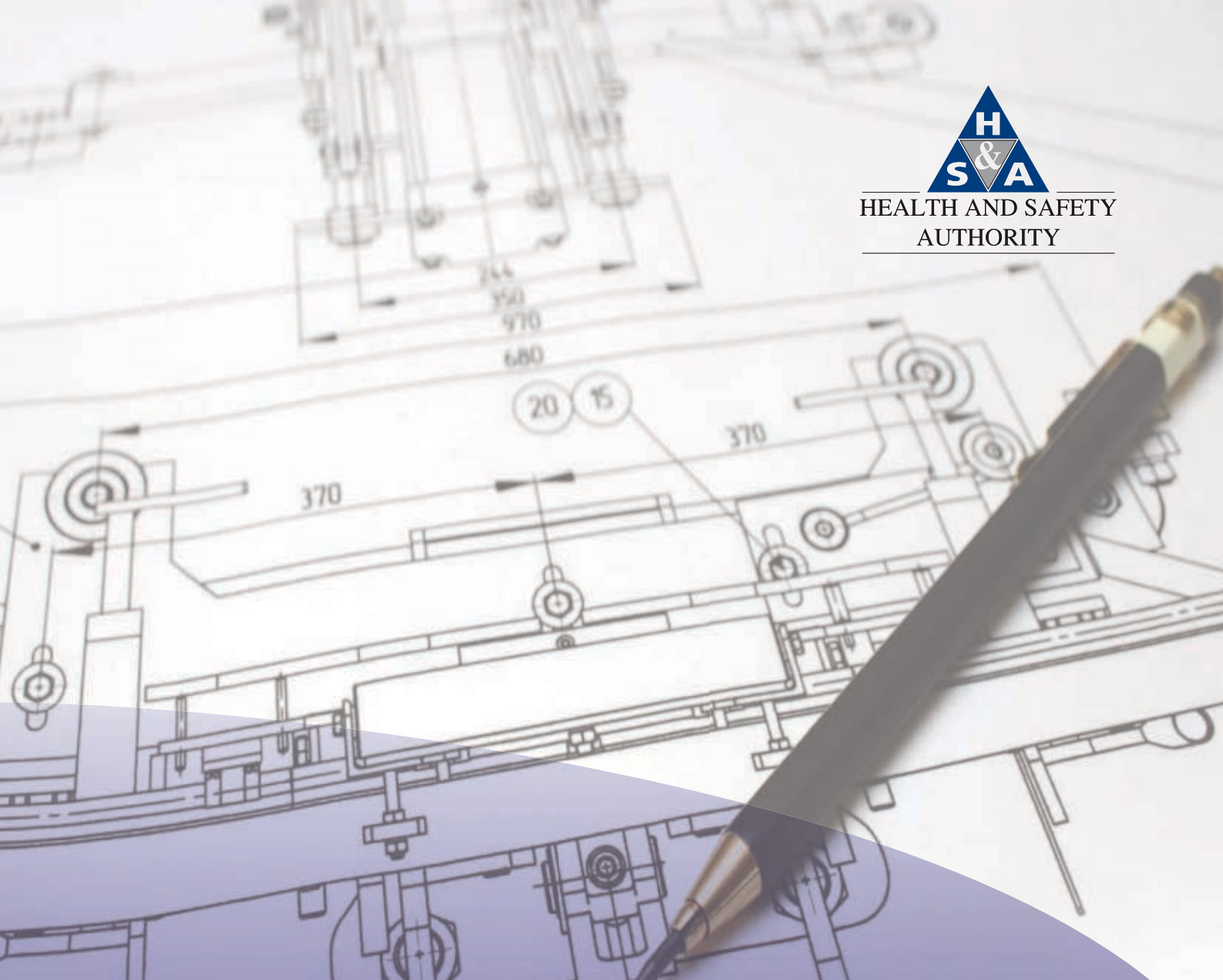




HEALTH AND SAFETY  
AUTHORITY



# Code of Practice for the Design and Installation of Anchors



# CONTENTS

1	FOREWORD .....	1
2	STATUS AND SCOPE OF THIS CODE OF PRACTICE.....	3
3	INTRODUCTION .....	9
4	DEFINITIONS.....	13
5	BACKGROUND TO THE CONSTRUCTION PRODUCTS DIRECTIVE .....	19
6	TYPES OF ANCHORS COVERED BY THIS CODE OF PRACTICE .....	23
7	ROLES AND RESPONSIBILITIES .....	29
8	DESIGN AND SPECIFICATION OF ANCHORS .....	35
9	INFORMATION SUPPLIED BY ANCHOR MANUFACTURER/SUPPLIER.....	56
10	INSTALLATION OF ANCHORS IN CONCRETE.....	60
11	SUPERVISION AND INSPECTION OF ANCHORS .....	63
12	TESTING OF ANCHORS .....	66
13	CERTIFICATION OF DESIGN AND INSTALLATION.....	68
14	CHANGE MANAGEMENT — ALTERNATIVE ANCHORS.....	69
<b>APPENDIX A:</b>		
RECOMMENDED FORMS FOR THE DESIGN AND INSTALLATION OF ANCHORS..		71
<b>APPENDIX B:</b>		
EXAMPLE OF EUROPEAN TECHNICAL APPROVAL DOCUMENT (ETA) .....		78
<b>APPENDIX C:</b>		
INFORMATION SOURCES .....		92



# 1 FOREWORD

The Health and Safety Authority, with the consent of Mr Pat Breen TD, Minister for Employment and Small Business, publishes this amended code of practice entitled *Code of Practice for the Design and Installation of Anchors*, in accordance with section 60 of the Safety, Health and Welfare at Work Act 2005.

The aim of this code of practice is to provide practical guidance to designers, specifiers and installers of metal anchors on the requirements and prohibitions set out in the relevant statutory provisions.

In particular, but not exclusively, this code of practice provides practical guidance as to the observance of the provisions of:

1. Chapter 1 of Part 2 (sections 8 to 12 in relation to the general duties of employers) and Chapter 2 of Part 2 (sections 13 to 15 in relation to the general duties of employees etc.) of the Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005).
2. Part 2 (Regulations 6 to 23 in relation to design and management), Part 3 (Regulations 24 to 29 in relation to the general duties of contractors and others) and Part 4 (Regulation 30 in relation to site safety and access to construction sites, Regulation 35 in relation to protection from falling material and protective safety helmets, Regulation 40 in relation to lighting of workplaces, Regulation 42 in relation to projecting nails and loose material, Regulation 43 in relation to construction of temporary structures and Regulation 44 in relation to avoidance of danger from collapse of structure) of the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013).
3. Chapter 2 of Part 2 (Regulations 27 to 61 in relation to the use of work equipment), Chapter 3 of Part 2 (Regulations 62 to 67 in relation to personal protective equipment), Part 3 (Regulations 74 to 93 in relation to electricity) and Part 4 (Regulations 94 to 119 in relation to work at height) of the Safety, Health and Welfare at Work (General Application) Regulations 2007 to 2016

This code of practice comes into operation on Monday 1st May 2017. Notice of publication of this code of practice was published in the *Iris Oifigiúil* of Tuesday 11th April 2017.

As regards the use of codes of practice in criminal proceedings, section 61 of the 2005 Act provides as follows:

- 61.(1) Where in proceedings for an offence under this Act relating to an alleged contravention of any requirement or prohibition imposed by or under a relevant statutory provision being a provision for which a code of practice had been published or approved by the Authority under section 60 at the



time of the alleged contravention, subsection (2) shall have effect with respect to that code of practice in relation to those proceedings.

- (2)(a) Where a code of practice referred to in subsection (1) appears to the court to give practical guidance as to the observance of the requirement or prohibition alleged to have been contravened, the code of practice shall be admissible in evidence.
- (2)(b) Where it is proved that any act or omission of the defendant alleged to constitute the contravention—
- (i) is a failure to observe a code of practice referred to in subsection (1), or
  - (ii) is a compliance with that code of practice, then such failure or compliance is admissible in evidence.
- (3) A document bearing the seal of the Authority and purporting to be a code of practice or part of a code of practice published or approved of by the Authority under this section shall be admissible as evidence in any proceedings under this Act.

**Dr Marie Dalton**  
**Secretary to the Board**  
**Health and Safety Authority**

## 2 STATUS AND SCOPE OF THIS CODE OF PRACTICE

This code of practice is published by the Health and Safety Authority in accordance with section 60 of the Safety, Health and Welfare at Work Act 2005. The code is intended to provide practical guidance on the procedures for safe design and installation of anchors in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013) , as well as relevant provisions of the Safety, Health and Welfare at Work Act 2005 (No. 10 of 2005) and the Safety, Health and Welfare at Work (General Application) Regulations 2007 (S.I. No. 299 of 2007) to 2016.

A failure to observe any part of this code of practice will not of itself render a person liable to civil or criminal proceedings. Where the code gives practical guidance on the observance of any of the relevant statutory provisions, then compliance or non-compliance with those provisions of the code may be admissible in evidence in any criminal proceedings.

You are not obliged to follow the practical guidance outlined in this code of practice or to complete of the various forms contained within. It may be acceptable for duty holders to take an alternative approach that deals with the relevant provisions covered in this code. In this case duty holders will need to satisfy themselves that their alternative approach is equivalent with that outlined in the code. However, a person who follows the approach outlined in this code will normally be doing enough to comply with legislation.

Part D of the Building Regulations (Amendment) (No. 2) Regulations 2000 (S.I. No. 249 of 2000) relates to materials and workmanship. In particular sections D1 and D3 are relevant to the design and installation of anchors:

- D1 All works to which these Regulations apply shall be carried out with proper materials and in a workmanlike manner.**
- D3 In this Part “proper materials” means materials which are fit for the use for which they are intended and for the conditions in which they are to be used, and includes materials which—**
- (a) bear a CE Marking in accordance with the provisions of the Construction Products Directive; or**
  - (b) comply with an appropriate harmonized standard, European technical approval or national technical specification as defined in article 4(2) of the Construction Products Directive; or**
  - (c) comply with an appropriate Irish Standard or Irish Agrément Board Certificate or with an alternative national technical specification of any State which is a contracting part to the Agreement on the European Economic Area, which provides in use an equivalent level of safety and suitability.**

**“Agreement on the European Economic Area” means the Agreement on the European Economic Area between the European Communities, their Member States and the Republic of Austria, the Republic of Finland, the Republic of Iceland, the principality of Liechtenstein, the Kingdom of Norway, the Kingdom of Sweden and the Swiss confederation, as published in the Official Journal of the European Communities (OJ L1/9 of 3 January, 1994).”**

This code of practice particularly applies to the design and installation of anchors that are used in **Safety Critical Situations**. The European Technical Approval guideline documents define Safety Critical Situations as being ‘where the failure of such connections would cause risk to human life and/or considerable economic consequences’. For the purposes of this code Safety Critical Situations will mean:

**where the failure of such connections would cause risk of human injury or death.**

The anchors considered here are in accordance with the European Communities (Construction Products) Regulations 1992 (S.I. No. 198 of 1992) and European Communities (Construction Products)(Amendment) Regulations 1994 (S.I. No. 210 of 1994), which together implement the European Communities Construction Products Directive.

Given the importance of the reliability and stability of the anchor in protecting the safety, health and welfare of persons, each anchor used in a structural capacity is required to have a European Technical Approval (ETA). The anchor should be designed in accordance with the design method specified in the ETA and installed in accordance with the manufacturer’s instructions.

Owing to the vast range of applications for anchors it is impossible to create a complete list of cases where anchorages would be considered to be safety critical. This code of practice therefore provides guidance and examples of cases where anchorages could be safety critical. **The designer must always complete a design risk assessment in order to verify if the application is a Safety Critical Situation.**

**Table 2.1: Examples of Safety Critical Situations**

1	Structural connection in concrete	The use of chemical resin to provide post-installed reinforcement bars in a concrete structure may be a Safety Critical Situation if the bars are subjected to high-tensile loads.
2	Structural steel connections	The connection of structural steel beams or columns to concrete members may be considered Safety Critical Situations.
3	Temporary works	In concrete structures many forms of shuttering, formwork, temporary propping and temporary supports fixed to concrete may be considered Safety Critical Situations.

4	High-level structures	Roof structures that are connected to concrete members may be considered Safety Critical Situations.
5	Ancillary steelwork	Heavy railings, gates, grills and fencing fixed to concrete may be considered Safety Critical Situations.
6	Cantilevered steelwork	Various types of balconies, balustrades, canopies and awnings connected to concrete structures may be considered Safety Critical Situations.
7	Cladding systems	Cladding systems such as curtain walling, brick support systems, stone support systems and glazing support systems fixed to concrete may be considered Safety Critical Situations.
8	Elevators	Elevator and escalator installations fixed to concrete may be considered Safety Critical Situations.
9	Mechanical and electrical installations	Systems suspended from concrete such as heavy ceilings, mechanical and electrical installations, systems may be considered Safety Critical Situations.
10	Signs and ancillary structures	Large signage and gantries fixed to concrete may be considered Safety Critical Situations.
11	Plant and equipment	Heavy cranes and machinery fixed to concrete may be considered Safety Critical Situations.
12	Barriers	Crash barriers and barricades fixed to concrete may be considered Safety Critical Situations.
13	Safety systems	Fall arrest anchor points and ladder support ties fixed to concrete may be considered Safety Critical Situations.
14	Lifting devices	Post-installed lifting devices in concrete members may be considered Safety Critical Situations.
15	Tie systems	Scaffolding ties fixed to concrete may be considered Safety Critical Situations.

This guidance is intended to help the designer and installer to identify the type of applications that are safety critical. It is not intended as a definitive list of applications.

Your particular application has to be assessed on a site-specific basis to determine if it is a Safety Critical Situation. You should take into account if there is redundancy in the proposed system when determining if the anchor is safety critical. Any system that does not include an element of redundancy should be considered to be safety critical.

The examples given in Table 2.1 demonstrate the range of applications in which anchors are used. While there may be hundreds of anchors used in a particular application, there is often a single design taking the worst-case loading. This design is then applied to all instances of that application on the project.

The following panels set out the role of the designer, the anchor supplier and the anchor installer when fixing mechanical plant to the underside of a concrete slab. In this example the equipment will be suspended from the slab within a service void that is above a corridor in a building.



### Designer

- Decides an anchor is required.
- Completes a design risk assessment to determine if it is a Safety Critical Situation.
- Gathers all necessary information to design the anchor, using form FM-01 (Appendix A) or a drawing to communicate the requirements.
- If the anchor manufacturer/supplier is assisting in the design, the designer must approve the design.
- If designing the anchor, completes form FM-02 (Appendix A).



### Anchor Manufacturer/Supplier

- Provides information on available/suitable anchors.
- Assists in the design of the anchor if requested and if competent to undertake the design.
- Advises on alternative anchors.
- If designing the anchor, completes form FM-02 (Appendix A) and sends this or a computer printout to the designer for approval.



### Anchor Installer

- Purchases the correct anchor.
- Installs the anchor in accordance with the manufacturer's instructions.
- If there are installation problems on site, then discusses these with the contractor and anchor designer.
- Supervises installation and completes form FM-03 (Appendix A).

Sample forms are provided in Appendix A, which may be used communicating the specification and correct installation of the anchor. They are not mandatory forms and anchor specifiers and installers may use their own versions.

The first form (Anchor/FM-01) helps the designer to gather the information that is necessary to complete the anchor design. Alternatively the information can be communicated by including the anchor requirements on drawings.

The second form (Anchor/FM-02) communicates the anchor specification to the contractor. Alternatively the information can be communicated using the anchor manufacturer's computer printout or hand calculations.

**For each application there will generally be one anchor design, which will specify the anchor that is to be used on site. Even though there may be several hundred of these anchors installed, there is one design and therefore one design form to be completed by the anchor specifier.**

The third form (Anchor/FM-03) is used as a checklist by the contractor supervising the installation of the anchor on site.

### European Technical Approval (ETA)

Currently there are only ETAs for structural connections in concrete. Therefore it is generally not acceptable to design, specify or install anchors for use in a Safety Critical Situation that do not have an ETA or that are to be installed in any base material other than concrete. This is primarily due to the current lack of reliable load data for anchors in base materials such as masonry or brickwork, without site-specific testing.

In the event that it is not practicable to install an anchor in concrete, the anchor specifier may specify the use of an anchor in a base material other than concrete. In such cases the anchor specifier must satisfy himself or herself that the capacity of the connection (anchor and base material) specified is sufficient to support the design loads adequately. The anchor manufacturer must be consulted on the use of the anchor outside of its ETA. The capacity of the specified connection must be fully assessed and agreed as being adequate between the anchor specifier and the anchor manufacturer.

Anchor technology is continually evolving and new solutions are being developed for



masonry. Once these anchors have received an ETA they will be available to anchor specifiers to design for use in masonry, in accordance with the design method in the Guideline for European Technical Approval (ETAG).

The design of the connection must be clearly and unambiguously communicated to the anchor installer. This is a particular requirement where the connection design deviates from its ETA.

The design of the anchor is a critical element in the integrity of the structure and contributes to its stability and robustness. Accordingly, verifiable calculations and drawings are to be prepared by the anchor specifier, taking account of all the loads and load paths acting on the anchor.

*Guideline for European Technical Approval of Metal Anchors for Use in Concrete* (ETAG 001, Edition 2007, Part 1) states:

**In setting out the assessment and design procedures in this Guideline, it has been assumed that the design of the anchorages and the specification of the anchor are under the control of an engineer experienced in anchorages and concrete work.**

**It is also assumed that the anchor installation is undertaken by trained personnel under the supervision of the site engineer, to ensure that the specifications are effectively implemented.**

### Road Map to this Code of Practice

All persons to whom this code applies should have a good knowledge of Sections 1 to 7, which provide important information applicable to all roles. Specific duty holders should also refer to the following sections.

