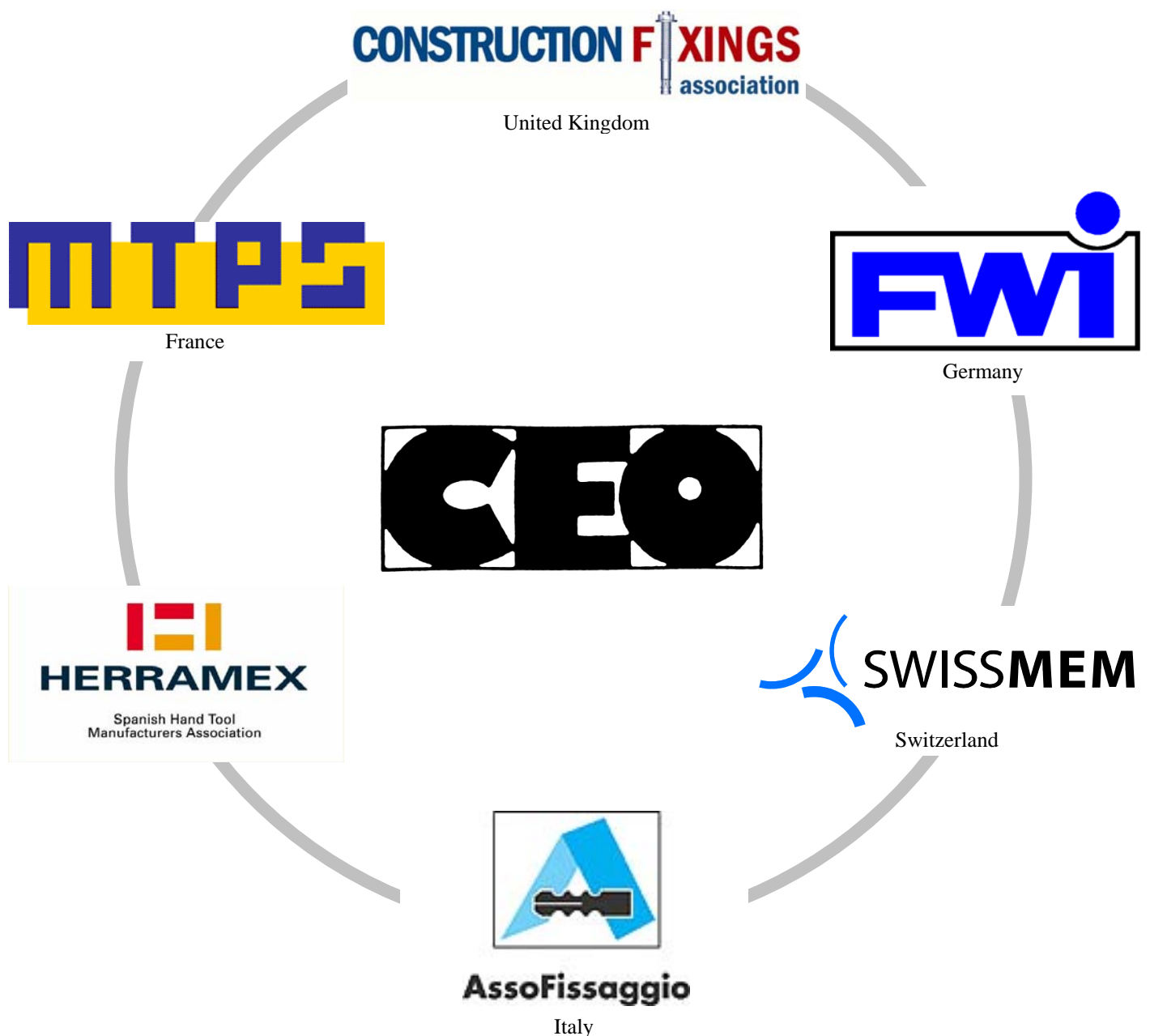




COMITÉ EUROPÉEN DE L'OUTILLAGE
EUROPEAN TOOL COMMITTEE
EUROPÄISCHES WERKZEUGKOMITEE

Guidance Note: European Technical Approvals for Anchors used in construction

This guidance note has been written by the Technical Working Group of the CEO Anchor Section and is endorsed by the following member organisations:



Individual member companies are listed on the back page.



