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ADJUSTABLE CONCRETE SCREWS

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## 1 SCOPE OF THE EAD

### 1.1 Description of the construction product

Concrete screws are used in many different fastening applications for structural and non-structural components. So far the qualification of concrete screws basically accounts for an installation procedure that consists of drilling a cylindrical hole, screwing the anchor into the pre-drilled hole and tightening of the concrete screw (anchor). During the setting process the special thread of the anchor cuts an internal thread into the concrete member creating a mechanical interlock.

For many applications the concrete screws require loosening and retightening to facilitate attachment and realignment or allow levelling of the attached component. As this type of installation procedure is not covered by the current version of European Assessment Document (ETAG 001-3 used as European Assessment Document according to Art. 66 (3) of the Construction Products Regulation (CPR)) and may have a significant influence on the performance (mechanical resistance and stability) of the fastening, this setting process (if permitted for a specific product) needs to be accounted for in the assessment of the anchor to fulfil safety in use requirements.

The mechanical interlock is achieved by screwing the anchor into a pre-drilled cylindrical hole. The special thread of the anchor cuts an internal thread into the concrete member while setting. This type of anchor is commonly referred to as concrete screw. Concrete screws with a thread over the entire anchorage depth are covered only.

This EAD applies to anchors in which all the metal parts directly anchored in the concrete and designed to transmit the applied loads are made of either carbon steel, stainless steel or a combination thereof.

This EAD covers the following installation tools

- a non-calibrated torque wrench or
- a calibrated torque spanner or
- an electrical or pneumatic impact screw driver.

Multiple setting of concrete screws is not covered in this EAD.

The effective anchorage depth of concrete screws shall be determined according to Figure 1.1.

This EAD applies to anchors with a minimum diameter (thread size) of 6 mm (M6), where the diameter applies to the shaft of the concrete screw.

The minimum anchorage depth shall be 40 mm. This requirement is fulfilled with the condition  $(h_{nom} - h_s) \geq 40$  mm.

For anchors for multiple use for non-structural applications see ETAG 001-6, 2.1.3.

Anchors with internal thread are covered only if they have a thread length of at least  $d + 5$  mm after taking account of possible tolerances.

The product is marked with respect to material, strength or dimensions such that the relevant product characteristic may be allocated to the corresponding anchor type.

The product is not covered by a harmonised European standard (hEN).

Concerning product packaging, transport, storage, maintenance, replacement and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport, storage, maintenance, replacement and repair of the product as he considers necessary.

It is assumed that the product will be installed according to the manufacturer's instructions or (in absence of such instructions) according to the usual practice of the building professionals.

Relevant manufacturer's stipulations having influence on the performance of the product covered by this European Assessment Document shall be considered for the determination of the performance and detailed in the ETA.

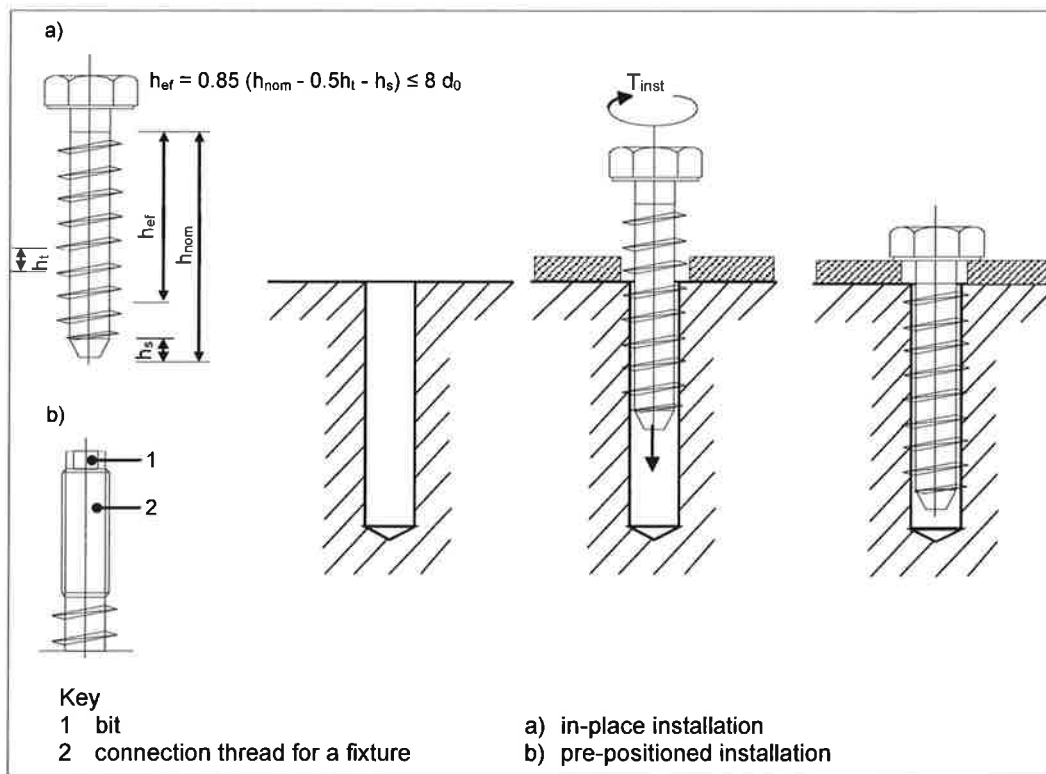


Figure 1.1 Concrete screw, installation process and effective anchorage depth.

