Deutsches Institut für Bautechnik

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Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment

ETA-17/0784 of 6 October 2017

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	SMART high load anchor type S-ZA
Product family to which the construction product belongs	Mechanical anchor for use in concrete
Manufacturer	pgb - Polska Sp. z o.o. ul. Fryderyka Wilhelma Redena 3 41-807 ZABRZE POLEN
Manufacturing plant	pgb-Polska plant 4
This European Technical Assessment contains	20 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 330232-00-0601

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Specific Part

1 Technical description of the product

The SMART highload anchor type S-ZA is an anchor made of galvanised steel or made of stainless steel which is placed into a drilled hole and anchored by torque-controlled expansion. The following anchor types are covered:

- Anchor type S-ZAK with threaded bolt,
- Anchor type S-ZAT with hexagon head screw,
- Anchor type S-ZAV with countersunk washer and countersunk screw.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 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 and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance for static and quasi-static loading	See Annex C1 to C5
Characteristic resistance for seismic performance category C1 and C2	See Annex C6 to C7
Displacements under tension and shear loads	See Annex C9 and C10

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	See Annex C8

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

In accordance with the European Assessment Document EAD Nr. 330232-00-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 6 October 2017 by Deutsches Institut für Bautechnik

BD Dipl.-Ing. Andreas Kummerow
Head of Department

Beglaubigt:
Baderschneider

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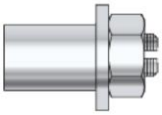
SMART highload anchor type S-ZA

Anchor type SMART highload anchor type S-ZAK with threaded bolt

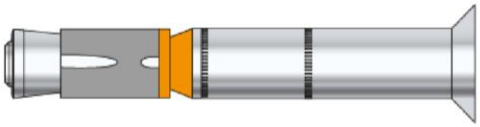


S-ZAK (M6-M20)
S-ZAK (M8-M16) A4

Anchor type SMART highload anchor type S-ZAT with hexagon head screw

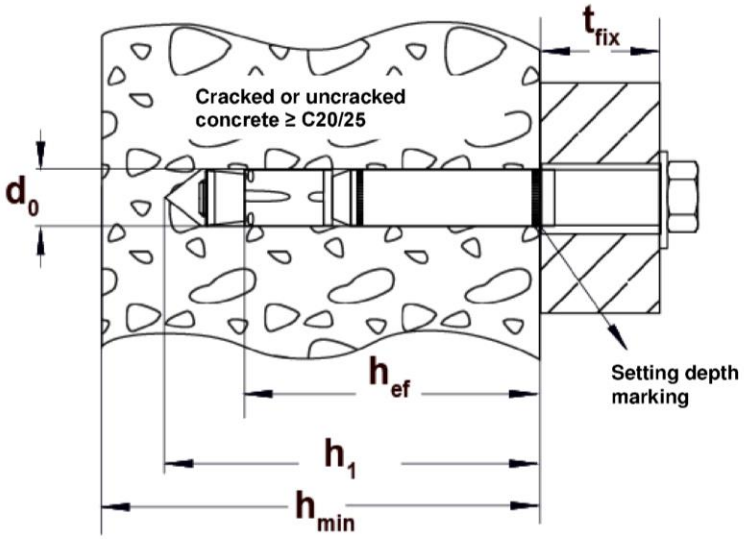
S-ZAT (M6-M20)
S-ZAT (M8-M16) A4

Anchor type SMART highload anchor type S-ZAV with countersunk washer and countersunk screw



S-ZAV (M6-M12)
S-ZAV (M8-M12) A4

Installation condition



SMART highload anchor type S-ZA	
Product description Product and installation situation	**Annex A1**

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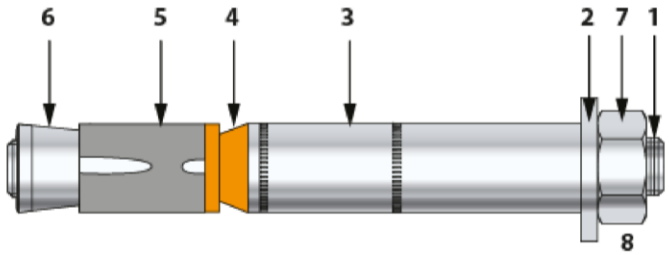
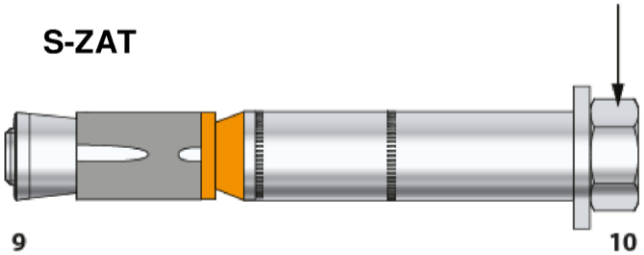
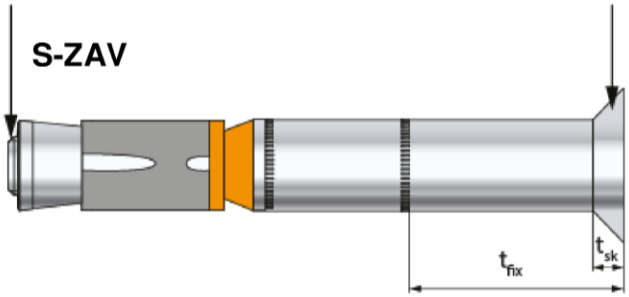
S-ZAK



