



---

European Organisation for Technical Approvals  
Europäische Organisation für Technische Zulassungen  
Organisation Européenne pour l'Agrément Technique

---

## **ETAG 020**

**Edition March 2006**

**amended version March 2012**

**GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL**

**of**

# **PLASTIC ANCHORS FOR MULTIPLE USE IN CONCRETE AND MASONRY FOR NON-STRUCTURAL APPLICATIONS**

**Part one:**

**GENERAL**

**EOTA©**

Kunstlaan 40 Avenue des Arts  
B – 1040 Brussels

# TABLE OF CONTENTS

## PART ONE: GENERAL

<b>FOREWORD</b> .....	<b>6</b>
Background of the subject .....	6
Reference documents .....	7
Updating conditions .....	8
<b>SECTION ONE: INTRODUCTION</b> .....	<b>9</b>
<b>1. PRELIMINARIES</b> .....	<b>9</b>
1.1. Legal basis .....	9
1.2. Status of ETAG .....	9
<b>2. SCOPE, USE CATEGORIES, ASSUMPTIONS AND DESIGN AND INSTALLATION QUALITY</b> .....	<b>10</b>
2.1. Scope .....	10
2.1.1. General .....	10
2.1.2. Anchors .....	10
2.1.2.1. Types and operating principles .....	10
2.1.2.2. Materials .....	12
2.1.2.3. Dimensions .....	12
2.1.3. Base materials .....	12
2.1.3.1. General .....	12
2.1.3.2. Normal weight concrete .....	13
2.1.3.3. Solid masonry units .....	13
2.1.3.4. Hollow or perforated masonry units .....	13
2.1.3.5. Autoclaved aerated concrete .....	13
2.1.4. Actions .....	13
2.2. Use Categories .....	14
2.3. Assumptions .....	14
2.4. Design and installation quality .....	14
<b>3. TERMINOLOGY</b> .....	<b>15</b>
3.1. Common terminology and abbreviations .....	15
3.1.1. Works and Products .....	15
3.1.1.1. Construction works (and parts of works) (often simply referred to as “works”) (ID 1.3.1) .....	15
3.1.1.2. Construction products (often simply referred to as “products”) (ID 1.3.2) .....	15
3.1.1.3. Incorporation (of products in works) (ID 1.3.2) .....	15
3.1.1.4. Intended use (ID 1.3.4) .....	15
3.1.1.5. Execution (ETAG-format) .....	15
3.1.1.6. System (EOTA/TB guidance) .....	15
3.1.2. Performances .....	15
3.1.2.1. Fitness for intended use (of products) (CPD 2.1) .....	15
3.1.2.2. Serviceability (of works) .....	16
3.1.2.3. Essential Requirements (for works) .....	16
3.1.2.4. Performance (of works, parts of works or products) (ID 1.3.7) .....	16
3.1.2.5. Actions (on works or parts of the works) (ID 1.3.6) .....	16

3.1.2.6.	Classes or levels (for Essential Requirements and for related product performances) (ID 1.2.1) .....	16
3.1.3.	ETAG - Format.....	16
3.1.3.1.	Requirements (for works) (ETAG-format 4.).....	16
3.1.3.2.	Methods of verification (for products) (ETAG-format 5.).....	16
3.1.3.3.	Specifications (for products) (ETAG-format 6.) .....	16
3.1.4.	Working life .....	17
3.1.4.1.	Working life (of works or parts of the works) (ID 1.3.5(1)) .....	17
3.1.4.2.	Working life (of products).....	17
3.1.4.3.	Economically reasonable working life: (ID 1.3.5(2)) .....	17
3.1.4.4.	Maintenance (of works) (ID 1.3.3(1)) .....	17
3.1.4.5.	Normal maintenance (of works) (ID 1.3.3(2)).....	17
3.1.4.6.	Durability (of products).....	17
3.1.5.	Conformity.....	17
3.1.5.1.	Attestation of conformity (of products).....	17
3.1.5.2.	Identification (of a product) .....	17
3.2.	Specific terminology and abbreviations.....	18
3.2.1.	General .....	18
3.2.2.	Anchors .....	19
3.2.3.	Base materials .....	20
3.2.4.	Loads/forces.....	20
3.2.5.	Tests .....	20
<b>SECTION TWO: GUIDANCE FOR THE ASSESSMENT OF THE FITNESS FOR USE .....</b>		<b>21</b>
(a)	Applicability of the ETAG .....	21
(b)	General layout of this section.....	21
(c)	Levels or classes or minimum requirements, related to the Essential Requirements and to the product performance (see ID [2] clause 1.2).....	21
(d)	Working life (durability) and serviceability.....	21
(e)	Fitness for the intended use.....	22
(f)	Case by case provisions .....	22
(g)	Dangerous substances .....	22
<b>4.</b>	<b>REQUIREMENTS FOR WORKS, AND THEIR RELATIONSHIP TO THE PRODUCT CHARACTERISTICS .....</b>	<b>22</b>
4.0.	General.....	23
4.1.	Mechanical resistance and stability (ER 1) .....	24
4.2.	Safety in case of fire (ER 2) .....	24
4.2.1.	Reaction to fire .....	24
4.2.2.	Resistance to fire .....	24
4.3.	Hygiene, health and the environment (ER 3) .....	24
4.4.	Safety in use (ER 4) .....	24
4.4.1.	General .....	24
4.4.2.	Suitability.....	24
4.4.2.1.	General .....	24
4.4.2.2.	Types of installation .....	24
4.4.2.3.	Correct installation .....	25
4.4.2.4.	Functioning in cracks .....	25
4.4.2.5.	Moisture content .....	25
4.4.2.6.	Temperature .....	25
4.4.2.7.	Sustained loading .....	25

4.4.2.8. Relaxation .....	25
4.4.2.9. Installation torque moment .....	25
4.4.3. Admissible service conditions .....	26
4.4.3.1. Level of loading .....	26
4.4.3.2. Displacement .....	26
4.4.3.3. Edge distance and anchor spacing.....	26
4.5. Protection against noise (ER 5).....	26
4.6. Energy economy and heat retention (ER 6) .....	26
4.7. Aspects of durability, serviceability and identification .....	26
<b>5. METHODS OF VERIFICATION .....</b>	<b>26</b>
5.0. General .....	26
5.1. Mechanical resistance and stability .....	26
5.2. Safety in case of fire .....	27
5.2.1. Reaction to fire .....	27
5.2.2. Resistance to fire .....	27
5.3. Hygiene, health and environment.....	27
5.4. Safety in use .....	27
5.4.1. General .....	27
5.4.2. Tests for suitability .....	29
5.4.2.1. General .....	29
5.4.2.2. Types of installation .....	29
5.4.2.3. Influence of the diameter of the drill hole.....	29
5.4.2.4. Functioning in cracks .....	29
5.4.2.5. Moisture content .....	29
5.4.2.6. Temperature .....	30
5.4.2.7. Sustained loading .....	30
5.4.2.8. Relaxation .....	31
5.4.2.9. Maximum torque moment .....	31
5.4.3. Tests for admissible service conditions .....	31
5.5. Protection against noise .....	31
5.6. Energy economy and heat retention .....	31
5.7. Aspects of durability, serviceability and identification .....	31
5.7.1. Tests for checking durability of the metal parts (corrosion) .....	31
5.7.2. Durability of the coating .....	31
5.7.3. Tests for checking durability of the polymeric sleeve .....	32
5.7.4. Influence of UV-exposure .....	32
<b>6. ASSESSING AND JUDGING THE FITNESS FOR USE.....</b>	<b>33</b>
6.0. General .....	33
6.1. Mechanical resistance and stability .....	33
6.2. Safety in case of fire .....	33
6.2.1. Reaction to fire .....	33
6.2.2. Resistance to fire .....	33
6.3. Hygiene, health and environment.....	33
6.4. Safety in use .....	33
6.4.1. General .....	33
6.4.1.1. 5 %-fractile of the ultimate loads.....	33
6.4.1.2. Conversion of ultimate loads to take account of concrete-, masonry- and steel strength.	34
6.4.1.3. Criteria for all tests .....	34

6.4.2.	Criteria valid for suitability tests .....	35
6.4.2.1.	General .....	35
6.4.2.2.	Types of installation .....	35
6.4.2.3.	Influence of the diameter of drill hole.....	35
6.4.2.4.	Functioning in cracks .....	35
6.4.2.5.	Moisture content .....	35
6.4.2.6.	Temperature .....	36
6.4.2.7.	Sustained load tests.....	36
6.4.2.8.	Relaxation .....	37
6.4.2.9.	Maximum torque moment .....	37
6.4.3.	Admissible service conditions .....	37
6.5.	Protection against noise .....	37
6.6.	Energy economy and heat retention .....	37
6.7.	Aspects of durability, serviceability and identification .....	37
6.7.1.	Durability of the metal parts .....	37
6.7.2.	Durability of the polymeric sleeve .....	38
6.7.3.	Influence of UV-exposure .....	38
6.7.4.	Identification .....	38
6.7.4.1.	General .....	38
6.7.4.2.	Identification of the polymeric parts .....	38
<b>7.</b>	<b>ASSUMPTIONS AND RECOMMENDATIONS UNDER WHICH THE FITNESS FOR USE OF THE PRODUCTS IS ASSESSED .....</b>	<b>39</b>
7.0.	General.....	39
7.1.	Design methods for anchorages .....	39
7.2.	Packaging, transport and storage .....	39
7.3.	Installation of anchors .....	39
	<b>SECTION THREE: ATTESTATION OF CONFORMITY (AC).....</b>	<b>41</b>
<b>8.</b>	<b>ATTESTATION OF CONFORMITY .....</b>	<b>41</b>
8.1.	EC decision .....	41
8.2.	Responsibilities.....	41
8.2.1.	Initial type-testing .....	41
8.2.2.	Factory production control (FPC).....	41
8.2.3.	Initial inspection and continuous surveillance, assessment of the factory production control system.....	41
8.3.	Documentation .....	42
8.4.	CE marking and information.....	43
	<b>SECTION FOUR: ETA CONTENT.....</b>	<b>44</b>
<b>9.</b>	<b>THE ETA CONTENT.....</b>	<b>44</b>
9.1.	The ETA-content .....	44
9.1.1.	Model ETA .....	44
9.1.2.	Checklist for the issuing body .....	44
9.1.3.	Definition of the anchor and its intended use.....	44
9.1.4.	Characteristics of the anchor with regard to safety in use and methods of verification.....	44
9.1.5.	Assumptions under which the fitness of the anchor for the intended use was favourably assessed.....	44

# FOREWORD

---

## Background of the subject

The Guideline for European Technical Approval (ETA) of „PLASTIC ANCHORS FOR MULTIPLE USE IN CONCRETE AND MASONRY FOR NON-STRUCTURAL APPLICATIONS“ sets out the basis for assessing anchors to be used in concrete and masonry and consists of:

- Part 1**      General
- Part 2**      Plastic anchors for use in normal weight concrete
- Part 3**      Plastic anchors for use in solid masonry
- Part 4**      Plastic anchors for use in hollow or perforated masonry
- Part 5**      Plastic anchors for use in autoclaved aerated concrete (AAC)

The following Annexes are full Parts of the Guideline:

- Annex A**    Details of tests
- Annex B**    Recommendations for tests to be carried out on construction works (informative)
- Annex C**    Design methods for anchorages

In this Guideline, the auxiliary verbs are used as follows in accordance with the „Rules for the drafting and presentation of European Standards (PNE-Rules)“ [3]

English	German	French
shall	muss	doit
should	sollte	il convient de
may	darf	peut
can	kann	peut

This Guideline sets out the requirements for anchors, the acceptance criteria they shall meet and guidance in understanding these two central features, also the assessment and test methods used in carrying out assessments. In addition, more general aspects of relevance, including the information required by all parties concerned and quality control, are included.

The general assessment approach adopted in this Guideline is based on combining relevant existing knowledge and experience of anchor behaviour with testing. Using this approach, testing is needed to assess the suitability of anchors.

Anchors and their behaviour in use are of interest to a number of bodies, including manufacturers, planning and design engineers, building contractors and specialist installers. Behaviour in use depends on many factors including the design of the anchor, the embedment concrete and masonry, the quality of installation, the type of loading, etc.

The individual and collective influence of the different factors referred to above are not sufficiently known at present to allow determination, by purely theoretical means, of the behaviour of anchorages under the various types of loading. It is necessary therefore to carry out tests to enable a safe assessment to be made of the influence of the different factors on the loadbearing and long-term stability of anchorages.


