Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

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European Technical Assessment ETA-16/0308 of 23 May 2016

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	TURBO SMART
Product family to which the construction product belongs	Concrete screw of sizes 6, 8, 10, 12 and 14 mm for use in concrete
Manufacturer	pgb - Polska Sp. z o.o. ul. Jondy 5 44-100 GLIWICE POLEN
Manufacturing plant	manufacturing plant 3
This European Technical Assessment contains	16 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	Guideline for European technical approval of "Metal anchor for use in concrete", ETAG 001 Part 3: "Undercut anchors, April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011 and European Assessment Document (EAD) 330011-00-0601.

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Specific Part

1 Technical description of the product

The TURBO SMART concrete screw is an anchor in size 6, 8, 10, 12 and 14 mm made of galvanised steel or stainless steel. The anchor is screwed into a predrilled cylindrical drill hole. The special thread of the anchor cuts an internal thread into the member while setting. The anchorage is characterised by mechanical interlock in the special thread.

Product and 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
Product performance for static and quasi-static action	See Annex C 1 and C 2
Product performance for seismic category C1	See Annex C 4
Displacements under tension and shear loads	See Annex C 3

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 C 5

3.3 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

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

In accordance with guideline for European technical approval ETAG 001, April 2013 used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011, and European Assessment Document EAD 330011-00-0601 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 at Deutsches Institut für Bautechnik.

Issued in Berlin on 23 May 2016 by Deutsches Institut für Bautechnik

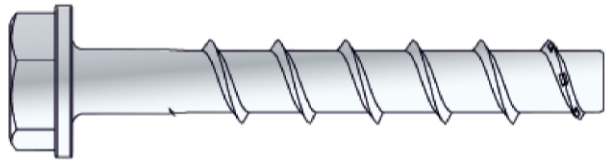
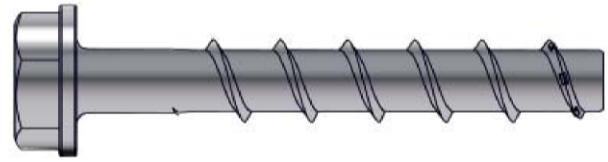
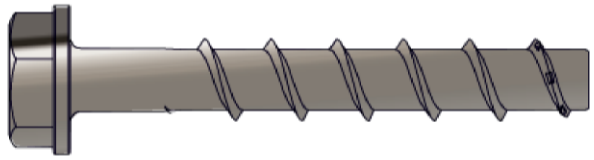
Andreas Kummerow
p. p. Head of Department

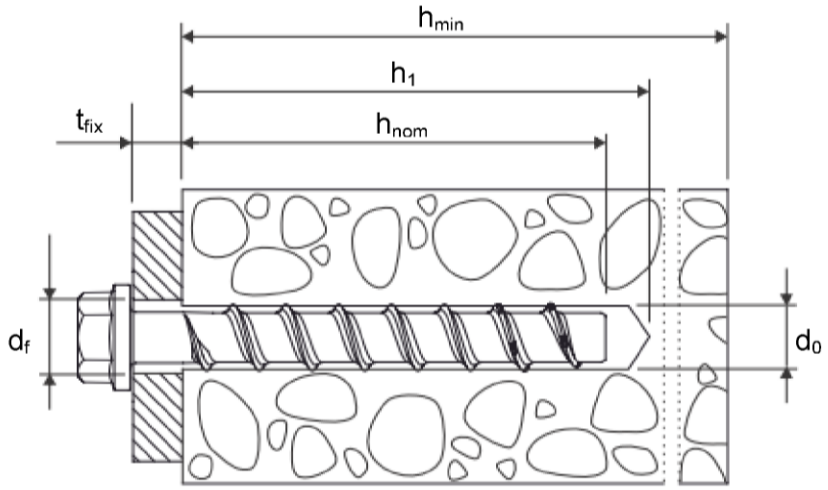
beglaubigt:
Tempel

Deutsches Institut für Bautechnik DIBt

product and installed condition

TURBO SMART concrete screw

	Carbon steel, zinc-plated
	Carbon steel, zinc-flake coating
	Stainless steel A4 and HCR



d_0	=	nominal drill bit diameter
h_{nom}	=	nominal anchorage depth
h_1	=	depth of the drill hole
h_{min}	=	minimum thickness of member
t_{fix}	=	thickness of fixture
d_f	=	diameter of clearance hole in the fixture

