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European Technical Assessment

ETA-05/0044 of 20/08/2015

English translation prepared by CSTB - Original version in French language

General Part

Nom commercial *Trade name*	**SPIT TRIGA Z XTREM**
Famille de produit *Product family*	**Cheville métallique en acier galvanisé à expansion par vissage à couple contrôlé, de fixation dans le béton: dimensions M6, M8, M10, M12, M16 et M20. Avec catégories de performances sismiques C1 et C2 : dimensions M10, M12, M16.** ***Torque-controlled expansion anchor, made of galvanized steel, for use in concrete: sizes M6, M8, M10, M12 M16 et M20. With seismic performance categories C1 and C2: sizes, M10, M12, M16.***
Titulaire *Manufacturer*	Société Spit Route de Lyon F-26501 BOURG-LES-VALENCE France
Usine de fabrication e *Manufacturing plants*	Société Spit Route de Lyon F-26501 BOURG-LES-VALENCE France
Cette evaluation contient: *This Assessment contains*	22 pages incluant 17 annexes qui font partie intégrante de cette évaluation 22 *pages including 17 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-05/0044 valide du 01/09/2011 au 01/09/2016 ETA-05/0044 with validity from 01/09/2011 to 01/09/2016

Specific Part

1 Technical description of the product

The SPIT TRIGA Z XTREM anchor is an anchor made of galvanized 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. 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 11
Characteristic resistance under seismic action Cat 2 acc. TR045	See Annex C 12
Displacements	See Annex C 13

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 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.

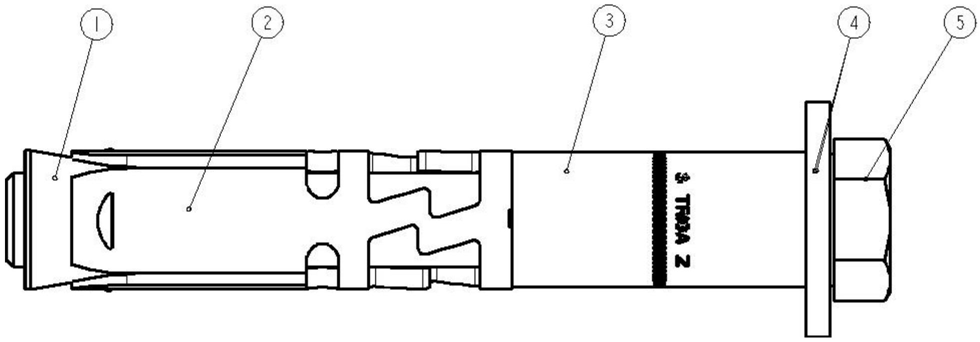
The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

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:



1. cone
2. expansion sleeve
3. distance sleeve
4. washer
5. screw (or threaded rod with hexagonal nut or countersunk head)

Marking on the sleeve: S TRIGA Z
S : Manufacturer SPIT
TRIGA Z : Trade name

Table 1: Materials

Part	Designation	Material	Protection
1	Cone	1.0765 steel EN 10 087	Galvanised 5 µm
2	Expansion sleeve	1.5530 steel EN 10 149-2	Galvanised 5 µm
3	Distance sleeve	TS 37 a BK or S300Pb NF A 49 341	Galvanised 5 µm
4	Threaded rod	1. Steel Grade 8.8 EN 20 898-1	Galvanised 5 µm
5	Screw	Steel Grade 8.8 EN 20 898-1	Galvanised 5 µm
6	Washer	HLE S550MC	Galvanised 5 µm
7	Hexagonal nut	Grade 8 EN 20 898-2	Galvanised 5 µm

