

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

**ETA-16/0470**  
**of 6 October 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

Apolo MEA concrete screw BTS, BTS A4 and BTS HCR

Product family  
to which the construction product belongs

Concrete screw of sizes 6, 8, 10, 12 and 14 mm for use in  
concrete

Manufacturer

Apolo MEA Befestigungssysteme GmbH  
Industriestraße 6  
86551 Aichach  
DEUTSCHLAND

Manufacturing plant

Werk 16

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 Apolo MEA 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.  
 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         | Anchorage 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.

English translation prepared by DIBt

**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 6 October 2016 by Deutsches Institut für Bautechnik

Uwe Bender  
Head of Department

*beglaubigt:*  
Tempel

**product and installed condition**

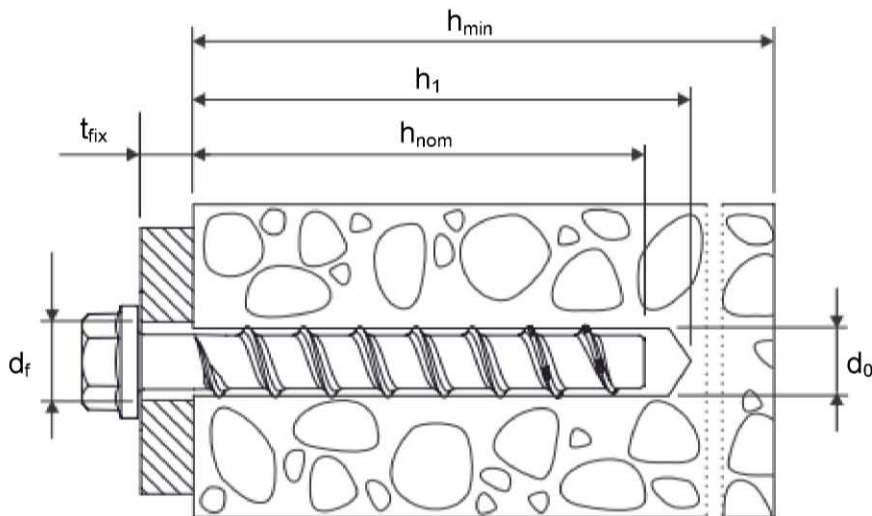
**Apolo MEA concrete screw BTS**



**carbon steel, zinc plated or  
zinc flake coated**



**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

**Apolo MEA concrete screw BTS**























**Product description**

Installed condition

**Annex A 1**

**Table A1: materials and variants**

| part  | name           | Material                               |  |                          |          |
|---|----------------|--|--|--------------------------|----------|
| 1,<br>2,<br>3,<br>4,<br>5,<br>6,<br>7,<br>8,<br>9,<br>10,<br>11 | Concrete screw | BTS                                    | Steel EN 10263-4 galvanized acc. to EN ISO 4042 or zinc flake coating acc. to EN ISO 10683 ( $\geq 5\mu\text{m}$ ) |                          |          |
| BTS A4  |                | 1.4401, 1.4404, 1.4571, 1.4578         |  |                          |          |
| BTS HCR   |                | 1.4529                                 |  |                          |          |
|   |                |  |  | BTS<br>BTS A4<br>BTS HCR |          |
|   |                | characteristic steel yield strength    | $f_{yk}$   | [N/mm <sup>2</sup> ]     | 560      |
|   |                | characteristic steel ultimate strength | $f_{uk}$   | [N/mm <sup>2</sup> ]     | 700      |
|   |                | elongation at rupture                  | $A_5$  | [%]                      | $\leq 8$ |

|   |   |     |  |
|---|---|-----|--|
|    |    | 1)  | Anchor version with connection thread and hexagon socket<br>e.g. BTS 8x105 M10 IN5 |
|  |  | 2)  | Anchor version with connection thread and hexagon drive<br>e.g. BTS 8x105 M10 SW7  |
|  |  | 3)  | Anchor version with washer, hexagon head and TORX<br>e.g. BTS 8x80 SW13 VZ 40      |
|  |  | 4)  | Anchor version with washer and hexagon head<br>e.g. BTS 8x80 SW13                  |
|  |  | 5)  | Anchor version with washer, hexagon head and OS<br>e.g. BTS 8x80 SW13 OS           |
|  |  | 6)  | Anchor version with countersunk head<br>e.g. BTS 8x80 C VZ 40                      |
|  |  | 7)  | Anchor version with pan head<br>e.g. BTS 8x80 P VZ 40                              |
|  |  | 8)  | Anchor version with large pan head<br>e.g. BTS 8x80 LP VZ 40                       |
|  |  | 9)  | Anchor version with countersunk head and connection thread<br>e.g. BTS 6x55 AG M8  |
|  |  | 10) | Anchor version with hexagon drive and connection thread<br>e.g. BTS 6x55 M8 SW10   |
|  |  | 11) | Anchor version with internal thread and hexagon drive<br>e.g. BTS 6x55 IM M8/10    |

