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European Technical Assessment

ETA-16/0934
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General Part

Technical Assessment Body issuing the European Technical Assessment	**ZAG Ljubljana**
Trade name of the construction product	**Sormat through bolts S-KA+/ S-KAK+/ S-KAH+/ S-KAH+ HCR**
Product family to which the construction product belongs	**33: Torque controlled expansion anchor of sizes M8, M10, M12 and M16 for use in concrete**
Manufacturer	**SORMAT OY** **Harjutie 5** **21290 RUSKO** **Finland** www.sormat.com
Manufacturing plant	**Sormat Plant 1**
This European Technical Assessment contains	17 pages including 14 annexes, which form an integral part of the document
This European Technical Assessment is issued in according to Regulation (EU) No 305/2011, on the basis of	EAD 330232-00-0601, edition October 2016
This version replaces	ETA-16/0934 issued on 06.05.2019

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Specific Parts

1 Technical description of the product

The Sormat through bolts S-KA+/S-KAK+/S-KAH+/S-KAH+ HCR is an anchor made of zinc plated carbon steel (S-KA+), hot dip galvanized carbon steel (S-KAK+), stainless steel (S-KAH+) and high corrosion resistant stainless steel (S-KAH+ HCR). It consists of a bolt, expansion sleeve, hexagonal nut and washer.

Anchors are made in sizes M8, M10, M12 and M16. Anchor is placed into a drilled hole and anchored by torque-controlled expansion.

For the installed anchor see Figure given in Annex A1.

2 Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

The performances given in Chapter 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex 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 manufacturer, 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 and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

The basic work requirements for mechanical resistance and stability are listed in Annexes C1 and C2 for static and quasi-static loading and in Annexes C6 and C7 for seismic performance.

3.2 Safety in case of fire (BWR 2)

The basic work requirements for safety in case of fire are listed in Annexes C3 and C4.

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if specifications of intended use according to Annex B1 are kept.

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4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the decision 96/582/EC of the European Commission[1] the system of assessment and verification of constancy of performance (see Annex V to regulation (EU) No 305/2011) **1** apply.

5 Technical details necessary for the implementation of the AVCP system, as provided for on the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in chapter 3 of EAD 330232-00-0601.

Issued in Ljubljana on 12.03.2020

Signed by:

Franc Capuder, M.Sc., Research Engineer

Head of Service of TAB

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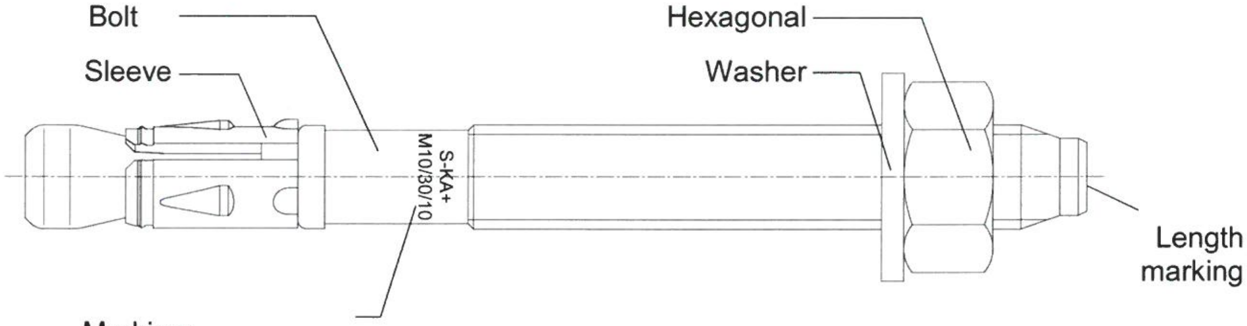
1 Official Journal of the European Communities L 254 of 8.10.1996

SORMAT through bolt



Marking:

S-KA+:	S-KA+ M…/$t_{fix,max}$/$t_{fix,min}$	- zinc plated
S-KAK+:	S-KAK+ M…/$t_{fix,max}$/$t_{fix,min}$	- hot dip galvanized
S-KAH+:	S-KAH+ M…/$t_{fix,max}$/$t_{fix,min}$	- stainless steel A4
S-KAH+ HCR:	S-KAH+ HCR M…/$t_{fix,max}$/$t_{fix,mi}$	- high corrosion resistant stainless steel

