed for drilling with hollow drill bit.

Upat Injection system UPM 55	
Performance Characteristic resistance to combined pull-out and concrete failure for fractional reinforcing bars; working life 50 years	Annex C33



fraction	teristic nal reinf ked and	orcing b	oars in	hamme	er or dia	amond	drilled	holes;	ailure 1	for
Rebar size			#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Combined pull-out and cor	ncrete cor	e failure								
Calculation diameter	d	[mm]	9,5	12,7	15,9	19,1	22,2	25,4	28,7	32,3
Uncracked concrete										
Characteristic bond resista	ance in un	cracked	concret	e C20/25	5					
Hammer-drilling with standar	d drill bit c	r hollow d	Irill bit (d	ry or wet	concret	<u>e)</u>				
Tem- l: 24 °C / 40 °C			14,0	13,0	12,4	11,9	11,4	11,0	10,8	10,5
perature II: 35 °C / 60 °C	τ _{Rk,100,ucr}	[N/mm ²]	11,3	11,3	10,5	9,8	9,8	9,0	9,0	9,0
range III 50 °C / 72 °C			8,4	8,4	8,5	7,8	7,8	7,2	7,2	7,2
Hammer-drilling with standar	<u>rd drill bit c</u>	r hollow d								
Tem- <u>I: 24 °C / 40 °C</u>	-		13,9	13,0	11,9	11,0	10,1	9,5	8,6	8,5
perature II: 35 °C / 60 °C	$ au_{ extsf{Rk},100, ext{ucr}}$	[N/mm ²]	12,0	10,5	9,0	8,3	8,3	7,5	7,5	6,8
range III 50 °C / 72 °C			8,4	7,8	7,8	7,2	6,5	5,9	5,9	5,2
Installation factors; Hamm	er-drilling	with star	ndard di	ill bit or	hollow					
Dry or wet concrete	- γinst	[-]					,0			
Water filled hole				- \		- 1,	,4			
Diamond-drilling (dry or wet of Tem- I: 24 °C / 40 °C	concrete a	<u>s well as v</u>			0.0	7.5	7.5	6.0	6.0	6.0
Tem- : 24 °C / 40 °C perature II: 35 °C / 60 °C		[N/mm ²]	11,3 11,3	9,8 9,8	9,0 9,0	7,5 7,5	7,5 7,5	6,8 6,8	6,8 6,8	6,0 6,0
range III 50 °C / 72 °C	_ T Rk,100,ucr	[IN/IIIII-] 	8,4	7,2	7,2	6,5	5,9	5,9	5,2	5,2
Installation factors			0,4	1,2	1,2	0,5	0,0	<u> </u>	<u> </u>	
Dry or wet concrete						1	,0			
Water filled hole	— γinst	[-]				1				
Cracked concrete						I,	, +			
Characteristic bond resista	noo in or	acked ee	noroto C	20/25						
Hammer-drilling with standar					concret	٥)				
1 01001100	d drill bit c	Tiollow d	6,0	6,4	5,2	<u>5,2</u>	5,2	5,2	5,2	5,2
Tem- I: 24 °C / 40 °C perature II: 35 °C / 60 °C	. σ	[N/mm ²]		6,4	5,2	5,2	5,2	5,2	5,2	5,2
range III 50 °C / 72 °C	τ Rk,100,cr	[[[]]	6,0	6,4	5,2	5,2	5,2	5,2	5,2	5,2
Hammer-drilling with standar	d drill bit c	r hollow d				J 5,2	0,2	<u> </u>	0,2	0,2
I: 04 %C / 40 %C	d drill bit c		6,4	5,2	4,2	3,9	3,9	3,9	3,9	3,3
Tem- <u>I: 24 °C / 40 °C</u> perature II: 35 °C / 60 °C		[N/mm ²]	6,4	5,2	4,2	3,9	3,9	3,9	3,9	3,3
range III 50 °C / 72 °C	τ Rk,100,cr	[14/11111]	5,5	5,2	3,9	3,9	3,9	3,9	3,9	3,3
Installation factors; Hamm	or drilling	with otor					3,9	3,9	3,9	3,3
Dry or wet concrete	er-ariiiiig	with Star	luaru ur	III DIL OI	Hollow		,0			
Water filled hole	γinst	[-]		1,2			,0	1,4		
Diamond-drilling (dry or wet	concrete)	I .	<u> </u>	1,4		<u> </u>		ι,-τ		
Tem- I: 24 °C / 40 °C	<u>conordio</u>		6,0	5,6	3,9	3,9	4,6	4,6	4,6	3,3
perature II: 35 °C / 60 °C	$ au_{ extsf{Rk,100,cr}}$	[N/mm ²]	6,0	5,6	3,9	3,9	4,6	4,6	4,6	3,3
range III 50 °C / 72 °C	_ •KK,100,cr	[6,0	5,6	3,9	3,9	4,6	4,6	4,6	3,3
Installation factors			,-	,-	,-	,-	,-	,-	,-	,-
Dry or wet concrete	γinst	[-]				1.	,0			
1) Not allowed for drilling w			•				•			
Upat Injection system	UPM 55									
Performance Characteristic resistance to reinforcing bars; uncracked								A	nnex C	34

English translation prepared by DIBt



Threaded	d rod	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Displace	ment-Factors	for tension I	oading ¹⁾					
Uncracke	ed or cracked	concrete; Te	emperature i	range I, II, III				
$\delta_{ extsf{N0-Factor}}$	[mm/(N/mm²)]	0,08	0,09	0,10	0,11	0,11	0,12	0,13
δ _{N∞-Factor}	[[[[[[[]]]]]	0,12	0,13	0,15	0,16	0,17	0,19	0,19
Displace	ment-Factors	for shear loa	ading ²⁾					
Uncrack	ed or cracked	concrete; Te	emperature i	range I, II, III				
δv0-Factor	[100 to //c N 1]	0,15	0,12	0,09	0,07	0,07	0,05	0,05
δ∨∞-Factor	[mm/kN]	0,22	0,18	0,14	0,11	0,10	0,08	0,07

¹⁾ Calculation of effective displacement:

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \cdot \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

Table C35.2: Displacements for fractional Upat IST

Upat IST	•	3/8"	1/2"	5/8"	3/4"
Displace	ment-Factors	for tension loading 1)			
Uncrack	ed or cracked	concrete; Temperatu	re range I, II, III		
δ N0-Factor	[mm/(N/mm ²)]	0,10	0,10	0,11	0,13
δ _{N∞-Factor}	[[[[[[[]]	0,15	0,16	0,17	0,19
Displace	ment-Factors	for shear loading ²⁾			
Uncrack	ed or cracked	concrete; Temperatu	re range I, II, III		
δ V0-Factor	[mm/kN]	0,09	0,08	0,07	0,05
δ∨∞-Factor	[mm/kN]	0,14	0,12	0,10	0,08

¹⁾ Calculation of effective displacement:

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \, \cdot \, \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{V^{\infty}} = \delta_{V^{\infty}\text{-Factor}} \cdot V$

V = acting shear loading

U	pat	Injec	tion	Sys	tem	UPN	55
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Performance

