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-16/0470 of 16 July 2021

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	CELO Concrete screw BTS
Product family to which the construction product belongs	Mechanical fasteners for use in concrete
Manufacturer	CELO Befestigungssysteme GmbH Industriestraße 6 86551 Aichach DEUTSCHLAND
Manufacturing plant	Werk 16
This European Technical Assessment contains	22 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, Edition 10/2016
This version replaces	ETA-16/0470 issued on 6 October 2016

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Specific Part

1 Technical description of the product

The CELO concrete screw BTS is an anchor in size 6, 8, 10, 12 and 14 mm made of galvanised steel respectively steel with zinc flake coating, made of stainless or high corrosion resistant 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.

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 to tension load (static and quasi-static loading)	See Annex C 1 and C 2
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1 and C 2
Displacements (static and quasi-static loading)	See Annex C 7
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 3, C 4, C 5 and C 8
Durability	See Annex B 1

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 6

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

In accordance with European Assessment Document EAD No. 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 at Deutsches Institut für Bautechnik.

Issued in Berlin on 16 July 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of Section

beglaubigt:
Baderschneider

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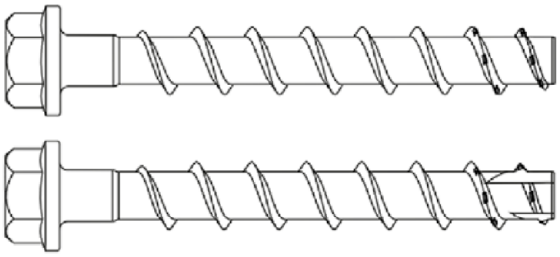
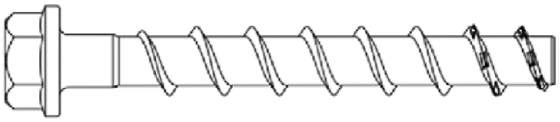
Product in installed condition

CELO concrete screw BTS

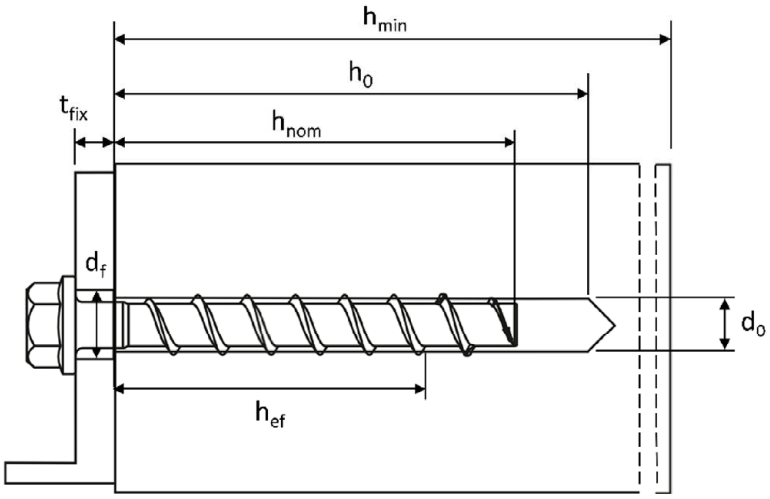
- Galvanized carbon steel
- Zinc flakes coated carbon steel



- Stainless steel A4
- Stainless steel HCR



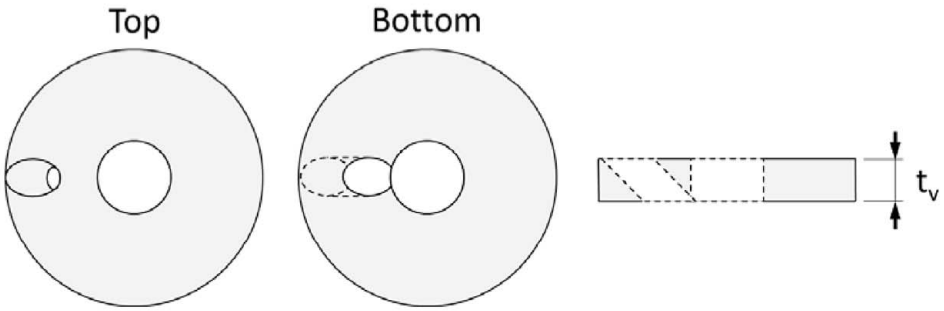
e.g. CELO concrete screw, zinc flakes coated, with hexagon head and fixture



d_0 = nominal drill hole diameter
t_{fix} = thickness of fixture
d_f = clearance hole diameter

h_{min} = minimum thickness of member
h_{nom} = nominal embedment depth
h_0 = drill hole depth
h_{ef} = effective embedment depth

Filling washer (optional) to fill annular gap



CELO concrete screw BTS	Annex A1
Product description Product in installed condition	

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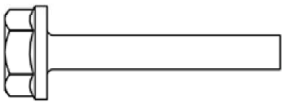
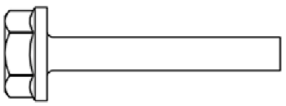
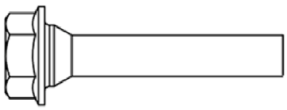
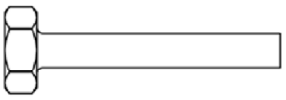
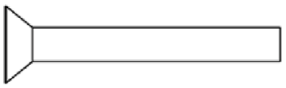
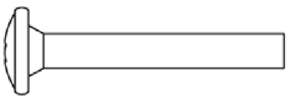
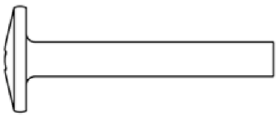
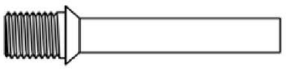
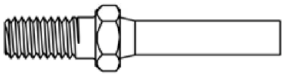
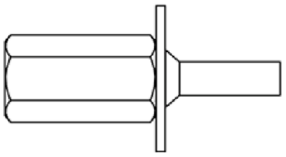
 	Configuration with metric connection threat and hexagon socket e.g. BTS 8x105 M10 IN5
 	Configuration with metric connection threat and hexagon drive e.g. BTS 8x105 M10 SW7
 	Configuration with washer and hexagon head e.g. BTS B 8x80 SW13
 	Configuration with washer, hexagon head and TORX drive e.g. BTS B 8x80 SW13 TX40
 	Configuration with washer and underhead reinforcement e.g. BTS M 14x130 SW24
 	Configuration with hexagon head e.g. BTS K 8x80 SW13
 	Configuration with countersunk head and TORX drive e.g. BTS ST 8x80 TX40
 	Configuration with pan head and TORX drive e.g. BTS PT 8x80 TX40
 	Configuration with large pan head and TORX drive e.g. BTS PLT 8x80 TX40
 	Configuration with countersunk head and connection thread e.g. BTS E 6x55 M8
 	Configuration with hexagon drive and connection thread e.g. BTS E 6x55 M8 SW10
 	Configuration with internal thread and hexagon drive e.g. BTS H 6x55 M8/10