The CEO is a European Manufacturer Association and consists of several Professional Sections. The Anchor Section includes many European anchor manufacturers (see page 8).

**Guidance Note:
European Technical Approvals for anchors used in construction**

1 INTRODUCTION

In 1997 the European Organisation for Technical Approvals (EOTA) published the first European Technical Approval Guideline (ETAG 001) for **Metal Anchors for Use in Concrete**.

The CEO has actively participated in the relevant EOTA Working Group and has strongly supported the process. Based on this guideline many companies have since gained **European Technical Approvals (ETAs)** for their products.

This Guidance Note is intended to help the users of ETAs, i.e. the specifiers and installers of anchors, to understand how to select a product with an ETA to the most appropriate ETAG Part and to ensure that installation is carried out to the requirements of the ETA.

The full benefits to specifiers and users are summarised in section 8.0.

2 LEGAL BACKGROUND

One of the main aims of the European Union is to avoid barriers to trade between Member States. These barriers may be created by different national technical specifications. The intention of the EU was to harmonise the specifications for products in several Directives, which had to be transferred into national law in the Member States. Anchors are covered by the Construction Products Directive^[1,2] (CPD). This Directive describes in a general way how to demonstrate fitness of a construction product for its intended use. This can be done by following a harmonised standard or – if a product standard does not exist - by gaining an ETA based on a harmonised European Technical Approval Guideline (e.g. ETAG 001 *Metal anchors for use in concrete*).

No national regulations shall contradict these technical specifications. During a transitional period of almost 3 years after endorsement of the ETAG, either existing national regulations or ETAs may be used. After that only ETAs are valid in the Member States. For most of the Parts of ETAG 001 the transitional period has already expired.

3 ETAGS ISSUED TO DATE AND UNDER DEVELOPMENT.

3.1 At the time of publication the following ETAGs have been published.

ETAG 001 Part	Comments	End of co-existence period	
Part 1 Anchors, general	<i>Requirements common to all types</i>	31 07 02	
Part 2 Torque controlled expansion anchors		31 07 02	
Part 3 Undercut anchors		31 07 02	
Part 4 Deformation controlled expansion anchors		<i>Requirements specific to each type</i>	31 07 02
Part 5 Bonded anchors*			28 02 05
Part 6 Anchors for multiple use for non-structural applications.	<i>Effectively a separate ETAG</i>	01 08 06	
Appendixes: A Details of tests; B Admissible service conditions; C Design methods for anchorages.	<i>Relating to all ETAG parts</i>	31 07 02	

* Separate Technical Reports cover Torque controlled bonded anchors and Rebar anchoring.

3.2 ETAGs are being developed for Plastic anchors and Injection anchors for masonry.

The EOTA website www.eota.be lists ETAGs endorsed by the Commission (downloadable), along with Technical Reports and details of revisions to ETAGs contained in History/Progress Files and a list of ETAs awarded to date.



4 TERMINOLOGY

EOTA *European Organisation for Technical Approvals*

The organisation responsible for developing ETAGs in line with mandates issued by the European Commission. Includes Approval Bodies from member states. CEO represents European manufacturers as listed on page 8.

ETAG *Guideline for European Technical Approval*

The Key document for manufacturers, approval bodies and test laboratories. The framework for test procedures, assessments and design methods against which anchors are tested and assessed. Products not covered by the exact scope of a particular ETAG may be handled via a special procedure by agreement among the Approval Bodies of EOTA. ETAG 001 Annex C *Design methods for anchorages* is a key document for specifiers.

ETA *European Technical Approval*

The Key document for specifiers. It confirms fitness for the intended use and contains details of the anchor specification, performance characteristics, Design Method and application limits. It indicates which ETAG the anchor is approved to and which Option is covered for the category of use (see section 5).