Displacements for fractional Threaded rods and fractional Upat IST

Annex C35

English translation prepared by DIBt



Table (C36.1: Dis	placemer	nts for fra	ctional re	einforcing	g bars			
Rebar si	ze	#3	#4	#5	#6	#7	#8	#9	#10
Displace	ment-Factors	for tension	loading 1)						
Uncrack	ed or cracked	concrete;	Temperatu	re range I,	II, III				
$\delta_{ ext{N0-Factor}}$	[mm/(N/mm ²)]	0,08	0,09	0,10	0,11	0,11	0,12	0,13	0,13
$\delta_{\text{N}\infty\text{-Factor}}$	[[[]]]]	0,12	0,13	0,15	0,16	0,17	0,18	0,19	0,20
Displace	ment-Factors	for shear l	oading ²⁾						
Uncrack	ed or cracked	concrete;	Temperatu	re range I,	II, III				
$\delta_{ extsf{V0-Factor}}$	[mama/kN]]	0,15	0,12	0,09	0,07	0,07	0,06	0,05	0,05
δ∨∞-Factor	[mm/kN]	0,22	0,18	0,14	0,11	0,10	0,09	0,08	0,07

1) Calculation of effective displacement:

 $\delta_{V0} = \delta_{V0\text{-Factor}} \cdot V$

 $\delta_{\text{N0}} = \delta_{\text{N0-Factor}} \cdot \tau$

 $\delta_{V\infty} = \delta_{V\infty\text{-Factor}} \cdot V$

 $\delta_{\mathsf{N}^{\infty}} = \delta_{\mathsf{N}^{\infty}\text{-}\mathsf{Factor}} \cdot \tau$

V = acting shear loading

²⁾ Calculation of effective displacement:

 τ = acting bond strength under tension loading

Upat Injection system UPM 55

Performance
Displacements for fractional reinforcing bars

Annex C36



Table C37.1: Characteristic resistance to steel failure under tension / shear loading for metric Anchor rods and Threaded rods under seismic action performance category C1

Anchor	rod / Threaded rod				M10	M12	M14	M16	M20	M22	M24	M27	M30
Characte	eristic resistance to	steel fa	ailur	e und	er tension I	oading	l ¹⁾						
Anchor	rods and Threaded re	ods, p	erfor	mano	ce category	C1 2)							
,			4.8		23,2(21,4)	33,7	46,0	62,8	98,0	121,2	141,2	183,6	224,4
istic	Steel zinc plated	≥	5.8		29,0(26,8)	42,1	57,5	78,5	122,5	151,5	176,5	229,5	280,5
Characteristic resistance NRK,s,C1		ropert	8.8	[kN]	46,4(42,8)	67,4	92,0	125,6	196,0	242,4	282,4	367,2	448,8
aract ssista NRK,s	Stainless steel R	Property class	50	נגואן	29,0	42,1	57,5	78,5	122,5	151,5	176,5	229,5	280,5
- re Sha	and high corrosion	<u>L</u>	70		40,6	59,0	80,5	109,9	171,5	212,1	247,1	321,3	392,7
	resistant steel HCR		80		46,4	67,4	92,0	125,6	196,0	242,4	282,4	367,2	448,8
Charact	eristic resistance to s	steel fa	ailure	e und	er shear loa	ading v	vithout	lever	arm ¹⁾				
Anchor	rods, performance ca	ategor	y C1	2)									
			4.8		13,9(12,8)	20,2	27,6	37,6	58,8	72,7	84,7	110,1	134,6
Characteristic resistance VRKs,C1	Steel zinc plated		5.8		17,4(16,0)	25,2	34,5	47,1	73,5	90,9	105,9	137,7	168,3
naracterist resistance V _{Rks,C1}		Property class	8.8	[kN]	23,2(21,4)	33,7	46,0	62,8	98,0	121,2	141,2	183,6	224,4
arac sist	Stainless steel R	\ \(\frac{1}{2} \) \(\frac{1} \) \(\frac{1} \) \(\frac{1}{2} \) \(\frac{1}{2} \	50	נגואן	14,5	21,0	28,7	39,2	61,2	75,7	88,2	114,7	140,2
Sha .	and high corrosion	<u> </u>	70		20,3	29,5	40,2	54,9	85,7	106,0	123,5	160,6	196,3
	resistant steel HCR		80		23,2	33,7	46,0	62,8	98,0	121,2	141,2	183,6	224,4
Threade	d rods, performance	categ	ory (C1 ²⁾									
0			4.8		9,7(9,0)	14,1	19,3	26,3	41,1	50,9	59,3	77,1	97,2
istic	Steel zinc plated	.≥.	5.8		12,1(11,2)	17,7	24,1	32,9	51,4	63,6	74,1	96,3	117,8
ten tan tan		roperty class	8.8 50	[kN]	16,2(15,0)	23,6	32,2	43,9	68,6	84,8	98,8	128,5	157,0
naracterist resistance V _{RK,S,C1}	Stainless steel R	Q S	50	[KIN]	10,1	14,7	20,1	27,4	42,8	53,0	61,7	80,3	98,1
Characteristic resistance VRk,s,C1	and high corrosion	₫.	70		14,2	20,6	28,1	38,4	60,0	74,2	86,4	112,4	137,4
	resistant steel HCR		80		16,2	23,6	32,2	43,9	68,6	84,8	98,8	128,5	157,0

¹⁾ 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.

Upat Injection system UPM 55

Performance

Characteristic resistance to steel failure under tension / shear loading for metric Anchor rods / Threaded rods under seismic action performance category C1

Annex C37

²⁾ Partial factors for performance category C1 or C2 see table C39.1; for Anchor rods the factor for steel ductility is 1,0.



Table C38.1: Characteristic resistance to steel failure under tension / shear loading for metric Anchor rods and Threaded rods under seismic action performance category C2

			<u>'</u>			3							
Anchor	rod / Threaded rod				M10	M12	M14	M16	M20	M22	M24	M27	M30
Charact	eristic resistance to	steel fa	ailure	und	er tens	ion Ioa	ding						
Anchor	rods and Threaded r	ods, p	erfor	mano	e cate	ory C2	1)						
			4.8		_2)	30,3	_2)	56,5	88,2	_2)	141,2	_2)	_2)
S Stic	Steel zinc plated	>	5.8		_2)	37,9	_2)	70,6	110,2	_2)	176,5	_2)	_2)
Characteristic resistance NRK,S,C2		Property class	8.8	[LAI]	_2)	60,6	_2)	113,0	176,4	_2)	282,4	_2)	_2)
Irac sist	Stainless steel R	1 5 ES	50	[kN]	_2)	37,9	_2)	70,6	110,2	_2)	176,5	_2)	_2)
Sha re	and high corrosion	<u> </u>	70		_2)	53,1	_2)	98,9	154,3	_2)	247,1	_2)	_2)
	resistant steel HCR		80		_2)	60,6	_2)	113,0	176,4	_2)	282,4	_2)	_2)
Charact	eristic resistance to	steel fa	ailure	und	er shea	ır loadi	ng with	out lev	er arm				
Anchor	rods, performance ca	ategor	y C2	1)									
	-		4.8		_2)	13,3	_2)	28,2	45,2	_2)	77,0	_2)	_2)
Characteristic resistance VRK,S,C2	Steel zinc plated	_	5.8		_2)	16,6	_2)	35,3	56,5	_2)	96,3	_2)	_2)
haracterist resistance V _{Rk,s,C2}		Property class	8.8	FLANT	_2)	22,2	_2)	47,1	75,4	_2)	128,4	_2)	_2)
rac sist	Stainless steel R	을 함	8.8 50	[kN]	_2)	13,9	_2)	29,4	47,1	_2)	80,3	_2)	_2)
Cha re	and high corrosion	а.	70		_2)	19,4	_2)	41,2	66,0	_2)	112,4	_2)	_2)
	resistant steel HCR		80		_2)	22,2	_2)	47,1	75,4	_2)	128,4	_2)	_2)
Threade	ed rods, performance	categ	ory C	2 ¹⁾									
			4.8		_2)	13,3	_2)	26,3	41,1	_2)	59,3	_2)	_2)
stic g	Steel zinc plated	_	5.8		_2)	16,6	_2)	32,9	51,4	_2)	74,1	_2)	_2)
teris anc s,c2		ss	8.8	FLANT	_2)	22,2	_2)	43,9	68,6	_2)	98,8	_2)	_2)
haracterist resistance V _{Rk,s,C2}	Stainless steel R	Property class	50	[kN]	_2)	13,9	_2)	27,4	42,8	_2)	61,7	_2)	_2)
Characteristic resistance VRK,S,C2	and high corrosion	_	70		_2)	19,4	_2)	38,4	60,0	_2)	86,4	_2)	_2)
	resistant steel HCR		80		_2)	22,2	_2)	43,9	68,6	_2)	98,8	_2)	_2)

¹⁾ Partial factors for performance category C1 or C2 see table C39.1; for Anchor rods the factor for steel ductility is 1,0.