## Reference documents

- [1] Directive relating to construction products (CPD): Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (89/106/EEC) taking account of the modified provisions (93/68/EEC)
- [2] Council Directive 89/106/EEC, Construction Products. Interpretative Documents, Brussels, 16-7-1993
- [3] Internal Regulations CEN/CENLEC Part 3: Rules for the drafting and presentation of European Standards (PNE-Rules) Edition 1991-09
- [4] EN 1992-1-1:2011-01: Eurocode 2 - Design of concrete structures – Part 1-1: General rules and rules for buildings
- [5] EN 206-1:2000-12/A1:2004/A2:2005: Concrete Part 1: Specification, performance, production and conformity
- [6] EN 197-1:2011-09: Cement Part 1: Composition, specifications and conformity criteria for common cements
- [7] ISO 6783:1982: Coarse aggregates for concrete - determination of particle density and water absorption - hydrostatic balance method
- [8] EN 1996-1-1:2010-12: Eurocode 6 - Design of masonry structures - Part 1-1: General rules for reinforced and unreinforced masonry structures
- [9] EN 771-1 to 6:2011-07: Specification for masonry units
- [10] EN 12602:2008: Prefabricated reinforced components of autoclaved aerated concrete
- [11] ISO 3506:2009: Mechanical properties of corrosion-resistant stainless-steel fasteners
- [12] ISO 5922:2005: Malleable cast iron
- [13] DIN 8035:1976-11: Hammer drills
- [14] NF E 66-079: Rotary and rotary impact masonry drill bits with hardened tips. Dimensions. July 1993.
- [15] ISO 5468:2006: Rotary and rotary impact masonry drill bits with hard metal tips - dimensions
- [16] ISO 1110:1997: Plastics - Polyamides - Accelerated conditioning of test specimens
- [17] ISO 3167:2002: Plastics - Multipurpose test specimens
- [18] ISO 11357-1:2009: Plastics – Differential scanning calorimetry (DSC) – Part 1: General principles
- [19] ISO 1133:2005: Plastics; Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
- [20] EN 1990:2010-12 - Eurocode: Basis of Structural Design
- [21] EN 1991: 2010-12 - Eurocode 1: Actions on structures
- [22] EC Decision 96/603/EC: COMMISSION DECISION of 4 October 1996 establishing the list of products belonging to Classes A 'No contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/EEC on construction products
- [23] ETAG 001, Part 5:2008: Guideline for European Technical Approval of Metal Anchors for use in concrete – Part 5: Bonded Anchors
- [24] TR 020:2004: EOTA Technical Report: Evaluation of Anchorages in Concrete concerning Resistance to Fire

## Updating conditions

The edition of a reference document given in this list is that which has been adopted by EOTA for its specific use.

When a new edition becomes available, this supersedes the edition mentioned in the list only when EOTA has verified or re-established (possibly with appropriate linkage) its compatibility with the Guideline.

EOTA comprehension documents permanently take on board all useful information on the updating of reference documents and on the general understanding of this ETAG as developed when delivering ETAs  by consensus among the EOTA members.

EOTA Technical reports go into detail in some aspects and as such are not Part of the ETAG but express the common understanding of existing knowledge and experience of the EOTA-bodies at that moment. When knowledge and experience is developing, especially through approval work, these reports can be amended and supplemented. When this happens, the effect of the changes upon the ETAG will be determined by EOTA and laid down in the relevant comprehension documents.

Readers and users of this ETAG are advised to check the current status of the content of this document with an EOTA member.



# Section one:

## INTRODUCTION

---

### 1. PRELIMINARIES

#### 1.1. Legal basis

This ETAG has been established in compliance with the provisions of the Council Directive 89/106/EEC (CPD) [1] and has been established taking into account the following steps:

- |   |                     |  |
|---|---------------------|--|
| • the final mandate issued by the EC                            | November 1996       |  |
| • the final mandate issued by the EFTA                          | not relevant        |  |
| • adoption of the Guideline by the Executive Commission of EOTA | June 2004<br>XXX    | (Edition March 2006)<br>(Edition XXX 2011) |
| • opinion of the Standing Committee for Construction            | January 2006<br>XXX | (Edition March 2006)<br>(Edition XXX 2011) |
| • endorsement by the EC   | July 2006<br>XXX    | (Edition March 2006)<br>(Edition XXX 2011) |

This document is published by the Member States in their official language or languages according to art. 11.3 of the CPD.

This edition replaces the March 2006 edition.

#### 1.2. Status of ETAG

- a) **An ETA is one of the two types of technical specifications** in the sense of the EC 89/106 Construction Products Directive [1]. This means that Member States shall presume that the approved products are fit for their intended use, i.e. they enable works in which they are employed to satisfy the Essential Requirements during an economically reasonable working life, provided that :
- the works are properly designed and built;
  - the conformity of the products with the ETA has been properly attested.
- b) **This ETAG is a basis for ETAs**, i.e. a basis for technical assessment of the fitness for use of a product for an intended use. An ETAG is not itself a technical specification in the sense of the CPD. This ETAG expresses the common understanding of the approval bodies, acting together within EOTA, as to the provisions of the Construction Products Directive 89/106 [1] and of the Interpretative Documents [2], in relation to the products and uses concerned, and is written within the framework of a mandate given by the Commission and the EFTA secretariat, after consulting the Standing Committee for Construction.
- c) When accepted by the European Commission after consultation with the Standing Committee for Construction this **ETAG is binding** for the issuing of ETAs for the products for the defined intended uses.

The application and satisfaction of the provisions of an ETAG (examinations, tests and evaluation methods) leads to an ETA and a presumption of fitness of a product for the defined use only through an evaluation and approval process and decision, followed by the corresponding attestation of conformity. This distinguishes an ETAG from a harmonised European standard which is the direct basis for attestation of conformity.

Where appropriate, products which are outside of the precise scope of this ETAG may be considered through the approval procedure without Guidelines according to art. 9.2 of the CPD.

The requirements in this ETAG are set out in terms of objectives and of relevant actions to be taken into account. It specifies values and characteristics, the conformity with which gives the presumption that the requirements set out are satisfied, wherever the state of art permits and after having been confirmed as appropriate for the particular product by the ETA.

This Guideline indicates alternate possibilities for the demonstration of the satisfaction of the requirements.

## 2. Scope, use categories, assumptions and design and installation quality

### 2.1. Scope

#### 2.1.1. General

The Guideline for European Technical Approval (ETA) of „PLASTIC ANCHORS FOR MULTIPLE USE IN CONCRETE AND MASONRY FOR NON-STRUCTURAL APPLICATIONS“ sets out the basis for assessing anchors to be used in concrete and masonry and consists of:

- Part 1** General
- Part 2** Plastic anchors for use in normal weight concrete
- Part 3** Plastic anchors for use in solid masonry
- Part 4** Plastic anchors for use in hollow or perforated masonry
- Part 5** Plastic anchors for use in autoclaved aerated concrete (AAC)

The general requirements and assessment procedures applicable to all base materials are set out in Part 1 of the Guideline. The subsequent Parts contain requirements and assessment procedures as well as details of the number of tests to be carried out for each base material and are only applicable in connection with Part 1.

The following Annexes are full Parts of the Guideline:

- Annex A** Details of tests
- Annex B** Recommendations for tests to be carried out on construction works (informative)
- Annex C** Design methods for anchorages

This Guideline covers the assessment of post-installed plastic anchors in different base materials according to Parts 2 to 5.

When using plastic anchors, the requirements mainly concerning safety in use as identified in Essential Requirement N°4 (ER 4) of the CPD shall be satisfied; failure of the fixture can represent an immediate risk to human life<sup>1</sup>. However such failure may jeopardise the meeting of other Essential Requirements for parts of the works.

The plastic anchors shall be used for multiple fixings. By multiple anchor use it is assumed that in the case of excessive slip or failure of one anchor the load can be transmitted to neighbouring anchors without significantly violating the requirements on the fixture in the serviceability and ultimate limit state.

Therefore the design of the fixture shall 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 requirements on the strength and stiffness of the fixture are fulfilled and the load transfer in the case of excessive slip or failure of one anchor needs not to be taken into account in the design of the fixture. The values for  $n_1$ ,  $n_2$  and  $n_3$  are given in the following Parts of this Guideline.

#### 2.1.2. Anchors

##### 2.1.2.1. Types and operating principles

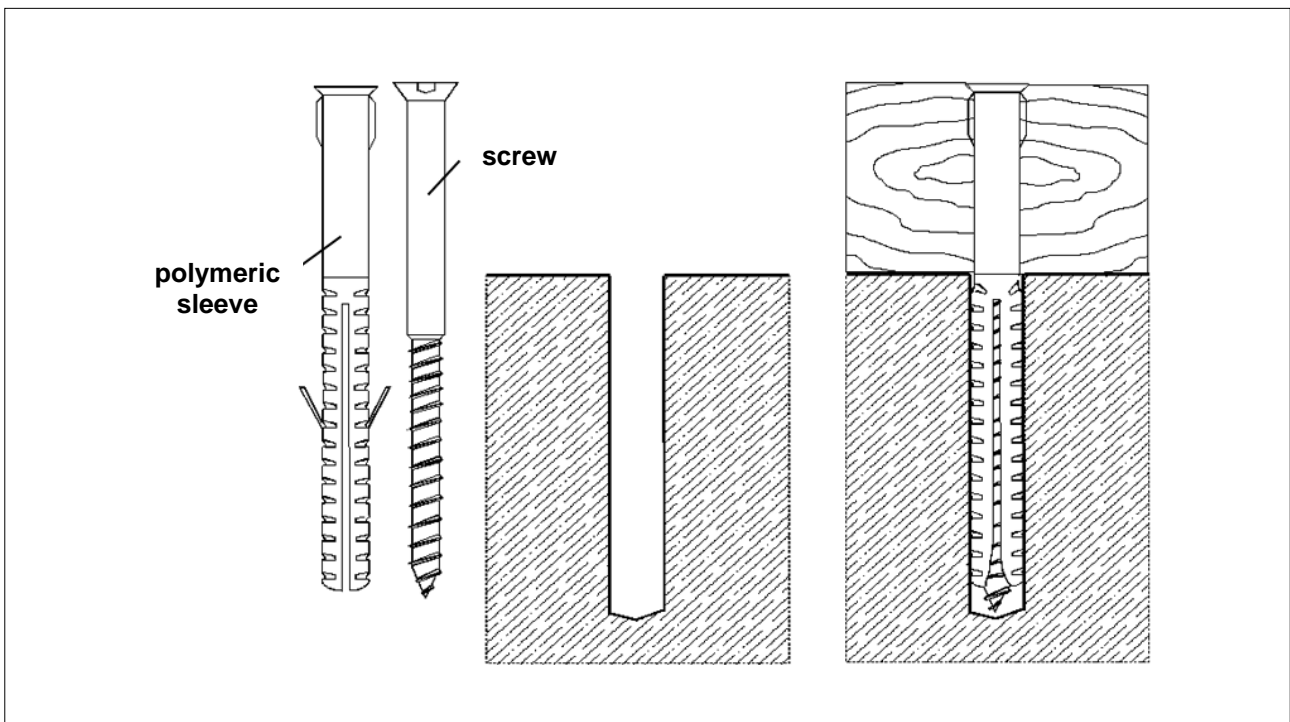
Plastic anchors consisting of an expansion element and a polymeric sleeve which passes through the fixture. Polymeric sleeve and expansion element are a unit and of approximately the same length. The polymeric sleeve is expanded by hammering or screwing in the expansion element which presses the sleeve against the wall of the drilled hole.

The polymeric sleeve shall be fixed in the hole in the correct position. An uncontrolled setting of the sleeve in the drilled hole during setting shall be avoided; this can be done e.g. with a collar on the upper end of the sleeve.

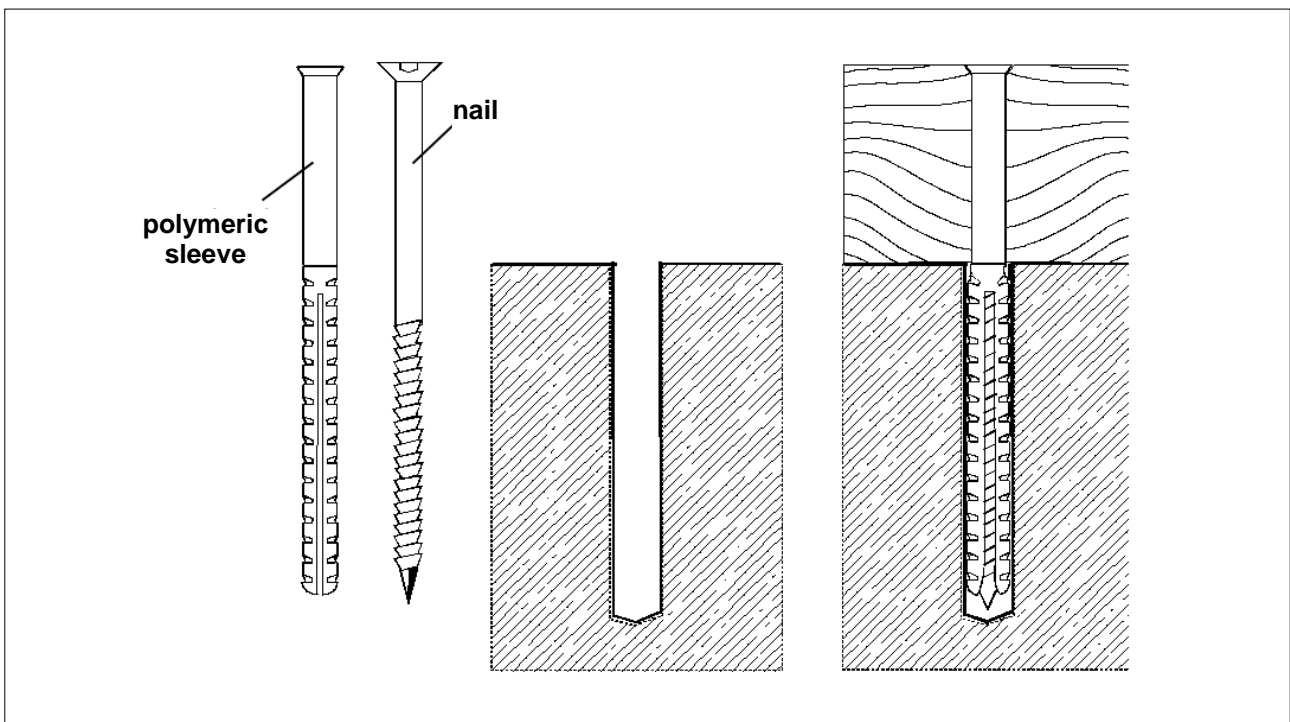
- 
- (1) The rules in relation to Essential Requirements (ERs) to be satisfied for the works are defined by the member states in their national regulations. As these national regulations determine whether plastic anchors shall or shall not meet the Essential Requirements and hence whether CE marking is appropriate, it is the responsibility of designers and users to select a product for a particular use such that ERs for the works are met.

