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European Technical Assessment

ETA-16/0934
of 2. 4. 2025

English version prepared by ZAG

General Part

**Technical Assessment Body issuing the
European Technical Assessment**

ZAG

Trade name of the construction product

**Sormat through bolts S-KA+,
S-KAK+, S-KAH +, S-KAH+ HCR /
EJOT through bolts BA-V Plus,
BA-F Plus, BA-E Plus, BA-E Plus 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

**EJOT SORMAT OY
Vähäkorventie 10
21250 MASKU
Finland
www.ejot.fi**

Manufacturing plant

EJOT Production Plants

**This European Technical Assessment
contains**

**17 pages including 3 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 330232-01-0601-v01,
edition February 2021**

This version replaces

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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 / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR is an anchor made of zinc plated carbon steel (S-KA+, S-KA+ / BA-V Plus), hot dip galvanized carbon steel (S-KAK+ / BA-F Plus) stainless steel (S-KAH+ / BA-E Plus) and high corrosion resistant stainless steel (S-KAH+ HCR / BA-E Plus 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 A(1/3).

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 C (1/7) and C (2/7) for static and quasi-static loading and in Annexes C (6/7) and C (7/7) 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 C (3/7) and C (4/7).

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if specifications of intended use according to Annex B (1/4) are kept. Sormat through bolt S-KAK+ / EJOT through bolt BA-F Plus are suitable for variable working life up to 50 years in accordance to Annex B, Table B.1.

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 Commission¹ 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

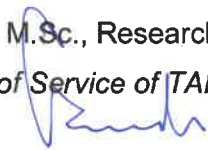
Technical details necessary for the implementation of the AVCP system are laid down in chapter 3 of EAD 330232-01-0601-v01.

Issued in Ljubljana on 2. 4. 2025

Signed by:

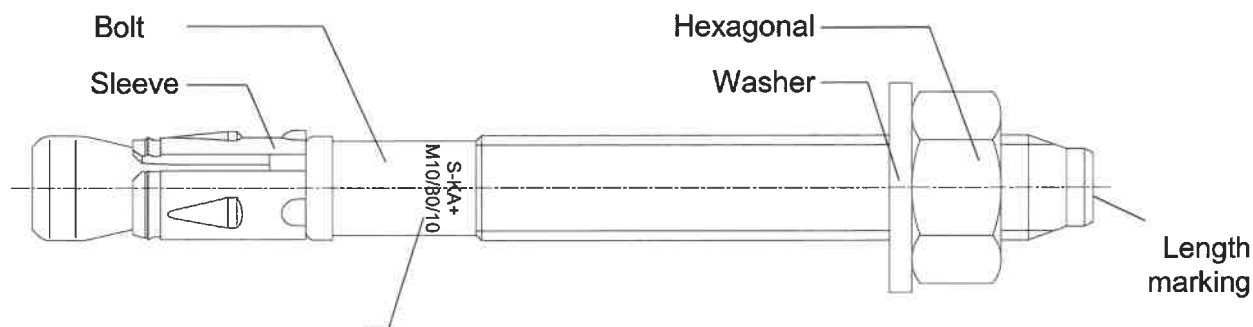
Franc Capuder, M.Sc., Research Engineer

Head of Service of TAB



¹ Official Journal of the European Communities L 254 of 8.10.1996

SORMAT through bolt / EJOT through bolt



Marking (optional):

S-KA+ / BA-V Plus:	S-KA+ M.../t _{fix,max} /t _{fix,min}	- zinc plated
S-KAK+ / BA-F Plus:	S-KAK+ M.../t _{fix,max} /t _{fix,min}	- hot-dip galvanized
S-KAH+ / BA-E Plus:	S-KAH+ M.../t _{fix,max} /t _{fix,min}	- stainless steel A4
S-KAH+ HCR / BA-E Plus HCR:	S-KAH+ HCR M.../t _{fix,max} /t _{fix,min}	- high corrosion resistant stainless steel

Length marking (optional):