S-ZAT



S-ZAV



Marking:

expansion sleeve:
- Identifying mark of manufacturing plant ◇
- additional marking of stainless steel A4 A4
- Anchor identity (alternatively on distance sleeve) SZ
- size of thread (alternatively on distance sleeve) M10

Distance sleeve:
- Diameter 15
- max. thickness of fixture 25
- additional marking for countersunk version SK

additional marking on the washer of anchor size SZ 24/M16L L

Table A1: Designation of anchor parts and materials

Part	Designation	Materials galvanised ≥ 5 µm, acc. to EN ISO 4042:1999	Stainless steel A4
1	Threaded bolt	Steel, Strength class 8.8, EN ISO 898-1:2013	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
2	Washer	Steel, EN 10139:1997	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
3	Distance sleeve	Precision steel tubes DIN 2394/2393	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
4	Ring	Polyethylene	Polyethylene
5	Expansion sleeve	Steel, EN 10139:1997	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
6	Threaded cone	Steel, Strength class 8, EN ISO 898-2:2012	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
7	Hexagon nut	Steel, Strength class 8, EN ISO 898-2:2012	ISO 3506, strength class 70, stainless steel 1.4401 or 1.4571, EN 10088:2005
8	Hexagon head screw	Steel, Strength class 8.8, EN ISO 898-1:2013	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
9	Countersunk screw	Steel, Strength class 8.8, EN ISO 898-1:2013	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005
10	Countersunk washer	Steel, EN 10083-2:2006	Stainless steel, 1.4401, 1.4404 or 1.4571, EN 10088:2005, zinc plated

SMART highload anchor type S-ZA

Product description
Marking and materials

Annex A2

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Specifications of intended use

SMART highload anchor type S-ZA, steel zinc plated	**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Static or quasi-static action	✓						
Seismic action (S-ZAK and S-ZAT)	-	C1 + C2					
Seismic action (S-ZAV)	-	C1 + C2			-		
Fire exposure	R 30 … R 120						

SMART highload anchor type S-ZA, stainless steel A4	**12/M8**	**15/M10**	**18/M12**	**24/M16**
Static or quasi-static action	✓			
Seismic action (S-ZAK and S-ZAT)	C1 + C2			
Seismic action (S-ZAV)	C1 + C2			-
Fire exposure	R30 … R120			

Base materials:

- Cracked and uncracked concrete
- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000
- Strength classes C20/25 to C50/60 according to EN 206-1:2000

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (zinc plated steel or stainless steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel).

  Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor pools or atmosphere with extreme chemical pollution (e.g. in 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.
- 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 (e.g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages under static or quasi-static actions, seismic actions und under fire exposure are designed in accordance with FprEN 1992-4:2016 and TR 055.

Installation:

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- In case of aborted hole: new drilling at a minimum distance away of twice the depth of the aborted hole or smaller distance if the aborted drill hole is filled with high strength mortar and if under shear or oblique tension load it is not in the direction of load application.
- Anchor installation such that the effective anchorage depth is complied with. This compliance is ensured when the embedment mark of the anchor does no more exceed the concrete surface.
- Drill hole by hammer drilling only (use of vacuum drill bits is admissible)

SMART highload anchor type S-ZA	**Annex B1**
Intended use Specifications	

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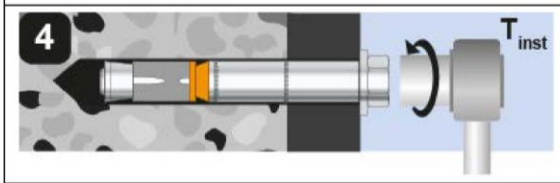
Installation instructions

	Drill hole perpendicular to concrete surface. If using a vacuum drill bit, proceed with step 3.
	Blow out dust. Alternatively vacuum clean down to the bottom of the hole.
	Drive in anchor.
	Apply tightening torque T_{inst} by using calibrated torque wrench.