Attestation Of Conformity

The attestation of conformity procedure requires initial type testing of the anchor product by an independent body. It also requires factory production control and its supervision by an independent laboratory. This ensures that both the product and its performance remain unchanged in regular production from that tested in the approval procedure. The ETAG 001 *Metal Anchors for use in Concrete* requires attestation to high levels as safety critical applications are covered.

CE marking

An anchor product must have an ETA and have achieved the Attestation of Conformity before the manufacturer may affix CE marking. It allows the construction works to meet the relevant Essential Requirements of the Construction Products Directive. CE marking enables products to be offered for sale throughout the EU. It is not intended as a quality mark but effectively the requirements are sufficiently strict that, *in this case*, it may be regarded as one. At present CE marking is already mandatory in most member states of the EU.

5 ETAG 001 Metal anchors for use in concrete

This ETAG and its various parts covers applications for which failure of the anchor would involve risk to life and/or serious economic consequences.

There are significant differences between the scope of applications, and the methods of assessment and test, covered by Parts 1 – 5, see section 5.1, and Part 6, see section 5.2.

5.1 Parts 1 – 5

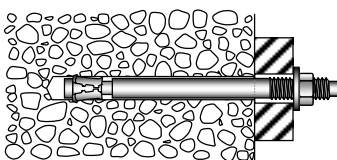
5.1.1 Scope:

This ETAG covers anchors for single and multiple use in structural and non-structural applications. The full scope of the limitations are discussed in section 6.

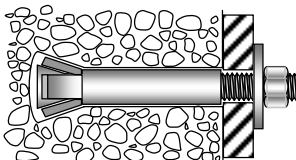
5.1.2 Types of anchor covered.

The main types of anchor are covered, as shown below, other types may be covered later.

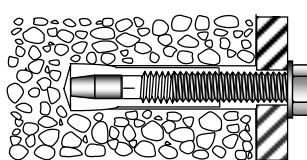
Part 2 Torque controlled



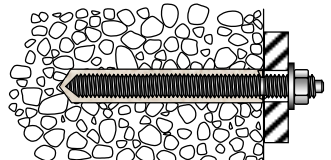
Part 3 Undercut



Part 4 Deformation controlled



Part 5 Bonded anchors



These illustrations are general examples only, other configurations of anchors also fall within these categories.

5.1.3 Options

There are 12 options covering the various application parameters including concrete strength and condition (i.e. cracked or non-cracked); loading direction and edge/spacing criteria. Options 1 (Valid for cracked and non-cracked concrete) & 7 (valid for non-cracked concrete only) are the most comprehensive, Options 6 and 12 are the least - involving severe application limitations.

When selecting an anchor for a particular application care will be needed to check that the Option of a particular ETA covers the application parameters.



5.1.3 Options – continued

Application parameters for options are tabulated below along with the relevant Design Method see 5.1.6.

Option No.	Concrete		Load quoted for				Reduced Edge & Spacing	Design Method
	Cracked & Non-cracked	Non-cracked only	C20/25 only	C20/25 up to C50/60	One value - any direction	Tensile & Shear values		
1	✓			✓		✓	✓	A
2	✓		✓			✓	✓	A
3	✓			✓	✓		✓	B
4	✓		✓		✓		✓	B
5	✓			✓	✓			C
6	✓		✓		✓			C
7		✓		✓		✓	✓	A
8		✓	✓			✓	✓	A
9		✓		✓	✓		✓	B
10		✓	✓		✓		✓	B
11		✓		✓	✓			C
12		✓	✓		✓			C

5.1.4 Test regimes

Comprehensive tests with demanding requirements mean specifiers have full confidence.

Requirements are laid down for three key aspects:

Suitability, Admissible Service Conditions, Durability.

Suitability

These tests investigate the sensitivity of anchors to various influencing factors, where appropriate, such as low and high concrete strength, repeated loads, location in cracks, repeated crack openings, sustained loads, elevated temperatures and aspects of installation such as hole cleaning, drill diameter tolerance, installation torque, humidity and temperature. Tests are only required in cracked concrete when the approval covers use in cracked concrete.