TURBO SMART concrete screw

Product description

Product and installed condition

Annex A 1

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Table A1: materials and variants

Part	Type		Material	f_{yk}	f_{uk}	Elongation at rupture A_5
1 2 3 4 5 6 7 8 9 10 11	Concrete screw	TURBO SMART	Steel EN 10263-4 galvanized according to EN ISO 4042 or zinc-flake coating according to EN ISO 10683 (≥ 5µm)	560 N/mm²	700 N/mm²	≤ 8 %
		TURBO SMART A4	1.4401, 1.4404, 1.4571, 1.4578			
		TURBO SMART HCR	1.4529			

f_{yk} = nominal characteristic steel yield strength

f_{uk} = nominal characteristic steel ultimate strength

1		TURBO SMART S-BSZ	Concrete screw version with hexagon head with pressed-on washer
2		TURBO SMART S-BSM	Concrete screw version with hexagon head with pressed-on washer and T-drive
3		TURBO SMART S-BSH	Concrete screw version with hexagon head
4		TURBO SMART S-BSV	Concrete screw with countersunk head
5		TURBO SMART S-BSP	Concrete screw with pan head
6		TURBO SMART S-BSF	Concrete screw with large pan head
7		TURBO SMART S-BSE	Concrete screw with countersunk head and connection thread
8		TURBO SMART S-BSB	Concrete screw with hexagonal head and connection thread
9		TURBO SMART S-BSS	Concrete screw with hexagon drive and connection thread
10		TURBO SMART S-BSA	Concrete screw with connection thread and hexagon socket drive
11		TURBO SMART S-BSI	Concrete screw with internal metric thread and hexagon drive

TURBO SMART concrete screw

Product descriptions

Materials and versions

Annex A 2

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Table A2: dimensions and markings

Anchor size TURBO SMART			6		8			10		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			40	55	45	55	65	55	75	85
Length of the anchor	L ≤	[mm]	500							
Diameter of shaft	d_k	[mm]	5,1		7,1			9,1		
Diameter of thread	d_s	[mm]	7,5		10,6			12,6		

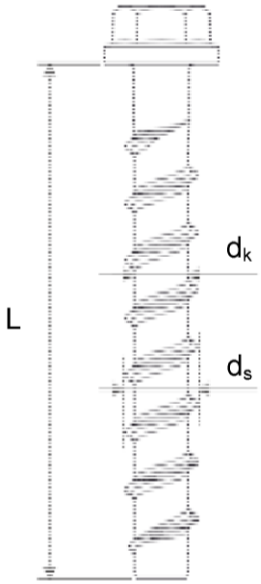
Anchor size TURBO SMART			12			14		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			65	85	100	75	100	115
Length of the anchor	L ≤	[mm]	500					
Diameter of shaft	d_k	[mm]	11,1			13,1		
Diameter of thread	d_s	[mm]	14,6			16,6		

Marking:

TURBO SMART
Anchor type: TSM
Anchor size: 10
Length of the anchor: 100

TURBO SMART A4
Anchor type: TSM
Anchor size: 10
Length of the anchor: 100
Material: A4

TURBO SMART HCR
Anchor type: TSM
Anchor size: 10
Length of the anchor: 100
Material: HCR



TURBO SMART concrete screw

Product descriptions
Dimensions and markings

Annex A 3

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Intended use

Anchorages subject to:

- static and quasi-static loads, all sizes and all embedment depth,
- used for anchorages with requirements related to resistance of fire, all sizes and all embedment depth,
- used for anchorages with seismic action category C1, sizes 8-14 for maximum embedment depth h_{nom3}.

Base materials:

- reinforced and unreinforced concrete according to EN 206-1:2000-12,
- strength classes C20/25 to C50/60 according to EN 206-1:2000-12,
- cracked and uncracked concrete.