SMART highload anchor type S-ZA	
Intended use Installation instructions	**Annex B2**

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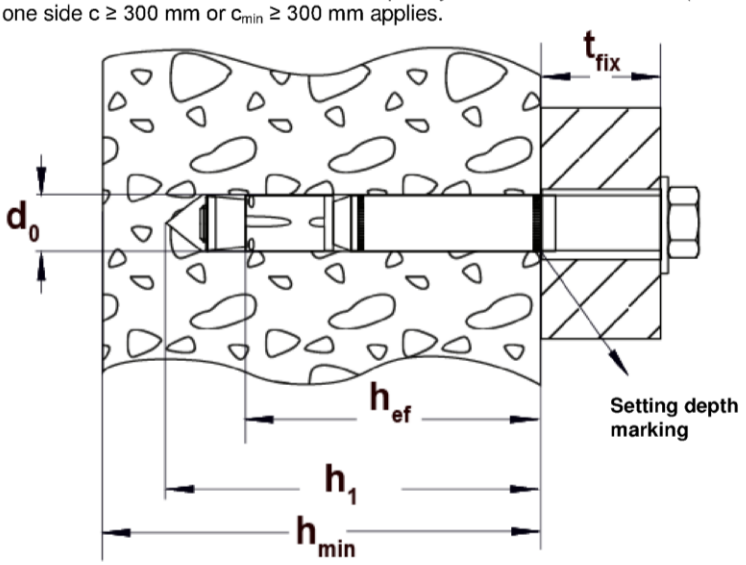
Table B1: Installation parameters, steel zinc plated

Anchor size			10/M6	12/M8	15/M10	18/M12	24/M16	24/M16L	28/M20
Size of thread		[-]	M6	M8	M10	M12	M16	M16	M20
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125
Nominal diameter of drill bit	d_0 =	[mm]	10	12	15	18	24	24	28
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	10,45	12,5	15,5	18,5	24,55	24,55	28,55
Depth of drill hole	$h_1 \geq$	[mm]	65	80	95	105	130	145	160
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	12	14	17	20	26	26	31
Thickness of fixture	$t_{fix\ min}$	[mm]	0	0	0	0	0	0	0
S-ZAK and S-ZAT	$t_{fix\ max}$	[mm]	200	200	200	250	300	300	300
Thickness of fixture S-ZAV	$t_{fix\ min}$ [2]	[mm]	8	10	14	18	-	-	-
	$t_{fix\ max}$	[mm]	200	200	200	250	-	-	-
Thickness of countersunk washer S-ZAV	t_{sk}	[mm]	4	5	6	7	-	-	-
Required setting torque	T_{inst} (S-ZAK, S-ZAT)	[Nm]	15	30	50	80	160	160	280
	T_{inst} (S-ZAV)	[Nm]	10	25	55	70	-	-	-
Minimum thickness of member	h_{min}	[mm]	100	120	140	160	200	230	250
Minimum spacing [1) 3)]	s_{min}	[mm]	50	50	60	70	100	100	125
cracked concrete	for c ≥	[mm]	50	80	120	140	180	180	300
Minimum edge distance [1) 3)]	c_{min}	[mm]	50	55	60	70	100	100	180
cracked concrete	for s ≥	[mm]	50	100	120	160	220	220	540
Minimum spacing [1) 3)]	s_{min}	[mm]	50	60	60	70	100	100	125
uncracked concrete	for c ≥	[mm]	80	100	120	140	180	180	300
Minimum edge distance [1) 3)]	c_{min}	[mm]	50	60	60	70	100	100	180
uncracked concrete	for s ≥	[mm]	100	120	120	160	220	220	540

[1] Intermediate values by linear interpolation
[2] Depending on the existing shear load, the thickness of the fixture may be reduced to the thickness of the countersunk washer t_{sk} (see Annex A2). It must be verified that the present shear load can be transferred completely into the distance sleeve (bearing of hole).
[3] For fire exposure from more than one side c ≥ 300 mm or c_{min} ≥ 300 mm applies.



