DECLARATION OF PERFORMANCE
DoP no. 2873-08420/1 EN

Version: 1 Print date: 04.01.2021

1. Unique identification code of the product-type: **TOX Liquix Multi 1**

2. Intended use/es:

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

3. Manufacturer: **TOX-Dübel-Technik GmbH, Brunnenstraße 31, D-72505 Krauchenwies Ablach**
4. Authorised representative: **--**
5. System/s of AVCP: **1**
6. a) Harmonised standard: **--**
   Notified body/ies: --
6. b) European Assessment Document: **EAD 330499-01-0601**
   European Technical Assessment: **ETA-17/0501; 21.05.2019**
   Technical Assessment Body: **DIBt**
   Notified body/ies: **2873 TU Darmstadt**
7. Declared performance/s:

Mechanical resistance and stability (BWR1)

Essential characteristics	Performances
Characteristic resistance to tension load (static and quasi-static loading)	See Annex C1, C2, C4, C6
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C1, C3, C5, C7
Displacements (static and quasi-static loading)	See Annex C8, C9, C10
Characteristic resistance for seismic performance category C1	See Annex C11, C12, C13, C14, C15
Characteristic resistance and displacement for seismic performance categorie C2	No performance assessed

Hygiene, health and the environment (BWR 3)

Essential characteristics	Performances
Content, emission and/or release of dangerous substances	No performance assessed

8. Appropriate Technical Documentation and/or Specific Technical Documentation: **--**

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:

i.A. Daniel Wilhelm (Applications Engineering)
Krauchenwies-Ablach, 04.01.2021

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

Size				**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Cross section area		A_s	[mm²]	36,6	58	84,3	157	245	353	459	561
Characteristic tension resistance, Steel failure [1]											
Steel, Property class 4.6 and 4.8		$N_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
Steel, Property class 5.6 and 5.8		$N_{Rk,s}$	[kN]	18 (17)	29 (27)	42	78	122	176	230	280
Steel, Property class 8.8		$N_{Rk,s}$	[kN]	29 (27)	46 (43)	67	125	196	282	368	449
Stainless steel A2, A4 and HCR, class 50		$N_{Rk,s}$	[kN]	18	29	42	79	123	177	230	281
Stainless steel A2, A4 and HCR, class 70		$N_{Rk,s}$	[kN]	26	41	59	110	171	247	-	-
Stainless steel A4 and HCR, class 80		$N_{Rk,s}$	[kN]	29	46	67	126	196	282	-	-
Characteristic tension resistance, Partial factor [2]											
Steel, Property class 4.6 and 5.6		$\gamma_{Ms,N}$	[-]	2,0							
Steel, Property class 4.8, 5.8 and 8.8		$\gamma_{Ms,N}$	[-]	1,5							
Stainless steel A2, A4 and HCR, class 50		$\gamma_{Ms,N}$	[-]	2,86							
Stainless steel A2, A4 and HCR, class 70		$\gamma_{Ms,N}$	[-]	1,87							
Stainless steel A4 and HCR, class 80		$\gamma_{Ms,N}$	[-]	1,6							
Characteristic shear resistance, Steel failure [1]											
Without lever arm	Steel, Property class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
	Steel, Property class 5.6 and 5.8	$V^0_{Rk,s}$	[kN]	9 (8)	15 (13)	21	39	61	88	115	140
	Steel, Property class 8.8	$V^0_{Rk,s}$	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Stainless steel A2, A4 and HCR, class 50	$V^0_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
	Stainless steel A2, A4 and HCR, class 70	$V^0_{Rk,s}$	[kN]	13	20	30	55	86	124	-	-
	Stainless steel A4 and HCR, class 80	$V^0_{Rk,s}$	[kN]	15	23	34	63	98	141	-	-
With lever arm	Steel, Property class 4.6 and 4.8	$M^0_{Rk,s}$	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	$M^0_{Rk,s}$	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
	Steel, Property class 8.8	$M^0_{Rk,s}$	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
	Stainless steel A2, A4 and HCR, class 50	$M^0_{Rk,s}$	[Nm]	19	37	66	167	325	561	832	1125
	Stainless steel A2, A4 and HCR, class 70	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	-	-
	Stainless steel A4 and HCR, class 80	$M^0_{Rk,s}$	[Nm]	30	59	105	266	519	896	-	-
Characteristic shear resistance, Partial factor [2]											
Steel, Property class 4.6 and 5.6		$\gamma_{Ms,V}$	[-]	1,67							
Steel, Property class 4.8, 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25							
Stainless steel A2, A4 and HCR, class 50		$\gamma_{Ms,V}$	[-]	2,38							
Stainless steel A2, A4 and HCR, class 70		$\gamma_{Ms,V}$	[-]	1,56							
Stainless steel A4 and HCR, class 80		$\gamma_{Ms,V}$	[-]	1,33							