CELO concrete screw BTS	
Product description Screw types	**Annex A2**

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Table 1: Material

Part	Product name	Material
all types	CELO BTS	- Steel EN 10263-4:2017 galvanized acc. to EN ISO 4042:2018 - Zinc flake coating according to EN ISO 10683:2018 (≥5µm) - Zinc flake coating according to EN ISO 10683:2018 special coating KORR (≥20µm)
	CELO BTS A4	1.4401; 1.4404; 1.4571; 1.4578
	CELO BTS HCR	1.4529

Part	Product name	Nominal characteristic steel Yield strength f_{yk} [N/mm²]	Nominal characteristic steel Ultimate strength f_{uk} [N/mm²]	Rupture elongation A_5 [%]
all types	CELO BTS CELO BTS A4 CELO BTS HCR	560	700	≤ 8

Table 2: Dimensions

Anchor size			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
Screw length	≤ L	[mm]	500													
Core diameter	d_K	[mm]	5,1		7,1			9,1			11,1			13,1		
Thread outer diameter	d_s	[mm]	7,5		10,6			12,6			14,6			16,6		
Thickness of filling washer	t_v	[mm]	-		5			5			5			5		

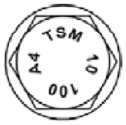
Marking:

BTS

Screw type:	BTS
Screw size:	10
Screw length:	100

BTS A4

Screw type:	BTS
Screw size:	10
Screw length:	100
Material:	A4

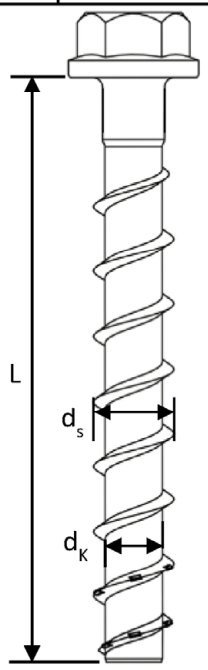


BTS M

Screw type:	BTS M
Screw size:	10
Screw length:	100

BTS HCR

Screw type:	BTS
Screw size:	10
Screw length:	100
Material:	HCR



CELO concrete screw BTS

Product description
Material, Dimensions and markings

Annex A3

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Specification of Intended use

Table 3: Anchorages subject to

BTS concrete screw size		6		8			10			12			14		
Nominal embedment depth		h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
	[mm]	40	55	45	55	65	55	75	85	65	85	100	65	85	115
Static and quasi-static loads		All sizes and all embedment depths													
Fire exposure															
C1 category - seismic		ok	ok	1)		ok	ok	1)	ok	1)		ok	1)		ok
C2 category – seismic (A4 and HCR: no performance assessed)		1)					1)								

1) no performance assessed

Base materials:

- Compacted reinforced and unreinforced concrete without fibers according to EN 206:2013.
- Strength classes C20/25 to C50/60 according to EN 206:2013.
- Cracked and uncracked concrete.

Use conditions (Environmental conditions):

- Concrete screws subject to 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 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).

CELO concrete screw BTS	Annex B1
Intended use Specification	

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Specification of Intended use - continuation

Design:

- Anchorages are to be designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Verifiable calculation notes and drawings are to be 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 are designed according to EN 1992-4:2018 and EOTA Technical Report TR 055.

  The design for shear load according to EN 1992-4:2018, Section 6.2.2 applies for all specified diameters d_f of clearance hole in the fixture in Annex B3, Table 4.

Installation:

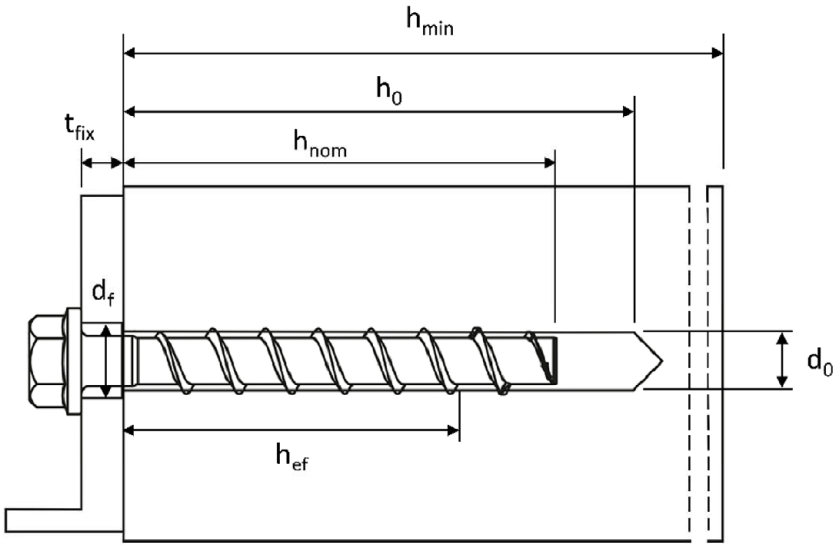
- Hammer drilling or hollow drilling.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters on site.
- In case of aborted hole: new drilling must be drilled at a minimum distance of twice the depth of aborted hole or closer, if the aborted hole is filled with high strength mortar and only if the hole is not in the direction of the oblique tensile or shear load.
- After installation further turning of the anchor must not be possible. The head of the anchor is supported in the fixture and is not damaged.
- The borehole may be filled with injection mortar CF-T 300V or ATA 2004C.
- Adjustability according to Annex B6 for sizes 6-14, all embedment depths except for seismic application.
- Cleaning of borehole is not necessary, if using a hollow drill.