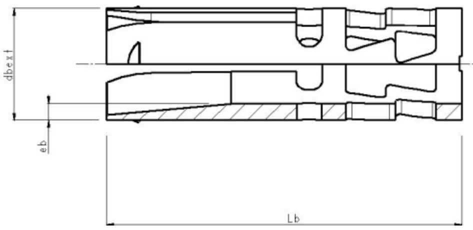
SPIT TRIGA Z XTREM expansion anchor

Product description

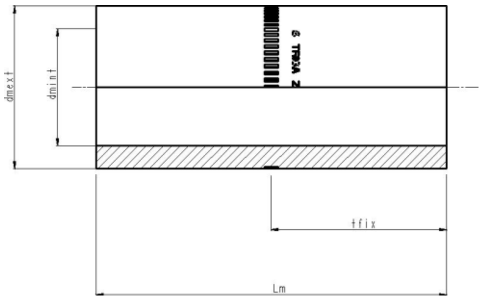
Parts, Materials

Annex A1

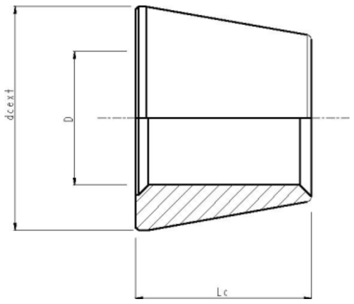
Versions, parts and dimensions of the anchor :



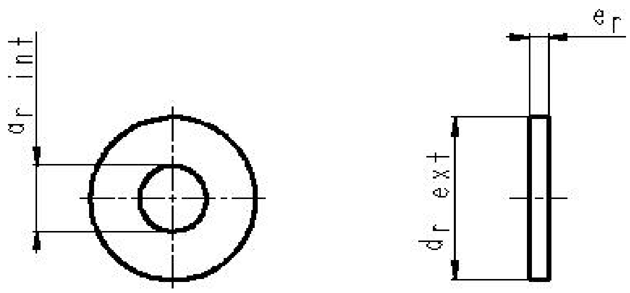
Expansion sleeve



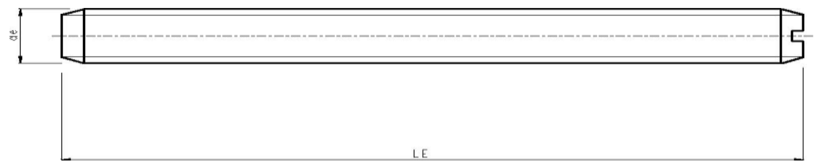
Distance sleeve



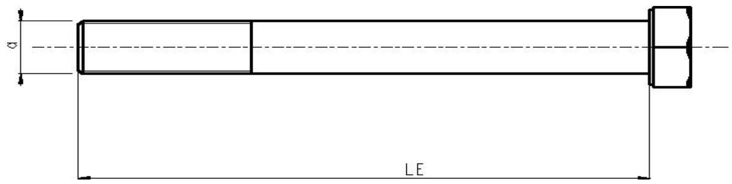
Cone



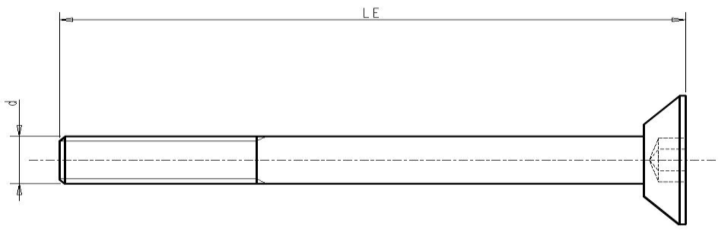
washer



Threaded rod (type E)



Screw (type V)



Countersunk head screw (type TF)

SPIT TRIGA Z XTREM expansion anchor	**Annex A2**
Product description Parts, dimensions	

Table 2 : Dimensions

	Dimensions of anchor bolt SPIT TRIGA Z															
	References	**Rod**		**Washer**			**Distance sleeve**				**Expansion sleeve**			**Cone**		
	TRIGA Z	LE	d	Er	dr_{ext}	dr_{int}	Lm	dm_{ext}	dm_{int}	t_{fix}	Lb	db_{ext}	eb	Lc	dc	D
M6	**V6-10/5**	65	6	2	18	6,7	25	9,5	6,2	5	30	9,5	1,5	8	9,8	6
	V6-10/20	80					40			20						
	E6-10/50	117					70			20						
M8	**V8-12/10**	80	8	2	20	8,7	30	11,5	8,2	10	40	11,5	1,5	9,5	11,8	8
	V8-12/20	90					40			20						
	V8-12/50	80					70			50						
	E8-12/20	99					40			20						
	E8-12/35	114					55			35						
	E8-12/55	134					75			55						
	E8-12/95	174					115			95						
	TF8-12/16	85					30			16						
	TF8-12/26	95					40			26						
M10	**V10-15/10**	95	10	3	26	10,5	30	14,5	10,2	10	50	14,5	2	10,5	14,8	10
	V10-15/20	105					40			20						
	V10-15/55	95					75			55						
	E10-15/20	114					40			20						
	E10-15/35	129					55			35						
	E10/15/55	149					75			55						
	E10-15/100	194					120			100						
	TF10-15/27	105					40			27						
M12	**V12-18/10**	105	12	3	30	12,5	33	17,5	12,4	10	57	17,5	2,5	13	17,8	12
	V12-18/25	120					48			25						
	V12-18/55	105					78			55						
	E12-18/25	132					48			25						
	E12-18/45	152					68			45						
	E12-18/65	172					88			65						
	E12-18/100	207					123			100						
M16	**V16-24/10**	130	16	4	40	16,7	35	23	16,5	10	75	23,5	3,5	18,7	23,8	16
	V16-24/25	145					50			25						
	V16-24/50	145					75			50						
	E16-24/25	159					50			25						
	E16-24/55	189					80			55						
	E16-24/100	234					125			100						
M20	**V20-28/25**	170	20	4	45	20,7	56	27	20,5	25	94	27,5	3,5	19,6	27,8	20
	E20-28/25	192					56			25						
	E20-28/60	227					91			60						
	E20-28/100	267					131			100						