Performance

Table C38.2: Characteristic resistance to steel failure under tension / shear loading for metric reinforcing bars (B500B) under seismic action performance category C1

	-				-										
Nominal diameter of the bar	r	ф	10	12	14	16	18	20	22	24	25	26	28	30	32
Characteristic res	istance	to st	eel fa	ilure u	nder t	ensio	n load	ing							
Reinforcing bar B	500B ac	c. to	DIN 4	88-2:2	2009-0	8, perf	formai	1се са	tegory	C1 1)					
Characteristic resistance	N _{Rk,s,C1}	[kN]	42,3	61,0	83,1	108,5	137,1	169,5	205,2	244,0	265,1	286,2	332,6	381,2	434,1
Characteristic res	istance	to st	eel fa	ilure u	nder s	hear l	oadin	g, with	out le	ver ar	m				
Reinforcing bar B	500B ac	c. to	DIN 4	88-2:2	2009-0	8, perf	forma	1се са	tegory	C1 1)					
Characteristic resistance	V _{Rk,s,C1}	[kN]	14,8	21,3	29,1	37,9	48,0	59,3	71,8	85,4	92,7	100,1	116,4	133,4	151,9
1) Partial factors	for perfo	rman	ce cat	egory	C1 see	e table	C39.1								
Upat Injection	system	UP	M 55												

Z251783.25 8.06.01-280/22

Characteristic resistance to steel failure for metric Anchor rods / Threaded rods and reinforcing bars under seismic action performance category C2 and C1 respectively

Annex C38

²⁾ No performance assessed.



Partial factors for metric Anchor rods, Threaded rods and **Table C39.1:** reinforcing bars (B500B) under

seismic action performance category C1 or C2

Anch	or rod / Threaded rod				M10 to M30
Nom	inal diameter of the ba	ır		ф	10 to 32
Tens	ion loading, steel failu	ıre ¹⁾			
			4.8		1,50
Z, S	Steel zinc plated		5.8		1,50
] N. Jo		erty ss	8.8		1,50
actc	Stainless steel R and	Property class	50	[-]	2,86
Partial factor γ _{Ms,N}	high corrosion	ш	70		1,87 / Anchor rod HCR: 1,50 ²⁾
Par	resistant steel HCR		80		1,60
	Reinforcing bar	В	500B		1,40
Shea	r loading, steel failure	, 1)			
			4.8		1,25
>,	Steel zinc plated		5.8		1,25
Jr YM		erty ss	8.8		1,25
factor ‱,∨	Stainless steel R and	Property class	50	[-]	2,38
artial f	high corrosion	ш	70		1,56 / Anchor rod HCR: 1,25 ²⁾
Par	resistant steel HCR		80		1,33
	Reinforcing bar	В	500B		1,50

Upat Injection system UPM 55	
Performance Partial factors for metric Anchor rods, Threaded rods, and reinforcing bars (B500B) under seismic action performance category C1 or C2	Annex C39

¹⁾ In absence of other national regulations. ²⁾ Only admissible for high corrosion resistant steel HCR, with f_{yk} / $f_{uk} \ge 0.8$ and $A_s > 12$ % (e.g. Anchor rods).



Table C40.1: Characteristic resistance for combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer drilled holes under seismic action performance category C1; working life 50 years

Anchor r	od /	Threaded rod			M10	M12	M14	M16	M20	M22	M24	M27	M30
Characte	eristi	c bond resistan	ce, com	bined pul	ll-out a	nd con	crete c	one fai	lure				
Hammer-	-drill	ing with standa	rd drill k	oit or holle	ow dril	bit (dr	y or we	t conc	rete)				
Tem-	l:	24 °C / 40 °C			7,0	7,0	6,7	6,0	5,7	6,7	6,7	6,7	6,7
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	7,0	7,0	6,7	6,0	5,7	6,7	6,7	6,7	6,7
range	III:	50 °C / 72 °C			7,0	7,0	6,7	5,7	5,7	6,7	6,7	6,7	6,7
Hammer	-drill	ing with standa	rd drill k	oit or holle	ow dril	l bit (wa	ater fille	ed hole)				
Tem-	l:	24 °C / 40 °C			7,5	7,5	6,5	5,7	5,7	5,7	5,7	5,7	5,7
perature	II:	35 °C / 60 °C	$ au_{Rk,C1}$	[N/mm ²]	7,5	7,5	6,5	5,7	5,7	5,7	5,7	5,7	5,7
range	III:	50 °C / 72 °C			6,8	6,8	6,5	5,7	5,7	5,7	5,7	5,7	5,7
Installati	on fa	actors											
Tension	load	ing											
Dry or we	t cor	ncrete		r 1					1,0				
Water fille	ed ho	ole	γinst	[-]	·	1	,2				1,4	·	·

Table C40.2: Characteristic resistance for combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer drilled holes under seismic action performance category C1; working life 100 years

Anchor r	od /	Threaded rod			M10	M12	M14	M16	M20	M22	M24	M27	M30
Characte	eristi	c bond resistan	ce, com	bined pul	ll-out a	nd con	crete c	one fai	lure				
Hammer	-drill	ing with standa	rd drill k	oit or holle	ow dril	bit (dr	y or we	t conc	rete)				
Tem-	_l:	24 °C / 40 °C			5,5	5,3	5,8	4,6	4,6	5,4	5,3	5,1	5,0
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	5,5	5,3	5,8	4,6	4,6	5,4	5,3	5,1	5,0
range	III:	50 °C / 72 °C	'		5,5	5,3	5,5	4,3	4,3	5,0	5,0	4,8	4,8
Hammer	-drill	ing with standa	rd drill b	oit or holl	ow dril	bit (wa	ater fille	ed hole)				
Tem-	l:	24 °C / 40 °C			5,9	5,6	5,7	4,3	4,6	4,6	4,5	4,3	4,2
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	5,9	5,6	5,7	4,3	4,6	4,6	4,5	4,3	4,2
range	III:	50 °C / 72 °C	•		5,3	5,1	5,3	4,3	4,3	4,3	4,2	4,1	4,0
Installati	on fa	actors											
Tension	load	ing											
Dry or we	et cor	ncrete		[]					1,0				
Water fille	ed ho	ole	γinst	[-]	·	1	,2		·		1,4		

Upat Injection system UPM 55	
Performance Characteristic resistance for combined pull-out and concrete failure under seismic action (C1) for Anchor rods / Threaded rods; working life 50 and 100 years	Annex C40