**Apolo MEA concrete screw BTS**

**Product descriptions**  
Materials und versions

**Annex A 2**

**Table A2: dimensions and markings**

| Anchor size BTS                        |          |      | 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                   | $L \leq$ | [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 BTS                        |          |      | 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                   | $L \leq$ | [mm] | 500        |            |            |            |            |            |            |            |
| Diameter of shaft                      | $d_k$    | [mm] | 11,1       |            |            | 13,1       |            |            |            |            |
| Diameter of thread                     | $d_s$    | [mm] | 14,6       |            |            | 16,6       |            |            |            |            |



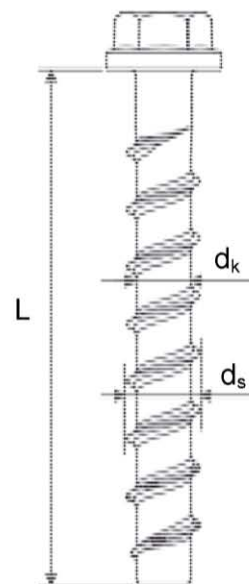
Marking:  
BTS  
Anchor type: TSM  
Anchor size: 10  
Length of the anchor: 100



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



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



**Apolo MEA concrete screw BTS**

**Product descriptions**  
Dimensions and markings

**Annex A 3**

## Intended use

### Anchorage 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 actions 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 exists: 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 exists: 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 also applies for the specified diameter  $d_f$  of clearance hole in the fixture in Annex B2, Table B1.
- In CEN/TS 1992-4-1, section 5.2.3.1 the 3. indent will be replaced as follow: only the most unfavorable anchors of an anchor group take up shear loads, if diameter  $d_f$  of the clearance hole is larger than given in CEN/TS 1992-4-1, Table 1.
- 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.

**Apolo MEA concrete screw BTS**

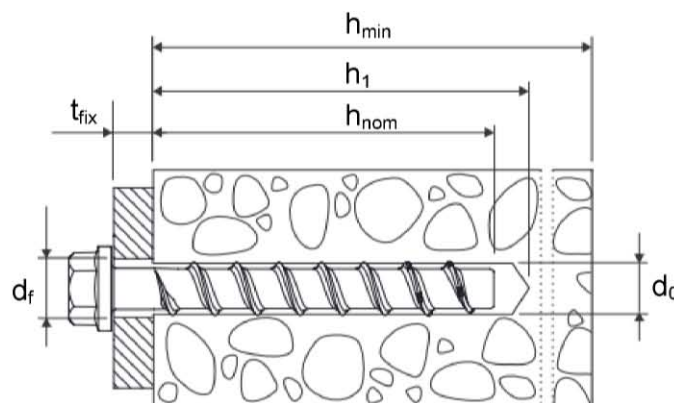
**Intended use**  
Specifications

**Annex B 1**



**Table B1: Installation parameters**

| Anchor size BTS   |                 |      | 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          | $T_{inst} \leq$ | [Nm] | 10   |            | 20         |            |            | 40         |            |            |  |
| Impact screw driver   |                 | [Nm] | Max. torque according to manufacturer's instructions |            |            |            |            |            |            |            |  |
|   |                 |      | 160  |            | 300        |            |            | 400        |            |            |  |
| Anchor size BTS   |                 |      | 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 | $T_{inst} \leq$ | [Nm] | 60   |            |            | 80         |            |            |            |            |  |
| Impact screw driver   |                 |      | Max. torque according to manufacturer's instructions |            |            |            |            |            |            |            |  |
|   |                 |      | 650  |            |            | 650        |            |            |            |            |  |



