Centre Scientifique et Technique du Bâtiment
84 avenue Jean Jaurès
CHAMPS-SUR-MARNE
F-77447 Marne-la-Vallée Cedex 2

Tél. : (33) 01 64 68 82 82
Fax : (33) 01 60 05 70 37

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European Technical Assessment

ETA-13/0397 of 27/02/2015

English translation prepared by CSTB - Original version in French language

General Part

Nom commercial *Trade name*	**Injection system DeWalt PURE110-PRO**
Famille de produit *Product family*	***Cheville à scellement de type "à injection" pour fixation dans le béton fissuré M10, M12, M16, M20, M24, M27, M30, et fers à béton 10, 12, 14, 16, 20, 25, 28, 32mm.*** ***Bonded injection type anchor for use in cracked concrete: sizes M10, M12, M16, M20, M24, M27, M30, and rebars size 10, 12, 14, 16, 20, 25, 28, 32mm***
Titulaire *Manufacturer*	DeWalt Stanley Black&Decker Deutschland GmbH European Anchor Development Center Black-&-Decker Str. 40 65510 Idstein Germany
Usine de fabrication e *Manufacturing plants*	Plant 1
Cette evaluation contient: *This Assessment contains*	32 pages incluant 29 annexes qui font partie intégrante de cette évaluation *32 pages including 29 annexes which form an integral part of this assessment*
Base de l'ETE *Basis of ETA*	ETAG 001, Version April 2013, utilisée en tant que EAD *ETAG 001, Edition April 2013 used as EAD*
Cette evaluation remplace: *This Assessment replace*	ATE-13/0397 valide du 28/05/2013 au 28/05/2018 *ETA-13/0397 with validity from 28/05/2013 to 28/05/2018*

Specific Part

1 Technical description of the product

The injection system DeWalt PURE110-PRO is a bonded anchor system (injection type) consisting of a "side-by-side" cartridge (385ml, 585ml, 1400ml) or (400ml, 600ml, 620 ml) or a peeler type cartridge (265ml) with injection mortar DeWalt PURE110-PRO for 3:1 and 1:1 system (ratio between mortar and hardener) and a steel element.

The steel element can be **threaded rods** made of zinc plated carbon, stainless steel or high corrosion resistant stainless steel or can be **rebars**.

The steel element is placed into a rotary/percussion drilled hole filled with the injection mortar and transfers loads into the concrete by bond stresses between anchor rod and mortar as well as between mortar and surface of the drill hole.

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

2 Specification of the intended use

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

The provisions made in this European technical assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic tension resistance acc. TR 029	See Annex C1-2, C5-6
Characteristic shear resistance acc. TR 029	See Annex C3, C7
Displacements	See Annex C4, C8
Characteristic tension resistance acc. CEN/TS 1992-4	See Annex C9-10,C13-14
Characteristic shear resistance acc. CEN/TS 1992-4	See Annex C11, C15
Displacements	See Annex C12, C16
Seismic design acc. TR045	See Annex C17 to 20

3.2 Safety in case of fire (BWR 2)

Not relevant.

3.3 Hygiene, health and the environment (BWR 3)

Regarding dangerous substances contained in this European technical assessment, there may be requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3.4 Safety in use (BWR 4)

For Basic requirement Safety in use the same criteria are valid as for Basic Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not relevant.

3.6 Energy economy and heat retention (BWR 6)

Not relevant.

3.7 Sustainable use of natural resources ((BWR 7)

For the sustainable use of natural resources no performance was determined for this product.

3.8 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B 2 are kept.

4 Assessment and verification of constancy of performance (AVCP)

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

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

5 Technical details necessary for the implementation of the AVCP system

Technical details necessary for the implementation of the Assessment and verification of constancy of performance (AVCP) system are laid down in the control plan deposited at Centre Scientifique et Technique du Bâtiment.

The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

The original French version is signed by

Charles Baloche
Technical Director

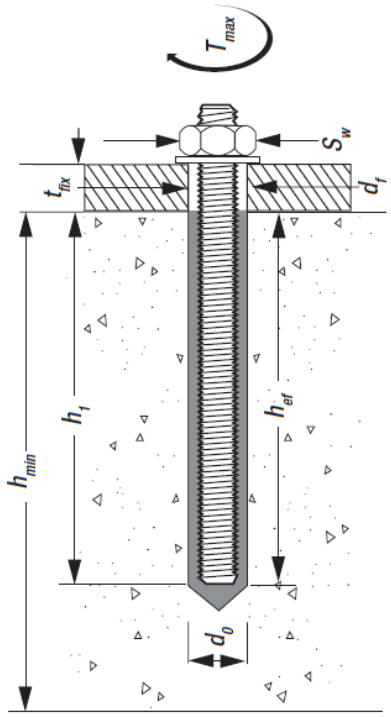
[1] Official Journal of the European Communities L 254 of 08.10.1996

Assembled anchor:

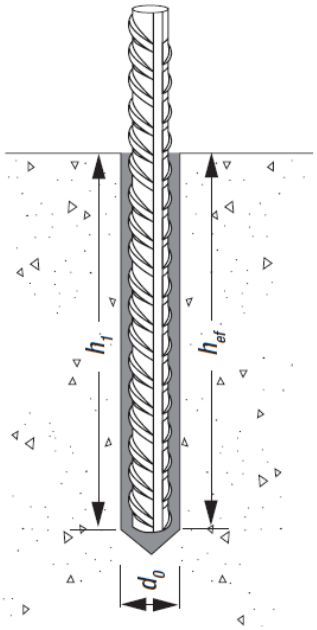
Threaded rod M10, M12, M16, M20, M24, M27 and M30 with washer and nut