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

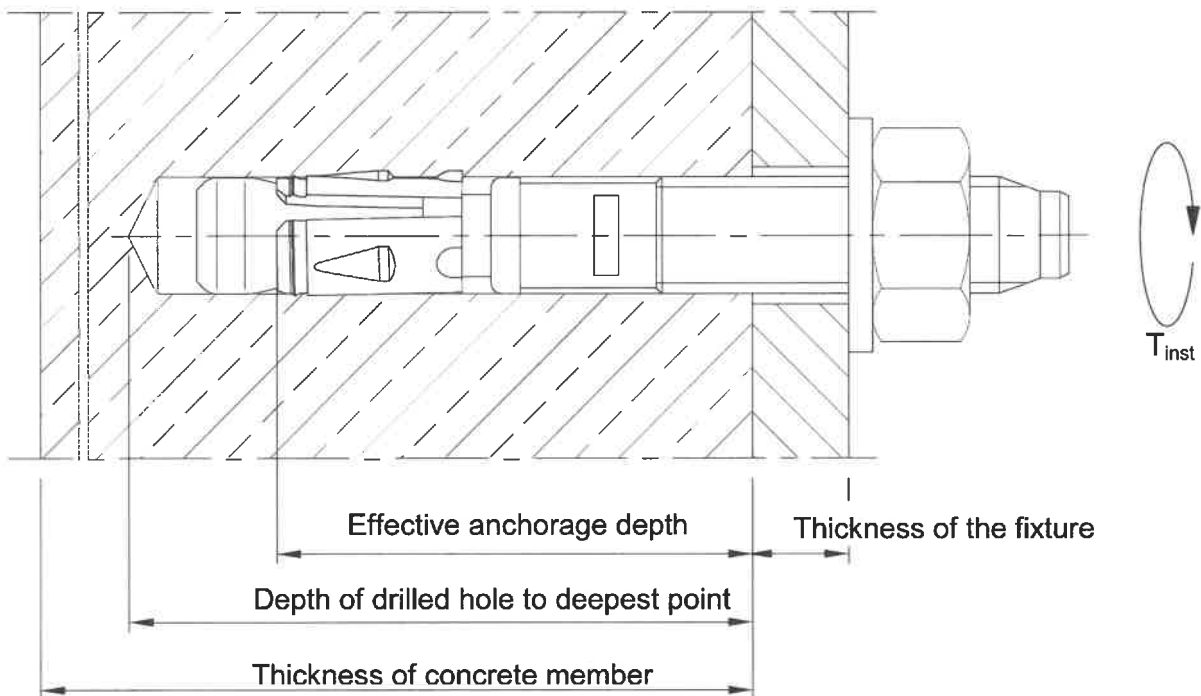
Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Product description

Product

Annex A (1/3)

SORMAT through bolt / EJOT Through bolt after installation



**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

Product description
Installation condition

Annex A (2/3)

SORMAT through bolt / EJOT Through bolt

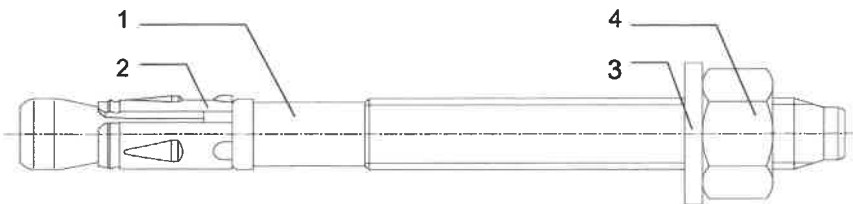


Table A1: Materials for S-KA+ / BA-V Plus, and S-KAK+ / BA-F Plus

Part	Designation	Material ^{1) 2)}
1	Bolt	Cold formed carbon steel, EN 10263-2 / Turned carbon steel, EN 10263-2 - for M12 and M16
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+ / BA-V Plus:** Parts 1,3 and 4 are zinc electroplated according to EN ISO 4042 $\geq 5\mu\text{m}$ and bright passivated;

²⁾ **S-KAK+ / BA-F Plus:** Parts 1,3 and 4 are hot dip galvanized according to EN ISO 10684 $\geq 50\ \mu\text{m}$

Table A2: Materials for S-KAH+ / BA-E Plus

Part	Designation	Material
1	Bolt	Cold formed 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 / BA-E Plus HCR

Part	Designation	Material
1	Bolt	Cold formed 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)

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR	Annex A (3/3)
Product description Materials	

Specifications of intended use

Anchorage 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+ / BA-V Plus anchors may be used in concrete subject to dry internal conditions.
- The S-KAK+ / BA-F Plus anchors may be used indoor and outdoor in concrete subject to dry internal conditions and to external atmospheric condition C1 – CX according to EAD 330232-01-0601-v01;
- The S-KAH+ / BA-E Plus 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 / BA-E Plus 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 application with resistance under fire exposure the anchorages are designed in accordance with the method given in EN 1992-4:2018, Annex D.
- For application with resistance under seismic load the anchorages are designed in accordance with EN 1992-4:2018, Annex C.
- 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 than that of the concrete to which the characteristic loads apply for.