**Apolo MEA concrete screw BTS**

**Intended use**

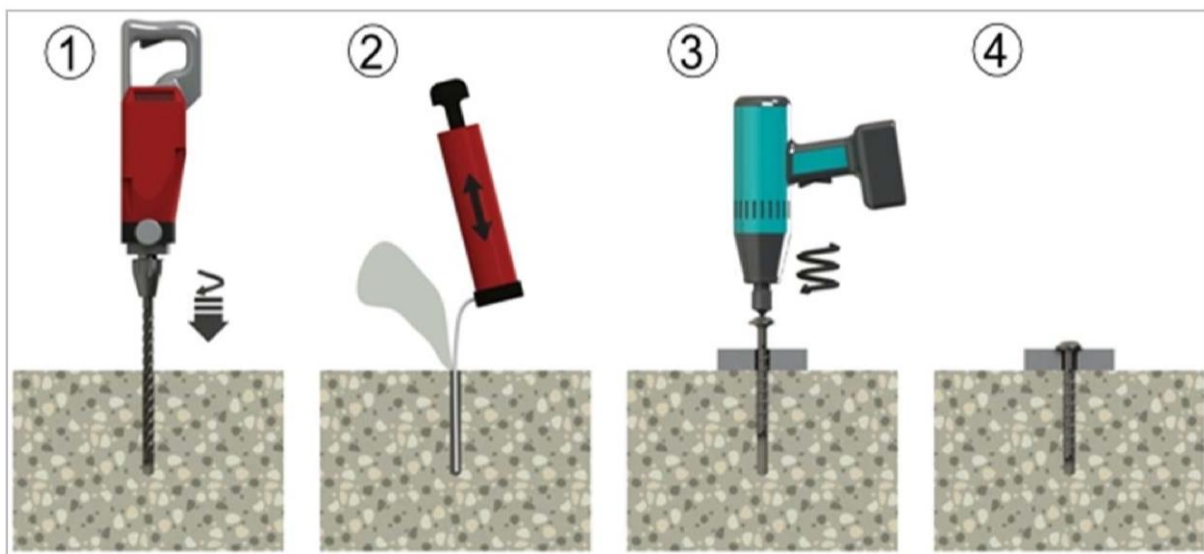
Installation parameters

**Annex B 2**

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

| Anchor size BTS                        |           |      | 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 BTS                        |           |      | 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**