Two types of plastic anchors are covered:

- Plastic anchors with a screw as an expansion element (setting: screwed in) - see Figure 2.1a.
- Plastic anchors with a nail as an expansion element (setting: hammered in) - see Figure 2.1b.



**Figure 2.1a:** Example of plastic anchor (screwed in)



**Figure 2.1b:** Example of plastic anchors (hammered in)

### 2.1.2.2. Materials

- Expansion element: metal (steel) or polymeric material

The required tests for the suitability and durability of the plastic anchor in case of an expansion element made out of polymeric material shall be decided on by the responsible Approval Body.

- Polymeric sleeve: Polymeric material

- Polyamide PA6 and PA6.6
- polyethylene PE or polypropylene PP
- other polymeric materials

Reprocessed material obtained from external sources and recycled material is not allowed to be used as polymeric material.

Only virgin material (so-called A-material) shall be used. However, reworked material received as own waste material from the manufacturing process may be added to the manufacturing process. This regenerated material is of the same feedstock and identical with the rest of the material. The allowable percentage of this reworked material shall be according to the recommendations of the manufacturer of the virgin material.

### 2.1.2.3. Dimensions

This Guideline applies to plastic anchors with an external diameter  $d$  of the polymeric sleeve and an anchorage depth  $h_{\text{nom}}$  as follows:

$d \geq 6 \text{ mm};$	$h_{\text{nom}} \geq 30 \text{ mm}$	for use in concrete
$d \geq 8 \text{ mm};$	$h_{\text{nom}} \geq 50 \text{ mm}$	for use in other base materials

## 2.1.3. Base materials

### 2.1.3.1. General

This Guideline applies to the use of plastic anchors in concrete (normal weight or autoclaved aerated) and/or masonry units of clay, calcium silicate, normal weight concrete, lightweight concrete, autoclaved aerated concrete or other similar materials. As far as the specification of the different masonry units is concerned EN 771-1 to 5 [9] shall be taken as reference. The design and construction of masonry structures in which the plastic anchors are to be anchored shall be in accordance with EN 1996-1-1:2005: Eurocode 6 [8] and the relevant national regulations.

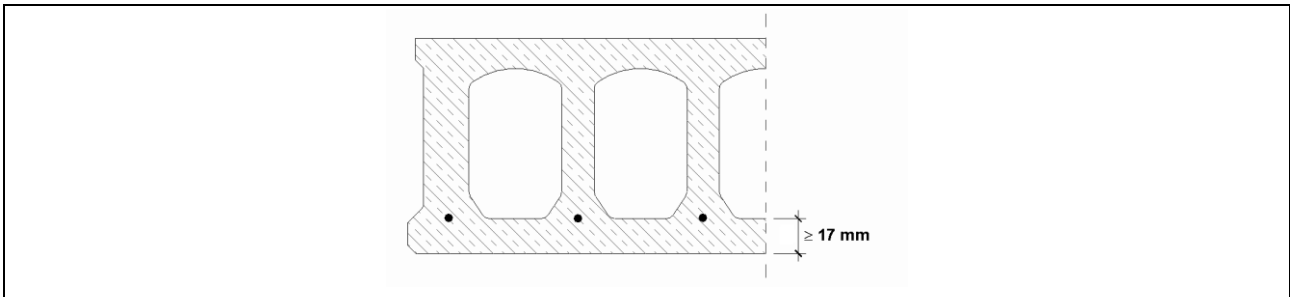
Attention is drawn to the fact that the standards for masonry are not very restrictive with regard to details of units (e.g. type, dimensions and location of hollows, number and thickness of webs). Anchor resistance and load displacement behaviour, however, decisively depend on these influencing factors.

An assessment of the plastic anchor is, in principle, only possible for each particular well-defined masonry unit concerned. For the assessment of the behaviour of the plastic anchor in other less well-defined base materials, tests on the construction site are to be carried out according to Annex B or national requirements. The characteristic resistance of the plastic anchor in less well-defined base materials may only be determined by so-called "job-site tests" if the plastic anchor has already an ETA with characteristic values for the equivalent base material (according to use category a, b, c or d) as it is present on the construction works.

This Guideline applies to applications where the minimum thickness of the base material in which plastic anchors are installed is at least  $h = 80 \text{ mm}$ .

In special cases [e.g. thin skins (weather resistant skin) of external wall panels] the minimum thickness of the base material may be reduced to 40 mm, if the influence of the setting position of the plastic anchor is considered according to ETAG 020 (Amendment 2011), Part 2, 5.4.3, Figure 5.1.

In precast prestressed hollow core slabs anchors may be fastened in an element with a minimum thickness of 17 mm (see Figure 2.2), if the influence of the setting position of the plastic anchor is taken into account according to ETAG 020 (Amendment 2011), Part 2, 5.4.3, Figure 5.2.



**Figure 2.2:** Example of precast prestressed hollow core slabs

### 2.1.3.2. Normal weight concrete

This Guideline applies to the use of plastic anchors in normal weight concrete strength classes C12/15 at least according to EN 206-1 [5].

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

### 2.1.3.3. Solid masonry units

In general, solid masonry units do not have any holes or cavities other than those inherent in the material. However, solid units may have a vertically perforation of up to 15 % of the cross section.

### 2.1.3.4. Hollow or perforated masonry units

Masonry units consisting of hollow or perforated units have a certain volume percentage of voids which pass through the masonry unit.

For the assessment of plastic anchors anchored in hollow or perforated units it has also to be assumed that the anchor may be situated in solid material (e.g. joints, solid part of unit without holes) so that also tests in solid material may be required.

### 2.1.3.5. Autoclaved aerated concrete

This Guideline applies to the use of plastic anchors in autoclaved aerated concrete according to EN 771-4 [9] or EN 12602 [10].

## 2.1.4. Actions

This Guideline covers applications only where the components in which the plastic anchors are embedded are subject to predominantly static or quasi-static loads.

This Guideline applies to plastic anchors subject to static or quasi-static actions in tension, shear or combined tension and shear or bending; it is not applicable to plastic anchors loaded in compression or subject to fatigue, impact, or seismic actions.

## 2.2. Use Categories

The Guideline applies to anchorages in respect of the following use categories:

- a) Use categories are a function of the base material:
- Use category a: Plastic anchors for use in **normal weight concrete**
  - Use category b: Plastic anchors for use in **solid masonry**
  - Use category c: Plastic anchors for use in **hollow or perforated masonry**
  - Use category d: Plastic anchors for use in **autoclaved aerated concrete**

Combinations of different use categories are possible.

- b) Use categories in respect of durability aspects:
- use in structures subject to dry, internal conditions,
  - use in structures subject to other environmental conditions.

## 2.3. Assumptions

The state of the art does not enable the development, within a reasonable time, of full and detailed verification methods and corresponding technical criteria/guidance for acceptance for some particular aspects or products. This ETAG contains assumptions taking account of the state of art and makes provisions for appropriate, additional *case-by-case approaches* when examining ETA-applications, within the general framework of the ETAG and under the CPD consensus procedure between EOTA members.

The guidance remains valid for other cases which do not deviate significantly. The general approach of the ETAG remains valid but the provisions then need to be modified case by case in an appropriate way. This use of the ETAG is the responsibility of the ETA-body which receives the special application, and subject to consensus within EOTA. Experience in this respect is collected, after endorsement in EOTA-TB, in the ETAG-Format-Comprehension document.

## 2.4. Design and installation quality

In setting out the assessment procedures in this Guideline, it has been assumed that the design of the anchorages and the specification of the plastic anchor are under the control of an engineer experienced in anchorages. It is also assumed that the anchor installation is undertaken by trained personnel under the supervision of the person responsible for technical matters on site, to ensure that the specifications are effectively implemented.

### 3. TERMINOLOGY

#### 3.1. Common terminology and abbreviations

*This common terminology is based upon the EC Construction Products Directive 89/106 and the Interpretative documents as published in the Official Journal of the EC on 28.2.1994. It is limited to items and aspects relevant for approval work. They are partly definitions and partly clarifications.*

##### 3.1.1. Works and Products

###### 3.1.1.1. Construction works (and parts of works) (often simply referred to as “works”) (ID 1.3.1)

Everything that is constructed or results from construction operations and is fixed to the ground.

(This covers both building and civil engineering works, and both structural and non structural elements).

###### 3.1.1.2. Construction products (often simply referred to as “products”) (ID 1.3.2)

Products which are produced for incorporation in a permanent manner in the works and placed as such on the market.

(The term includes materials, elements, components and systems or installations)

###### 3.1.1.3. Incorporation (of products in works) (ID 1.3.2)

Incorporation of a product in a permanent manner in the works means that:

- its removal reduces the performance capabilities of the works, and
- that the dismantling or the replacement of the product are operations which involve construction activities.

###### 3.1.1.4. Intended use (ID 1.3.4)

Role(s) that the product is intended to play in the fulfilment of the Essential Requirements.

*(N.B. This definition covers only the intended use as far as relevant for the CPD)*

###### 3.1.1.5. Execution (ETAG-format)

Used in this document to cover all types of incorporation techniques such as installation, assembling or incorporation, etc.

###### 3.1.1.6. System (EOTA/TB guidance)

Part of the works realised by:

- particular combination of a set of defined products, and
- particular design methods for the system, and/or
- particular execution procedures.

##### 3.1.2. Performances

###### 3.1.2.1. Fitness for intended use (of products) (CPD 2.1)

Means that the products have such characteristics that the works in which they are intended to be incorporated, assembled, applied or installed, can, if properly designed and built, satisfy the Essential Requirements.

*(N.B. This definition covers only the intended fitness for intended use as far as relevant for the CPD)*

### **3.1.2.2. Serviceability (of works)**

Ability of the works to fulfil their intended use and in particular the Essential Requirements relevant for this use.

The products shall be suitable for construction works which (as a whole and in their separate parts) are fit for their intended use, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions which are foreseeable (CPD Annex I, Preamble).

### **3.1.2.3. Essential Requirements (for works)**

Requirements applicable to works, which may influence the technical characteristics of a product, and are set out in objectives in the CPD, Annex I (CPD, art. 3.1).

### **3.1.2.4. Performance (of works, parts of works or products) (ID 1.3.7)**

The quantitative expression (value, grade, class or level) of the behaviour of the works, parts of works or of the products, for an action to which it is subject or which it generates under the intended service conditions (works or parts of works) or intended use conditions (products).

*As far as practicable the characteristics of products, or groups of products, should be described in measurable performance terms in the technical specifications and Guidelines for ETA. Methods of calculation, measurement, testing (where possible), evaluation of site experience and verification, together with compliance criteria shall be given either in the relevant technical specifications or in references called up in such specifications.*

### **3.1.2.5. Actions (on works or parts of the works) (ID 1.3.6)**

Service conditions of the works which may affect the compliance of the works with the Essential Requirements of the Directive and which are brought about by agents (mechanical, chemical, biological, thermal or electro-mechanical) acting on the works or parts of the works.

*Interactions between various products within a work are considered as "actions".*

### **3.1.2.6. Classes or levels (for Essential Requirements and for related product performances) (ID 1.2.1)**

A classification of product performance(s) expressed as a range of requirement levels of the works, determined in the IDs or according to the procedure provided for in art. 20.2a of the CPD.