Rebar ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28 and ∅ 32 acc. to Annex 4

Threaded rod



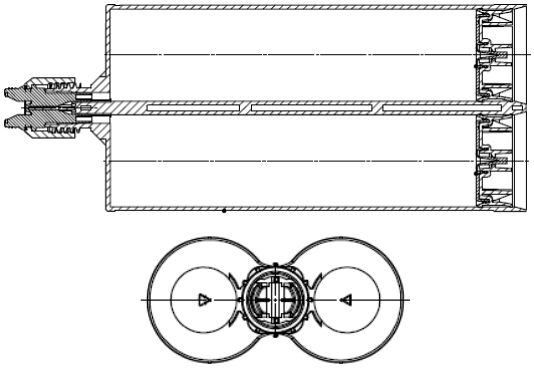
Rebar



DeWalt PURE110-PRO Injection resin with anchor rod for concrete	
Product description Product (Steel) and Installation	**Annex A1**

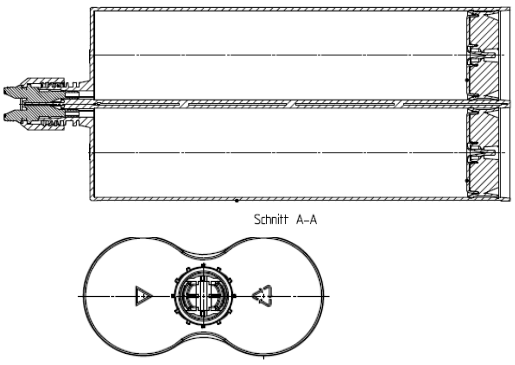
Cartridge: DeWalt PURE110-PRO

1:1 system



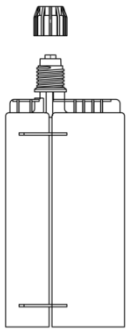
400ml

1:1 system



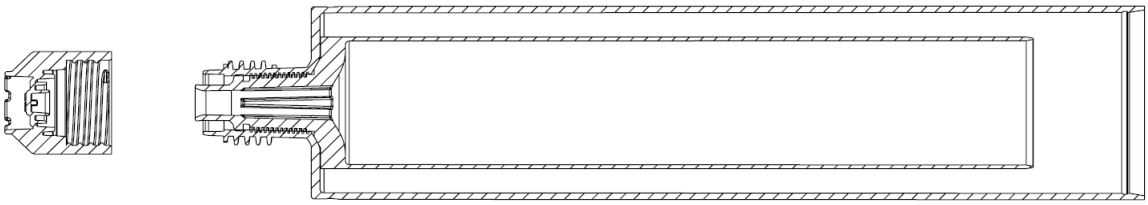
600 ml / 620 ml

3:1 system

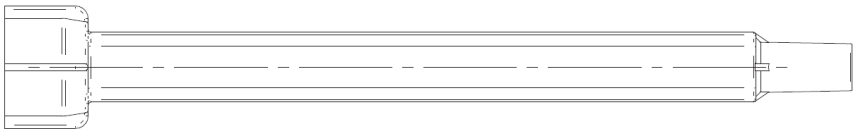


385 ml, 585 ml and 1400 ml

peeler cartridge



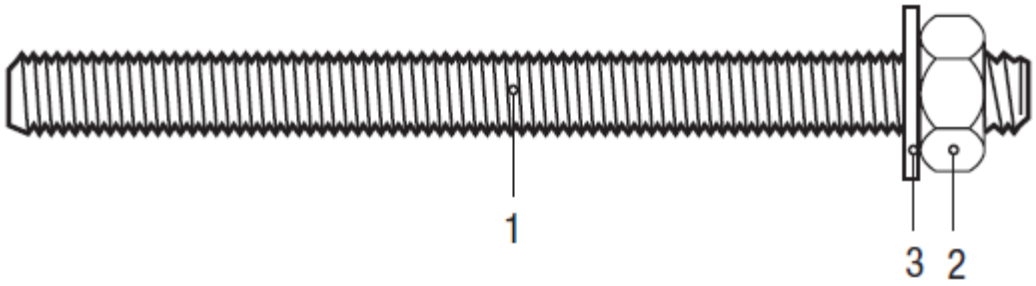
Static mixing nozzle:



Use category:
- Hammer-drilling
- Application in cracked concrete, option 1
- Installation in dry, wet concrete or flooded boreholes
- Overhead installation (provided a piston plug for sizes > M20)

Temperature range:
- 40°C to +40°C (max. short term temperature +40°C and max. long term temperature +24°C)
- 40°C to +60°C (max. short term temperature +60°C and max. long term temperature +43°C)
- 40°C to +72°C (max. short term temperature +72°C and max. long term temperature +43°C)
- 40°C to +80°C (max. short term temperature +80°C and max. long term temperature +43°C)