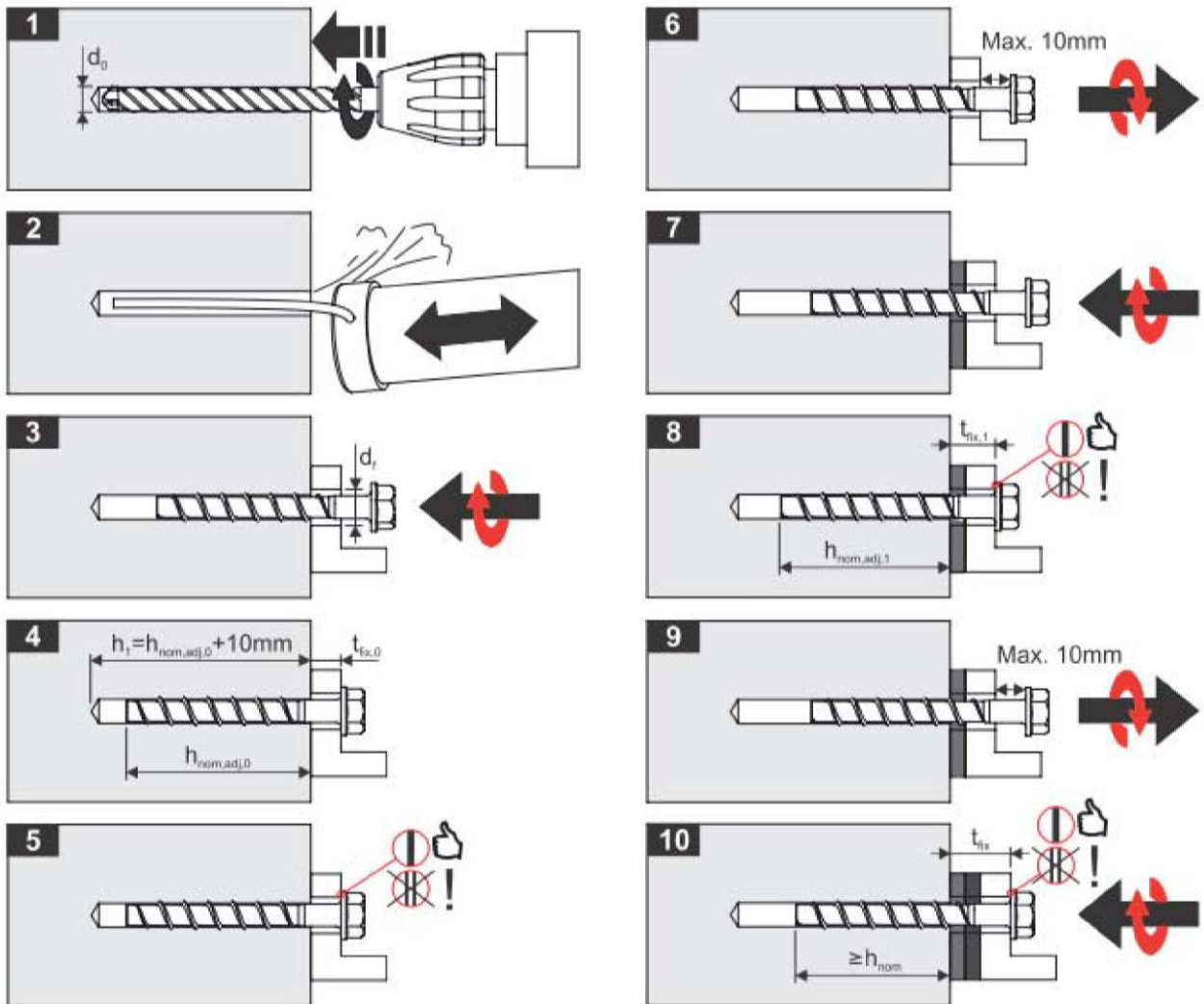
**Apolo MEA concrete screw BTS**

**Intended use**

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

**Annex B 3**

### Installation instructions for adjustability



### Installation instructions

The 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  $h_{nom}$ .

**Apolo MEA concrete screw BTS**

**Intended use**

Installation instruction for adjustability

**Annex B 4**

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

| Anchor size BTS  |                      |                | 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         |
| <b>steel failure for tension- and shear load</b>         |                      |                |                     |            |            |            |            |            |                                  |            |
| characteristic load                                      | $N_{Rk,s}$           | [kN]           | 14,0                |            | 27,0       |            |            | 45,0       |                                  |            |
|  | $V_{Rk,s}$           | [kN]           | 7,0                 | 13,5       |            |            | 17,0       | 22,5       | 34,0                             |            |
|  | $k_2^{1)}$           | [-]            | 0,8                 |            | 0,8        |            |            | 0,8        |                                  |            |
|  | $M^0_{Rk,s}$         | [Nm]           | 10,9                |            | 26,0       |            |            | 56,0       |                                  |            |
| <b>pull-out failure</b>                                  |                      |                |                     |            |            |            |            |            |                                  |            |
| 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 $N_{Rk,p}$                         | $\psi_C$             | C30/37         | 1,22                |            |            |            |            |            |                                  |            |
|  |                      | C40/50         | 1,41                |            |            |            |            |            |                                  |            |
|  |                      | C50/60         | 1,55                |            |            |            |            |            |                                  |            |
| <b>concrete cone and splitting failure</b>               |                      |                |                     |            |            |            |            |            |                                  |            |
| 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              | $s_{cr,N}$     | $3 \times h_{ef}$   |            |            |            |            |            |                                  |            |
|  | edge distance        | $c_{cr,N}$     | $1,5 \times h_{ef}$ |            |            |            |            |            |                                  |            |
| splitting failure  | spacing              | $s_{cr,Sp}$    | 120                 | 160        | 120        | 140        | 150        | 140        | 180                              | 210        |
|  | edge distance        | $c_{cr,Sp}$    | 60                  | 80         | 60         | 70         | 75         | 70         | 90                               | 105        |
| installation safety factor                               | $\gamma_2^{2)}$      | [-]            | 1,0                 |            |            |            |            |            |                                  |            |
|  | $\gamma_{inst}^{1)}$ |                |                     |            |            |            |            |            |                                  |            |
| <b>concrete pry out failure (pry-out)</b>                |                      |                |                     |            |            |            |            |            |                                  |            |
| k-Factor   | $k^{2)}$             | [-]            | 1,0                 |            |            |            |            |            | 2,0                              |            |
|  | $k_3^{1)}$           |                |                     |            |            |            |            |            |                                  |            |
| <b>concrete edge failure</b>                             |                      |                |                     |            |            |            |            |            |                                  |            |
| 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         |                                  |            |