CELO concrete screw BTS	**Annex B2**
Intended use Specification continuation	

Table 4: Installation parameters

BTS concrete screw size			6		8			10		
Nominal embedment depth		h_{nom}	h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
		[mm]	40	55	45	55	65	55	75	85
Nominal drill hole diameter	d_0	[mm]	6		8			10		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	6,40		8,45			10,45		
Drill hole depth	$h_0 \geq$	[mm]	45	60	55	65	75	65	85	95
Clearance hole diameter	$d_f \leq$	[mm]	8		12			14		
Installation torque (version with connection thread)	T_{inst}	[Nm]	10		20			40		
Torque impact screw driver		[Nm]	Max. torque according to manufacturer's instructions							
			160		300			400		

BTS concrete screw size			12			14		
Nominal embedment depth		h_{nom}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
		[mm]	65	85	100	75	100	115
Nominal drill hole diameter	d_0	[mm]	12			14		
Cutting diameter of drill bit	$d_{cut} \leq$	[mm]	12,50			14,50		
Drill hole depth	$h_0 \geq$	[mm]	75	95	110	85	110	125
Clearance hole diameter	$d_f \leq$	[mm]	16			18		
Installation torque (version with connection thread)	T_{inst}	[Nm]	60			80		
Torque impact screw driver		[Nm]	Max. torque according to manufacturer's instructions					
			650			650		



CELO concrete screw BTS

Intended use
Installation parameters

Annex B3

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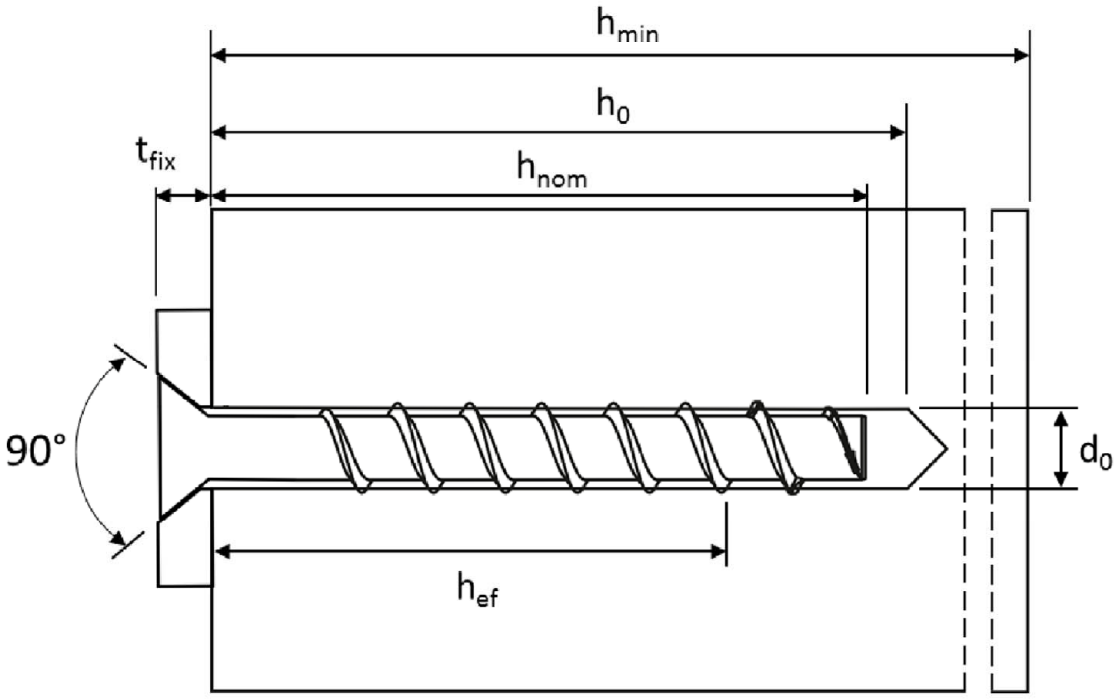
Table 5: Minimum thickness of member, minimum edge distance and minimum spacing

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

BTS concrete screw size			12			14		
Nominal embedment depth		h_{nom}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
		[mm]	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	



CELO concrete screw BTS

Intended use
Minimum thickness of member, minimum edge distance and minimum spacing

Annex B4

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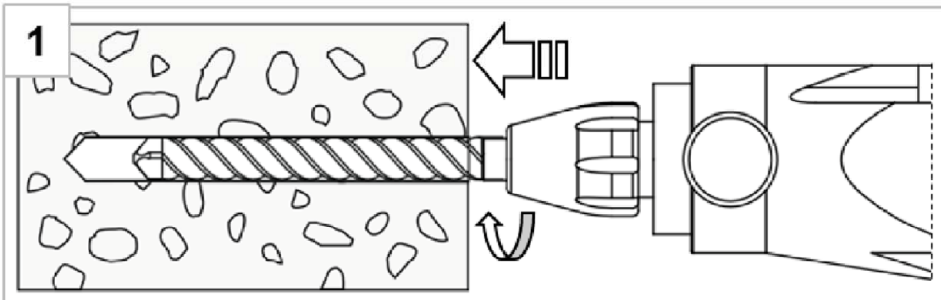
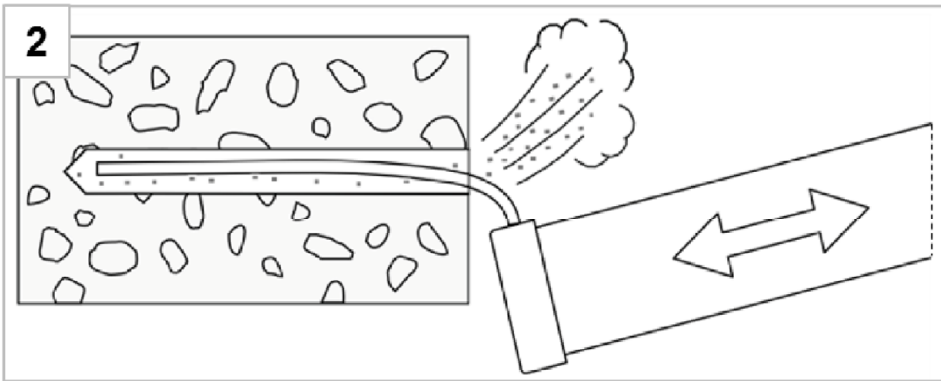
Installation Instructions