Table 1: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 5.8, 8.8, EN ISO 898-1:1999
2	Hexagon nut, EN ISO 4032	Property class 5 (for class 5.8 rod) EN ISO 898-2, Property class 8 (for class 8.8 rod) EN ISO898-2
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Steel, zinc plated
Stainless steel		
1	Anchor rod	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005, >M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4401 / 1.4404 / 1.4571 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4401 /1.4404 / 1.4571, EN 10088
High corrosion resistance steel		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088

Commercial standard rod with:
- Materials, dimensions and mechanical properties (Table 1a)
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

Table 2: Materials (Rebar)

Abstract of EN 1992-1-1 Annex C, Table C.1, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Characteristic yield strength f_{yk} or $f_{0,2k}$ [N/mm²]		400 to 600	
Minimum value of $k = (f_t / f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} [%]		≥ 5,0	≥ 7,5
Bendability		Bend/Rebend test	
Maximum deviation from nominal mass (individual bar) [%]	Nominal bar size [mm] ≤ 8 > 8	± 6,0 ± 4,5	

Abstract of EN 1992-1-1 Annex C, Table C.2N, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Min. value of related rib area $f_{R,min}$	nominal diameter of the rebar [mm] : 8 to 12 > 12	0,040 0,056	

Rib height of the bar shall be in the range $0,05d \le h \le 0,07d$
(d: Nominal diameter of the bar; h: Rib height of the bar)

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads,
- Seismic action for category C1.

Base materials:

- Cracked concrete and non-cracked concrete
- Reinforced or unreinforced normal weight concrete of strength classes C 20/25 at least to C50/60 at most according to ENV 206: 2000-12.

Use conditions (Environmental conditions):

- The threaded rods made of zinc plated or galvanized carbon steel may only be used in concrete subject to dry internal conditions.
- The threaded rods made of stainless steel A4 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure (including industrial and marine environment), or exposure in permanently damp internal conditions, if no particular aggressive conditions exist.
- The threaded rods made of high corrosion resistant stainless steel (HCR) may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions.
- All bond elements may be installed in dry or wet concrete as well as flooded holes (no sea water) for all diameters.

Design:

- The anchorages are designed in accordance with the EOTA Technical Report TR 029 and CEN/TS 1992-4.
- For seismic applications the anchorages are designed in accordance with TR045 “Design of Metal Anchors For Use In Concrete Under Seismic Actions”.
- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings.

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor.
- Anchor installation in accordance with the manufacturer’s specifications and drawings and using the appropriate tools.
- Effective anchorage depth, edge distances and spacing not less than the specified values without minus tolerances.
- Hole drilling by hammer drill.
- Clean the hole in accordance with Annex B3; before brushing clean the brush and checking whether the brush diameter according to Annex B4 and B5 is sufficient. The brush shall produce natural resistance as it enters the anchor hole. If this is not the case a new brush or a brush with a larger diameter must be used;

- For overhead installation piston plugs shall be used, embedded metal parts shall be fixed during the curing time, e.g. with wedges, Overhead installation is permitted for all sizes (the piston plug is needed for drill diameter > 24mm);
- For injection of the mortar in bore holes > 190 mm, extension nozzle shall be used;
- Mortar injection by using the equipment including the special mixing nozzle shown in Annex A2; discarding the first portion of mortar of each new cartridge until a homogeneous colour is achieved; taking from the manufacturer instruction the admissible processing time (open time) of a cartridge as a function of the ambient temperature of the concrete; filling the drill hole uniformly from the drill hole bottom, in order to avoid entrapment of air; removing the special mixing nozzle slowly bit by bit during pressing-out; filling the drill hole with a quantity of the injection mortar corresponding to 2/3 of the drill hole; inserting immediately the threaded rod, slowly and with a slight twisting motion, removing excess of injection mortar around the rod; observing the curing time according to Annex B4 Table 5 until the rod may be loaded; during curing of the injection mortar the temperature of the concrete must not fall below 5°C;
- Application of the torque moment given in Annex B3 Table 3 using a calibrated torque wrench.
- In case of aborted drill hole: the drill hole shall be filled with mortar.

Note:

Rebars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 only. The basic assumptions for the design according to anchor theory shall be observed. This includes the consideration of tension and shear loads and the corresponding failure modes as well as the assumption that the base material (concrete structural element) remains essentially in the serviceability limit state (either uncracked or cracked) when the connection is loaded to failure. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the rebars act as dowels to take up shear forces. Connections with reinforcing bars in concrete structures designed in accordance with EN1992-1-1: 2004 (e.g. connection of a wall loaded with tension forces in one layer of the reinforcement with the foundation) are not covered by this European technical assessment.

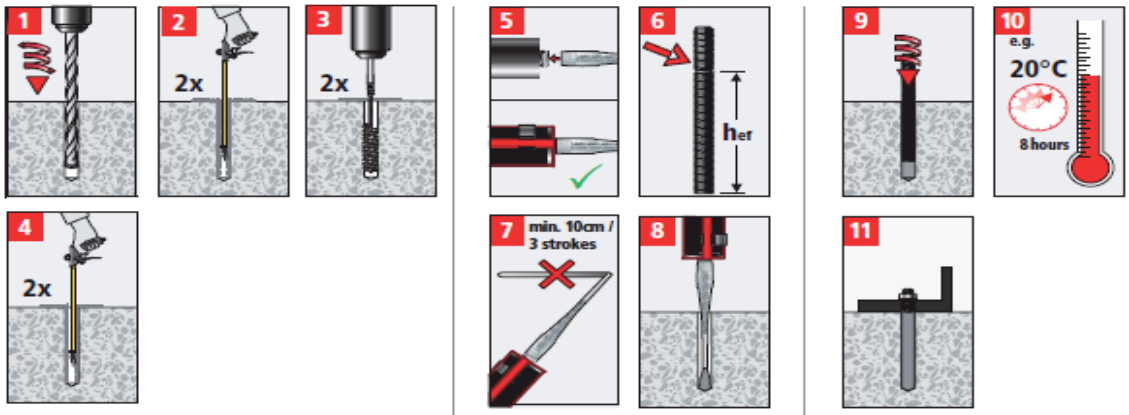
Table 3: Installation parameters for threaded rod

