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

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European Technical Assessment

ETA-15/0314 of 09/06/2015

English translation prepared by CSTB - Original version in French language

General Part

Nom commercial *Trade name*	**Stud anchor BOAX-FMC**
Famille de produit *Product family*	**Cheville métallique à expansion par vissage à couple contrôlé, de fixation dans le béton fissuré et non fissuré diamètres M8, M10, M12 et M16** ***Torque-controlled expansion anchor for use in cracked and non-cracked concrete: sizes M8, M10, M12 and M16***
Titulaire *Manufacturer*	SIMPSON STRONG-TIE® ZAC Les Quatre Chemins 85400 Sainte-Gemme-la-Plaine FRANCE
Usine de fabrication *Manufacturing plants*	Simpson Strong-Tie® manufacturing facilities
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*	

Specific Part

1 Technical description of the product

The Stud anchor BOAX-FMC 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 (BWR 1)

Essential characteristic	Performance
Characteristic tension resistance acc. ETAG 001, Annex C	See Annex C 1
Characteristic shear resistance acc. ETAG 001, 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. TR 045	See Annex C 9
Characteristic resistance under seismic action Cat 2 acc. TR 045	See Annex C 10
Displacements	See Annex C 11

3.2 Safety in case of fire (BWR 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 (BWR 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 (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 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 applies

.

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.

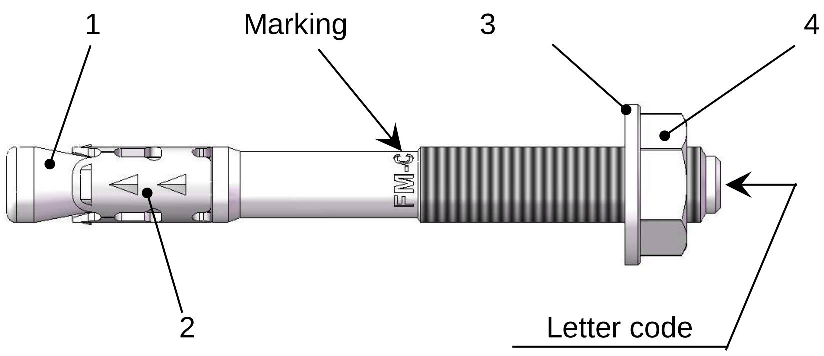
The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

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:



1. Bolt
2. Expansion sleeve
3. Washer
4. Hexagonal nut

<u>Marking on the bolt:</u>

≠ BOAX and/or FM-C (FMC)
followed by MX/Y where
MX = thread diameter
Y = fixture thickness

Table 1: Materials

Part	Designation	Material	Protection
1	Bolt	M8 and M10: 19MnB4 DIN 1654-T4	Galvanised[1)] ≥ 8µm
		M12 and M16 C30BKD EU 119-74	
2	Expansion sleeve	Stainless steel X2CrNiMo 17-12-2 UNI EN 10088/2	-
3	Washer	C-steel DIN 125/1 (normal), DIN 9021 (large), DIN 440 (large)	Galvanised[1)] ≥ 8µm
4	Hexagonal nut	C-steel DIN 934, steel grade 8	Galvanised[1)] ≥ 8µm

[1)] Special galvanised

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads,
- Seismic actions, performances categories C1 (M8 to M16) and C2 (M10 to M16),
- Fire exposure.

Base materials:

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

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions.

Design:

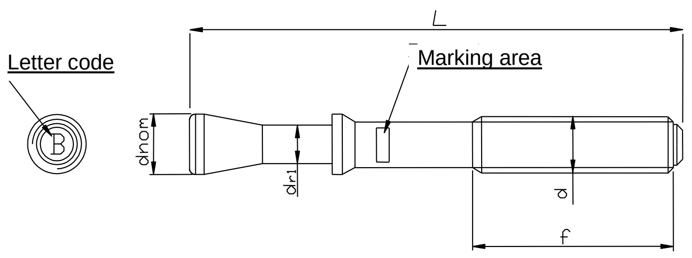
- The anchorages are designed in accordance with the ETAG 001, Annex C “Design Method for Anchorages” or CEN/TS 1992-4 '' Design of fastenings for use in concrete” under the responsibility of an engineer experienced in anchorages and concrete work.
- For seismic application the anchorages are designed in accordance with TR 045 “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 TR 020 “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.