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads (sizes M6 to M20),
- Seismic loads (performance categories C1 and C2 for sizes M10 to M16),
- Fire (sizes M6 to M20).

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 EN 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 3: Installation parameters

		Embedment depth h_{ef}	Drill hole diameter	Depth of drill hole h_1	Thickness of fixture t_{fix}	Setting torque T_{inst}	Thickness of concrete member	Diameter of clearance hole d_f
		[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
M6	**V6-10/5**	50	10	70	5	15	100	12
	V6-10/20				20			
	E6-10/50				50			
M8	**V8-12/10**	60	12	80	1	25	120	14
	V8-12/20				10			
	V8-12/50				50			
	E8-12/20				20			
	E8-12/35				35			
	E8-12/55				55			
	E8-12/95				95			
	TF8-12/16				16			
	TF8-12/26				26			
M10	**V10-15/10**	70	15	90	10	50	140	17
	V10-15/20				20			
	V10-15/55				55			
	E10-15/20				20			
	E10-15/35				35			
	E10/15/55				55			
	E10-15/100				100			
	TF10-15/27				27			
M12	**V12-18/10**	80	18	105	10	80	160	20
	V12-18/25				25			
	V12-18/55				55			
	E12-18/25				25			
	E12-18/45				45			
	E12-18/65				65			
	E12-18/100				100			
M16	**V16-24/10**	100	24	131	10	120	200	26
	V16-24/25				25			
	V16-24/50				50			
	E16-24/25				25			
	E16-24/55				55			
	E16-24/100				100			
M20	**V20-28/25**	125	28	157	25	200	250	31
	E20-28/25				25			
	E20-28/60				60			
	E20-28/100				100			