## 1.2 Information on the intended use of the construction product

### 1.2.1 Intended use

This European Assessment Document (EAD) covers concrete screw anchors installed with a setting procedure involving adjustment steps. The concrete screws are intended for use in concrete. If adjustment steps such as loosening and retightening of the anchor are permitted for a product, the assessment in this EAD shall be performed. The manufacturer shall specify in the manufacturer product installation instructions (MPII) if the product is allowed to be installed with adjustments and the adjustment process shall be clearly described in the MPII.

The EAD addresses preconditions, assumptions, required tests and the assessment for concrete screws installed with an installation procedure involving adjustment steps.

The qualification for a setting process with adjustments is in addition to the complete qualification according to the relevant European Assessment Document (ETAG 001-1 and 3 used as EAD) for concrete screws for use in cracked and non-cracked concrete.

Concrete screws qualified for multiple use for non-structural applications according to ETAG 001-6 used as EAD are also covered by this document.

The anchor is intended to be used for anchorages for which basic works requirements for mechanical resistance and stability and safety in use shall be fulfilled and failure of anchorages made with these products may cause risk to human life and/or lead to considerable economic consequences.

This EAD applies to the use of anchors installed in normal weight concrete with strength classes in the range C20/25 to C50/60 according to EN 206 [2]. Exceptions see ETAG 001-6, 2.2.1.

This EAD does not cover anchorages made in screeds or toppings, which can be uncharacteristic of the concrete and/or excessively weak.

This EAD applies to applications where the minimum thickness of members in which anchors are installed is

- for general application:  $h \geq 2 h_{ef}$  and at least  $h \geq 100$  mm and
- for anchors for multiple use for non-structural applications only:  $h \geq 2 h_{ef}$  and at least  $h \geq 80$  mm.

This EAD applies to applications in respect to:

- static and quasi-static loading
- seismic actions (product assessed for seismic performance categories C1 and C2 and used in design according to TR 045 [5] and prEN 1992-4 [8])
- tension, shear or combined tension and shear or bending
- requirements related to resistance to fire
- use in cracked and non-cracked concrete (cr)
- use in uncracked concrete only (ucr)
- concrete temperature range in service condition  $-40$  °C to  $+80$  °C

This EAD applies to anchorages in respect to durability:

- use in structures subjects to dry, internal conditions,
- use in structures subjects to other environmental conditions.

This EAD provides assessment requirements resulting in performance characteristics consistent with and to be used in the design provisions of

- a) ETAG 001 Annex C [3], method A and Technical Report 020 [4],
- b) CEN/TS 1992-4:2009 [1], design method A,
- c) Technical Report TR 045 [5],

*Note 1: The same assessment requirements are valid for the design according to prEN 1992-4 [8], Design of concrete structures – Part 4: Design of Fastenings for Use in Concrete, which is a revision of b) that is in progress at the time of finalisation of this EAD.*

### 1.2.2 Working life/Durability

The assessment methods included or referred to in this EAD have been written based on the manufacturer's request to take into account a design working life of the concrete screw for the intended use of 50 years when installed in the works (provided that the concrete screw is subject to appropriate installation (see 1.1)). These provisions are based upon the current state of the art and the available knowledge and experience.

When assessing the product the intended use as foreseen by the manufacturer shall be taken into account. The real working life may be, in normal use conditions, considerably longer without major degradation affecting the basic requirements for works<sup>1</sup>.

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<sup>1</sup> The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works is subject, as well as on the particular conditions of the design, execution, use and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the working life referred to above.

The indications given as to the design working life of the construction product cannot be interpreted as a guarantee neither given by the product manufacturer or his representative nor by EOTA when drafting this EAD nor by the Technical Assessment Body issuing an ETA based on this EAD, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

### 1.3 Specific terms used in this EAD

#### 1.3.1 Abbreviations

- MPII = Manufacturer product installation instructions  
 SP = Setting processes with adjustments

#### 1.3.2 Notation

- $c_{cr}$  = characteristic edge distance  
 $c_{cr,N}$  = characteristic edge distance for concrete cone failure in tension  
 $c_{cr,N,\bar{n}}$  = characteristic edge distance for concrete cone failure in tension under fire conditions  
 $c_{cr,sp}$  = characteristic edge distance for concrete splitting  
 $c_{cr,V}$  = characteristic edge distance for concrete edge failure in shear  
 $c_{min}$  = minimum edge distance  
 $d_o$  = nominal drill hole diameter  
 $d_{cut}$  = drill bit diameter  
 $d_{cut,m}$  = medium diameter of drill bit (see ETAG 001 Annex A, Figure 3.1)  
 $d_{cut,max}$  = maximum diameter of drill bit (see ETAG 001 Annex A, Figure 3.1)  
 $d_{nom}$  = effective diameter of anchor for calculation of concrete edge failure  
 $h$  = thickness of the concrete member  
 $h_{ef}$  = effective anchorage depth (see Figure 1.1)  
 $h_{ltz}$  = length of effective load transfer zone (see Figure 2.3)  
 $h_{nom}$  = nominal embedment depth (see Figure 1.1)  
 $h_{nom,adj,0}$  = nominal embedment depth at the initial step of the adjusted setting process (see Figure 1.1)  
 $h_s$  = length of the tip of the concrete screw (= length of the embedded end of the concrete screw without the full height of thread) (see Figure 1.1)  
 $h_t$  = thread pitch (see Figure 1.1)  
 $h_{1,adj}$  = depth of drilled hole for the adjusted setting process  
 $h_{1,std}$  = depth of drilled hole for the standard setting process (assessment according to ETAG 001-3)  
 $k$  = factor for calculation of characteristic resistance for pryout failure  
 $l_f$  = effective length of anchor in shear loading (for calculation resistance for concrete edge failure)  
 $M^0_{Rk,s}$  = characteristic resistance for steel failure with lever arm  
 $n_a$  = number of adjustments for representative setting process