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

**Intended use
Specifications**

Annex B (1/7)

Installation:

- 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.

Durability:

- Variable working life up to 50 years.

Table B1: Durability of hot dip galvanized coatings in accordance with EN ISO 10684 Chapter 8.3 for coatings with mean thickness of minimum 50 µm

Corrosivity category	Corrosivity	Durability
		Thickness according to Chapter 8.3 EN ISO 10684 $\geq 50 \mu\text{m}$ in average Durability [years]
C1	Very low	50 ¹⁾
C2	Low	50 ¹⁾
C3	Medium	25
C4	High	12,5
C5	Very high	5
CX	Extreme	2

¹⁾ Durability of coatings thickness of $\geq 50 \mu\text{m}$ in average is limited to 50 years

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

**Intended use
Specifications**

Annex B (2/7)

Table B2: Description of typical atmospheric environments **indoor**, related to the estimation of corrosivity categories according to EN ISO 9223-2012-02 Table C.1 and the corresponding durability categories according to EAD 330232-01-0601, chapter 2.2.20 a (1), (2)

Corrosivity category	Corrosivity	Typical environments - Examples	
		Indoor	EAD 330232 [1], chapter 2.2.20 a)
C1	Very low	Heated spaces with low relative humidity and insignificant pollution, e.g., offices, schools, museums	(1)
C2	Low	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution, e.g., storage, sport halls	(1)
C3	Medium	Spaces with moderate frequency of condensation and moderate pollution from production process, e.g., food-processing plants, laundries, breweries, dairies	(2)
C4	High	Spaces with high frequency of condensation and high pollution from production process, e.g., industrial processing plants, swimming pools	(2)
C5	Very high	Spaces with very high frequency of condensation and/or high pollution from production process, e.g., mines, caverns for industrial purposes, unventilated sheds in subtropical and tropical zones	(2)
CX	Extreme	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or high pollution from production process, e.g., unventilated sheds, humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion-stimulating particulate matter	(2)

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

**Intended use
Specifications**

Annex B (3/7)

Table B3: Description of typical atmospheric environments **outdoor**, related to the estimation of corrosivity categories according to EN ISO9223-2012-02, Table C.1 and the corresponding durability categories according to EAD 330232-01-0601, chapter 2.2.20 a) (1), (2)

Corrosivity category	Corrosivity	Typical environments - Examples	
		outdoor	EAD 330232 [1], chapter 2.2.20 a)
C1	Very low	Dry or cold zone, atmospheric environment with very low pollution and time of wetness, e.g. certain deserts, Arktik/Antarktik	(2)
C2	Low	Temperature zone, atmospheric environment with low SO ₂ pollution (lower than 5 µg/m ³), e.g., rural areas, small towns. Dry or cold zone, atmospheric environment with short time of wetness, e.g., deserts, subartic areas.	(2)
C3	Medium	Temperature zone, atmospheric environment with medium SO ₂ pollution (up to 30 µg/m ³), or some effect of chlorides, e.g., urban areas, coastal areas with low deposition of chlorides. Subtropical zone, atmospheric environment with low pollution.	(2)
C4	High	Temperature zone, atmospheric environment with high SO ₂ pollution (30 µg/m ³ to 90 µg/m ³), or substantial effect of chlorides, e.g., polluted urban areas, industrial areas, coastal areas without spray of salt water or exposure to strong effect of deicing salts. Subtropical and tropical zone, atmosphere with medium pollution.	(2)
C5	Very high	Temperature zone, atmospheric environment with very high SO ₂ pollution (90 µg/m ³ to 250 µg/m ³), or significant effect of chlorides, e.g., industrial areas, coastal areas, sheltered positions on coastline. Subtropical and tropical zone, atmosphere with medium pollution.	(2)
CX	Extreme	Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high SO ₂ pollution (higher than 250 µg/m ³) including accompanying and production factors and/or strong effect of chlorides, e.g., extreme industrial areas, coastal and offshore areas, occasional contact with salt spray.	(2)

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

**Intended use
Specifications**

Annex B (4/7)