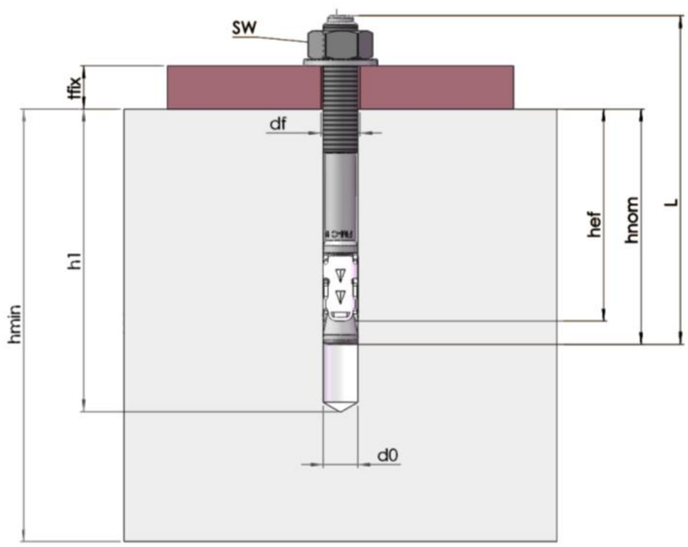
Installation:

- 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

	d x L	Letter code ID	L (mm)	d_{nom} (mm)	d_{r1} (mm)	f (mm)
M8	M8x68	A	68	8	5,8	30
	M8x75	B	75			30
	M8x90	C	90			40
	M8x115	D	115			60
	M8x135	E	135			80
	M8x165	G	165			80
M10	M10x90	A	90	10	7,4	40
	M10x105	B	105			55
	M10x115	C	115			55
	M10x135	D	135			85
	M10x155	E	155			85
	M10x185	F	185			85
M12	M12x110	A	110	12	8,8	65
	M12x120	B	120			65
	M12x145	C	145			85
	M12x170	D	170			85
	M12x200	E	200			85
M16	M16x130	A	130	16	11,8	65
	M16x150	B	150			85
	M16x185	C	185			85
	M16x220	D	220			85





Stud anchor BOAX-FMC	**Annex B2**
Intended Use Installation parameters	

Table 3: Installation data

	dxL	ID	t_{fix} (mm)	d_0 (mm)	h_1 (mm)	h_{nom} (mm)	h_{ef} (mm)	d_f (mm)	h_{min} (mm)	T_{inst} (Nm)	sw (mm)
M8	M8x68	A	4	8	70	54	48	9	100	20	13
	M8x75	B	10								
	M8x90	C	25								
	M8x115	D	50								
	M8x135	E	70								
	M8x165	G	100								
M10	M10x90	A	10	10	80	67	60	12	120	40	17
	M10x105	B	25								
	M10x115	C	35								
	M10x135	D	55								
	M10x155	E	75								
	M10x185	F	105								
M12	M12x110	A	10	12	100	81	72	14	150	60	19
	M12x120	B	20								
	M12x145	C	45								
	M12x170	D	70								
	M12x200	E	100								
M16	M16x130	A	10	16	115	97	86	18	170	120	24
	M16x150	B	30								
	M16x185	C	60								
	M16x220	D	100								

			M8	M10	M12	M16
Min. member thickness	h_{min}	[mm]	100	120	150	170
Minimum edge distance	c_{min}	[mm]	50	60	70	85
Corresponding spacing	s ≥	[mm]	75	120	150	170
Minimum spacing	s_{min}	[mm]	50	60	70	80
Corresponding edge distance	c ≥	[mm]	65	80	90	120

Table 4: Characteristic values for tension loads in case of static and quasi static loading for design method A acc. ETAG 001, Annex C

				M8	M10	M12	M16
Steel failure							
Char. resistance		$N_{Rk,s}$	[kN]	23,8	38,7	54,7	98,4
Partial safety factor		γ_{Ms} 1)	[-]	1,5			
Pullout failure $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$							
Char. resistance in concrete C20/25	non-cracked	$N^0_{Rk,p}$	[kN]	**9**	**16**	**20**	**35**
	cracked	$N^0_{Rk,p}$	[kN]	**6**	**12**	**16**	**20**
Partial safety factor for cracked or non-cracked concrete		γ_{Mp} 1)	[-]	1,5 2)			
Increasing factor for N_{RK}	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		h_{ef}	[mm]	48	60	72	86
Partial safety factor for craked or non-cracked concrete		$\gamma_{Mc} = \gamma_{Msp}$ 1)		1,5 2)			
Increasing factor for N_{RK}	concrete C30/37	Ψ_c	[-]	1,22			
	concrete C40/50		[-]	1,41			
	concrete C50/60		[-]	1,55			
Char. spacing	concrete cone failure	$s_{cr,N}$	[mm]	140	180	220	260
	splitting failure	$s_{cr,sp}$	[mm]	290	360	430	520
Char. edge distance	concrete cone failure	$c_{cr,N}$	[mm]	70	90	110	130
	splitting failure	$c_{cr,sp}$	[mm]	145	180	215	260