## **3.1.3. ETAG - Format**

### **3.1.3.1. Requirements (for works) (ETAG-format 4.)**

Expression and application, in more detail and in terms applicable to the scope of the Guideline, of the relevant requirements of the CPD (given concrete form in the IDs and further specified in the mandate), for works or parts of the works, taking into account the durability and serviceability of the works.

### **3.1.3.2. Methods of verification (for products) (ETAG-format 5.)**

Verification methods used to determine the performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, evaluation of site experience, etc.).

*These verification methods are related only to the assessment of the plastic anchors and for judging their fitness for use. Verification methods for particular designs of works are called here "project testing", for identification of products are called "identification testing", for surveillance of execution or executed works are called "surveillance testing", and for attestation of conformity are called "AC-testing".*

### **3.1.3.3. Specifications (for products) (ETAG-format 6.)**

Transposition of the requirements into precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the products and their intended use. *The satisfaction of the specifications is deemed to satisfy the fitness for use of the products concerned.*

*Specifications may also be formulated with regard to the verification of particular designs, for identification of products, for surveillance of execution or executed works and for attestation of conformity, when relevant.*



### **3.1.4. Working life**

#### **3.1.4.1. Working life (of works or parts of the works) (ID 1.3.5(1))**

The period of time during which the performance will be maintained at a level compatible with the fulfilment of the Essential Requirements.

#### **3.1.4.2. Working life (of products)**

Period of time during which the performances of the product are maintained - under the corresponding service conditions - at a level compatible with the intended use conditions.

#### **3.1.4.3. Economically reasonable working life: (ID 1.3.5(2))**

Working life which takes into account all relevant aspects, such as costs of design, construction and use, costs arising from hindrance of use, risks and consequences of failure of the works during its working life and cost of insurance covering these risks, planned partial renewal, costs of inspections, maintenance, care and repair, costs of operation and administration, of disposal and environmental aspects.

#### **3.1.4.4. Maintenance (of works) (ID 1.3.3(1))**

A set of preventive and other measures which are applied to the works in order to enable the works to fulfil all its functions during its working life. These measures include cleaning, servicing, repainting, repairing, replacing parts of the works where needed, etc.

#### **3.1.4.5. Normal maintenance (of works) (ID 1.3.3(2))**

Maintenance, normally including inspections, which occurs at a time when the cost of the intervention which has to be made is not disproportionate to the value of the part of the works concerned, consequential costs (e.g. exploitation) being taken into account.

#### **3.1.4.6. Durability (of products)**

Ability of the product to contribute to the working life of the works by maintaining its performances, under the corresponding service conditions, at a level compatible with the fulfilment of the Essential Requirements by the works.

### **3.1.5. Conformity**

#### **3.1.5.1. Attestation of conformity (of products)**

Provisions and procedures as laid down in the CPD and fixed according to the directive, aiming to ensure that, with acceptable probability, the specified performance of the product is achieved by the ongoing production.

#### **3.1.5.2. Identification (of a product)**

Product characteristics and methods for their verification, allowing to compare a given product with the one that is described in the technical specification.

## ABBREVIATIONS

Concerning the Construction products directive:

<b>AC:</b>	Attestation of Conformity
<b>CEN:</b>	Comité Européen de Normalisation
<b>CPD:</b>	Construction Products Directive
<b>EC:</b>	European Commission
<b>EFTA:</b>	European Free Trade Association
<b>EN:</b>	European Standards
<b>EU</b>	European Union
<b>FPC:</b>	Factory Production Control
<b>ID:</b>	Interpretative Documents of the CPD
<b>ISO:</b>	International Standardisation Organisation
<b>SCC:</b>	Standing Committee for Construction of the EC

Concerning approval:

<b>EOTA:</b>	European Organisation for Technical Approvals
<b>ETA:</b>	European Technical Approval
<b>ETAG:</b>	European Technical Approval Guideline
<b>TB:</b>	EOTA-Technical Board
<b>UEAtc:</b>	Union Européenne pour l'Agrément technique dans la construction

General:

<b>TC:</b>	Technical Committee
<b>WG:</b>	Working Group

### 3.2. Specific terminology and abbreviations

#### 3.2.1. General

<b>Anchor</b>	=	a manufactured, assembled component for achieving anchorage between the base material and the fixture.
<b>Anchor group</b>	=	several anchors (working together)
<b>Fixture</b>	=	component to be fixed to the base material
<b>Anchorage</b>	=	an assembly comprising base material, anchor or anchor group and fixture.

### 3.2.2. Anchors

The notations and symbols frequently used in this Guideline are given below. Further particular notation and symbols are given in the text.

<b>a</b>	=	spacing between outer anchors of adjoining groups or between single anchors
<b>a<sub>1</sub></b>	=	spacing between outer anchors in adjoining groups or between single anchors in direction 1
<b>a<sub>2</sub></b>	=	spacing between outer anchors in adjoining groups or between single anchors in direction 2
<b>b</b>	=	width of the member of the base material
<b>c<sub>1</sub></b>	=	edge distance in direction 1
<b>c<sub>2</sub></b>	=	edge distance in direction 2
<b>c<sub>cr</sub></b>	=	edge distance for ensuring the transmission of the characteristic resistance of a single anchor
<b>c<sub>min</sub></b>	=	minimum allowable edge distance
<b>d</b>	=	nominal diameter of the anchor
<b>d<sub>o</sub></b>	=	drill hole diameter
<b>d<sub>cut</sub></b>	=	cutting diameter of drill bit
<b>d<sub>cut,max</sub></b>	=	cutting diameter at the upper tolerance limit (maximum diameter bit)
<b>d<sub>cut,min</sub></b>	=	cutting diameter at the lower tolerance limit (minimum diameter bit)
<b>d<sub>cut,m</sub></b>	=	medium cutting diameter of drill bit
<b>d<sub>f</sub></b>	=	diameter of clearance hole in the fixture
<b>d<sub>nom</sub></b>	=	outside diameter of anchor
<b>h</b>	=	thickness of member (wall)
<b>h<sub>min</sub></b>	=	minimum thickness of member
<b>h<sub>o</sub></b>	=	depth of cylindrical drill hole at shoulder
<b>h<sub>1</sub></b>	=	depth of drilled hole to deepest point
<b>h<sub>ef</sub></b>	=	effective anchorage depth
<b>h<sub>nom</sub></b>	=	overall anchor embedment depth in the base material
<b>s<sub>1</sub></b>	=	spacing of anchors in an anchor group in direction 1
<b>s<sub>2</sub></b>	=	spacing of anchors in an anchor group in direction 2
<b>s<sub>cr</sub></b>	=	spacing for ensuring the transmission of the characteristic resistance of a single anchor
<b>s<sub>min</sub></b>	=	minimum allowable spacing
<b>T</b>	=	torque moment
<b>T<sub>inst</sub></b>	=	setting torque when the screw of the plastic anchor is fully attached to the anchor collar
<b>T<sub>u</sub></b>	=	maximum torque moment that can be applied to the plastic anchor
<b>t<sub>fix</sub></b>	=	thickness of fixture

### 3.2.3. Base materials

$f_c$	=	concrete compressive strength measured on cylinders
$f_{c,cube}$	=	concrete compressive strength measured on cubes
$f_{c,test}$	=	compressive strength of concrete at the time of testing
$f_{cm}$	=	mean concrete compressive strength
$f_{ck}$	=	nominal characteristic concrete compressive strength (based on cylinder)
$f_{ck,cube}$	=	nominal characteristic concrete compressive strength (based on cubes)
$\rho$	=	bulk density of unit
$f_b$	=	normalised mean compressive strength of masonry unit
$f_{b,test}$	=	mean compressive strength of the test masonry unit at the time of testing
$f_{y,test}$	=	steel tensile yield strength in the test
$f_{yk}$	=	nominal characteristic steel yield strength
$f_{u,test}$	=	steel ultimate tensile strength in the test
$f_{uk}$	=	nominal characteristic steel ultimate strength

### 3.2.4. Loads/forces

$F$	=	force in general
$N$	=	normal force (+N = tension force)
$V$	=	shear force
$N_{Rk}, V_{Rk}$	=	characteristic anchor resistance (5 %-fractile of results) under tension or shear force respectively

### 3.2.5. Tests

$F_{Ru}^t$	=	ultimate load in a test
$F_{Ru,m}^t$	=	mean ultimate load in a test series
$F_{Rk}^t$	=	5 %-fractile of the ultimate load in a test series
$n$	=	number of tests of a test series
$v$	=	coefficient of variation
$\delta(\delta_N, \delta_V)$	=	displacement (movement) of the anchor at the surface of the base material relative to the surface of the base material in direction of the load (tension, shear) outside the failure area  The displacement includes the steel and base material deformations and a possible anchor slip.

## Section two:

# GUIDANCE FOR THE ASSESSMENT OF THE FITNESS FOR USE

---

### GENERAL NOTES

#### (a) Applicability of the ETAG

This ETAG provides guidance on the assessment of a family of products and their intended uses. It is the manufacturer or producer who defines the product for which he is seeking ETA and how it is to be used in the works, and consequently the scale of the assessment.

It is therefore possible that for some products, which are fairly conventional, only some of the tests and corresponding criteria are sufficient to establish fitness for use. In other cases, e. g. special or innovative products or materials, or where there is a range of uses, the whole package of tests and assessment may be applicable.

Common clauses:

#### (b) General layout of this section

The assessment of the fitness of products with regard to their fitness for intended use in construction works is a process with the following steps:

- Chapter 4 clarifies *the specific requirements for the works* relevant to the products and uses concerned, beginning with the Essential Requirements for works (CPD [1] art. 11.2) and then listing the corresponding relevant characteristics of products.
- Chapter 5 extends the list in Chapter 4 into more precise definitions and *the methods available to verify* product characteristics and to indicate how the requirements and the relevant product characteristics are described. This is done by test procedures, methods of calculation and of proof, etc. (selection of the appropriate methods)
- Chapter 6 provides guidance on *the assessing and judging methods* to confirm fitness for the intended use of the products.
- Chapter 7 *assumptions and recommendations* is only relevant in so far as they concern the basis upon which the assessment of the product is made concerning its fitness for the intended use.

#### (c) Levels or classes or minimum requirements, related to the Essential Requirements and to the product performance (see ID [2] clause 1.2)

According to the CPD [1], "Classes" in this ETAG refer only to mandatory levels or classes laid down in the EC-mandate.

This ETAG indicates, however, the compulsory way of expressing relevant performance characteristics for the product. If, for some uses, at least one Member State has no regulations, a manufacturer always has the right to opt out of one or more of them, in which case the ETA will state "no performance determined" against that aspect, except for those properties for which, when no determination has been made, the product does not any longer fall under the scope of the ETAG; such cases are indicated in the ETAG.

#### (d) Working life (durability) and serviceability

The provisions, test and assessment methods in this Guideline or referred to, have been written, based upon the assumed intended working life of the product for the intended use of 50 years, provided that the product is subject to appropriate use and maintenance (cf. Ch. 7). These provisions are based upon the current state of the art and the available knowledge and experience.

An "assumed intended working life" means that it is expected that, when an assessment following the ETAG-provisions is made, and when this working life has elapsed, the real working life may be, in normal use conditions, considerably longer without major degradation affecting the Essential Requirements.

The indications given for characteristics linked to the working life of a product cannot be interpreted as a guarantee given by the producer or the Approval Body. They should only be regarded as a means for the specifiers to choose the appropriate criteria for products in relation to the expected, economically reasonable working life of the works (based upon ID [2] par. 5.2.2).

For products or components with a shorter estimated working life, the intended use shall be limited to specific applications where the shorter durability is clearly stated.

**(e) Fitness for the intended use**

According to the CPD [1] it has to be understood that within the terms of this ETAG, products shall “have such characteristics that the works in which they are to be incorporated, assembled, applied or installed, can, if properly designed and built, satisfy the Essential Requirements” (CPD, art. 2.1).

Hence, the products shall be suitable for use in construction works which (as a whole and in their separate parts) are fit for their intended use, account being taken of economy, and in order to satisfy the Essential Requirements. Such requirements, shall, subject to normal maintenance, be satisfied for an economically reasonable working life. The requirements generally concern actions which are foreseeable. (CPD Annex I, preamble).

**(f) Case by case provisions**

Not relevant.

**(g) Dangerous substances**

Not relevant.

#### **4. REQUIREMENTS FOR WORKS, AND THEIR RELATIONSHIP TO THE PRODUCT CHARACTERISTICS**

This chapter sets out the aspects of performance to be examined in order to satisfy the relevant Essential Requirements, by:

- expressing in more detail, within the scope of the ETAG, the relevant Essential Requirements of the CPD in the Interpretative Documents and in the mandate, for works or parts of the works, taking into account the actions to be considered, as well as the expected durability and serviceability of the works.
- applying them to the scope of the ETAG for products, and providing a list of relevant product characteristics and other applicable properties.