[1] Values are only valid for the given stress area A_s. Values in brackets are valid for undersized threaded rods with smaller stress area A_s for hot-dip galvanised threaded rods according to EN ISO 10684:2004+AC:2009.
[2] in absence of national regulation

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 1

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Table C2: Characteristic values of tension loads under static and quasi-static action

Anchor size threaded rod					**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic tension resistance			$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	11	10	9
	II: 80°C/50°C				7,5	9	9	9	9	8,5	7,5	6,5
	III: 120°C/72°C				5,5	6,5	6,5	6,5	6,5	6,5	5,5	5,0
	I: 40°C/24°C	flooded bore hole			7,5	8,5	8,5	8,5	No Performance Assessed (NPA)			
	II: 80°C/50°C				5,5	6,5	6,5	6,5				
	III: 120°C/72°C				4,0	5,0	5,0	5,0				
Characteristic bond resistance in cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	5,0	5,5	5,5	5,5	5,5	6,5	6,5
	II: 80°C/50°C				2,5	3,5	4,0	4,0	4,0	4,0	4,5	4,5
	III: 120°C/72°C				2,0	2,5	3,0	3,0	3,0	3,0	3,5	3,5
	I: 40°C/24°C	flooded bore hole			4,0	4,0	5,5	5,5	No Performance Assessed (NPA)			
	II: 80°C/50°C				2,5	3,0	4,0	4,0				
	III: 120°C/72°C				2,0	2,5	3,0	3,0				
Increasing factors for concrete Ψ_c			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
Concrete cone failure												
Non-cracked concrete			$k_{ucr,N}$	[-]	11,0							
Cracked concrete			$k_{cr,N}$	[-]	7,7							
Edge distance			$c_{cr,N}$	[mm]	$1,5\ h_{ef}$							
Axial distance			$s_{cr,N}$	[mm]	$2\ c_{cr,N}$							
Splitting												
Edge distance	$h/h_{ef} \geq 2,0$		$c_{cr,sp}$	[mm]	$1,0\ h_{ef}$							
	$2,0 > h/h_{ef} > 1,3$				$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$							
	$h/h_{ef} \leq 1,3$				$2,4\ h_{ef}$							
Axial distance			$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							
Installation factor												
for dry and wet concrete			γ_{inst}	[-]	1,0	1,2						
for flooded bore hole					1,4				NPA			

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 2

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

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Steel failure without lever arm										
Characteristic shear resistance Steel, strength class 4.6 and 4.8	$V^0_{Rk,s}$	[kN]	$0{,}6 \cdot A_s \cdot f_{uk}$ (or see Table C1)							
Characteristic shear resistance Steel, strength class 5.6, 5.8 and 8.8 Stainless Steel A2, A4 and HCR, all classes	$V^0_{Rk,s}$	[kN]	$0{,}5 \cdot A_s \cdot f_{uk}$ (or see Table C1)							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1{,}2 \cdot W_{el} \cdot f_{uk}$ (or see Table C1)							
Elastic section modulus	W_{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Concrete pry-out failure										
Factor	k_8	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$	
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