1) In absence of other national regulations

2) The value contains an installation safety factor $\gamma_2 = 1.0$

Table 5: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. ETAG 001, Annex C

			M8	M10	M12	M16
Steel failure without lever arm						
Char. resistance	$V_{Rk,s}$	[kN]	12,9	24,2	33,8	66,4
Partial safety factor	γ_{Ms} 1)	[-]	1,5			
Steel failure with lever arm						
Char. bending resistance	$M^0_{Rk,s}$	[Nm]	34	67	118	300
Partial safety factor	γ_{Ms} 1)	[-]	1,5			
Concrete pry-out failure						
Factor in equation (5.6) of ETAG Annex C, § 5.2.3.3	k	[-]	1,0	2,0	2,0	2,0
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)			
Concrete edge failure						
Effective length of anchor under shear loading	l_f	[mm]	48	60	72	86
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)			

1) The installation safety factor γ_2 = 1.0 is included

Stud anchor BOAX-FMC	**Annex C2**
Design according to ETAG 001, Annex C Characteristic resistance under shear loads	

Table 6: Characteristic tension resistance in cracked and non-cracked concrete under fire exposure for design method A acc. ETAG 001, Annex C and TR 020[1)]

			M8	M10	M12	M16
Steel failure						
Characteristic resistance	R30 $N_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1
	R60 $N_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4
	R90 $N_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0
	R120 $N_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6
Pullout failure (cracked and non-cracked concrete)						
Char. resistance in concrete ≥ C20/25	R30 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R60 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R90 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R120 $N_{Rk,p,fi}$	[kN]	1,2	2,4	3,2	4,0
Concrete cone and splitting failure[2)] (cracked and non-cracked concrete)						
Char. resistance in concrete ≥ C20/25	R30 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R60 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R90 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R120 $N^0_{Rk,c,fi}$	[kN]	2,3	4,0	6,3	9,9
Characteristic spacing	$s_{cr,N,fi}$	[mm]	4 x h_{ef}			
Characteristic edge distance	$c_{cr,N,fi}$	[mm]	2 x h_{ef}			

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.

2) As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed (see TR 020 section 2.2.1.4).

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}.

Stud anchor BOAX-FMC

Design according to ETAG 001, Annex C and TR 020
Characteristic tension resistance under fire exposure

Annex C3

Table 7: Characteristic shear resistance in cracked and non-cracked concrete under fire exposure for design method A acc. ETAG 001, Annex C and TR 020[1)]

			M8	M10	M12	M16
Steel failure without lever arm						
Characteristic resistance	R30 $V_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1
	R60 $V_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4
	R90 $V_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0
	R120 $V_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6
Steel failure with lever arm						
Characteristic bending moment	R30 $M^0_{Rk,s,fi}$	[Nm]	0,4	1,1	2,6	6,7
	R60 $M^0_{Rk,s,fi}$	[Nm]	0,3	1,0	2,0	5,0
	R90 $M^0_{Rk,s,fi}$	[Nm]	0,3	0,7	1,7	4,3
	R120 $M^0_{Rk,s,fi}$	[Nm]	0,2	0,6	1,3	3,3
Concrete pry-out failure						
Factor in equation (5.6) of ETAG 01 Annex C, § 5.2.3.3	k	[-]	1,0	2,0	2,0	2,0
Characteristic resistance	R30 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R60 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R90 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R120 $V_{Rk\ cp,fi}$	[kN]	2,3	8,0	12,7	19,8
Concrete edge failure						
Eff. length of anchor under shear loading	l_f	[mm]	48	60	72	86
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16

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 method A acc. CEN/TS 1992-4-4