SMART highload anchor type S-ZA

Intended use
Installation parameters, **steel zinc plated**

Annex B3

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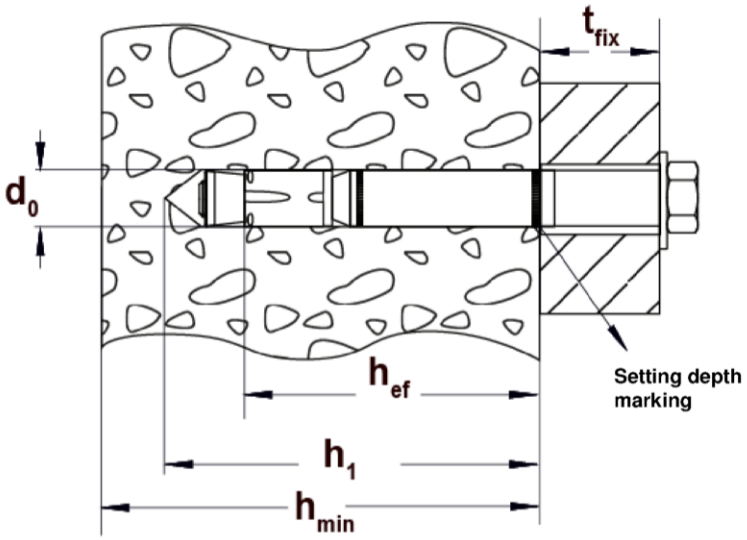
Table B2: Installation parameters, stainless steel A4

Anchor size			[-]	12/M8	15/M10	18/M12	24/M16
Size of thread			[-]	M8	M10	M12	M16
Effective anchorage depth		h_{ef}	[mm]	60	71	80	100
Nominal diameter of drill bit		d_0 =	[mm]	12	15	18	24
Cutting diameter of drill bit		$d_{cut} \leq$	[mm]	12,5	15,5	18,5	24,55
Depth of drill hole		$h_1 \geq$	[mm]	80	95	105	130
Diameter of clearance hole in the fixture		$d_f \leq$	[mm]	14	17	20	26
Thickness of fixture S-ZAK and S-ZAT		$t_{fix\ min}$	[mm]	0	0	0	0
		$t_{fix\ max}$	[mm]	200	200	250	300
Thickness of fixture S-ZAV		$t_{fix\ min}$ [2]	[mm]	10	14	18	-
		$t_{fix\ max}$	[mm]	200	200	250	-
Thickness of countersunk washer S-ZAV		t_{sk}	[mm]	5	6	7	-
Required setting torque	T_{inst}	(S-ZAK)	[Nm]	35	55	90	170
	T_{inst}	(S-ZAT)	[Nm]	30	50	80	170
	T_{inst}	(S-ZAV)	[Nm]	17,5	42,5	50	-
Minimum thickness of member		h_{min}	[mm]	120	140	160	200
Minimum spacing [1) 3)]		s_{min}	[mm]	50	60	70	80
cracked concrete		for c ≥	[mm]	80	120	140	180
Minimum edge distance [1) 3)]		c_{min}	[mm]	50	60	70	80
cracked concrete		for s ≥	[mm]	80	120	160	200
Minimum spacing [1) 3)]		s_{min}	[mm]	50	60	70	80
uncracked concrete		for c ≥	[mm]	80	120	140	180
Minimum edge distance [1) 3)]		c_{min}	[mm]	50	85	70	180
uncracked concrete		for s ≥	[mm]	80	185	160	80

[1)] Intermediate values by linear interpolation
[2)] Depending on the existing shear load, the thickness of the fixture may be reduced to the thickness of the countersunk washer t_{sk} (see Annex A2). It must be verified that the present shear load can be transferred completely into the distance sleeve (bearing of hole).
[3)] For fire exposure from more than one side c ≥ 300 mm or c_{min} ≥ 300 mm applies.



SMART highload anchor type S-ZA

Intended use
Installation parameters, **stainless steel A4**

Annex B4

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Table C1: Characteristic values for **tension load, cracked concrete** under static or quasi-static action**, steel zinc plated**

Anchor size			**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Installation safety factor	γ_{inst}	[-]	1,0						
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	16	29	46	67	126	126	196
Partial safety factor	γ_{Ms}	[-]	1,5						
Pull-out failure									
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	5	12	16	1)	1)	1)	1)
Increasing factor for $N_{Rk,p}$	ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0,5}$						
Concrete cone failure									
Effective anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125
Factor for k_1	$k_{cr,N}$	[-]	7,7						

1) Pull-out is not decisive.

Table C2: Characteristic values for **tension load**, **cracked concrete** under static or quasi-static action**, stainless steel A4**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**
Installation safety factor	γ_{inst}	[-]	1,0			
Steel failure						
S-ZAK						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1,5			
S-ZAT and S-ZAV						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1,87			
Pull-out failure						
Characteristic resistance in cracked concrete C20/25	$N_{Rk,p}$	[kN]	9	16	1)	1)
Increasing factor for $N_{Rk,p}$	ψ_C	[-]	$\left(\frac{f_{ck}}{20}\right)^{0,5}$			
Concrete cone failure						
Effective anchorage depth	h_{ef}	[mm]	60	71	80	100
Factor for k_1	$k_{cr,N}$	[-]	7,7			

1) Pull-out is not decisive.