Table C	41.1: Characte metric re performa	einforc	ing bars	in h	namr	ner (drille	d ho	les						e for	•
Nominal d	diameter of the bar		Ф	10	12	14	16	18	20	22	24	25	26	28	30	32
	ristic bond resistan	ce, com				cond										-
	drilling with standa															
	I: 24 °C / 40 °C			7,0	7,0	6,7	5,7	5,7	5,7	6,7	6,7	6,7	6,7	6,7	6,7	4,8
Tem- – perature	II: 35 °C / 60 °C	$ au_{ extsf{Rk,C1}}$	[N/mm ²]	-	7,0	6,7	<u> </u>	5,7	5,7	6,7	6,7	6,7	6,7	6,7	6,7	4,8
range [–]	III: 50 °C / 72 °C	-		7,0	7,0	6,7	5,7	5,7	5,7	6,7	6,7	6,7	6,7	6,7	6,7	4,8
Hammer-c	drilling with standa	rd drill k	it or holl	ow d	rill bi	it (wa	ter fi	lled I	nole)						·	I
_	I: 24 °C / 40 °C			7,5	6,5	6,5	5,7	5,7	5,7	5,7	5,7	5,7	5,7	5,7	5,7	4,8
Tem- – perature	II: 35 °C / 60 °C	$ au_{ extsf{Rk,C1}}$	[N/mm ²]	7,5	6,5	6,5	5,7	5,7	5,7	5,7	5,7	5,7	5,7	5,7	5,7	4,8
range -	III: 50 °C / 72 °C	-		6,5	6,5	5,8	5,8	5,7	5,7	5,7	5,7	5,7	5,7	5,7	5,7	4,8
Installatio	on factors		1								1					
Tension lo	oading															
Dry or wet		- Vinat	[-]							1,0						
Water filled	d hole	γinst	[-]			1,2						1	,4			
	p 0	noc car	egory C	I, W	OIKI	ng i	ite 1	uu y	ears	5						
	diameter of the bar		ф	10	12	14	16	18	20	22	24	25	26	28	30	32
Character	diameter of the bar	ce, com	ф bined pu	10 II-out	12 and	14 cond	16 crete	18	20 failu	22 ire	24	25	26	28	30	32
Character	diameter of the bar ristic bond resistan drilling with standa	ce, com	ф bined pu	10 II-out ow d	12 and	14 cond	16 crete	18 cone	20 failt	22 ure ete)						
Character Hammer-c	diameter of the bar ristic bond resistan drilling with standa	ce, com rd drill b	φ bined pu bit or holl	10 II-out ow d 6,0	12 and rill bi	14 cond t (dr)	16 crete y or v	18 cone vet c	20 failu oncre	22 ure ete) 4,4	4,4	4,4	4,4	4,4	4,4	3,1
Character Hammer-c	diameter of the bar ristic bond resistan drilling with standa l: 24 °C / 40 °C ll: 35 °C / 60 °C	ce, com	ф bined pu	10 II-out ow d 6,0 6,0	12 and rill bi 5,6	14 cond t (dr) 4,4 4,4	16 y or v 3,7 3,7	18 cone vet c 3,7 3,7	20 failu oncre 3,7 3,7	22 ure ete) 4,4 4,4	4,4	4,4	4,4	4,4	4,4	3,1
Character Hammer-c Tem- — perature range	diameter of the bar ristic bond resistan drilling with standa I: 24 °C / 40 °C II: 35 °C / 60 °C	rd drill b	φ bined pu bit or holl [N/mm²]	10 II-out 6,0 6,0 6,0	12 and rill bi 5,6 5,6 5,6	14 cond t (dr) 4,4 4,4 4,4	16 y or v 3,7 3,7 3,7	18 cone vet c 3,7 3,7 3,7	20 failu oncre 3,7 3,7 3,7	22 ure ete) 4,4 4,4	4,4	4,4	4,4	4,4	4,4	3,1
Character Hammer-c Tem- — perature range	diameter of the bar ristic bond resistan drilling with standa I: 24 °C / 40 °C II: 35 °C / 60 °C III: 50 °C / 72 °C drilling with standa	rd drill b	φ bined pu bit or holl [N/mm²]	10 II-out 6,0 6,0 6,0 ow d	12 and 5,6 5,6 5,6 rill bi	14 cond t (dr) 4,4 4,4 4,4	16 y or v 3,7 3,7 3,7 ter fi	18 cone vet c 3,7 3,7 3,7 lled I	20 failu oncre 3,7 3,7 3,7 nole)	22 ure ete) 4,4 4,4 4,4	4,4 4,4 4,4	4,4 4,4 4,4	4,4 4,4 4,4	4,4 4,4 4,4	4,4 4,4 4,4	3,1 3,1 3,1
Character Hammer-c Tem- — perature range — Hammer-c	diameter of the bar ristic bond resistan drilling with standa I: 24 °C / 40 °C II: 35 °C / 60 °C III: 50 °C / 72 °C drilling with standa	rd drill k	φ bined pu bit or holl [N/mm²] bit or holl	10 II-out 6,0 6,0 6,0 ow d	12 and rill bi 5,6 5,6 5,6 rill bi	14 cond t (dry 4,4 4,4 4,4 4,4 4,4	16 3,7 3,7 3,7 ter fi	18 cone vet cone 3,7 3,7 3,7 lled I 3,7	3,7 3,7 3,7 nole)	22 ete) 4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	3,1 3,1 3,1
Character Hammer-c Tem- perature range Tem- perature perature	diameter of the bar ristic bond resistand drilling with standa 1: 24 °C / 40 °C 11: 35 °C / 60 °C 11: 50 °C / 72 °C 11: 24 °C / 40 °C 11: 35 °C / 60 °C	rd drill b	φ bined pu bit or holl [N/mm²]	10 III-out 6,0 6,0 6,0 ow d 6,4 6,4	12 and rill bi 5,6 5,6 5,6 rill bi 5,2	14 cond t (dr) 4,4 4,4 4,4 t (wa 4,2 4,2	3,7 3,7 3,7 3 ,7 ter fi	3,7 3,7 3,7 11ed I 3,7	20 e failu oncre 3,7 3,7 3,7 nole) 3,7	22 4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	3,1 3,1 3,1 3,1
Character Hammer-c Tem- perature range Hammer-c Tem- perature range range	diameter of the bar ristic bond resistand drilling with standa : 24 °C / 40 °C : 35 °C / 60 °C : 50 °C / 72 °C : 24 °C / 40 °C : 35 °C / 60 °C : 35 °C / 60 °C : 50 °C / 72 °C	rd drill k	φ bined pu bit or holl [N/mm²] bit or holl	10 II-out 6,0 6,0 6,0 ow d	12 and rill bi 5,6 5,6 5,6 rill bi	14 cond t (dry 4,4 4,4 4,4 4,4 4,4	3,7 3,7 3,7 3 ,7 ter fi	18 cone vet cone 3,7 3,7 3,7 lled I 3,7	3,7 3,7 3,7 nole)	22 ete) 4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7	4,4 4,4 4,4 3,7 3,7	3,1 3,1 3,1 3,1 3,1 3,1
Character Hammer-c Tem- perature range Tem- perature range range Tem- perature range Tem- perature range Tem- perature	diameter of the bar ristic bond resistand drilling with standa I: 24 °C / 40 °C II: 35 °C / 60 °C drilling with standa I: 24 °C / 40 °C III: 35 °C / 60 °C III: 35 °C / 60 °C III: 50 °C / 72 °C on factors	rd drill k	φ bined pu bit or holl [N/mm²] bit or holl	10 III-out 6,0 6,0 6,0 ow d 6,4 6,4	12 and rill bi 5,6 5,6 5,6 rill bi 5,2	14 cond t (dr) 4,4 4,4 4,4 t (wa 4,2 4,2	3,7 3,7 3,7 3 ,7 ter fi	3,7 3,7 3,7 11ed I 3,7	20 e failu oncre 3,7 3,7 3,7 nole) 3,7	22 4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	3,1 3,1 3,1 3,1
Character Hammer-c Tem- perature range Hammer-c Tem- perature range - Installatio Tension lo	diameter of the bar ristic bond resistand drilling with standa : 24 °C / 40 °C : 35 °C / 60 °C : 50 °C / 72 °C : 24 °C / 40 °C : 35 °C / 60 °C : 50 °C / 72 °C	rd drill k	φ bined pu bit or holl [N/mm²] bit or holl	10 III-out 6,0 6,0 6,0 ow d 6,4 6,4	12 and rill bi 5,6 5,6 5,6 rill bi 5,2	14 cond t (dr) 4,4 4,4 4,4 t (wa 4,2 4,2	3,7 3,7 3,7 3 ,7 ter fi	3,7 3,7 3,7 11ed I 3,7	20 e failu oncre 3,7 3,7 3,7 nole) 3,7	22 4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	3,1 3,1 3,1 3,1
Character Hammer-c Tem- perature range Tem- perature range range Tem- perature range Tem- perature range Tem- perature	diameter of the bar ristic bond resistand drilling with standa : 24 °C / 40 °C : 35 °C / 60 °C : 50 °C / 72 °C : 35 °C / 60 °C : 35 °C / 60 °C : 50 °C / 72 °C	rd drill k	φ bined pu bit or holl [N/mm²] bit or holl	10 III-out 6,0 6,0 6,0 ow d 6,4 6,4	12 and rill bi 5,6 5,6 5,6 rill bi 5,2	14 cond t (dr) 4,4 4,4 4,4 t (wa 4,2 4,2	3,7 3,7 3,7 3 ,7 ter fi	3,7 3,7 3,7 11ed I 3,7	20 e failu oncre 3,7 3,7 3,7 nole) 3,7	22 4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	3,1 3,1 3,1 3,1
Character Hammer-c Tem- perature range Hammer-c Tem- perature range Installatio Tension lo Dry or wet Water filled	diameter of the bar ristic bond resistand drilling with standa : 24 °C / 40 °C : 35 °C / 60 °C : 50 °C / 72 °C : 35 °C / 60 °C : 35 °C / 60 °C : 50 °C / 72 °C : 50 °C / 72 °C : 50 °C / 72 °C	rd drill k TRk,C1 rd drill k TRk,C1	φ bined pu bit or holl [N/mm²] bit or holl [N/mm²]	10 II-out 6,0 6,0 6,0 ow d 6,4 5,5	12 and rill bi 5,6 5,6 5,6 5,2 5,2 5,2	14 cond t (dry 4,4 4,4 4,2 4,2 3,8	16 y or v 3,7 3,7 3,7 3,7 3,7 3,8	18 cone vet c 3,7 3,7 3,7 1led I 3,7 3,7	20 failu oncre 3,7 3,7 3,7 3,7 3,7 3,7	22 4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7	4,4 4,4 4,4 3,7 3,7 3,7	3,7 3,7 3,7	4,4 4,4 4,4 3,7 3,7	3,7 3,7 3,7	3, 3, 3,