Length marking:

Length marking	A	B	C	D	E	F
Length (mm)	38,1-50,8	50,8-63,5	63,5-76,2	76,2-88,9	88,9-101,6	101,6-114,3

Length marking	G	H	I	J	K
Length (mm)	114,3-127,0	127,0-139,7	139,7-152,4	152,4-165,1	165,1-177,8

Length marking	L	M	N	O	P
Length (mm)	177,8-190,5	190,5-203,2	203,2-215,9	215,9-228,6	228,6-241,3

Length marking	Q	R	S
Length (mm)	241,3-254,0	254,0-279,4	279,4-304,8

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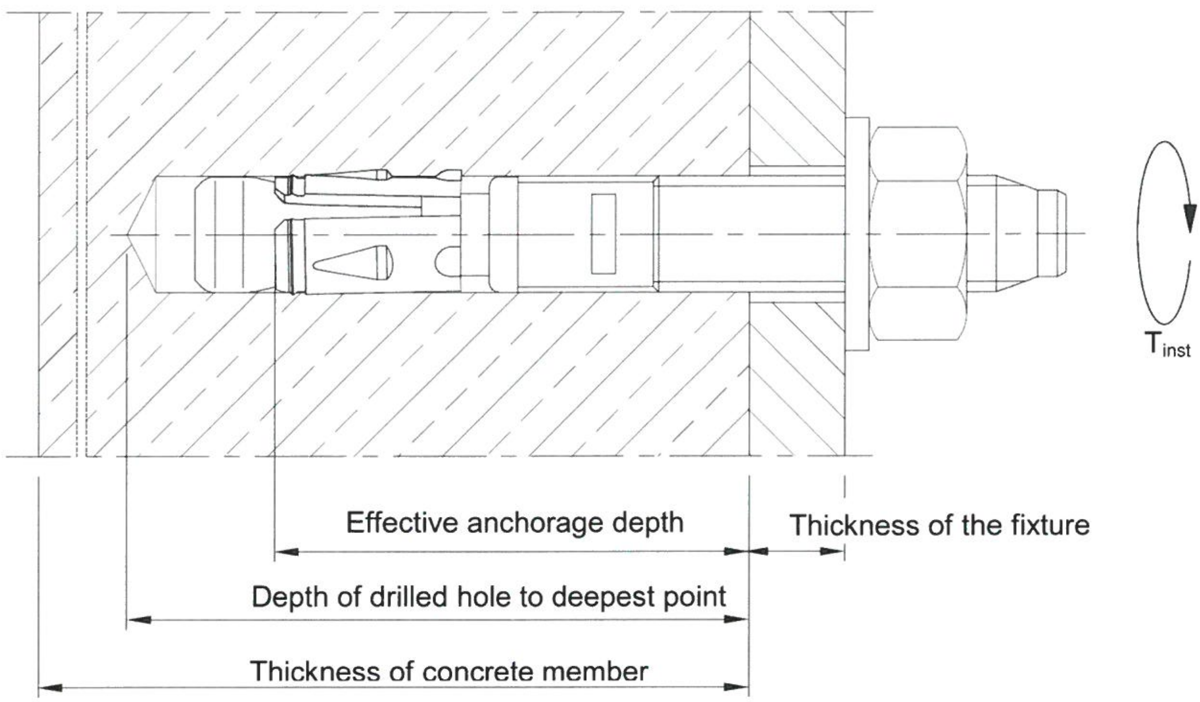
Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	**Annex A1**
Product description Product	

SORMAT through bolt after installation



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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	Annex A2
Product description Installation condition	