Installed anchor

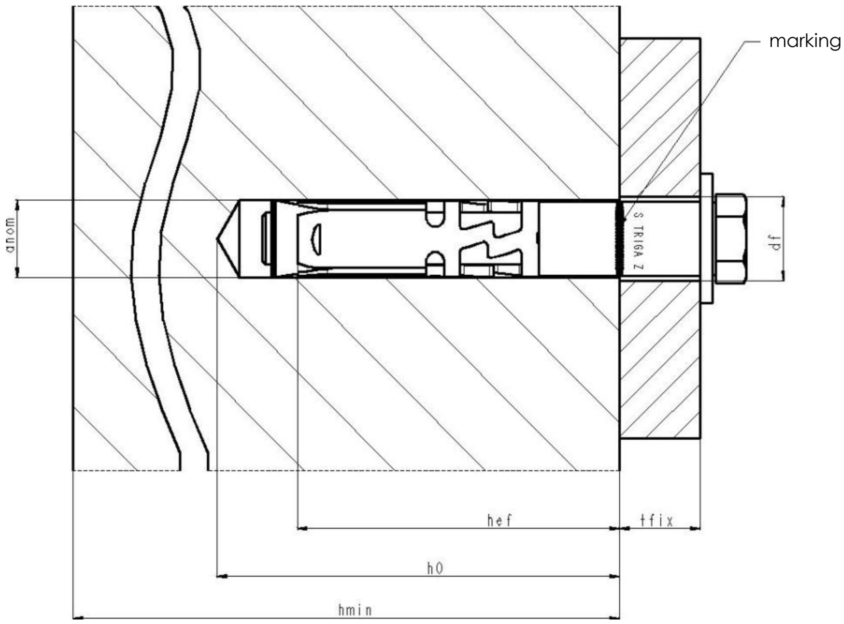


Table 4: Minimum spacing and edge distance, minimum thickness member

			M6	**M8**	**M10**	**M12**	**M16**	**M20**
Min. member thickness	h_{min}	(mm)	100	120	140	160	200	250
Minimum spacing	S_{min}	(mm)	50	60	70	80	100	125
For C_{min} =		(mm)	80	100	100	160	180	300
Minimum edge distance	C_{min}	(mm)	50	60	70	80	100	150
For S_{min} =		(mm)	100	100	160	200	220	300

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

				M6	M8	M10	M12	M16	M20
Steel failure									
Characteristic resistance		$N_{Rk,s}$	[kN]	16	29	46	67	126	196
Partial safety factor		γ_{Ms}	[-]	1,50					
Pull-through failure (cracked and non-cracked concrete) $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$									
Characteristic resistance in concrete C20/25	non-cracked	$N^0_{Rk,p}$	[kN]	-*	20	-*	-*	-*	-*
	cracked			5	12	16	-*	-*	-*
Partial safety factor		γ_{Mp} 1)	[-]	1,50 2)					
Increasing factor for N_{Rk}	C30/37	ψ_c	[-]	1,22					
	C40/50			1,41					
	C50/60			1,55					
Concrete cone failure and splitting (cracked and non-cracked concrete)									
Effective embedment depth		h_{ef}	[mm]	50	60	70	80	100	125
Partial safety factor		$\gamma_{Mc} = \gamma_{Msp}$ 1)	[-]	1,50 2)					
		$\psi_{ucr,N}$	[-]	1,4					
Char. spacing	concrete cone failure	$s_{cr,N}$	[mm]	150	180	210	240	300	375
	splitting failure	$s_{cr,sp}$	[mm]	300	300	300	300	380	480
Char. edge distance	concrete cone failure	$c_{cr,N}$	[mm]	75	90	105	120	150	185
	splitting failure	$c_{cr,sp}$	[mm]	150	150	150	150	190	240

* not decisive failure mode

1) In absence of other national regulations

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

Table 6: Characteristic values for shear loads in case of static and quasi static loading for design method A acc. ETAG001, Annex C

			M6	M8	M10	M12	M16	M20
Steel failure without lever arm								
Screw and countersunk versions – type V and TF								
Char. resistance	$V_{Rk,s}$	[kN]	23,4	32,6	49,1	72,7	117,2	173,5
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Threaded rod version – type E								
Char. resistance	$V_{Rk,s}$	[kN]	14,3	19,0	31,0	47,4	93,1	109,9
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Threaded rod only (without distance sleeve)								
Char. resistance	$V_{Rk,s}$	[kN]	8,0	14,6	23,2	33,7	62,8	98,0
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Steel failure with lever arm								
Char. bending moment	$M^0_{Rk,s}$	[Nm]	12	30	60	105	266	519
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Concrete pry-out failure								
Factor in equation (5.6) of ETAG 001 Annex C, § 5.2.3.3	k	[-]	1,0	2,0				
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)					
Concrete edge failure								
Effective length of anchor under shear loading	l_f	[mm]	50	60	70	80	100	125
Outside diameter of anchor	d_{nom}	[mm]	9,5	11,5	14,5	17,5	23,5	27,4
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)					

1) The installation safety factor $\gamma_2 = 1.0$ is included

Table 7: Characteristic tension resistance under fire exposure for design method A acc. ETAG001, Annex C

			M6	M8	M10	M12	M16	M20
Steel failure								
Characteristic resistance	R30 $N_{Rk,s,fi}$	[kN]	0,9	2,8	4,5	17,6	32,8	51,1
	R60 $N_{Rk,s,fi}$	[kN]	0,6	2,1	3,3	11,4	21,3	33,2
	R90 $N_{Rk,s,fi}$	[kN]	0,4	1,3	2,1	5,3	9,8	15,3
	R120 $N_{Rk,s,fi}$	[kN]	0,3	0,9	1,5	2,2	4,1	6,4
Pullout failure								
Characteristic resistance in concrete ≥ C20/25	R30 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R60 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R90 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R120 $N_{Rk,p,fi}$	[kN]	1,0	2,4	3,2	-	-	-
Concrete cone and splitting failure [2)]								
Characteristic resistance in concrete ≥ C20/25	R30 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R60 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R90 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R120 $N^0_{Rk,c,fi}$	[kN]	2,5	4,0	5,9	8,2	14,4	25,2
Characteristic spacing	$s_{cr,N,fi}$	[mm]	$4 \times h_{ef}$					
Characteristic edge distance	$c_{cr,N,fi}$	[mm]	$2 \times h_{ef}$					

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.