English translation prepared by DIBt



Table C42.1: Characteristic resistance and displacements for combined pull-out and concrete failure for metric Anchor rods and Threaded rods in hammer drilled holes under seismic action performance category C2; working life 50 and 100 years

Anchor r	od /	Threaded rod			M12	M16	M20	M24	
Characte	risti	c bond resistan	ce, com	bined pu	ll-out and conci	rete cone failure			
Hammer-	-drill	ing with standa	rd drill l	oit or holl	ow drill bit (dry	or wet concrete)		
Tem-	I:	24 °C / 40 °C			3,5	5,8	5,0	3,1	
perature	II:	35 °C / 60 °C	$ au_{Rk,C2}$	[N/mm ²]	3,5	5,8	5,0	3,1	
range	III:	50 °C / 72 °C			3,3	5,5	4,7	2,9	
Hammer-	-drill	ling with standa	rd drill l	oit or holl	ow drill bit (wat	er filled hole)			
Tem_	l:	24 °C / 40 °C			3,5	5,8	5,0	3,1	
	H:	35 °C / 60 °C	$ au_{ ext{Rk,C2}}$	[N/mm ²]	3,5	5,8	5,0	3,1	
range	III:	50 °C / 72 °C			3,3	5,5	4,7	2,9	
Installati	on fa	actors							
Tension	load	ling							
Dry or we	t cor	ncrete				1	,0		
Water fille	ed ho	ole	γ inst	[-]	1	,2	1,	1,4	
Displace	men	t-Factors for ter	nsion lo	ading ¹⁾					
δ _{N,C2(50%)-F}	actor		Г	//N1/mama2\1	0,09	0,10	0,11	0,12	
δ _{N,C2(100%)} -	-Factor	-	լտու	/(N/mm ²)]	0,15	0,17	0,17	0,18	

0,18

0,25

1) Calculation of effective displacement:

Displacement-Factors for shear loading 2)

 $\delta_{\text{N,C2(50\%)}} = \delta_{\text{N,C2(50\%)-Factor}} \cdot \tau$

 δ V,C2(50%)-Factor

 δ V,C2(100%)-Factor

 $\delta_{\text{N,C2(100\%)}} = \delta_{\text{N,C2(100\%)-Factor}} \cdot \tau$

 τ = acting bond strength under tension loading

²⁾ Calculation of effective displacement:

0,07

0,11

 $\delta_{\text{V,C2(50\%)}} = \delta_{\text{V,C2(50\%)-Factor}} \cdot \text{V}$

0,10

0,14

 $\delta_{V,C2(100\%)} = \delta_{V,C2(100\%)\text{-Factor}} \cdot V$

V = acting shear loading

U	pat	Injec	tion	sys:	tem	UP	M	55
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Performance

Characteristic resistance for combined pull-out and concrete failure under seismic action (C2) for Anchor rods and Threaded rods; working life 50 and 100 years

[mm/kN]

Annex C42

0,06

0,09



Table C43.1:	Characteristic resistance to steel failure under tension or shear loading
	for fractional Threaded rods
	under seismic action performance category C1

	under	seisr	nic action performa	ance	categ	ory C1					
Threa	aded rod				3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
			eel failure under tensi	ion Ic	ading						
Threa	aded rods, performa	nce c	ategory C1 ¹⁾								
			F568M, Class 5.8		25,0	45,7	72,9	107,9	148,9	195,4	246,0
ළ			F1554, Grade 36		19,9	36,5	58,3	86,2	119,1	156,2	196,7
stano	Steel zinc plated	ဟ	F1554, Grade 55		25,8	47,3	75,3	111,5	154,0	202,0	254,4
resis		clas	F1554, Grade 105		43,0	78,8	125,6	185,9	256,7	336,8	424,0
eristic re N _{Rk,s,C1}		Property class	A193, B7	[kN]	43,0	78,8	125,6	185,9	256,7	336,8	424,0
cteri N		go	F593, Alloy Group 2		34,4	63,0	100,5	126,4	174,5	229,0	288,3
Characteristic resistance NRK,S,C1	Stainless steel R		A193, Grade B8M, Class 1		25,8	47,3	75,3	111,5	154,0	202,0	254,4
			A193, Grade B8M, Class 2B		32,7	59,9	95,4	141,3	195,1	255,9	322,2
Char	acteristic resistance	to ste	to steel failure under shear loading without lever arm								
Threa	aded rods, performa	nce c	ategory C1 ¹⁾								
			F568M, Class 5.8		12,0	21,9	34,9	51,7	53,6	70,3	88,5
g g			F1554, Grade 36		8,3	15,3	24,4	36,2	50,0	65,6	82,6
tanc	Steel zinc plated	, ,	F1554, Grade 55		10,3	18,9	30,1	44,6	46,2	60,6	76,3
esis		lass	F1554, Grade 105		15,0	27,6	43,9	65,0	89,8	117,8	148,4
lic re ks,c1		Property class	A193, B7	[kN]	17,2	31,5	50,2	74,3	77,0	101,0	127,2
erist V _R	VRKs,C.		F593, Alloy Group 2	[,	13,7	25,2	40,2	50,5	52,3	68,7	86,5
Characteristic resistance VRKs,C1	ਬੁੱਧ ਇਹ Stainless steel R		A193, Grade B8M, Class 1		10,3	18,9	30,1	44,6	46,2	60,6	76,3
			A193, Grade B8M, Class 2B		13,1	23,9	38,1	56,5	58,5	76,7	96,6