SORMAT through bolt

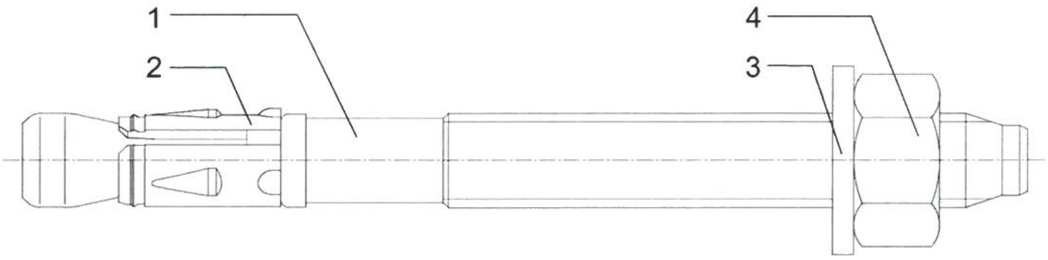

Table A1: Materials for S-KA+ and S-KAK+

Part	Designation	Material [1) 2)]
1	Bolt	Cold forged carbon steel, EN 10263-2
2	Sleeve	Cold rolled galvanized steel strip, EN 10346 or stainless strip, EN 10088-2
3	Washer	Steel, DIN 125 (EN ISO 7089), DIN 440 (EN ISO 7094), DIN 9021 (EN ISO 7093)
4	Hexagonal nut	Steel, electroplated, property class 8, DIN 934 (EN ISO 4032)

[1)] **S-KA+:** Parts 1,3 and 4 are zinc electroplated according to EN ISO 4042 ≥ 5μm and bright passivated
[2)] **S-KAK+:** Parts 1,3 and 4 are hot dip galvanized according to EN ISO 10684 ≥ 50 μm

Table A2: Materials for S-KAH+

Part	Designation	Material
1	Bolt	Cold forged stainless steel, EN 10088-3
2	Sleeve	Stainless steel strip, EN 10088-2
3	Washer	Stainless steel, DIN 125 (EN ISO 7089), DIN 440 (EN ISO 7094), DIN 9021 (EN ISO 7093)
4	Hexagonal nut	Stainless steel, property class 80, DIN 934 (EN ISO 4032)

Table A3: Materials for S-KAH+ HCR

Part	Designation	Material
1	Bolt	Cold forged stainless steel, EN 10088-3 1.4529/1.4565
2	Sleeve	Stainless steel strip, EN 10088-2
3	Washer	Stainless steel, W 1.4529 / 1.4565, DIN 125 (EN ISO 7089), DIN 440 (EN ISO 7094), DIN 9021 (EN ISO 7093)
4	Hexagonal nut	Stainless steel, property class 70, W 1.4529 / 1.4565 DIN 934 (EN ISO 4032)

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	**Annex A3**
Product description Materials	

Specifications of intended use

Anchorages subjected to:

- Static, quasi static and seismic load,
- fire exposure.

Base materials:

- Cracked and non-cracked concrete.
- Reinforced and unreinforced normal weight concrete of strength class C20/25 at minimum and C50/60 at maximum according to EN 206:2013+A1:2016.

Use conditions (Environmental conditions):

- The S-KA+ and S-KAK+ anchors may be used in concrete subject to dry internal conditions.
- The S-KAH+ anchors may be used in concrete subject to dry internal conditions and also in concrete subject to external atmospheric exposure (including industrial and marine environment), or exposure in permanently damp internal conditions, if no particular aggressive conditions exist.
- The S-KAH+ HCR anchors may be used in concrete subject to dry internal conditions and also in concrete subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions.

  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. desulphurization plants or road tunnels where de-icing materials are used).

Design:

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Anchorages under static and quasi-static actions are designed in accordance with EOTA TR 055, Edition December 2016 or EN 1992-4:2018.
- For seismic application the anchorages are designed in accordance with EOTA 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 the method given in EOTA TR 020, Edition May 2004.
- Verifiable calculation notes and drawings are prepared taking into account of the load to be anchored. The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.).

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters on 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 using the appropriate tools.
- Checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower that of the concrete to which the characteristic loads apply for.
- Check of concrete being well compacted, e.g. without significant voids.
- Cleaning of the hole of drilling dust.
- Anchor installation ensuring the specified embedment depth.
- Keeping of the edge distance and spacing to the specified values without minus tolerances.
- 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 non-shrinkage mortar. No shear or oblique tension loads are allowed in the direction of a not filled aborted hole.
- Application of the torque moment given in Annex B2 using a calibrated torque wrench.