When a product characteristic or other applicable property is specific to one of the Essential Requirements, it is dealt with in the appropriate place. If, however, the characteristic or property is relevant to more than one Essential Requirement, it is addressed under the most relevant one with cross reference to the other(s). This is especially important where a manufacturer claims “No performance determined” for a characteristic or property under one Essential Requirement and it is critical for the assessing and judging under another Essential Requirement. Similarly, characteristics or properties which have a bearing on durability assessments shall be dealt with under ER 2 or ER 4, with reference under 4.7. Where there is a characteristic which only relates to durability, this is dealt with in 4.7.

4.0. General

**Table 4.1: The relevant Essential Requirements (excluding ER 2), the relevant paragraphs of corresponding IDs and related product performance to be assessed.**

Essential Requirement	Corresponding ID paragraph	Corresponding performances	Anchor performances and characteristics	Test method for verification of characteristic
ER 4 Safety in use	ID 4 2 impacts of falling objects, forming part of the works, upon users	Stability under predominantly static actions	Suitability under normal site conditions  requirements for an acceptable load/displacement behaviour, a certain ultimate load and limited scatter	Tests for suitability – installation safety under site conditions  – under repeated/sustained loads  – under different temperatures and humidity
			Admissible service conditions  – charact. resistance for tension/shear/combined tension and shear  – characteristic spacing; charact. edge distance  – minimum spacing and minimum edge distance  – displacement for serviceability limit state	Tests for admissible service conditions  – tension and shear loading not influenced by edge and spacing effects  – tension loading with characteristic edge distance  – with minimum spacing and minimum edge distance  – derived from tension/shear loading (see first dash)
Aspects of Durability			resistance against environmental conditions	Tests under different environmental conditions

#### **4.1. Mechanical resistance and stability (ER 1)**

Requirements with respect to the mechanical resistance and stability of non load bearing parts of the works are not included in this Essential Requirement but are under the Essential Requirement safety in use (see 4.4).

#### **4.2. Safety in case of fire (ER 2)**

The Essential Requirement laid down in the Council Directive 89/106/EEC is as follows:

The following aspects of performance are relevant to this Essential Requirement for the anchor.

##### **4.2.1. Reaction to fire**

The reaction to fire performance of the anchor shall be in accordance with laws, regulations and administrative provisions applicable to the anchor in its intended end use application. This performance shall be expressed in the form of a classification specified in accordance with the relevant EC decision.

##### **4.2.2. Resistance to fire**

The resistance to fire performance of the assembled system of which the anchor form part shall be in accordance with laws, regulations and administrative provisions applicable to the assembled system of which the anchor form part in its intended end use application. This performance shall be expressed in the form of a classification specified in accordance with the relevant EC decision and the appropriate CEN classification standards.

#### **4.3. Hygiene, health and the environment (ER 3)**

not relevant

#### **4.4. Safety in use (ER 4)**

##### **4.4.1. General**

Even though a plastic anchor is a product which is not intended for structural use, mechanical resistance and stability is still required.

Installed plastic anchors shall sustain the design loads in tension, shear and combined tension and shear to which they are subjected for the assumed working life while providing:

- (1) an adequate resistance to failure (ultimate limit state),
- (2) adequate resistance to displacements (serviceability limit state).

For plastic anchors the following aspects of performance are relevant for the Essential Requirement 4:

##### **4.4.2. Suitability**

###### **4.4.2.1. General**

The behaviour of plastic anchors, both in normal service conditions and in anticipated adverse conditions (see the following sub-clauses of suitability) shall in all important aspects be predictable.

###### **4.4.2.2. Types of installation**

Plastic anchors shall function correctly for the types of installation for which they are intended by the manufacturer.



#### 4.4.2.3. Correct installation

Correct installation of plastic anchors shall be easily achieved under normal site conditions with the equipment specified by the manufacturer, without resulting damage that can adversely affect their behaviour in service. Installation shall be practicable at normal ambient temperatures (within the range 0 °C to + 40 °C if other limit values are not explicitly prescribed).

It shall be possible to control and verify the correct installation of the anchor.

Except in cases where special tools are provided by the manufacturer, installation shall be reasonably easily achieved using the tools normally available on site.

#### 4.4.2.4. Functioning in cracks

The functioning of a plastic anchor, including its ability to sustain its design load with an appropriate safety factor and to limit displacements, shall not be adversely affected by concrete cracks.

#### 4.4.2.5. Moisture content

The functioning of a plastic anchor, including its ability to sustain its design load with an appropriate safety factor and to limit displacements, shall not be adversely affected by humidity of the polymeric sleeve.

#### 4.4.2.6. Temperature

The functioning of a plastic anchor, including its ability to sustain its design load with an appropriate safety factor and to limit displacements, shall not be adversely affected by temperatures in the base material near to the surface within a base material temperature range to be specified by the manufacturer which may be either:

**Range a):** min T to +40 °C  
(max **short** term temperature +40 °C and max **long** term temperature +24 °C)

**Range b):** min T to +80 °C  
(max **short** term temperature +80 °C and max **long** term temperature +50 °C)

**Range c):** on manufacturer's request with min T to T1  
(maximum short term temperature:  $T1 > +40$  °C in steps of 10 K, maximum long term temperature: 0,6 T1 to 1,0 T1 in steps of 5 K)

The lowest service temperature min T is specified by the manufacturer and has to be checked by corresponding pull-out tests described in 5.4.2.6b).

The performance shall not be adversely affected by short term temperatures within the service temperature range or by long term temperatures up to the maximum long term temperature.

Performance at the maximum **long** term temperature and maximum **short** term temperature is checked by tests described in 5.4.2.6 and 5.4.2.7.

Functioning shall also be validated for the range of installation temperatures to be specified by the manufacturer in terms of lowest and highest installation ambient temperatures, normally in the range 0 °C to +40 °C. Performance at minimum installation temperature is checked by tests as described in 5.4.2.6 c).

There is experience for polyamide for service temperatures down to -20 °C. Therefore the performance of plastic anchors made out of polyamide has to be checked by pull-out tests only at the lowest service temperature, if this lowest service temperature specified by the manufacturer is less than -20 °C.

#### 4.4.2.7. Sustained loading

Plastic anchors shall be capable of sustaining their design loads for the assumed working life of the fixture without significant increase in displacement which could render the anchorage ineffective.

#### 4.4.2.8. Relaxation

The functioning of a plastic anchor, including its ability to sustain its design load with an appropriate safety factor and to limit displacements, shall not be adversely affected by relaxation of the anchor.

#### 4.4.2.9. Installation torque moment

The installation torque moment of a plastic anchor shall not adversely affect the behaviour of the anchor.

#### **4.4.3. Admissible service conditions**

The service conditions considered in an assessment are, to some extent, subject of the choice of the assessment applicant. The extent of the assessment to verify that the requirements are met will depend on this choice.

##### **4.4.3.1. Level of loading**

Plastic anchors shall sustain a level of loading which ensures they can be used in practical application(s), consistent with their diameter and embedment depth. All plastic anchors are required to sustain tensile loads even, e.g. where the predominant form of loading is in shear.

##### **4.4.3.2. Displacement**

The displacement of plastic anchors, both in the short and long term, shall remain within the specified limits as a function of the intended use.

##### **4.4.3.3. Edge distance and anchor spacing**

In service, plastic anchors shall be able to be used at spacings (anchor to anchor, anchor to edge of member or to joints) compatible with normal structural applications.

#### **4.5. Protection against noise (ER 5)**

Not relevant

#### **4.6. Energy economy and heat retention (ER 6)**

Not relevant

#### **4.7. Aspects of durability, serviceability and identification**

The plastic anchor characteristics shall not change during the working life, therefore the mechanical properties on which the suitability and bearing behaviour of the plastic anchor depend shall not be adversely affected by ambient physico-chemical effects such as corrosion and degradation caused by environmental conditions (e.g. alkalinity, moisture, pollution) or by degradation of any coating of the expansion element due to the above mentioned effects.

### **5. METHODS OF VERIFICATION**

#### **5.0. General**

This chapter refers to the verification methods used to determine the various aspects of performance of the products in relation to the requirements for the works (calculations, tests, engineering knowledge, site experience, etc.) as set out in chapter 4.

#### **5.1. Mechanical resistance and stability**

Not relevant

## 5.2. Safety in case of fire

### 5.2.1. Reaction to fire

The metal parts of plastic anchors are assumed to satisfy the requirements for Class A1 of the characteristic reaction to fire, in accordance with the provisions of EC Decision 96/603/EC (as amended) [22] without the need for testing on the basis of its listing in that Decision.

The anchorages are used to fix a cladding or component which is not class A1 and the plastic parts of the anchor are located in the drilled hole of the base material (concrete or masonry) and fixture. Where the plastic parts of the anchor are embedded in concrete or masonry it may be assumed that these plastic parts do not make any contribution to fire growth or to the fully developed fire and they have no influence to the smoke hazard.

In the context of this end use application the plastic parts embedded in concrete/masonry can be considered to satisfy any reaction to fire requirements.

Where the plastic parts of the anchor are embedded in the cladding/component which is not class A 1 the plastic parts can be considered not to influence the reaction to fire class of the cladding/component.

### 5.2.2. Resistance to fire

The suitability of a plastic anchor for use in a system that is required to provide a specific fire resistance class shall be assessed according to the Technical Report N° 020 "Evaluation of anchorages in concrete concerning Resistance to Fire" **Fout! Verwijzingsbron niet gevonden..**

## 5.3. Hygiene, health and environment

Not relevant

## 5.4. Safety in use

### 5.4.1. General

The tests involved in the assessment of plastic anchors fall into 4 categories:

- (1) Tests for confirming their suitability
- (2) Tests for evaluating the admissible service conditions
- (3) Tests for checking durability
- (4) Tests for identification

Part 1 of this Guideline gives the general test conditions for testing the suitability of plastic anchors in concrete and masonry. The particular suitability tests and the number of tests are listed in Table 5.1 of the relevant subsequent Parts of this Guideline. Special additional suitability tests for the different base materials like hollow masonry are given in the relevant subsequent Parts. All suitability tests for plastic anchors in autoclaved aerated concrete are given in Part 5.

Tests for evaluating the admissible service conditions are given in the subsequent Parts for the different base materials.

The details of tests are given in Annex A.

Plastic anchors usually have only one anchorage depth ( $h_{nom}$ ). If the anchor has more than one possible anchorage depth, then tests will need to be done at each specified depth, unless the manufacturer chooses to test the most onerous depth, in which case the results will also apply to less onerous depths.

The tests for the assessment of the plastic anchors shall be performed in the base material for which the anchor is intended to be used according to the following Table 5.0.

**Table 5.0: Required tests for the intended use of plastic anchors**

Use category for the intended use			Required Tests for the intended use
normal weight concrete  (1)	solid masonry  (2)	hollow or perforated masonry  (2)	
<b>a</b>			tests according to Part 2, Table 5.1 and Table 5.2
	<b>b</b>		tests according to Part 3, Table 5.1 and Table 5.2
<b>a</b>	<b>b</b>		suitability tests according to Part 2, Table 5.1, the reduction factors may be used for the characteristic resistance in normal weight concrete and solid masonry. Admissible service condition tests according to Part 2, Table 5.2 and Part 3, Table 5.2.
<b>a</b>	<b>b</b>	<b>c</b>	suitability tests according to Part 2, Table 5.1, the reduction factors may be used for the characteristic resistance in normal weight concrete and masonry. Admissible service condition tests according to Part 2, Table 5.2 and Part 3, Table 5.2 and Part 4, Table 5.2 in hollow or perforated units for which it is intended to be used. For additional tests see Part 4.
	<b>b</b>	<b>c</b>	suitability tests according to Part 3, Table 5.1, the reduction factors may be used for the characteristic resistance in masonry. Admissible service condition tests according to Part 3, Table 5.2 and Part 4, Table 5.2 in hollow or perforated units for which it is intended to be used. For additional tests see Part 4.
		<b>c</b>	suitability tests according to Part 3, Table 5.1. Admissible service condition tests according to Part 4, Table 5.2, in hollow or perforated units for which it is intended to be used.
<b>d autoclaved aerated concrete</b>			tests according to Part 5

(1) C12/15 at least

(2) Masonry units of clay, calcium silicate, normal weight concrete and/or lightweight concrete

## 5.4.2. Tests for suitability

### 5.4.2.1. General

The purpose of the suitability tests is to establish whether a plastic anchor is capable of safe, effective behaviour in service including consideration of adverse conditions both during site installation and in service.

The suitability of plastic anchors for anchorage in concrete and masonry can be adequately assessed by the suitability tests given in Table 5.1 of the relevant subsequent Parts of this Guideline. The detailed test conditions are described in the following chapter.

If no other conditions are specified in the following sections or in the subsequent Parts of this Guideline, the tests shall be performed with anchor sleeves with a standard moisture content, installed in holes drilled with drill bits with  $d_{cut,m}$  at normal temperature ( $T = +21 \pm 3 \text{ }^\circ\text{C}$ ).

The loads to be applied during the tests according to 5.4.2.7 (sustained load tests) are valid for tests in normal strength concrete only. The loads to be applied during tests in other base materials are given in the corresponding Parts of this Guideline.