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

Annex C 3

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

Anchor size internal threaded anchor rods					**IG-M 6**	**IG-M 8**	**IG-M 10**	**IG-M 12**	**IG-M 16**	**IG-M 20**
Steel failure[1]										
Characteristic tension resistance, Steel, strength class	5.8	$N_{Rk,s}$	[kN]		10	17	29	42	76	123
	8.8	$N_{Rk,s}$	[kN]		16	27	46	67	121	196
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,N}$	[-]		1,5					
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 [2]		$N_{Rk,s}$	[kN]		14	26	41	59	110	124
Partial factor		$\gamma_{Ms,N}$	[-]		1,87					2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in non-cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	12	12	12	12	11	9
	II: 80°C/50°C				9	9	9	9	8,5	6,5
	III: 120°C/72°C				6,5	6,5	6,5	6,5	6,5	5,0
	I: 40°C/24°C	flooded bore hole			8,5	8,5	8,5	No Performance Assessed (NPA)		
	II: 80°C/50°C				6,5	6,5	6,5			
	III: 120°C/72°C				5,0	5,0	5,0			
Characteristic bond resistance in cracked concrete C20/25										
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	5,0	5,5	5,5	5,5	5,5	6,5
	II: 80°C/50°C				3,5	4,0	4,0	4,0	4,0	4,5
	III: 120°C/72°C				2,5	3,0	3,0	3,0	3,0	3,5
	I: 40°C/24°C	flooded bore hole			4,0	5,5	5,5	No Performance Assessed (NPA)		
	II: 80°C/50°C				3,0	4,0	4,0			
	III: 120°C/72°C				2,5	3,0	3,0			
Increasing factors for concrete ψ_c		C25/30			1,02					
		C30/37			1,04					
		C35/45			1,07					
		C40/50			1,08					
		C45/55			1,09					
		C50/60			1,10					
Concrete cone failure										
Non-cracked concrete		$k_{ucr,N}$	[-]		11,0					
Cracked concrete		$k_{cr,N}$	[-]		7,7					
Edge distance		$c_{cr,N}$	[mm]		1,5 h_{ef}					
Axial distance		$s_{cr,N}$	[mm]		2 $c_{cr,N}$					
Splitting failure										
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]		1,0 h_{ef}					
	$2,0 > h/h_{ef} > 1,3$				$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right)$					
	$h/h_{ef} \leq 1,3$				2,4 h_{ef}					
Axial distance		$s_{cr,sp}$	[mm]		2 $c_{cr,sp}$					
Installation factor										
for dry and wet concrete		γ_{inst}	[-]		1,2					
for flooded bore hole					1,4			NPA		

[1] Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
[2] For IG-M20 strength class 50 is valid

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 4

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

Anchor size for internal threaded anchor rods				**IG-M 6**	**IG-M 8**	**IG-M 10**	**IG-M 12**	**IG-M 16**	**IG-M 20**
Steel failure without lever arm[1]									
Characteristic shear resistance, Steel, strength class	5.8	$V^0_{Rk,s}$	[kN]	5	9	15	21	38	61
	8.8	$V^0_{Rk,s}$	[kN]	8	14	23	34	60	98
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70[2]		$V^0_{Rk,s}$	[kN]	7	13	20	30	55	40
Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Ductility factor		k_7	[-]	1,0					
Steel failure with lever arm[1]									
Characteristic bending moment, Steel, strength class	5.8	$M^0_{Rk,s}$	[Nm]	8	19	37	66	167	325
	8.8	$M^0_{Rk,s}$	[Nm]	12	30	60	105	267	519
Partial factor, strength class 5.8 and 8.8		$\gamma_{Ms,V}$	[-]	1,25					
Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70[2]		$M^0_{Rk,s}$	[Nm]	11	26	52	92	233	456
Partial factor		$\gamma_{Ms,V}$	[-]	1,56					2,38
Concrete pry-out failure									
Factor		k_8	[-]	2,0					
Installation factor		γ_{inst}	[-]	1,0					
Concrete edge failure									
Effective length of fastener		l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$					$\min(h_{ef}; 300mm)$
Outside diameter of fastener		d_{nom}	[mm]	10	12	16	20	24	30
Installation factor		γ_{inst}	[-]	1,0					

[1] Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.
[2] For IG-M20 strength class 50 is valid