In absence of other national regulation the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

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 shear resistance under fire exposure for design method A acc. ETAG001, Annex C

			M6	M8	M10	M12	M16	M20
Steel failure without lever arm								
Characteristic resistance	R30 $V_{Rk,s,fi}$	[kN]	0,9	2,8	4,5	17,6	32,8	51,1
	R60 $V_{Rk,s,fi}$	[kN]	0,6	2,1	3,3	11,4	21,3	33,2
	R90 $V_{Rk,s,fi}$	[kN]	0,4	1,3	2,1	5,3	9,8	15,3
	R120 $V_{Rk,s,fi}$	[kN]	0,3	0,9	1,5	2,2	4,1	6,4
Steel failure with lever arm								
Characteristic resistance in concrete ≥ C20/25	R30 $M^0_{Rk,s,fi}$	[kN]	0,9	2,9	5,8	27,3	69,5	135,5
	R60 $M^0_{Rk,s,fi}$	[kN]	0,6	2,1	4,2	17,8	45,2	88,1
	R90 $M^0_{Rk,s,fi}$	[kN]	0,4	1,3	2,7	8,2	20,9	40,7
	R120 $M^0_{Rk,s,fi}$	[kN]	0,3	0,9	1,9	3,4	8,7	17,0
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	2,0	2,0
Characteristic resistance	R30 $V_{Rk,cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R60 $V_{Rk, cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R90 $V_{Rk, cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R120 $V_{Rk, cp,fi}$	[kN]	2,5	4,0	5,9	8,2	14,4	25,2
Concrete edge failure								
Eff. length of anchor under shear loading	l_f	[mm]	50	60	70	80	100	125
Outside diameter of anchor	d_{nom}	[mm]	6	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.

In absence of other national regulation the partial safety factor for resistance under fire exposure $\gamma_{M,fi}$ = 1,0 is recommended.

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}.

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

				M6	M8	M10	M12	M16	M20
Steel failure									
Characteristic resistance		$N_{Rk,s}$	[kN]	16	29	46	67	126	196
Partial safety factor		γ_{Ms}	[-]	1,50	1,50	1,50	1,50	1,50	1,50
Pull-through failure in cracked and non-cracked concrete $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$									
Characteristic resistance in concrete C20/25	non-cracked	$N^0_{Rk,p}$	[kN]	-*	20	-*	-*	-*	-*
	cracked			5	12	16	-*	-*	-*
Partial safety factor		γ_{Mp} 1)	[-]	1,50 2)					
Increasing factor for N_{Rk}	C30/37	ψ_c	[-]	1,22					
	C40/50			1,41					
	C50/60			1,55					
Concrete cone failure in cracked and non-cracked concrete									
Effective embedment depth		h_{ef}	[mm]	50	60	70	80	100	125
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)	[-]	1,50 2)					
Char. spacing	concrete cone failure	$s_{cr,N}$	[mm]	150	180	210	240	300	375
	splitting failure	$s_{cr,sp}$	[mm]	300	300	300	300	380	480
Char. edge distance	concrete cone failure	$c_{cr,N}$	[mm]	75	90	105	120	150	185
	splitting failure	$c_{cr,sp}$	[mm]	150	150	150	150	190	240

* not decisive failure mode

1) In absence of other national regulations

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

Table 10: Characteristic values for shear loads in case of static and quasi static loading for design method A acc. CEN/TS 1992-4