Anchor size		**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Nominal drill hole diameter	d_0 [mm] =	12	14	18	24	28	32	35
Embedment depth and bore hole depth	$h_{ef,min}$ [mm] =	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm] =	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d_f [mm] ≤	12	14	18	22	26	30	33
Diameter of steel brush	d_b [mm] ≥	14	16	20	26	30	34	37
Torque moment	T_{inst} [Nm]	20	40	80	120	160	180	200
Thickness of fixture	$t_{fix,min}$ [mm] >	0						
	$t_{fix,max}$ [mm] <	500						
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$				
Minimum spacing	s_{min} [mm]	50	60	80	100	120	135	150
Minimum edge distance	c_{min} [mm]	50	60	80	100	120	135	150

Table 4: Installation parameters for reinforcing bar

Rebar size		**∅ 10**	**∅ 12**	**∅ 14**	**∅ 16**	**∅ 20**	**∅ 25**	**∅ 28**	**∅ 32**
Nominal drill hole diameter	d_0 [mm] =	14	16	18	20	24	32	35	37
Embedment depth and bore hole depth	$h_{ef,min}$ [mm] =	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm] =	200	240	280	320	400	500	560	640
Diameter of steel brush	d_b [mm] ≥	16	18	20	22	26	34	37	40
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm≥ 100 mm	$h_{ef} + 2d_0$						
Minimum spacing	s_{min} [mm]	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	50	60	70	80	100	125	140	160

Installation instruction



1 Drill a hole to the size and embedment required. Water must be removed prior to cleaning.

2 Starting from the rear of the hole, blow the hole clean with compressed air at least two times.If the rear of the drill hole cannot be reached an extension must be used.

3 Brush the hole with an appropriate sized wirebrush a minimum of two times. If the rear of the drill hole cannot be reached by brush an extension must be used.

4 Please repeat procedure two.

5 Attach a supplied static mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended gel time, as well as for newcartridges, a new static-mixer must be used.

6 Prior to inserting the threaded rod into the filled hole, the position of the embedment depth must be marked on the anchor rods or rebar. Insert marked rebar/rod into unfilled hole to check if embedment is reached.

7 Prior to dispensing into the anchor hole, squeeze out either 3 strokes or 1 stroke with a minimum of 10cm until the mortar shows a consistent colour.

8 Fill the cleaned hole approximately two-thirds with adhesive starting from the rear of the hole. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets.For embedments larger than 190 mm an extension-nozzle must be used. For overhead and horizontal installation with an anchor diameter larger than 20 mm, use a piston plug and extension nozzle. Observe gel-working times.

9 Push the threaded rod or reinforcing bar into the hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The rod or rebar should be free of dirt, grease, oil or other foreign material. For overhead installation use wedges to secure the threaded rod from sliding out of the hole.

10 Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured.

11 After full curing, the fixture can be installed. Make sure the max. torque is not exceeded. Ensure that the anchor is fully seated at the bottom of the hole (in case the threaded rod is not marked) and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed.

Table 5: Minimum curing time

Concrete temperature	Gelling-working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
≥ + 5 °C[1)]	90 min	72 h	144 h
≥ + 10 °C	90 min	24 h	48 h
≥ + 20 °C	25 min	8 h	16 h
≥ + 30 °C	20 min	8 h	16 h
≥ + 40 °C	12 min	4 h	8 h

[1)] Cartridge temperature > 20°C.

DeWalt PURE110-PRO Injection resin with anchor rod for concrete

Assembly instructions

Annex B4

Steel brush and extension

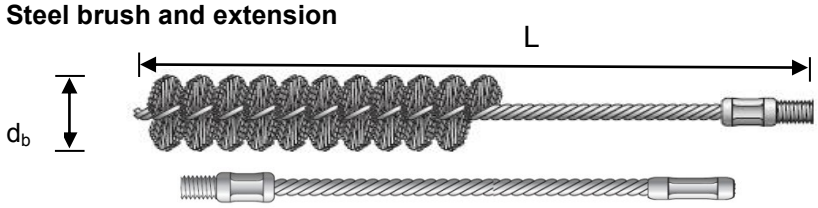


Table 6: Parameter cleaning and setting tools

Threaded rod [mm]	Rebar [mm]	Drill bit Ø d_0 [mm]	Brush diameters nominal d_b [mm]	Brush diameters minimum $d_{b,min}$ [mm]	Total length L [mm]	Piston plug denom. (Ø) [mm]
M10		12	14	12,5	170	-
M12	10	14	16	14,5	200	-
	12	16	18	16,5	200	-
M16	14	18	20	18,5	300	-
	16	20	22	20,5	300	-
M20	20	24	26	24,5	300	#24 (22)
M24		28	30	28,5	300	#28 (27)
M27	25	32	34	32,5	300	#28 (29)
M30	28	35	37	35,5	300	#35 (34)
	32	37	40	37,5	300	#35 (36)