Admissible Service Conditions

These tests determine the characteristic resistances as well as appropriate edge and spacing distances dependent on the option chosen by the manufacturer.

Durability

Various environmental conditions are considered. Generally no tests are required if zinc plated anchors are restricted to dry indoor conditions and stainless steel anchors are used for normal external atmospheric exposure or permanently damp internal conditions. For harsh environments different materials or coatings may be approved following special tests. Bonded anchor materials are subject to special accelerated ageing tests.

5.1.5 Assessment criteria applied to test results

Comprehensive requirements for all suitability tests include:

- Load/displacement curves are assessed to ensure smooth curves with no uncontrolled slip.
- Products must show a limited scatter of results.
- Comparison of ultimate values from tests with various influencing factors against results from a reference test.

Special requirements are also set for individual tests.

Characteristic resistances for some anchors may be higher or lower than for previously published values due to the harmonised safety approach of the ETAG. Resistances for cracked concrete are lower than for non-cracked concrete.

5.1.6 Design methods

Three design approaches are elaborated in ETAG 001 Annex C as indicated in the table above – section 5.1.3. These are related to the options. Some terminology is new and will need to be understood to avoid confusion with previous publications from different manufacturers.



5.1.6 Design methods - continued

In addition to the parameters which differentiate the 12 options such as concrete strength and condition (i.e. cracked or non-cracked), loading direction, spacing centres and edge distances, there are many other parameters which need to be considered in arriving at a design that will satisfy all the necessary criteria and assumptions on which the ETA has been based. These are detailed in ETAG 001 Annex C "Design Methods for anchorages."

Some of these parameters include:- concrete member thickness, plate stiffness of the fixture, diameter of clearance holes in the fixture and eccentricity of loading in tension, shear or bending.

Design (selection) of the anchor is intended to be carried out by a suitably qualified engineer.

Most manufacturers provide software to assist in the selection of fixings for these safety critical applications. This is undoubtedly the most efficient way to ensure that all the necessary criteria have been taken into account although selection using Technical Data sheets will still, in theory, be possible. Manufacturers sometimes publish performance characteristics based on criteria other than ETA. The basis of data used in the design (selection) process should therefore be checked.

5.1.6.1 Cracked and non-cracked concrete

The responsibility for the decision as to whether the concrete in the area of an anchorage is cracked or not rests solely with the specifying engineer.

Concrete may be cracked as a result of a variety of causes. ETAG 001 Annex C allows each Member State to give guidance on the distinction between cracked and non-cracked concrete. [See National Annex on P 8 notes on UK Guidance.] In the absence of such guidance a method is given for determining whether a particular part of the structure is cracked or not, by calculating the stress condition. If no such consideration is made then cracked concrete should be assumed.

This means it is possible to solve the problem as there are numerous qualified products on the market. However, the qualification class of the product makes the application more expensive.

Verifying that concrete is not cracked can be required when the amount of the load occurring and the geometrical conditions (small structures, close spacing and edge distances of the anchors) require detailed calculation by exploring all possibilities. The capacity of anchors suitable for cracks given in the ETA can be at least 40% greater when they are anchored in concrete which is not cracked. The extra effort in the calculation can thus be justified.

5.1.6.2 Safety concept

The safety concept is based on the Partial Safety Factor approach as required by new standards and approval guidelines rather than the Global Safety Factor approach previously adopted by most standards .

Ultimate limit state

$S_d \leq R_d$	Where	S_d = Design Action in accordance with the relevant code R_d = Design Resistance
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S_d is calculated according to Eurocode 1. If G_k and Q_k act in the same direction then the following applies:

$S_d = \gamma_G \cdot G_k + \gamma_Q \cdot Q_k$	Where	G_k (Q_k) = Characteristic value of permanent (variable) action γ_G (γ_Q) = Partial safety factor for permanent (variable) action
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$R_d = R_k / \gamma_M$	Where	R_k = Characteristic resistance of the anchor γ_M = Partial safety factors for the base material
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The characteristic resistances and partial safety factors are given in the ETA.

Serviceability limit state

Displacements at service loads are quoted in the ETA for use in the serviceability limit state design.