Use conditions (Environmental conditions):

- The anchor may only be used in dry internal conditions: All screw types,
- Structural subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition no particular aggressive conditions exits: screw types made of stainless steel with marking A4,
- Structural subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition if particular aggressive conditions exits: screw types made of stainless steel with marking HCR.
  Note: Such 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 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 are designed for design Method A in accordance with:
  - ETAG 001, Annex C, Edition August 2010 or
  - CEN/TS 1992-4:2009,
- Anchorages under seismic actions are designed in accordance with:
  - EOTA Technical Report TR 045, Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure
  - Fastenings in stand-off installation or with a grout layer are not allowed
- Anchorages under fire exposure are designed in accordance with:
  - EOTA Technical Report TR 020, Edition May 2004 or
  - CEN/TS 1992-4:2009, Annex D (It must be ensured that local spalling of the concrete cover does not occur).
- The design method according to ETAG 001, Annex C, section 4.2.2 also applies for the specified diameter d_f of clearance hole in the fixture in Annex B2, Table B1.
- The condition according to CEN/TS 1992-4-1, Section 5.2.3.3, no. 3) is also fulfilled for the specified diameter d_f of clearance hole in the fixture in Annex B2, Table B1.

Installation:

- Hammer drilling only.
- Anchor installation carried out by appropriately qualified personal 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 aborted hole or smaller distance if the aborted hole is filled with high strength mortar and if under shear or oblique tension load it is not the direction of the load application.
- After installation further turning of the anchor is not possible. The head of the anchor is supported on the fixture and is not damaged.
- Adjustability according to Annex B4: sizes 8-14, all anchorage depths.

TURBO SMART concrete screw	Annex B 1
Intended use Specifications	

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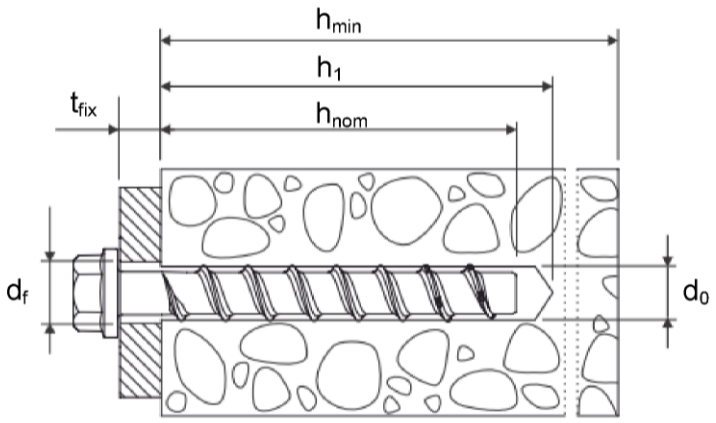
Table B1: Installation parameters

Anchor size TURBO SMART			**6**		**8**			**10**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			40	55	45	55	65	55	75	85
Nominal drill bit diameter	d_0	[mm]	6		8			10		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	6,40		8,45			10,45		
Depth of drill hole	$h_1 \geq$	[mm]	45	60	55	65	75	65	85	95
Diameter of clearing hole in the fixture	$d_f \leq$	[mm]	8		12			14		
Installation torque for version with connection thread	T_{inst}	[Nm]	10		20			40		
Recommended impact screw driver		[Nm]	Max. torque according to manufacturer's instructions							
			160		300			400		

Anchor size TURBO SMART			**12**			**14**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			65	85	100	75	100	115
Nominal drill bit diameter	d_0	[mm]	12			14		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	12,50			14,50		
Depth of drill hole	$h_1 \geq$	[mm]	75	95	110	85	110	125
Diameter of clearing hole in the fixture	$d_f \leq$	[mm]	16			18		
Installation torque for version with connection thread metrical	T_{inst}	[Nm]	60			80		
Recommended impact screw driver			Max. torque according to manufacturer's instructions					
			500			500		



TURBO SMART concrete screw

Intended use

Installation parameters

Annex B 2

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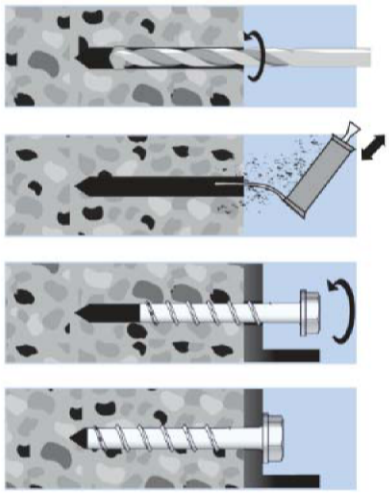
Table B2: Minimum thickness of member, minimum edge distance and minimum spacing