#### Designer

- Section 8 – Design and specification of anchors
- Section 9 – Information supplied by anchor manufacturer/supplier
- Section 13 – Certification of design and installation
- Section 14 – Change management

#### Anchor Manufacturer/Supplier

- Section 8 – Design and specification of anchors
- Section 9 – Information supplied by anchor manufacturer/supplier
- Section 13 – Certification of design and installation
- Section 14 – Change management

#### Anchor Installer

- Section 9 – Information supplied by anchor manufacturer/supplier
- Section 10 – Installation of anchors in concrete
- Section 12 – Testing of anchors

#### Contractor

- Section 9 – Information supplied by anchor manufacturer/supplier
- Section 11 – Supervision and inspection of anchors
- Section 13 – Certification of design and installation
- Section 14 – Change management

### 3 INTRODUCTION

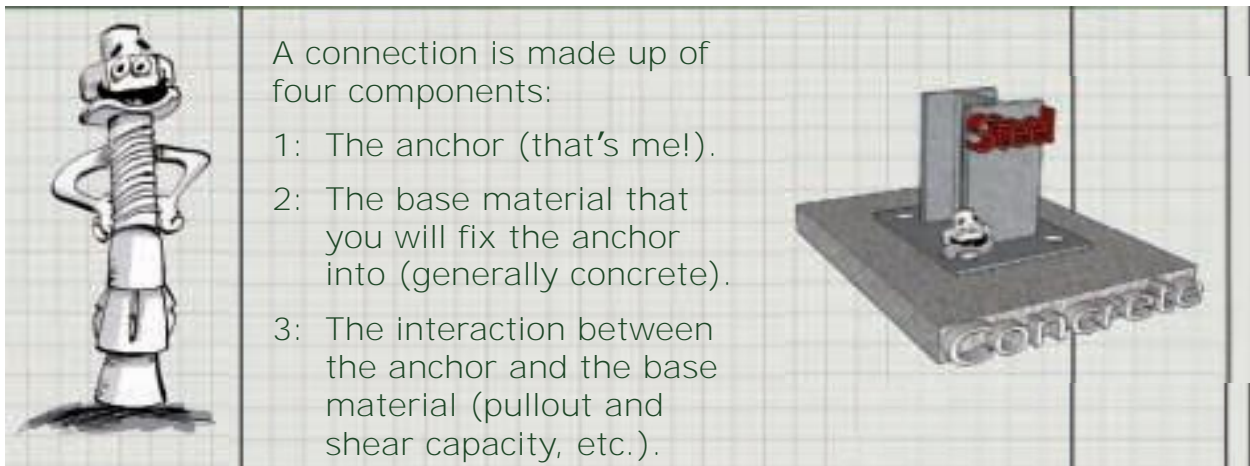
Anchors play an important role in construction:

- z They allow for the speedy connection of two or more structural elements.
- z Anchors with ETA are manufactured to a high standard and are only awarded an ETA after rigorous testing.
- z There is a wide variety of anchors available for different applications.

Every connection has four components:

- z **Anchor:** There is a wide variety of types, sizes and functions.
- z **Base material:** The material into which the anchor is installed, usually concrete.
- z **Interaction:** The interaction between the anchor and the base material.
- z **Fixture:** The item to be fixed to the base material, usually a steel member.

#### Components of a Connection



A connection is made up of four components:

- 1: The anchor (that's me!).
- 2: The base material that you will fix the anchor into (generally concrete).
- 3: The interaction between the anchor and the base material (pullout and shear capacity, etc.).
- 4: The item you are fixing, maybe a steel baseplate.



There are two different design methods for the type of anchors considered in this code of practice. Both methods are valid; however, they are completely different and care needs to be taken to ensure that you are using the correct information when designing.

The first method is called Global Safety Factor and has been in use for many years.

The second method is called Partial Safety Factor: this relatively new method follows the European design standards and is the method used for anchors with ETA.





## Global Safety Factors (Used for Non-Safety Critical Situations)

Ref:	Detail:	Output:
	<p>This design approach is based on Global Safety Factors. Use this approach only when the anchor being considered does not have an ETA.</p> <p>You consider a single (global) factor of safety for the performance of both the base material and the anchor.</p> <p>When using this method you must use <b><u>UNFACTORED DESIGN ACTIONS</u></b>.</p>	



## Partial Safety Factors (Used for Safety Critical Situations)

Ref:	Detail:	Output:
	<p>This method is based on Partial Safety Factors and is sometimes referred to as Concrete Capacity Method.</p> <p>You have to consider different factors of safety for (1) the base material and (2) the anchor material.</p> <p>You then examine different modes of failure for the anchor under each load direction:</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="430 1496 805 1758" style="border: 1px solid black; padding: 5px;"> <p><b>TENSION LOAD</b></p> <p>Failure modes:</p> <ul style="list-style-type: none"> <li>- Steel failure.</li> <li>- Pull-out failure.</li> <li>- Concrete cone failure.</li> <li>- Splitting failure.</li> </ul> </div> <div data-bbox="837 1496 1212 1758" style="border: 1px solid black; padding: 5px;"> <p><b>SHEAR LOAD</b></p> <p>Failure modes:</p> <ul style="list-style-type: none"> <li>- Steel failure.</li> <li>- Concrete pry-out failure.</li> <li>- Concrete edge failure.</li> </ul> </div> </div> <p>Using Partial Safety Factor can result in a more economic design; but it takes more design analysis.</p> <p>When using this method you must use <b><u>FACTORED DESIGN ACTIONS</u></b>.</p>	

Irrespective of the design method used, all anchor specifiers need to ensure that they have up-to-date technical data from the anchor supplier for the particular anchor being considered.

The anchor specifier needs to establish which design method is most appropriate for the connection. During the design process the anchor specifier must strictly comply with the chosen design method, in particular by using the capacities stated in the ETA for both the chosen anchor and the design method.

For example:

- z If the anchor specifier is using a Global Safety Factor design approach, Unfactored Design Actions must be compared to the Recommended Loads stated in the technical manual for the particular anchor.
- z If the anchor specifier is using a Partial Safety Factor design approach, the Factored Design Actions must be compared to the Design Resistance for the particular anchor.
- z Anchor manufacturers often give technical data relating to the ultimate resistance or characteristic resistance of the anchor. This information must not be used in any anchor design, irrespective of the design method chosen.

The anchor specifier needs to consider all loads that will act on an anchor and the direction of these loads. Loads will change during the construction process and the anchor specifier needs to ensure that the most onerous load conditions have been considered.

Once the chosen design method has been fully completed, the anchor specifier needs to conclude the design process by specifying the anchor. The anchor specifier must detail the anchor explicitly, so that the correct anchor is procured and installed. To achieve this, the anchor specifier should use the full anchor designation that is in the anchor manufacturer's technical manual.

At this stage the anchor can be installed by the contractor on site. The contractor must ensure that the anchor installer has the most up-to-date information for the installation of the anchor. Different types of anchor have specific requirements for the correct installation. If these are not followed, as per the manufacturer's instructions, then the anchor may not have the capacity determined by the anchor specifier. Common errors that can occur on site include:

- z Use of a drill bit with the wrong diameter.
- z Use of a wrong drilling system, for example in case of undercut anchors.
- z Use of wrong setting tools, for example not using a torque wrench for torque controlled expansion anchors.
- z Failure to clean the hole, if cleaning is required by the manufacturer.
- z Installation of the anchor such that the fixture cannot be installed without significant manipulations, for example anchor is not flush with the concrete surface in cases where required.
- z Hammering in an anchor that should be installed by rotation, for example anchor rod for a bonded anchor.

Each of these errors could seriously affect the performance and capacity of the installed

anchor. Table 7.1 details information that the anchor specifier should provide to the anchor installer in order to prevent these errors occurring on site (see Section 7).

The anchor supplier should make technical information available to both the anchor specifier and the anchor installer to allow them to undertake their tasks. Specifiers and installers should consult with the anchor manufacturer if there is any doubt as to the choice of the appropriate anchor or the correct installation procedures.

## 4 DEFINITIONS

The following definitions relate to this code of practice.

**“Admissible loading”** means the load allowed for a fastener under service conditions as per a design code. For anchors designed in accordance with the Concrete Capacity Method, loads are factored by the appropriate factor of safety. The loading can be applied in different directions:

- z Axial (tension or compression): Load application in the direction of the axis of the anchor.
- z Shear: Direction of load application is perpendicular to the axis of the anchor.
- z Combined tension and shear: Combination of tensile and shear loading applied simultaneously.
- z Bending: Shear with lever arm applied to an anchor (e.g. a stand-off detail).

**“Anchor”** means a manufactured, assembled component for achieving a connection between the base material and the fixture. Under the Safety, Health and Welfare at Work Act 2005, an anchor is considered to be an article. There are currently four main types of anchor:

- z Torque-controlled expansion anchors.
- z Undercut anchors.
- z Deformation-controlled expansion anchors.
- z Bonded anchors.

**“Anchor installer”** means a competent person or organisation who installs anchors.

**“Anchor manufacturer/supplier”** means a competent person or organisation who designs, manufactures, imports or supplies anchors. An anchor manufacturer could also be an anchor specifier.

**“Anchor specifier”** means a competent person or organisation who designs the connection and specifies an anchor.

**“Article”** means:

- z Any plant, machine, machinery, appliance, apparatus, tool or any other work equipment for use or operation (whether exclusively or not) by persons at work.
- z Any article designed for use as a component in, part of or to control any such plant, machine, machinery, appliance, apparatus, work equipment, tool or any other work equipment.
- z Any other product used by persons at work.





“**Base material**” means the material into which the anchor is installed. In the context of this code of practice the only base material currently considered is concrete. The concrete may be cracked (in the tensile zone of the concrete member) or non-cracked (in the compression zone of the concrete member).

“**Client**” means any person commissions or procures the carrying out of a project or who undertakes a project.

“**Competent person**” means a person who, having regard to the task he or she is required to perform and taking account of the size or hazards (or both of them) of the undertaking or establishment in which he or she undertakes work, the person possesses sufficient training, experience and knowledge appropriate to the nature of the work to be undertaken.

“**Concrete Capacity Method**” means the Partial Safety Factor design method for connections under due consideration of the safety and design concept within the scope of the European Technical Approvals of anchors.

“**Concrete strength ( $f_{ck,cylinder}$  or  $f_{ck,cube}$ )**” refers to the strength of the concrete base material into which the anchor is to be installed. The nominal characteristic strength is given for both 150mm Ø concrete cylinder test specimens and 150mm concrete cube test specimens. In Ireland the nominal characteristic concrete compressive strength is based on concrete cube strength. The concrete strength designation is listed as C followed by two numbers. The first number refers to the cylinder strength and the second to the cube strength, as illustrated below. You will generally refer to the second number.

Concrete Strength			
Ref:	Detail:		Output:
	<b>Concrete strength designation (I.S. EN 206)</b>	<b>Cylinder compressive strength (150mm)</b>	<b>Cube compressive strength (150mm)</b>
		$f_{ck,cylinder}$	$f_{ck,cube}$
	C12/15	12 N/mm <sup>2</sup>	15 N/mm <sup>2</sup>
	C20/25	20 N/mm <sup>2</sup>	25 N/mm <sup>2</sup>
	C25/30	25 N/mm <sup>2</sup>	30 N/mm <sup>2</sup>
	C30/37	30 N/mm <sup>2</sup>	37 N/mm <sup>2</sup>
	C35/45	35 N/mm <sup>2</sup>	45 N/mm <sup>2</sup>
	C40/50	40 N/mm <sup>2</sup>	50 N/mm <sup>2</sup>
	C45/55	45 N/mm <sup>2</sup>	55 N/mm <sup>2</sup>
C50/60	50 N/mm <sup>2</sup>	60 N/mm <sup>2</sup>	

**“Connection”** means an assembly comprising the base material (concrete), the anchor or anchor group and the component/fixture fixed to the concrete.

**“Contractor”** means a competent contractor or an employer whose employees undertake, carry out or manage construction work, or any person who carries out or manages construction work for a fixed or other sum and who supplies the materials and labour (whether his or her own labour or that of another) to carry out such work or who supplies the labour only.

**“Construction Products Directive (CPD)”** is the European Council Directive 89/106/EC relating to construction products. The six essential requirements are:

- z Mechanical resistance and stability.
- z Safety in case of fire.
- z Hygiene, health and the environment.
- z Safety in use.
- z Protection against noise.
- z Energy economy and heat retention.

**“Construction stage”** means the period of time that starts when preparation of the construction site begins and ends when construction work on the project is complete.

**“Creep”** means the condition whereby some materials may sustain a particular level of stress over the short term but will fail at significantly lower levels over the long term. This condition afflicts plastic and some resin materials and, to put it into context, to a small degree concrete. All anchors with ETAs have satisfied sustained load tests and are suitable for long-term loadings, they will not exhibit the characteristics of creep when subject to the design resistances implicit in the ETA.

**“Design”** means the preparation of drawings, particulars, specifications, calculations, the preambles and preliminaries of bills of quantities in so far as they contain specifications or other expressions of purpose, according to which a project, or any part or component of a project, is to be executed.

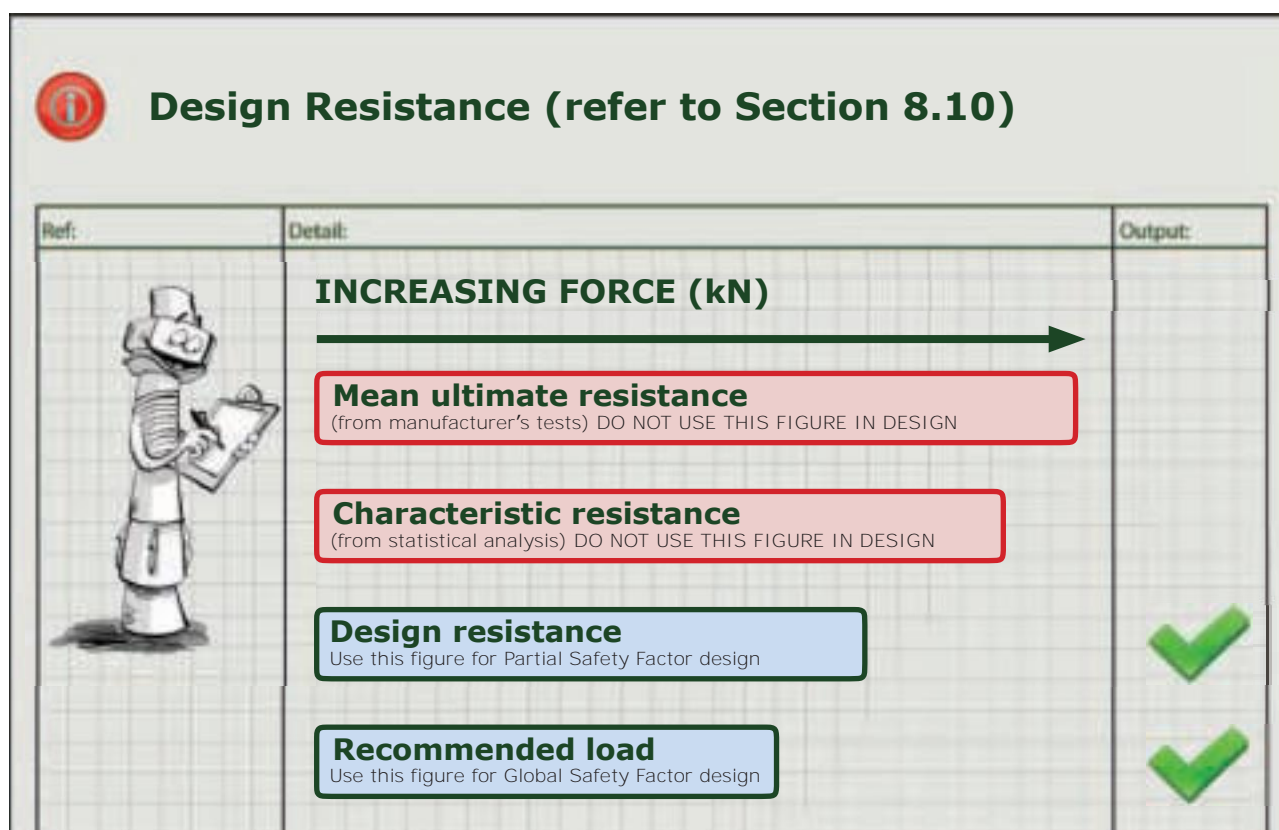
**“Design action”** means the force acting on the anchor. This code considers three basic design actions:

- z Tension.
- z Shear.
- z Combined shear and tension (or bending).

**“Design process”** means the process for preparing and designing a project, including alterations to the design and the design of temporary works to facilitate construction of the project.

“**Design resistance**” means the capacity of the anchor to resist factored design actions, in accordance with the Concrete Capacity Method. The design resistance of an anchor is based on the following:

- z **Mean ultimate resistance:** the mean of the test results for the maximum load sustained by a particular anchor at failure.
- z **Characteristic resistance:** the application of a statistical coefficient to the mean ultimate resistance.
- z **Design resistance:** the application of a material partial safety factor to the characteristic resistance. **This value should be used for the Partial Safety Factor design method (Concrete Capacity Method).**
- z **Recommended load:** the application of a load partial safety factor to the design resistance to arrive at a working load for a particular anchor. **This value should be used for the Global Safety Factor design method.**



“**Design risk assessment**” means a written method by which a designer (permanent works designer, anchor specifier or temporary works designer) takes account of the General Principles of Prevention as specified in the Safety, Health and Welfare at Work Act 2005.

“**Designer**” means a competent person engaged in work related to the design of a project.

“**Elongation**” means the movement of the anchor under load contributed by the strain of the steel and elastic concrete strain (excluding slip of the anchor).

“**EOTA**” is the European Organisation for Technical Approvals. The role of EOTA is primarily to monitor and progress the drafting of Guidelines for European Technical Approvals (ETAGs) and to coordinate all activities relating to the issuing of European Technical Approvals (ETAs). EOTA operates in close co-operation with the European Commission, European Free Trade Association (EFTA), European Committee for Standardisation (CEN), European trade associations and industrial organisations, which are also present as observers at various EOTA levels. EOTA is born out of the Construction Products Directive 89/106/EC (CPD). EOTA comprises the Approval Bodies nominated to issue European Technical Approvals (ETAs) by EU Member States and EFTA States who have contracted to the European Economic Area Agreement.

“**ETA**” means a European Technical Approval. An ETA for a construction product is a favourable technical assessment of its fitness for an intended use, based on the contribution made by this product to the fulfillment of the six essential requirements stated in the CPD for the construction works in which the product is installed. An anchor with a current ETA has CE Marking status.

“**Fixture**” means a component to be fixed to the concrete base material.

“**Global safety factor**” means the application of a single safety factor ( $\gamma$ ) to the mean ultimate failure of the anchor. This determines the recommended load.

