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

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European Technical Assessment

ETA-09/0317 of 18/07/2014

English translation prepared by CSTB - Original version in French language

General Part

Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011:

Nom commercial *Trade name*	**POWERS THROUGHBOLT PTB-ETA1-PRO**
Famille de produit *Product family*	**Cheville métallique à expansion par vissage à couple contrôlé, de fixation dans le béton fissuré : diamètres M8, M10, M12, M16 et M20** ***Torque-controlled expansion anchor for use in cracked concrete: sizes M8, M10, M12, M16 and M20***
Titulaire *Manufacturer*	Powers Fasteners Europe Stanley Black&Decker Deutschland GmbH European Anchor Development Center Black-&-Decker Str. 40 65510 Idstein Germany
Usine de fabrication e *Manufacturing plants*	Plant 1 & 2
Cette evaluation contient: *This Assessment contains*	18 pages incluant 15 annexes qui font partie intégrante de cette évaluation 18 *pages including 15 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 replaces*	ATE 09/0317 valide du 03/06/2013 au 03/06/2018 *ETA-09/0317 with validity from 03/06/2013 to 03/06/2018*

1 Technical description of the product

The Powers PTB-ETA1-PRO anchor is an anchor made of zinc electroplated steel which is placed into a drilled hole and anchored by torque-controlled expansion.

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 (ER 1)

Essential characteristic	Performance
Characteristic tension resistance acc. ETAG001, Annex C	See Annex C 1
Characteristic shear resistance acc. ETAG001, Annex C	See Annex C 2
Characteristic tension resistance acc. CEN/TS 1992-4	See Annex C 5
Characteristic shear resistance acc. CEN/TS 1992-4	See Annex C 6
Characteristic resistance under seismic action Cat. 1 acc. TR045	See Annex C 9
Characteristic resistance under seismic action Cat. 2 acc. TR045	See Annex C 10
Displacements	See Annex C 11

3.2 Safety in case of fire (ER 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Characteristic tension resistance under fire acc. ETAG001, Annex C	See Annex C 3
Characteristic shear resistance under fire acc. ETAG001, Annex C	See Annex C 4
Characteristic tension resistance under fire acc. CEN/TS 1992-4	See Annex C 7
Characteristic shear resistance under fire acc. CEN/TS 1992-4	See Annex C 8

3.3 Hygiene, health and the environment (ER 3)

Regarding dangerous substances contained in this European technical approval, 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 (ER 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 (ER 5)

Not relevant.

3.6 Energy economy and heat retention (ER 6)

Not relevant.

3.7 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B1 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.

Issued in Marne La Vallée on 18-07-2014 by

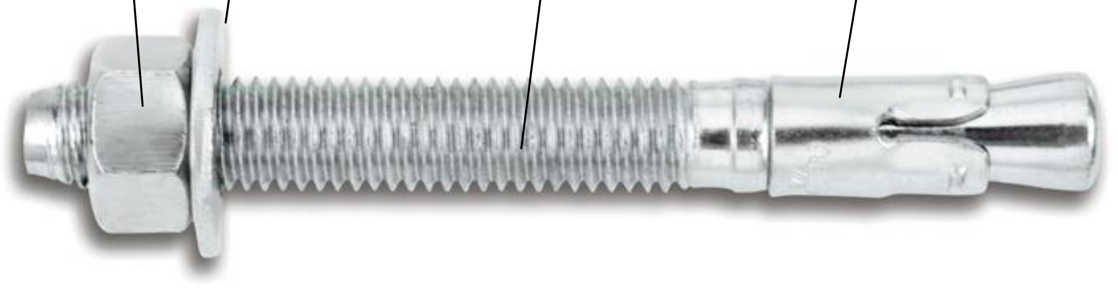
Charles Baloche

Directeur technique

The original French version is signed

1 Official Journal of the European Communities L 254 of 08.10.1996

Hex head version:

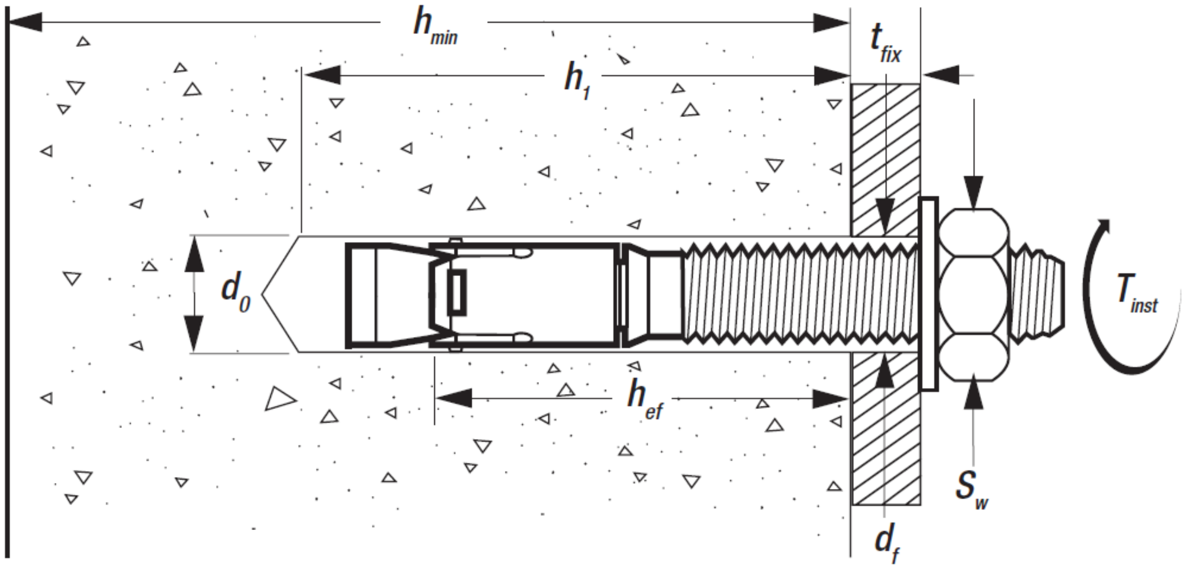


Marking: on the bolt, PTB1 (product name)

followed by X / Y where

X = nominal diameter,
Y = total length of the anchor

Anchor in use:



POWERS THROUGHBOLT PTB-ETA1-PRO	**Annex A1**
Product description Installation condition	

Different parts of the anchor:

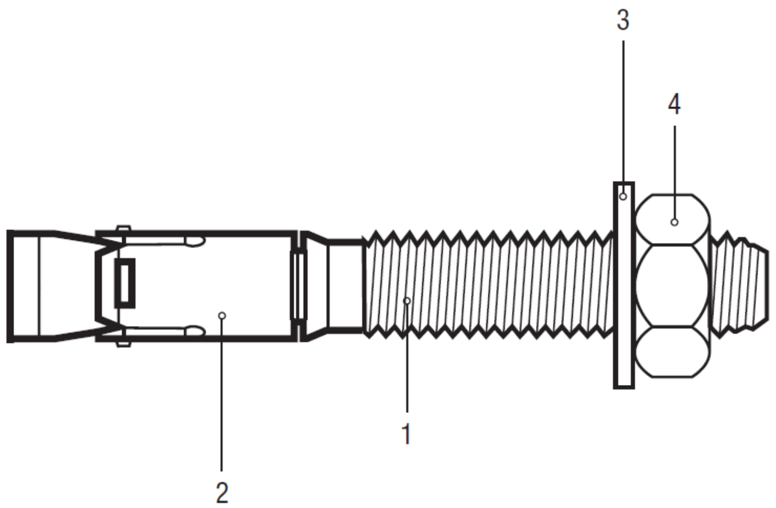


Table 1: Materials

Part	Designation	Material	Protection
1	Bolt M8 to M20	Coldformed steel, grade C-1035	Zinc plated 5 µm
2	Expansion clip	M8 SS430	-
		M10 to M20 Carbon steel	Zinc plated
3	Washer	DIN 125 or EN ISO 7089	Zinc plated
		DIN 9021 or DIN EN ISO 7093	Zinc plated
4	Hexagonal nut	DIN 934 or DIN EN ISO 4032, Grade 8 acc. to DIN EN ISO 20898-2	Zinc plated

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads.
- Seismic loads (category C1 for M8 to M16, category C2 for M12).
- Fire.