SORMAT through bolt – EJOT through bolt

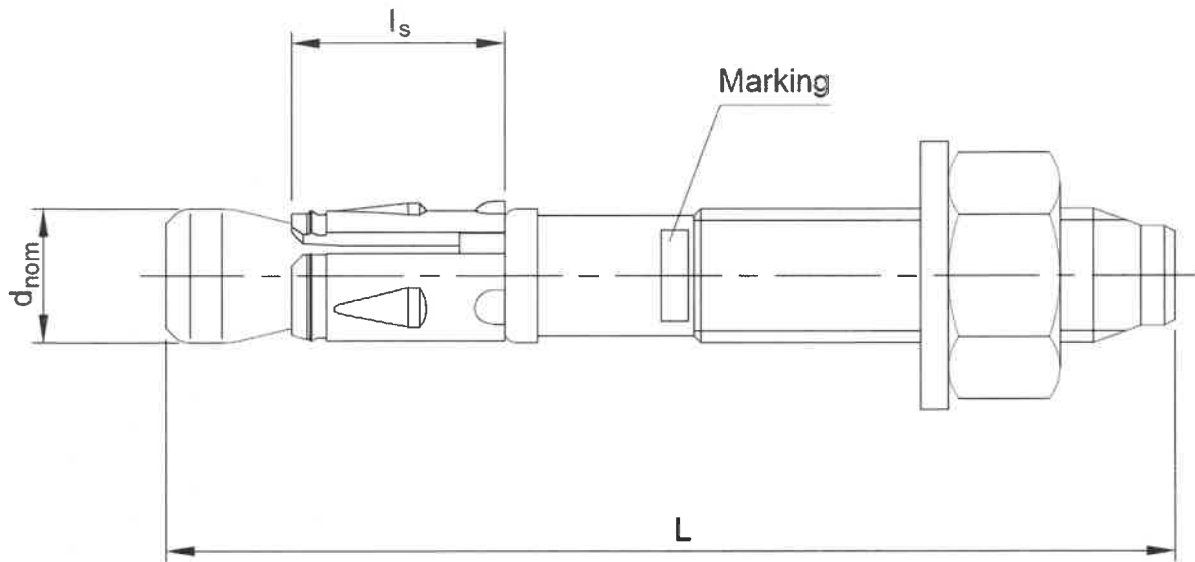


Table B1: Dimension of an anchor

Size	Nominal diameter d_{nom} [mm]	Sleeve length l_s [mm]	Total length L [mm]
M8	8	14,8	52 ... 420
M10	10	17,9	62 ... 420
M12	12	19,1	78 ... 420
M16	16	26,0	98 ... 420

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

Intended use
Anchor dimensions

Annex B (5/7)