1



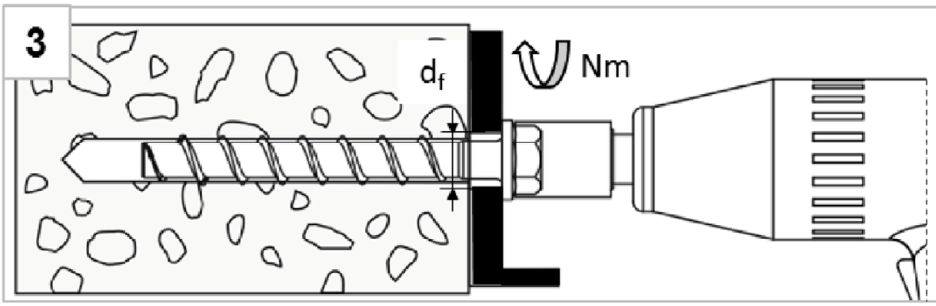
Create hammer drilled or hollow drilled borehole

2



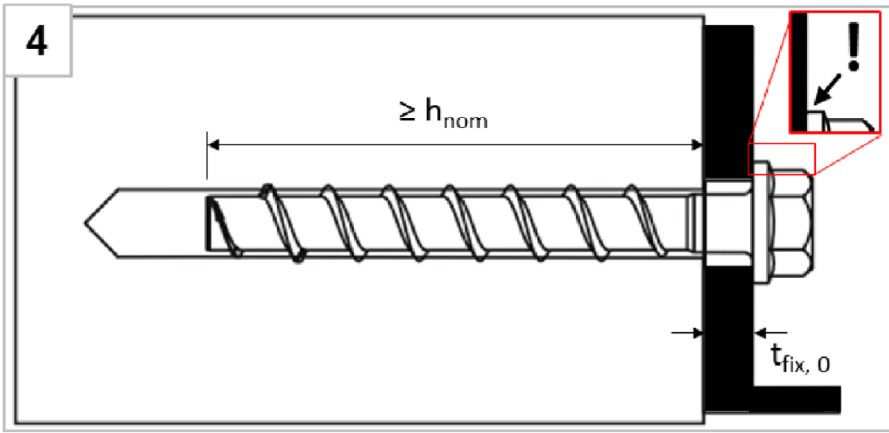
Remove drill dust by vacuuming or blowing of

3



Install with torque impact screw driver or torque wrench

4



The head must be undamaged and in contact with the fixture

Note:
Cleaning of borehole is not necessary when using a hollow drill

CELO concrete screw BTS	
Intended use Installation instructions	**Annex B5**

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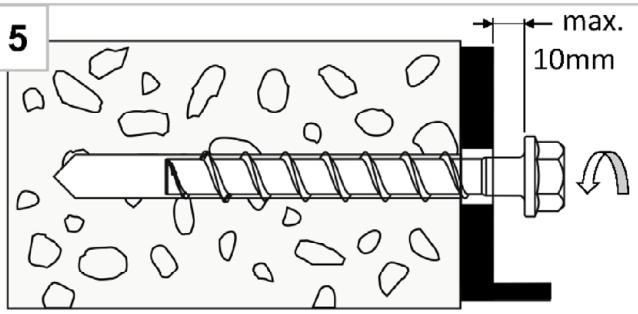
Installation Instructions – Adjustment