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	**Annex B1**
Intended use Specifications	

SORMAT through bolt

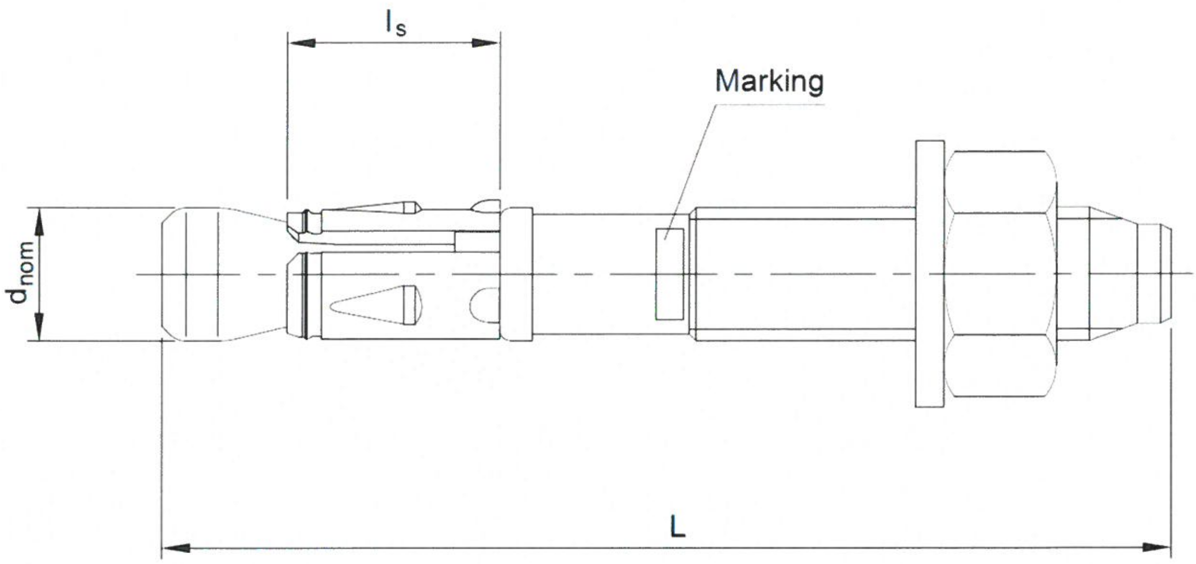

Table B1: Dimension of an anchor

Size	Nominal diameter d_{nom} [mm]	Sleeve length l_s [mm]	Total length L [mm]
M8	8	14,8	62 … 420
M10	10	17,9	62 … 420
M12	12	19,1	78 … 420
M16	16	26,0	118 … 420

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	Annex B2
Intended use Anchor dimensions	

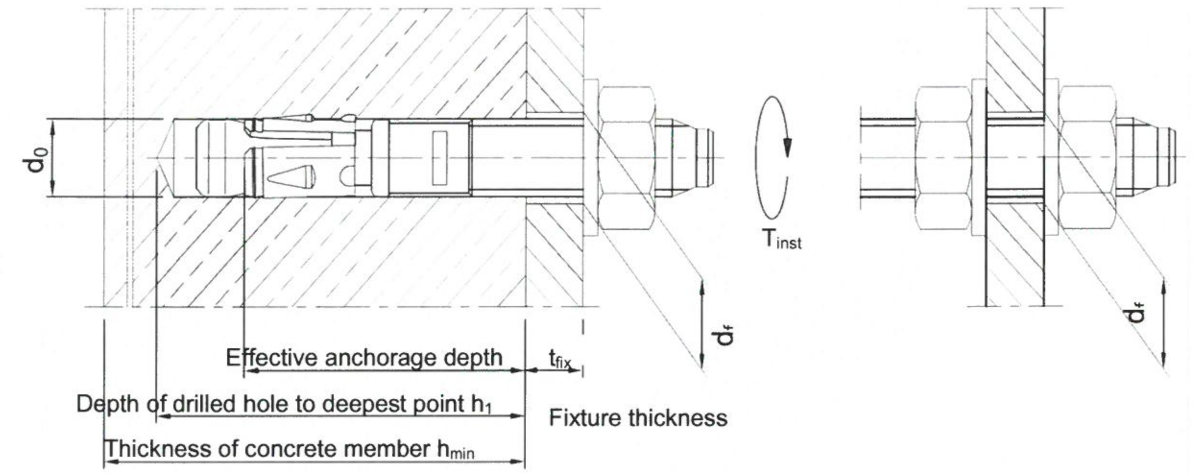

Table B2: Installation data

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR			Anchor size					
			M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
Drill hole diameter	d_0	[mm]	8	10	10	12	12	16
Cutting diameter at the upper tolerance limit (maximum diameter bit)	$d_{cut,max} \leq$	[mm]	8,45	10,45	10,45	12,50	12,50	16,50
Depth of drilled hole to deepest point	$h_1 \geq$	[mm]	60	55	75	70	90	110
Effective anchorage depth	h_{ef}	[mm]	48	40	60	50	70	85
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	9	12	12	14	14	18
Thickness of the fixture	$t_{fix,max}$	[mm]	358	358	338	342	322	302
Required torque S-KA+/S-KAK+	T_{inst}	[Nm]	15	30	30	60	60	110
S-KAH+/S-KAH+ HCR			20	45	45	60	60	110