### 5.4.2.2. Types of installation

These tests are for nailed-in plastic anchors only. The tests shall be carried out according to Annex A, 5.2 at minimum installation temperature. After complete setting of the anchor, an additional hammer blow (using a hammer with a reasonable weight) shall be carried out on the anchor. Then a tensile test shall be performed at minimum installation temperature.

### 5.4.2.3. Influence of the diameter of the drill hole

For the drill hole the maximum diameter ( $d_{cut,max}$ ) and the minimum diameter ( $d_{cut,min}$ ) of drill bit according to Annex A, 3 is to be used. The tension tests shall be carried out according to Annex A, 5.2.

### 5.4.2.4. Functioning in cracks

Tests in cracks with a crack width of 0,35 mm shall be carried out.

### 5.4.2.5. Moisture content

The moisture content of the polymeric material may influence the plastic anchor behaviour. For the tests 3 different humidity levels are defined:

**standard:** equilibrium water content at  $T = +21 \pm 3 \text{ }^\circ\text{C}$  and  $50 \pm 3 \%$  relative humidity.

**dry:** equilibrium water content at  $T = +21 \pm 3 \text{ }^\circ\text{C}$  and  $\leq 10 \%$  relative humidity.

**wet:** equilibrium water content after storing under water (wet condition means water saturated)

For standard humidity the conditioning may be done according to ISO 1110 [16].

*The dry conditioning can be reached by drying the polymeric sleeve in an oven at  $+70 \text{ }^\circ\text{C}$  until the mass loss is smaller than 0,1 % in 3 consecutive measurements every 24 hours. The wet conditioning can be reached by placing the polymeric sleeve under water until the mass increase is smaller than 0,1 % in 3 consecutive measurements every 24 h.*

The tension tests shall be carried out according to Annex A.

#### 5.4.2.6. Temperature

##### a) Effect of increased temperature

The tests shall be carried out according to Annex A at the following temperatures for the different temperature ranges given in 4.4.2.6:

- **Temperature range a) with maximum short term temperature up to +40 °C:**  
Tests are performed with the maximum **short** term temperature at +40 °C. The maximum **long** term temperature at approximately +24 °C is checked by the tests with normal ambient temperature.
- **Temperature range b) with maximum short term temperature up to +80 °C:**  
Tests are performed with the maximum **short** term temperature at +80 °C and with the maximum **long** term temperature at +50 °C.
- **Temperature range c) on manufacturer's request:**  
Tests are performed with the maximum **short** term temperature and the maximum **long** term temperature as specified by the manufacturer according to 4.4.2.6 [range c)].

##### b) Effect of lowest service temperature min T

After installation of the plastic anchors at normal ambient temperature raise the test member temperature to the maximum long term temperature and keep the test member at this temperature for 4 days. After that cool the test member to the lowest service temperature min T according to the specification of the manufacturer and carry out tension tests according to Annex A.

Plastic anchors made out of polyamide have to be checked by pull-out tests only at the lowest service temperature, if this lowest service temperature specified by the manufacturer is less than -20 °C.

##### c) Effect of minimum installation temperature

The plastic anchor shall be installed at the lowest installation temperature (plastic anchor and base material) specified by the manufacturer. After that cool the test member to the required minimum service temperature and carry out tension tests according to Annex A.

#### 5.4.2.7. Sustained loading

The test is performed at normal temperature ( $T = +21 \pm 3$  °C) for temperature range a), b) and c) and at maximum **long** term temperature for temperature range b) and c) [ $T = +50 \pm 3$  °C for temperature range b)].

The plastic anchor shall be installed at normal temperature.

The plastic anchor is then subjected to a load according to equation (5.3) which is kept constant (variation within  $\pm 5$  %).

For the tests at the maximum **long** term temperature [temperature range b) and c)] the test specimens, the loading equipment, the displacement transducers and the installed plastic anchors shall be heated to the maximum long term temperature at least for 24 hours before loading the plastic anchors.

The tests will generally be carried out over at least 5000 hours for polymeric sleeves of PE, PP or other polymeric materials; however tests with at least 3000 hours are sufficient for polymeric sleeves of PA6 or PA6.6 based on current experience with this material.

$$N_p = 0,4 \cdot N_{Rk} \quad (5.3)$$

with:

$N_{Rk}$  = characteristic resistance of single anchor given in the ETA for the specific base material

After completion of the sustained load test the plastic anchor shall be unloaded and the displacement shall be measured. Immediately after unloading a tension test shall be performed.

#### **5.4.2.8. Relaxation**

The plastic anchors are installed in the test member and left there unloaded for 24 hours and up to 500 hours. After that tension tests shall be carried out according to Annex A.

This test is not required for screwed-in plastic anchors with polyamide PA 6 polymeric sleeve, if failure is predominantly caused by pulling out the sleeve and the screw together.

#### **5.4.2.9. Maximum torque moment**

The plastic anchor shall be installed with a screw driver. The torque moment shall be measured with a calibrated torque moment transducer. The torque moment shall be increased until failure of the plastic anchor.

The torque moment is measured as a function of time. From the gradient of this curve two torque moments can be determined, the one if the screw is fully attached to the anchor collar ( $T_{inst}$ ) and the maximum value ( $T_u$ ) that can be applied to the plastic anchor.

#### **5.4.3. Tests for admissible service conditions**

All tests for the determination of characteristic resistances to actions (tension, shear with or without lever arm), spacing and edge distance as well as the load-displacement behaviour are described in the relevant subsequent Parts of the Guideline for the different base materials.

The test procedures are described in Annex A.

If existing information is available from the manufacturer and the corresponding test report contains all relevant data, then the Approval Body may reduce the number of tests for admissible service conditions given in the subsequent Parts, making use of this existing information. However, it will be considered in the assessment only if the results are consistent with the Institute's test results or experience.

#### **5.5. Protection against noise**

Not relevant.

#### **5.6. Energy economy and heat retention**

Not relevant.

#### **5.7. Aspects of durability, serviceability and identification**

##### **5.7.1. Tests for checking durability of the metal parts (corrosion)**

No special tests are required, if the conditions given in 6.7.1 are complied with. If the anchor is to be used in particularly aggressive conditions such as permanent or alternate immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels, where de-icing materials are used) special considerations including testing may be necessary, taking into account the environmental conditions and the available experience.

##### **5.7.2. Durability of the coating**

The durability of the coating of the metal part that ensures the suitability and the bearing behaviour of the anchor shall be shown. Furthermore it shall be shown that the coating does not negatively affect the durability of the polymeric sleeve. No special test conditions can be given in this Guideline for checking the durability of any coating because they depend on the type of coating. Any appropriate tests shall be decided on by the responsible Approval Body. Zinc coatings (electroplated or hot dip galvanised) need not be subjected to testing if used under dry internal conditions.

### 5.7.3. Tests for checking durability of the polymeric sleeve

The durability of the polymeric sleeve shall be verified against the relevant chemical attack. Relevant chemical attack is considered e.g. high alkalinity (pH = 13,2). Furthermore it shall be verified that any coating of the steel parts do not negatively influence the durability of the polymeric sleeve.

The check for durability against high alkalinity may be done for example by the following tests.

*Test specimen:*

1. *Tension bars manufactured according to ISO 3167 [17]*
2. *Determination of the water content of the tension bars following ISO 3167 [17]. If the water content is higher than 0,1 percentage by weight, the slices have to be dried.*
3. *Drill holes (diameter 2,8 mm) with a special drill into the centre of the tension bars perpendicular to the flat side of the specimen followed by rubbing the hole with a reamer (diameter  $3,0 \pm 0,05$  mm).*
4. *Pressing a round pin (according to Table 5.2) quickly into tension bars.*
5. *Putting the tension bars into different agents (see table 5.2 for number of necessary tension bars).*
  - *Water (reference tests)*
  - *High alkalinity (pH = 13,2)*

*Tests in water (reference test):*

*The tension bars with pins are stored under standard climate conditions in a container filled with condensed water. All specimens shall be completely covered for 2000 hours.*

*Tests with high Alkalinity:*

*The tension bars with pins are stored under standard climate conditions ( $T = +21 \text{ °C} \pm 3 \text{ °C}$ ) in a container filled with an alkaline fluid (pH = 13,2). All slices shall be completely covered for 2000 hours. The alkaline fluid is produced by mixing water with  $\text{Ca(OH)}_2$  (calcium hydroxide) powder or tablets until the pH-value of 13,2 is reached. The alkalinity shall be kept as close as possible to pH 13,2 during the storage and not fall below a value of 13,0. Therefore the pH-value has to be checked and monitored at regular intervals (at least daily).*

6. *Visual analysis to observe cracks after storage with a microscope with a magnification  $\geq 100$ .*

*The tests have to be carried out for each colour of the plastic anchor.*

**Table 5.2: Necessary number of tests on tension bars with pins**

	<i>Diameter of pins [mm]</i>	<i>water</i>	<i>High alkalinity</i>
<i>reference-test</i>	3,0	5	-
<i>test</i>	3,5	-	5

For PP, PE or other polymeric materials (compare 2.1.2.2.) equal or equivalent tests have to be performed.

### 5.7.4. Influence of UV-exposure

No tests are required. In general the plastic anchors are not exposed to UV-radiation for an extended period of time during the use as they are covered by the fixture.



## 6. ASSESSING AND JUDGING THE FITNESS FOR USE

### 6.0. General

This chapter details the performance requirements to be met (chapter 4) in precise and measurable (as far as possible and proportional to the importance of the risk) or qualitative terms, related to the product and its intended use, using the outcome of the verification methods (chapter 5).

### 6.1. Mechanical resistance and stability

Not relevant.

### 6.2. Safety in case of fire

#### 6.2.1. Reaction to fire

The metal parts of plastic anchors can be classified to class A1 in accordance with the provisions of EC Decision 96/603/EC (as amended).

In the context of the end use application of the anchorages the plastic material of the anchor embedded in concrete/masonry can be considered to satisfy any reaction to fire requirements. Where the plastic parts of the anchor are embedded in the cladding/component which is not class A1 the plastic parts can be considered not to influence the reaction to fire class of the cladding/component.

#### 6.2.2. Resistance to fire

The suitability of a plastic anchor for use in a system that is required to provide a specific fire resistance class, shall be assessed according to the Technical Report N° 020 "Evaluation of anchorages in concrete concerning Resistance to Fire" [24].

### 6.3. Hygiene, health and environment

Not relevant.

### 6.4. Safety in use

#### 6.4.1. General

##### 6.4.1.1. 5 %-fractile of the ultimate loads

The 5 %-fractile of the ultimate loads measured in a test series is to be calculated according to statistical procedures for a confidence level of 90 %. If a precise verification does not take place, in general, a normal distribution and an unknown standard deviation of the population shall be assumed.

$$F_{5\%} = F \cdot (1 - k_s \cdot v) \quad (6.0)$$

e.g.:

$$n = 5 \text{ tests:} \quad k_s = 3,40$$

$$n = 10 \text{ tests:} \quad k_s = 2,57$$

### 6.4.1.2. Conversion of ultimate loads to take account of concrete-, masonry- and steel strength

In case of pull out failure the influence of the concrete strength greater than C16/20 is not taken into account in the evaluation of the tests.

For concrete strength C12/15 Equation (6.0a) is valid.

$$F_{Ru(C12/15)} = 0,7 \cdot F_{Ru(C20/25)} \quad (6.0a)$$

The conversion to take account of masonry strength or autoclaved aerated concrete strength is given in the relevant subsequent Parts.