			M6	M8	M10	M12	M16	M20
Steel failure without lever arm								
Screw and countersunk versions – type V and TF								
Char. resistance	$V_{Rk,s}$	[kN]	23,4	32,6	49,1	72,7	117,2	173,5
Factor considering ductility	k_2	[-]	0,8					
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Threaded rod version – type E								
Char. resistance	$V_{Rk,s}$	[kN]	14,3	19,0	31,0	47,4	93,1	109,9
Factor considering ductility	k_2	[-]	0,8					
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Threaded rod only (without distance sleeve)								
Char. resistance	$V_{Rk,s}$	[kN]	8,0	14,6	23,2	33,7	62,8	98,0
Factor considering ductility	k_2	[-]	0,8					
Partial safety factor	γ_{Ms} 1)	[-]	1,25					
Steel failure with lever arm								
Char. bending moment	$M^0_{Rk,s}$	[Nm]	12	30	60	105	266	519
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	[-]	1,0	2,0				
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)					
Concrete edge failure								
Effective length of anchor under shear loading	l_f	[mm]	50	60	70	80	100	125
Outside diameter of anchor	d_{nom}	[mm]	9,5	11,5	14,5	17,5	23,5	27,4
Partial safety factor	γ_{Mc} 1)	[-]	1,5 1)					

1) The installation safety factor $\gamma_2 = 1.0$ is included

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

			M6	M8	M10	M12	M16	M20
Steel failure								
Characteristic resistance	R30 $N_{Rk,s,fi}$	[kN]	0,9	2,8	4,5	17,6	32,8	51,1
	R60 $N_{Rk,s,fi}$	[kN]	0,6	2,1	3,3	11,4	21,3	33,2
	R90 $N_{Rk,s,fi}$	[kN]	0,4	1,3	2,1	5,3	9,8	15,3
	R120 $N_{Rk,s,fi}$	[kN]	0,3	0,9	1,5	2,2	4,1	6,4
Pullout failure (cracked and non-cracked concrete)								
Characteristic resistance in concrete ≥ C20/25	R30 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R60 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R90 $N_{Rk,p,fi}$	[kN]	1,2	3,0	4,0	-	-	-
	R120 $N_{Rk,p,fi}$	[kN]	1,0	2,4	3,2	-	-	-
Concrete cone and splitting failure[2] (cracked and non-cracked concrete)								
Characteristic resistance in concrete ≥ C20/25	R30 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R60 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R90 $N^0_{Rk,c,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R120 $N^0_{Rk,c,fi}$	[kN]	2,5	4,0	5,9	8,2	14,4	25,2
Characteristic spacing	$s_{cr,N,fi}$	[mm]	$4 \times h_{ef}$					
Characteristic edge distance	$c_{cr,N,fi}$	[mm]	$2 \times h_{ef}$					

[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.

In absence of other national regulation the partial safety factor for resistance under fire exposure $\gamma_{M,fi} = 1,0$ is recommended.

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 shear resistance in cracked and non-cracked concrete under fire exposure for design method A acc. CEN/TS 1992-4

			M6	M8	M10	M12	M16	M20
Steel failure without lever arm								
Characteristic resistance	R30 $V_{Rk,s,fi}$	[kN]	0,9	2,8	4,5	17,6	32,8	51,1
	R60 $V_{Rk,s,fi}$	[kN]	0,6	2,1	3,3	11,4	21,3	33,2
	R90 $V_{Rk,s,fi}$	[kN]	0,4	1,3	2,1	5,3	9,8	15,3
	R120 $V_{Rk,s,fi}$	[kN]	0,3	0,9	1,5	2,2	4,1	6,4
Steel failure with lever arm								
Characteristic resistance in concrete ≥ C20/25	R30 $M^0_{Rk,s,fi}$	[kN]	0,9	2,9	5,8	27,3	69,5	135,5
	R60 $M^0_{Rk,s,fi}$	[kN]	0,6	2,1	4,2	17,8	45,2	88,1
	R90 $M^0_{Rk,s,fi}$	[kN]	0,4	1,3	2,7	8,2	20,9	40,7
	R120 $M^0_{Rk,s,fi}$	[kN]	0,3	0,9	1,9	3,4	8,7	17,0
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	2,0	2,0
Characteristic resistance	R30 $V_{Rk,cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R60 $V_{Rk, cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R90 $V_{Rk, cp,fi}$	[kN]	3,2	5,0	7,4	10,3	18,0	31,4
	R120 $V_{Rk, cp,fi}$	[kN]	2,5	4,0	5,9	8,2	14,4	25,2
Concrete edge failure								
Eff. length of anchor under shear loading	l_f	[mm]	50	60	70	80	100	125
Outside diameter of anchor	d_{nom}	[mm]	6	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} ≥ 300 mm and ≥ 2 · h_{ef}.