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Intended use

Installation data

Annex B3

Table B3: Minimum thickness of concrete member, spacing and edge distance

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR			Anchor size					
			M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
Minimum thickness of concrete member	h_{min}	[mm]	100	100	120	100	140	170
	$h_{min\text{-}red}$	[mm]	80	/	100	/	/	/
Minimum spacing for h_{min}	s_{min}	[mm]	35	50	40	55	60	65
	$c \geq$	[mm]	50	95	60	110	70	95
Minimum edge distance for h_{min}	c_{min}	[mm]	40	50	50	60	55	65
	$s \geq$		55	190	100	215	110	150
Minimum spacing for $h_{min\text{-}red}$	s_{min}	[mm]	35	/	40	/	/	/
	$c \geq$	[mm]	55	/	100	/	/	/
Minimum edge distance for $h_{min\text{-}red}$	c_{min}	[mm]	40	/	60	/	/	/
	$s \geq$		60	/	90	/	/	/

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Intended use

Installation data

Annex B4

Table C1: Characteristic resistances under tension loads in case of static and quasi-static loading for design according EOTA TR 055 or EN 1992-4:2018

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR				Anchor size					
				M8	M10-red	M10	M12-red	M12	M16
Steel failure									
Characteristic resistance	S-KA+/ S-KAK+	$N_{Rk,s}$	[kN]	15	26	26	39	39	73
	S-KAH+/ S-KAH+ HCR			15	26	26	40	40	73
Partial safety factor		γ_{Ms} [2)]	[-]	1,4					
Pull-out failure									
Characteristic resistance in **cracked** concrete C20/25		$N_{Rk,p}$	[kN]	8,5	1)	12	1)	16	24
Characteristic resistance in **non-cracked** concrete C20/25		$N_{Rk,p}$	[kN]	11	12	19	1)	25	36
Increasing factor for $N_{Rk,p}$		ψ_C	C25/30	1,09	1,12	1,07	1,12	1,11	1,10
			C30/37	1,17	1,22	1,13	1,22	1,21	1,18
			C35/45	1,23	1,32	1,17	1,32	1,29	1,25
			C40/50	1,30	1,41	1,23	1,41	1,38	1,32
			C45/55	1,37	1,50	1,28	1,50	1,46	1,39
			C50/60	1,43	1,58	1,33	1,58	1,53	1,46
Partial safety factor		γ_{inst} [2)]	[-]	1,0					
		γ_{Mp} [3)]	[-]	1,5[3)]					
Concrete cone and splitting failure									
Effective anchorage depth		h_{ef}	[mm]	48	40	60	50	70	85
Factor for cracked concrete		k_{cr}	[-]	7,7					
Factor for non-cracked concrete		k_{ucr}	[-]	11,0					
Spacing		$s_{cr,N}$	[mm]	144	120	180	150	210	254
Edge distance		$c_{cr,N}$	[mm]	72	60	90	75	105	127
Spacing (splitting)		$s_{cr,sp}$	[mm]	192	160	240	200	280	340
Edge distance (splitting)		$c_{cr,sp}$	[mm]	96	80	120	100	140	170
Partial safety factor		γ_{Msp} [2)]	[-]	1,5					

1) Pull-out failure is not decisive
2) In absence of other national regulations
3) The installation safety factor of γ_{inst} = 1,0 is included

Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Performance

Characteristic resistance under tension loads

Annex C1

Table C2: Characteristic resistances under shear loads in case of static and quasi-static loading for design according to EOTA TR 055 or EN 1992-4:2018