In case of concrete failure (concrete cone or splitting failure) Equation (6.0b) shall be used.

$$F_{Ru(f_c)} = F_{Ru}^t \cdot (f_c / f_{c,test})^{0.5} \quad (6.0b)$$

In case of steel failure the failure load shall be converted to the nominal steel strength by Equation (6.0c)

$$F_{Ru(f_{uk})} = F_{Ru}^t \cdot \frac{f_{uk}}{f_{u,test}} \quad (6.0c)$$

with:

$$F_{Ru(f_{uk})} = \text{failure load at nominal steel ultimate strength}$$

### 6.4.1.3. Criteria for all tests

In all tests the following criteria shall be met:

- (1) The load-displacement curves shall show a steady increase (see Figure 6.1). A reduction in load and/or a horizontal or near-horizontal part in the curve caused by uncontrolled slip of the anchor is not acceptable up to a load of:

$$N_1 = 0,4 \cdot N_{Ru} \quad (6.1)$$

with:

$$N_{Ru} = \text{maximum load in the single test.}$$

If the requirements on the load-displacement behaviour are not fulfilled by the tension tests according to 5.4.2 and/or 5.4.3, then the factor  $\alpha_1$  shall be calculated.

$$\alpha_1 = \frac{\alpha}{\text{req.}\alpha} \quad (6.2)$$

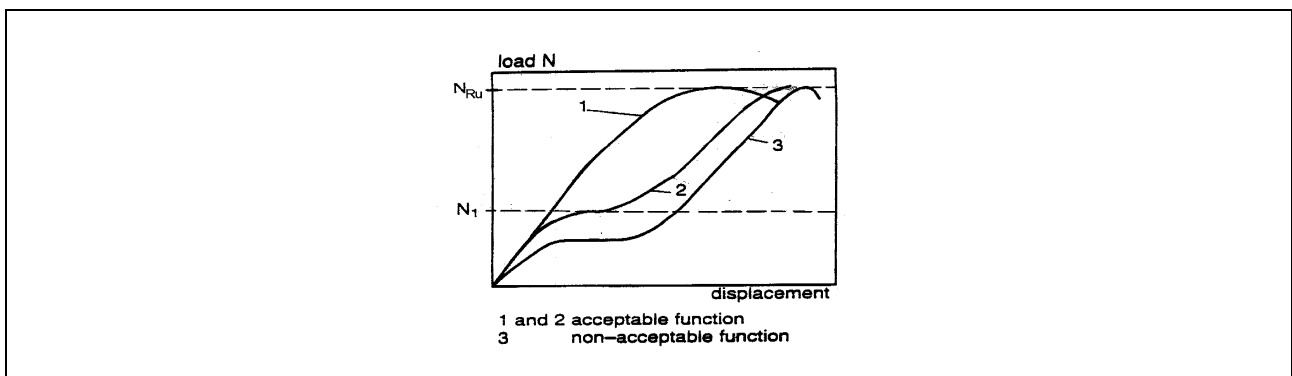
with:

$$\alpha = \text{lowest ratio } N_1/N_u \text{ in the test series}$$

$$N_1 = \text{load at which uncontrolled slip of the anchor occurs (see Figure 6.1)}$$

$$N_u = \text{failure load in that test}$$

$$\text{req.}\alpha = 0,4$$



**Figure 6.1:** Requirements for the load-displacement curve

- (2) In each test series, the coefficient of variation of the ultimate load shall be smaller than  $v = 20\%$ .

## 6.4.2. Criteria valid for suitability tests

### 6.4.2.1. General

Approval for a plastic anchor can only be obtained if the criteria for the suitability tests are met by all test results. Additional to the criteria described in 6.4.1.3 the following criteria shall be considered.

The conditions for the displacement behaviour during the sustained load tests (Section 6.4.2.7) are valid for tests in normal weight concrete. For tests in other base materials these conditions are given in the corresponding Parts of this Guideline.

In the suitability tests the factor  $\alpha$  shall be larger than the value given in Table 5.1 of the subsequent Parts:

$$\alpha = \text{lesser value of } \frac{N_{Ru,m}^t}{N_{Ru,m}^r} \quad (6.4a)$$

$$\text{and } \frac{N_{Rk}^t}{N_{Rk}^r} \quad (6.4b)$$

with:

$$N_{Ru,m}^t ; N_{Rk}^t = \text{mean value or 5 \% -fractile, respectively, of the ultimate loads in a test series}$$

$$N_{Ru,m}^r ; N_{Rk}^r = \text{mean value or 5 \% -fractile, respectively, of failure loads in the reference tests [e.g. tests for admissible service conditions according to Table 5.2, line 1 (suitability tests in non-cracked concrete) or line 2 (suitability tests in cracked concrete)].}$$

Equation (6.4b) is based on test series with a comparable number of test results in both series. If the number of tests in the two series is very different, then Equation (6.4b) may be omitted when the coefficient of variation of the test series is smaller than or equal to the coefficient of variation of the reference test series or if the coefficient of variation in the suitability tests is  $v \leq 15 \%$ .

If the criterion for the required value of  $\alpha$  (see Tables 5.1) is not met in a test series, then the factor  $\alpha_2$  shall be calculated. Exceptions see Section 6.4.2.6 b, 6.4.2.6 c and 6.4.2.7.

$$\alpha_2 = \frac{\alpha}{\text{req.}\alpha} \quad (6.5)$$

with:

$$\alpha = \text{lowest value according to Equation (6.4) in the test series}$$

$$\text{req.}\alpha = \text{required value of } \alpha \text{ according to Tables 5.1}$$

### 6.4.2.2. Types of installation

These tests are for nailed-in anchors only. The required  $\alpha$  in the tests is  $\geq 0,90$ . If the requirements concerning  $\alpha$  are not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

### 6.4.2.3. Influence of the diameter of drill hole

The required  $\alpha$  in the tests is  $\geq 0,80$  for tests with  $d_{\text{cut,max}}$  and 1,0 for tests with  $d_{\text{cut,min}}$ . If the requirements concerning  $\alpha$  are not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

### 6.4.2.4. Functioning in cracks

The required  $\alpha$  in the tests is  $\geq 0,75$ . If the requirements concerning  $\alpha$  are not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

### 6.4.2.5. Moisture content

The required  $\alpha$  in the tests with dry and wet conditioning of the plastic sleeve is  $\geq 0,80$ . If the requirements concerning  $\alpha$  are not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

#### 6.4.2.6. Temperature

##### a) Effect of increased temperature

The required  $\alpha$  for the tests at maximum **long** term temperature is:

- req.  $\alpha \geq 1,0$  for temperature ranges b) ( $T = +50$  °C) and c) (0,6T1 to 1,0T1, chosen by the manufacturer)

The required  $\alpha$  for the tests at maximum **short** term temperature are:

- req.  $\alpha \geq 0,80$  for +40 °C [temperature range a)]
- req.  $\alpha \geq 0,80$  for +80 °C [temperature range b)]
- req.  $\alpha \geq 0,80$  for +T1 [temperature range c) chosen by the manufacturer]

If the requirements concerning  $\alpha$  are not fulfilled in the tests at the maximum long term or maximum short term temperature,  $\alpha_2$  shall be calculated according to Equation (6.5).

##### b) Effect of lowest service temperature, min T

The required  $\alpha$  for the tests at lowest service temperature is 1,0.

If this condition is not fulfilled, then the lowest service temperature shall be increased to the next step and the tests at minimum installation temperature shall be repeated until the condition is fulfilled.

##### c) Effect of minimum installation temperature

The required  $\alpha$  for the tests at the minimum installation temperature is 1,0.

If this condition is not fulfilled, then the minimum installation temperature shall be increased and the tests at minimum installation temperature shall be repeated until the condition is fulfilled.

#### 6.4.2.7. Sustained load tests

The displacements measured in the tests have to be extrapolated according to Equation (6.6) (Findley approach) to 50 years (tests at normal ambient temperature), or 10 years (tests at maximum long term temperature).

The curve fitting shall start with the displacement measured after approximately 100 h.

$$s(t) = s_0 + a \cdot t^b \quad (6.6)$$

$s_0$  = initial displacement under the sustained load at  $t = 0$  (measured directly after applying the sustained load)

$a, b$  = constants (tuning factors), evaluated by a regression analysis of the deformations measured during the sustained load tests

The extrapolated displacements shall be less than the mean value of the displacements at the load at overcoming the friction resistance in the reference tests according to 5.4.3 in non-cracked concrete. The load at overcoming the friction resistance may be evaluated as described in ETAG 001, Part 5, Section 6.1.1.1 (a) [23] for the load at loss of adhesion.

If this condition is not fulfilled, the tests have to be repeated with a lower load  $N_p$  until the requirement is fulfilled and the characteristic resistance calculated according to the following Parts shall be reduced by the factor  $N_p$  (applied) /  $N_p$  (required).

As required according to Table 5.0 for the intended use category the failure loads measured in the pullout tests subsequent to the sustained loading at normal temperature [Table 5.1, line 6 in Part 2, 3 and 5] shall be compared with the failure loads measured in the reference tension tests according to 5.4.3 in the equivalent base material [Table 5.2, line 1 in Part 2, 3 and 5].

The failure loads measured in the pullout tests subsequent to the sustained loading at maximum long term temperature [Table 5.1, line 6 in Part 2, 3 and 5] shall be compared with the failure loads measured in the temperature tests at maximum long term temperature [Table 5.1, line 5 in Part 2, Part 3 (exception see Part 3, 6.4.2) and Part 5 (exception see Part 5, 6.4.2)].

The values shall be calculated according to 6.4.2.1. The required  $\alpha$  is 0,9. If this condition is not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

#### 6.4.2.8. Relaxation

The required  $\alpha$  in the tests after 24 h is  $\geq 0,90$  and for tests after up to 500 h is  $\geq 1,0$ .

If the requirements concerning  $\alpha$  are not fulfilled,  $\alpha_2$  shall be calculated according to Equation (6.5).

#### 6.4.2.9. Maximum torque moment

The installation of the plastic anchor shall be practicable without steel failure or turn-through in the hole. This condition may be assumed to be fulfilled if the following conditions are met.

The ratio  $\xi$  of the maximum torque moment  $T_u$  to the installation moment  $T_{inst}$  shall be determined for each test:

$$\xi_i = T_{u,i} / T_{inst,i} \quad (6.7)$$

The 5 %-fractile of the ratio for all tests shall be at least 1,3.

If this requirement is not met, the tension tests according to Section 5.4.2 have to be carried out with anchors which are installed with  $1,3 \cdot T_{inst}$ .

#### 6.4.3. Admissible service conditions

The assessment of the tests for admissible service conditions and the determination of the characteristic resistance are described in the relevant subsequent Parts of the Guideline for the different base materials.

#### 6.5. Protection against noise

Not relevant.

#### 6.6. Energy economy and heat retention

Not relevant.

#### 6.7. Aspects of durability, serviceability and identification

##### 6.7.1. Durability of the metal parts

The assessment/testing required with respect to corrosion resistance will depend on the specification of the plastic anchor in relation to its use. Supporting evidence that corrosion will not occur is not required if the steel parts of the plastic anchor are protected against corrosion, as set out below:

Plastic anchors intended for use in structures subject to dry, internal conditions:

In general, no special corrosion protection is necessary for steel parts as coatings provided for preventing corrosion during storage prior to use and for ensuring proper functioning (e.g. a zinc coating with a minimum thickness of 5 microns) is considered sufficient.

Plastic anchors for use in structures subject to external atmospheric exposure or exposure in permanently damp internal conditions:

In general the metal parts of the anchors shall be made of an appropriate grade of stainless steel. The grade of stainless steel suitable for the various service environments (marine, industrial, etc.) shall be in accordance with existing rules. Grade A4 of ISO 3506 [11] or equivalent may be used under internal and external or other environmental conditions if no particularly aggressive conditions exist.

Where a form of protection (material or coating) other than those mentioned above is specified, it will be necessary to provide evidence in support of its effectiveness in the defined service conditions; with due regard to the aggressiveness of the conditions concerned.

If an anchor involves the use of different metals, these shall be electrolytically compatible with each other. In dry internal conditions, carbon steel is compatible with malleable cast iron according to ISO 5922 [12].

Assessment of the durability of the coating is based on the type of coating and the intended conditions of use (i.e. dry internal or external conditions).

### 6.7.2. Durability of the polymeric sleeve

The assessment/testing required with respect to high alkalinity (pH = 13,2) shall be presented and it will depend on the specification of the plastic anchor in relation to its use.

The durability with respect to high alkalinity is proven, if for all specimen tested according to 5.7.3 no cracks are visible with a microscope using a magnification of at least 100.

### 6.7.3. Influence of UV-exposure

The manufacturer shall ensure that the packaging of the plastic anchors protects the anchors against UV-radiation during the storage.

### 6.7.4. Identification

#### 6.7.4.1. General

Characteristics as specified in the manufacturer's specification for production control and as required above are to be checked using ISO, European or recognised standard test methods as nominated by the manufacturer and accepted by the Approval Body.

Wherever possible, checks shall be carried out on finished components. Where dimensions or other factors prevent testing to a recognised standard, e.g. tensile properties where the required ratio of length to diameter does not exist in the finished component, then the tests shall still be carried out on the finished component if practicable, in order to produce results for comparison purposes. Where this is not possible, tests shall be carried out on the raw material; however, it shall be noted that where the production process changes the characteristics of the material, then a change to the production process can render the results of these tests invalid.

Deviations of samples from the specification on the manufacturer's drawings shall be identified and appropriate action taken to ensure compliance before testing plastic anchors.

A minimum number of each component of the plastic anchors and special drill bits and setting tools, if appropriate, depending on factors such as the production process and the bag size, is to be taken and dimensions measured and checked against the drawings provided by the manufacturer. The tolerances specified for all components shall be complied with and the dimensions shall conform to the appropriate ISO or European standards where relevant.

The results obtained shall be assessed to ensure that they are within the manufacturer's specification.

#### 6.7.4.2. Identification of the polymeric parts

The product shall be clearly identified. Where possible, reference to European standards shall be made. The chemical constitution and composition of the materials shall be submitted by the applicant to the Approval Body which shall observe strict rules of confidentiality. Under no circumstances shall such information be disclosed to any other party.

This composition shall be checked by the Approval Body on the basis of the declaration made by the applicant, and it shall be documented by fingerprint (IR-spectrum).