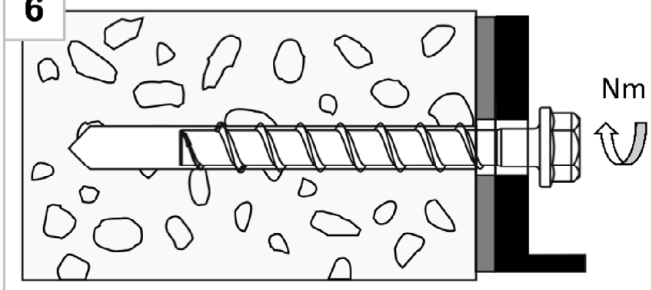
1. Adjustment

5



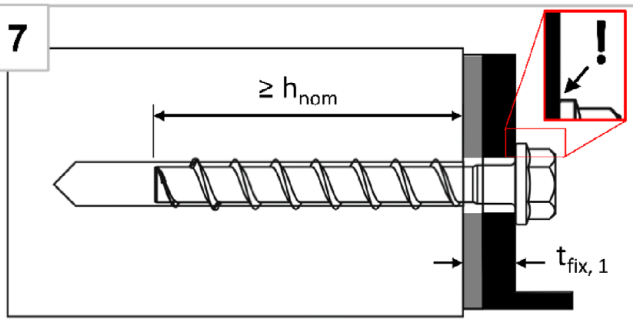
Screw may be untightened maximum 10mm

6



After adjustment, tighten the screw again

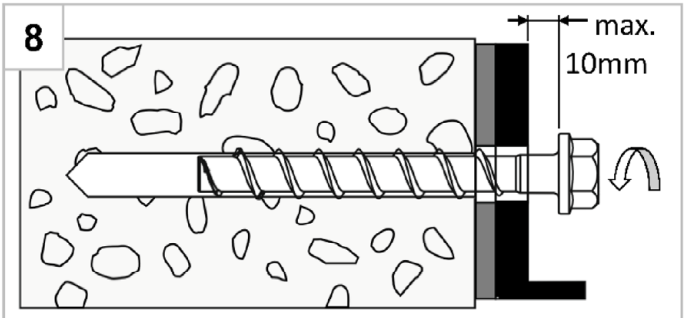
7



The head must be undamaged and in contact with the fixture

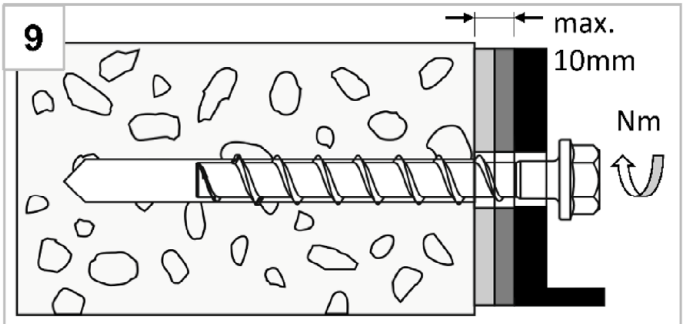
2. Adjustment

8



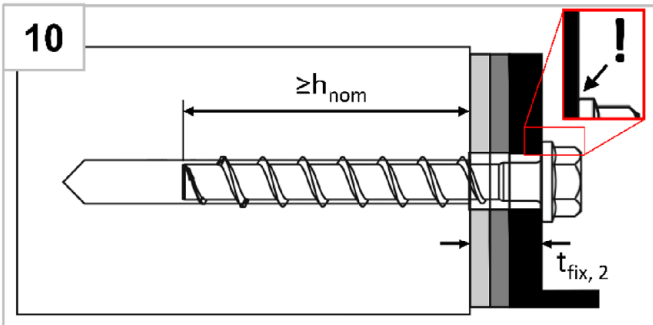
Screw may be untightened maximum 10mm

9



After adjustment, tighten the screw again

10



The head must be undamaged and in contact with the fixture

Note:
The fastener can be adjusted maximum two times. The total allowed thickness of shims added during the adjustment process is 10mm. The final embedment depth after adjustment process must be larger or equal than h_{nom}.

CELO concrete screw BTS	
Intended use Installation instructions - Adjustment	**Annex B6**

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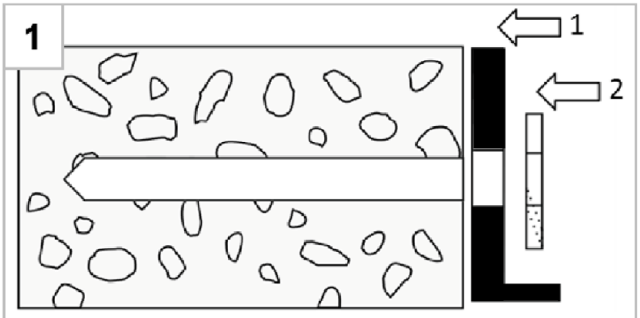
Installation Instructions – Filling annular gap

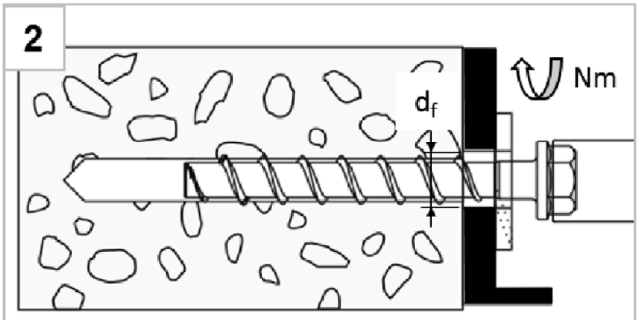
Positioning of fixture and filling washer

1



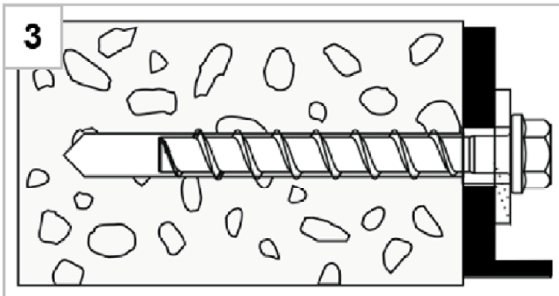
After preparing borehole (Annex B5, figure 1+2), position first fixture (1), than filling washer (2)

2



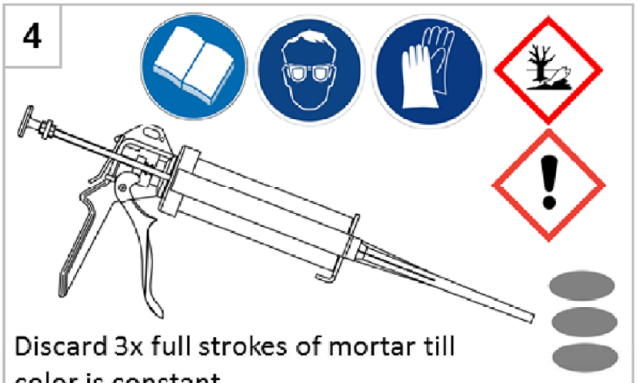
Install with torque impact screw driver or torque wrench

3



Installed condition without injected mortar in the filling washer

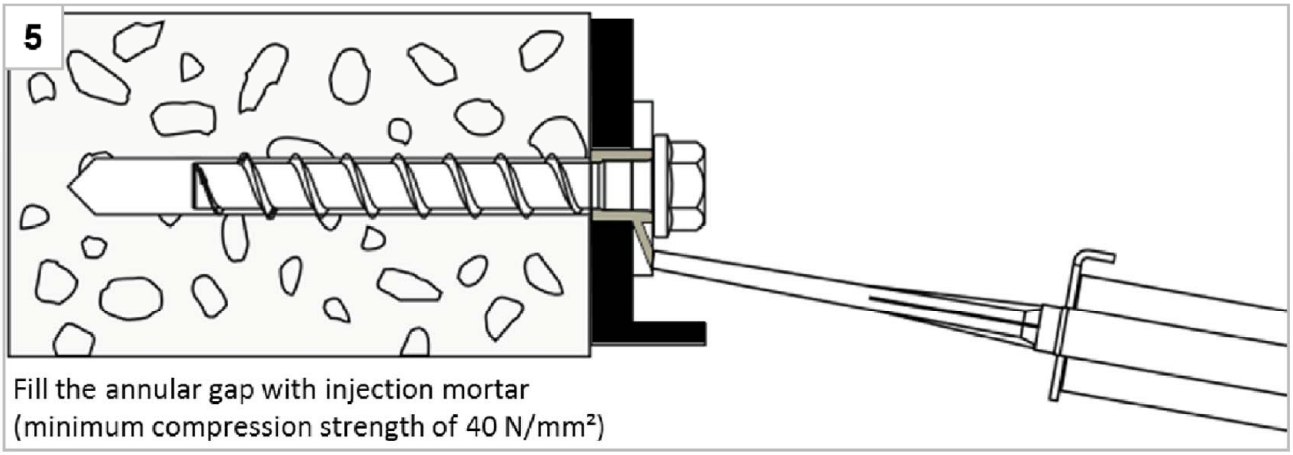
4



Discard 3x full strokes of mortar till color is constant

Filling the annular gap

5



Fill the annular gap with injection mortar (minimum compression strength of 40 N/mm²)

Note:
For seismic loading the installation with filled and without filled annular gap is approved.
Differences in performance can be found in Annex C5 - C7.