Rec. compressed air tool (min 6 bar)
Drill bit diameter (d_0): 12 mm to 37 mm

Piston plug for overhead or horizontal installation
Drill bit diameter (d_0): 24 mm to 37 mm

Table 7: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. TR 029 in uncracked concrete

Anchor size threaded rod				**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure										
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	46	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50						
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	41	59	110	171	247	230	280
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87					2,86	
Combined pullout and concrete cone failure										
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25										
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,ucr}$ [N/mm²]		12	12	11	11	10	10	10
Temperature range II: 60°C/43°C				12	12	11	11	10	10	10
Temperature range III: 72°C/43°C				12	11	11	10	10	9,5	9,5
Temperature range IV: 80°C/43°C				9	9	8,5	8	8	8	7,5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8 [2]						
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8 [2]						
Increasing factors for concrete ψ_c		C30/37		1,10						
		C40/50		1,18						
		C50/60		1,23						
Splitting failure										
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$						
		$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$						
		$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$						
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8 [2]						
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		1,8 [2]						

[1] In absence of other national regulations
[2] The value contains an installation safety factor γ_2= 1.2

Table 8: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. TR 029 in cracked concrete

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure									
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,50						
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	41	59	110	171	247	230	280
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,87					2,86	
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,cr}$ [N/mm²]	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range II: 60°C/43°C			7	7	6,5	6,5	6,5	6,5	6,5
Temperature range III: 72°C/43°C			7	6,5	6,5	6,5	6,5	6,5	6,5
Temperature range IV: 80°C/43°C			5,5	5,5	5	5	5	5	5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]						
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]						
Increasing factors for concrete ψ_c	C30/37		1,10						
	C40/50		1,18						
	C50/60		1,23						
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$						
	$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$						
	$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)	γ_{Msp} [1)]		1,9 [2)]						
Partial safety factor (flooded bore hole)	γ_{Msp} [1)]		1,9 [2)]						

[1)] In absence of other national regulations
[2)] The value contains an installation safety factor γ_2= 1.2

Table 9: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. TR 029 in uncracked and cracked concrete

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure without lever arm									
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25						
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56					2,38	
Steel failure with lever arm									
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25						
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56					2,38	
Concrete pry out failure									
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0						
Partial safety factor	γ_{Mcp} [1)]		1,50 [2)]						
Concrete edge failure									
See chapter 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors									
Partial safety factor	γ_{Mc} [1)]		1,50 [2)]						

[1)] In absence of other national regulations

[2)] The value contains a partial safety factor γ_2= 1.0

Table 10: Displacements for tension loads [1)]

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Temperature range 40°C/24°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 40°C/24°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

Table 11: Displacements for shear loads [2)]

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Temperature range 40°C/24°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,050	0,050	0,050
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,050	0,050	0,050
Temperature range 40°C/24°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,181	0,148	0,115	0,090	0,065
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,272	0,222	0,172	0,135	0,097
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,181	0,148	0,115	0,090	0,065
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,272	0,222	0,172	0,135	0,097

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

DeWalt PURE110-PRO Injection resin with anchor rod for concrete

Design according to TR 029 Design method A:
Application with threaded rod
Displacements

Annex C4

Table 12: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. TR 029 in uncracked concrete

Anchor size reinforcing bar			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø28**	**Ø32**
Steel failure										
Characteristic tension resistance, B 500 B acc. to DIN 488-2:2009	$N_{Rk,s}$	[kN]	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,4							
Combined pullout and concrete cone failure										
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25										
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,cr}$ [N/mm²]	12	12	11	11	11	10	10	9,5
Temperature range II: 60°C/43°C			12	12	11	11	11	10	10	9,5
Temperature range III: 72°C/43°C			12	11	11	11	10	10	9,5	9,5
Temperature range IV: 80°C/43°C			9	9	9	8,5	8	8	8	7,5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]							
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]							
Increasing factors for concrete ψ_c	C30/37		1,10							
	C40/50		1,18							
	C50/60		1,23							
Splitting failure										
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$							
	$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
	$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	γ_{Msp} [1)]		1,8 [2)]							
Partial safety factor (flooded bore hole)	γ_{Msp} [1)]		1,8 [2)]							

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1,2$ is included.

Regarding design of post-installed rebar as anchor see annex B1 and B2.

Table 13: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. TR 029 in cracked concrete

Anchor size reinforcing bar			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø28**	**Ø32**
Steel failure (Properties acc. to Annex 4)										
Characteristic tension resistance, B 500 B acc. to DIN 488-2:2009	$N_{Rk,s}$	[kN]	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,4							
Combined pullout and concrete cone failure										
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25										
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,cr}$ [N/mm²]	7	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range II: 60°C/43°C			7	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range III: 72°C/43°C			7	6,5	6,5	6	6	6	6	6
Temperature range IV: 80°C/43°C			5,5	5,5	5,5	5	5	5	5	5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]							
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]							
Increasing factors for concrete ψ_c	C30/37		1,10							
	C40/50		1,18							
	C50/60		1,23							
Splitting failure										
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$							
	$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
	$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	γ_{Msp} [1)]		1,9 [2)]							
Partial safety factor (flooded bore hole)	γ_{Msp} [1)]		1,9 [2)]							

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1,2$ is included.