“**Partial safety factor**” means the strict separation of factors of safety for both the anchor materials and the applied loads, as detailed below.

z Partial safety factor for the applied loads, represented by the symbol  $\gamma_F$ .

z Partial safety factor for material failure modes, represented by the symbol  $\gamma_M$ .  
Depending on the failure mode there are four partial safety factors that you need to consider:

z  $\gamma_{Ms}$  for steel failure.

z  $\gamma_{Mp}$  for pull-out failure.

z  $\gamma_{Mc}$  for concrete cone failure.

z  $\gamma_{Msp}$  for splitting failure.

Partial safety factors are applicable to the Concrete Capacity Method.

“**Permanent works designer**” means a competent person engaged in the design of the permanent structure. A permanent works designer could be an anchor specifier.

**“Project supervisor construction stage (PSCS)”** means a competent person appointed by the client under the Safety, Health and Welfare at Work (Construction) Regulations 2013 to carry out the duties under Regulations 16 to 22.

**“Project supervisor design process (PSDP)”** means a competent person appointed by the Client under the Safety, Health and Welfare at Work (Construction) Regulations 2013 to carry out the duties under Regulations 11 to 14.

**“Safety Critical Situation”** means circumstances where the failure of such connections would cause risk of human injury or death.

**“Temporary works”** means any temporary structure used to support a permanent structure while it is not self-supporting.

**“Temporary works designer”** means a competent person engaged in the design of temporary works. A temporary works designer could be an anchor specifier.

**“Temporary works erector”** means a competent person whose employees undertake, carry out or manage the erection of temporary works, or any person who carries out or manages the erection of temporary works for a fixed or other sum and who supplies the materials and labour (whether his or her own labour or that of another) to carry out such work or who supplies the labour only.

## 5 BACKGROUND TO THE CONSTRUCTION PRODUCTS DIRECTIVE

The basic legal European Union document for building products is Regulation (EU) No. 305 of 2011 of the European Parliament as transposed into Irish legislation by the European Union (Construction Products) Regulations 2013, S.I. 225 of 2013. The Regulations indicate the procedure for the verification of building products so that they are suitable for their intended application. The Regulations apply to construction products used in buildings and on civil engineering projects. Construction products that fall within the scope of the Regulations, have to meet specific requirements under the six essential requirements that apply to all building products:

- z Mechanical resistance and stability.
- z Safety in case of fire.
- z Hygiene, health and the environment.
- z Safety in use.
- z Protection against noise.
- z Energy economy and heat retention.

For each construction product family, a specific Guideline for European Technical Approval (ETAG) is required in which particular characteristics are given. The ETAG describes the necessary tests and defines the requirements. For example, **ETAG 001, Part 1, Edition 2007: Guideline for European Technical Approval of Metal Anchors for Use in Concrete**. Based on this guideline, a European Technical Approval (ETA) can be granted by an approved body for each construction product, in this case metal anchors for use in concrete. There are numerous other European Commission documents that give assistance with particular problems, for example attestation of conformity, CE marking or quality assurance.

The European Regulation is largely aimed at governments, i.e. the legislators of the Member States. The six essential requirements are directed at specialists for the preparation of guidelines and standards in particular. The ETAG regulates the tasks and obligations of:

- z The approval bodies in the member countries (e.g. IAB, DIBt, CSTB, BBA).
- z The approved bodies (independent test laboratories and institutions for quality assurance).
- z The anchor manufacturer.

The anchor specifier is directed to ETAG 001, Annex C: Design methods for anchorages. Together with the Concrete Capacity Method specified in Annex C and the data for a specific anchor from its ETA, the specifier is required to design the connection for the selected anchor in the conditions in which it will be used.

The ETA for a particular anchor is an important design document, as it provides the anchor specifier with:

- z Confirmation that an anchor has undergone stringent testing to one or more



of the twelve design options and will therefore function reliably and that its performance can be compared with that of others on a like for like basis.

- z Clear direction as to the intended use of the anchor.
- z The characteristics of the anchor – sizes, tolerances, material values, markings etc.
- z Details of the anchor manufacturer’s factory production controls.
- z Requirements for CE Marking.
- z Technical data for the different anchor-sizes covered by the ETA.
- z Installation details, for example minimum depth of embedment, hole diameter and setting tools.
- z The characteristic resistance of the anchor for tension and shear, as determined by laboratory testing.
- z The relevant partial safety factors.
- z Requirements for minimum thickness of base material.
- z Requirements for anchor spacing and edge distances.

### Important Design Note

Ref:	Detail:	Output:
	<p><b>The <u>Characteristic Resistance</u> of the anchor in the manufacturer’s technical data should not be used for design purposes, unless the appropriate partial safety factor has been applied.</b></p> <p><b>Each manufacturer provides <u>Design Resistance</u> values for their ETA anchors, which allow the anchor specifier to use the <u>Partial Safety Factor</u> design approach in accordance with Annex C of ETAG 001.</b></p> <p><b>When using a Global Safety Factor design approach use the <u>Recommended Loads</u> given by the manufacturer.</b></p>	

There is a link between the proposed ETAs and the European Construction Products Regulations. In particular the use of anchors in accordance with the ETA provides a means for building and civil engineering works to comply with the six essential requirements of this Council Directive.

In the context of safety in the design and installation of anchors, essential requirements 1 (mechanical resistance and stability), 2 (safety in case of fire) and 4 (safety in use) are of particular importance.

### **1 Mechanical resistance and stability**

The construction works must be designed and built in such a way that the loadings that are liable to act on it during its construction and use will not lead to:

- z Collapse of the whole or part of the work.
- z Major deformations to an inadmissible degree.
- z Damage to other parts of the works or to fittings or installed equipment as a result of major deformation of the load-bearing construction.
- z Damage by an event to an extent disproportionate to the original cause.

### **2 Safety in case of fire**

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

- z The load-bearing capacity of the construction can be assumed for a specific period of time.
- z The generation and spread of fire and smoke within the whole works are limited.
- z The spread of the fire to neighbouring construction works is limited.
- z Occupants can leave the works or be rescued by other means.
- z The safety of rescue teams is taken into consideration.

### **3 Hygiene, health and the environment**

The construction works must be designed and built in such a way that it will not be a threat to the hygiene or health of the occupants or neighbours, in particular as a result of:

- z Giving off of toxic gas.
- z Presence of dangerous particles or gases in the air.
- z Emission of dangerous radiation.
- z Pollution or poisoning of the water or soil.

- z Faulty elimination of waste water, smoke, solid or liquid wastes.
- z Presence of damp in parts of the works or on surfaces within the works.

### **4 Safety in use**

The construction work must be designed and built in such a way that it does not present unacceptable risks of accidents in service or in operation such as slipping, falling, collision, burns, electrocution and injury from explosion.

### **5 Protection against noise**

The construction works must be designed and built in such a way that noise perceived by the occupants or people nearby is kept down to a level that will not threaten their health and will allow them to sleep, rest and work in satisfactory conditions.

### **6 Energy economy and heat retention**

The construction works and its heating, cooling and ventilation installations must be designed and built in such a way that the amount of energy required in use shall be low, having regard to the climatic conditions of the location and the occupants.

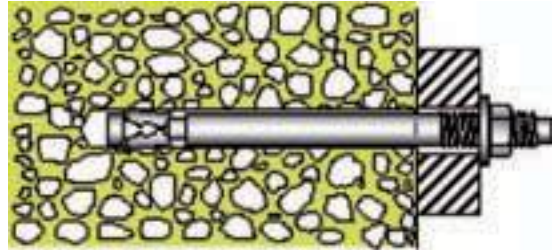
## 6 TYPES OF ANCHORS COVERED BY THIS CODE OF PRACTICE

There are currently four anchor types covered by ETAG 001 for which it is possible to get an ETA.

Each part of ETAG 001 deals with an individual type of anchor, as set out below.

### ETAG 001, Part 2: Torque-Controlled Expansion Anchors

Tightening the nut draws the tapered end of the bolt into a metal collar causing it to expand. The setting and resistance of the anchor is controlled by the torque applied. For a well-designed anchor this will ensure the required clamping force is achieved (hence the fixture will not move) while safeguarding the bolt material from being over-stressed.



There are three general sub-types of the torque-controlled expansion anchor:

- z Sleeve-type torque-controlled expansion anchor with one or more expansion cones. It may be installed through the fixture and is suitable for use in concrete only.



- z Bolt-type torque-controlled expansion anchor with one or more cones, which may be installed through the fixture and is suitable for use in concrete only.

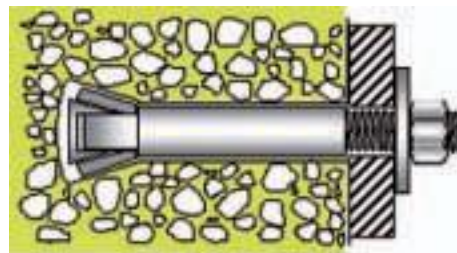


- z Shield-type expansion anchor, which may not be installed through the fixture. It is suitable for use in concrete or hard masonry.



## ETAG 001, Part 3: Undercut Anchors

An undercut anchor is characterised by a strong mechanical interlock provided by the undercut in the concrete base material. The mechanical interlock is formed by segments, which are made to open into the undercut shape either by turning the nut to draw the tapered cone into the segments or by driving the sleeves over the tapered cone. The undercut may be formed by a special drilling system or by the anchor itself, this characterises the two main sub-types:



- z Undercut drilled before anchor installation.

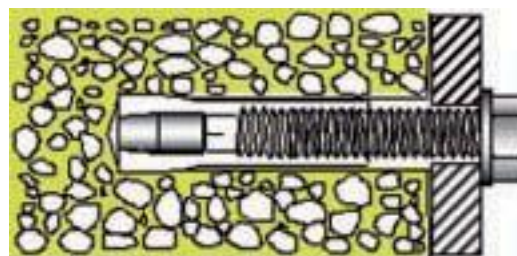


- z Undercut made during the setting of the anchor (self-undercut anchors).



## ETAG 001, Part 4: Deformation-Controlled Expansion Anchors

Expansion is achieved and controlled by the displacement of an expander element with respect to a sleeve or shell or vice versa. Although in theory several types of such anchors exist, the 'drop-in' type shown below is the most common. There are three sub-types of deformation controlled anchors:



- z Internally threaded cone-down type (drop-in) anchor suitable for use in concrete only.



- z Shank-down type anchor (stud anchor).

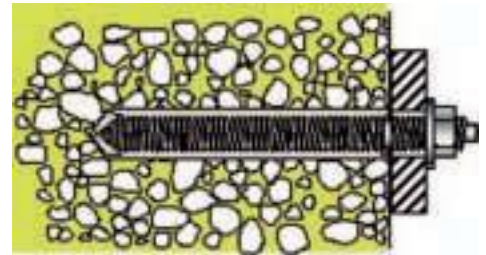


- z Sleeve-down type anchor.



### ETAG 001, Part 5: Bonded Anchors

The anchor is bonded to the base material by either a two-part resin grout or a cementitious grout, which may be introduced either in a capsule or from an injection cartridge with special mixing nozzle. These anchors are based on a wide variety of mixing techniques and installation procedures. The sub-types based on installation techniques include:



- z Bonded anchor.



- z Undercut bonded anchor.
- z Torque-controlled bonded anchor.

There are sub-types, which are also based on the different techniques for mixing the bonding agent and include:

- z Glass or soft skin capsule.



- z Injection type.





- z Bulk mixing type. This system is not currently covered by ETAG 001, Part 5: Bonded anchors, due to the problems of controlling the mix proportions and mixing technique.



Chemical anchors are available in various forms:

- z Polyester.
- z Vinylester.
- z Pure epoxy.
- z Cementitious.
- z Hybrids.

When considering a chemical anchor, the anchor specifier should seek competent advice on the most suitable type for the intended application, environment and installation conditions.

Creep and long-term behaviour of chemical anchors are covered in the ETA.

For overhead applications in particular, the anchor specifier should refer to the ETA and confirm that the proposed anchor is suitable for this application.



These illustrations were provided by the Construction Fixings Association and are general examples only; other configurations of anchors also fall within these categories. Specifiers and installers should refer to the anchor manufacturer's technical data for the particular anchor considered.

ETAs are granted to these four different anchor types based on strict criteria set out in ETAG 001. Individual manufacturers decide which of their products to put forward for testing in order to be granted an ETA. Each ETA expires after five years and the anchor manufacturer has to apply for renewal of the ETA after this period.

There are anchors on the Irish market that comply with the four main types, but which have not been tested in accordance with ETAG 001 and therefore do not have an ETA.

In order that the anchor specifier can be satisfied that he or she is specifying an approved anchor, the most current data should be sought from the anchor supplier prior to undertaking the design. The anchor specifier should have the current data sheet or software for the chosen anchor system, together with valid ETA. This enables the anchor specifier to proceed with a valid design for the particular application and to specify a particular anchor.




## What the Anchor Specifier Should Do!

Ref:	Detail:	Output:
	<p><b>To complete a valid design the anchor specifier should:</b></p> <ul style="list-style-type: none"> <li>z <b>Obtain current technical data from the anchor supplier.</b></li> <li>z <b>Request a valid ETA from the supplier.</b></li> <li>z <b>Design the anchor in accordance with the design method in the ETA, usually the Concrete Capacity Method.</b></li> <li>z <b>Specify an anchor with an ETA.</b></li> <li>z <b>If there is no anchor available with an ETA for the application concerned, then request suitable technical data from the anchor supplier to validate the design.</b></li> </ul>	

Similarly the anchor installer needs to be satisfied that the anchor provided complies with the design and that the anchor has an ETA. This can be confirmed by the presence of the CE Mark and the ETA number on the packaging.



## What the Anchor Installer Should Do!

Ref:	Detail:	Output:
	<p><b>Before starting work on site the anchor installer should:</b></p> <ul style="list-style-type: none"> <li>z <b>Confirm that the anchor type being used satisfies the design requirements of the specifier.</b></li> <li>z <b>Ensure that he or she is familiar with the installation instructions.</b></li> <li>z <b>Check that the anchor packaging has CE marking affixed.</b></li> <li>z <b>Check the ETA Number on the packaging.</b></li> <li>z <b>Ensure that installers have all the necessary setting equipment and are trained in the installation of the particular type of anchor concerned.</b></li> </ul>	  

The ETA number will appear as follows:

**ETA 08 / 1234**



Year that ETA is issued, in 2-digit format (e.g. 2008)  
 ETAs are valid for five years

## 7 ROLES AND RESPONSIBILITIES

### 7.1 General

The following persons are likely to be involved during different stages of the anchor selection, design and installation and have responsibilities for providing the correct information, producing the correct specification and correctly installing the anchor on site.

- z Anchor manufacturer/supplier.
- z Anchor specifier (for permanent or temporary anchors).
- z Anchor installer.

**Situations may arise on site where a person makes a decision in relation to the anchor, for example to change the anchor type. In such a situation that person is an anchor specifier and must comply with this code of practice.**

Specific responsibilities for the management of health and safety during this process lie with the:

- z Project supervisor design process.
- z Contractor (note that a contractor in charge of a place of work may engage other contractors to undertake the actual installation of the anchor).
- z Project supervisor construction stage.

The Safety, Health and Welfare at Work (Construction) Regulations 2013 impose specific statutory duties irrespective of the contractual arrangements that may exist between the different parties. The regulations require cooperation between the different persons and the coordination of activities to avoid overlaps or gaps arising that could be confusing and/or dangerous. In addition there is a duty to monitor these activities and to take remedial action if required. Therefore it is essential that clear lines of communications are established between these different parties from the start of the project.

In addition to the provisions of the 2013 Construction Regulations, anchors are also governed by the provisions of the Safety, Health and Welfare at Work Act 2005, sections 16 and 17.

### 7.1 Anchor Manufacturer/Anchor Supplier:

Under the Safety, Health and Welfare at Work Act 2005, each anchor manufacturer and supplier is required to ensure that the anchors supplied are designed and manufactured so as to be safe and without risk to health, on the basis that the anchor is subsequently:

- z Specified properly by the anchor specifier, in accordance with ETAG 001 and the data contained in the ETA. This information may also be available in the manufacturer's technical manual.
- z Installed properly by the installer, in accordance with the manufacturer's instructions.


Anchor suppliers are required to provide such information as is necessary for the specifier and the installer to ensure the anchor’s safe installation, use, maintenance, cleaning, dismantling or disposal, without risk to safety or health.

Anchor manufacturers submit each anchor to undergo stringent tests to establish the parameters for its safe use. This is particularly the case with anchors that have achieved European Technical Approval. Therefore ETA anchors specified and installed in accordance with the manufacturer’s instructions may not require additional site testing.



Anchor suppliers have a range of information available, which the specifier and installer should request, including:

- z ETAs.
- z Test reports, if the anchor is to be installed in base materials other than concrete or where the quality or strength of the base material is unknown.
- z Technical manuals.
- z Technical data sheets.
- z Design data, including anchor capacities for different load conditions.
- z Computer aided anchor design software.
- z Design guides.
- z Installation instructions.
- z Safety data sheets.
- z Safety instructions.
- z Installation instructions in pictogram format on the anchor packaging.
- z Fire behaviour.

In addition, anchor suppliers will often provide technical advice and support for the design, specification and installation of their products.



## Where to Get Information

Ref:	Detail:	Output:
	<ul style="list-style-type: none"> <li>z <b>Most anchor suppliers make information available on their websites.</b></li> <li>z <b>Before you specify an anchor, you should first check that you have the most up-to-date information.</b></li> <li>z <b>A quick check online or a call to your supplier is all that is needed to confirm that the information you have is correct.</b></li> </ul>	

## 7.2 Anchor Specifier

The anchor specifier must ensure, as far as reasonably practicable, that any risks to safety or health are eliminated or minimised in the design. In order to do this the anchor specifier must determine the most appropriate anchor for the particular application and determine the appropriate design method for that anchor. The anchor supplier will be able to provide technical assistance to the specifier in this regard. The specifier must complete the design in accordance with the chosen design method (Global Safety Factor or Partial Safety Factor). The design must take into account the most onerous loads that the anchor will be subjected to and the direction of the loads.

Anchors are often used in temporary situations to provide fixing points for units or operatives over a short duration. It is important to stress that the scope of this code of practice covers the use of anchors in Safety Critical Situations where their failure may cause serious injury or death. Whether the anchors are being used in a temporary or permanent capacity is irrelevant in the context of the consequence of an anchor failure.