CELO concrete screw BTS	
Intended use Installation instructions - Filling annular gap	**Annex B7**

Deutsches Institut für Bautechnik DIBt

Table 6: Characteristic values for static and quasi-static loading, sizes 6-10

BTS concrete screw size				6		8			10		
Nominal embedment depth			h_{nom}	h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			[mm]	40	55	45	55	65	55	75	85
Steel failure for tension and shear loading											
Characteristic tension load		$N_{Rk,s}$	[kN]	14,0		27,0			45,0		
Partial factor		$\gamma_{Ms,N}$	[-]	1,5							
Characteristic shear load		$V^0_{Rk,s}$	[kN]	7,0		13,5		17,0	22,5	34,0	
Partial factor		$\gamma_{Ms,V}$	[-]	1,25							
Ductility factor		k_7	[-]	0,8							
Characteristic bending load		$M^0_{Rk,s}$	[Nm]	10,9		26,0			56,0		
Pull-out failure											
Characteristic tension load C20/25	cracked	$N_{Rk,p}$	[kN]	2,0	4,0	5,0	9,0	12,0	9,0	≥ $N^0_{Rk,c}$ [1]	
	uncracked	$N_{Rk,p}$	[kN]	4,0	9,0	7,5	12,0	16,0	12,0	20,0	26,0
Increasing factor for $N_{Rk,p}$	C25/30	Ψ_c	[-]	1,12							
	C30/37			1,22							
	C40/50			1,41							
	C50/60			1,58							
Concrete failure: Splitting failure, concrete cone failure and pry-out failure											
Effective embedment depth		h_{ef}	[mm]	31	44	35	43	52	43	60	68
k-factor	cracked	k_{cr}	[-]	7,7							
	uncracked	k_{ucr}	[-]	11,0							
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	resistance	$N^0_{Rk,sp}$	[kN]	4,0	9,0	7,5	12,0	16,0	12,0	20,0	26,0
	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
Factor for pry-out failure		k_8	[-]	1,0						2,0	
Installation factor		γ_{inst}	[-]	1,0							
Concrete edge failure											
Effective length in concrete		$l_f = h_{ef}$	[mm]	31	44	35	43	52	43	60	68
Nominal outer diameter of screw		d_{nom}	[mm]	6		8			10		

[1] $N^0_{Rk,c}$ according to EN 1992-4:2018

CELO concrete screw BTS

Performances
Characteristic values for static and quasi-static loading, sizes 6-10

Annex C1

Deutsches Institut für Bautechnik DIBt

Table 7: Characteristic values for static and quasi-static loading, sizes 12-14

BTS concrete screw size				12			14		
Nominal embedment depth			h_{nom}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			[mm]	65	85	100	75	100	115
Steel failure for tension and shear loading									
Characteristic tension load		$N_{Rk,s}$	[kN]	67,0			94,0		
Partial factor		$\gamma_{Ms,N}$	[-]	1,5					
Characteristic shear load		$V^0_{Rk,s}$	[kN]	33,5	42,0		56,0		
Partial factor		$\gamma_{Ms,V}$	[-]	1,25					
Ductility factor		k_7	[-]	0,8					
Characteristic bending load		$M^0_{Rk,s}$	[Nm]	113,0			185,0		
Pull-out failure									
Characteristic tension load C20/25	cracked	$N_{Rk,p}$	[kN]	12,0	$\geq N^0_{Rk,c}$ [1]				
	uncracked	$N_{Rk,p}$	[kN]	16,0					
Increasing factor for $N_{Rk,p}$	C25/30	Ψ_c	[-]	1,12					
	C30/37			1,22					
	C40/50			1,41					
	C50/60			1,58					
Concrete failure: Splitting failure, concrete cone failure and pry-out failure									
Effective embedment depth		h_{ef}	[mm]	50	67	80	58	79	92
k-factor	cracked	$k_1 = k_{cr}$	[-]	7,7					
	uncracked	$k_1 = k_{ucr}$	[-]	11,0					
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	resistance	$N^0_{Rk,sp}$	[kN]	16,0	27,0	35,0	21,5	34,5	43,5
	spacing	$s_{cr,Sp}$	[mm]	150	210	240	180	240	280
	edge distance	$c_{cr,Sp}$	[mm]	75	105	120	90	120	140
Factor for pry-out failure		k_8	[-]	1,0	2,0		1,0	2,0	
Installation factor		γ_{inst}	[-]	1,0					
Concrete edge failure									
Effective length in concrete		$l_f = h_{ef}$	[mm]	50	67	80	58	79	92
Nominal outer diameter of screw		d_{nom}	[mm]	12			14		

[1] $N^0_{Rk,c}$ according to EN 1992-4:2018

CELO concrete screw BTS

Performances
Characteristic values for static and quasi-static loading, sizes 12-14

Annex C2

Deutsches Institut für Bautechnik DIBt

Table 8: Seismic category C1 – Characteristic load values (only BTS B, BTS K, BTS ST, BTS, BTS E[1)], BTS PT/PTL und BTS H[1)])