5.1.6.3 Design approach

ETAG 001, Annex C provides a sophisticated design concept. In order to gain optimum performance of the anchors and at the same time an economical design. The method distinguishes between different load directions (tension, shear, combined tension and shear) and the following different failure modes:

Tension load:

- steel failure
- concrete cone failure
- pull-out / pull-through failure
- splitting failure

Shear load:

- steel failure
- concrete edge failure
- pryout failure

The design resistance R_d is calculated for every mode of failure considering all influencing parameters, such as embedment depth, cross-sectional area and steel strength of the anchor, axial and edge spacings, thickness of concrete member, concrete strength, reinforcement, eccentricity of load and condition of concrete (cracked or uncracked). The design resistance is compared with the corresponding design action S_d . The most unfavourable mode of failure is decisive for each load direction.

Subsequent to the proof for separate tension and shear loads an interaction requirement has to be fulfilled for combined tension and shear loads.



5.2 ETAG 001 Part 6 Anchors for multiple use for non-structural applications

ETAG 001 Part 6 is sufficiently different in scope to be regarded as a different ETAG although, for convenience, it is designated part of ETAG 001 and many aspects of test methods, assessment criteria and design methods are common. The basic idea of this Guideline is to take benefit of the fact that in case of excessive slip or failure of one anchor the load is transferred to neighbouring anchors.

5.2.1 Scope:

ETAG Part 6 covers anchors for Multiple Use in non-structural applications. The definition of Multiple Use is the responsibility of each member state. [See National Annex on P 8 for details of UK definition.]

A framework definition is included as follows:

“For example the design of the fixture may specify the number n_1 of fixing points to fasten the fixture and the number n_2 of anchors per fixing point. Furthermore by specifying the design value of actions N_{Sd} on a fixing point to a value $\leq n_3$ (kN) up to which the strength and stiffness of the fixture are fulfilled and the load transfer in the case of excessive slip or failure of one anchor need not to be taken into account in the design of the fixture.”

The definitions of the member states are included in an Annex to the ETAG Part 6. Where a member state has not adopted their own definition the following default value applies.

$$n_1 \geq 4; n_2 \geq 1 \text{ and } n_3 \leq 3.0 \text{ kN or}$$

$$n_1 \geq 3; n_2 \geq 1 \text{ and } n_3 \leq 2.0 \text{ kN.}$$

The value n_3 might be increased if in the design it is shown that the requirements on the strength and stiffness of the fixture in the serviceability and ultimate states after the failure of one anchor are fulfilled.

The test and assessment regime has been designed around cracked concrete so the designer need not consider this aspect

5.2.2 Types of anchor covered

All types of anchor covered in ETAG 001 Parts 2 – 5 are covered here.

5.2.3 Options

Options 1 – 6 from ETAG 001 apply.

5.2.4 Test regimes

Due to the “Multiple Use” qualification of this ETAG Part the test regime is reduced compared with ETAG 001 Parts 1 – 5 and some assessment criteria are relaxed. Characteristic resistances will be slightly higher for a product tested to this part compared with values for cracked concrete if tested to Parts 1 – 5.