¹⁾ Partial factors for performance category C1 or see table C45.1

Upat Injection system UPM 55	
Performance Characteristic resistance to steel failure under tension or shear loading for Anchor rods and Threaded rods under seismic action (performance category C1)	Annex C43



Table C44.1: Characteristic resistance to steel failure under tension / shear loading for fractional reinforcing bars under seismic action performance category C1

Rebar size			#3	#4	#5	#6	#7	#8	#9	#10
Characteri	stic resistance to steel fa	ilure u	nder ten	sion loa	ding					
Reinforcin	g bar materials, performa	ance ca	ategory (C1 ¹⁾						
<u>.</u>	A615 (A767), Grade 40		29,3	53,3	82,3	117,4	160,0	210,9	266,8	338,8
naracterist resistance N _{Rk,s,C1}	A615 (A767), Grade 60	[kN]	44,0	80,0	123,4	176,2	240,1	316,4	400,2	508,2
Characteristic resistance NRK,S,C1	A615 (A767), Grade 75	נאון	48,9	88,9	137,2	195,8	266,8	351,6	444,7	564,6
O		39,1	71,1	109,7	156,6	213,4	281,3	355,7	451,7	
Characteri	stic resistance to steel fa	ilure u	nder sh	ear loadi	ng, with	out lever	arm			
Reinforcin	g bar materials, performa	ance ca	ategory (C1 ¹⁾						
<u>.</u> 9	A615 (A767), Grade 40		13,0	23,6	36,5	52,1	71,0	93,6	118,4	150,4
aracterist esistance VRK,s,C1	A615 (A767), Grade 60	[FNI]	16,3	29,6	45,6	65,2	88,8	117,0	148,0	188,0
Characteristic Resistance VRK,S,C1	A615 (A767), Grade 75	[kN]	18,1	32,9	50,7	72,4	98,7	130,1	164,5	208,9
0 -	A706 (A767), Grade 60		14,4	26,3	40,6	57,9	78,9	104,0	131,6	167,1

¹⁾ Partial factors for performance category C1 see table C45.1.

Upat Injection system UPM 55

Performance
Characteristic resistance to steel failure under tension/shear loading for fractional reinforcing bars under seismic action (performance category C1)

Annex C44



		seismic action performa							
	aded rod r size			3/8" to 5/8" #3 t	3/4" to 1 1/8"				
	ion loading, st	teel failure 1)		#0 t	0 # 10				
		F568M, Class 5.8	\sqcap	1	,50				
	Threaded	F1554, Grade 36	1	1,94					
	rod,	F1554, Grade 55	1 [1,64					
	zinc plated	F1554, Grade 105		1	,43				
Ns,N		A193, B7		1	,43				
or ⅓	Threaded	F593, Alloy Group 2		1,85	2,27				
Partial factor ‱,	rod, stainless	A193, Grade B8M, Class 1	[-]	3	5,00				
Parti	steel R	A193, Grade B8M, Class 2B		1	,52				
		A615 (A767), Grade 40] L	1	,80				
	Reinforcing	A615 (A767), Grade 60] L	1	,80				
	bar	A615 (A767), Grade 75] L	1	,60				
		A706 (A767), Grade 60		1	,60				
Shea	r loading, stee								
		F568M, Class 5.8	↓		,25				
	Threaded	F1554, Grade 36	┤		,61				
	rod, zinc plated	F1554, Grade 55	\downarrow \vdash		,36				
_	·	F1554, Grade 105	┨	1,50 1,50					
YMs,∨		A193, B7	$+$ \vdash						
Partial factor	Threaded rod,	F593, Alloy Group 2 A193, Grade B8M, Class 1	[-]	1,54	1,89				
Partial	stainless steel R	A193, Grade B8M, Class 2B		1,27					
		A615 (A767), Grade 40	1	1	,50				
	Reinforcing	A615 (A767), Grade 60	1	1	,50				
	bar	A615 (A767), Grade 75	1	1	,33				
		A706 (A767), Grade 60	1	1	,33				

seismic action performance category C1 (fractional size)



Table C46.1: Characteristic resistance for combined pull-out and concrete failure for fractional Threaded rods in hammer drilled holes under seismic action performance category C1; working life 50 years

Threade	d ro	d			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Characte	eristi	ic bond resista	nce, cor	nbined pu	ıll-out an	d concre	te cone f	ailure			
Hammer	-dril	ling with stand	ard drill	bit or hol	low drill	bit (dry o	r wet con	crete)			
Tem-	l:	24 °C / 40 °C			8,5	9,0	9,1	8,5	8,5	8,2	7,1
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	8,5	9,0	9,1	8,5	8,5	8,2	7,1
range	III:	50 °C / 72 °C	-		8,0	8,5	8,5	8,5	8,5	8,2	7,1
Hammer	-dril	ling with stand	ard drill	bit or hol	low drill	bit (wate	r filled ho	le)			
Tem-	l:	24 °C / 40 °C	_		7,4	7,7	7,5	6,0	6,0	5,8	5,0
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	7,4	7,7	7,5	6,0	6,0	5,8	5,0
range	III:	50 °C / 72 °C	-		6,9	7,3	7,0	6,0	6,0	5,8	5,0
Installati	on f	actors									
Tension	load	ling									
Dry or we	et co	ncrete		F 1				1,0			
Water fill	ed ho	ole	- γinst	[-]		1,2			1,	4	

Table C46.2: Characteristic resistance for combined pull-out and concrete failure for fractional Threaded rods in hammer drilled holes under seismic action performance category C1; working life 100 years

Threade	d ro	d			3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"
Characte	erist	ic bond resista	nce, cor	nbined pu	ıll-out ar	d concre	te cone f	ailure			
Hammer	r-dril	ling with stand	ard drill	bit or hol	low drill	bit (dry o	r wet con	crete)			
Tem-	I:	24 °C / 40 °C			6,8	6,8	6,9	6,9	6,8	6,3	5,3
perature	II:	35 °C / 60 °C	τ _{Rk,C1}	[N/mm ²]	6,8	6,8	6,9	6,9	6,8	6,3	5,3
range	III:	50 °C / 72 °C	-		6,4	6,4	6,5	6,4	6,4	5,9	5,1
Hammer	r-dril	ling with stand	ard drill	bit or hol	low drill	bit (wate	filled ho	le)			
Tem-	I:	24 °C / 40 °C			5,9	5,9	5,7	4,9	4,8	4,4	3,7
perature	II:	35 °C / 60 °C	τ _{Rk,C1}	[N/mm ²]	5,9	5,9	5,7	4,9	4,8	4,4	3,7
range	III:	50 °C / 72 °C	•		5,5	5,5	5,3	4,5	4,5	4,2	3,6
Installat	ion f	actors									
Tension	load	ling									
Dry or we	et co	ncrete		[]				1,0			
Water fill	ed h	ole	γinst	[-]		1,2			1,	,4	