$N_{RK,p,adj}$	= characteristic tension resistance for pull-out in case of installation with adjusted setting
$N_{RK,s}$	= characteristic tension resistance for steel
$S_{cr}$	= characteristic spacing
$S_{cr,N}$	= characteristic spacing for concrete cone failure in tension
$S_{cr,N,\bar{f}}$	= characteristic spacing for concrete cone failure in tension under fire conditions
$S_{cr,sp}$	= characteristic spacing for concrete splitting
$S_{cr,V}$	= characteristic spacing for concrete edge failure in shear
$S_{min}$	= minimum spacing
$t_{adj}$	= total thickness of the various adjustment layers, i.e. = $n_a \cdot t_{shim}$
$t_{fix,max}$	= maximum thickness of the fixture as given in the ETA
$t_{fix,0}$	= thickness of the fixture at the initial step of the adjusted setting process
$t_{fix,x}$	= thickness of the fixture at the $x^{\text{th}}$ adjustment adding a shim during the adjusted setting process
$t_{shim}$	= thickness of a shim
$T_{inst}$	= installation torque
$V_{RK,s}$	= characteristic shear resistance for steel
$\delta_0$	= displacement of anchor under short term loading
$\delta_\infty$	= long term displacement of anchor
$\Delta W$	= crack width (in addition to the width of the hairline crack)
$\Delta W_1$	= upper crack width in the crack movement test
$\Delta W_2$	= lower crack width in the crack movement test
$\gamma_{inst}$	= installation factor for design according to CEN/TS 1992-4
$\gamma_2$	= installation factor for design according to ETAG 001 Annex C, 3.2.2.1
$\gamma_{2,adj}$	= installation factor for the adjusted setting process
$\gamma_{2,std}$	= installation factor for the standard setting process
$\psi_c$	= increasing factor accounting for concrete strength

### 1.3.3 Indices

$seis$	= seismic
$eq$	= earthquake (synonymous to seismic)

### 1.3.4 Definitions

adjustment	= loosening and retightening of a concrete screw during installation to facilitate attachment and realignment or allow levelling of the attached component.
suitability tests	= designation taken from ETAG 001-1:2013, 5.1.2



service conditions tests = Tests described in ETAG 001-1:2013, 5.1.3

## 2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

### 2.1 Essential characteristics of the product

Table 2.1 shows how the performance of the adjustable concrete screw is assessed in relation to the essential characteristics.

**Table 2.1 Essential characteristics of the product and methods and criteria for assessment of the performance of the product in relation to those essential characteristics**

No	Essential characteristic	assessment methods	Type of expression of product performance
<b>Basic Works Requirement 1: Mechanical resistance and stability</b>			
1	Characteristic resistance under static and quasi-static loading	See 2.2.2	Level ( $N_{Rk}$ [kN])
			Level ( $V_{Rk}$ [kN])
			Level ( $M^0_{Rk,s}$ [Nm])
			Level ( $c_{min}, s_{min}$ [mm])
			Level ( $c_{cr}, s_{cr}$ [mm])
			Level ( $h_{min}$ [mm])
			Level ( $\gamma_2, \gamma_{inst}$ [-])
			Level ( $l_r$ [mm])
			Level ( $k$ [-])
			Level ( $n_a$ [-])
2	Characteristic resistance under seismic loading	See 2.2.3	Level ( $N_{Rk,seis}$ or $N_{Rk,eq}$ [kN])
			Level ( $V_{Rk,seis}$ or $V_{Rk,eq}$ [kN])
<b>Basic Works Requirement 2: Safety in case of fire</b>			
3	Reaction to fire	See 2.2.4	Class (A1)
4	Resistance to fire	See 2.2.5	Level ( $F_{Rk,fi}$ [kN])
			Level ( $c_{cr,N,fi}, s_{cr,N,fi}$ [mm])
<b>Basic Works Requirement 4: Safety and accessibility in use</b>			
5	Displacement of anchor for serviceability limit state	See 2.2.6	Level ( $\delta_0, \delta_{-}$ [mm])

### 2.2 Methods and criteria for assessment of the performance of the product in relation to essential characteristics of the product

Characterisation of products to be assessed shall be done in accordance with available specifications, notably the product properties according to Table 2.2 shall be determined. The results may also be used for the purposes of the assessment and verification of constancy of performance.

A pre-condition for the assessment according to this EAD is the complete assessment of the concrete screw in accordance with ETAG 001-3 for installation without adjustment. This EAD only addresses

deviations from ETAG 001 regarding testing and assessment of concrete screws for adjustability during installation.

As far as applicable ETAG 001-1 "General" and Annex A "Details of test" [3] shall be followed for test members, test setup and details of tests. Modifications are addressed in section 2.2.2, which overrule conflicting provisions in ETAG 001 Annex A.