The following characteristics for virgin material (see 2.1.2.2) shall be specified, where relevant, in accordance with ISO, European or national standards, together with any others, as necessary:

DSC curve:	differential scanning calorimetry ISO 11357 [18]
MFR value:	melt mass-flow rate ISO 1133 [19]
MVR value:	melt volume-flow rate ISO 1133 [19]

If not all details of the chemical constitution and the composition of the material will be submitted by the applicant to the Approval Body, then additional identification methods are required:

- Manufacturing process parameters (e.g. temperature, pressure, time, product/production codes)
- Testing of physical characteristics-data (depending on the polymeric material, e. g. nominal physical properties, absorption of humidity, stress-strain behaviour, toughness and notch sensitivity, shear modulus, dynamic stability, creep rupture, action on chemical agents).

The factory production control should consider the extent of the submitted detail of the chemical constitution and the composition of the material.

## **7. ASSUMPTIONS AND RECOMMENDATIONS UNDER WHICH THE FITNESS FOR USE OF THE PRODUCTS IS ASSESSED**

### **7.0. General**

This chapter sets out the assumptions and recommendations for design, installation and execution, packaging, transport and storage, use, maintenance and repair under which the assessment of the fitness for use according to the ETAG can be made (only when necessary and in so far as they have a bearing on the assessment or on the products).

For the assessment of the behaviour of the plastic anchor in other base materials than those defined in the ETA, tests on the construction site are to be carried out according to Annex B or national requirements.

### **7.1. Design methods for anchorages**

The assessment of the anchor shall be made assuming that the design method given in Annex C is used. However, if an alternative design method should be proposed the Approval Body shall judge this design method and the relevance of the assessment, in particular the relevance of the tests to be undertaken.

The overall assumption shall be made that the design and dimensioning of anchorages is based on technical considerations and in particular the following:

- the design of the fixture is such that in the case of excessive slip or failure of one anchor the load can be transmitted to neighbouring anchors without significantly violating the requirements on the fixture in the serviceability and ultimate limit state. Therefore the design of the fixture shall 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 be taken into account in the design of the fixture.
- the preparation of verifiable calculation notes and drawings for determining the relevant concrete or masonry in the region of the anchorage, the loads to be transmitted and their transmission to the supports of the structure.
- consideration not only of direct loads but also the important additional loads caused by restraint of intrinsic (e.g. shrinkage) or extrinsic deformation (e.g. by temperature variations) in the anchor, in the fixture or in the base material together with verification of the distribution of loads in these structures and assemblies.

### **7.2. Packaging, transport and storage**

#### Storage conditions

The storage conditions shall be clearly stated, including any temperature limits.

#### Temperature requirements for installation

#### Temperatures for service conditions

The manufacturer shall state the range of temperatures for which the quoted characteristic load is valid.

Any time limitations on exposure to high or low temperatures shall be clearly stated.

### **7.3. Installation of anchors**

Anchor installation should be carried out by trained personnel and under the supervision of the person responsible for technical matters of the site.

The loading capacity and reliability of anchorages are greatly affected by the manner in which the anchors are installed. It is therefore necessary to provide information and appropriate specifications for correct installation of the anchors on site.

Anchors shall be used only as supplied by the manufacturer. It is not permissible to exchange the components on which the suitability and loading capacity of the anchors depend.

Anchors shall be installed in accordance with the technical approval, the manufacturer's specifications and the drawings prepared for that purpose using the appropriate tools. It is important, in ensuring correct installation, that the engineer responsible transmits all the necessary information to the installer. It is necessary to use the appropriate tools with the corresponding anchor type. Before placing an anchor, checks should be made to ensure that the strength class of the base material in which the anchor is to be placed is not lower than that of the base material to which the characteristic loads apply.

Holes are to be drilled perpendicular to the surface unless specifically required otherwise by the manufacturer's specifications. Normally hard metal hammer-drill bits in accordance with ISO or current national standards shall be used. Many drill bits exhibit marks indicating that these requirements have been met. If the drill bits do not bear a conformity mark, proof of suitability shall be provided.

All special drill bits (e.g. stopdrills or diamond core drill bits) required in accordance with manufacturer's installation instructions have to be in compliance with the manufacturer's specifications. This has to be confirmed by the factory production control for the drill bits.

The use of unsuitable drill bits may involve a considerable reduction in the loads that the anchorage can transmit.

Holes are to be cleared of drilling dust.

Anchors are to be installed ensuring not less than the specified embedment depth. The edge distance and spacing are to be kept to the specified values; no minus tolerances are to be allowed.

When drilling holes in concrete, care is to be taken not to damage reinforcement in close proximity to the hole position.

Action is to be taken in the event that drilling is aborted, e.g. by encountering reinforcement. For example, it may be recommended to either install the same anchors (if possible) or a longer anchor (if necessary) immediately beside the aborted drill hole, provided that anchoring depth is increased by the depth of the aborted drill hole, or make a new drilling at a minimum distance away of twice the depth of the aborted hole. Alternatively, a smaller distance may be chosen, provided the aborted drill hole is filled with high strength mortar.

Additionally, anchors shall not be installed in prestressed elements without taking account of the risk of the structural damage that may occur, due to their installation, particularly in zones where prestressing forces are applied.

In the absence of national regulations, it is recommended that the distance between the side of the drill hole and the outside of prestressed reinforcement is at least 50 mm; for determining the position of the prestressed reinforcement in the structure, a suitable device (e.g. reinforcement detector) shall be used.

When installed, anchors shall function correctly.

Where it is likely that anchors will be subjected to temperatures below 0 °C, measures shall be taken to avoid the ingress of water into the hole and subsequent risk of local cracking of the concrete due to ice pressure.

Control methods on site after installation will in general not be necessary due to the fact that any suitability tests have taken account of minor inaccuracies during installation. Moreover, gross errors are not covered by this Guideline and shall be avoided by proper training of the installers and supervision on site.



## **Section three:**

# **ATTESTATION OF CONFORMITY (AC)**

---

### **8. ATTESTATION OF CONFORMITY**

#### **8.1. EC decision**

The system of attestation of conformity specified by the European Commission Decision 97/463(EC), is system **2+** described in Council Directive (89/106/EEC) Annex III, 2(ii) [1], first possibility and is detailed as follows:

- (a) tasks for the manufacturer
  - (1) initial type-testing of the product; (see 8.2.1)
  - (2) factory production control; (see 8.2.2)
  - (3) testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan. This testing is covered by normal FPC testing.
- (b) tasks for the approved body
  - (4) certification of factory production control on the basis of:
    - initial inspection of factory and of factory production control; (see 8.2.3)
    - continuous surveillance, assessment and approval of factory production control. (see 8.2.3)

#### **8.2. Responsibilities**

##### **8.2.1. Initial type-testing**

Initial type-testing will be available as part of the work required for the assessment of products for ETA.

The tests will have been conducted by the Approval Body or under its responsibility (which may include a proportion conducted by an approved laboratory or by the manufacturer) in accordance with chapter 5 of this ETAG. The Approval Body will have assessed the results of these tests in accordance with chapter 6 of this ETAG, as part of the ETA issuing procedure.

Where appropriate this assessment shall be used by the approved body for certification of factory production control purposes.

##### **8.2.2. Factory production control (FPC)**

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures. This production control system shall ensure that the product is in conformity with the ETA.

##### **8.2.3. Initial inspection and continuous surveillance, assessment of the factory production control system**

Assessment of the factory production control system is the responsibility of the approved body.

An assessment shall be carried out on each production unit to demonstrate that the FPC is in conformity with the ETA and the technical documentation of the relevant ETA. This assessment shall be based on an initial inspection of the factory.

Subsequently continuous surveillance of FPC is necessary to ensure continuing conformity with the ETA.

It is recommended that surveillance inspections be conducted at least twice per year. However, for factories which are the subject of a certified quality assurance system assessed by a body notified under the CPD for these products or working under sub-contract to the approved body, surveillance visits may be carried at less frequent intervals.

### 8.3. Documentation

In order to help the approved body make an evaluation of conformity the Approval Body issuing the ETA shall supply the information detailed below. This information together with the requirements given in EC Guidance Paper B Construct 95/135 Rev 1, will generally form the basis on which the FPC is assessed by the approved body.

- (1) the ETA
- (2) basic manufacturing processes
- (3) product and materials specifications
- (4) test plan
- (5) other relevant information

This information shall initially be prepared or collected by the Approval Body and where appropriate shall be agreed with the manufacturer. The following gives guidance on the type of information required:

- (1) The ETA  
See chapter 9 of this ETAG.  
Any additional (possibly confidential) information shall be declared in the ETA.
- (2) Basic manufacturing processes  
The basic manufacturing process shall be described in sufficient detail to support the proposed FPC methods.  
Anchors are normally manufactured using conventional manufacturing techniques. Any critical process or treatment of the parts which affects performance shall be highlighted.
- (3) Product and materials specification  
Product and materials specifications will be required for the various components and any bought-in components e.g. nuts, washers.  
These specifications can take the form of:  
detailed drawings (including manufacturing tolerances)  
raw materials specifications  
references to European standards and grades (International standards may be used if an EN does not exist, and national standards may only be used if they are accepted in the country of use of the anchor)  
manufacturers data sheets e.g. for raw materials not covered by a recognised standard e.g. friction control coating.
- (4) Test plan  
The manufacturer and the Approval Body issuing the ETA shall agree on a test plan (CPD [1] Annex III 1b).  
This test plan is necessary to ensure that the product specification remains unchanged.  
The validity of the type and frequency of checks/tests conducted during production and on the final product shall be considered as a function of the production process. This will include the checks conducted during manufacture on properties that cannot be inspected at a later stage and for checks on the final product. These will normally include:
  - material properties e.g. tensile strength, hardness, surface finish
  - determination of the dimensions of component parts
  - coating thickness
  - checking correct assembly.Where bought-in components/materials are supplied without certificates of relevant properties they shall be subject to checks/tests by the manufacturer before acceptance.

#### 8.4. CE marking and information

Every plastic anchor shall be clearly identifiable before installation and shall be marked by:

- the name or identifying mark of the producer
- the plastic anchors identity (commercial name)
- the minimum anchorage depth or the maximum admissible thickness of the fixture

The packaging or the delivery tickets associated with the product shall contain the CE conformity marking. The "CE"-marking shall be accompanied by the following information:

1. identification number of FPC certification body;
2. name or identifying mark of the producer and manufacturing plant;
3. the last two digits of the year in which the marking was affixed;
4. number of the European Technical Approval;
5. number of the relevant Part of the ETAG Plastic Anchor for use in concrete and masonry;
6. size of the plastic anchor;
7. use category a, b, c and/or d

All installation data and the allowable base material shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

- allowable base material for the intended use
- drill bit diameter ( $d_{cut}$ )
- overall anchor embedment depth in the base material ( $h_{nom}$ )
- minimum hole depth ( $h_o$ )
- information on the installation procedure, including the minimum installation temperature and cleaning of the hole, preferably by means of an illustration
- allowable temperature range according to 4.4.2.6 a), b) or c)
- reference to any special installation equipment needed
- identification of the manufacturing batch

All data shall be presented in a clear and explicit form.

.

## Section four:

# ETA CONTENT

---

## 9. THE ETA CONTENT

### 9.1. The ETA-content

#### 9.1.1. Model ETA

The format of the ETA shall be based on the Commission Decision of 1997-07-22, EC Official Journal L236 of 1997-08-27.

#### 9.1.2. Checklist for the issuing body

The technical part of the ETA shall contain information on the following items, in the order and with reference to the relevant Essential Requirement. For each of the listed items (9.1.3. to 9.1.5.), the ETA shall either give the mentioned indication/statement/description or state that the verification/assessment of this item has not been carried out and therefore that the NPD option is used. The items given here are with reference to the relevant clause of this Guideline:

#### 9.1.3. Definition of the anchor and its intended use

- Definition
- Intended use
- Multiple use

#### 9.1.4. Characteristics of the anchor with regard to safety in use and methods of verification

- characteristic values to be used for the calculation of the ultimate limit state
- characteristic values of displacement for serviceability limit state
- Definition of the base material which was used in the tests (type of material, strength, density, type of aggregate, hole dimension and location of the masonry unit). The base material on construction works for which the plastic anchor is intended to be used shall have at least the required material properties. This means that the base material on site shall be such that the performance of the anchor is not worse than that declared by the manufacturer (but could be better).
- minimum allowable edge distance and minimum allowable spacing

In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

The ETA is issued for the product/kit on the basis of agreed data/information, deposited with the Approval Body which identifies the product that has been assessed and judged. Changes to the product/production process, which could result in this deposited data/information being incorrect, shall be notified to the Approval Body before the changes are introduced. The Approval Body will decide whether or not such changes affect the ETA and consequently the validity of the CE marking on the basis of the ETA and if so whether further assessment/alterations to the ETA, shall be necessary.

#### 9.1.5. Assumptions under which the fitness of the anchor for the intended use was favourably assessed

- Design methods for anchorages
- Transport and storage
- Installation of anchors