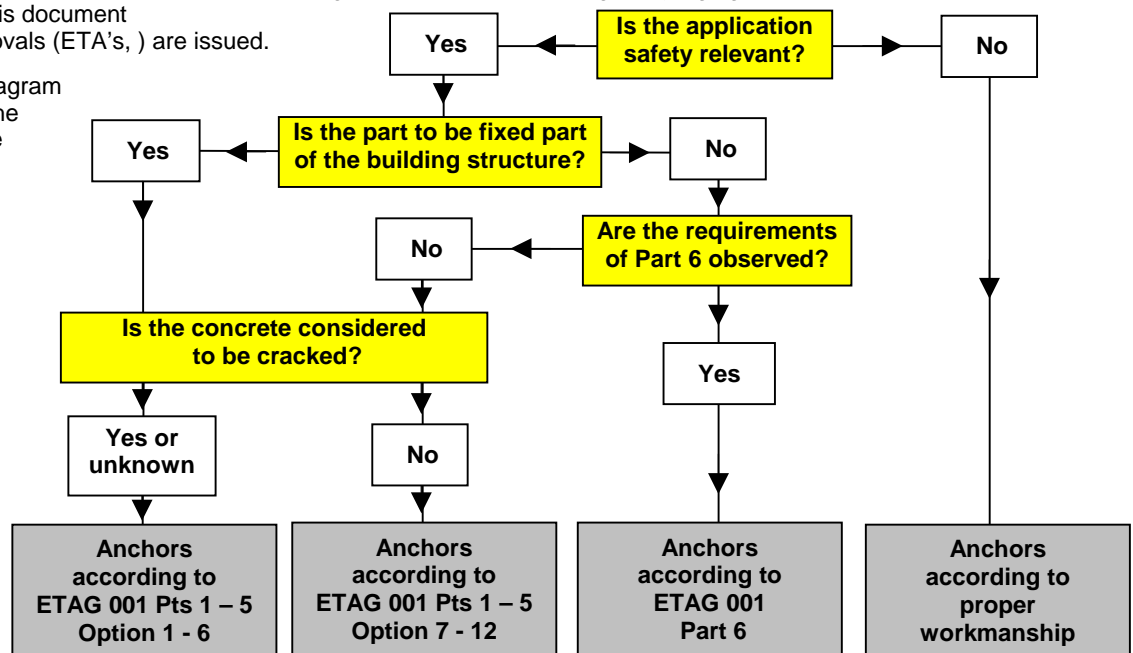
5.2.5 Design methods

Design methods A, B and C from ETAG 001 Annex C apply.

6 SELECTING APPROVED ANCHORS

The European Technical Approval Guideline (ETAG 001) gives details for assessing and judging the fitness of anchors for an intended use. Based on this document European Technical Approvals (ETA's,) are issued.

The adjacent sequence diagram is intended to assist with the necessary questions in the selection of the best qualified product.





6.1 Explanations of the questions

Is the application relevant with respect to safety?

To answer this question requires engineering judgement and is the responsibility of the design engineer. In general safety relevance must be assumed when the failure of the anchorage would compromise the stability of the works, cause risk to human life and/or lead to considerable economic consequences.

If this can be answered definitely with “no” the user can select and use anchors according to trade practices. If the reply is “yes” approved products must be used with respect to the both the legal and engineering aspects.

It is always possible to imagine a chain of events leading to the worst consequences resulting from the failure of any anchorage. This would suggest that all applications should be considered to be safety relevant. However the probability of this chain of events arising should be taken into account.

Is the part to be fixed part of the building structure?

Simplified, the answer to the question is easy: What happens if the fixed part is removed? If the column of a warehouse is removed the structure will collapse (if the respective loads occur). Therefore, the column is part of the load bearing structure. However, if a pipeline in a building is removed the load bearing structure is preserved but the use of the building is restricted. Therefore, the pipeline is not part of the load bearing structure.

Is the concrete considered to be cracked?

This question is answered in section 5.1.6.1.

Are the requirements of Part 6 observed?

This question is answered in section 5.2.

7 INSTALLING APPROVED ANCHORS

7.1. Anchors

All CEO manufacturers give the information on the specific conditions for installing their anchors. This information respects the requirements of the corresponding European Technical Approval and may be printed either directly on anchor boxes or on a notice within boxes. This information includes:


- drill bit diameter,
- thread diameter,
- maximum thickness of the fixture,
- minimum installation depth,
- minimum hole depth,
- required torque moment,
- information on the installation procedure, including cleaning of the hole, preferably by means of an illustration,
- reference to any special installation equipment needed,
- identification of the manufacturing batch.