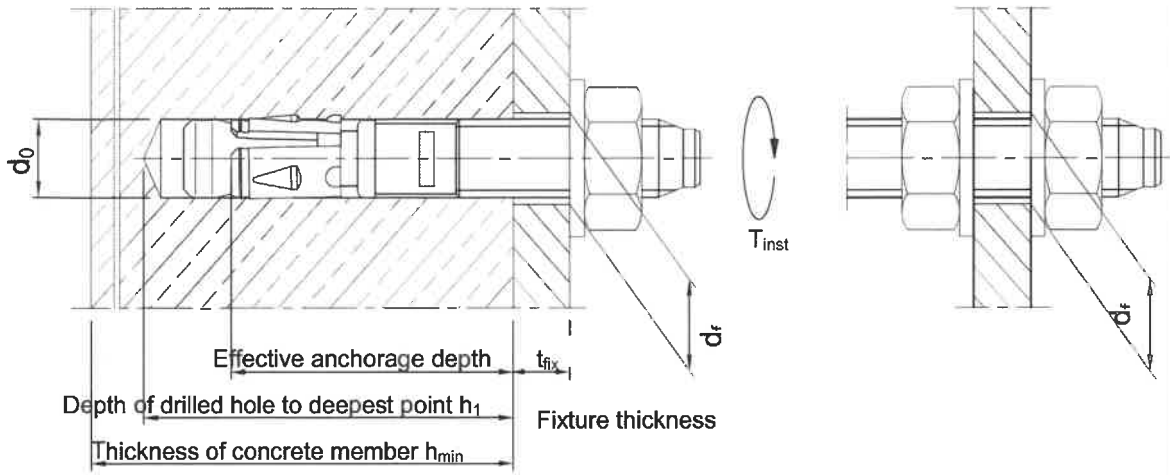


Table B2: Installation data

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR		Anchor size							
		M8-1	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Drill hole diameter	d_0 [mm]	8		10		12		16	
Cutting diameter at the upper tolerance limit (maximum diameter bit)	$d_{cut,max} \leq$ [mm]	8,45		10,45		12,50		16,50	
Depth of drilled hole to deepest point	$h_1 \geq$ [mm]	47	60	55	75	70	90	90	110
Effective anchorage depth	h_{ef} [mm]	35	48	40	60	50	70	65	85
Diameter of clearance hole in the fixture	$d_f \leq$ [mm]	9		12		14		18	
Thickness of the fixture	$t_{fix,max}$ [mm]	371	358	358	338	342	322	322	302
Required torque S-KA+, / BA-V Plus, S-KAK+ / BA-F Plus	T_{inst} [Nm]	15		30		60		110	
S-KAH+ / BA-E Plus, S-KAH+ HCR / BA-E Plus HCR		20		45		60		110	

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Intended use
Installation data

Annex B (6/7)

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

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR			Anchor size							
			M8-1	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Minimum thickness of concrete member	h_{min} [mm]		80	100	100	120	100	140	120	170
	$h_{min-red}$ [mm]		/	80	/	100	/	/	/	/
Minimum spacing for h_{min}	s_{min} [mm]		55	35	50	40	55	60	65	65
	$c \geq$ [mm]		75	50	95	60	110	70	100	95
Minimum edge distance for h_{min}	c_{min} [mm]		40	40	50	50	60	55	65	65
	$s \geq$ [mm]		140	55	190	100	215	110	200	150
Minimum spacing for $h_{min-red}$	s_{min} [mm]		/	35	/	40	/	/	/	/
	$c \geq$ [mm]		/	55	/	100	/	/	/	/
Minimum edge distance for $h_{min-red}$	c_{min} [mm]		/	40	/	60	/	/	/	/
	$s \geq$ [mm]		/	60	/	90	/	/	/	/

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

**Intended use
Installation data**

Annex B (7/7)

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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size							
				M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Steel failure											
Characteristic resistance	S-KA+ / BA-V Plus, S-KA+ / BA-V Plus S-KAK+ / BA-F Plus	$N_{Rk,s}$	[kN]	15	15	26	26	39	39	73	73
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR		[kN]	15	15	26	26	40	40	73	73
Partial safety factor		γ_{Ms} ³⁾	[-]	1,4							
Pull-out failure											
Characteristic resistance in cracked concrete C20/25		$N_{Rk,p}$	[kN]	5	8,5	²⁾	12	²⁾	16	²⁾	24
Characteristic resistance in non-cracked concrete C20/25		$N_{Rk,p}$	[kN]	8	11	12	19	²⁾	25	²⁾	36
Increasing factor for $N_{Rk,p}$		ψ_C	C25/30	1,08	1,09	1,12	1,07	1,12	1,11	1,11	1,10
			C30/37	1,14	1,17	1,22	1,13	1,22	1,21	1,20	1,18
			C35/45	1,20	1,23	1,32	1,17	1,32	1,29	1,29	1,25
			C40/50	1,26	1,30	1,41	1,23	1,41	1,38	1,37	1,32
			C45/55	1,31	1,37	1,50	1,28	1,50	1,46	1,44	1,39
			C50/60	1,35	1,43	1,58	1,33	1,58	1,53	1,51	1,46
Partial safety factor		γ_{inst} ³⁾	[-]	1,0							
		γ_{Mp} ⁴⁾	[-]	1,5 ⁴⁾							
Concrete cone and splitting failure											
Effective anchorage depth		h_{ef}	[mm]	35	48	40	60	50	70	65	85
Factor for cracked concrete		k_{cr}	[-]	7,7							
Factor for non-cracked concrete		k_{ucr}	[-]	11,0							
Spacing		$s_{cr,N}$	[mm]	106	144	120	180	150	210	195	254
Edge distance		$c_{cr,N}$	[mm]	53	72	60	90	75	105	98	127
Spacing (splitting)		$s_{cr,sp}$	[mm]	170	192	160	240	200	280	286	340
Edge distance (splitting)		$c_{cr,sp}$	[mm]	85	96	80	120	100	140	143	170
Partial safety factor		γ_{Msp} ³⁾	[-]	1,5							

¹⁾ For use in dry internal exposure and for statically indeterminate structural components