Base materials:

- Cracked concrete and non-cracked concrete.
- Reinforced or unreinforced normal weight concrete of strength classes C20/25 at least to C50/60 at most according to ENV 206: 2000-12.

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions.

Design:

- The anchorages are designed in accordance with the ETAG001 Annex C “Design Method for Anchorages” or CEN/TS 1992-4-4 " Design of fastenings for use in concrete” under the responsibility of an engineer experienced in anchorages and concrete work.
- For seismic application the anchorages are designed in accordance with TR045 “Design of Metal Anchors For Use In Concrete Under Seismic Actions”.
- For application with resistance under fire exposure the anchorages are designed in accordance with method given in TR020 “Evaluation of Anchorage in Concrete concerning Resistance to Fire”.
- 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.
- Cleaning of the hole of drilling dust.
- Application of specified torque moment using a calibrated torque wrench.
- In case of aborted hole, drilling of new hole at a minimum distance of twice the depth of the aborted hole, or smaller distance provided the aborted drill hole is filled with high strength mortar and no shear or oblique tension loads in the direction of aborted hole.

Table 2: Anchor dimensions

				PTB-ETA1-PRO				
				M8	M10	M12	M16	M20
Length cone bolt	Minimum	L	[mm]	60	80	85	115	155
	Maximum		[mm]	240	220	220	220	220
Fixture thickness	Minimum	t_{fix}	[mm]	1	1	1	1	1
	Maximum		[mm]	185	140	125	110	65
Diameter cone neck		d_{neck}	[mm]	5,5	7,3	8,7	11,7	14,6
Length expansion clip		l_{clip}	[mm]	14	18	22	26	30
Width torque wrench		SW	[mm]	13	17	19	24	30

Table 3: Installation data

			PTB-ETA1-PRO				
			M8	M10	M12	M16	M20
Drill hole diameter	d_{cut}	[mm]	≤ 8,45	≤ 10,45	≤ 12,5	≤ 16,5	≤ 20,5
Drill hole depth for $h_{ef,min}$	$h_{1,min}$	[mm]	55	75	75	100	150
Drill hole depth for $h_{ef,max}$	$h_{1,max}$	[mm]	-	-	95	120	-
Minimum embedment depth	$h_{ef,min}$	[mm]	40	60	60	80	110
Maximum embedment depth	$h_{ef,max}$	[mm]	-	-	80	100	-
Installation torque	T_{inst}	[Nm]	25	45	70	120	200
Diameter through hole fixture	d_f	[mm]	9	12	14	18	22
Min. member thickness $h_{ef,min}$	$h_{min,1}$	[mm]	100	120	120	160	250
Min. member thickness $h_{ef,max}$	$h_{min,2}$	[mm]	-	-	160	200	-
Minimum edge distance	c_{min}	[mm]	55	60	65	85	95
Corresponding spacing	for s ≥	[mm]	120	150	190	160	240
Minimum spacing	s_{min}	[mm]	50	55	60	70	95
Corresponding edge distance	for c ≥	[mm]	90	90	100	130	240