Anchor size TURBO SMART			**6**		**8**			**10**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			40	55	45	55	65	55	75	85
Minimum thickness of member	h_{min}	[mm]	100		100		120	100	130	130
Minimum edge distance	c_{min}	[mm]	40		40	50		50		
Minimum spacing	s_{min}	[mm]	40		40	50		50		

Anchor size TURBO SMART			**12**			**14**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			65	85	100	75	100	115
Minimum thickness of member	h_{min}	[mm]	120	130	150	130	150	170
Minimum edge distance	c_{min}	[mm]	50		70	50	70	
Minimum spacing	s_{min}	[mm]	50		70	50	70	

Installation instructions



1. **Drilling:**
   Choose the correct drill diameter (d_0) and drilling depth (h_1).
2. **Cleaning of the drill hole**:
   Remove drill dust by e.g. blowing.
3. **Installation:**
   Install the anchor by impact screw driver or by hand.
4. **Complete:**
   Verify that the head is pressed to the fixture.

TURBO SMART concrete screw

Intended use

Minimum thickness of member, minimum spacing, minimum edge distance and installation instructions

Annex B 3

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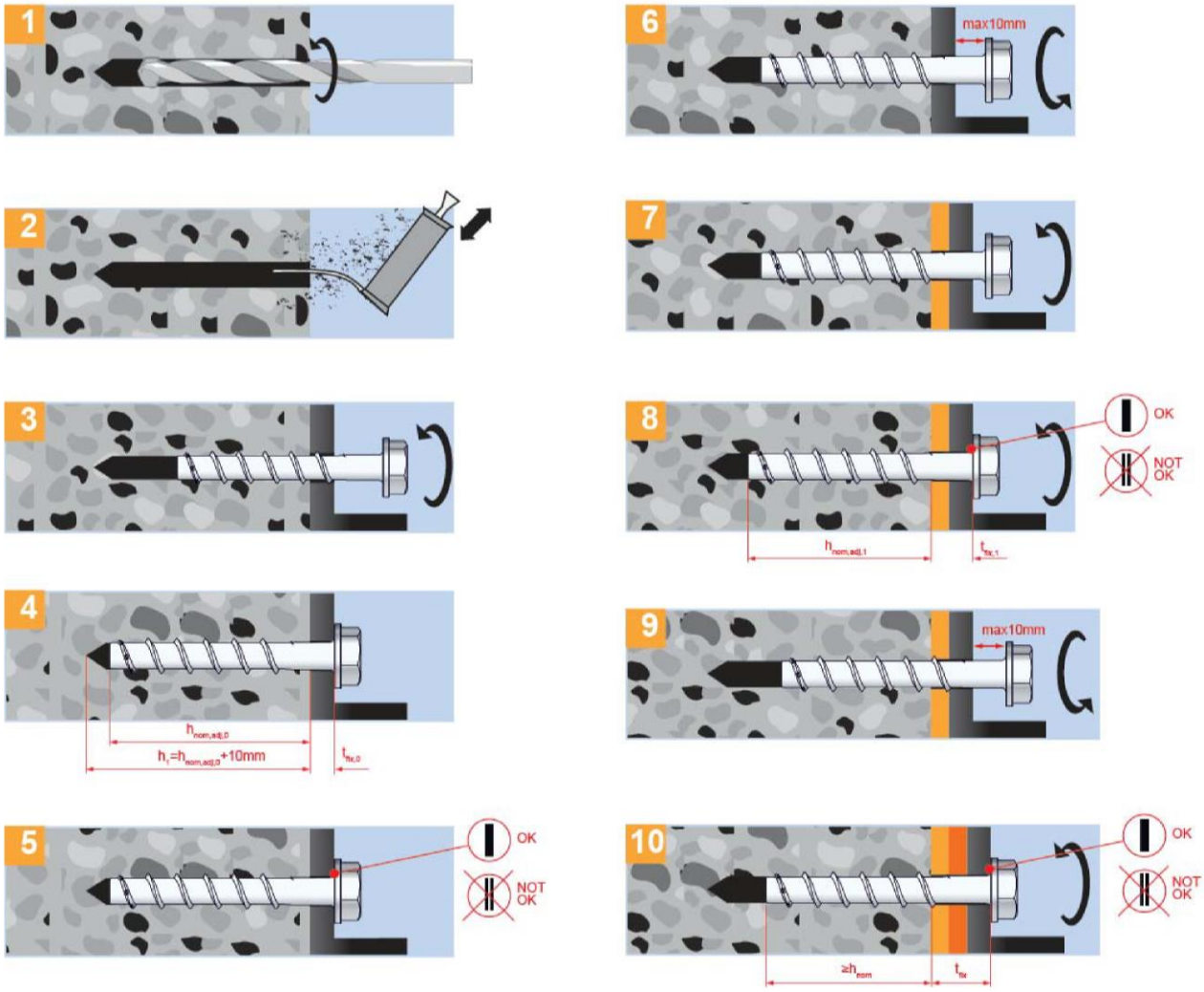
Installation instructions for adjustability