²⁾ Pull-out failure is not decisive

³⁾ In absence of other national regulations

⁴⁾ The installation safety factor of $\gamma_{inst} = 1,0$ is included

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Performance

Characteristic resistance under tension loads

Annex C (1/7)

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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size							
				M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Steel failure without lever arm											
Characteristic resistance	S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	$V_{Rk,s}$	[kN]	12,6		20,4		30,0	30,0	54,1	
	S-KAH+ / BA-E Plus, S-KAH+ HCR / BA-E Plus HCR			15,8				34,4	34,4	68,6	
Partial safety factor	γ_{Ms} ²⁾	[-]		1,25							
Factor for considering ductility	k_7	[-]		1,0							
Steel failure with lever arm											
Characteristic resistance	S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	$M^0_{Rk,s}$	[Nm]	26,3		51		90		219,8	
	S-KAH+ / BA-E Plus, S-KAH+ HCR / BA-E Plus HCR			25,1						214,8	
Partial safety factor	γ_{Ms} ²⁾	[-]		1,25							
Concrete pryout failure											
k-factor	k_8	[-]		2,21	1,94	3,31	3,31	2,84	2,84	2,71	2,71
Partial safety factor	γ_{Mc} ²⁾	[-]		1,5							
Concrete edge failure											
Effective length of anchor under shear load	l_f	[mm]		35	48	40	60	50	70	65	85
Outside diameter of anchor	d_{nom}	[mm]		8		10		12		16	
Partial safety factor	γ_{Mc} ²⁾	[-]		1,5							

¹⁾ For use in dry internal exposure and for statically indeterminate structural components

²⁾ In absence of other national regulations

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Performance

Characteristic resistance under shear loads

Annex C (2/7)

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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size							
				M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Steel failure											
Characteristic resistance $N_{Rk,s,fi}$	S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	R30	[kN]	1,31	1,31	2,09	2,09	3,05	3,05	5,69	5,69
		R60	[kN]	1,05	1,05	1,66	1,66	2,40	2,40	4,47	4,47
		R90	[kN]	0,80	0,80	1,24	1,24	1,74	1,74	3,25	3,25
		R120	[kN]	0,67	0,67	1,02	1,02	1,41	1,41	2,64	2,64
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	R30	[kN]	3,92	3,92	6,66	6,66	10,25	10,25	19,09	19,09
		R60	[kN]	2,70	2,70	4,59	4,59	7,07	7,07	13,16	13,16
		R90	[kN]	1,48	1,48	2,52	2,52	3,88	3,88	7,23	7,23
		R120	[kN]	0,87	0,87	1,48	1,48	2,29	2,29	4,26	4,26
Pull-out failure											
Characteristic resistance $N_{Rk,p,fi}$	R30	[kN]	1,25	2,13	²⁾	3,00	²⁾	4,00	²⁾	6,00	
	R60	[kN]	1,25	2,13	²⁾	3,00	²⁾	4,00	²⁾	6,00	
	R90	[kN]	1,25	2,13	²⁾	3,00	²⁾	4,00	²⁾	6,00	
	R120	[kN]	1,00	1,70	²⁾	2,40	²⁾	3,20	²⁾	4,80	
Concrete cone and splitting failure ³⁾											
Characteristic resistance $N^0_{Rk,c,fi}$	R30	[kN]	1,25	2,87	1,82	5,02	3,18	7,38	5,86	11,98	
	R60	[kN]	1,25	2,87	1,82	5,02	3,18	7,38	5,86	11,98	
	R90	[kN]	1,25	2,87	1,82	5,02	3,18	7,38	5,86	11,98	
	R120	[kN]	1,00	2,30	1,46	4,02	2,55	5,90	4,69	9,59	
Spacing	$s_{cr,N,fi}$	[mm]	4 x h_{ef}								
	s_{min}	[mm]	55	35	50	40	55	60	65	65	
Edge distance	$c_{cr,N,fi}$	[mm]	2 x h_{ef}								
	c_{min}	[mm]	Fire attack from one side: $c_{min} = 2 \times h_{ef}$ Fire attack from more than one side: $c_{min} \geq 300 \text{ mm and } \geq 2 \times h_{ef}$								

¹⁾ For use in dry internal exposure and for statically indeterminate structural components

²⁾ Pull-out isn't decisive

³⁾ 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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Performance

Characteristic tension resistance under fire exposure

Annex C (3/7)