				M8	M10	M12	M16
Steel failure							
Char. resistance		$N_{Rk,s}$	[kN]	23,8	38,7	54,7	98,4
Partial safety factor		γ_{Ms} [1)]	[-]	1,5			
Pullout failure $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$							
Char. resistance in concrete C20/25	non-cracked	$N^0_{Rk,p}$	[kN]	**9**	**16**	**20**	**35**
	cracked	$N^0_{Rk,p}$	[kN]	**6**	**12**	**16**	**20**
Partial safety factor for cracked or non-cracked concrete		γ_{Mp} [1)]	[-]	1,5 [2)]			
Increasing factor for $N_{RK,p}$	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		h_{ef}	[mm]	48	60	72	86
Factor for cracked concrete		k_{cr}		7,2			
Factor for non cracked concrete		k_{ucr}		10,1			
Partial safety factor		$\gamma_{Mc}=\gamma_{Msp}$ [1)]		1,5 [2)]			
Char. spacing	concrete cone failure	$s_{cr,N}$	[mm]	140	180	220	260
	splitting failure	$s_{cr,sp}$	[mm]	290	360	430	520
Char. edge distance	concrete cone failure	$c_{cr,N}$	[mm]	70	90	110	130
	splitting failure	$c_{cr,sp}$	[mm]	145	180	215	260

1) In absence of other national regulations

2) The value contains an installation safety factor $\gamma_2 = 1.0$

Stud anchor BOAX-FMC	**Annex C5**
Design according to CEN/TS 1992-4 Characteristic resistance under tension loads	

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

			M8	M10	M12	M16
Steel failure without lever arm						
Char. resistance	$V_{Rk,s}$	[kN]	12,9	24,2	33,8	66,4
Factor considering ductility	k_2	[-]	0,8			
Partial safety factor	γ_{Ms} [1)]	[-]	1,5			
Steel failure with lever arm						
Char. bending moment	$M^0_{Rk,s}$	[Nm]	34	67	118	300
Partial safety factor	γ_{Ms} [1)]	[-]	1,5			
Concrete pry-out failure						
Factor in equation (16) of CEN TS 1992-4-4, § 6.2.2.3	k_3	[-]	1,0	2,0	2,0	2,0
Partial safety factor	γ_{Mc} [1)]	[-]	1,5 [1)]			
Concrete edge failure						
Effective length of anchor under shear loading	l_f	[mm]	48	60	72	86
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16
Partial safety factor	γ_{Mc} [1)]	[-]	1,5 [1)]			

[1)] The installation safety factor γ_2 =1.0 is included

Stud anchor BOAX-FMC	**Annex C6**
Design according to CEN/TS 1992-4 Characteristic resistance under shear loads	

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

			M8	M10	M12	M16
Steel failure						
Characteristic resistance	R30 $N_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1
	R60 $N_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4
	R90 $N_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0
	R120 $N_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6
Pullout failure (cracked and non-cracked concrete)						
Char. resistance in concrete ≥ C20/25	R30 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R60 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R90 $N_{Rk,p,fi}$	[kN]	1,5	3,0	4,0	5,0
	R120 $N_{Rk,p,fi}$	[kN]	1,2	2,4	3,2	4,0
Concrete cone and splitting failure[2)] (cracked and non-cracked concrete)						
Char. resistance in concrete ≥ C20/25	R30 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R60 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R90 $N^0_{Rk,c,fi}$	[kN]	2,9	5,0	7,9	12,3
	R120 $N^0_{Rk,c,fi}$	[kN]	2,3	4,0	6,3	9,9
Characteristic spacing	$s_{cr,N,fi}$	[mm]	4 x h_{ef}			
Characteristic edge distance	$c_{cr,N,fi}$	[mm]	2 x h_{ef}			

1) Design under fire exposure is performed according to the design method given in CEN/TS 1992-4-1, Annex D. Under fire exposure usually cracked concrete is assumed.

2) As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed (see CEN/TS 1992-4-1,Section D.3.2.4)

.

CEN/TS 1992-4-1, Annex D 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 ≥ $2 \cdot h_{ef}$.

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

			M8	M10	M12	M16
Steel failure without lever arm						
Characteristic resistance	R30 $V_{Rk,s,fi}$	[kN]	0,4	0,9	1,7	3,1
	R60 $V_{Rk,s,fi}$	[kN]	0,3	0,8	1,3	2,4
	R90 $V_{Rk,s,fi}$	[kN]	0,3	0,6	1,1	2,0
	R120 $V_{Rk,s,fi}$	[kN]	0,2	0,5	0,8	1,6
Steel failure with lever arm						
Characteristic bending moment	R30 $M^0_{Rk,s,fi}$	[Nm]	0,4	1,1	2,6	6,7
	R60 $M^0_{Rk,s,fi}$	[Nm]	0,3	1,0	2,0	5,0
	R90 $M^0_{Rk,s,fi}$	[Nm]	0,3	0,7	1,7	4,3
	R120 $M^0_{Rk,s,fi}$	[Nm]	0,2	0,6	1,3	3,3
Concrete pry-out failure						
Factor in equation (16) of CEN TS 1992-4-4, § 6.2.2.3	k_3	[-]	1,0	2,0	2,0	2,0
Characteristic resistance	R30 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R60 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R90 $V_{Rk,cp,fi}$	[kN]	2,9	10,0	15,8	24,7
	R120 $V_{Rk,cp,fi}$	[kN]	2,3	8,0	12,7	19,8
Concrete edge failure						
Eff. length of anchor under shear loading	l_f	[mm]	48	60	72	86
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16

[1)] Design under fire exposure is performed according to the design method given in given in CEN/TS 1992-4-1, Annex D. Under fire exposure usually cracked concrete is assumed.