Table 4: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. ETAG001, Annex C

				PTB-ETA1-PRO				
				M8	**M10**	**M12**	**M16**	**M20**
Steel failure								
Characteristic resistance		$N_{Rk,s}$	[kN]	22	31	43	79	95
Partial safety factor		γ_{Ms} [1)]	[-]	1,5				
Pullout failure								
Characteristic resistance in cracked concrete C20/25								
Minimum embedment depth		$N_{Rk,p}$	[kN]	4	9	12	25	20
Maximum embedment depth		$N_{Rk,p}$	[kN]	-	-	12	25	-
Partial safety factor for cracked concrete		γ_{Mp} [1)]	[-]	1,8 [2)]				
Characteristic resistance in non-cracked concrete C20/25								
Minimum embedment depth		$N_{Rk,p}$	[kN]	7,5	16	- [4)]	30	50
Maximum embedment depth		$N_{Rk,p}$	[kN]	-	-	30	- [4)]	-
Partial safety factor for non-cracked concrete		γ_{Mp} [1)]	[-]	1,5 [3)]				1,8 [2)]
Increasing factor N_{RK} for	concrete C30/37	Ψ_c	[-]	1,22				
	concrete C40/50		[-]	1,41				
	concrete C50/60		[-]	1,55				
Concrete cone failure and splitting failure								
Effective embedment depth	*Minimum*	$h_{ef,min}$	[mm]	40	60	60	80	110
	Maximum	$h_{ef,max}$	[mm]	-	-	80	100	-
Partial safety factor in	cracked concrete	$\gamma_{Mc} = \gamma_{Msp}$ [1)]	[-]	1,8 [2)]				
	non-cracked concrete			1,5 [3)]				1,8 [2)]
Increasing factor N_{RK} for	concrete C30/37	Ψ_c	[-]	1,22				
	concrete C40/50		[-]	1,41				
	concrete C50/60		[-]	1,55				
Characteristic spacing for failure by	concrete cone *($h_{ef,min}$)*	$s_{cr,N,min}$	[mm]	120	180	180	240	330
	concrete cone ***($h_{ef,max}$)***	$s_{cr,N,max}$	[mm]	-	-	240	300	-
	splitting *($h_{ef,min}$)*	$s_{cr,sp,min}$	[mm]	200	300	300	400	550
	splitting ***($h_{ef,max}$)***	$s_{cr,sp,max}$	[mm]	-	-	400	500	-
Characteristic edge distance for failure by	concrete cone *($h_{ef,min}$)*	$c_{cr,N,min}$	[mm]	60	90	90	120	165
	concrete cone ***($h_{ef,max}$)***	$c_{cr,N,max}$	[mm]	-	-	120	150	-
	splitting *($h_{ef,min}$)*	$c_{cr,sp,min}$	[mm]	100	150	150	200	275
	splitting ***($h_{ef,max}$)***	$c_{cr,sp,max}$	[mm]	-	-	200	250	-

1) In absence of other national regulations

2) The value contains an installation safety factor $\gamma_2 = 1,2$

3) The value contains an installation safety factor $\gamma_2 = 1,0$

4) Pullout failure not decisive. Use Equation acc. to ETAG 001, Annex C, for concrete cone failure.

Table 5: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. ETAG001, Annex C

			PTB-ETA1-PRO				
			M8	**M10**	**M12**	**M16**	**M20**
Steel failure without lever arm							
Characteristic resistance	$V_{Rk,s}$	[kN]	10	15,5	21	37	54
Partial safety factor	γ_{Ms} 1)	[-]	1,25				
Steel failure with lever arm							
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	23	45	77	194	380
Partial safety factor	γ_{Ms} 1)	[-]	1,25				
Concrete pry-out failure							
Factor in Eq. (5.6) of ETAG Annex C, § 5.2.3.3	k	[-]	1	2	2	2	2
Partial safety factor	γ_{Mc} 1)	[-]	1,5				
Concrete edge failure							
Effective length under shear loading *($h_{ef,min}$)*	$l_{f,min}$	[mm]	40	60	60	80	110
Effective length under shear loading ***($h_{ef,max}$)***	$l_{f,max}$	[mm]	-	-	80	100	-
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20
Partial safety factor	γ_{Mc} 1)	[-]	1,5				

1) In absence of other national regulations

Table 6: Characteristic tension resistance in cracked and non-cracked concrete under fire exposure [1] for design method A acc. ETAG001, Annex C