7.2. Installation of anchors

The fitness for use of the anchor is assumed if the anchor is installed as follows:

- anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters on the job site
- use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor;
- anchor installation in accordance with the manufacturer's specifications, including the use of a suitably qualified drill bit*;
- anchor positioning in accordance with drawings prepared for that purpose by an engineer;
- thickness of the fixture corresponding to the range of required thickness values for the type of anchor;
- check of concrete being well compacted, e.g. without significant voids;
- clearing the hole of drilling dust;
- anchor installation ensuring the specified embedment depth, that is the appropriate depth marking of the anchor not exceeding the concrete surface or embedment depth control;
- keeping of the edge distance and spacing to the specified values without minus tolerances;
- positioning of the drill holes without damaging the reinforcement;
- in case of an aborted hole: either the new hole should be drilled at a minimum distance away of twice the depth of the aborted hole or at a smaller distance if the aborted drill hole is filled with high strength mortar. If under shear or oblique tension load the aborted hole must be filled if it is in the direction of the load;
- application of the recommended torque moment using a calibrated torque wrench.

* Drill bits carrying the inspection mark will satisfy this requirement,
(go to www.pgm-online.org for more information)

Inspection mark 



8 BENEFITS OF EUROPEAN TECHNICAL APPROVALS

The use of CE-marked anchors with a European Technical Approval has numerous benefits for specifiers and installers.

Anchors approved in accordance with the comprehensive test regimes and assessment criteria of ETAG 001 will necessarily correspond to state-of-the-art anchoring technology.

The liabilities of both specifiers and installers are safeguarded.

The thorough investigation of anchor functioning in the suitability tests means that installation safety is assured and anchors will not be sensitive to reasonable variations from the manufacturer's installation instructions which may occur in the construction process.

Performance values may be relied upon.

Design according to ETAG 001 Annex C, geared to the specific option of the approval, along with software to guide the selection process, means that specifiers can be confident that the most suitable anchor has been chosen. This ensures economic design of anchors with an appropriate safety margin. European Technical Approvals are accepted in all EU member states – a benefit in the case of foreign contracts.

CE marking of anchors demonstrates a permanent internal factory production control of the manufacturing process which is regularly monitored by an independent body, so the specifier can be confident that the product supplied to the job site has the same performance as that tested in the approval process.

Installers benefit from clear installation instructions which the manufacturer is obliged to provide while site engineers can identify the installed product from obligatory markings.

Overall this combination of benefits means that all parties to the construction process and the resulting building can be confident in the long term security of the anchorages used, including the user of the building who will never even be aware of the existence of the anchors.

Literature

- [1] Council Directive 89/106/EEG of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products modified by the directive 93/68/EEG of 22.7.93, Official Journal of the European Community No. L 40 of 11.2.89 and L 220 of 30.8.93.
- [2] Council Directive 89/106/EEC. Construction products. Interpretative documents, Brussels, 16.7.93.

This Guidance Note was compiled by the Technical Working Group of the CEO Anchor Section and endorsed by the national organisations shown on the front page and the following member companies who may be direct members or members of one or more national organisations:

Artex-Rawlplug, Artur Fischer, Ejot, Exchem Mining and Construction, Friulsider, G & B Fissaggi, Hilti, Index, Keil, Liebig, MKT, Placoplatre, Spit, Toge, Tox.

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Logon to www.fixingscfa.co.uk for contact details.



National Annex - UK Guidance.

Cracked and non-cracked concrete.

ETAG 001 Metal anchors for use in concrete allows each member state to publish its own guidance on how cracked and non-cracked concrete shall be regarded in that state. The UK National Technical Committee - Anchors, run by the British Board of Agrément which is the UK spokesperson on the EOTA Working Group, has agreed a document giving such guidance. *"Use of anchors with ETAs – UK Guidance – distinction between cracked and non-cracked concrete."* This gives guidance on how the status of concrete may be determined in the UK and includes diagrams to enable specifiers to identify areas which may be regarded as cracked or non-cracked without calculation. This guidance is downloadable, free of charge, from the CFA website at www.fixingscfa.co.uk. (See page "ETAs")

UK definition of "Multiple use".

ETAG 001 Part 6 Anchors for multiple use for non-structural applications also allows each member state to define "Multiple use". The UK National Technical Committee has agreed a UK definition which appears in an annex to the ETAG Part 6 and may also be downloaded, free of charge, from the CFA website at www.fixingscfa.co.uk. (See page "ETAs")