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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size							
				M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Steel failure without lever arm											
Characteristic resistance $V_{Rk,s,fi}$	S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	R30	[kN]	1,31	1,31	2,09	2,09	3,05	3,05	5,69	5,69
		R60	[kN]	1,05	1,05	1,66	1,66	2,40	2,40	4,47	4,47
		R90	[kN]	0,80	0,80	1,24	1,24	1,74	1,74	3,25	3,25
		R120	[kN]	0,67	0,67	1,02	1,02	1,41	1,41	2,64	2,64
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	R30	[kN]	3,92	3,92	6,66	6,66	10,25	10,25	19,09	19,09
		R60	[kN]	2,70	2,70	4,59	4,59	7,07	7,07	13,16	13,16
		R90	[kN]	1,48	1,48	2,52	2,52	3,88	3,88	7,23	7,23
		R120	[kN]	0,87	0,87	1,48	1,48	2,29	2,29	4,26	4,26
Steel failure with lever arm											
Characteristic resistance $M_{Rk,s,fi}^0$	S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	R30	[Nm]	0,38	0,38	1,12	1,12	2,62	2,62	6,66	6,66
		R60	[Nm]	0,34	0,34	0,97	0,97	1,97	1,97	4,99	4,99
		R90	[Nm]	0,26	0,26	0,75	0,75	1,70	1,70	4,33	4,33
		R120	[Nm]	0,19	0,19	0,60	0,60	1,31	1,31	3,33	3,33
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	R30	[Nm]	0,75	0,75	1,87	1,87	3,93	3,93	9,99	9,99
		R60	[Nm]	0,60	0,60	1,50	1,50	3,28	3,28	8,32	8,32
		R90	[Nm]	0,45	0,45	1,20	1,20	2,62	2,62	6,66	6,66
		R120	[Nm]	0,38	0,38	1,05	1,05	2,10	2,10	5,33	5,33
Concrete pryout failure											
k-factor	k_8	[-]	2,21	1,94	3,31	3,31	2,84	2,84	15,88	2,71	
Characteristic resistance $V_{Rk,cp,fi}$	R30	[kN]	2,76	5,57	6,02	16,62	9,03	20,96	15,88	32,47	
	R60	[kN]	2,76	5,57	6,02	16,62	9,03	20,96	15,88	32,47	
	R90	[kN]	2,76	5,57	6,02	16,62	9,03	20,96	15,88	32,47	
	R120	[kN]	2,21	4,46	4,83	13,31	7,24	16,76	12,71	25,99	
Concrete edge failure											
The initial value $V_{Rk,c,fi}^0$ of the characteristic resistance in concrete C20/25 to C50/60 under fire exposure may be determined by:											
$V_{Rk,c,fi}^0 = 0,25 \times V_{Rk,c}^0 \quad (\leq R90) \quad \quad V_{Rk,c,fi}^0 = 0,20 \times V_{Rk,c}^0 \quad (R120)$											
with $V_{Rk,c}^0$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature.											

¹⁾ For use in dry internal exposure and for statically indeterminate structural components
 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 $c_{min} \geq 300$ mm and $\geq 2 \times h_{ef}$.
 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 bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Performance

Characteristic shear resistance under fire exposure

Annex C (4/7)

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

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR			Anchor size							
			M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
Cracked C20/25 – C50/60	N	[kN]	2,4	4,1	4,3	5,7	6,1	7,6	8,59	11,4
	δ_{N0}	[mm]	0,46	0,98	0,49	0,62	0,54	0,24	0,37	0,78
	$\delta_{N\infty}$	[mm]	0,65	1,47	0,98	1,37	0,98	1,26	2,16	2,21
Non-cracked C20/25 - C50/60	N	[kN]	3,8	5,2	5,7	9,0	8,5	11,9	12,3	17,1
	δ_{N0}	[mm]	0,09	0,19	0,06	0,27	0,05	0,11	0,19	0,14
	$\delta_{N\infty}$	[mm]	0,65	1,47	0,98	1,37	0,98	1,26	2,16	2,21