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/ S-KAH+ HCR				Anchor size					
				M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
Steel failure without lever arm									
Characteristic resistance	S-KA+/ S-KAK+	$V_{Rk,s}$	[kN]	12,6	20,4	20,4	30,0	30,0	54,1
	S-KAH+/ S-KAH+ HCR			15,8			34,4	34,4	68,6
Partial safety factor		γ_{Ms} 1)	[-]	1,25					
Factor for considering ductility		k_7	[-]	1,0					
Steel failure with lever arm									
Characteristic resistance	S-KA+/ S-KAK+	$M^0_{Rk,s}$	[Nm]	26,3	51	51	90	90	219,8
	S-KAH+/ S-KAH+ HCR			25,1					214,8
Partial safety factor		γ_{Ms} 1)	[-]	1,25					
Concrete pryout failure									
k-factor		k_8	[-]	1,94	3,31	3,31	2,84	2,84	2,71
Partial safety factor		γ_{Mc} 1)	[-]	1,5					
Concrete edge failure									
Effective length of anchor under shear load		l_f	[mm]	48	40	60	50	70	85
Outside diameter of anchor		d_{nom}	[mm]	8	10		12		16
Cracked concrete without any edge reinforcement		$\Psi_{re,V}$	[-]	1,0					
Cracked concrete with straight edge reinforcement > Ø12 mm				1,2					
Cracked concrete with edge reinforcement and closely spaced stirrups (a ≤ 100mm) or **non-cracked concrete**				1,4					
Partial safety factor		γ_{Mc} 1)	[-]	1,5					

1) In absence of other national regulations

Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Performance

Characteristic resistance under shear loads

Annex C2

Table C3: Characteristic resistances under tension loads in case of fire exposure for design according to EOTA TR 020 or EN 1992-4:2018

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR				Anchor size					
				M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
Steel failure									
Characteristic resistance $N_{Rk,s,fi}$	S-KA+/S-KAK+	R30	[kN]	1,31	2,09	2,09	3,05	3,05	5,69
		R60	[kN]	1,05	1,66	1,66	2,40	2,40	4,47
		R90	[kN]	0,80	1,24	1,24	1,74	1,74	3,25
		R120	[kN]	0,67	1,02	1,02	1,41	1,41	2,64
	S-KAH+/ S-KAH+ HCR	R30	[kN]	3,92	6,66	6,66	10,25	10,25	19,09
		R60	[kN]	2,70	4,59	4,59	7,07	7,07	13,16
		R90	[kN]	1,48	2,52	2,52	3,88	3,88	7,23
		R120	[kN]	0,87	1,48	1,48	2,29	2,29	4,26
Pull-out failure									
Characteristic resistance $N_{Rk,p,fi}$		R30	[kN]	2,13	1)	3,00	1)	4,00	6,00
		R60	[kN]	2,13	1)	3,00	1)	4,00	6,00
		R90	[kN]	2,13	1)	3,00	1)	4,00	6,00
		R120	[kN]	1,70	1)	2,40	1)	3,20	4,80
Concrete cone and splitting failure 2)									
Characteristic resistance $N^0_{Rk,c,fi}$		R30	[kN]	2,87	1,82	5,02	3,18	7,38	11,98
		R60	[kN]	2,87	1,82	5,02	3,18	7,38	11,98
		R90	[kN]	2,87	1,82	5,02	3,18	7,38	11,98
		R120	[kN]	2,30	1,46	4,02	2,55	5,90	9,59
Spacing		$s_{cr,N,fi}$	[mm]	$4 \times h_{ef}$					
		s_{min}	[mm]	35	50	40	55	60	65
Edge distance		$c_{cr,N,fi}$	[mm]	$2 \times h_{ef}$					
		c_{min}	[mm]	Fire attack from one side: $c_{min} = 2 \times h_{ef}$					
				Fire attack from more than one side: $c_{min} \geq 300$ mm and $\geq 2 \times h_{ef}$					

1) Pull-out isn't decisive

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

Design under fire exposure is performed according to the design method given in EOTA TR 020.

Under fire exposure usually cracked concrete is assumed. The design equations are given in EOTA TR 020 § 2.2.1.