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 5

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

Anchor size reinforcing bar				**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure												
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ [1]								
Cross section area		A_s	[mm²]	50	79	113	154	201	314	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 [2]								
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked concrete C20/25												
Temperature range I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10	12	12	12	12	12	11	10	8,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	7,5	9	9	9	9	9	8,0	7,0	6,0
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5	6,5	6,0	5,0	4,5
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7,5	8,5	8,5	8,5	8,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	5,5	6,5	6,5	6,5	6,5				
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	4,0	5,0	5,0	5,0	5,0				
Characteristic bond resistance in cracked concrete C20/25												
Temperature range I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	4,0	5,0	5,5	5,5	5,5	5,5	5,5	6,5	6,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,5	4,0	4,0	4,0	4,0	4,0	4,5	4,5
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	3,0	3,0	3,0	3,5	3,5
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	4,0	4,0	5,5	5,5	5,5	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,5	3,0	4,0	4,0	4,0				
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	2,0	2,5	3,0	3,0	3,0				
Increasing factors for concrete ψ_c		C25/30		1,02								
		C30/37		1,04								
		C35/45		1,07								
		C40/50		1,08								
		C45/55		1,09								
		C50/60		1,10								
Concrete cone failure												
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0								
Cracked concrete		$k_{cr,N}$	[-]	7,7								
Edge distance		$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$								
Axial distance		$s_{cr,N}$	[mm]	$2\ c_{cr,N}$								
Splitting												
Edge distance	$h/h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$								
Edge distance	$2{,}0 > h/h_{ef} > 1{,}3$	$c_{cr,sp}$	[mm]	$2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}} \right)$								
Edge distance	$h/h_{ef} \leq 1{,}3$	$c_{cr,sp}$	[mm]	$2{,}4\ h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								
Installation factor												
for dry and wet concrete		γ_{inst}	[-]	1,2	1,2							
for flooded bore hole		γ_{inst}	[-]	1,4					NPA			

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

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 6

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Table C7: Characteristic values of shear loads under static and quasi-static action

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure without lever arm											
Characteristic shear resistance	$V^0_{Rk,s}$	[kN]	$0{,}50 \cdot A_s \cdot f_{uk}$ [1)]								
Cross section area	A_s	[mm²]	50	79	113	154	201	314	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 [2)]								
Ductility factor	k_7	[-]	1,0								
Steel failure with lever arm											
Characteristic bending moment	$M^0_{Rk,s}$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}$ [1)]								
Elastic section modulus	W_{el}	[mm³]	50	98	170	269	402	785	1534	2155	3217
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 [2)]								
Concrete pry-out failure											
Factor	k_8	[-]	2,0								
Installation factor	γ_{inst}	[-]	1,0								
Concrete edge failure											
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$		
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	25	28	32
Installation factor	γ_{inst}	[-]	1,0								

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

TOX Injection System Liquix Multi 1 or Liquix Multi 1 snow for concrete

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

Annex C 7

Table C8: Displacements under tension load[1] (threaded rod)

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Non-cracked concrete C20/25 under static and quasi-static action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,021	0,023	0,026	0,031	0,036	0,041	0,045	0,049
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,030	0,033	0,037	0,045	0,052	0,060	0,065	0,071
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,050	0,056	0,063	0,075	0,088	0,100	0,110	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,072	0,081	0,090	0,108	0,127	0,145	0,159	0,172
Cracked concrete C20/25 under static and quasi-static action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090		0,070					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105		0,105					
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255		0,245					
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219		0,170					
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255		0,245					

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

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

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Non-cracked concrete C20/25 under static and quasi-static action										
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05
Cracked concrete C20/25 under static and quasi-static action										
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07
	$\delta_{V\infty}$-factor	[mm/kN]	0,18	0,18	0,17	0,15	0,14	0,13	0,12	0,10

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Performances
Displacements (threaded rods)

Annex C 8

Table C10: Displacements under tension load[1)] (Internal threaded anchor rod)

Anchor size Internal threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,023	0,026	0,031	0,036	0,041	0,049
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,033	0,037	0,045	0,052	0,060	0,071
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,081	0,090	0,108	0,127	0,145	0,172
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,056	0,063	0,075	0,088	0,100	0,119
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,081	0,090	0,108	0,127	0,145	0,172
Cracked concrete C20/25 under static and quasi-static action								
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090	0,070				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105				
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245				
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170				
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245				

[1)] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

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

Anchor size Internal threaded anchor rod			IG-M 6	IG-M 8	IG-M 10	IG-M 12	IG-M 16	IG-M 20
Non-cracked and cracked concrete C20/25 under static and quasi-static action								
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$-factor	[mm/kN]	0,10	0,09	0,08	0,08	0,06	0,06