The design of temporary anchors may differ slightly from permanent anchors. For example the base concrete material used may not have had the standard 28-day curing time and consequently the specifier should use a reduced concrete strength in calculating anchor capacities. The specifier must be satisfied that the actual partial safety factors used in the design of temporary anchors accurately reflect the specific use of the anchor on site. The anchor specifier must also take into account the range of additional loads that may act on the temporary anchor during use.

If the specifier considers that the consequence of failure of a temporary anchor is such that serious injury or death may be likely to occur, then this code must be followed in the design and installation of that anchor. Once the design calculations are completed and checked, the specifier can proceed to specify the anchor. In this case the specifier must specify the anchor explicitly and completely, so that the anchor installed on site matches the design criteria.

### When Specifying an Anchor



- z **Get the most up-to-date design information from the supplier.**
- z **Decide on the design approach: Partial Safety Factor or Global Safety Factor.**
- z **Complete the design and get it checked.**
- z **Communicate the design in clear and unambiguous terms.**



The anchor specifier should avoid using generic terms, such as '20mm chemical anchor, or similar approved'. Instead, the anchor specifier must specify the anchor as per the manufacturer's designation, including the information listed in Table 7.1.

**Table 7.1: Information to be Provided to the Installer (refer to Anchor/FM-02)**

A	Make:	State the name of the manufacturer
B	Type:	Give the type of anchor, i.e. torque-controlled
C	Reference no.:	Each anchor has a unique reference number
D	Diameter:	State the nominal diameter of the anchor
E	Hole diameter (concrete):	State the drill hole diameter in the concrete
F	Hole diameter (fixture):	State the drill hole diameter in the fixture
G	Length:	State the length, as used in the design
H	Material:	State the grade of steel required
I	Corrosion:	State if the anchor is to be stainless steel, etc.
J	No. of anchors per fixture:	State how many anchors are required
K	Anchor spacing:	State the designed distance between anchors
L	Minimum edge distance:	State how close the anchor can be to the edge(s)
M	Minimum base material thickness:	State the minimum thickness of concrete
N	Minimum base material strength:	Give the minimum strength used in the design
O	Hole depth:	State the depth of hole required
P	ETA No.:	State anchor's ETA reference (if applicable)
Q	Markings:	If the anchor has identification marks, state them
R	Torque:	Specify the setting/tightening torque (if required)
S	Setting details:	Provide specific installation requirements
T	Actions on anchor/capacity:	Provide load cases considered/capacity of anchor
U	Additional fixing requirements:	If you have more requirements, state them

The specifier may use the sample form Anchor/FM-02 in Appendix A as a means of communicating the anchor design and specification to the contractor procuring the anchors and to the anchor installer.

### 7.3 Anchor Installer

The anchor installer must ensure, as far as reasonably practicable, that nothing in the manner in which the anchor is installed makes it unsafe or a risk to safety or health when used.

The anchor supplier will be able to provide advice or guidance to the installer for the correct installation procedures. In addition the supplier may provide training for the correct installation of their anchors.



The installer must have referred to the anchor installation instructions, which are on the packaging and available from the supplier, prior to commencing the work. The anchor installer must ensure that the correct drilling and setting tools are available for the proper installation of the anchor. Steps in the installation procedure must not be omitted or partially undertaken, for example failing to blow out the drill hole prior to setting the anchor.

Installation instructions are provided on the technical data sheets and on the anchor's packaging. The material safety data sheet should also be referred to if the anchor system includes components that could be hazardous to safety or health. These are available from the anchor supplier/manufacturer.

The person installing the anchor must have received the appropriate instructions for the correct installation of the particular anchor and the installation must be supervised by a competent person appointed by the contractor, so as to ensure that the anchor is installed in accordance with the manufacturer's instructions. In this context, the anchor installer must be made aware of the consequences of failing to adhere to the correct installation instructions.

The installer should not proceed with the installation of the anchor if, due to site conditions, it cannot be set in accordance with the manufacturer's instructions. The conflict should be referred back to the anchor specifier and the anchor supplier, so that a solution can be designed and an alternative anchor or an alternative method can be specified.

The anchor installer may use the sample form Anchor/FM-03 in Appendix A as a means of recording the correct installation of the specified anchor.

### 7.4 Project Supervisor Design Process (PSDP)

The PSDP has a responsibility under the Safety, Health and Welfare at Work (Construction) Regulations 2013 to take reasonable steps to bring about co-operation between designers on the same project and to ensure, as far as reasonably practicable, coordination of their activities in relation to the design of the project with a view to protecting persons at work. In this respect, the PSDP should coordinate the activities of the anchor specifier with those of other designers, irrespective of whether the anchors are permanent or temporary.

The PSDP should coordinate sign-off of the anchor design with the anchor specifier. This can be done using either a permanent works design certificate or a temporary works design certificate, or with a similar project-specific certificate. Examples of permanent and temporary works design certificates are contained in the *Guidelines on the Procurement, Design and Management Requirements of the Safety Health and Welfare at Work (Construction) Regulations 2013*.

### 7.5 Contractor

The contractor should ensure that the specified anchor is procured and that the anchor installer is trained for the correct installation of that anchor type. In addition the contractor should ensure that the installer is working under competent supervision.

### 7.6 Project Supervisor Construction Stage (PSCS)

The PSCS is required to coordinate the implementation of the Safety, Health and Welfare at Work (Construction) Regulations 2013 and therefore the activities of contractors engaged in the installation of anchors.

The PSCS should ensure that the installation of anchors is coordinated with the activities of other contractors. The PSCS should also ensure that the appropriate contractor completes form Anchor/FM-03 (see Appendix A).

## 8 DESIGN AND SPECIFICATION OF ANCHORS

### 8.1 General

The information supplied here is intended to give the design engineer a basic knowledge of the design factors that need to be taken into account when selecting an anchor for any safety critical application.

The Safety, Health and Welfare at Work Act 2005 stipulates that:

**2.-(2)(a) For the purposes of the relevant statutory provisions, a person is deemed to be a competent person where, having regard to the task he or she is required to perform and taking account of the size or hazards (or both of them) of the undertaking or establishment in which he or she undertakes work, the person possesses sufficient training, experience and knowledge appropriate to the nature of the work to be undertaken.**

In the context of the design or specification of anchors, the employer should ensure that the person specifying the anchor has the following:

#### Training

- z This may be in the form of in-house training in the use of the design software or technical manuals. Alternatively it may involve attending seminars provided by anchor suppliers. It may also be considered as formal training provided in structural design or partial safety factor design in accordance with Eurocodes.

#### Knowledge

- z The anchor specifier should have a working knowledge of the technical manuals and the design software provided. If the anchor specifier is using particular software for the first time, guidance should be sought from another specifier who has knowledge of the software or from the anchor supplier directly.

#### Experience

- z The anchor specifier should have experience of designing anchors of the type being considered. If the anchor specifier lacks direct experience, guidance should be sought from another specifier who has experience of the anchor type or from the anchor supplier directly.

ETAG 001, Annex C, provides a sophisticated design concept, including three design methods. In order to gain optimum performance of the anchor and at the same time an economical design, the Concrete Capacity Method distinguishes between different load directions (tension, shear, combined tension and shear) and provides design models and

advice on the following different failure modes:

### **z Tension load:**

- z Steel failure.
- z Concrete cone failure.
- z Pull-out/pull-through failure.
- z Splitting failure.

### **z Shear load:**

- z Steel failure.
- z Concrete edge failure.
- z Pryout failure.

The specification of the correct anchor for a specific application is something which cannot be over stressed. The anchor specifier should seek the most current technical data from the anchor manufacturer, together with the ETA. If the anchor specifier has any doubt about an anchor selection he or she should always contact the manufacturer for technical advice.

When selecting an anchor for a particular application there are a number of factors that need to be addressed by the anchor specifier, as set out below.

## **8.2 Type of Base Material**

### **8.2.1 Concrete**

When a mixture of cement, aggregates and water hardens and cures it becomes concrete. Concrete is the base material into which most structural connections are **made and for which most anchors are designed. Manufacturers' performance** values are generally quoted for a concrete base material.

Performance is most commonly quoted for C20/25 grade concrete, however, the higher option ETA allows for increased capacities for higher concrete strength up to C50/60. Using the Concrete Capacity Method in ETAG 001, Annex C, it is possible to calculate the increased load capacity of an anchor installed in higher strength concrete.

### **8.2.2 Cracked/Non-cracked Concrete**

Concrete may be cracked for a variety of reasons, mainly due to the loading of the structure (cracked concrete in the tension zone, non-cracked in the compression zone). Steel reinforcement bars are cast in the concrete to take up the tensile forces. ETAG 001 differentiates between anchors approved for use in both cracked and non-cracked concrete. The correct anchor type should be selected to suit the concrete condition.

The performance for most anchors is usually quoted for non-reinforced concrete. In general, reinforcement does not improve anchor performance. If reinforcement is hit during the drilling process then the aborted hole should be filled with a strong non-shrink grout. The new hole should be located away from the aborted hole by at least the depth of the aborted hole.

### 8.2.3 Masonry

Masonry panels can be awkward materials to fix into. The strength can vary from 5 to 70N/mm<sup>2</sup>, masonry units may be solid or have perforations and the mortar may be weak or non-existent in parts of the joints.

Bonded (especially injection-type) anchors are particularly suitable as they exert no expansion stresses in the base material and will also fill any small voids present. If considering a mechanical anchor, the most appropriate metal anchors are thin-walled sleeve anchors, which exert low expansion stresses and are less likely to crack weak bricks than anchors with thick expanders. Special plastic anchors may also be suitable.

There is currently no load data available for the design of anchors for masonry base materials and there are no anchors available with an ETA for use in masonry units produced in Ireland. It is anticipated that in the future there may be bonded anchors for use in masonry, which will be covered by the principles in EOTA TR029. When available, these anchors should be designed in accordance with their ETA.

In the interim, given the large variation in the strength of this base material and the difficulty in determining the resistance of the base material to anchor loads, it is not considered safe to specify or install safety critical anchors into masonry panels.

In the case of base materials other than concrete, the anchor specifier may consider other options, such as incorporating sufficiently sized concrete pad stones into the masonry panels, in order to facilitate the use of ETA anchors.

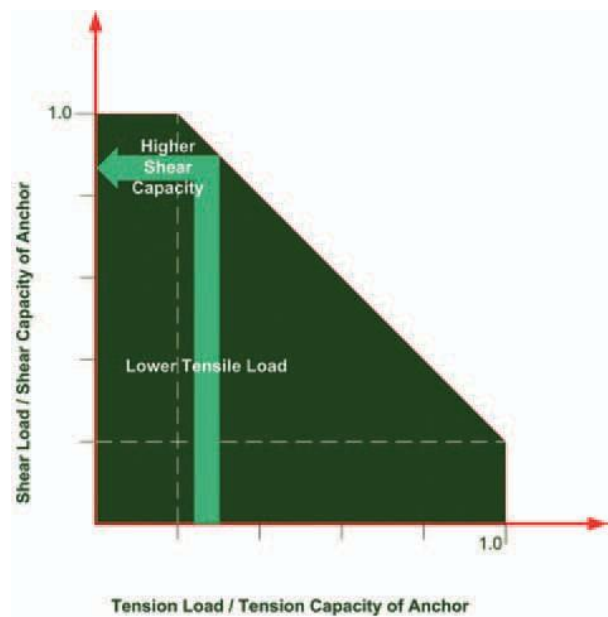
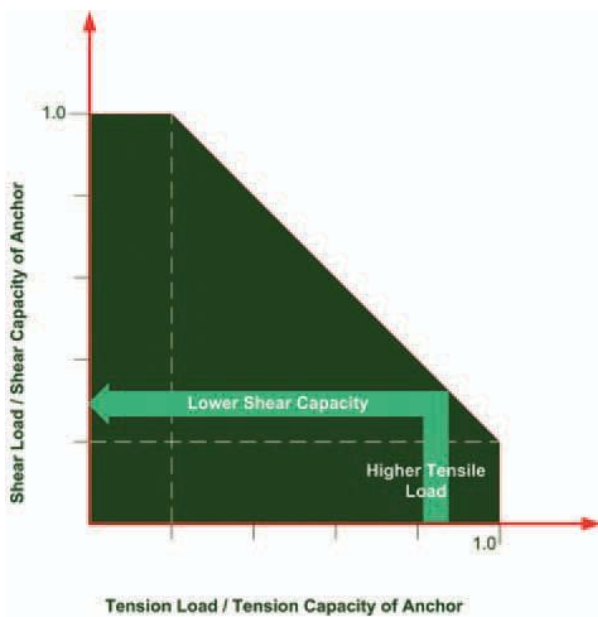
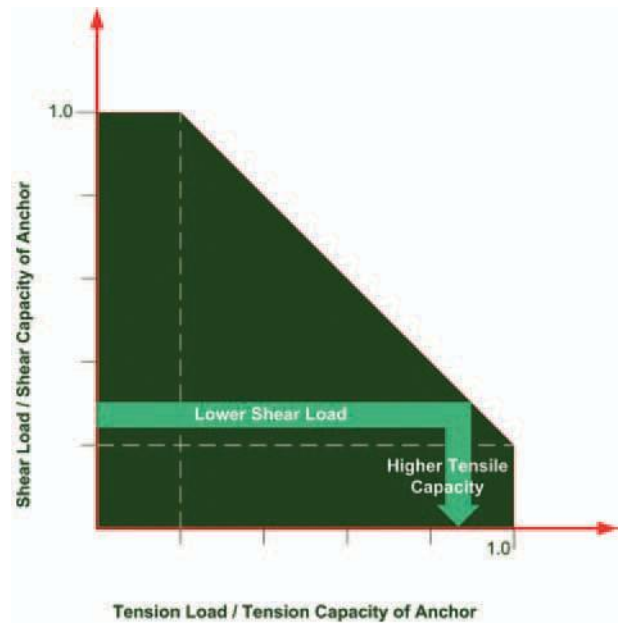
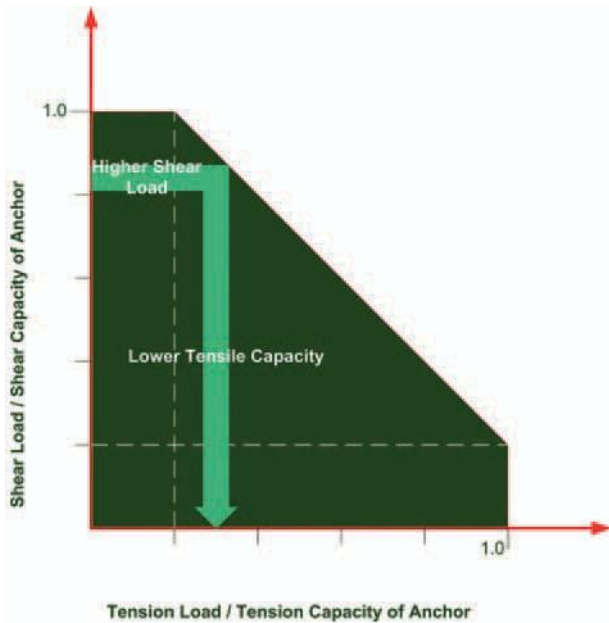
Outside the scope of this code, there are plastic anchors for non-structural use in masonry, which are covered by ETAG 020 (Part 3 relates to plastic anchors in solid masonry panels and Part 4 to plastic anchors in hollow or perforated masonry panels).

### 8.3 Load Type

When considering the load type, the anchor specifier needs to decide if there is a tensile, shear or combined load acting on the anchor(s). In addition the anchor specifier may need to consider bending moments acting on the anchor. For example in the case of stand-off anchor applications, where the load is acting on the anchor at a distance from the surface of the base material, thus imposing bending moments. The manufacturers publish resistances in their technical data as a result of exhaustive tests using recognised test procedures (ETAG 001, Annex A: Details of tests). Recommended loads are commonly derived from characteristic loads subject to a global safety factor. ETAs quote characteristic loads together with the partial safety factors needed to derive the design resistances of the anchor, for all possible anchor failure modes.

### 8.4 Load Direction

The magnitude of the load applied to an anchor must be less than the manufacturer's recommended load in the direction concerned. According to ETAG 001, Annex C, the applied load multiplied by a partial safety factor must be smaller than the characteristic resistance of the anchor divided by a partial safety factor. In the case of combined loads a check must be carried out to ensure that the resolved components are less than the recommended tensile and shear loads without exceeding the capacity in the direction concerned.



Some anchors are noticeably stronger in shear than in tension. For example, heavy-duty sleeve anchors or thick-walled sleeve anchors.

## Not All Anchors Are The Same!



**Anchors from different manufacturers may have different capacities in terms of resistance.**

**Before you proceed with an anchor specification you must check that the anchor can operate within its capacity.**

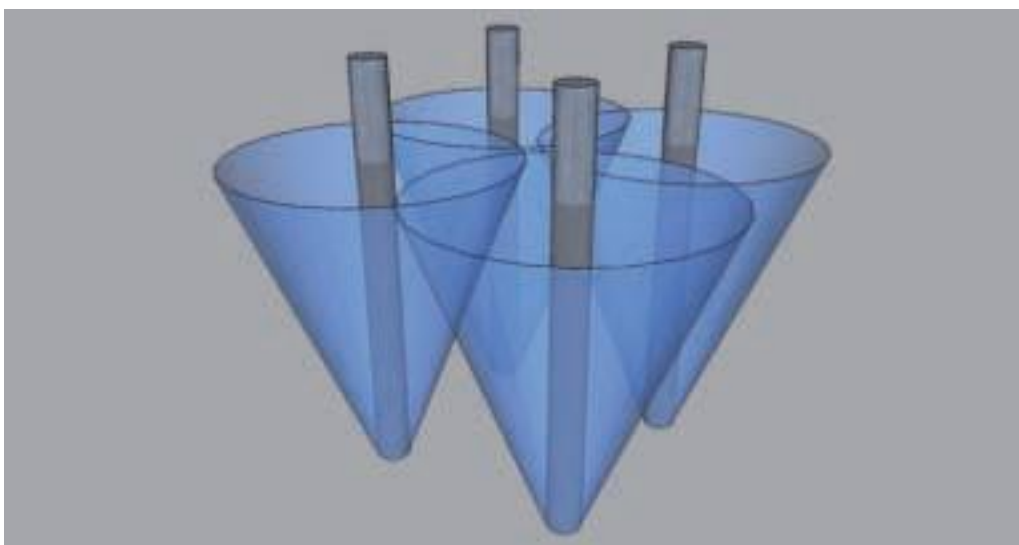
**If you cannot get an anchor to work, then changing to a different type of anchor may be the solution.**



### 8.5 Edge and Anchor Spacing

The next step in the design process is to look at the effect of anchor spacing and edge distances on the anchor. When a tensile load is applied to an anchor it creates a stress cone in the concrete, which will resist this applied load. For anchors in tension, the concrete cone capacity is determined by the tensile strength of the stress cone in the concrete surrounding the anchor. The size of the cone is a function of the setting depth and is measured by the area of the cone base at the concrete surface.