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Performance

Characteristic resist. for combined pull-out and concrete failure under seismic action (C1) for Anchor rods / Threaded rods; working life 50 and 100 years (fractional size)

Annex C46



Table C47.1: Characteristic resistance for combined pull-out and concrete failure for fractional reinforcing bars in hammer drilled holes under seismic action performance category C1; working life 50 years

Rebar si	ze				#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Characte	Characteristic bond resistance, combined pull-out and concrete cone failure											
Hammer	Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)											
Tem-	I:	24 °C / 40 °C			6,2	7,0	7,0	7,0	7,0	7,0	7,0	7,0
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	6,2	7,0	7,0	7,0	7,0	7,0	7,0	7,0
range -	III:	50 °C / 72 °C			6,2	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Hammer	-drill	ling with standa	ard drill	bit or hol	low dril	l bit (wa	ter filled	hole)				
Tem-	I:	24 °C / 40 °C			6,6	5,7	5,7	5,3	5,3	5,3	5,3	4,4
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	6,6	5,7	5,7	5,3	5,3	5,3	5,3	4,4
range	III:	50 °C / 72 °C			5,7	5,7	5,3	5,3	5,3	5,3	5,3	4,4
Installati	on fa	actors										
Tension	load	ing										
Dry or we	Ory or wet concrete						·	1,	,0		·	
Water fille	ed ho	ole	γinst	[-]	1,2 1,4							

¹⁾ Not allowed for drilling with hollow drill bit.

Table C47.2: Characteristic resistance for combined pull-out and concrete failure for fractional reinforcing bars in hammer drilled holes under seismic action performance category C1; working life 100 years

Rebar si	ze				#3	#4	#5	#6	#7	#8	#9	#10 ¹⁾
Characte	Characteristic bond resistance, combined pull-out and concrete cone failure Hammer-drilling with standard drill bit or hollow drill bit (dry or wet concrete)											
Hammer	-dril	ling with standa	ard drill	bit or hol	low dril	l bit (dry	or wet	concret	e)			
Tem-	I:	24 °C / 40 °C			5,2	5,6	4,6	4,6	4,6	4,6	4,6	4,6
perature	II:	35 °C / 60 °C	$ au_{ ext{Rk,C1}}$	[N/mm ²]	5,2	5,6	4,6	4,6	4,6	4,6	4,6	4,6
range	III:	50 °C / 72 °C	•		5,2	5,6	4,6	4,6	4,6	4,6	4,6	4,6
Hammer-drilling with standard drill bit or hollow drill bit (water filled hole)												
Tem-	I:	24 °C / 40 °C	- τ _{Rk,C1}		5,6	4,6	3,7	3,4	3,4	3,4	3,4	2,9
perature	II:	35 °C / 60 °C		[N/mm ²]	5,6	4,6	3,7	3,4	3,4	3,4	3,4	2,9
range	III:	50 °C / 72 °C	•		4,9	4,6	3,4	3,4	3,4	3,4	3,4	2,9
Installati	on f	actors							•	•		
Tension	load	ling										
Dry or we	Dry or wet concrete 1,0											
Water fill	ed h	ole	γinst	[-]	·	1,2				1,4	·	

¹⁾ Not allowed for drilling with hollow drill bit.

Upat Injection system UPM 55	
Performance Characteristic resistance for combined pull-out and concrete failure under seismic action (C1) for and reinforcing bars; working life 50 and 100 years (fractional size)	Annex C47



Table C48.1: Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 1

Fire resistance to steel failure un	der tension and	d shear load	ling				
Anchor rod / Threaded rod ISO 898-1 Class 5.8 and higher	R30		R60				
	N _{Rk,s,fi,30} [kN]	V _{Rk,s,fi,30} [kN]	M ⁰ _{Rk,s,fi,30} [Nm]	N _{Rk,s,fi,60} [kN]	V _{Rk,s,fi,60} [kN]	M ⁰ _{Rk,s,fi,60} [Nm]	
M8	1,6	1,6	1,7	1,2	1,2	1,2	
M10	3,3	3,3	4,2	2,3	2,3	3,0	
M12	5,8	5,8	9,1	4,0	4,0	6,2	
M14	6,6	6,6	12,0	4,6	4,6	8,4	
M16	10,9	10,9	15,1	7,5	7,5	11,2	
M20	11,1	11,1	29,4	8,2	8,2	21,8	
M22	13,7	13,7	40,5	10,1	10,1	30,0	
M24	16,0	16,0	50,9	11,8	11,8	37,7	
M27	20,8	20,8	75,5	15,4	15,4	56,0	
M30	25,4	25,4	102,0	18,8	18,8	75,6	
Anchor rod / Threaded rod ISO 898-1 Class 5.8 and higher		R90			R120		
	N _{Rk,s,fi,90} [kN]	V _{Rk,s,fi,90} [kN]	M ⁰ _{Rk,s,fi,90} [Nm]	N _{Rk,s,fi,120} [kN]	V _{Rk,s,fi,120} [kN]	M ⁰ _{Rk,s,fi,120} [Nm]	
M8	0,8	0,8	0,8	0,6	0,6	0,6	
M10	1,4	1,4	1,8	0,9	0,9	1,1	
M12	2,1	2,1	3,3	1,2	1,2	1,9	
M14	2,7	2,7	4,9	1,7	1,7	3,2	
M16	4,0	4,0	7,3	2,3	2,3	5,3	
M20	5,3	5,3	14,2	3,9	3,9	10,4	
M22	6,6	6,6	19,5	4,8	4,8	14,3	
M24	7,7	7,7	24,6	5,6	5,6	18,0	
M27	10,0	10,0	36,4	7,3	7,3	26,7	
M30	12,3	12,3	49,3	9,0	9,0	36,1	

Upat Injection system UPM 55	
Performance Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 1	Annex C48



Table C49.1: Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 2

Anchor rods R and HCR and Threaded rod, EN ISO 3506-1 Class A4-50 and higher		R30			R60		
	N _{Rk,s,fi,30} [kN]	V _{Rk,s,fi,30} [kN]	M ⁰ _{Rk,s,fi,30} [Nm]	N _{Rk,s,fi,60} [kN]	V _{Rk,s,fi,60} [kN]	M ⁰ _{Rk,s,fi,60} [Nm]	
M8	0,7	0,7	0,7	0,5	0,5	0,6	
M10	1,4	1,4	1,8	1,1	1,1	1,5	
M12	2,5	2,5	3,9	2,1	2,1	3,9	
M14	3,4	3,4	6,2	2,8	2,8	6,2	
M16	4,7	4,7	9,9	3,9	3,9	9,9	
M20	7,3	7,3	19,4	6,1	6,1	19,4	
M22	9,0	9,0	26,7	7,5	7,5	26,7	
M24	10,5	10,5	33,6	8,8	8,8	28,0	
M27	13,7	13,7	49,9	11,4	11,4	41,6	
M30	16,8	16,8	67,4	14,0	14,0	56,2	
Anchor rods R and HCR and Threaded rod, EN ISO 3506-1 Class A4-50 and higher		R90			R120		
	N _{Rk,s,fi,90} [kN]	V _{Rk,s,fi,90} [kN]	M ⁰ _{Rk,s,fi,90} [Nm]	N _{Rk,s,fi,120} [kN]	V _{Rk,s,fi,120} [kN]	M ⁰ Rk,s,fi,120 [Nm]	
M8	0,4	0,4	0,4	0,3	0,3	0,3	
M10	0,9	0,9	1,2	0,8	0,8	1,0	
M12	1,6	1,6	3,9	1,3	1,3	3,9	
M14	2,3	2,3	6,2	1,8	1,8	6,2	
M16	3,1	3,1	9,9	2,5	2,5	9,9	
M20	4,9	4,9	19,4	3,9	3,9	19,4	
M22	6,0	6,0	26,7	4,8	4,8	26,7	
M24	7,0	7,0	22,4	5,6	5,6	17,9	
M27	9,1	9,1	33,2	7,3	7,3	26,6	
M30	11,2	11,2	44,9	8,9	8,9	35,9	