Installation instructions

The TURBO SMART anchor may be adjusted maximum two times while the anchor may turn back at most 10 mm.
The total allowed thickness of shims added during the adjustment process is 10mm.
The final embedment depth after adjustment process must be equal or larger than h_{nom}.

TURBO SMART concrete screw	**Annex B 4**
Intended use Installation instruction for adjustability	

Deutsches Institut für Bautechnik DIBt

Table C1: Characteristic values for design method A according to ETAG 001, Annex C or CEN/TS 1992-4 for TURBO SMART 6, 8 and 10

Anchor size TURBO SMART				**6**		**8**			**10**		
Nominal embedment depth h_{nom} [mm]				h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
				40	55	45	55	65	55	75	85
steel failure for tension- and shear load											
characteristic load		$N_{Rk,s}$	[kN]	14,0		27,0			45,0		
		$V_{Rk,s}$	[kN]	7,0		17,0			34,0		
		k_2 [1]	[-]	0,8		0,8			0,8		
		$M^0_{Rk,s}$	[Nm]	10,0		26,0			56,0		
pull-out failure											
characteristic tension load in cracked concrete C20/25		$N_{Rk,p}$	[kN]	2,0	4,0	5,0	9,0	12,0	9,0	Pull-out failure is not decisive	
characteristic tension load in uncracked concrete C20/25		$N_{Rk,p}$	[kN]	4,0	9,0	7,5	12,0	16,0	12,0	20,0	25,0
increasing factor for $N_{Rk,p}$		Ψ_C	C30/37	1,22							
			C40/50	1,41							
			C50/60	1,55							
concrete cone and splitting failure											
effective anchorage depth		h_{ef}	[mm]	31	44	35	43	52	43	60	68
factor for	cracked	k_{cr} [1]	[-]	7,2							
	uncracked	k_{ucr} [1]	[-]	10,1							
concrete cone failure	spacing	$s_{cr,N}$	[mm]	3 x h_{ef}							
	edge distance	$c_{cr,N}$	[mm]	1,5 x h_{ef}							
splitting failure	spacing	$s_{cr,Sp}$	[mm]	120	160	120	140	150	140	180	210
	edge distance	$c_{cr,Sp}$	[mm]	60	80	60	70	75	70	90	105
installation safety factor		γ_2 [2]	[-]	1,0							
		γ_{inst} [1]	[-]								
concrete pry out failure (pry-out)											
k-Factor		k [2] / k_3 [1]	[-]	1,0					2,0		
concrete edge failure											
effective length of anchor		$l_f = h_{ef}$	[mm]	31	44	35	43	52	43	60	68
outside diameter of anchor		d_{nom}	[mm]	6		8			10		

[1] Parameter relevant only for design according to CEN/TS 1992-4:2009

[2] Parameter relevant only for design according to ETAG 001, Annex C

TURBO SMART concrete screw

Performances

Characteristic values for TURBO SMART 6, 8 and 10

Annex C 1

Deutsches Institut für Bautechnik DIBt

Table C2: Characteristic values for design method A according to ETAG 001, Annex C or CEN/TS 1992-4 for TURBO SMART 12 and 14