SMART highload anchor type S-ZA

Performance
Characteristic values for **tension load** in **cracked concrete** under static or quasi-static action

Annex C1

Deutsches Institut für Bautechnik DIBt

Table C3: Characteristic values for **tension load in uncracked concrete**, under static or quasi-static action, **steel zinc plated**

Anchor size			**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Installation safety factor	γ_{inst}	[-]	1,0						
Steel failure									
Characteristic resistance	$N_{Rk,s}$	[kN]	16	29	46	67	126	126	196
Partial safety factor	γ_{Ms}	[-]	1,5						
Pull-out failure									
Characteristic resistance in uncracked concrete C20/25	$N_{Rk,p}$	[kN]	1)	20	1)	1)	1)	1)	1)
Splitting failure (The higher resistance of case 1 and case 2 may be applied.)									
Case 1									
Characteristic resistance in uncracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	12	16	25	30	40	70	50
Edge distance	$c_{cr,sp}$	[mm]	$1,5\ h_{ef}$						
Case 2									
Characteristic resistance in uncracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	17,4	20,0	29,4	35,2	49,2	60,7	68,8
Edge distance	$c_{cr,sp}$	[mm]	$2,5\ h_{ef}$					$1,5\ h_{ef}$	$2,5\ h_{ef}$
Increasing factor for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_c	[-]	$\left(\frac{f_{ck}}{20}\right)^{0,5}$						
Concrete cone failure									
Effective Anchorage depth	h_{ef}	[mm]	50	60	71	80	100	115	125
Edge distance	$c_{cr,N}$	[mm]	$1,5\ h_{ef}$						
Factor for k_1	$k_{ucr,N}$	[-]	11,0						

1) Pull-out is not decisive.

SMART highload anchor type S-ZA

Performance
Characteristic values for **tension load** in **uncracked concrete,** under static or quasi-static action, **steel zinc plated**

Annex C2

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Table C4: Characteristic values for **tension load** in **uncracked concrete** under static or quasi-static action, **stainless steel A4**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**
Installation safety factor	γ_{inst}	[-]	1,0			
Steel failure						
S-ZAK						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1,5			
S-ZAT and S-ZAV						
Characteristic resistance	$N_{Rk,s}$	[kN]	26	41	60	110
Partial safety factor	γ_{Ms}	[-]	1,87			
Pull-out failure						
Characteristic resistance in uncracked concrete C20/25	$N_{Rk,p}$	[kN]	16	25	35	1)
Splitting failure						
Characteristic resistance in uncracked concrete C20/25	$N^0_{Rk,sp}$	[kN]	16	25	35	49,2
Edge distance	$c_{cr,sp}$	[mm]	180	235	265	300
Increasing factor for $N_{Rk,p}$ and $N^0_{Rk,sp}$	ψ_c	[-]	$\left(\frac{f_{ck}}{20}\right)^{0,5}$			
Concrete cone failure						
Effective anchorage depth	h_{ef}	[mm]	60	71	80	100
Edge distance	$c_{cr,N}$	[mm]	1,5 h_{ef}			
Factor for k_1	$k_{ucr,N}$	[-]	11,0			

1) Pull-out is not decisive.

SMART highload anchor type S-ZA

Performance
Characteristic values for **tension loads** in **uncracked concrete** under static or quasi-static action, **stainless steel A4**

Annex C3

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Table C5: Characteristic values of **shear load** under static or quasi-static action, **steel zinc plated**

Anchor size			**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Steel failure without lever arm									
S-ZAK									
Characteristic resistance	$V_{Rk,s}$	[kN]	16	25	36	63	91	91	122
Factor	k_7	[-]	1,0						
S-ZAT									
Characteristic resistance	$V_{Rk,s}$	[kN]	18	30	48	73	126	126	150
Factor	k_7	[-]	1,0						
S-ZAV									
Characteristic resistance	$V_{Rk,s}$	[kN]	18	30	48	73	126	126	150
Factor	k_7	[-]	1,0						
Partial safety factor	γ_{Ms}	[-]	1,25						
Steel failure with lever arm									
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	12	30	60	105	266	266	519
Partial safety factor	γ_{Ms}	[-]	1,25						
Concrete pry-out failure									
Factor	k_8	[-]	1,8	2,0					
Concrete edge failure									
Effective length of anchor in shear loading	l_f	[mm]	50	60	71	80	100	115	125
Outside diameter of anchor	d_{nom}	[mm]	10	12	15	18	24	24	28