BTS concrete screw size			6		8	10		12	14
Nominal embedment depth		h_{nom}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom3}	h_{nom3}	h_{nom3}
		[mm]	40	55	65	55	85	100	115
Steel failure for tension and shear load (version **BTS B, BTS K, BTS ST, BTS, BTS E[1)], BTS PT/PTL, BTS H[1)]**)									
Characteristic load	$N_{Rk,s,C1}$	[kN]	14,0		27,0	45,0		67,0	94,0
Partial factor	$\gamma_{Ms,C1}$	[-]	1,5						
Characteristic load	$V_{Rk,s,C1}$	[kN]	4,7	5,5	8,5	13,5	15,3	21,0	22,4
Partial factor	$\gamma_{Ms,C1}$	[-]	1,25						
With filling of the annular gap [2)]	α_{gap}	[-]	1,0						
Without filling of the annular gap [3)]	α_{gap}	[-]	0,5						
Pull-out failure (version **BTS B, BTS K, BTS ST, BTS, BTS E[1)], BTS PT/PTL, BTS H[1)]**)									
Characteristic tension load in cracked concrete C20/25	$N_{Rk,p,C1}$	[kN]	2,0	4,0	12,0	9,0	≥ $N^0_{Rk,c}$ [4)]		
Concrete cone failure (version **type S, type SK, type ST, type ST-6[1)], type P, type I[1)]**)									
Effective embedment depth	h_{ef}	[mm]	31	44	52	43	68	80	92
Edge distance	$c_{cr,N}$	[mm]	1,5 x h_{ef}						
Spacing	$s_{cr,N}$	[mm]	3 x h_{ef}						
Installation safety factor	γ_{inst}	[-]	1,0						
Concrete pry-out failure (version **BTS B, BTS K, BTS ST, BTS, BTS PT/PTL**)									
Factor for pry-out failure	k_8	[-]	1,0				2,0		
Concrete edge failure (version **BTS B, BTS K, BTS ST, BTS, BTS PT/PTL**									
Effective length in concrete	$l_f = h_{ef}$	[mm]	31	44	52	43	68	80	92
Nominal outer diameter of screw	d_{nom}	[mm]	6	6	8	10	10	12	14

[1)] only tension load
[2)] With filling of the annular gap according to annex B7, figure 5
[3)] Without filling of the annular gap according to annex B5
[4)] $N^0_{Rk,c}$ according to EN 1992-4:2018

CELO concrete screw BTS

Performances
Seismic category C1 – Characteristic load values

Annex C3

Deutsches Institut für Bautechnik DIBt

Table 9: Seismic category C2 [1] – Characteristic load values **with filled annular gap according to annex B7, figure 5** (only BTS B, BTS K, BTS, BTS PT/PTL)

BTS concrete screw size			8	10	12	14
Nominal embedment depth	h_{nom}		h_{nom3}			
		[mm]	65	85	100	115
Steel failure for tension and shear load (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Characteristic load	$N_{Rk,s,C2}$	[kN]	27,0	45,0	67,0	94,0
Partial factor	$\gamma_{Ms,C2}$	[-]	1,5			
Characteristic load	$V_{Rk,s,C2}$	[kN]	9,9	18,5	31,6	40,7
Partial factor	$\gamma_{Ms,C2}$	[-]	1,25			
With filling of the annular gap	α_{gap}	[-]	1,0			
Pull-out failure (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Characteristic load in cracked concrete	$N_{Rk,p,C2}$	[kN]	2,4	5,4	7,1	10,5
Concrete cone failure (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Effective embedment depth	h_{ef}	[mm]	52	68	80	92
Edge distance	$c_{cr,N}$	[mm]	1,5 x h_{ef}			
Spacing	$s_{cr,N}$	[mm]	3 x h_{ef}			
Installation safety factor	γ_{inst}	[-]	1,0			
Concrete pry-out failure (version BTS B, BTS K, BTS, BTS PT/PTL)						
Factor for pry-out failure	k_8	[-]	1,0	2,0		
Concrete edge failure (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Effective length in concrete	$l_f = h_{ef}$	[mm]	52	68	80	92
Nominal outer diameter of screw	d_{nom}	[mm]	8	10	12	14

1) A4 and HCR not suitable

CELO concrete screw BTS

Performances
Seismic category C2 – Characteristic load values with filled annular gap

Annex C4

Deutsches Institut für Bautechnik DIBt

Table 10: Seismic category C2 [1] – Characteristic load values **without filled annular gap according to annex B5** (only BTS B, BTS K, BTS, BTS PT/PTL, BTS ST)

BTS concrete screw size			8	10	12	14
Nominal embedment depth	h_{nom}		h_{nom3}			
		[mm]	65	85	100	115
Steel failure for tension and shear load (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Characteristic load	$N_{Rk,s,C2}$	[kN]	27,0	45,0	67,0	94,0
Partial factor	$\gamma_{Ms,C2}$	[-]	1,5			
Characteristic load	$V_{Rk,s,C2}$	[kN]	10,3	21,9	24,4	23,3
Partial factor	$\gamma_{Ms,C2}$	[-]	1,25			
Without filling of the annular gap	α_{gap}	[-]	0,5			
Pull-out failure (version **BTS B, BTS K, BTS, BTS PT/PTL)**						
Characteristic load in cracked concrete	$N_{Rk,p,C2}$	[kN]	2,4	5,4	7,1	10,5
Steel failure for tension and shear load (version **BTS ST**)						
Characteristic load	$N_{Rk,s,C2}$	[kN]	27,0	45,0	no performance assessed	
Partial factor	$\gamma_{Ms,C2}$	[-]	1,5			
Characteristic load	$V_{Rk,s,C2}$	[kN]	3,6	13,7		
Partial factor	$\gamma_{Ms,C2}$	[-]	1,25			
Without filling of the annular gap	α_{gap}	[-]	0,5			
Pull-out failure (version **BTS ST**)						
Characteristic load in cracked concrete	$N_{Rk,p,C2}$	[kN]	2,4	5,4	no performance assessed	
Concrete cone failure (version **BTS B, BTS K, BTS ST, BTS, BTS PT/PTL)**						
Effective embedment depth	h_{ef}	[mm]	52	68	80	92
Edge distance	$c_{cr,N}$	[mm]	$1,5 \times h_{ef}$			
Spacing	$s_{cr,N}$	[mm]	$3 \times h_{ef}$			
Installation safety factor	γ_{inst}	[-]	1,0			
Concrete pry-out failure (version **BTS B, BTS K, BTS ST, BTS, BTS PT/PTL**)						
Factor for pry-out failure	k_8	[-]	1,0	2,0		
Concrete edge failure (version **BTS B, BTS K, BTS ST, BTS, BTS PT/PTL)**						
Effective length in concrete	$l_f = h_{ef}$	[mm]	52	68	80	92
Nominal outer diameter of screw	d_{nom}	[mm]	8	10	12	14

[1] A4 and HCR not suitable

CELO concrete screw BTS

Performances
Seismic category C2 – Characteristic load values without filled annular gap