**Table 2.2 Product properties, assessment method**

Number	Product property	Assessment method:
(1)	(2)	(3)
1	Dimensions (outer diameter, inner diameter, thread length, etc.)	Caliper and/or gauge
2	Tensile Load ( $N_p$ ) or tensile strength ( $f_{uk}$ )	manufacturer standard (**)
3	Yield strength ( $f_{yk}$ ) or $N_{p0.2}$	manufacturer standard (**)
4	Core hardness and Surface hardness (at specified functioning relevant points of the product)	Tests acc. to EN ISO 6507 or EN ISO 6508
5	Zinc plating (where relevant)	x-ray measurement
6	Fracture elongation (for seismic performance)	manufacturer standard (**)
7	Hard metal tip of anchor made of stainless steel (where relevant)	Check of material, geometry, position and fixing to stainless steel

(\*\*) Tests according to a procedure defined by the manufacturer and agreed by the TAB are used for this purpose as no specific standard exists for concrete screws.

The essential characteristics are only valid if the following conditions are fulfilled on jobsite:

- The product is installed in accordance with the manufacturer's product installation instructions (MPII).  
*Note 2: Concrete screws may be sensitive to the applied torque or power while setting. Therefore it is assumed that the manufacturer specifies a maximum installation torque or power limit for electric impact screw drivers. If manufacturer's product installation instructions (MPII) do not exist, the installation tools or equipment used in service condition tests apply*
- This EAD takes account of a reasonable degree of imperfection in relation to installation and thus control methods on site after installation will in general not be necessary. This assumes, however, that gross errors on site will be avoided by use of instructions and correct training of the installers and supervision on site.
- Plaster or similar materials are removed, unless there is information from the planning engineer that this layer was taken into account.
- Holes are drilled perpendicular (maximum deviation 5°) to the surface unless specifically required otherwise by the manufacturer's instructions.
- Hard metal hammer-drill bits in accordance with ISO 5468 [10] or National Standards are used to ensure proper tolerances.
- Aborted or unused drill holes are filled with non-shrinkage mortar with strength at least or equal to the base material and  $\geq 40 \text{ N/mm}^2$ .
- Embedment depth of the anchor  $h_{nom}$  as given in the ETA.

- After setting further turning of the anchor is not possible.
- The head of the anchor is supported on the fixture and is not damaged.

### 2.2.1 Setting process with adjustment

Two different setting processes are used during the assessment in this EAD. Setting process SP1 describes the representative setting process with  $n_a$  adjustments as requested by the manufacturer. To check the sensitivity to a deviation from this procedure, setting process SP2 is accounted for in the assessment with two additional adjustments ( $n_a + 2$ ).

*Note 3: The expected (representative) setting process encountered on the jobsite typically involves 2 adjustments and the typical total thickness of added shims in such a case is 10 mm or smaller.*

For both setting processes drill the hole with a depth of  $h_{1,adj} = h_{1,std} + n_a \cdot t_{shim}$ , where  $h_{1,std}$  is the hole depth for the standard (non-adjusted) setting process and  $t_{shim}$  is the thickness of one shim for the assessment process.  $t_{shim} = 5$  mm is selected as the thickness of a shim to account for practical experience (adjustment situation on a jobsite) and allow for a reasonable assessment procedure. The two setting processes are defined as follows:

Setting process SP1:

**Table 2.3 Setting process SP1**

step	action
setting (S)	set the concrete screw with a fixture of thickness $t_{fix,0} = t_{fix,max} - t_{adj}$ , with $t_{adj} = n_a \cdot t_{shim}$ and $t_{shim} = 5$ mm; this corresponds to setting it to the depth $h_{nom,adj,0} = h_{nom,std} + n_a \cdot t_{shim}$ .
1 <sup>st</sup> adjustment (A1)	1) loosen the concrete screw and insert a shim with thickness $t_{shim} = 5$ mm ( $t_{fix,1} = t_{fix,0} + t_{shim}$ ); 2) tighten the concrete screw.
2 <sup>nd</sup> adjustment (A2)	1) loosen the concrete screw and insert an additional shim with thickness $t_{shim} = 5$ mm ( $t_{fix,2} = t_{fix,1} + t_{shim}$ ); 2) tighten the concrete screw.
...	...
$n_a$ <sup>th</sup> adjustment (A $n_a$ )	1) loosen the concrete screw and insert an additional shim with thickness $t_{shim} = 5$ mm ( $t_{fix,na} = t_{fix,na-1} + t_{shim}$ ); 2) tighten the concrete screw; with this step the nominal embedment depth given in the ETA for the product has to be reached.