Table 14: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. TR 029 in uncracked and cracked concrete

Anchor size reinforcing bar			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure without lever arm										
Characteristic shear resistance, B 500 B acc. to DIN 488-2: 2009 [3]	$V_{Rk,s}$	[kN]	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,5							
Steel failure with lever arm										
Characteristic shear resistance, B 500 B acc. to DIN 488-2: 2009 [4]	$M^0_{Rk,s}$	[Nm]	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ [1]		1,5							
Concrete pry out failure										
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0							
Partial safety factor	γ_{Mcp} [1]		1,50 [2]							
Concrete edge failure										
See chapter 5.2.3.4 of Technical Report TR 029 for the design of bonded anchors										
Partial safety factor	γ_{Mc} [1]		1,50 [2]							

[1] In absence of other national regulations

[2] The partial safety factor $\gamma_2 = 1,0$ is included.

[3] For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $V_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.5).

[4] For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $M^0_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.6b).

Regarding design of post-installed rebar as anchor see annex B1 and B2

Table 15: Displacements for tension loads [1)]

Anchor size threaded rod			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø28**	**Ø32**
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 16: Displacements for shear loads [2)]

Anchor size threaded rod			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø28**	**Ø32**
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,060	0,040	0,040	0,040
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,060	0,040	0,040	0,040
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,198	0,181	0,148	0,106	0,081	0,048
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,296	0,272	0,222	0,159	0,122	0,072
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,198	0,181	0,148	0,106	0,081	0,048
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,296	0,272	0,222	0,159	0,122	0,072

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 17: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in uncracked concrete

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure									
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,50						
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	41	59	110	171	247	230	280
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,87					2,86	
Combined pullout and concrete cone failure									
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,ucr}$ [N/mm²]	12	12	11	11	10	10	10
Temperature range II: 60°C/43°C			12	12	11	11	10	10	10
Temperature range III: 72°C/43°C			12	11	11	10	10	9,5	9,5
Temperature range IV: 80°C/43°C			9	9	8,5	8	8	8	7,5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]						
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]						
Increasing factors for concrete ψ_c	C30/37		1,10						
	C40/50		1,18						
	C50/60		1,23						
Factor ref. bond strength $\tau_{Rk,c}$ acc. eq(8) CEN/TS 1992-4-5	k_8		10,1						
Concrete cone failure									
Characteristic edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$						
Factor concrete cone equation	k_{ucr}		10,1						
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$						
	$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$						
	$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1)]		1,8 [2)]						
Partial safety factor (flooded bore hole)			1,8 [2)]						

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1,2$ is included.

Table 18: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in cracked concrete

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure									
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s}$	[kN]	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s}$	[kN]	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,50						
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s}$	[kN]	41	59	110	171	247	230	281
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,87				2,86		
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,cr}$ [N/mm²]	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range II: 60°C/43°C			7	7	6,5	6,5	6,5	6,5	6,5
Temperature range III: 72°C/43°C			7	6,5	6,5	6,5	6,5	6,5	6,5
Temperature range IV: 80°C/43°C			5,5	5,5	5	5	5	5	5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]						
Partial safety factor (flooded bore hole)			1,9 [2)]						
Increasing factors for concrete ψ_c	C30/37		1,10						
	C40/50		1,18						
	C50/60		1,23						
Factor ref. bond strength $\tau_{Rk,c}$ acc. eq(8) CEN/TS 1992-4-5	k_8		7,2						
Concrete cone failure									
Characteristic edge distance	$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$						
Factor concrete cone equation	k_{cr}		7,2						
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$						
	$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$						
	$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$						
Partial safety factor (dry and wet concrete)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1)]		1,9 [2)]						
Partial safety factor (flooded bore hole)			1,9 [2)]						

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1,2$ is included.

Table 19: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in uncracked and cracked concrete

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Steel failure without lever arm									
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25						
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56					2,38	
Steel failure with lever arm									
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25						
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56					2,38	
Factor bending	k_2		0,80						
Concrete pry out failure									
Factor k_3 according to CEN/TS 1992/4			2,0						
Partial safety factor	γ_{Mcp} [1)]		1,50 [2)]						
Concrete edge failure			**See CEN/TS 1992-4-5. Section 6.3.4**						
Partial safety factor	γ_{Mc} [1)]		1,50 [2)]						

[1)] In absence of other national regulations

[2)] The partial safety factor γ_2 = 1,0 is included.