SMART highload anchor type S-ZA

Performance
Characteristic values for **shear load** under static or quasi-static action, **steel zinc plated**

Annex C4

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Table C6: Characteristic values for **shear load** under static or quasi-static action, **stainless steel A4**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**
Steel failure without lever arm						
Characteristic resistance	$V_{Rk,s}$	[kN]	24	37	62	92
S-ZAK						
Factor	k_7	[-]	1,0			
Partial safety factor	γ_{Ms}	[-]	1,25			
S-ZAT						
Factor	k_7	[-]	1,0			
Partial safety factor	γ_{Ms}	[-]	1,36			
S-ZAV						
Factor	k_7	[-]	0,8			
Partial safety factor	γ_{Ms}	[-]	1,36			
Steel failure with lever arm						
Characteristic resistance	$M^0_{Rk,s}$	[Nm]	26	52	92	232
S-ZAK						
Factor	k_7	[-]	1,0			
Partial safety factor	γ_{Ms}	[-]	1,25			
S-ZAT						
Factor	k_7	[-]	1,0			
Partial safety factor	γ_{Ms}	[-]	1,56			
S-ZAV						
Factor	k_7	[-]	0,8			
Partial safety factor	γ_{Ms}	[-]	1,56			
Concrete pry-out failure						
Factor	k_8	[-]	2,0			
Concrete edge failure						
Effective length of anchor in shear loading	l_f	[mm]	60	71	80	100
Outside diameter of anchor	d_{nom}	[mm]	12	15	18	24

SMART highload anchor type S-ZA

Performance
Characteristic values for **shear load** under static or quasi-static action, **stainless steel A4**

Annex C5

Deutsches Institut für Bautechnik DIBt

Table C7: Characteristic values for **seismic action, Category C1 and C2, steel zinc plated**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Tension load								
Installation safety factor	γ_{inst}	[-]	1,0					
Steel failure								
Characteristic tension resistance category **C1**	$N_{Rk,s,eq,C1}$	[kN]	29	46	67	126	126	196
Characteristic tension resistance category **C2**	$N_{Rk,s,eq,C2}$	[kN]	29	46	67	126	126	196
Partial safety factor	γ_{Ms}	[-]	1,5					
Pull-out failure								
Characteristic tension resistance category **C1**	$N_{Rk,p,eq,C1}$	[kN]	12	16	25	36	44,4	50,3
Characteristic tension resistance category **C2**	$N_{Rk,p,eq,C2}$	[kN]	5,4	16,4	22,6	29,0	41,2	43,6
Shear load								
Steel failure without lever arm								
S-ZAK								
Characteristic shear resistance category **C1**	$V_{Rk,s,eq,C1}$	[kN]	18,0	27,1	43,4	51,9	51,9	96,4
Characteristic shear resistance category **C2**	$V_{Rk,s,eq,C2}$	[kN]	12,7	20,5	31,5	50,1	50,1	67,1
S-ZAT								
Characteristic shear resistance category **C1**	$V_{Rk,s,eq,C1}$	[kN]	18,0	27,1	43,4	51,9	51,9	96,4
Characteristic shear resistance category **C2**	$V_{Rk,s,eq,C2}$	[kN]	12,7	20,5	31,5	69,3	69,3	67,1
S-ZAV								
Characteristic shear resistance category **C1**	$V_{Rk,s,eq,C1}$	[kN]	25,2	36,5	50,4	-	-	-
Characteristic shear resistance category **C2**	$V_{Rk,s,eq,C2}$	[kN]	19,2	29,3	39,4	-	-	-
Partial safety factor	γ_{Ms}	[-]	1,25					