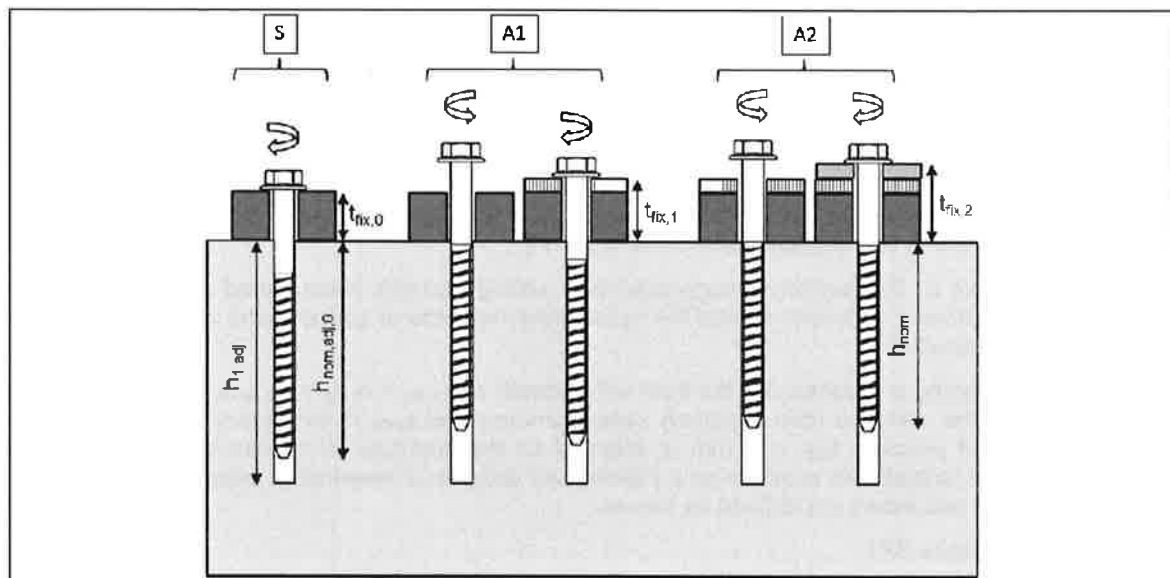


Figure 2.1 Setting process SP1 for  $n_a = 2$

Setting process SP2:

Table 2.4 Setting process SP2

step	action
setting (S)	set the concrete screw with a fixture of thickness $t_{fix,0} = t_{fix,max} - t_{adj}$ , with $t_{adj} = n_a \cdot t_{shim}$ and $t_{shim} = 5 \text{ mm}$ ; this corresponds to setting it to the depth $h_{nom,adj,0} = h_{nom,std} + n_a \cdot t_{shim}$ .
1 <sup>st</sup> adjustment (A1)	1) loosen the concrete screw and insert a shim with thickness $t_{shim} = 5 \text{ mm}$ ( $t_{fix,1} = t_{fix,0} + t_{shim}$ ); 2) tighten the concrete screw;
2 <sup>nd</sup> adjustment (A2)	1) loosen the concrete screw; 2) re-tighten the concrete screw without adding a shim;
3 <sup>rd</sup> adjustment (A3)	1) loosen the concrete screw and insert an additional shim with thickness $t_{shim} = 5 \text{ mm}$ ( $t_{fix,2} = t_{fix,1} + t_{shim}$ ); 2) tighten the concrete screw;
4 <sup>th</sup> adjustment (A4)	1) loosen the concrete screw; 2) re-tighten the concrete screw without adding a shim.
$(n_a - 2)$ additional adjustments	repeat step A3 ( $n_a - 2$ ) times; with this step the nominal embedment depth given in the ETA for the product has to be reached.

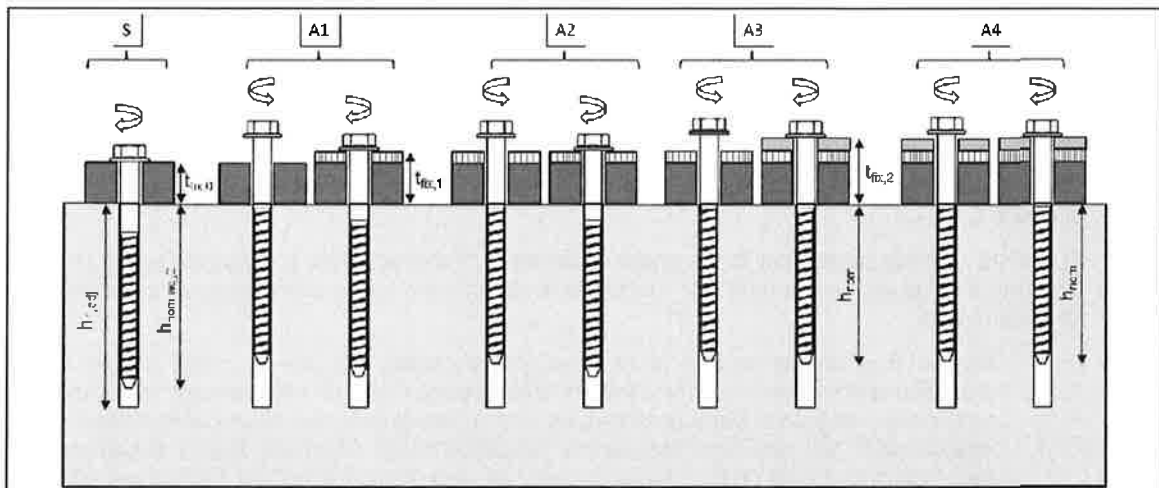


Figure 2.2 Setting process SP2 for  $n_a = 2$

For the tests given in this EAD the use of the corresponding setting process is given in Table 2.5.

## 2.2.2 Characteristic resistances under static and quasi-static loading

### 2.2.2.1 Installation of anchors

Install the anchor in a hairline crack according to the manufacturer's printed installation instructions MP11. Additional provisions given in ETAG 001 Annex A, 3 shall be followed. Use drill bits with a diameter as given Table 2.5. Test internally threaded anchors with the bolt specified by the manufacturer and report the bolt type in the test report.

### 2.2.2.2 Test setup

For tests in cracked concrete the anchor shall be located in the crack over the entire effective load transfer zone,  $h_{ltz}$ , of the anchor (meaning, e.g. over the entire anchorage depth for a concrete screw, see Figure 2.3). It shall be verified that the anchor is located in the crack over the length defined above, e.g. by use of a borescope.

All tension tests shall be performed according to ETAG 001 Annex A, with unconfined test setup (see ETAG 001 Annex A, Figure 4.1) unless specified otherwise in the specific test section below.