For anchor groups, these surface areas may overlap resulting in a combined cone that will have a capacity less than the capacity of a single anchor, multiplied by the number of anchors in the group.



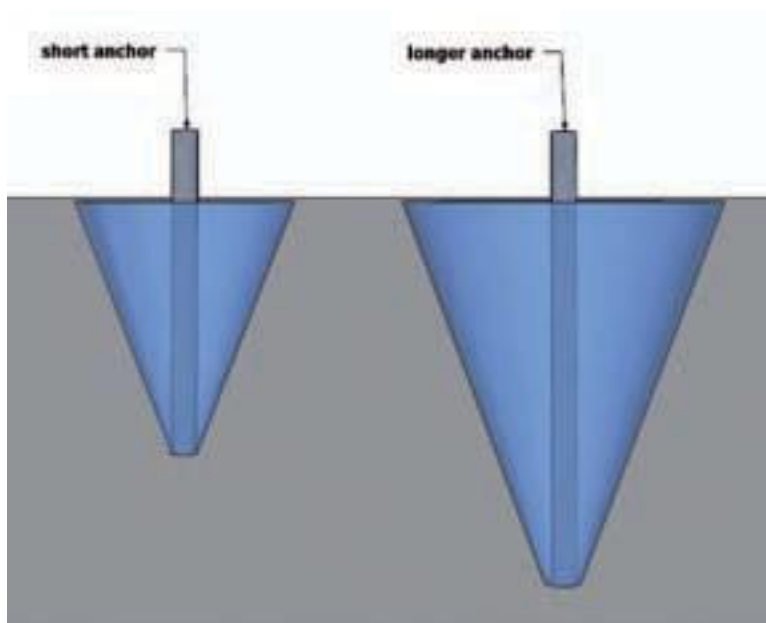


As the above diagram illustrates, a reduction must be taken into consideration because of the overlapping of the cones. The same principles apply to edge distances. Therefore the distance an anchor is set from a concrete edge and neighbouring anchors must be given serious consideration in the design process.

### 8.6 Effect of Increase Embedment Depth

In terms of tensile load, the embedment depth should also be considered. The concrete cone resistance for all anchors is calculated for the effective embedment depth  $h_{ef}$ . In every case performance will increase as embedment depth increases until the mode of failure changes, for example from concrete cone failure to pull-out failure or steel failure.

#### Effective embedment depth ( $h_{ef}$ )



### 8.7 Load Type: Static and Dynamic Loads

The data published by most manufacturers is generally quoted for predominantly static loading. Where loads are dynamic in nature, extra consideration must be given. The main difference between static and dynamic loads is the effectiveness of inertia and damping force. These forces result from vibrating, alternating and shock loads and must be taken into account when determining applied loads.

Dynamic actions are generally classified into three groups:

- z Fatigue loads.
- z Seismic loads.
- z Shock loads.

Not all anchors are suitable for these situations and if the design engineer is not sure of anchor selection he or she is recommended to contact the different manufacturers' technical services.

## 8.8 Corrosion

When selecting an anchor it is also important to consider the environment in which the anchor is set. Corrosion of the anchor can be avoided by specifying measures appropriate to the environment, for example the anchor specifier can specify protective coatings or stainless steel. Corrosion protection requires special attention: if in doubt, the anchor specifier should seek specialist advice.

### 8.8.1 Types of Corrosion

#### 8.8.1.1 Bi-metallic (Galvanic Corrosion)

Bi-metallic corrosion occurs when two dissimilar metals are in contact in the presence of an electrolyte. This should be avoided as the rate of corrosion may be accelerated, depending on the particular metals in contact and their mass. For example when zinc-plated steel components are fixed with stainless steel anchors the increased corrosion of the plated steel part will be minor due to its larger area. However, generally it is best to isolate dissimilar metals.

#### 8.8.1.2 Chemical Corrosion

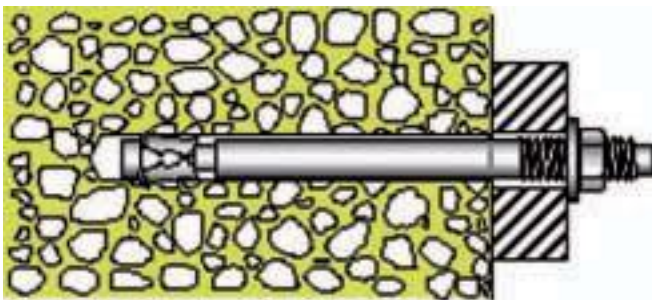
Chemical corrosion occurs in high atmospheric pollution or marine environments and in this case even Grade A4 stainless steel may have a reduced life expectancy. Special alloy steels are available for these situations and it is recommended that the anchor specifier consult the manufacturer.

#### 8.8.1.3 Stress Corrosion

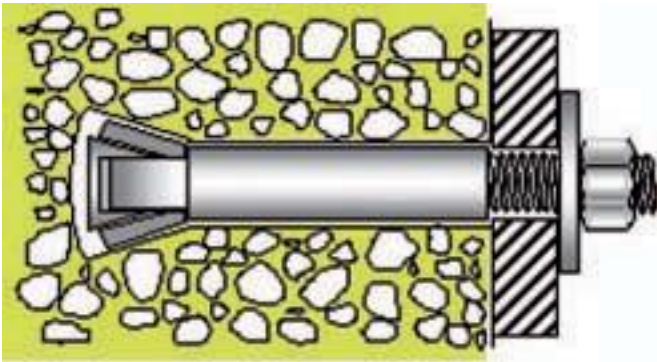
Stress corrosion occurs in conditions where elevated temperatures coincide with moisture and the presence of corrosive gases, for example in swimming pools and road tunnels. Normal materials, including A4 stainless steel may not be suitable. Special alloy steels are available. Again it is recommended to contact the manufacturer for advice.

## 8.9 Anchor Type

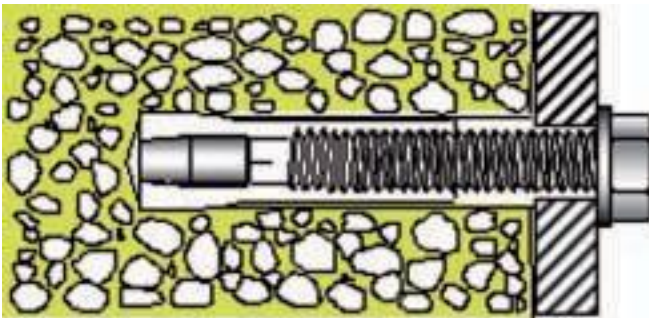
Once all of the above criteria have been considered the next step is to select a suitable anchor. Depending on the base material, load type and magnitude, anchor and edge spacing, one of the following anchors, each with its own operational principle, will be chosen.



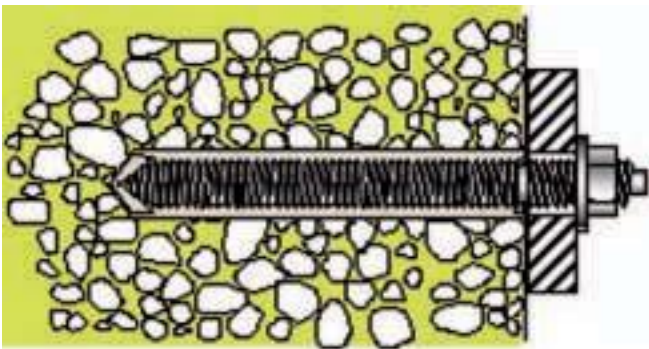
Torque-controlled expansion anchor



Undercut anchor



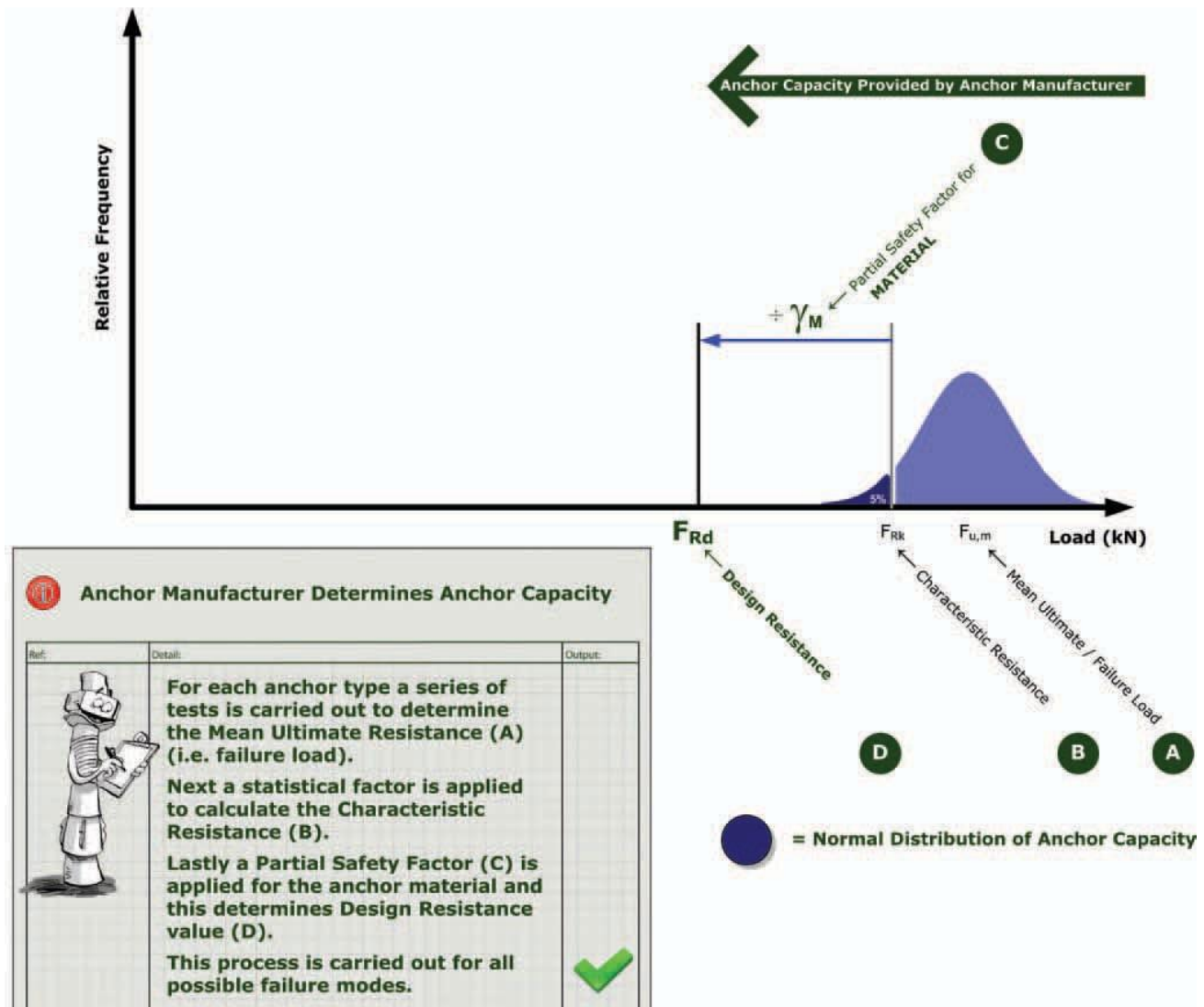
Deformation-controlled expansion anchor



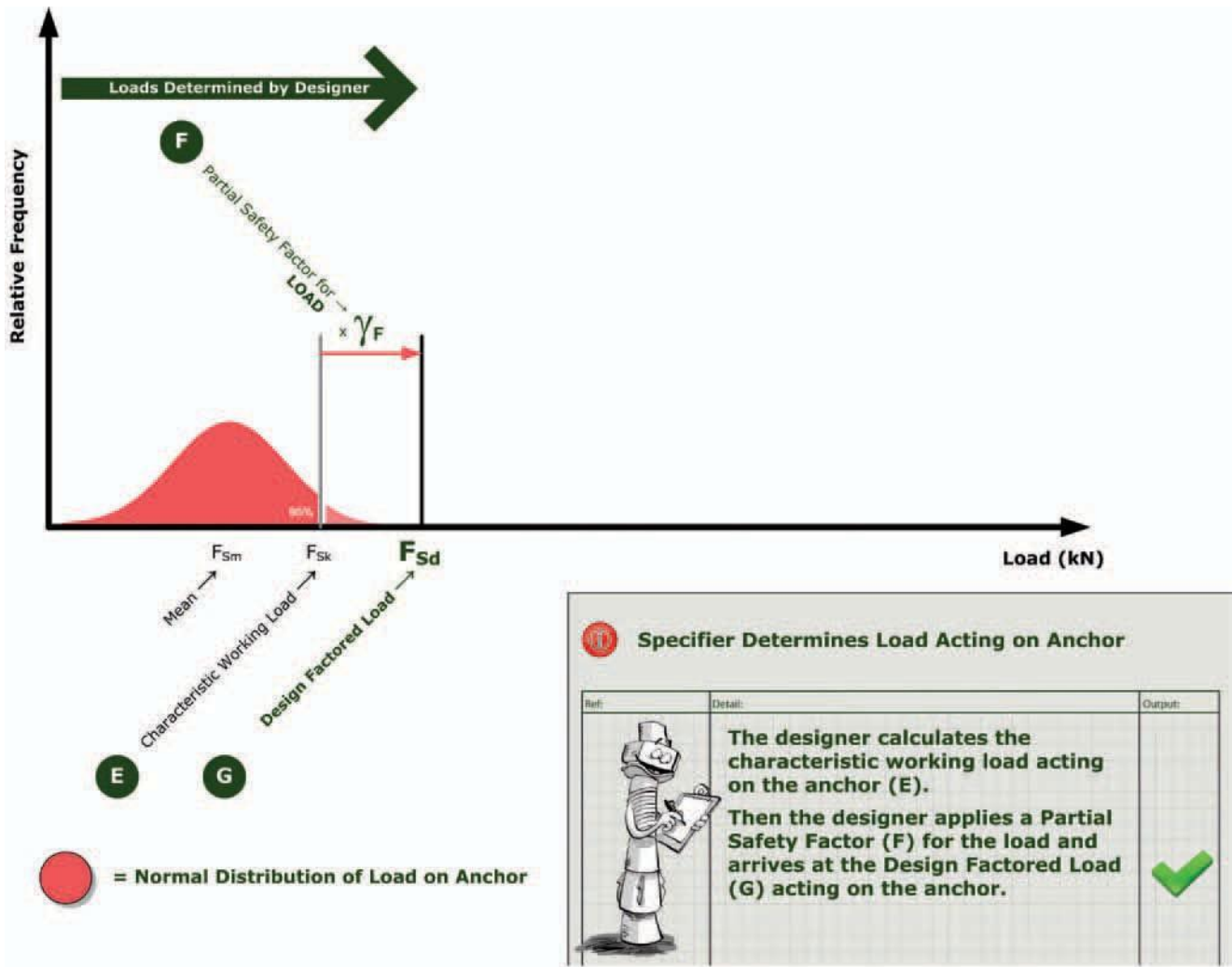
Bonded anchor

### 8.10 Anchor Design

Each manufacturer provides comprehensive technical data to anchor specifiers to allow them to complete the anchor design. In accordance with ETAG requirements the manufacturers have to undertake extensive independent testing for each anchor type. This enables the manufacturers to publish the capacity of each anchor.



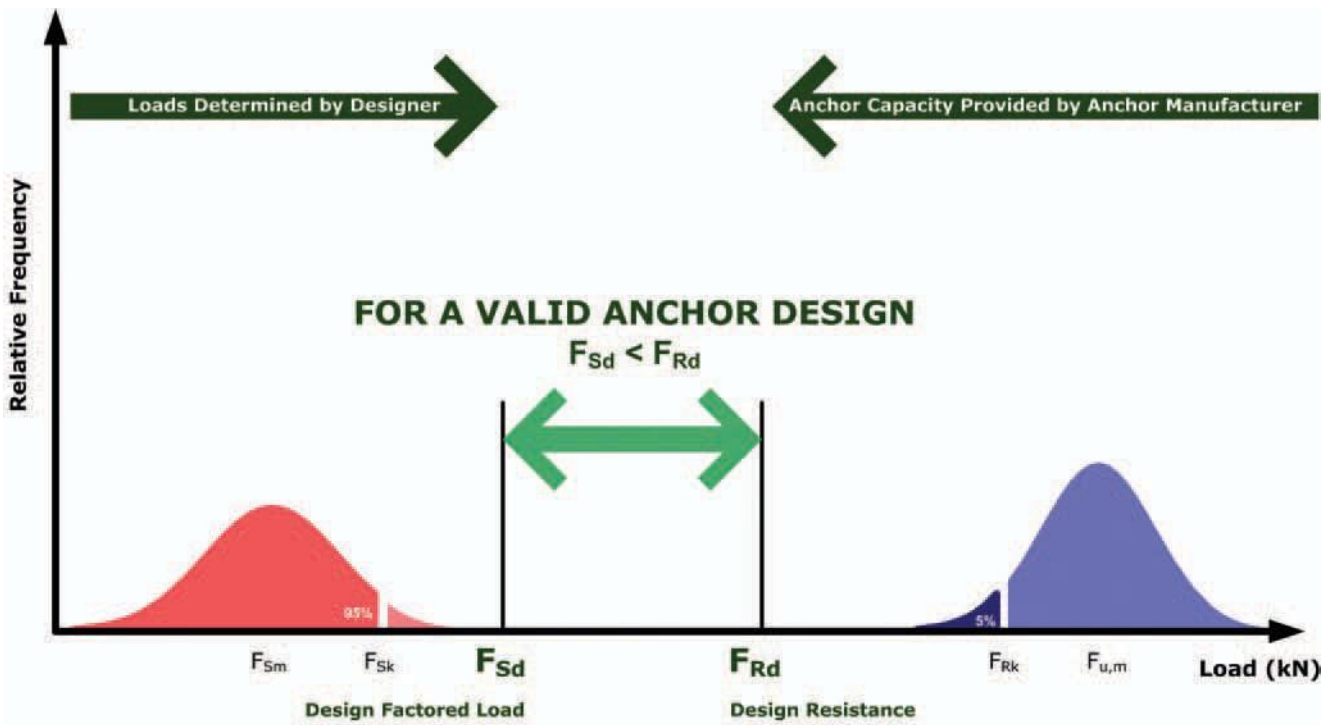
Next the anchor specifier calculates the loads acting on the anchors.