SMART highload anchor type S-ZA

Performance
Characteristic values for **seismic action, steel zinc plated**

Annex C6

Deutsches Institut für Bautechnik DIBt

Table C8: Characteristic values for **seismic action, Category C1 and C2, stainless steel A4**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**
Tension load						
Installation safety factor	γ_{inst}	[-]	1,0			
Steel failure						
Characteristic tension resistance, category **C1**	$N_{Rk,s,eq,C1}$	[kN]	26	41	60	110
Characteristic tension resistance, category **C2**	$N_{Rk,s,eq,C2}$	[kN]	26	41	60	110
Partial safety factor **S-ZAK**	γ_{Ms}	[-]	1,5			
Partial safety factor **S-ZAT and S-ZAV**	γ_{Ms}	[-]	1,87			
Pull-out failure						
Characteristic tension resistance, category **C1**	$N_{Rk,p,eq,C1}$	[kN]	9	16	26	36
Characteristic tension resistance, category **C2**	$N_{Rk,p,eq,C2}$	[kN]	4,8	16,5	24,8	44,5
Shear load						
Steel failure without lever arm						
S-ZAK						
Characteristic shear resistance, category **C1**	$V_{Rk,s,eq,C1}$	[kN]	9,6	13,3	25,4	75,4
Characteristic shear resistance, category **C2**	$V_{Rk,s,eq,C2}$	[kN]	9,7	14,0	18,0	32,2
Partial safety factor	γ_{Ms}	[-]	1,25			
S-ZAT						
Characteristic shear resistance, category **C1**	$V_{Rk,s,eq,C1}$	[kN]	9,6	13,3	25,4	75,4
Characteristic shear resistance, category **C2**	$V_{Rk,s,eq,C2}$	[kN]	9,7	14,0	18,0	32,2
Partial safety factor	γ_{Ms}	[-]	1,36			
S-ZAV						
Characteristic shear resistance, category **C1**	$V_{Rk,s,eq,C1}$	[kN]	11,5	23,3	31,6	-
Characteristic shear resistance, category **C2**	$V_{Rk,s,eq,C2}$	[kN]	10,8	17,4	15,4	-
Partial safety factor	γ_{Ms}	[-]		1,36		-

SMART highload anchor type S-ZA

Performance
Characteristic values for **seismic action, stainless steel A4**

Annex C7

Deutsches Institut für Bautechnik DIBt

Table C9: Characteristic values under **fire exposure** in cracked and uncracked concrete C20/25 to C50/60

Anchor size				**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Tension load										
Steel failure										
Steel zinc plated										
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	1,0	1,9	4,3	6,3	11,6		18,3
	R60			0,8	1,5	3,2	4,6	8,6		13,5
	R90			0,6	1,0	2,1	3,0	5,0		7,7
	R120			0,4	0,8	1,5	2,0	3,1		4,9
Stainless steel A4										
Characteristic resistance	R30	$N_{Rk,s,fi}$	[kN]	-	6,1	10,2	15,7	29,2	-	-
	R60			-	4,4	7,3	11,1	20,6	-	-
	R90			-	2,6	4,3	6,4	12,0	-	-
	R120			-	1,8	2,8	4,1	7,7	-	-
Shear load										
Steel failure without lever arm										
Steel zinc plated										
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	1,0	1,9	4,3	6,3	11,6		18,3
	R60			0,8	1,5	3,2	4,6	8,6		13,5
	R90			0,6	1,0	2,1	3,0	5,0		7,7
	R120			0,4	0,8	1,5	2,0	3,1		4,9
Stainless steel A4										
Characteristic resistance	R30	$V_{Rk,s,fi}$	[kN]	-	14,3	22,7	32,8	61,0	-	-
	R60			-	11,1	17,6	25,5	47,5	-	-
	R90			-	7,9	12,6	18,3	34,0	-	-
	R120			-	6,3	10,0	14,6	27,2	-	-
Steel failure with lever arm										
Steel zinc plated										
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	0,8	2,0	5,6	9,7	24,8		42,4
	R60			0,6	1,5	4,1	7,2	18,3		29,8
	R90			0,4	1,0	2,7	4,7	11,9		17,1
	R120			0,3	0,8	1,9	3,1	6,6		10,7
Stainless steel A4										
Characteristic resistance	R30	$M^0_{Rk,s,fi}$	[Nm]	-	6,2	13,2	24,4	61,8	-	-
	R60			-	4,5	9,4	17,2	43,6	-	-
	R90			-	2,7	5,6	10,0	25,3	-	-
	R120			-	1,8	3,6	6,4	16,2	-	-

If pull-out is not decisive in Equation (D.4) and (D.5) FprEN1992, $N_{Rk,p}$ must be replaced by $N^0_{Rk,c}$.