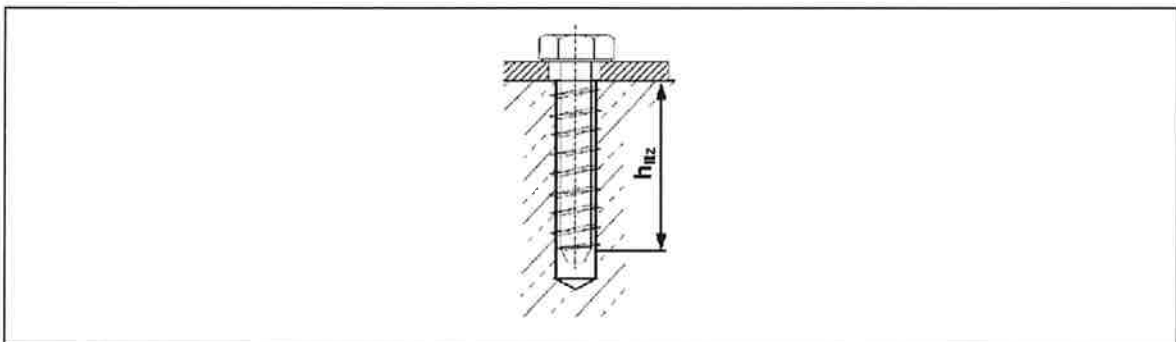


Figure 2.3 Effective load transfer zone

### 2.2.2.3 Test Program

The test program for the assessment of the adjusted setting process consists of

- Service condition tests
- Suitability tests.

The purpose of the service condition tests is to determine the basic technical data required to predict the performance of the anchors under service conditions and derive corresponding design information.

Suitability tests are performed to assess the sensitivity of the anchor system regarding variations in the properties of the base material and foreseeable deviations from the manufacturer's installation instructions and establish a safe, effective and robust behaviour of the anchor system under normal and adverse installation conditions.

The required additional tests for anchors installed with adjusted setting process are given in Table 2.5. These single anchor tests are carried out such that no influence of the edge is present, i.e. with edge distance  $c > c_{cr,N}$ .

The tests shall be performed for all anchor diameters. If the adjusted setting process is requested for concrete screws with more than one embedment depth for a specific diameter, all embedment depths shall be tested.

*Note 4: It is recommended to perform the suitability test series F1adj before the service condition test series A3adj. If the results of test series F1adj do not show any reduction regarding both mean value and characteristic value and no increase in the mean value of the displacement compared to the results of the service condition tests A3 of the standard setting procedure (according to ETAG 001-1, Table 5.4, line 3), the service condition test series A3adj may be omitted. The condition concerning displacement is needed because displacement information is to be stated in the ETA also for the adjusted setting process.*

**Table 2.5 Test program for adjustability option**

	Purpose of test	Concrete <sup>1)</sup>	Crack width $\Delta w$ <sup>2)</sup> [mm]	Drill bit $d_{cut}$	Minimum number of tests <sup>3)</sup>	Setting process	Test procedure see Sections
<b>Service condition tests</b>							
A1adj	Tension capacity in non-cracked concrete with adjusted setting process	C20/25	0,0	$d_{cut,m}$	5	SP1	2.2.2.4
A3adj	Tension capacity in cracked concrete with adjusted setting process <sup>4)</sup>	C20/25	0,3	$d_{cut,m}$	5	SP1	2.2.2.5
<b>Suitability tests</b>							
F0adj	Setting tests with impact screw driver	C20/25	0,0	$d_{cut,max}$	15	SP1	2.2.2.6
F1adj	Installation safety – anchorage intensity with adjusted setting process	C20/25	0,3	$d_{cut,m}$	5	SP2	2.2.2.7
F5adj	Functioning in crack movements with adjusted setting process	C20/25	0,1 - 0,3	$d_{cut,m}$	5	SP1	2.2.2.8
<sup>1)</sup> minimum member thickness $h_{min} \geq 2 h_{ef}$ <sup>2)</sup> Crack width added to the hairline crack width after anchor installation but before loading of anchor. <sup>3)</sup> Test all anchor diameters to be qualified. <sup>4)</sup> If test series F1adj does not show a reduction in the ultimate load (mean value and characteristic value) and no increase in the mean value of the displacements as compared to the results of the tests according to ETAG 001-1, Table 5.4, line 3, this test series may be omitted.							

**2.2.2.4 Test for tension capacity in non-cracked concrete with adjusted setting process**

Purpose:

This test series is performed to determine the tension capacity of the anchor system in non-cracked concrete for the setting process with the representative number of adjustments.

Execution of test:

Install the anchor in non-cracked concrete C20/25 using a drill bit diameter of  $d_{cut,m}$  and applying setting process SP1. After the installation of the anchor perform the tension test according to ETAG 001 Annex A, 5.2.1.

Record the maximum tension load and the corresponding displacement and plot the load-displacement response.

### **2.2.2.5 Test for tension capacity in cracked concrete with adjusted setting process**

Purpose:

This test series is performed to determine the tension capacity of the anchor system in cracked concrete for the setting process with the representative number of adjustments.

Execution of test:

Install the anchor in cracked concrete C20/25 using a drill bit diameter of  $d_{cut,m}$  and applying setting process SP1. After the installation of the anchor open the crack by  $\Delta w = 0,3$  mm and perform the tension test according to ETAG 001 Annex A, 5.2.1.