Upat Injection system UPM 55	
Performance Fire resistance to steel failure under tension and shear loading for metric Anchor rods and Threaded rods part 2	Annex C49



Table C50.1: Fire resistance to steel failure under tension and shear loading for fractional Threaded rods

tension and shear loading for fractional Threaded rods						
Fire resistance to steel failure unde	r tension and	d shear load	ling			
Threaded rod	R30			R60		
Steel zinc plated; detailed materials see Table A7.1, part No 2 1)	N _{Rk,s,fi,30} [kN]	V _{Rk,s,fi,30} [kN]	M ⁰ _{Rk,s,fi,30} [Nm]	N _{Rk,s,fi,60} [kN]	V _{Rk,s,fi,60} [kN]	M ⁰ _{Rk,s,fi,60} [Nm]
3/8"	2,7	2,7	3,2	1,9	1,9	2,3
1/2"	5,9	5,9	9,6	4,1	4,1	6,7
5/8"	6,7	6,7	13,7	4,9	4,9	10,1
3/4"	9,7	9,7	24,3	7,2	7,2	18,0
7/8"	13,5	13,5	39,4	10,0	10,0	29,2
1"	17,7	17,7	59,3	13,1	13,1	43,9
1 1/8"	22,3	22,3	83,8	16,5	16,5	62,2
Threaded rod		R90		R120		
Steel zinc plated; detailed materials see Table A7.1, part No 2 1)	N _{Rk,s,fi,90} [kN]	V _{Rk,s,fi,90} [kN]	M ⁰ _{Rk,s,fi,90} [Nm]	N _{Rk,s,fi,120} [kN]	V _{Rk,s,fi,120} [kN]	M ⁰ Rk,s,fi,120 [Nm]
3/8"	1,1	1,1	1,4	0,8	0,8	0,9
1/2"	2,3	2,3	3,7	1,3	1,3	2,2
5/8"	3,6	3,6	7,5	2,2	2,2	4,5
3/4"	4,7	4,7	11,7	3,4	3,4	8,6
7/8"	6,5	6,5	19,0	4,7	4,7	13,9
1"	8,5	8,5	28,6	6,2	6,2	20,9
1 1/8"	10,7	10,7	40,5	7,9	7,9	29,6
Threaded rod	10,7	R30	10,0	,,,,,	R60	20,0
	l NI		N 40			N4 0
Stainless steel R; detailed materials see Table A7.1, part No 2	N _{Rk,s,fi,30} [kN]	V _{Rk,s,fi,30} [kN]	M ⁰ _{Rk,s,fi,30} [Nm]	N _{Rk,s,fi,60} [kN]	V _{Rk,s,fi,60} [kN]	M ⁰ Rk,s,fi,60 [Nm]
3/8"	1,1	1,1	1,4	0,9	0,9	1,1
1/2"	2,7	2,7	4,4	2,2	2,2	3,7
5/8"	4,3	4,3	8,9	3,6	3,6	7,4
3/4"	6,4	6,4	16,1	5,4	5,4	13,4
7/8"	8,9	8,9	26,1	7,4	7,4	21,7
1"	11,7	11,7	39,2	9,7	9,7	32,6
1 1/8"	14,7	14,7	55,4	12,3	12,3	46,2
Threaded rod	R90 R1		R90 R120			
Stainless steel R; detailed materials see Table A7.1, part No 2	N _{Rk,s,fi,90} [kN]	V _{Rk,s,fi,90} [kN]	M ⁰ Rk,s,fi,90 [Nm]	N _{Rk,s,fi,120} [kN]	V _{Rk,s,fi,120} [kN]	M ⁰ Rk,s,fi,120 [Nm]
3/8"	0,7	0,7	0,9	0,6	0,6	0,7
1/2"	1,8	1,8	2,9	1,4	1,4	2,3
5/8"	2,9	2,9	5,9	2,3	2,3	4,7
3/4"	4,3	4,3	10,7	3,4	3,4	8,5
7/8"	5,9	5,9	17,4	4,7	4,7	13,9
1"	7,8	7,8	26,1	6,2	6,2	20,9
1 1/8"	9,8	9,8	36,9	7,8	7,8	29,5
1 1/0	1 3,0	J,0	1 55,5	, , o	1,0	23,5

¹⁾ No performance assessed for ASTM F1554 Grade 36.

Upat Injection system UPM 55	
Performance Fire resistance to steel failure under tension and shear loading for fractional Threaded rods	Annex C50



Characteristic bond resistance for cracked concrete under fire conditions for metric and fractional Anchor rods and Threaded rods in hammer drilled holes with standard drill bit or hollow drill bit

The characteristic bond resistance for cracked concrete under fire conditions for a given temperature.

 $\tau_{Rk,fi}(\theta)$ has to be calculated by the following equation:

$$\tau_{Rk,fi}(\theta) = k_{fi,p}(\theta) \cdot \tau_{Rk,cr,C20/25}$$

θ Temperature in °C in the mortar layer,

Characteristic bond resistance for cracked concrete under fire exposure for a $\tau_{\mathsf{Rk},\mathsf{fi}}(\theta)$

given temperature in N/mm² for concrete classes C20/25 to C50/60.

 $k_{fi,p}(\theta)$ Reduction factor under fire conditions.

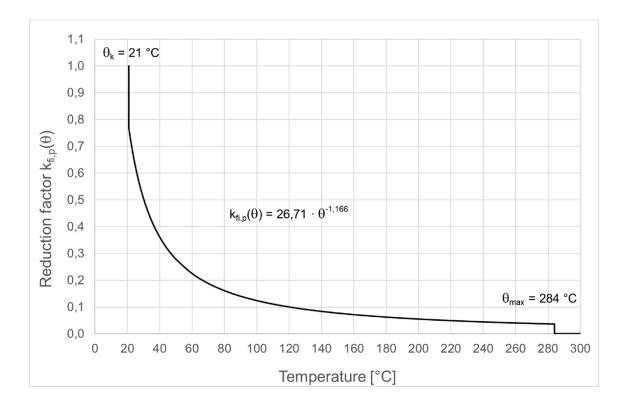
Characteristic bond resistance for cracked concrete C20/25 in N/mm², $au_{\text{Rk,cr,C20/25}}$

given in Table C5.1, Table C6.1, Table C26.1 or Table C28.1, respectively.

 $\mathbf{k_{fi,p}}(\theta) = 26,71 \cdot \theta^{-1,166} \le 1,0$ If: $\theta > 21$ °C Anchor rods or

see Figure C51.1 $k_{fi,p}(\theta) = 0$ Threaded rods If: $\theta > \theta_{max} = 284 \, ^{\circ}C$

Figure C51.1: Graph of reduction factor $k_{fi,p}$ (θ) for Anchor rods or Threaded rods.



Upat Injection system UPM 55

Performance

Characteristic bond resistance under fire conditions for anchor rods and threaded rods

Annex C51