			PTB-ETA1-PRO				
			M8	**M10**	**M12**	**M16**	**M20**
Steel failure							
Characteristic resistance	R30 $N_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1	4,9
	R60 $N_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4	3,7
	R90 $N_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0	3,.2
	R120 $N_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6	2,5
Pullout failure (cracked and non-cracked concrete)							
Characteristic resistance in concrete ≥ C20/25							
Minimum embedment depth	R30 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
	R60 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
	R90 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
	R120 $N_{Rk,p,fi}$	[kN]	0,8	1,8	2,4	5	4,0
Maximum embedment depth	R30 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
	R60 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
	R90 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
	R120 $N_{Rk,p,fi}$	[kN]	-	-	2,4	5	-
Concrete cone and splitting failure [2] (cracked and uncracked concrete)							
Characteristic resistance in concrete ≥ C20/25							
Minimum embedment depth	R30 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
	R60 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
	R90 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
	R120 $N^0_{Rk,c,fi}$	[kN]	1,5	4	2,4	8,2	18,3
Maximum embedment depth	R30 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
	R60 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
	R90 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
	R120 $N^0_{Rk,c,fi}$	[kN]	-	-	8,2	14,4	-
Characteristic spacing for ($h_{ef,min}$)	$s_{cr,N,min,fi}$	[mm]	160	240	240	320	440
Characteristic spacing for (**$h_{ef,max}$**)	$s_{cr,N,max,fi}$	[mm]	-	-	320	400	-
Characteristic edge distance for ($h_{ef,min}$)	$c_{cr,N,min,fi}$	[mm]	80	120	120	160	220
Characteristic edge distance for (**$h_{ef,max}$**)	$c_{cr,N,max,fi}$	[mm]	-	-	160	200	-

[1] Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.1. TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

[2] As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed.

Table 7: Characteristic shear resistance in cracked and non-cracked concrete under fire exposure [1)] for design method A acc. ETAG001, Annex C

			PTB-ETA1-PRO				
			M8	M10	M12	M16	M20
Steel failure without lever arm							
Characteristic resistance	R30 $V_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1	4,9
	R60 $V_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4	3,7
	R90 $V_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0	3,2
	R120 $V_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6	2,5
Steel failure with lever arm							
Characteristic bending resistance	R30 $M^0_{Rk,s,fi}$	[Nm]	0,37	1,1	2,6	6,7	13,0
	R60 $M^0_{Rk,s,fi}$	[Nm]	0,34	1,0	2,0	5,0	9,7
	R90 $M^0_{Rk,s,fi}$	[Nm]	0,26	0,7	1,7	4,3	8,4
	R120 $M^0_{Rk,s,fi}$	[Nm]	0,19	0,6	1,3	3,3	6,5
Concrete pry-out failure							
Factor in equation (5.6) of ETAG Annex C, § 5.2.3.3	k	[-]	1	2	2	2	2
Characteristic resistance for $h_{ef,min}$	R30 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
	R60 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
	R90 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
	R120 $V_{Rk,cp,fi}$	[kN]	1,5	8	8	16,5	36,6
Characteristic resistance for $h_{ef,max}$	R30 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
	R60 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
	R90 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
	R120 $V_{Rk,cp,fi}$	[kN]	-	-	16,5	28,8	-
Concrete edge failure							
Effective length under shear loading ($h_{ef,min}$)	$l_{f,min}$	[mm]	40	60	60	80	110
Effective length under shear loading ($h_{ef,max}$)	$l_{f,max}$	[mm]	-	-	80	100	-
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20

1) Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.2.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