[1)] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Annex C 9

Performances
Displacements (Internal threaded anchor rod)

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Table C12: Displacements under tension load[1] (rebar)

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Non-cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,021	0,023	0,026	0,028	0,031	0,036	0,043	0,047	0,052
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,030	0,033	0,037	0,041	0,045	0,052	0,061	0,071	0,075
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,050	0,056	0,063	0,069	0,075	0,088	0,104	0,113	0,126
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,072	0,081	0,090	0,099	0,108	0,127	0,149	0,163	0,181
Cracked concrete C20/25 under static and quasi-static action											
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090	0,070							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105							
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245							
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245							

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C13: Displacement under shear load[1] (rebar)

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Non-cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
	$\delta_{V\infty}$-factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,04	0,04
Cracked concrete C20/25 under static and quasi-static action											
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,12	0,12	0,11	0,11	0,10	0,09	0,08	0,07	0,06
	$\delta_{V\infty}$-factor	[mm/kN]	0,18	0,18	0,17	0,16	0,15	0,14	0,12	0,11	0,10

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Performances
Displacements (rebar)

Annex C 10

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Table C14: Characteristic values of tension loads under seismic action (performance category C1)

Anchor size threaded rod					**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M27**	**M30**
Steel failure												
Characteristic tension resistance			$N_{Rk,s,eq}$	[kN]	$1{,}0 \cdot N_{Rk,s}$							
Partial factor			$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked and cracked concrete C20/25												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	2,5	3,1	3,7	3,7	3,7	3,8	4,5	4,5
	II: 80°C/50°C				1,6	2,2	2,7	2,7	2,7	2,8	3,1	3,1
	III: 120°C/72°C				1,3	1,6	2,0	2,0	2,0	2,1	2,4	2,4
	I: 40°C/24°C	flooded bore hole			2,5	2,5	3,7	3,7	No Performance Assessed (NPA)			
	II: 80°C/50°C				1,6	1,9	2,7	2,7				
	III: 120°C/72°C				1,3	1,6	2,0	2,0				
Increasing factors for concrete ψ_c			C25/30 to C50/60		1,0							
Concrete cone failure												
Non-cracked concrete			$k_{ucr,N}$	[-]	11,0							
Cracked concrete			$k_{cr,N}$	[-]	7,7							
Edge distance			$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$							
Axial distance			$s_{cr,N}$	[mm]	$2\ c_{cr,N}$							
Splitting												
Edge distance	$h/h_{ef} \geq 2{,}0$		$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$							
	$2{,}0 > h/h_{ef} > 1{,}3$				$2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right)$							
	$h/h_{ef} \leq 1{,}3$				$2{,}4\ h_{ef}$							
Axial distance			$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$							
Installation factor												
for dry and wet concrete			γ_{inst}	[-]	1,0	1,2						
for flooded bore hole					1,4				NPA			

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Annex C 11

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

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

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Steel failure without lever arm										
Characteristic shear resistance (Seismic C1)	$V_{Rk,s,eq}$	[kN]	$0{,}70 \cdot V^0_{Rk,s}$							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k_7	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s,eq}$	[Nm]	No Performance Assessed (NPA)							
Concrete pry-out failure										
Factor	k_8	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$	
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[1)]							