Table 20: Displacements for tension loads [1)]

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Temperature range 40°C/24°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 40°C/24°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,097	0,118	0,139	0,155	0,171
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,097	0,118	0,139	0,155	0,171

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 21: Displacements for shear loads [2)]

Anchor size threaded rod			**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Temperature range 40°C/24°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,050	0,050	0,050
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,050	0,050	0,050
Temperature range 40°C/24°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,181	0,148	0,115	0,090	0,065
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,272	0,222	0,172	0,135	0,097
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25									
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,181	0,148	0,115	0,090	0,065
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,272	0,222	0,172	0,135	0,097

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 22: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in uncracked concrete

Anchor size reinforcing bar			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure **in bolt**										
Characteristic tension resistance, B 500 B acc. to DIN 488-2: 2009	$N_{Rk,s}$	[kN]	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,40							
Combined pullout and concrete cone failure										
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25										
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,ucr}$ [N/mm²]	12	12	11	11	11	10	10	9,5
Temperature range II: 60°C/43°C			12	12	11	11	11	10	10	9,5
Temperature range III: 72°C/43°C			12	11	11	11	10	10	9,5	9,5
Temperature range IV: 80°C/43°C			9	9	9	8,5	8	8	8	7,5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]							
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]							
Increasing factors for concrete ψ_c	C30/37		1,10							
	C40/50		1,18							
	C50/60		1,23							
Factor ref. bond strength $\tau_{Rk,c}$ acc. eq(8) CEN/TS 1992-4-5	k_8		10,1							
Concrete cone failure **in bolt**										
Characteristic edge distance	$c_{cr,N}$	[mm]	$1{,}5 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$							
Factor concrete cone equation	k_{cr}		10,1							
Splitting failure **in bolt**										
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$							
	$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
	$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$							
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)	$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1)]		1,8 [2)]							
Partial safety factor (flooded bore hole)			1,8 [2)]							

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1{,}2$ is included.

Regarding design of post-installed rebar as anchor see annex B1 and B2

Table 23: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in cracked concrete

Anchor size reinforcing bar				**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure											
Characteristic tension resistance, B 500 B acc. to DIN 488-2: 2009		$N_{Rk,s}$	[kN]	43	62	85	111	173	270	339	442
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,40							
Combined pullout and concrete cone failure											
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete and flooded bore hole	$\tau_{Rk,ucr}$ [N/mm²]		7	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range II: 60°C/43°C				7	7	7	6,5	6,5	6,5	6,5	6,5
Temperature range III: 72°C/43°C				7	6,5	6,5	6	6	6	6	6
Temperature range IV: 80°C/43°C				5,5	5,5	5,5	5	5	5	5	5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]							
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,9 [2)]							
Increasing factors for concrete ψ_c		C30/37		1,10							
		C40/50		1,18							
		C50/60		1,23							
Factor ref. bond strength $\tau_{Rk,c}$ acc. eq(8) CEN/TS 1992-4-5		k_8		7,2							
Concrete cone failure											
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,N}$	[mm]	$2 \cdot c_{cr,N}$							
Factor concrete cone equation		k_{cr}		7,2							
Splitting failure											
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$							
		$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
		$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \circ c_{cr,sp}$							
Partial safety factor (dry and wet concrete)		$\gamma_{Mc} = \gamma_{Mp} = \gamma_{Msp}$ [1)]		1,9 [2)]							
Partial safety factor (flooded bore hole)				1,9 [2)]							

[1)] In absence of other national regulations

[2)] The partial safety factor $\gamma_2 = 1,2$ is included.

Regarding design of post-installed rebar as anchor see annex B1 and B2

Table 24: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. CEN/TS1992-4 in uncracked and cracked concrete

Anchor size reinforcing bar			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure without lever arm										
Characteristic shear resistance, B 500 B acc. to DIN 488-2: 2009	$V_{Rk,s}$	[kN]	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,5							
Steel failure with lever arm										
Characteristic shear resistance, B 500 B acc. to DIN 488-2: 2009	$M^0_{Rk,s}$	[Nm]	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,5							
Factor bending	k_2		0,80							
Concrete pry out failure										
Factor k_3 according to CEN/TS 1992-4			2,0							
Partial safety factor	γ_{Mcp} [1)]		1,50 [2)]							
Concrete edge failure			**See CEN/TS 1992-4-5. Section 6.3.4**							
Partial safety factor	γ_{Mc} [1)]		1,50 [2)]							

[1)] In absence of other national regulations

[2)] The partial safety factor γ_2 = 1,0 is included.

Regarding design of post-installed rebar as anchor see annex B1 and B2

Table 25: Displacements for tension loads [1)]

Anchor size threaded rod			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,040	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181
Temperature range 80°C/43°C, 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,076	0,087	0,097	0,118	0,144	0,160	0,181
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,086	0,086	0,087	0,097	0,118	0,144	0,160	0,181

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 26: Displacements for shear loads [2)]

Anchor size threaded rod			**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,060	0,040	0,040	0,040
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,060	0,050	0,040	0,040	0,040	0,030	0,030	0,030
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,090	0,080	0,060	0,060	0,060	0,040	0,040	0,040
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,198	0,181	0,148	0,106	0,081	0,048
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,296	0,272	0,222	0,159	0,122	0,072
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,231	0,214	0,198	0,181	0,148	0,106	0,081	0,048
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,346	0,321	0,296	0,272	0,222	0,159	0,122	0,072

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Seismic design according to Technical Report 045 "Design of Metal Anchors under Seismic Action":
The recommended seismic performance categories are given in Table 27. The value of a_g or that of the product a_g•S used in a Member State to define thresholds for the seismicity classes may be found in its National Annex of EN 1998-1 and may be different to the values given in Table 27. Furthermore, the assignment of the seismic performance categories C1 and C2 to the seismicity level and building importance classes is in the responsibility of each individual Member State.