CEN/TS 1992-4-1, Annex D 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. TR 045 "Design of Metal anchor under Seismic Actions"

Anchor sizes			**M8**	**M10**	**M12**	**M16**
Tension load						
Steel failure						
Characteristic resistance	$N_{Rk,s,seis}$	[kN]	23,8	38,7	54,7	98,4
Partial safety factor[1)]	$\gamma_{Ms,seis}$	[-]	1,5			
Pull-out failure $N_{Rk,p,seis} = \Psi_c \times N^0_{Rk,p,seis}$						
Characteristic resistance	$N^0_{Rk,p,seis}$	[kN]	6	12	16	20
Partial safety factor[1)]	$\gamma_{Mp,seis}$	[-]	1,5			
Shear loads						
Steel failure without lever arm						
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	7,7	17,0	30,4	57,6
Partial safety factor[1)]	$\gamma_{Ms,seis}$	[-]	1,5			

[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. TR 045 "Design of Metal anchor under Seismic Actions"

Anchor sizes			M8	M10	M12	M16
Tension load						
Steel failure						
Characteristic resistance [2)]	$N_{Rk,s,seis}$	[kN]	-	38,7	54,7	98,4
Partial safety factor[3)]	$\gamma_{Ms,seis}$	[-]	1,5			
Pull-out failure $N_{Rk,p,seis} = \Psi_c \times N^0_{Rk,p,seis}$						
Characteristic resistance[2)]	$N^0_{Rk,p,seis}$	[kN]	-	3,3	11,8	20,0
Partial safety factor[3)]	$\gamma_{Mp,seis}$	[-]	1,5			
Displacement at DLS[1) 2)]	$\delta_{N,seis (DSL)}$	[mm]	-	2,5	5,0	4,4
Displacement at ULS [1) 2)]	$\delta_{N,seis (ULS)}$	[mm]	-	10,7	20,4	17,8
Shear loads						
Steel failure without lever arm						
Characteristic resistance[2)]	$V_{Rk,s,seis}$	[kN]	-	11,9	19,3	31,2
Partial safety factor[3)]	$\gamma_{Ms,seis}$	[-]	1,5			
Displacement at DLS [1) 2)]	$\delta_{V,seis (DSL)}$	[mm]	-	5,0	7,0	7,0
Displacement at ULS[1) 2)]	$\delta_{V,seis (ULS)}$	[mm]	-	7,1	9,1	6,6

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.

Table 14: Displacements under tension loads

			M8	M10	M12	M16
Tension load in non-cracked concrete C20/25 [kN]			4,29	7,62	9,52	16,67
Displacement	δ_{N0}	[mm]	0,1	0,1	0,1	0,1
	$\delta_{N\infty}$	[mm]	0,5	0,5	0,5	0,5
Tension load in non-cracked concrete C50/60 [kN]			6,64	11,91	14,76	25,83
Displacement	δ_{N0}	[mm]	0,1	0,2	0,2	0,3
	$\delta_{N\infty}$	[mm]	0,5	0,5	0,5	0,5
Tension load in cracked concrete C20/25 [kN]			2,86	5,71	7,62	9,52
Displacement	δ_{N0}	[mm]	1,4	1,2	0,9	0,6
	$\delta_{N\infty}$	[mm]	1,4	1,2	1,3	0,6
Tension load in cracked concrete C50/60 [kN]			4,43	8,86	11,81	14,76
Displacement	δ_{N0}	[mm]	1,8	1,8	1,8	1,8
	$\delta_{N\infty}$	[mm]	1,8	1,8	1,8	1,8

Table 15: Displacements under shear loads

			M8	M10	M12	M16
Shear load in cracked and non-cracked concrete C20/25 to C50/60		**[kN]**	6,19	11,43	16,19	31,43
Displacement	δ_{V0}	[mm]	2,3	2,6	2,9	3,3
	$\delta_{V\infty}$	[mm]	3,4	3,9	4,3	4,9

Additional displacement due to anular gap between anchor and fixture is to be taken into account.