Table 8: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS 1992-4

				PTB-ETA1-PRO				
				M8	**M10**	**M12**	**M16**	**M20**
Steel failure								
Characteristic resistance		$N_{Rk,s}$	[kN]	22	31	43	79	95
Partial safety factor		γ_{Ms} 1)	[-]	1,5				
Pullout failure								
Characteristic resistance in cracked concrete C20/25								
Minimum embedment depth		$N_{Rk,p}$	[kN]	4	9	12	25	20
Maximum embedment depth		$N_{Rk,p}$	[kN]	-	-	12	25	-
Partial safety factor cracked concrete		γ_{Mp} 1)	[-]	1,8 2)				
Characteristic resistance in non-cracked concrete C20/25								
Minimum embedment depth		$N_{Rk,p}$	[kN]	7,5	16	- 4)	30	50
Maximum embedment depth		$N_{Rk,p}$	[kN]	-	-	30	- 4)	-
Partial safety factor non-cracked concrete		γ_{Mp} 1)	[-]	1,5 3)				1,8 2)
Increasing factor N_{RK} for	concrete C30/37	Ψ_c	[-]	1,22				
	concrete C40/50		[-]	1,41				
	concrete C50/60		[-]	1,55				
Concrete cone failure and splitting failure								
Effective embedment depth	*Minimum*	$h_{ef,min}$	[mm]	40	60	60	80	110
	Maximum	$h_{ef,max}$	[mm]	-	-	80	100	-
Factor in cracked concrete		k_{cr}	[-]	7,2				
Factor in non-cracked concrete		k_{ucr}	[-]	10,1				
Partial safety factor for	cracked concrete	$\gamma_{Mc} = \gamma_{Msp}$ 1)	[-]	1,8 2)				
	non-cracked concrete		[-]	1,5 3)				1,8 2)
Characteristic spacing for failure by	concrete cone ($h_{ef,min}$)	$s_{cr,N,min}$	[mm]	120	180	180	240	330
	concrete cone (**$h_{ef,max}$**)	$s_{cr,N,max}$	[mm]	-	-	240	300	-
	splitting ($h_{ef,min}$)	$s_{cr,sp,min}$	[mm]	200	300	300	400	550
	splitting (**$h_{ef,max}$**)	$s_{cr,sp,max}$	[mm]	-	-	400	500	-
Characteristic edge distance for failure by	concrete cone ($h_{ef,min}$)	$c_{cr,N,min}$	[mm]	60	90	90	120	165
	concrete cone (**$h_{ef,max}$**)	$c_{cr,N,max}$	[mm]	-	-	120	150	-
	splitting ($h_{ef,min}$)	$c_{cr,sp,min}$	[mm]	100	150	150	200	275
	splitting (**$h_{ef,max}$**)	$c_{cr,sp,max}$	[mm]	-	-	200	250	-

1) In absence of other national regulations
2) The value contains an installation safety factor γ_2= 1,2
3) The value contains an installation safety factor γ_2= 1,0
4) Pullout failure not decisive. Use Equation acc. to ETAG 001, Annex C, for concrete cone failure.

Table 9: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. CEN/TS 1992-4

			PTB-ETA1-PRO				
			M8	**M10**	**M12**	**M16**	**M20**
Steel failure without lever arm							
Characteristic resistance	$V_{Rk,s}$	[kN]	10	15,5	21	37	54
Factor considering ductility	k_2	[-]	0,8				
Partial safety factor	γ_{Ms} [1)]	[-]	1,25				
Steel failure with lever arm							
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	23	45	77	194	380
Partial safety factor	γ_{Ms} [1)]	[-]	1,25				
Concrete pry-out failure							
Factor in equation (16) of CEN/TS 1992-4-4, § 6.2.2.3	k_3	[-]	1	2	2	2	2
Partial safety factor	γ_{Mc} [1)]	[-]	1,5				
Concrete edge failure							
Effective length under shear loading *($h_{ef,min}$)*	$l_{f,min}$	[mm]	40	60	60	80	110
Effective length under shear loading ***($h_{ef,max}$)***	$l_{f,max}$	[mm]	-	-	80	100	-
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20
Partial safety factor	γ_{Mc} [1)]	[-]	1,5				

1) In absence of other national regulations

Table 10: Characteristic tension resistance in cracked and non-cracked concrete under fire exposure [1)] for design method A acc. CEN/TS 1992-4