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

Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	**Annex C3**
Performance Characteristic tension resistance under fire exposure	

Table C4: Characteristic resistances under shear loads in case of fire exposure for design according to EOTA TR 020 or EN 1992-4:2018

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR				Anchor size					
				M8	M10-red	M10	M12-red	M12	M16
Steel failure without lever arm									
Characteristic resistance $V_{Rk,s,fi}$	S-KA+/S-KAK+	R30	[kN]	1,31	2,09	2,09	3,05	3,05	5,69
		R60	[kN]	1,05	1,66	1,66	2,40	2,40	4,47
		R90	[kN]	0,80	1,24	1,24	1,74	1,74	3,25
		R120	[kN]	0,67	1,02	1,02	1,41	1,41	2,64
	S-KAH+/ S-KAH+ HCR	R30	[kN]	3,92	6,66	6,66	10,25	10,25	19,09
		R60	[kN]	2,70	4,59	4,59	7,07	7,07	13,16
		R90	[kN]	1,48	2,52	2,52	3,88	3,88	7,23
		R120	[kN]	0,87	1,48	1,48	2,29	2,29	4,26
Steel failure with lever arm									
Characteristic resistance $M^0_{Rk,s,fi}$	S-KA+/S-KAK+	R30	[Nm]	0,38	1,12	1,12	2,62	2,62	6,66
		R60	[Nm]	0,34	0,97	0,97	1,97	1,97	4,99
		R90	[Nm]	0,26	0,75	0,75	1,70	1,70	4,33
		R120	[Nm]	0,19	0,60	0,60	1,31	1,31	3,33
	S-KAH+/ S-KAH+ HCR	R30	[Nm]	0,75	1,87	1,87	3,93	3,93	9,99
		R60	[Nm]	0,60	1,50	1,50	3,28	3,28	8,32
		R90	[Nm]	0,45	1,20	1,20	2,62	2,62	6,66
		R120	[Nm]	0,38	1,05	1,05	2,10	2,10	5,33
Concrete pryout failure									
k-factor		k_8	[-]	1,0	1,0	2,0	1,0	2,0	2,0
Characteristic resistance $V_{Rk,cp,fi}$		R30	[kN]	2,87	1,82	10,04	3,18	14,76	23,96
		R60	[kN]	2,87	1,82	10,04	3,18	14,76	23,96
		R90	[kN]	2,87	1,82	10,04	3,18	14,76	23,93
		R120	[kN]	2,30	1,46	8,04	2,55	11,80	19,18

Concrete edge failure

The initial value $V^0_{Rk,c,fi}$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:

$V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ (≤ R90) $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120)

with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.

Design under fire exposure is performed according to the design method given in EOTA TR 020.

Under fire exposure usually cracked concrete is assumed. The design equations are given in EOTA TR 020 § 2.2.1.

EOTA 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 x h_{ef}.

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

Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Performance

Characteristic shear resistance under fire exposure

Annex C4

Table C5: Displacements under tension loads for static and quasi-static loading

SORMAT through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR			Anchor size					
			M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
Cracked C20/25 – C50/60	**N**	**[kN]**	**4,1**	**4,3**	**5,7**	**6,1**	**7,6**	**11,4**
	δ_{N0}	[mm]	0,981	0,494	0,619	0,541	0,241	0,777
	$\delta_{N\infty}$	[mm]	1,470	0,976	1,367	0,981	1,263	2,211
Non-cracked C20/25 - C50/60	**N**	**[kN]**	**5,2**	**5,7**	**9,0**	**8,5**	**11,9**	**17,1**
	δ_{N0}	[mm]	0,188	0,064	0,270	0,052	0,105	0,135
	$\delta_{N\infty}$	[mm]	1,470	0,976	1,367	0,981	1,263	2,211

Table C6: Displacements under shear loads for static and quasi-static loading

Cracked and non-cracked concrete C20/25 - C50/60			Anchor size					
			M8	**M10-red**	**M10**	**M12-red**	**M12**	**M16**
SORMAT through bolt S-KA+/S-KAK+	**V**	**[kN]**	**7,2**	**10,5**	**10,5**	**16,4**	**16,4**	**30,9**
	δ_{V0}	[mm]	1,090	1,943	0,680	2,438	2,127	2,778
	$\delta_{V\infty}$	[mm]	1,635	2,914	1,020	3,657	3,191	4,167
SORMAT through bolt S-KAH+/S-KAH+ HCR	**V**	**[kN]**	**9,0**	**10,5**	**10,3**	**16,4**	**16,4**	**39,2**
	δ_{V0}	[mm]	1,653	1,943	0,680	2,438	2,127	3,441
	$\delta_{V\infty}$	[mm]	2,480	2,914	1,020	3,657	3,191	5,162

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	Annex C5
Performance Displacements under tension and shear loads	