<sup>1)</sup> Parameter relevant only for design according to CEN/TS 1992-4:2009

<sup>2)</sup> Parameter relevant only for design according to ETAG 001, Annex C

**Apolo MEA concrete screw BTS**

**Performances**

Characteristic values for BTS 6, 8 and 10

**Annex C 1**

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

| Anchor size BTS  |                      |                | 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        |
| <b>steel failure for tension- and shear load</b>         |                      |                |                     |                                  |            |                                  |            |            |
| characteristic load                                      | $N_{RK,s}$           | [kN]           | 67,0                |                                  |            | 94,0                             |            |            |
|  | $V_{RK,s}$           | [kN]           | 33,5                | 42,0                             |            | 56,0                             |            |            |
|  | $k_2^{1)}$           | [-]            | 0,8                 |                                  |            | 0,8                              |            |            |
|  | $M^0_{RK,s}$         | [Nm]           | 113,0               |                                  |            | 185,0                            |            |            |
| <b>pull-out failure</b>                                  |                      |                |                     |                                  |            |                                  |            |            |
| 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 $N_{RK,p}$                         | $\Psi_C$             | C30/37         | 1,22                |                                  |            |                                  |            |            |
|  |                      | C40/50         | 1,41                |                                  |            |                                  |            |            |
|  |                      | C50/60         | 1,55                |                                  |            |                                  |            |            |
| <b>concrete cone and splitting failure</b>               |                      |                |                     |                                  |            |                                  |            |            |
| 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              | $s_{cr,N}$     | $3 \times h_{ef}$   |                                  |            |                                  |            |            |
|  | edge distance        | $c_{cr,N}$     | $1,5 \times h_{ef}$ |                                  |            |                                  |            |            |
| splitting failure  | spacing              | $s_{cr,Sp}$    | 150                 | 210                              | 240        | 180                              | 240        | 280        |
|  | edge distance        | $c_{cr,Sp}$    | 75                  | 105                              | 120        | 90                               | 120        | 140        |
| installation safety factor                               | $\gamma_2^{2)}$      | [-]            | 1,0                 |                                  |            |                                  |            |            |
|  | $\gamma_{inst}^{1)}$ |                |                     |                                  |            |                                  |            |            |
| <b>concrete pry out failure (pry-out)</b>                |                      |                |                     |                                  |            |                                  |            |            |
| k-Factor   | $k^{2)}$             | [-]            | 1,0                 | 2,0                              |            | 1,0                              | 2,0        |            |
|  | $k_3^{1)}$           |                |                     |                                  |            |                                  |            |            |
| <b>concrete edge failure</b>                             |                      |                |                     |                                  |            |                                  |            |            |
| effective length of anchor                               | $l_f = h_{ef}$       | [mm]           | 50                  | 67                               | 80         | 58                               | 79         | 92         |
| outside diameter of anchor                               | $d_{nom}$            | [mm]           | 12                  |                                  |            | 14                               |            |            |

<sup>1)</sup> Parameter relevant only for design according to CEN/TS 1992-4:2009

<sup>2)</sup> Parameter relevant only for design according to ETAG 001, Annex C

**Apolo MEA concrete screw BTS**

**Performances**

Characteristic values for BTS 12 and 14

**Annex C 2**

**Table C3: Displacements under tension load for BTS**

| Anchor size BTS                        |              |                    |      | 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 | $\delta_{N0}$      | [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        |
| un-cracked concrete                    | tension load | N                  | [kN] | 1,9        | 4,3        | 3,6        | 5,7        | 7,6        | 5,7        | 9,5        | 11,9       |
|  | displacement | $\delta_{N0}$      | [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 BTS                        |              |                    |      | 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 | $\delta_{N0}$      | [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        |            |            |
| un-cracked concrete                    | tension load | N                  | [kN] | 7,6        | 13,2       | 17,2       | 10,6       | 16,9       | 21,2       |            |            |
|  | displacement | $\delta_{N0}$      | [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 BTS**