				PTB-ETA1-PRO				
				M8	**M10**	**M12**	**M16**	**M20**
Steel failure								
Characteristic resistance		R30 $N_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1	4,9
		R60 $N_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4	3,7
		R90 $N_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0	3,2
		R120 $N_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6	2,5
Pullout failure (cracked and non-cracked concrete)								
Characteristic resistance in concrete ≥ C20/25								
Minimum embedment depth		R30 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
		R60 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
		R90 $N_{Rk,p,fi}$	[kN]	1	2,3	3	6,3	5,0
		R120 $N_{Rk,p,fi}$	[kN]	0,8	1,8	2,4	5	4,0
Maximum embedment depth		R30 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
		R60 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
		R90 $N_{Rk,p,fi}$	[kN]	-	-	3	6,3	-
		R120 $N_{Rk,p,fi}$	[kN]	-	-	2,4	5	-
Concrete cone and splitting failure [2)] (cracked and uncracked concrete)								
Characteristic resistance in concrete ≥ C20/25								
Minimum embedment depth		R30 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
		R60 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
		R90 $N^0_{Rk,c,fi}$	[kN]	1,8	5	3	10,3	22,8
		R120 $N^0_{Rk,c,fi}$	[kN]	1,5	4	2,4	8,2	18,3
Maximum embedment depth		R30 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
		R60 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
		R90 $N^0_{Rk,c,fi}$	[kN]	-	-	10,3	18	-
		R120 $N^0_{Rk,c,fi}$	[kN]	-	-	8,2	14,4	-
Characteristic spacing	($h_{ef,min}$)	$s_{cr,N,min,fi}$	[mm]	160	240	240	320	440
	(**$h_{ef,max}$**)	$s_{cr,N,max,fi}$	[mm]	-	-	320	400	-
Characteristic edge distance	($h_{ef,min}$)	$c_{cr,N,min,fi}$	[mm]	80	120	120	160	220
	(**$h_{ef,max}$**)	$c_{cr,N,max,fi}$	[mm]	-	-	160	200	-

1) Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.2.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to c_{min} ≥ 300 mm and ≥ 2 · h_{ef}.

2) As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed.

Table 11: Characteristic shear resistance in cracked and non-cracked concrete under fire exposure [1] for design method A acc. CEN/TS 1992-4

				PTB-ETA1-PRO				
				M8	**M10**	**M12**	**M16**	**M20**
Steel failure without lever arm								
Characteristic resistance		R30 $V_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1	4,9
		R60 $V_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4	3,7
		R90 $V_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0	3,2
		R120 $V_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6	2,5
Steel failure with lever arm								
Characteristic bending resistance		R30 $M^0_{Rk,s,fi}$	[Nm]	0,37	1,1	2,6	6,7	13,0
		R60 $M^0_{Rk,s,fi}$	[Nm]	0,34	1,0	2,0	5,0	9,7
		R90 $M^0_{Rk,s,fi}$	[Nm]	0,26	0,7	1,7	4,3	8,4
		R120 $M^0_{Rk,s,fi}$	[Nm]	0,19	0,6	1,3	3,3	6,5
Concrete pry-out failure								
Factor in equation (16) of CEN TS 1992-4-4, § 6.2.2.3		k_3	[-]	1	2	2	2	2
Characteristic resistance for $h_{ef,min}$		R30 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
		R60 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
		R90 $V_{Rk,cp,fi}$	[kN]	1,8	10	10	20,6	45,6
		R120 $V_{Rk,cp,fi}$	[kN]	1,5	8	8	16,5	36,6
Characteristic resistance for $h_{ef,max}$		R30 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
		R60 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
		R90 $V_{Rk,cp,fi}$	[kN]	-	-	20,6	36	-
		R120 $V_{Rk,cp,fi}$	[kN]	-	-	16,5	28,8	-
Concrete edge failure								
Effective length under shear loading	($h_{ef,min}$)	$l_{f,min}$	[mm]	40	60	60	80	110
	(**$h_{ef,max}$**)	$l_{f,max}$	[mm]	-	-	80	100	-
Outside diameter of anchor		d_{nom}	[mm]	8	10	12	16	20

[1] Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.2.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

Table 12: Characteristic values for resistance in case of seismic performance category C1 acc. TR045 "Design of Metal anchor under Seismic Actions"