Table C7: Characteristic resistances in case of seismic action for design acc. EOTA TR 045: Performance Category C1 and C2

SORMAT through bolt S-KA+/S-KAH+/S-KAH+ HCR				Anchor size			
				M8	**M10**	**M12**	**M16**
Tension - steel failure							
Characteristic resistance **C1**		$N_{Rk,s,seis,C1}$	[kN]	15,0		-	-
Characteristic resistance **C2**	S-KA+	$N_{Rk,s,seis,C2}$	[kN]	-	26,0	39,0	73,0
	S-KAH+/ S-KAH+ HCR	$N_{Rk,s,seis,C2}$	[kN]	-	26,0	40,0	73,0
Partial safety factor		$\gamma_{Ms,seis}$ [1)]	[-]	1,4			
Tension - pull-out failure							
Characteristic resistance **C1**	S-KA+	$N_{Rk,p,seis,C1}$	[kN]	8,5		-	-
	S-KAH+/ S-KAH+ HCR	$N_{Rk,p,seis,C1}$	[kN]	8,4		-	-
Characteristic resistance **C2**	S-KA+	$N_{Rk,p,seis,C2}$	[kN]	-	2,7	2,8	10,2
	S-KAH+/ S-KAH+ HCR	$N_{Rk,p,seis,C2}$	[kN]	-	3,2	3,3	11,1
Partial safety factor		$\gamma_{Mp,seis}$ [1)]	[-]	1,5 [2)]			
Concrete cone and splitting failure [3)]							
Effective anchorage depth		h_{ef}	[mm]	48	60	70	85
Partial safety factor		$\gamma_{Mc,seis}$ [1)] $\gamma_{Msp,seis}$ [1)]	[-]	1,5 [2)]			
Shear - steel failure without lever arm							
Characteristic resistance **C1**	S-KA+	$V_{Rk,s,seis,C1}$	[kN]	8,1		-	-
	S-KAH+/ S-KAH+ HCR	$V_{Rk,s,seis,C1}$	[kN]	7,9		-	-
Characteristic resistance **C2**	S-KA+	$V_{Rk,s,seis,C2}$	[kN]	-	8,5	13,8	30,7
	S-KAH+/ S-KAH+ HCR	$V_{Rk,s,seis,C2}$	[kN]	-	9,4	14,4	30,8
Partial safety factor		$\gamma_{Ms,seis}$ [1)]	[-]	1,25			
Concrete pryout and concrete edge failure [3)]							
Effective anchorage depth		h_{ef}	[mm]	48	60	70	85
Partial safety factor		$\gamma_{Mc,seis}$ [1)]	[-]	1,5 [2)]			

[1)] In absence of other national regulations
[2)] The installation safety factor of γ_2 = 1,0 is included
[3)] For concrete cone, splitting, pryout and edge failure, see EOTA TR 045

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR	**Annex C6**
Performance Characteristic resistances under seismic action Performance category C1 and C2	

Table C8: Displacements in case of seismic action for desgin acc. EOTA TR 045: Performance Category C2

SORMAT through bolt S-KA+/S-KAH+/S-KAH+ HCR				Anchor size			
				M8	M10	M12	M16
Displacement under tension loads							
Displacement **DLS**	S-KA+	$d_{N,seis}$	[mm]	-	3,1	5,6	4,0
	S-KAH+/S-KAH+ HCR	$d_{N,seis}$	[mm]	-	2,8	6,0	4,7
Displacement **ULS**	S-KA+	$d_{N,seis}$	[mm]	-	10,7	16,7	14,0
	S-KAH+/S-KAH+ HCR	$d_{N,seis}$	[mm]	-	6,8	15,5	15,1
Displacement under shear loads							
Displacement **DLS**	S-KA+	$d_{V,seis}$	[mm]	-	3,9	3,6	3,7
	S-KAH+/S-KAH+ HCR	$d_{V,seis}$	[mm]	-	4,5	4,7	3,9
Displacement **ULS**	S-KA+	$d_{V,seis}$	[mm]	-	5,8	5,3	6,8
	S-KAH+/S-KAH+ HCR	$d_{V,seis}$	[mm]	-	7,6	7,5	7,7

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Sormat through bolt S-KA+/S-KAK+/ S-KAH+/S-KAH+ HCR

Performance

Displacements under seismic action
Performance category C2

Annex C7