SMART highload anchor type S-ZA

Performance
Characteristic values under **fire exposure**

Annex C8

Deutsches Institut für Bautechnik DIBt

Table C10: Displacements under tension and shear load, **steel zinc plated**

Anchor size			**10/M6**	**12/M8**	**15/M10**	**18/M12**	**24/M16**	**24/M16L**	**28/M20**
Tension load									
Tension load in cracked concrete	N	[kN]	2,4	5,7	7,6	12,3	17,1	21,1	24
Displacement	δ_{N0}	[mm]	0,5	0,5	0,5	0,7	0,8	0,7	0,9
	$\delta_{N\infty}$	[mm]	2,0	2,0	1,3	1,3	1,3	1,3	1,4
Tension load in uncracked concrete	N	[kN]	8,5	9,5	14,3	17,2	24	29,6	34
Displacement	δ_{N0}	[mm]	0,8	1,0		1,1		1,3	0,3
	$\delta_{N\infty}$	[mm]	3,4			1,7		2,3	1,4
Seismic action C2									
Displacement for DLS	$\delta_{N,eq\ (DLS)}$	[mm]	-	3,3	3,0	5,0	3,0	3,0	4,0
Displacement for ULS	$\delta_{N,eq\ (ULS)}$	[mm]	-	12,2	11,3	16,0	9,2	9,2	13,8
Shear load									
S-ZAK									
Shear load in cracked and uncracked concrete	V	[kN]	9,1	14	20,7	35,1	52,1	52,1	77
Displacement	δ_{V0}	[mm]	2,5	2,1	2,7	3,0	5,1	5,1	4,3
	$\delta_{V\infty}$	[mm]	3,8	3,1	4,1	4,5	7,6	7,6	6,5
Seismic action C2									
Displacement for DLS	$\delta_{V,eq\ (DLS)}$	[mm]	-	2,3	3,1	3,0	2,6	2,6	1,6
Displacement for ULS	$\delta_{V,eq\ (ULS)}$	[mm]	-	4,8	6,4	6,1	6,6	6,6	4,8
S-ZAT									
Shear load in cracked and uncracked concrete	V	[kN]	10,1	17,1	27,5	41,5	72	72	77
Displacement	δ_{V0}	[mm]	2,9	2,5	3,6	3,5	7,0	7,0	4,3
	$\delta_{V\infty}$	[mm]	4,4	3,8	5,4	5,3	10,5	10,5	6,5
Seismic action C2									
Displacement for DLS	$\delta_{V,eq\ (DLS)}$	[mm]	-	2,3	3,1	3,0	3,3	3,3	1,6
Displacement for ULS	$\delta_{V,eq\ (ULS)}$	[mm]	-	4,8	6,4	6,1	8,2	8,2	4,8
S-ZAV									
Shear load in cracked and uncracked concrete	V	[kN]	10,1	17,1	27,5	41,5	72	72	77
Displacement	δ_{V0}	[mm]	2,9	2,5	3,6	3,5	7,0	7,0	4,3
	$\delta_{V\infty}$	[mm]	4,4	3,8	5,4	5,3	10,5	10,5	6,5
Seismic action C2									
Displacement for DLS	$\delta_{V,eq\ (DLS)}$	[mm]	-	3,1	3,9	3,9	-	-	-
Displacement for ULS	$\delta_{V,eq\ (ULS)}$	[mm]	-	10,2	11,8	13,0	-	-	-

SMART highload anchor type S-ZA

Performance
Displacements under tension and shear load, **steel zinc plated**

Annex C9

Deutsches Institut für Bautechnik DIBt

Table C11: Displacements under tension and shear load, **stainless steel A4**

Anchor size			**12/M8**	**15/M10**	**18/M12**	**24/M16**
Tension load						
Tension load in cracked concrete	N	[kN]	4,3	7,6	12,1	17,0
Displacement	δ_{N0}	[mm]	0,5	0,5	1,3	0,5
	$\delta_{N\infty}$	[mm]	1,2	1,6	1,8	1,6
Tension load in uncracked concrete	N	[kN]	7,6	11,9	16,7	24,1
Displacement	δ_{N0}	[mm]	0,2	0,3	1,2	1,5
	$\delta_{N\infty}$	[mm]	1,1	-	-	-
Seismic action C2						
Displacement for DLS	$\delta_{N,eq\ (DLS)}$	[mm]	4,7	4,5	4,3	4,9
Displacement for ULS	$\delta_{N,eq\ (ULS)}$	[mm]	13,3	12,7	9,7	10,1
Shear load						
Shear load in cracked concrete	V	[kN]	13,9	21,1	34,7	50,8
Displacement	δ_{V0}	[mm]	3,4	4,9	4,8	6,7
	$\delta_{V\infty}$	[mm]	5,1	7,4	7,1	10,1
Seismic action C2						
S-ZAK, S-ZAT						
Displacement for DLS	$\delta_{V,eq(DLS)}$	[mm]	2,8	3,1	2,6	3,3
Displacement for ULS	$\delta_{V,eq\ (ULS)}$	[mm]	5,6	5,8	5,0	6,9
S-ZAV						
Displacement for DLS	$\delta_{V,eq(DLS)}$	[mm]	2,5	2,8	2,9	-
Displacement for ULS	$\delta_{V,eq\ (ULS)}$	[mm]	5,8	5,9	6,9	-

SMART highload anchor type S-ZA

Performance
Displacements under tension and shear load, **stainless steel A4**

Annex C10