The seismic performance of anchors subjected to seismic loading is categorized by performance categories C1 and C2. Seismic performance category C1 provides anchor capacities only in terms of resistances at ultimate limit state, while seismic performance category C2 provides anchor capacities in terms of both resistances at ultimate limit state and displacements at damage limitation state and ultimate limit state.

Table 13 relates the seismic performance categories C1 and C2 to the seismicity level and building importance class. The level of seismicity is defined as a function of the product $a_g \cdot S$, where a_g is the design ground acceleration on Type A ground and S the soil factor both in accordance with EN 1998-1.

The value of a_g or that of the product $a_g \cdot S$ 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 13. 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 13 : Recommended seismic performance categories for metal anchors

Seismicity level [a]		**Importance Class acc. to EN 1998-1:2004, 4.2.5**			
Class	$a_g \cdot S$ [c]	**I**	**II**	**III**	**IV**
Very low [b]	$a_g \cdot S \le 0{,}05\,g$	No additional requirement			
Low [b]	$0{,}05\,g < a_g \cdot S \le 0{,}10\,g$	C1	C1 [d] or C2 [e]		C2
> low	$a_g \cdot S > 0{,}10\,g$	C1	C2		

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

b Definition according to EN 1998-1:2004, 3.2.1.

c a_g = design ground acceleration on Type A ground (EN 1998-1:2004, 3.2.1),
S = soil factor (see e.g. EN 1998-1:2004, 3.2.2).

d C1 for Type 'B' connections (see TR045 §5.1) for fixings of non-structural elements to structures

e C2 for Type 'A' connections (see TR045 § 5.1) for fixings structural elements to structures

Table 14 : Reduction factor α_{seis}

Loading	Failure mode	Single anchor [1)]	Anchor Group
Tension	Steel failure	1,0	1,0
	Pull-out failure	1,0	0,85
	Concrete cone failure	0,85	0,75
	Splitting failure	1,0	0,85
Shear	Steel failure	1,0	0,85
	Concrete edge failure	1,0	0,85
	Concrete pryout failure	0,85	0,75

[1)] In case of tension loading single anchor also addresses situations where only 1 anchor in a group of anchors is subjected to tension.

The seismic design shall be carried out according to TR045 Technical Report "Design of metal anchors for use in concrete underseismic actions". The characteristic seismic resistance $R_{k,seis}$ ($N_{Rk,seis}$, $V_{Rk,seis}$) of a fastening shall be calculated for each failure mode as follows :

$$R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot R^0_{k,seis}$$

Where

α_{gap} Reduction factor to take into account inertia effects due to an annular gap between anchor and fixture in case of shear loading;
= 1.0 in case of no hole clearance between anchor and fixture ;
= 0.5 in case of connections with standart hole clearance according ETAG 001 Annex C Table 4.1.

α_{seis} Reduction factor to take into account the influence of large cracks and scatter of load displacement curves, see Table 14;

$R^0_{k,seis}$ Basic characteristic seismic resistance for a given failure mode :

For steel and pull-out failure under tension load and steel failure under shear load $R^0_{k,seis}$ (i.e. $N_{Rk,s,seis}$, $N_{Rk,p,seis}$, $V_{Rk,s,seis}$) shall be taken from :
- Annex C11 for performance category C1
- Annex C12 for performance category C2

For all other failure modes $R^0_{k,seis}$ shall be determined as for the design situation for static and quasi-static loading according to ETAG 001, Annex C (i.e. $N_{Rk,c}$, $N_{Rk,sp}$, $V_{Rk,c}$, $V_{Rk,cp}$).

Table 15: Characteristic values for resistance in case of seismic performance category C1 acc. TR045 “Design of Metal anchor under Seismic Actions”

Anchor sizes			M6	M8	M10	M12	M16	M20
Tension load								
Steel failure								
Characteristic resistance	$N_{Rk,s,seis}$	[kN]	-	-	46	67	126	-
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]	-	-	9,2	25,8	36	-
Partial safety factor[1)]	$\gamma_{Mp,\ seis}$	[-]	-	-	1,5			-
Shear loads								
Steel failure without lever arm								
Characteristic resistance	$V_{Rk,s,seis}$	[kN]	-	-	17,1	28,4	60,5	-
Partial safety factor[1)]	$\gamma_{Ms,\ seis}$	[-]	-	-	1,25			-