After anchor selection it has to be shown that the design load acting on the anchor is smaller than the design resistance of the anchor. This is represented in the figure below. According to ETAG 001, Annex C: Design method 'A' procedure, the design resistances for all failure modes are checked and the failure mode with the least capacity is decisive.

The ETAG documents can be downloaded free of charge from the EOTA website at [www.eota.be](http://www.eota.be).





**Correct Anchor Design**

Ref:	Detail:	Output:
	<p>The design is correct when the loads acting on the anchor are less than the design resistance provided by the anchor manufacturer.</p>	
	<p><b>STEP 1:</b> Get the correct information from the manufacturer.</p>	✓
	<p><b>STEP 2:</b> Complete the design for all possible failure modes in each load direction.</p>	✓
	<p><b>STEP 3:</b> Get the design checked.</p>	✓
	<p><b>STEP 4:</b> Clearly communicate the design/anchor specification.</p>	✓

The anchor specifier needs to calculate the following possible failure modes and ensure that the design resistance of the anchor is greater than the loads applied in each case.

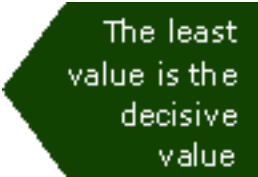
**In Tension**

- z Concrete cone failure (including edge and spacing effects).
- z Steel failure.
- z Pull-out failure.
- z Splitting failure.

The least value is the decisive value

### In Shear:

- z Steel failure (with and without lever arm).
- z Pryout failure (including edge and spacing effects).
- z Concrete edge failure (including edge and spacing effects).



The least  
value is the  
decisive  
value

All loading stages are to be identified by the anchor specifier at design stage. The anchor specifier shall consider the stresses experienced by the anchor throughout its lifespan.

Some manufacturers offer computer-aided software for the design of anchors according to the Partial Safety Factor design procedure. This greatly helps the anchor specifier to save time and costs for anchor design.

**Caution should be exercised in the use of the anchor design software, as a number of options are presented to the anchor specifier, the choice of which has considerable impact on the resultant output. Knowledge of ETAG 001, Annex C, will enable the specifier to verify the output from the design software.**

**The anchor specifier should ensure that the person inputting data into the computer has the requisite training, knowledge and experience, so that the anchor design will comply with the design assumptions and the site conditions.**

There are three basic scenarios that can exist when specifying anchors:

- z An anchor is not safety critical.
- z An anchor is being used in a Safety Critical Situation and is being designed and specified by the designer.
- z An anchor is being used in a Safety Critical Situation and while the designer will identify the need for the anchor, it will be designed and specified by the anchor manufacturer/supplier.

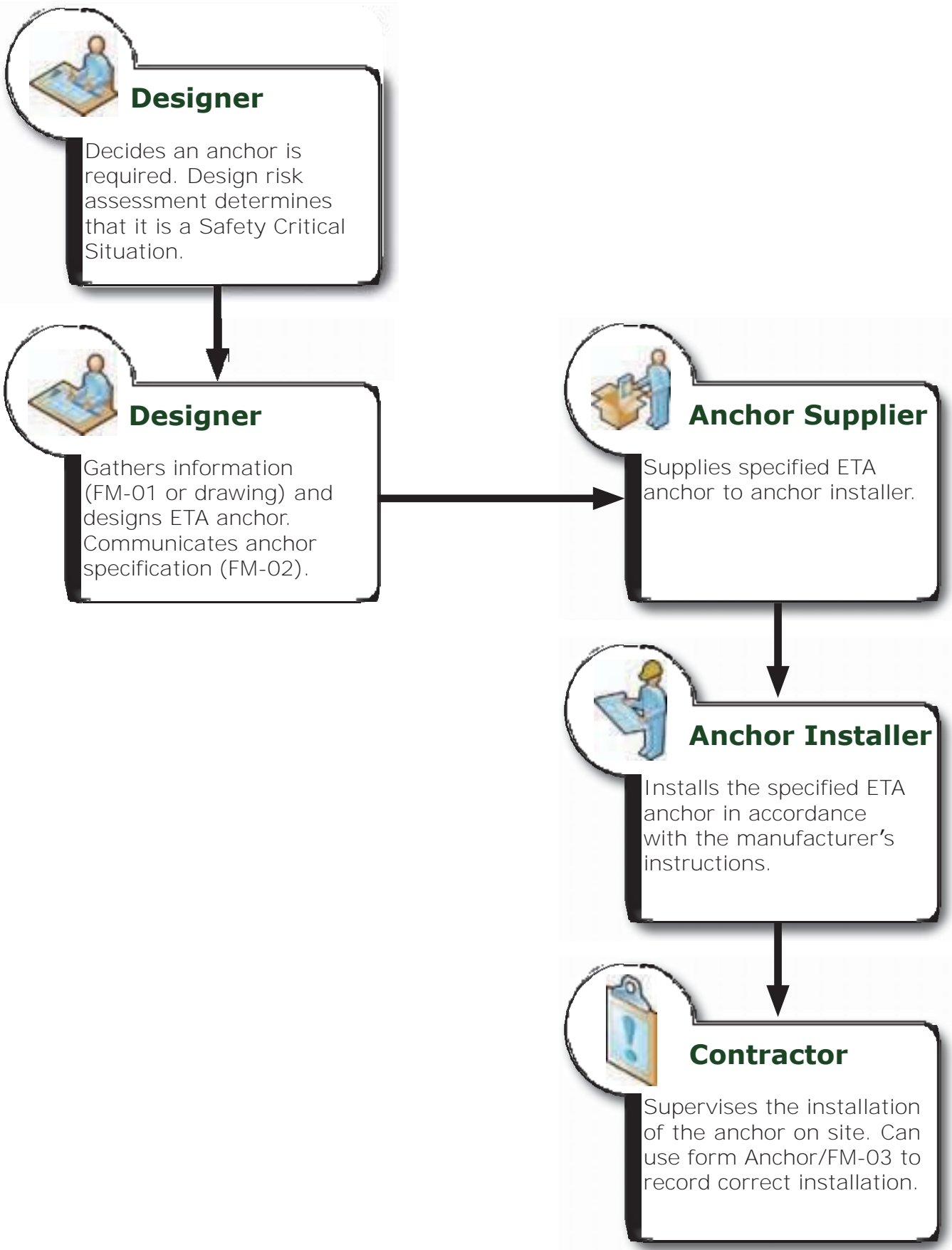
These three scenarios are summarised on the following pages.



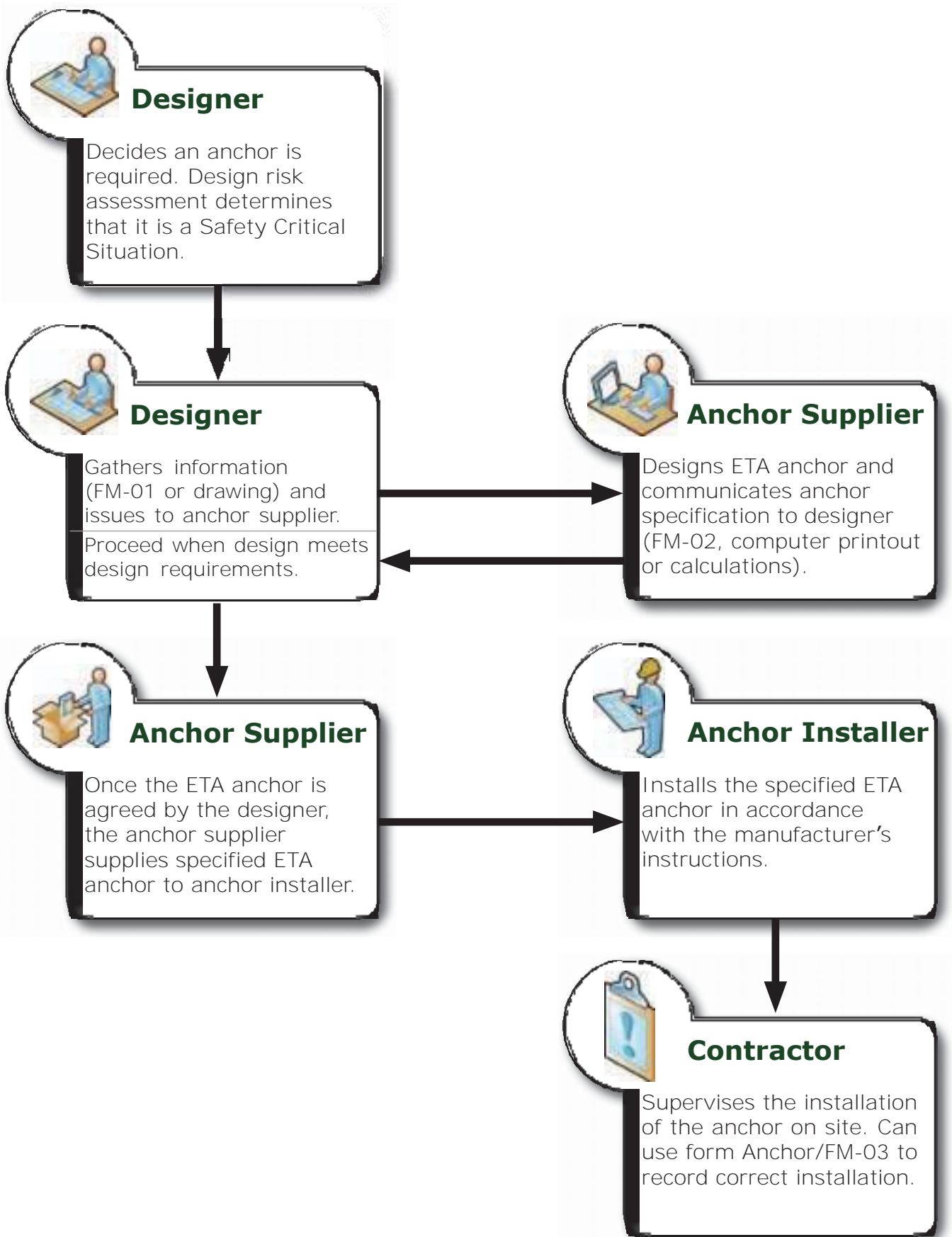
**SCENARIO 1: NON-SAFETY CRITICAL SITUATION**



**SCENARIO 2: SAFETY CRITICAL SITUATION, SPECIFIED BY DESIGNER**



**SCENARIO 3: SAFETY CRITICAL SITUATION, SPECIFIED BY ANCHOR SUPPLIER**



### YOU WILL NEED TO GATHER THIS INFORMATION BEFORE DESIGNING AND SPECIFYING AN ANCHOR

In order to undertake an anchor design, a minimum amount of information must be assembled beforehand.

This includes information on:

- z The concrete base material.
- z How close the anchors will be to the edge of the concrete.
- z The anchor plate.
- z The type of anchor being considered.
- z The ETA of the anchor.
- z Fire rating requirements and corrosion protection.
- z The loads acting on the anchor.
- z Project details.

If this information is not known, the anchor specifier will not be able to design the anchor.

Below is an example of the information that is required in relation to the concrete base material.

Information required for the design and specification of an anchor

Concrete | Edge Distances | Anchor Plate | Anchor Type | ETA | Other | Actions | Project Details

In order to design an anchor, you will need the following information about the base material.

Condition of concrete

Cracked concrete

Non-cracked concrete

Reinforcement

Non-reinforced concrete

Normally reinforced

Densely reinforced

Concrete strength

C20/25

C25/35

C30/37

C40/50

C45/55

C50/60

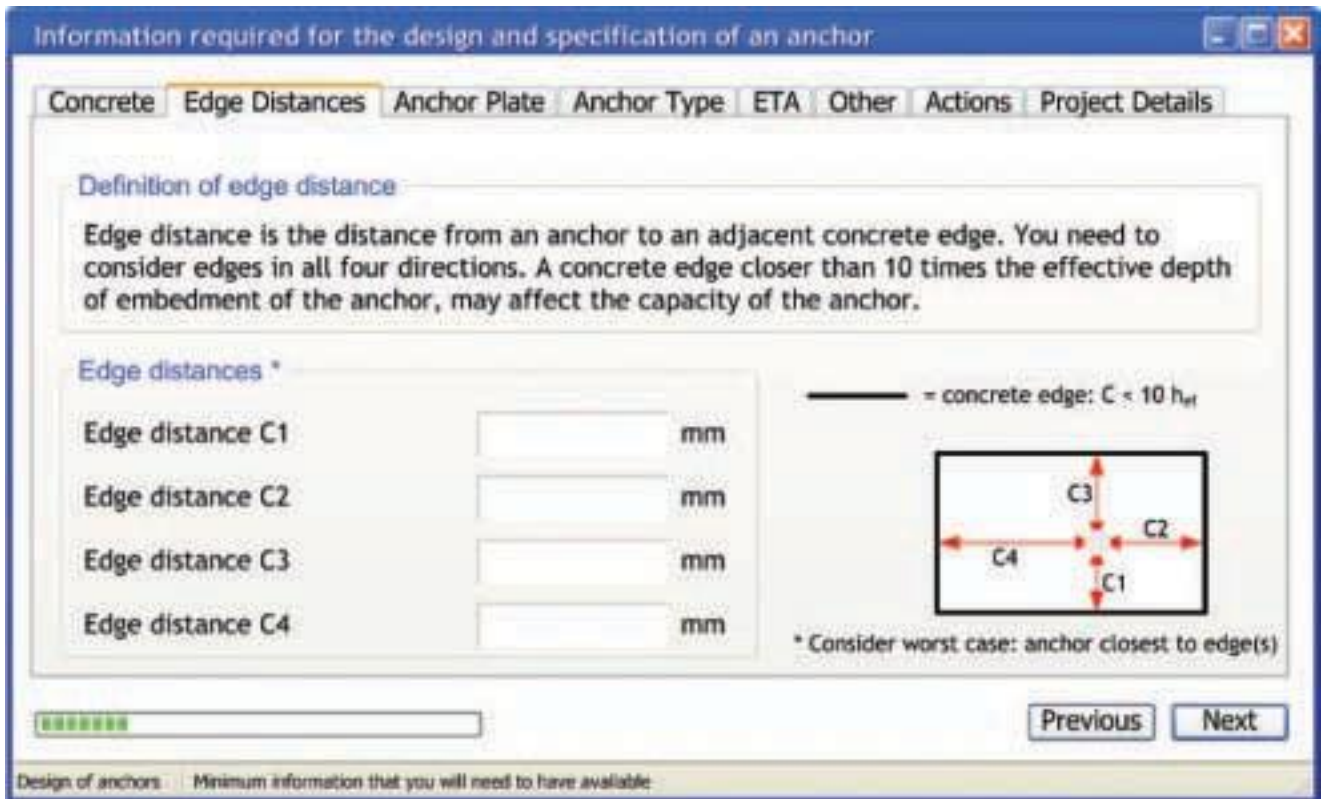
Concrete thickness

Thickness of concrete member  mm

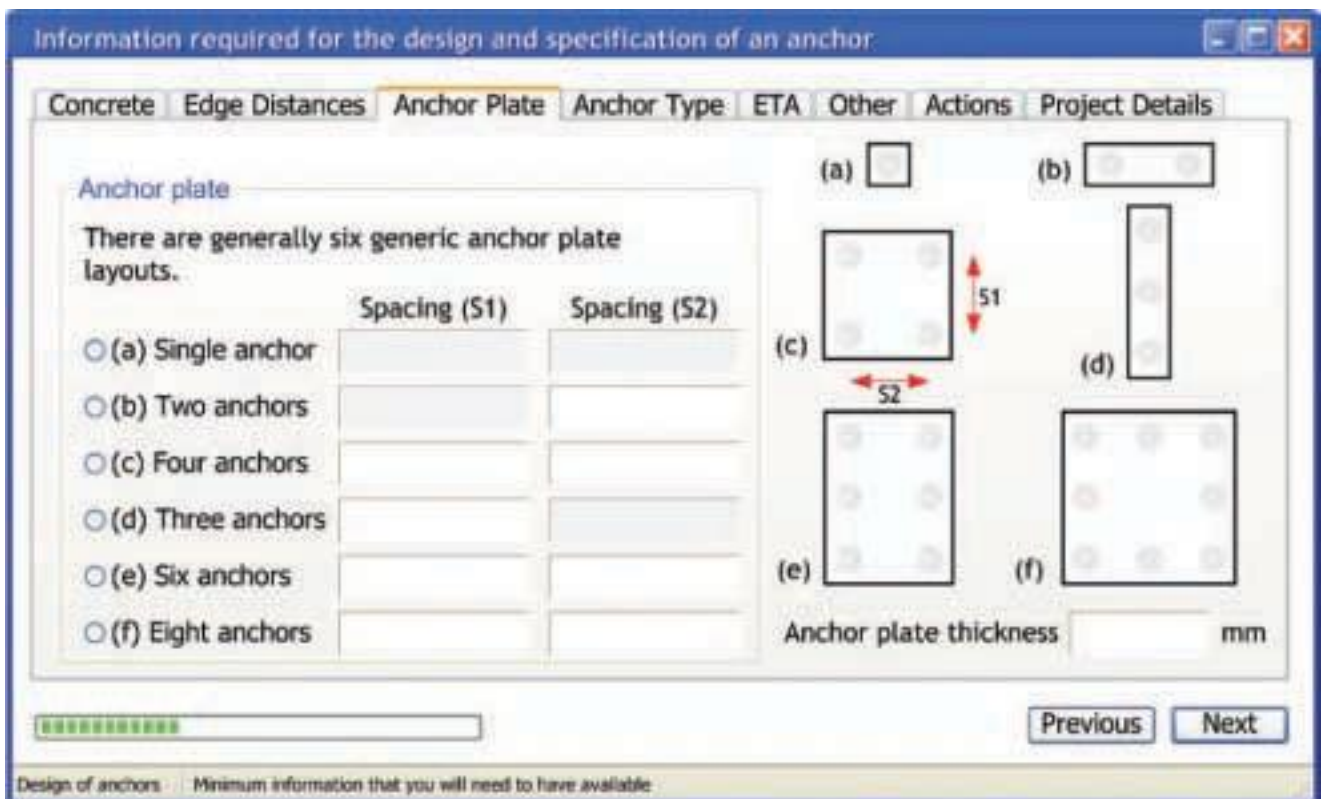
Next

Design of anchors Minimum information that you will need to have available

The second level of information to consider is the proximity of the anchor to a concrete edge. In particular the anchor specifier must consider edges that are closer than ten times the effective embedment depth of the anchor being considered.