| Anchor size BTS                        |                    |      |  | 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                           | $\delta_{V0}$      | [mm] |  | 1,55       |            | 2,7        |            |            | 2,7        |            |            |
|  | $\delta_{V\infty}$ | [mm] |  | 3,10       |            | 4,1        |            |            | 4,3        |            |            |
| Anchor size BTS                        |                    |      |  | 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                           | $\delta_{V0}$      | [mm] |  | 4,0        |            |            | 3,1        |            |            |            |            |
|  | $\delta_{V\infty}$ | [mm] |  | 6,0        |            |            | 4,7        |            |            |            |            |

**Apolo MEA concrete screw BTS**

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Displacements under tension and shear loads

**Annex C 3**

**Table C5: Characteristic values for seismic category C1**

| Anchor size BTS                                  |                 |      | 8              | 10                               | 12   | 14   |
|--|-----------------|------|----------------|----------------------------------|------|------|
| Nominal embedment depth $h_{nom}$ [mm]           |                 |      | $h_{nom3}$     |                                  |      |      |
|  |                 |      | 65             | 85                               | 100  | 115  |
| <b>steel failure for tension- and shear load</b> |                 |      |                |                                  |      |      |
| 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 |
| <b>pull-out failure</b>                          |                 |      |                |                                  |      |      |
| characteristic tension load in cracked concrete  | $N_{Rk,p,seis}$ | [kN] | 12,0           | Pull-out failure is not decisive |      |      |
| <b>concrete cone failure</b>                     |                 |      |                |                                  |      |      |
| effective anchorage depth                        | $h_{ef}$        | [mm] | 52             | 68                               | 80   | 92   |
| concrete spacing                                 | $s_{cr,N}$      | [mm] | 3 x $h_{ef}$   |                                  |      |      |
| cone failure edge distance                       | $c_{cr,N}$      | [mm] | 1,5 x $h_{ef}$ |                                  |      |      |
| installation safety factor                       | $\gamma_2$      | [-]  | 1,0            |                                  |      |      |
| <b>concrete pry out failure (pry-out)</b>        |                 |      |                |                                  |      |      |
| k-Factor   | k               | [-]  | 1,0            | 2,0                              |      |      |
| <b>concrete edge failure</b>                     |                 |      |                |                                  |      |      |
| effective length of anchor                       | $l_f = h_{ef}$  | [mm] | 52             | 68                               | 80   | 92   |
| outside diameter of anchor                       | $d_{nom}$       | [mm] | 8              | 10                               | 12   | 14   |

**Apolo MEA concrete screw BTS**

**Performances**

Characteristic values for seismic category C1

**Annex C 4**

**Table C6: Characteristic values of resistance to fire exposure for BTS**

| Anchor size BTS   |                           |                    |      | 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 |
| <b>steel failure for tension- and shear load (<math>F_{Rk,s,fi} = N_{Rk,s,fi} = V_{Rk,s,fi}</math>)</b> |                           |                    |      |              |     |     |      |      |    |    |    |    |    |     |    |     |     |
| Fire resistance class   |                           |                    |      |              |     |     |      |      |    |    |    |    |    |     |    |     |     |
| R30   | Characteristic Resistance | $F_{Rk,s,fi30}$    | [kN] | 0,9          | 2,4 | 4,4 | 7,4  | 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   |                           | $M^0_{Rk,s,fi30}$  | [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  |    |    |    |    |    |     |    |     |     |
| <b>edge distance</b>  |                           |                    |      |              |     |     |      |      |    |    |    |    |    |     |    |     |     |
| R30 bis R120  | $c_{cr, fi}$              |                    | [mm] | 2 x $h_{ef}$ |     |     |      |      |    |    |    |    |    |     |    |     |     |
| <b>spacing</b>  |                           |                    |      |              |     |     |      |      |    |    |    |    |    |     |    |     |     |
| R30 bis R120  | $s_{cr, fi}$              |                    | [mm] | 4 x $h_{ef}$ |     |     |      |      |    |    |    |    |    |     |    |     |     |

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  $N_{Rk,p}$ .

**Apolo MEA concrete screw BTS**

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Characteristic values of resistance to fire exposure

**Annex C 5**