Table 27: Recommended seismic performance categories for Anchors

Seismicity level *		**Importance class according to EN 1998-1: 2004, 4.2.5**			
	$a_g \cdot S$ [2)]	I	II	III	IV
Very low [1)]	$a_g \cdot S \leq 0{,}05 \cdot g$	no additional requirement			
Low [1)]	$0{,}05 \cdot g < a_g \cdot S \leq 0{,}1 \cdot g$	C1	C1 [3)] or C2 [4)]		C2
	$a_g \cdot S > 0{,}1 \cdot g$	C1	C2		

* The values defining the seismicity levels may be found in the National Annex of EN 1988-1.

[1)] Definition according to EN 1998-1: 2004, 3.2.1

[2)] $a_g = \gamma_1 \cdot a_{gR}$ Design ground acceleration on type A ground (Ground types as defined in EN1998-1:2004, Table 3.1

with γ_1= Importance factor (see EN1998-1: 2004, 4.2.5)

a_{gR}= Reference peak ground acceleration on type A ground (see EN1998-1: 2004, 3.2.1)

S= Soil factor (e.g. according to EN1998-1: 2004, 4.2.5

[3)] C1 for fixing of non-structural elements to structures

[4)] C2 for fixing of structural elements to structures

Table 28: Reduction factors α_{gap} and α_{seis} for resistance under seismic actions

Loading	Failure modes	α_{gap}	α_{seis}- single fastener	α_{seis}- fastener group
Tension	Steel failure	1,0	1,0	1,0
	Combined pullout and concrete failure	1,0	1,0	0,85
	Concrete cone failure	1,0	0,85	0,75
	Splitting failure	1,0	1,0	0,85
Shear	Steel failure without lever arm	0,5[1)]	1,0	0,85
	Steel failure with lever arm	-[2)]	-[2)]	-[2)]
	Concrete edge failure	0,5[1)]	1,0	0,85
	Concrete pryout failure	0,5[1)]	0,85	0,75

1) The limitation for the size of the clearance hole is given in TR029 Table 4.1

α_{gap}= 1,0 in case of no clearance between fastener and fixture

Table 29: Characteristic values of resistance under tension and shear loads in case of seismic performance category C1 for design acc. to EOTA TR045

Anchor size threaded rod			**M10**	**M 12**	**M 16**	**M 20**	**M24**	**M 27**	**M 30**
Steel failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0						
Characteristic tension resistance, Steel, property class 5.8	$N_{Rk,s,seis}$	[kN]	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8	$N_{Rk,s,seis}$	[kN]	46	67	125	196	282	368	449
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,50						
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$N_{Rk,s,seis}$	[kN]	41	59	110	171	247	230	280
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,87					2,86	
Combined pullout and concrete cone failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,75	0,80					
Temperature range I: 40°C/24°C	$\tau_{Rk,p,seis}$	[N/mm²]	5.5	5.5	5.0	5.0	5.0	5.0	5.0
Temperature range II: 60°C/43°C			5.5	5.5	5.0	5.0	5.0	5.0	5.0
Temperature range III: 72°C/43°C			5.5	5.0	5.0	5.0	5.0	5.0	5.0
Temperature range IV: 80°C/43°C			4.0	4.5	4.0	4.0	4.0	4.0	4.0
Partial safety factor	$\gamma_{Mp,seis}$ [1)]		1,9 [2)]						
Shear loads									
Seismic reduction factor	$\alpha_{V,seis}$	[-]	0,70						
Steel failure without lever arm, Steel, property class 5.8	$V_{Rk,s,seis}$	[kN]	11	15	27	43	62	81	98
Steel failure without lever arm, Steel, property class 8.8	$V_{Rk,s,seis}$	[kN]	16	24	44	69	99	129	157
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,25						
Steel failure without lever arm, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s,seis}$	[kN]	14	21	39	60	87	81	98
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,56					2,38	

[1)] In absence of other national regulations.

[2)] The partial safety factor γ_2 = 1.2 is included.

The definition of seismic performance category C1 is given in Annex C17.

Table 30: Characteristic values of resistance under tension and shear loads in case of seismic performance category C1 for design acc. to EOTA TR045

Anchor size threaded rod			**Ø 10**	**Ø12**	**Ø14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
Steel failure										
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0							
Characteristic tension resistance, B 500 B acc. to DIN 488-2:2009	$N_{Rk,s,seis}$	[kN]	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,40							
Combined pullout and concrete cone failure										
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,75	0,80						
Temperature range I: 40°C/24°C	$\tau_{Rk,p,seis}$	[N/mm²]	5.5	5.5	5.5	5.0	5.0	5.0	5.0	5.0
Temperature range II: 60°C/43°C			5.5	5.5	5.5	5.0	5.0	5.0	5.0	5.0
Temperature range III: 72°C/43°C			5.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Temperature range IV: 80°C/43°C			4.0	4.5	4.5	4.0	4.0	4.0	4.0	4.0
Partial safety factor	$\gamma_{Mp,seis}$ [1)]		1,9 [2)]							
Shear loads										
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,70							
Steel failure without lever arm, Steel, property class 5.8	$V_{Rk,s,seis}$	[kN]	15	22	29	39	60	95	118	155
Partial safety factor	$\gamma_{Ms,seis}$ [1)]		1,50							

[1)] In absence of other national regulations.

[2)] The partial safety factor γ_2 = 1.2 is included.

The definition of seismic performance category C1 is given in Annex C19.