Record the crack width, the maximum tension load and the corresponding displacement and plot the load-displacement response.

### **2.2.2.6 Setting tests with adjusted setting process**

Purpose:

This test series is performed to evaluate the setting of the concrete screw anchor with an impact screw driver. The tests shall be performed in non-cracked concrete to determine whether the concrete screw anchor can be properly and reliably set by using an impact screw driver.

Execution of test:

The tests shall be performed in non-cracked concrete C20/25 using a drill bit diameter of  $d_{cut,max}$  according to ETAG 001-3, 5.1.2.0(c). Setting process SP1 shall be applied for this test to set the concrete screw anchor to the designated depth. The following condition, which is given in ETAG 001-3, 5.1.2.0(c), shall be applied only to the last re-tightening step of the setting process: The anchor shall be set up to the designated depth; afterwards the impact screw driver shall be set on the head of the anchor with maximum power output. The screw driver shall be switched off automatically after 5 seconds.

The tests shall be performed with the most adverse head form of the product. If the most adverse head form is not obvious all head forms shall be tested.

### **2.2.2.7 Tests for installation safety with adjusted setting process**

Purpose:

This test series is performed to determine the sensitivity of the anchor to the number of adjustments during the setting process.

Execution of test:

The test shall be performed in cracked concrete C20/25 using a drill bit diameter of  $d_{cut,m}$  and applying setting process SP2. After the installation of the anchor open the crack by  $\Delta w = 0,3$  mm and perform the tension test according to ETAG 001 Annex A, 5.2.1.

Record the crack width, the maximum tension load and the corresponding displacement and plot the load-displacement response.

### **2.2.2.8 Tests for functioning in crack movement with adjusted setting process**

Purpose:

This test series is performed to evaluate the performance of the anchor, which has been installed using the representative number of adjustments during the setting process, located in cracks whose width is cycled.

Execution of test:

The test shall be performed in cracked concrete C20/25 using a drill bit diameter of  $d_{cut,m}$  and applying setting process SP1. After the installation of the anchor perform the crack movement test according to ETAG 001 Annex A, 5.5.

In addition to the requirements given in ETAG 001 Annex A, 5.5 record the crack widths  $\Delta w_1$  and  $\Delta w_2$  for each cycle during the crack movement test. Furthermore record the maximum tension load and the



corresponding displacement and plot the load-displacement response of the tension test to failure after completion of the crack movement test.

#### 2.2.2.9 Assessment of the test results

The assessment of the service condition tests (A1adj, A3adj) shall be carried out according to ETAG 001-1, 6.1.2. With regards to edge distance, spacing and characteristic shear resistance the following shall be taken into account.

The values for minimum edge distance  $c_{min}$  and minimum spacing  $s_{min}$  shall be assumed to be the same as for the standard setting process (assessment according to ETAG 001-3) unless specific tests are carried out for the adjusted setting process. This applies also to the characteristic edge distance  $c_{cr,N}$  and spacing  $s_{cr,N}$  for tension load (concrete cone failure), characteristic edge distance  $c_{cr,sp}$  and spacing  $s_{cr,sp}$  for tension load (splitting failure) as well as characteristic edge distance  $c_{cr,V}$  and spacing  $s_{cr,V}$  for shear loading at the edge (concrete edge failure).

The characteristic shear resistance in case of pry-out failure and the characteristic shear resistance in case of concrete edge failure are determined as for concrete screws installed with standard setting process.

The assessment of the suitability tests (F0adj, F1adj, F5adj) shall be carried out according to ETAG 001-1, 6.1.1.1 and 6.1.1.2 (a) taking into account the following aspects.

For the assessment of the setting tests (F0adj) all anchors in the test series shall complete the test without failure (steel rupture or concrete failure). Exception: If the number of tests in the test series F0adj is increased to  $n = 30$ , one failure is allowed.

Concerning the partial factor for installation (partial safety factor)  $\gamma_2$  ETAG 001-1, 6.1.2.2.2 applies. For the determination of the design resistance for installation with adjustments the larger value of  $\gamma_2$  as obtained for the standard setting process (assessment according to ETAG 001-3) and the setting process with adjustments, i.e.  $\gamma_{2,adj,fin} = \max(\gamma_{2,std}; \gamma_{2,adj})$ , shall be used.

#### 2.2.3 Characteristic resistance under seismic loading

The testing and assessment of resistance under seismic loading is optional. The option "No performance determined (NPD)" is possible. The tests shall be carried out with anchors installed according to manufacturer's product installation instructions applying setting process SP1. The test methods are described in ETAG 001 Annex E [3].

The assessment is described in ETAG 001 Annex E [3].

#### 2.2.4 Reaction to fire

The product is considered to satisfy the requirements for performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC (as amended) without the need for testing on the basis of its listing in that Decision.

Therefore the performance of the product is class A1.

#### 2.2.5 Resistance to fire

The suitability of the product for use in a system that is required to provide a specific fire resistance class, shall be verified and assessed according to the EOTA Technical Report N° 020 "Evaluation of anchorages in concrete concerning Resistance to Fire" [4].

#### 2.2.6 Displacements of anchors for serviceability limit state

The displacements measured in test series for characteristic resistance (A1adj for uncracked concrete and A3adj for cracked concrete) will be used for determination of the displacements for serviceability limit state.

The same assessment of displacements as described in ETAG 001-1 6.1.2.2.8 [3] applies.