The spacing of the anchors relative to each other affects the capacity of the anchor. Refer to Table 8.1 below when determining the dimensions of the anchor plate.





## Code of Practice for the Design and Installation of Anchors

The anchor specifier must identify the type of anchor. The four main types of anchor for use in concrete are detailed below.

The screenshot shows a software window titled "Information required for the design and specification of an anchor". The "Anchor Type" tab is selected. It contains several groups of radio buttons for selecting anchor types:

- Torque controlled expansion anchor
  - Sleeve torque controlled expansion anchor
  - Bolt torque controlled expansion anchor
  - Shield torque controlled expansion anchor
- Bonded anchor
  - Bonded anchor
  - Undercut bonded anchor
  - Torque-controlled bonded anchor
  - Glass or soft skin capsule
  - Injection type
  - Bulk mixing type
- Undercut anchor
  - Undercut drilled before anchor installation
  - Undercut made during installation
- Deformation controlled expansion anchor
  - Internally threaded cone-down type (drop-in)
  - Shank-down anchor
  - Sleeve-down anchor

There is also an "Other type" text input field. At the bottom, there are "Previous" and "Next" buttons and a progress bar.

The ETAG documents set out the different approval options available and the three main methods for designing ETA anchors. Full details are in the ETAG documents (see Appendix C: Information Sources).

The screenshot shows the same software window, but with the "ETA" tab selected. It contains the following sections:

- European technical approval**
  - Specifying an ETA anchor?  Yes  No
  - If yes, approval number: [text input field]
- Cracked and non-cracked approval options**
  - Option 1: up to C50/60; Design method A
  - Option 2: C20/25 only; Design method A
  - Option 3: up to C50/60; Design method B
  - Option 4: C20/25 only; Design method B
  - Option 5: up to C50/60; Design method C
  - Option 6: C20/25 only; Design method C
- Non-cracked approval options**
  - Option 7: up to C50/60; Design method A
  - Option 8: C20/25 only; Design method A
  - Option 9: up to C50/60; Design method B
  - Option 10: C20/25 only; Design method B
  - Option 11: up to C50/60; Design method C
  - Option 12: C20/25 only; Design method C

At the bottom, there are "Previous" and "Next" buttons and a progress bar.

The anchor specifier should consider the impact of fire on the performance of the anchor, particularly if specifying bonded anchors.

The screenshot shows a software window titled "Information required for the design and specification of an anchor". The "Other" tab is selected. Under the "Fire" section, there is a text box stating: "The load bearing capacity of chemical or plastic anchors is temperature dependent and decreases with increasing temperature." Below this are three radio button options: "No temperature requirements", "Long term temperature = 50°C; Short term temperature = 80°C", and "Long term temperature = 72°C; Short term temperature = 120°C". The "Anchor finishes" section has six radio button options: "Zinc plated and passivated steel (gvz)", "Hot dipped galvanised steel (fvz)", "Stainless steel: A1", "Stainless steel: A4 (grade 316)", and "High-corrosion resistant steel (1.4529)". At the bottom, there are "Previous" and "Next" buttons and a progress bar.

The anchor specifier must fully consider the loads that are going to act on the anchor. Anchor manufacturers provide specific guidance to assist the anchor specifier to identify the different load types.

The screenshot shows the same software window, but with the "Actions" tab selected. The "Type of actions" section contains a text box: "Consider static as well as non-static loads. For non-static loads a distinction is made between 'Pulsating loads' (size but not the direction of the load alters) and 'Alternating loads' (direction of the load may alter as well the size)." To the right are three radio button options: "Predominantly static actions", "Pulsating actions", and "Alternating actions". The "Actions" section has a table with four rows: "Tension ( $N_{sd}$ )", "Shear ( $V_{sd}$ )", "Moment ( $M_{sd}$ )", and "Torsion ( $M_{t,sd}$ )". Each row has input fields for a numerical value, the unit (kN or kNm), and a "Direction" dropdown menu. The "Bending" section has four radio button options: "No bending", "With non-load-bearing layer (thickness > d/2)", "Stand-off fixing without clamping to the concrete", and "Stand-off fixing with clamping to the concrete". At the bottom, there are "Previous" and "Next" buttons and a progress bar.



Lastly it is important to link this design information to a particular project. The anchor specifier can include his or her details and those of the project.

Information required for the design and specification of an anchor

Concrete Edge Distances Anchor Plate Anchor Type ETA Other Actions Project Details

Your details

Name

Contact number

Project details

Project

Address

Gather the information  Do the design  Communicate the design

Previous Finished

Design of anchors Minimum information that you will need to have available

Overall the steps are simple and straightforward:

- z Decide on the design approach to be followed.
- z Gather the necessary information together.
- z Design the anchor in accordance with the chosen design method.
- z Communicate the design in a clear and unambiguous manner.

Form Anchor/FM-01 provided in Appendix A will help the anchor specifier to gather the information needed to design an anchor.

### 8.11 Design of the Fixture

The design of the fixture is covered by separate standards and does not form part of this code of practice. However, particular attention should be taken in relation to the diameter of the clearance hole in the fixture and the projection of the fixture beyond the clearance hole.

Table 8.1 gives guidelines for detailing the dimensions of the fixture. If holes in the fixture are drilled, then the minimum projection should be 1.2 times the diameter of the clearance hole.

If the holes are punched, then the appropriate factor is 1.5.

The figures are rounded up to whole numbers.

**Table 8.1: Maximum Clearance Hole Diameter and Minimum Projections in Fixture**

<b>Anchor diameter</b>	<b>Max. clearance hole diameter</b>	<b>Min. projection (holes drilled)</b>	<b>Min. projection (holes punched)</b>
6mm	7mm	$7 \times 1.2 = 9\text{mm}$	$7 \times 1.5 = 11\text{mm}$
8mm	9mm	$9 \times 1.2 = 11\text{mm}$	$9 \times 1.5 = 14\text{mm}$
10mm	12mm	$12 \times 1.2 = 15\text{mm}$	$12 \times 1.5 = 18\text{mm}$
12mm	14mm	$14 \times 1.2 = 17\text{mm}$	$14 \times 1.5 = 21\text{mm}$
15mm	17mm	$17 \times 1.2 = 21\text{mm}$	$17 \times 1.5 = 26\text{mm}$
16mm	18mm	$18 \times 1.2 = 22\text{mm}$	$18 \times 1.5 = 27\text{mm}$
18mm	20mm	$20 \times 1.2 = 24\text{mm}$	$20 \times 1.5 = 30\text{mm}$
20mm	22mm	$22 \times 1.2 = 27\text{mm}$	$22 \times 1.5 = 33\text{mm}$
24mm	26mm	$26 \times 1.2 = 32\text{mm}$	$26 \times 1.5 = 39\text{mm}$
27mm	30mm	$30 \times 1.2 = 36\text{mm}$	$30 \times 1.5 = 45\text{mm}$
30mm	33mm	$33 \times 1.2 = 40\text{mm}$	$33 \times 1.5 = 50\text{mm}$




**Steel baseplate with punched holes**  
**20mm diameter anchors**  
**Maximum clearance hole = 22mm**  
**Minimum edge projection = 33mm**



## 9 INFORMATION SUPPLIED BY ANCHOR MANUFACTURER/SUPPLIER

The manufacturer and supplier of the anchor have a duty to provide standard fixing details and design data to both the specifier and the installer of the anchor, on request. The anchor should also be clearly labelled or marked with all relevant details required for its safe installation and intended use. Additional information regarding detailed anchor technology and design, ETA reports and safety data sheets, where applicable, should be made readily available.

Section 16 of the Safety, Health and Welfare at Work Act 2005 requires the anchor supplier to have this information available.



### Further Information

Ref:	Detail:	Output:
	<p><b>If you are unsure of the capacity of the anchor you are considering, please contact the supplier.</b></p> <p><b>Despite appearances, not all anchors are the same!</b></p> <p><b>Before you start designing please make sure you have up-to-date information and that you know how to use this information correctly.</b></p>	

The anchor manufacturer/supplier should readily provide, on request, the following information for the design of anchors.

### 9.1 Fixing Features

- z Material type used to manufacture the anchor (e.g. stainless steel, carbon steel).
- z Basic loading data (for a single anchor) for each material type and size:
  - z Mean ultimate resistance.  
**(Warning this figure should not be used in design)**
  - z Characteristic resistance.  
**(Warning this figure should not be used in design)**
  - z Design Resistance.
  - z Recommended resistance.

- z Setting details complete with dimensioned drawing.
- z Installation equipment required to install anchor adequately.
- z Setting operation detailing step-by-step procedures to install the anchor adequately.
- z Anchor geometry and mechanical properties.

### 9.2 Data Required for Detailed Design

- z Design method details (e.g. ETAG 001, Annex C, in accordance with Partial Safety concept, Eurocode 1).
- z Minimum thickness of base material.
- z Pull-out resistance or bond failure in the case of chemical anchors.
- z Concrete cone resistance as a function of embedment depth.
- z Minimum concrete edge and spacing criteria.
- z Reduction factors as required for edge distance, spacing, concrete strength and load direction(s).
- z Tensile and shear resistance of the steel.
- z Formula for combined tensile and shear loading situation.

Each anchor manufacturer generally provides the required information in one or both of the following formats:

- z Technical manuals.
- z Anchor design software.

The anchor specifier must be competent to undertake the design of the anchor, in either determining the correct or relevant information from the technical data, or by the correct use of the computer-aided design software provided by the anchor manufacturer.

The anchor specifier should also be aware of associated information on anchor technology and design, ETA reports and safety data sheets, where applicable.

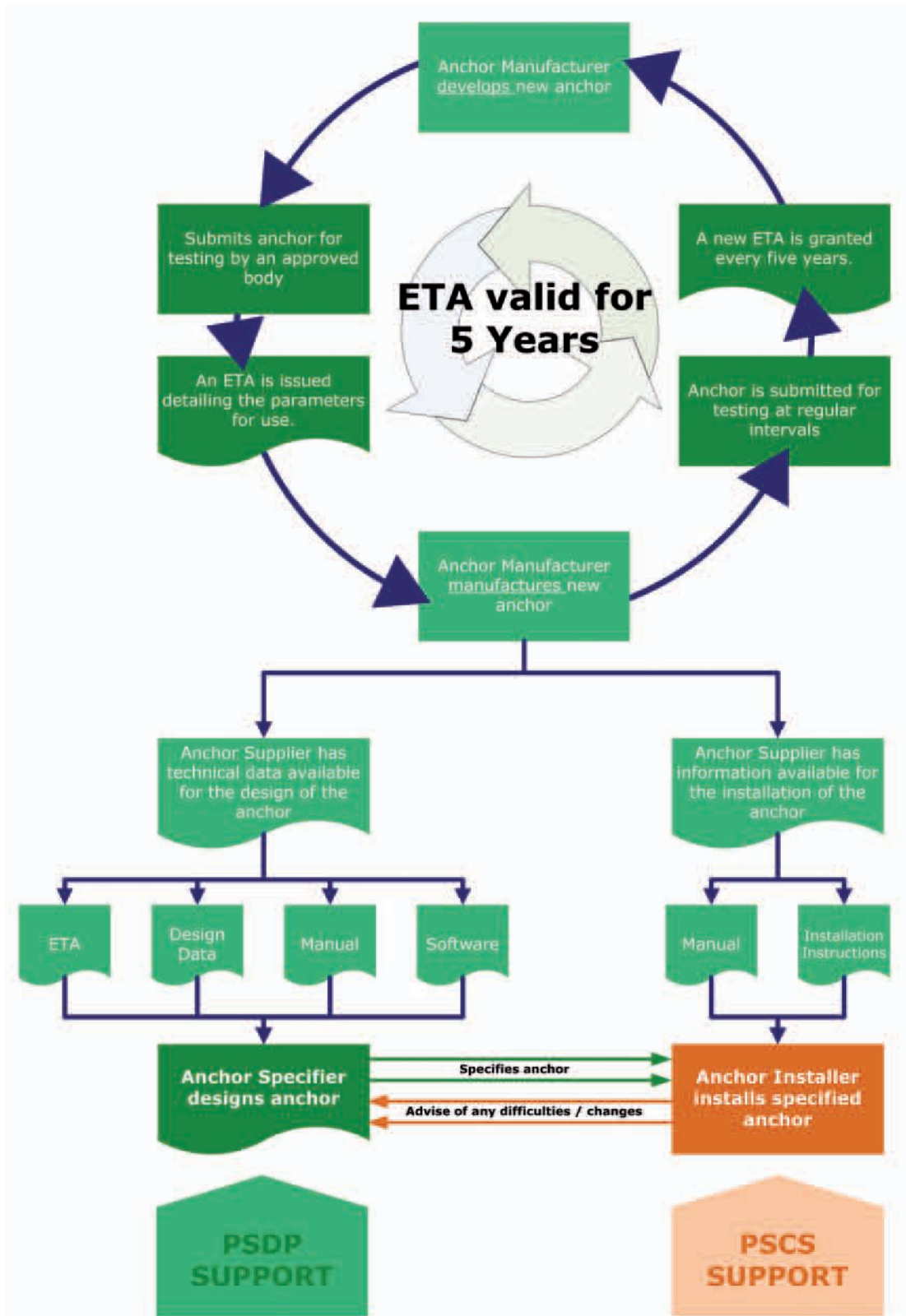
The following information should be clearly marked on the packaging or contained within the packaging of the anchor supplied by the manufacturer/supplier:

- z Size and type of anchor.
- z Base material suitability.
- z Setting details.
- z Setting operations.
- z Curing time and temperatures (where applicable).
- z Storage instructions (where applicable).

Each anchor should be clearly marked, identifying type of anchor and manufacturer.

The anchor manufacturer makes technical information available to both the anchor specifier and the anchor installer to allow them to undertake their tasks. Specifiers and installers should consult with the anchor manufacturer/supplier if they have any doubt as to the choice of the appropriate anchor or about the correct installation procedures.

The following chart outlines the life cycle of an anchor.



## 10 INSTALLATION OF ANCHORS IN CONCRETE

The Safety, Health and Welfare at Work Act 2005 stipulates that:

**2.-(2)(a) For the purposes of the relevant statutory provisions, a person is deemed to be a competent person where, having regard to the task he or she is required to perform and taking account of the size or hazards (or both of them) of the undertaking or establishment in which he or she undertakes work, the person possesses sufficient training, experience and knowledge appropriate to the nature of the work to be undertaken.**

The contractor should ensure that the person installing the anchor is competent and has the following:

### Training

- z Training in the setting of the particular anchor may be provided on site by the contractor or by the anchor supplier. Training from other sites may not be applicable as the installation requirements vary between different anchors.

### Knowledge

- z The anchor installer should have knowledge of the function of the anchor and the consequences if the installation procedures are not adhered to.

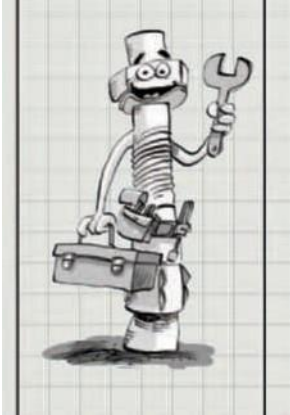
### Experience

- z The anchor installer should have experience of installing the particular type of anchor. If the installer has limited experience, closer supervision should be provided by the contractor to ensure that the installation is correct.

Each anchor type will have different instructions or requirements for the correct setting of the anchor. Section 10.1 provides an example of a set of instructions issued to an anchor installer, which should be carried out in sequence so as to ensure the correct installation of the anchor.



## Further Information



### TOOL-UP!

**Each type of anchor has different steps that you have to follow when you are installing it into concrete.**

**Holes for chemical anchors need special cleaning before you put in the chemicals.**

**When installing torque-controlled expansion anchors you will need a torque wrench.**



### 10.1 Installation of Torque-Controlled Anchor: Setting Operations

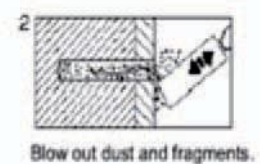
This is an example of installation instruction for a torque-controlled expansion anchor. Instructions will differ for each type of anchor or for variations of an anchor type. The anchor installer should refer to the instructions provided for the particular anchor being installed.

1. Drill hole with the correct nominal diameter drill bit, making sure to use a rotary hammer-drilling machine. Ensure that the drill bit tolerances are inside the requirements (e.g. by checking the quality mark stamped on the drill bit shaft). The hole should be as close to 90° to the surface as possible.

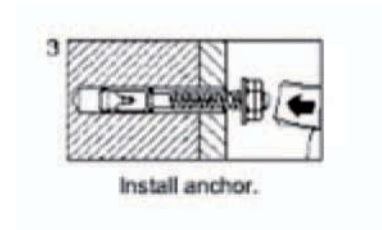


**Remember — check correct drilling depth and drill bit for wear as this could result in the hole being undersized.**

2. Clean the hole according to the manufacturer's written installation instructions. Using a pump, blow out dust and fragments from the hole. Just blowing may be adequate for most mechanical anchors.

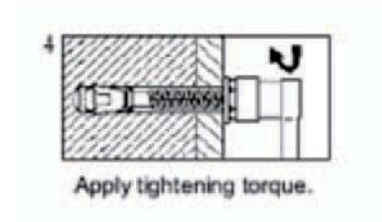


- When installing the anchor make sure the nut is located on the outside tread, as shown here.




- Tighten the anchor to the recommended tightening torque, as stated by the anchor manufacturer.