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

Table 16: Characteristic values for resistance in case of seismic performance category C2 acc. TR045 "Design of Metal anchor under Seismic Actions"

Anchor sizes			**M6**	**M8**	**M10**	**M12**	**M16**	**M20**
Tension load								
Steel failure								
Characteristic resistance [2]	$N_{Rk,s,seis}$	[kN]	-	-	46	67	126	-
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]	-	-	5,3	9,4	16,5	-
Partial safety factor [3]	$\gamma_{Mp,\ seis}$	[-]	-	-	1,5			-
Displacement at DLS [1) 2)]	$\delta_{N,seis\ (DSL)}$	[mm]	-	-	3,76	2,64	6,56	-
Displacement at ULS [1) 2)]	$\delta_{N,seis\ (ULS)}$	[mm]	-	-	15,87	12,09	17,75	-
Shear loads								
Steel failure without lever arm								
Characteristic resistance [2]	$V_{Rk,s,seis}$	[kN]	-	-	14,5	28,4	58,1	-
Partial safety factor [3]	$\gamma_{Ms,\ seis}$	[-]	-	-	1,5			-
Displacement at DLS [1) 2)]	$\delta_{V,seis\ (DSL)}$	[mm]	-	-	2,41	5,83	6,62	-
Displacement at ULS [1) 2)]	$\delta_{V,seis\ (ULS)}$	[mm]	-	-	7,48	8,92	11,14	-

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.

DLS: Damage Limitation State

ULS: Ultimate Limit State

SPIT TRIGA Z XTREM expansion anchor	**Annex C12**
Design according to TR045 Characteristic resistance under seismic actions	

Table 17: Displacements under tension loading

Screw, threaded rod and countersunk head versions			M6	M8	M10	M12	M16	M20
Tension load in non-cracked concrete C20/25 [kN]			7,7	9,5	14,1	17,2	24,0	33,5
Displacement	δ_{N0}	[mm]	0,1	0,1	0,1	0,1	0,1	0,1
	$\delta_{N\infty}$	[mm]	0,1	0,1	0,1	0,1	0,1	0,1
Tension load in non-cracked concrete C50/60 [kN]			7,7	13,9	21,8	26,6	37,2	51,9
Displacement	δ_{N0}	[mm]	0,1	0,2	0,4	0,5	0,8	1,2
	$\delta_{N\infty}$	[mm]	0,1	0,2	0,4	0,5	0,8	1,2
Tension load in cracked concrete C20/25 [kN]			2,4	5,7	7,6	12,3	17,1	23,9
Displacement	δ_{N0}	[mm]	0,6	0,6	0,6	0,7	0,7	0,8
	$\delta_{N\infty}$	[mm]	0,6	0,6	0,7	0,7	1,0	1,0
Tension load in cracked concrete C50/60 [kN]			3,7	8,9	11,8	19,0	26,6	37,1
Displacement	δ_{N0}	[mm]	0,7	0,9	1,1	1,3	1,7	2,2
	$\delta_{N\infty}$	[mm]	0,7	0,9	1,1	1,3	1,7	2,2

Table 18: Displacements under shear loads

Screw and countersunk head versions			M6	M8	M10	M12	M16	M20
Shear load in cracked and non-cracked concrete C20/25 to C50/60		**[kN]**	13,4	18,6	28,1	41,5	67,0	99,1
Displacement	δ_{V0}	[mm]	6,0 (+1,5)	6,4 (+1,5)	6,9 (+1,5)	7,4 (+1,5)	8,3 (+2,0)	9,4 (+2,0)
	$\delta_{V\infty}$	[mm]	9,0 (+1,5)	9,7 (+1,5)	10,4 (+1,5)	11,0 (+1,5	12,4 (+2,0)	14,1 (+2,0)

Threaded rod versions			M6	M8	M10	M12	M16	M20
Shear load in cracked and non-cracked concrete C20/25 to C50/60		**[kN]**	8,2	10,9	17,7	27,1	53,2	62,8
Displacement	δ_{V0}	[mm]	4,5 (+1,5)	4,8 (+1,5)	5,0 (+1,5)	5,3 (+1,5)	5,8 (+2,0	6,5 (+2,0)
	$\delta_{V\infty}$	[mm]	6,7 (+1,5)	7,1 (+1,5)	7,5 (+1,5)	7,9 (+1,5)	8,8 (+2,0)	9,8 (+2,0)

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