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

Cracked and non-cracked concrete C20/25 - C50/60			Anchor size							
			M8-1 ¹⁾	M8-2	M10-1	M10-2	M12-1	M12-2	M16-1	M16-2
S-KA+ / BA-V Plus, S-KAK+ / BA-F Plus	V	[kN]	7,2	7,2	10,5	10,5	16,4	16,4	30,9	30,9
	δ_{V0}	[mm]	1,09	1,09	1,94	0,68	2,44	2,13	2,78	2,78
	$\delta_{V\infty}$	[mm]	1,64	1,64	2,91	1,02	3,66	3,19	4,17	4,17
S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	V	[kN]	9,0	9,0	10,5	10,3	16,4	16,4	39,2	39,2
	δ_{V0}	[mm]	1,65	1,65	1,94	0,68	2,44	2,13	3,44	3,44
	$\delta_{V\infty}$	[mm]	2,48	2,48	2,91	1,02	3,66	3,19	5,16	5,16

¹⁾ For use in dry internal exposure and for statically indeterminate structural components

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

Performance

Displacements under tension and shear loads

Annex C (5/7)

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

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size			
				M8-2	M10-2	M12-2	M16-2
Tension - steel failure							
Characteristic resistance C1		$N_{Rk,s,seis,C1}$	[kN]	15,0	-	-	-
Characteristic resistance C2	S-KA+ / BA-V Plus,	$N_{Rk,s,seis,C2}$	[kN]	15,0	26,0	39,0	73,0
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$N_{Rk,s,seis,C2}$	[kN]	15,0	26,0	40,0	73,0
Partial safety factor		$\gamma_{Ms,seis}^{1)}$	[-]	1,4			
Tension - pull-out failure							
Characteristic resistance C1	S-KA+ / BA-V Plus,	$N_{Rk,p,seis,C1}$	[kN]	8,5	-	-	-
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$N_{Rk,p,seis,C1}$	[kN]	8,4	-	-	-
Characteristic resistance C2	S-KA+ / BA-V Plus,	$N_{Rk,p,seis,C2}$	[kN]	1,7	4,6	6,7	15,9
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$N_{Rk,p,seis,C2}$	[kN]	3,6	4,5	7,6	19,3
Partial safety factor		$\gamma_{Mp,seis}^{1)}$	[-]	1,5 ²⁾			
Concrete cone and splitting failure³⁾							
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+ / BA-V Plus,	$V_{Rk,s,seis,C1}$	[kN]	8,1	-	-	-
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$V_{Rk,s,seis,C1}$	[kN]	7,9	-	-	-
Characteristic resistance C2	S-KA+ / BA-V Plus,	$V_{Rk,s,seis,C2}$	[kN]	9,5	8,5	13,8	30,7
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$V_{Rk,s,seis,C2}$	[kN]	8,4	9,4	14,4	30,8
Partial safety factor		$\gamma_{Ms,seis}^{1)}$	[-]	1,25			
Concrete pryout and concrete edge failure³⁾							
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 $\gamma_2 = 1,0$ is included

³⁾ For concrete cone, splitting, pryout and edge failure, see EOTA TR 045

**Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR /
EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR**

Performance

Characteristic resistances under seismic action
Performance category C1 and C2

Annex C (6/7)

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

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR				Anchor size			
				M8-2	M10-2	M12-2	M16-2
Displacement under tension loads							
Displacement DLS	S-KA+ / BA-V Plus,	$\bar{d}_{N,seis}$	[mm]	4,6	3,1	5,6	4,0
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$\bar{d}_{N,seis}$	[mm]	3,8	2,8	6,0	4,7
Displacement ULS	S-KA+ / BA-V Plus,	$\bar{d}_{N,seis}$	[mm]	11,5	10,7	16,7	14,0
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$\bar{d}_{N,seis}$	[mm]	11,1	6,8	15,5	15,1
Displacement under shear loads							
Displacement DLS	S-KA+ / BA-V Plus	$\bar{d}_{V,seis}$	[mm]	2,7	3,9	3,6	3,7
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$\bar{d}_{V,seis}$	[mm]	2,7	4,5	4,7	3,9
Displacement ULS	S-KA+ / BA-V Plus,	$\bar{d}_{V,seis}$	[mm]	4,7	5,8	5,3	6,8
	S-KAH+ / BA-E Plus S-KAH+ HCR / BA-E Plus HCR	$\bar{d}_{V,seis}$	[mm]	4,8	7,6	7,5	7,7

Sormat through bolts S-KA+, S-KAK+, S-KAH+, S-KAH+ HCR / EJOT through bolts BA-V Plus, BA-F Plus, BA-E Plus, BA-E Plus HCR

Performance

Displacements under seismic action
Performance category C2

Annex C (7/7)