#### 2.2.7 Test report

In addition to the minimum requirements listed in ETAG 001 Annex A, 6 the report shall include at least the following information regarding the optional tests for installation with adjustments:

Test member

- Reinforcement ratio
- Drawing of test member (including dimensions and position of reinforcement)

**Test setup**

- Loading device
- Type and positioning of crack measurement device(s)
- Verification that the anchor is located in a crack over the required length
- Method of crack creation
- Verification that the crack width is approximately constant throughout the thickness of the test member

**Anchor installation**

- Position of the anchor in the slab and distances to other anchors or drill holes
- Drilling technique and cutting diameter of drill bit
- Method of hole cleaning
- Installation tools used in the tests
- Description of adjustment processes applied in the respective tests

**Measured values**

- (hairline) crack width before and after anchor installation
- Crack width for residual capacity tests
- Reduced load levels and reason for reduction (where applicable)
- Particulars of crack movement tests
  - Crack width  $\Delta w_1$  and  $\Delta w_2$  for each cycle
  - Ultimate load and corresponding displacement of residual capacity test

### **3 ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE**

#### **3.1 System of assessment and verification of constancy of performance**

For the products covered by this EAD the applicable European legal act is: 96/582/EC

The system(s) to be applied is (are): 1

#### **3.2 Tasks of the manufacturer**

The cornerstones of the actions to be undertaken by the manufacturer of the product in the process of verification of constancy of performance are laid down in Table 3.1.

The control plan may depend on the individual manufacturing process and has to be established between notified body and manufacturer for each product. Therefore, additional types of control not listed in Table 3.1 may be necessary.

For raw material or supplied parts of the anchor the relevant characteristics may be verified by inspection certificate 3.1 according to EN 10204 [9].

**Table 3.1 Control plan for the manufacturer; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Factory production control (FPC)</b> [including testing of samples taken at the factory in accordance with a prescribed test plan]					
<b>Raw material</b>					
1	Material	Identification of material number	specifications of the manufacturer	1	Each batch
2	Tension strength	manufacturer standard (*)		3	Each batch
3	Area reduction	manufacturer standard (*)		3	Each batch
4	Chemical analysis	To be specified with manufacturer		1	Each batch
5	Diameter of wire	Caliper		1	Each batch
6	Surface	visual		1	Each wire coil
<b>Tests after production steps</b>					
7	Dimensions of head	Caliper	specifications of the manufacturer	5	Each manufacturing batch
8	Geometry of thread (outer diameter, core diameter, thread length, pitch, tip length, etc.), straightness of the screw	Thread gauge, Caliper		5	
9	Surface hardness	EN ISO 6507-1 [6], EN ISO 6508-1 [7]		5	
10	Core hardness	EN ISO 6507-1 [6], EN ISO 6508-1 [7]		5	
11	Tensile strength (load)	manufacturer standard (*)		5	
12	Yield strength (load)	Manufacturer standard (*)		5	
13	Fracture elongation	manufacturer standard (*)		5	
14	Zinc plating	x-ray measurement		5	
15	Torx or other machine drive (if relevant)	Gauge		5	
16	Visual appearance	Visual		5	
17	Packaging and labelling	Visual	1	Each pallet	

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
18	Crack movement test (**)	ETAG 001 Annex A	ETAG 001-1	5	1 series per year for each diameter

(\*) Tests according to a procedure defined by the manufacturer and agreed by the TAB are used for this purpose as no specific standard exists for concrete screws.

(\*\*) Samples are taken by the notified body during the yearly surveillance and sent to the accredited laboratory.

### 3.3 Tasks of the notified body

The cornerstones of the actions to be undertaken by the notified body in the process of verification of constancy of performance for concrete screw for use in concrete with adjustability during installation are laid down in Table 3.3.

**Table 3.3 Control plan for the notified body; cornerstones**

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
<b>Initial inspection of the manufacturing plant and of factory production control</b>					
1	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the anchor.	-	Laid down in control plan	-	1
<b>Continuous surveillance, assessment and evaluation of factory production control</b>					
2	Verifying that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan.	-	Laid down in control plan	-	1/year

#### 4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

- [1] CEN/TS 1992-4: 2009, Design of fastenings for use in concrete
- [2] EN 206:2013, Concrete - Specification, performance, production and conformity
- [3] ETAG 001 Guideline for European Technical Approval of Metal Anchors for Use in Concrete,  
ETAG 001-1:2013, Anchors in general  
ETAG 001-3:2013, Undercut anchors  
ETAG 001-6:2011, Anchors for multiple use for non-structural applications  
Annex A:2013, Details of tests  
Annex B:2006, Tests for admissible service conditions  
Annex C:2010, Design methods for anchorages  
Annex E:2013, Assessment of metal anchors for use in concrete under seismic action
- [4] EOTA Technical Report 020, Evaluation of Anchorages in Concrete concerning Resistance to Fire,  
Edition May 2004
- [5] EOTA Technical Report 045, Design of Metal Anchors For Use in Concrete Under Seismic Actions,  
Edition February 2013
- [6] EN ISO 6507-1: 2005, Metallic materials - Vickers hardness test - Part 1: Test method
- [7] EN ISO 6508-1: 2005, Metallic materials - Rockwell hardness test - Part 1: Test method
- [8] prEN 1992-4: 2015, Eurocode 2: Design of concrete structures – Part 4: Design of fastenings for  
use in concrete
- [9] EN 10204: 2004, Metallic products – Types of inspection documents
- [10] ISO 5468: 2006, Rotary and rotary impact masonry drill bits with hard metal tips – Dimensions