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

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

Annex C 12

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

Anchor size reinforcing bar				**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure												
Characteristic tension resistance		$N_{Rk,s,eq}$	[kN]	$1{,}0 \cdot A_s \cdot f_{uk}$ [1]								
Cross section area		A_s	[mm²]	50	79	113	154	201	314	491	616	804
Partial factor		$\gamma_{Ms,N}$	[-]	1,4 [2]								
Combined pull-out and concrete failure												
Characteristic bond resistance in non-cracked and cracked concrete C20/25												
Temperature range I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	2,5	3,1	3,7	3,7	3,7	3,7	3,8	4,5	4,5
Temperature range II: 80°C/50°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,6	2,2	2,7	2,7	2,7	2,7	2,8	3,1	3,1
Temperature range III: 120°C/72°C	Dry, wet concrete	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	2,0	2,0	2,1	2,4	2,4
Temperature range I: 40°C/24°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	2,5	2,5	3,7	3,7	3,7	No Performance Assessed (NPA)			
Temperature range II: 80°C/50°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,6	1,9	2,7	2,7	2,7				
Temperature range III: 120°C/72°C	flooded bore hole	$\tau_{Rk,eq}$	[N/mm²]	1,3	1,6	2,0	2,0	2,0				
Increasing factors for concrete ψ_c		C25/30 to C50/60		1,0								
Concrete cone failure												
Non-cracked concrete		$k_{ucr,N}$	[-]	11,0								
Cracked concrete		$k_{cr,N}$	[-]	7,7								
Edge distance		$c_{cr,N}$	[mm]	$1{,}5\ h_{ef}$								
Axial distance		$s_{cr,N}$	[mm]	$2\ c_{cr,N}$								
Splitting												
Edge distance	$h/h_{ef} \geq 2{,}0$	$c_{cr,sp}$	[mm]	$1{,}0\ h_{ef}$								
Edge distance	$2{,}0 > h/h_{ef} > 1{,}3$	$c_{cr,sp}$	[mm]	$2 \cdot h_{ef} \left(2{,}5 - \frac{h}{h_{ef}} \right)$								
Edge distance	$h/h_{ef} \leq 1{,}3$	$c_{cr,sp}$	[mm]	$2{,}4\ h_{ef}$								
Axial distance		$s_{cr,sp}$	[mm]	$2\ c_{cr,sp}$								
Installation factor												
for dry and wet concrete		γ_{inst}	[-]	1,2	1,2							
for flooded bore hole		γ_{inst}	[-]	1,4					NPA			

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

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

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Table C17: Characteristic values of shear loads under seismic action (performance category C1)

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure without lever arm											
Characteristic shear resistance	$V_{Rk,s,eq}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}$ [2)]								
Cross section area	A_s	[mm²]	50	79	113	154	201	314	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5[2)]								
Ductility factor	k_7	[-]	1,0								
Steel failure with lever arm											
Characteristic bending moment	$M^0_{Rk,s,eq}$	[Nm]	No Performance Assessed (NPA)								
Concrete pry-out failure											
Factor	k_8	[-]	2,0								
Installation factor	γ_{inst}	[-]	1,0								
Concrete edge failure											
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$						$\min(h_{ef}; 300mm)$		
Outside diameter of fastener	d_{nom}	[mm]	8	10	12	14	16	20	25	28	32
Installation factor	γ_{inst}	[-]	1,0								
Factor for annular gap	α_{gap}	[-]	0,5 (1,0)[3)]								

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

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

Annex C 14

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Table C18: Displacements under tension load[1] (threaded rod)

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Cracked and non-cracked concrete C20/25 under seismic C1 action										
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090	0,070						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105						
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245						
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170						
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245						

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

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Cracked and non-cracked concrete C20/25 under seismic C1 action											
Temperature range I: 40°C/24°C	δ_{N0}-factor	[mm/(N/mm²)]	0,090	0,070							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,105	0,105							
Temperature range II: 80°C/50°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245							
Temperature range III: 120°C/72°C	δ_{N0}-factor	[mm/(N/mm²)]	0,219	0,170							
	$\delta_{N\infty}$-factor	[mm/(N/mm²)]	0,255	0,245							

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau$; τ: action bond stress for tension
$\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau$;

Table C20: Displacements under shear load[2] (threaded rod)

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Cracked and non-cracked concrete C20/25 under seismic C1 action										
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,12	0,12	0,11	0,10	0,09	0,08	0,08	0,07
	$\delta_{V\infty}$-factor	[mm/kN]	0,18	0,18	0,17	0,15	0,14	0,13	0,12	0,10

Table C21: Displacement under shear load[1] (rebar)

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Cracked and non-cracked concrete C20/25 under seismic C1 action											
All temperature ranges	δ_{V0}-factor	[mm/kN]	0,12	0,12	0,11	0,11	0,10	0,09	0,08	0,07	0,06
	$\delta_{V\infty}$-factor	[mm/kN]	0,18	0,18	0,17	0,16	0,15	0,14	0,12	0,11	0,10

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V$; V: action shear load
$\delta_{V\infty} = \delta_{V\infty}\text{-factor} \cdot V$;

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Annex C 15

Performances
Displacements under seismic C1 action (threaded rods and rebar)