Anchor size TURBO SMART				**12**			**14**		
Nominal embedment depth h_{nom} [mm]				h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
				65	**85**	**100**	**75**	**100**	**115**
steel failure for tension- and shear load									
characteristic load		$N_{Rk,s}$	[kN]	67,0			94,0		
		$V_{Rk,s}$	[kN]	40,0			56,0		
		k_2 [1]	[-]	0,8			0,8		
		$M^0_{Rk,s}$	[Nm]	113,0			185,0		
pull-out failure									
characteristic tension load in cracked concrete C20/25		$N_{Rk,p}$	[kN]	12,0	Pull-out failure is not decisive		Pull-out failure is not decisive		
characteristic tension load in uncracked concrete C20/25		$N_{Rk,p}$	[kN]	16,0					
increasing factor for $N_{Rk,p}$		Ψ_C	C30/37	1,22					
			C40/50	1,41					
			C50/60	1,55					
concrete cone and splitting failure									
effective anchorage depth		h_{ef}	[mm]	50	67	80	58	79	92
factor for	cracked	k_{cr} [1]	[-]	7,2					
	uncracked	k_{ucr} [1]	[-]	10,1					
concrete cone failure	spacing	$s_{cr,N}$	[mm]	3 x h_{ef}					
	edge distance	$c_{cr,N}$	[mm]	1,5 x h_{ef}					
splitting failure	spacing	$s_{cr,Sp}$	[mm]	150	210	240	180	240	280
	edge distance	$c_{cr,Sp}$	[mm]	75	105	120	90	120	140
installation safety factor		γ_2 [2]	[-]	1,0					
		γ_{inst} [1]	[-]						
concrete pry out failure (pry-out)									
k-Factor		k [2]	[-]	1,0	2,0		1,0	2,0	
		k_3 [1]							
concrete edge failure									
effective length of anchor		$l_f = h_{ef}$	[mm]	50	67	80	58	79	92
outside diameter of anchor		d_{nom}	[mm]	12			14		

[1] Parameter relevant only for design according to CEN/TS 1992-4:2009

[2] Parameter relevant only for design according to ETAG 001, Annex C

TURBO SMART concrete screw

Performances

Characteristic values for TURBO SMART 12 and 14

Annex C 2

Deutsches Institut für Bautechnik DIBt

Table C3: Displacements under tension load for TURBO SMART

Anchor size TURBO SMART				**6**		**8**			**10**		
Nominal embedment depth h_{nom} [mm]				h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
				40	**55**	**45**	**55**	**65**	**55**	**75**	**85**
Cracked concrete	tension load	N	[kN]	0,95	1,9	2,4	4,3	5,7	4,3	7,9	9,6
	displacement	δ_{N0}	[mm]	0,3	0,6	0,6	0,7	0,8	0,6	0,5	0,9
		δ_{∞}	[mm]	0,4	0,4	0,6	1,0	0,9	0,4	1,2	1,2
Un-cracked concrete	tension load	N	[kN]	1,9	4,3	3,6	5,7	7,6	5,7	9,5	11,9
	displacement	δ_{N0}	[mm]	0,4	0,6	0,7	0,9	0,5	0,7	1,1	1,0
		$\delta_{N\infty}$	[mm]	0,4	0,4	0,6	1,0	0,9	0,4	1,2	1,2

Anchor size TURBO SMART				**12**			**14**		
Nominal embedment depth h_{nom} [mm]				h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
				65	**85**	**100**	**75**	**100**	**115**
Cracked concrete	tension load	N	[kN]	5,7	9,4	12,3	7,6	12,0	15,1
	displacement	δ_{N0}	[mm]	0,9	0,5	1,0	0,5	0,8	0,7
		δ_{∞}	[mm]	1,0	1,2	1,2	0,9	1,2	1,0
Un-cracked concrete	tension load	N	[kN]	7,6	13,2	17,2	10,6	16,9	21,2
	displacement	δ_{N0}	[mm]	1,0	1,1	1,2	0,9	1,2	0,8
		$\delta_{N\infty}$	[mm]	1,0	1,2	1,2	0,9	1,2	1,0