			PTB-ETA1-PRO				
Anchor sizes			**M8**	**M10**	**M12**	**M16**	**M20**
Tension load							
Steel failure							
Characteristic resistance	$N_{Rk,s,seis}$	[kN]	22	31	43	79	-
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,5 [1)]				
Pull-out failure $N_{Rk,p,seis} = \Psi_c \cdot N^0_{Rk,p,seis}$							
Characteristic resistance	$N^0_{Rk,p,seis}$	[kN]	3,5	8,6	11,5	24,3	-
Partial safety factor	$\gamma_{Mp,seis}$ [1)]	[-]	1,8 [1)]				
Shear loads							
Steel failure without lever arm							
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	8,5	13,2	16,8	31,5	-
Partial safety factor	$\gamma_{Ms,seis}$	[-]	1,25 [1)]				

[1)] The recommended partial safety factors under seismic action ($\gamma_{M,seis}$) are the same as for static loading

Table 13: Characteristic values for resistance in case of seismic performance category C2 acc. TR045 "Design of Metal anchor under Seismic Actions"

Anchor sizes			PTB-ETA1-PRO M8	M10	M12	M16	M20
Tension load							
Steel failure							
Characteristic resistance [2]	$N_{Rk,s,seis}$	[kN]	-	-	43	-	-
Partial safety factor [3]	$\gamma_{Ms,seis}$	[-]	1,5				
Pull-out failure $N_{Rk,p,seis} = \Psi_c \cdot N^0_{Rk,p,seis}$							
Characteristic resistance [2]	$N^0_{Rk,p,seis}$	[kN]	-	-	11,5	-	-
Partial safety factor [3]	$\gamma_{Mp,\ seis}$	[-]	1,8				
Displacement at DLS [1) 2)]	$\delta_{N,sei\ (DLS)}$	[mm]	-	-	7,0	-	-
Displacement at ULS [1) 2)]	$\delta_{N,sei\ (ULS)}$	[mm]	-	-	20,5	-	-
Shear loads							
Steel failure without lever arm							
Characteristic resistance [2]	$V_{Rk,s,seis}$	[kN]	-	-	12,0	-	-
Partial safety factor [3]	$\gamma_{Ms,\ seis}$	[-]	1,25				
Displacement at DLS [1) 2)]	$\delta_{V,sei\ (DLS)}$	[mm]	-	-	5,6	-	-
Displacement at ULS [1) 2)]	$\delta_{V,sei\ (ULS)}$	[mm]	-	-	7,4	-	-

1) The listed displacements represent mean values.
2) A smaller displacement may be required in the design provisions stated in section "Design of Anchorage", e.g. in the case of displacement sensitive fastenings or "rigid" supports. The characteristic resistance associated with such smaller displacement may be determined by linear interpolation or proportional reduction.
3) The recommended partial safety factors under seismic action ($\gamma_{M,seis}$) are the same as for static loading.

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Table 14: Displacements under tension loading

			PTB-ETA1-PRO						
			M8	**M10**	**M12**		**M16**		**M20**
			h_{ef}	h_{ef}	$h_{ef,min}$	$h_{ef,max}$	$h_{ef,min}$	$h_{ef,max}$	h_{ef}
Tension load in non-cracked concrete C20/25 to C50/60		[kN]	6,6	11,8	17,3	22,2	22,2	36,9	30,7
Displacement	δ_{N0}	[mm]	0,1	0,1	0,2	0,2	0,3	0,6	0,4
	$\delta_{N\infty}$	[mm]	1,2	1,2	1,5	1,5	1,3	1,3	1,2
Tension load in cracked concrete C20/25 to C50/60 [kN]			2,2	7,4	9,8	9,8	15,9	22,1	12,3
Displacement	δ_{N0}	[mm]	0,4	0,6	0,7	0,7	0,8	1,2	0,5
	$\delta_{N\infty}$	[mm]	1,2	1,2	1,5	1,5	1,3	1,3	1,2

Table 15: Displacements under shear loads

			PTB-ETA1-PRO				
			M8	**M10**	**M12**	**M16**	**M20**
Shear load in non-cracked concrete C20/25		[kN]	5,8	8,9	12,4	21,1	25,8
Displacement	δ_{V0}	[mm]	1,2	2,2	2,2	3,6	3,5
	$\delta_{V\infty}$	[mm]	1,8	3,3	3,3	5,4	5,3

Displacement under shear loading: additional displacements due to through hole in the fixture shall be considered