Annex C5

Deutsches Institut für Bautechnik DIBt

Table 11: Fire exposure – characteristic values of resistance

BTS concrete screw size				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																	
characteristic Resistance	R30	$N_{Rk,s,fi30}$	[kN]	0,9		2,4			4,4			7,3			10,3		
	R60	$N_{Rk,s,fi60}$	[kN]	0,8		1,7			3,3			5,8			8,2		
	R90	$N_{Rk,s,fi90}$	[kN]	0,6		1,1			2,3			4,2			5,9		
	R120	$N_{Rk,s,fi120}$	[kN]	0,4		0,7			1,7			3,4			4,8		
	R30	$V_{Rk,s,fi30}$	[kN]	0,9		2,4			4,4			7,3			10,3		
	R60	$V_{Rk,s,fi60}$	[kN]	0,8		1,7			3,3			5,8			8,2		
	R90	$V_{Rk,s,fi90}$	[kN]	0,6		1,1			2,3			4,2			5,9		
	R120	$V_{Rk,s,fi120}$	[kN]	0,4		0,7			1,7			3,4			4,8		
	R30	$M^0_{Rk,s,fi30}$	[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	$M^0_{Rk,s,fi120}$	[Nm]	0,3		0,9			2,3			5,7			9,4		
Pull-out failure																	
Characteristic Resistance	R30-R90	$N_{Rk,p,fi}$	[kN]	0,5	1,0	1,3	2,3	3,0	2,3	4,0	4,8	3,0	4,7	6,2	3,8	6,0	7,6
	R120	$N_{Rk,p,fi}$	[kN]	0,4	0,8	1,0	1,8	2,4	1,8	3,2	3,9	2,4	3,8	4,9	3,0	4,8	6,1
Concrete cone failure																	
Characteristic Resistance	R30-R90	$N^0_{Rk,c,fi}$	[kN]	0,9	2,2	1,2	2,1	3,4	2,1	4,8	6,6	3,0	6,3	9,9	4,4	9,6	14,0
	R120	$N^0_{Rk,c,fi}$	[kN]	0,7	1,8	1,0	1,7	2,7	1,7	3,8	5,3	2,4	5,1	7,9	3,5	7,6	11,2

Edge distance												
R30 bis R120	$c_{cr,fi}$	[mm]	2 x h_{ef}									
In case of fire attack from more than one side, the minimum edge distance shall be ≥300mm.												
Spacing												
R30 bis R120	$s_{cr,fi}$	[mm]	4 x h_{ef}									
Pry-out failure												
R30 bis R120	k_8	[-]	1,0			2,0		1,0	2,0		1,0	2,0
The anchorage depth has to be increased for wet concrete by at least 30 mm compared to the given value.												

CELO concrete screw BTS

Performances
Fire exposure – characteristic values of resistance

Annex C6

Table 12: Displacements under static and quasi-static tension load

BTS concrete screw size				6		8			10		
Nominal embedment depth			h_{nom}	h_{nom1}	h_{nom2}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			[mm]	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
		$\delta_{N\infty}$	[mm]	0,4	0,4	0,6	1,0	0,9	0,4	1,2	1,2
Uncracked 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

BTS concrete screw size				12			14		
Nominal embedment depth			h_{nom}	h_{nom1}	h_{nom2}	h_{nom3}	h_{nom1}	h_{nom2}	h_{nom3}
			[mm]	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
		$\delta_{N\infty}$	[mm]	1,0	1,2	1,2	0,9	1,2	1,0
Uncracked 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 13: Displacements under static and quasi-static shear load

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

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

CELO concrete screw BTS

Performances
Displacements under static and quasi-static loads

Annex C7

Table 14: Seismic category C2 [1] – Displacements **with filled annular gap according to annex B7, figure 5** (only version BTS B, BTS K, BTS, BTS PT/PTL)

BTS concrete screw size			8	10	12	14
Nominal embedment depth		h_{nom}	h_{nom3}			
		[mm]	65	85	100	115
Displacements under tension loads (version **Typ B, BTS K, BTS, BTS PT/PTL)**						
Displacement DLS	$\delta_{N,C2(DLS)}$	[mm]	0,66	0,32	0,57	1,16
Displacement ULS	$\delta_{N,C2(ULS)}$	[mm]	1,74	1,36	2,36	4,39
Displacements under shear loads (version **Typ B, BTS K, BTS, BTS PT/PTL** with hole clearance)						
Displacement DLS	$\delta_{V,C2(DLS)}$	[mm]	1,68	2,91	1,88	2,42
Displacement ULS	$\delta_{V,C2(ULS)}$	[mm]	5,19	6,72	5,37	9,27

Table 15: Seismic category C2 [1] – Displacements **without filled annular gap according to annex B5** (only version type S, type SK, type ST, type P)

BTS concrete screw size			8	10	12	14
Nominal embedment depth		h_{nom}	h_{nom3}			
		[mm]	65	85	100	115
Displacements under tension loads (version **BTS B, BTS K, BTS, BTS PT/PTL**)						
Displacement DLS	$\delta_{N,C2(DLS)}$	[mm]	0,66	0,32	0,57	1,16
Displacement ULS	$\delta_{N,C2(ULS)}$	[mm]	1,74	1,36	2,36	4,39
Displacements under tension loads (version **BTS ST**)						
Displacement DLS	$\delta_{N,C2(DLS)}$	[mm]	0,66	0,32	no performance assessed	
Displacement ULS	$\delta_{N,C2(ULS)}$	[mm]	1,74	1,36		
Displacements under shear loads (version **BTS B, BTS K, BTS, BTS PT/PTL** with hole clearance)						
Displacement DLS	$\delta_{V,C2(DLS)}$	[mm]	4,21	4,71	4,42	5,60
Displacement ULS	$\delta_{V,C2(ULS)}$	[mm]	7,13	8,83	6,95	12,63
Displacements under shear loads (version **BTS ST** with hole clearance)						
Displacement DLS	$\delta_{V,C2(DLS)}$	[mm]	2,51	2,98	no performance assessed	
Displacement ULS	$\delta_{V,C2(ULS)}$	[mm]	7,76	6,25		

[1] A4 and HCR not suitable

CELO concrete screw BTS

Performances
Displacements under seismic loads

Annex C8