Table C4 : Displacements under shear load for TURBO SMART

Anchor size TURBO SMART			**6**		**8**			**10**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			40	**55**	**45**	**55**	**65**	**55**	**75**	**85**
shear load	V	[kN]	3,3		8,6			16,2		
displacement	δ_{V0}	[mm]	1,55		2,7			2,7		
	$\delta_{V\infty}$	[mm]	3,10		4,1			4,3		

Anchor size TURBO SMART			**12**			**14**		
Nominal embedment depth h_{nom} [mm]			h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			65	**85**	**100**	**75**	**100**	**115**
shear load	V	[kN]	20,0			30,5		
displacement	δ_{V0}	[mm]	4,0			3,1		
	$\delta_{V\infty}$	[mm]	6,0			4,7		

TURBO SMART concrete screw

Performances

Displacements under tension and shear loads

Annex C 3

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Table C5: Characteristic values for seismic category C1

Anchor size TURBO SMART			**8**	**10**	**12**	**14**
Nominal embedment depth h_{nom} [mm]			h_{nom3}			
			65	**85**	**100**	**115**
steel failure for tension- and shear load						
characteristic load	$N_{Rk,s,seis}$	[kN]	27,0	45,0	67,0	94,0
	$V_{Rk,s,\ seis}$	[kN]	8,5	15,3	21,0	22,4
pull-out failure						
characteristic tension load in cracked concrete C20/25	$N_{Rk,p,seis}$	[kN]	12,0	Pull-out failure is not decisive		
concrete cone failure						
effective anchorage depth	h_{ef}	[mm]	52	68	80	92
concrete cone failure – spacing	$s_{cr,N}$	[mm]	$3 \times h_{ef}$			
concrete cone failure – edge distance	$c_{cr,N}$	[mm]	$1{,}5 \times h_{ef}$			
installation safety factor	γ_2	[-]	1,0			
concrete pry out failure (pry-out)						
k-Factor	k	[-]	1,0	2,0		
concrete edge failure						
effective length of anchor	$l_f = h_{ef}$	[mm]	52	68	80	92
outside diameter of anchor	d_{nom}	[mm]	8	10	12	14

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Table C6: Characteristic values of resistance to fire exposure for TURBO SMART

Anchor size TURBO SMART				**6**		**8**			**10**			**12**			**14**		
Nominal embedment depth		h_{nom}		1	2	1	2	3	1	2	3	1	2	3	1	2	3
			[mm]	40	55	45	55	65	55	75	85	65	85	100	75	100	115
steel failure for tension- and shear load ($F_{Rk,s,fi} = N_{Rk,s,fi} = V_{Rk,s,fi}$)																	
Fire resistance class																	
R30	Characteristic Resistance	$F_{Rk,s,fi30}$	[kN]	0,9		2,4			4,4			7,3			10,3		
R60		$F_{Rk,s,fi60}$	[kN]	0,8		1,7			3,3			5,8			8,2		
R90		$F_{Rk,s,fi90}$	[kN]	0,6		1,1			2,3			4,2			5,9		
R120		$F_{Rk,s,fi120}$	[kN]	0,4		0,7			1,7			3,4			4,8		
R30		$M^0_{Rks,,fi30}$	[Nm]	0,7		2,4			5,9			12,3			20,4		
R60		$M^0_{Rk,s,fi60}$	[Nm]	0,6		1,8			4,5			9,7			15,9		
R90		$M^0_{Rk,s,fi90}$	[Nm]	0,5		1,2			3,0			7,0			11,6		
R120		$M^0_{Rks,,fi120}$	[Nm]	0,3		0,9			2,3			5,7			9,4		
edge distance																	
R30 bis R120		$c_{cr,\,fi}$	[mm]	$2 \times h_{ef}$													
spacing																	
R30 bis R120		$s_{cr,\,fi}$	[mm]	$4 \times h_{ef}$													

The characteristic resistance to fire exposure for pull-out failure, concrete cone failure, concrete pry-out failure and concrete edge failure shall be calculated according to TR 020 or CEN/TS 1992-4. If no value for $N_{Rk,p}$ is given, in the equation 2.4 and 2.5, TR 020 or in equation D.1 and D.2, CEN/TS 1992-4 the value of $N^0_{Rk,c}$ shall be inserted instead of $N_{Rk,p}$.

TURBO SMART concrete screw

Performances

Characteristic values of resistance to fire exposure

Annex C 5