**A torque wrench MUST be used to apply this torque.**





# 11 SUPERVISION AND INSPECTION OF ANCHORS

Close supervision of the installation of anchors is to be provided by a supervisor who is a competent member of the site management team. The supervisor appointed to undertake this role by the contractor should be trained in the installation of anchors and be competent to undertake this role.



## Supervision and Inspection of Anchors

Ref:	Detail:	Output:
	<p><b>When your workers are installing anchors, you must check that they are doing it in accordance with the instructions given.</b></p> <p><b>If an anchor is installed incorrectly, then it might not be able to carry the load that it was designed for.</b></p> <p><b>Give your workers the correct instructions and equipment and then make sure that they are doing it correctly.</b></p>	

The supervisor must ensure that the following issues have been adequately addressed:

**z The anchor type being used satisfies the design requirements of the specifier:**

- z Anchor make.
- z Anchor type.
- z Condition of anchor.
- z Anchor diameter and length.

**z The anchor position is as per the design:**

- z Anchor embedment.
- z Anchor location.

### **z The base material condition and hole dimensions are as specified:**

- z Concrete strength.
- z Anchor hole diameters and depths as per the manufacturer's recommendations.
- z Setting out of anchors on the base material as per design, including factors that affect the capacity of the anchor such as required minimum thickness of base material, minimum edge distances and minimum spacing between the anchors.

### **z Condition of unit to be fixed:**

- z Fixture condition.
- z Fixture type and material.
- z Hole locations and diameters as per design.

### **z Installed anchor:**

- z Correct torque.

### **z Change of requirements:**

- z If amendments are required – due to reinforcement clash, quality of concrete base material etc. – the proposed revised installation must be communicated to the anchor specifier for approval.

The supervisor shall be required to certify that the anchor is correctly installed and suitable for loading. This acceptance shall be recorded by completion of form Anchor/ FM-03 in Appendix A.

The supervision of the installation of the anchor is required to ensure that it is installed in accordance with:

- z The design.
- z The manufacturer's recommendations.

In the event that the anchor hole clashes with reinforcement or other changes arise, the supervisor should give clear instructions to the anchor installer for the correct installation of the anchor. In this instance the anchor specifier must be made aware of and approve the proposed changes prior to the anchors being installed on site. ETAG 001, Annex C: Design methods for anchorages, gives guidance on the effects of reinforcement on the anchor design.

Changes in the specification of the proprietary anchors should only be made where the proposed alternative satisfies all the original design parameters and has been approved by the anchor specifier. Proprietary anchors should never be adapted or altered.

Once the installation of the anchor has been completed, and prior to the anchor being

subjected to the intended design loading a thorough inspection shall be undertaken. The supervisor shall inspect the fixture and each anchor prior to and subsequent to the load being fully transmitted into them.

Any observations regarding movements, cracking, rotation etc. should be carefully recorded and communicated to the PSCS and the anchor specifier. If the supervisor has any concerns regarding the suitability of the anchor, the placing of further units should not proceed and the anchor in question should be made safe until the concerns have been addressed to the satisfaction of the PSCS and the anchor specifier.

A similar inspection should be undertaken at each stage of subsequent loading.

## 12 TESTING OF ANCHORS

On-site testing of ETA anchors is not normally required, as these anchors have undergone rigorous testing as part of the approval process.

Currently an ETA is granted for anchors used in concrete. Accordingly, design resistance capacity is only available for anchors with ETAs installed in concrete. At date of publication ETA design data is not available for anchors in other base materials.

If the anchor specifier intends to design anchors that do not have an ETA, or intends to use an ETA anchor outside the scope of the approval document, then testing of the anchor in the specific base material will be required to determine the safe capacity of the anchor in this particular base material. The anchor specifier will then design the anchor based on the test results.

Situations where testing may or may not be required are summarised below.

<b>Testing requirements:</b>			
	<b>ETA anchor installed in concrete, in accordance with manufacturer's instructions</b>	<b>ETA anchor installed in masonry or other base materials</b>	<b>Situations where there is concern over quality of installation</b>
<b>No testing required</b>	ETA anchors are tested in concrete by the anchor manufacturer.  <b>No additional site testing required.</b>		
<b>Testing required</b>		Anchor manufacturer's technical data does not currently include the use of ETA anchors in masonry or other base materials.  <b>Tests should be undertaken to determine the capacity of the base material for the anchor connection.</b>  <b>ULTIMATE LOAD TEST</b>	While an ETA anchor does not require additional site testing, there may be concerns as to the quality of the anchor installation.  <b>Tests should be undertaken to determine the capacity of connection is in accordance with the anchor design.</b>  <b>PROOF LOAD TEST</b>

Where tests are required, the requirements and objectives of the testing should be determined in advance. This will include the following considerations:

- z Type and condition of base material.
- z Anchor type.
- z Installation details.
- z Edge distances and spacing.
- z Load direction (generally tensile tests are undertaken).
- z Level of testing (ultimate load test or proof load test), refer to the anchor manufacturer.
- z Competency of the anchor tester.
- z Condition and calibration of the test equipment.
- z Format and contents of the test report.

If undertaking tests to determine the capacity of a base material (ultimate load tests), at least three tests should be carried out.

Tests to verify the quality of the anchor installation (proof load tests) should include 2.5 percent of the total number of anchors installed (1 in 40 anchors), with a minimum of three tests. The rate of testing should be increased if anchors fail to achieve the criteria established by the anchor specifier.

Refer to the anchor manufacturer/supplier for further information and site-specific guidance.



## 13 CERTIFICATION OF DESIGN AND INSTALLATION

In order to establish a formal record that the anchor system has been designed and installed to the approval of the anchor specifier, contractor, PSDP and PSCS, it is necessary to develop a system of certification. The certification system developed for use in conjunction with this code of practice also establishes lines of communication between the different parties involved.

Anchor specifiers should use form Anchor/FM-02 to record the design of temporary and permanent anchors so that the design assumptions for anchors can be clearly communicated. This record will assist the contractor to coordinate the checking of the anchor installations on site. A design risk assessment should be produced by the anchor specifier for the use of anchors for each particular application.

The anchor specifier and PSDP should complete either a permanent works design certificate (for permanent anchors) or a temporary works design certificate (for temporary anchors). While the use of the suggested Health and Safety Authority (HSA) certificates is not mandatory, it is anticipated that the anchor specifier and PSDP would use these or an equivalent alternative so as to communicate their compliance with health and safety legislation. Refer to the HSA's *Guidelines on the Procurement, Design and Management Requirements of the Safety, Health and Welfare at Work (Construction) Regulations 2013* for further information on permanent and temporary works design certificates.

As the installation process moves forward the contractor will arrange for the completion of the anchor installation checklist (form Anchor/FM-03) by the installation supervisor.

If amendments and redesign are required at any point during the design process or during the installation of the anchor, the PSDP will coordinate the activities of the designers (including the anchor specifier) and arrange for recertification as necessary.

The PSDP will liaise with the PSCS to ensure effective transfer of information from the anchor specifier to the contractor and to incorporate any amendments of the Safety and Health Plan into the Safety File.

On completion of the project the PSDP shall deliver the completed Safety File to the client, for his or her retention.

## 14 CHANGE MANAGEMENT — ALTERNATIVE ANCHORS

Change is an inevitable and continual process in the construction industry. Designs change when additional or new information becomes available. Proposed construction sequences and approaches can change when projects are awarded, as contractors seek to amend the materials and design used to suit their preferred method of working.

**The person instigating the change is considered to be a designer and should comply with the requirements of this code of practice.**

The successful management of change in the design and construction process requires that procedures be established which clearly define lines of communication and responsibilities. The flowcharts in Section 8 establish the various roles and responsibilities in the context of the scope of this code of practice.

The breakdown of communication and control systems can lead to significant changes taking place in the design assumptions or installation procedures without the knowledge of the anchor specifier. Un-communicated and/or un-documented changes can have serious consequences.

If changes are required to any element of the anchor design and/or installation, then they should be recorded on the design certificate and a full assessment of the changes should be completed by the anchor specifier. This process has to be coordinated by the PSDP.

Some typical changes that may occur are:

- z Unavailability of or delay in sourcing the specified anchor leading to alternatives being used.
- z Clashing with steel reinforcement leading to anchor holes being too short or in the wrong position.
- z A late change in the design loading information leading to under-specified anchors.

Irrespective of the cause of the change, the anchor specifier has to re-design the anchor so as to ensure that the proposed anchor satisfies the original design assumptions and will have adequate capacity to support the loads imposed.

Form Anchor/FM-02 in Appendix A can be used to communicate the revised anchor specification. The anchor specifier can also issue hand calculations or the computer printout for the alternative anchor.

# Appendices

## APPENDIX A

# Recommended Forms for the Design and Installation of Anchors

### **Sample Forms:**

#### **Anchor/FM-01 (information gathering)**

This form can be used to gather the information together in order to carry out an anchor design. You can use your own form or alternatively you can include the information on a drawing or sketch.

#### **Anchor/FM-02 (anchor specification)**

This form can be used to communicate the anchor design. You can use your own form or alternatively you can use the computer printout from the anchor manufacturer's computer-aided design software or hand calculations.

#### **Anchor/FM-03 (anchor installation)**

This form can be used to check that the anchor has been installed correctly on site. You can use your own checklist.

These sample forms are provided as examples. You may use similar forms, based on the ones included in this code of practice.

## Anchor/FM-01 (information gathering)

This form can be used to gather the information together in order to carry out an anchor design.



### Designer

- The designer can use this form to gather the information that will be needed to undertake the design of the anchor.
- If the design is going to be undertaken by another person (for example the anchor supplier), then this form is useful to communicate the particular application.
- The designer can complete this form and either use it in-house or forward it to the anchor supplier.

**Information Required for the Design of Temporary and Permanent Anchors** **Anchor Form: FM-01**

Use this form to gather the information that you will need in order to design the anchors. Refer to pages 50 to 54 of the code of practice. If you are getting someone else to design the anchors, you must be reasonably satisfied that they are competent to carry out this design.

Your name: \_\_\_\_\_

Company: \_\_\_\_\_

Telephone number: \_\_\_\_\_

Reference number: \_\_\_\_\_

Project: \_\_\_\_\_

Date: \_\_\_\_\_

Purpose / application: \_\_\_\_\_

Tick here if you are going to do the design in-house; or

Tick here if you are going to get someone else to do the design

Tick here if you are attaching a sketch or drawing

**Concrete**

Provide details of the concrete base material.

Condition of concrete:  Cracked concrete  Non-cracked concrete

Reinforcement:  Non-reinforced concrete  Normally reinforced  Densely reinforced

Concrete strength: \_\_\_\_\_ Concrete thickness: \_\_\_\_\_ mm

Edge distance (C1): \_\_\_\_\_ mm Edge distance (C2): \_\_\_\_\_ mm

Edge distance (C3): \_\_\_\_\_ mm Edge distance (C4): \_\_\_\_\_ mm

**Anchor Plate**

Provide details of the anchor plate. Attach a sketch of the plate, showing the anchor positions.

Number of anchors: \_\_\_\_\_ Spacing (S1): \_\_\_\_\_ mm Spacing (S2): \_\_\_\_\_ mm

Anchor plate material: \_\_\_\_\_ Anchor plate size: \_\_\_\_\_ mm

**Anchor Type**

Provide details of the type of anchor you intend to specify. There are four main types, refer to page 52.

Preferred anchor type:  Torque controlled expansion anchor  Undercut anchor  Bonded anchor  
 Deformation controlled expansion anchor  Other \_\_\_\_\_

Fire requirements: \_\_\_\_\_ Anchor finish: \_\_\_\_\_

**Actions (Loads)**

Provide details of all actions that will act on the anchor. Provide the maximum tension, shear and moment actions.

**Actions:**

Tension ( $N_{sd}$ ): \_\_\_\_\_ kN

Shear ( $V_{sd}$ ): \_\_\_\_\_ kN

Moment ( $M_{sd}$ ): \_\_\_\_\_ kNm

Torsion ( $M_{t, sd}$ ): \_\_\_\_\_ kNm

**Action direction:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Action type:**

Static actions

Pulsating actions

Alternating actions

Safety Critical Situation:  Yes, safety critical

No, not safety critical

No bending

With non-load bearing layer (thickness > d/2)

Stand-off fixing without clamping to concrete

Stand-off fixing with clamping to concrete

## Anchor/FM-02 (anchor specification)

This form can be used to communicate the anchor design.



### Designer

- If the designer has designed the anchor in-house, then he or she can use this form to communicate the specification of the anchor to the contractor.
- If an alternative anchor is being considered, then this form can be used to communicate the revised specification.
- This form should be issued to the anchor supplier and contractor, as appropriate.

OR



### Anchor Manufacturer/Supplier

- If the designer has requested the anchor supplier to undertake the design, then the anchor supplier should use this form to communicate the specification of the anchor back to the designer.
- Once the specification of the anchor is agreed with the designer, then this form can be used to communicate the anchor specification to the contractor.
- If an alternative anchor is being considered, then this form can be used to communicate the revised specification.
- This form should be issued to the designer and contractor, as appropriate.



**Communication of Temporary / Permanent Anchor Design**

**Anchor Form: FM-02**

Use this form to communicate the anchor design to the relevant people.

Customer name: \_\_\_\_\_

Company: \_\_\_\_\_

Telephone number: \_\_\_\_\_

Reference number: \_\_\_\_\_

Project: \_\_\_\_\_

Date: \_\_\_\_\_

Purpose / application: \_\_\_\_\_

Tick here if you are attaching the computer design output for the anchor

**Basis of Design**

We have prepared this design on the basis of the information you have provided to us.

Date: \_\_\_\_\_

Reference number: \_\_\_\_\_

**Anchor Design / Specification**

Provide the full specification of the anchor that you are recommending, based on your design.

Safety critical situation:  Yes, safety critical  No, not safety critical

Anchor make: \_\_\_\_\_

Anchor type: \_\_\_\_\_

Reference number: \_\_\_\_\_

Anchor diameter: \_\_\_\_\_ mm

Anchor length: \_\_\_\_\_ mm

Drill hole depth: \_\_\_\_\_ mm

Clearance hole dia.: \_\_\_\_\_ mm

Concrete drill hole dia.: \_\_\_\_\_ mm

Anchor material: \_\_\_\_\_

Corrosion protection: \_\_\_\_\_

No. anchors per fixture: \_\_\_\_\_

Anchor spacing: \_\_\_\_\_ mm

Min. edge distance: \_\_\_\_\_ mm

Min. concrete strength: \_\_\_\_\_

Min. concrete thickness: \_\_\_\_\_ mm

ETA number: \_\_\_\_\_

ETA design option: \_\_\_\_\_

Anchor markings: \_\_\_\_\_

Torque: \_\_\_\_\_

Setting details: \_\_\_\_\_

Additional comments: \_\_\_\_\_

This design is valid for the information provided. If the requirements of the anchor change then a new design must be completed and communicated. The anchor specification provided above should be included on drawings and/or in specifications. If an alternative anchor is proposed then a new design must be completed to verify that the proposed anchor complies with the original design intention.

Name: \_\_\_\_\_

Signature: \_\_\_\_\_

## Anchor/FM-03 (anchor installation)

This form can be used to check that the anchor has been installed correctly on site.



### Anchor Installer

- The contractor can use this form to record the correct installation of the anchor on site.
- It is intended that the supervision of the installation would be appropriate to the nature of the anchor, for example if the anchor is being used in Safety Critical Situations.
- This form is a checklist that can be used to confirm that the anchor is being installed in accordance with the manufacturer's instructions.
- This form does not need to be issued to other duty holders.
- Completed copies can be kept on site.

**Checking Installation of Temporary / Permanent Anchors**

**Anchor Form: FM-03**

Use this checklist to verify that the right anchors are being installed and that they are being installed correctly (e.g. in accordance with the manufacturer's instructions).

Project: \_\_\_\_\_

Anchor installer: \_\_\_\_\_

Supervisor: \_\_\_\_\_

Date: \_\_\_\_\_

Tick here if you are attaching anchor test results

**Specified Anchor**

Check the installation of the anchors against the following specification.

Anchor make: \_\_\_\_\_

Anchor type: \_\_\_\_\_

Reference number: \_\_\_\_\_

Location on site: \_\_\_\_\_

Anchor purpose:     Permanent anchor                       Temporary anchor

**Anchor Being Used On Site**

Check the anchor type. Tick if correct.

Correct make of anchor:

Correct type of anchor:

Correct anchor reference number:

Correct anchor material:

Correct anchor diameter:

Correct anchor length:

Correct corrosion protection:

Correct ETA reference number:

Correct head marking (if any):

**Installation of Anchor**

Check the anchor installation. Tick if correct.

Correct installation instructions available:

Correct number of anchors:

Correct edge distances and spacing:

Correct drill bit:

Correct hole diameter and hole depth:

Correct cleaning tools and procedures:

Correct setting tools:

Anchors installed correctly:

Anchor tests (if required / specified):

**Concrete Base Material**

Check the condition of the concrete base material.

Condition (generally): \_\_\_\_\_ (in anchorage area) \_\_\_\_\_

Clashes with rebar: \_\_\_\_\_ Concrete cube results: \_\_\_\_\_

Additional comments: \_\_\_\_\_

Supervisor's name: \_\_\_\_\_ Signature: \_\_\_\_\_

## APPENDIX B

### Example of European Technical Approval Document (ETA 05/0789)

**ETA 05/0789 is a fictitious reference number and does not relate to an actual ETA.**

This is an example of an ETA.

ETA-05/0789 is a fictitious reference number and this reference number does not relate to an approved ETA.

Centre Scientifique et  
Technique du Bâtiment  
4, avenue du Recteur Poincaré  
F-75782 PARIS Cedex 16  
Tél. : (33) 01 40 50 28 28  
Fax : (33) 01 45 25 61 51



EOTA APPROVED TESTING HOUSE:

CSTB undertook the testing of this particular anchor.

The year of granting the ETA is given in 2-digits, followed by a unique 4-digits reference number.

## European Technical Approval **ETA-05/0789**

(English language translation, the original version is in French language)

Nom commercial :  
Trade name:

[Manufacturer's Trade Name for Anchor]

Titulaire :  
Holder of approval:

[Address of the holder of the approval]

Type générique et utilisation prévue du produit de construction :  
Generic type and use of construction product:

Cheville à scellement en acier galvanisé pour fixation dans le béton non fissuré : diamètres M8, M10, M12, M16, M20, M24, M27 et M30.  
Bonded anchor made of galvanized steel for use in non cracked concrete: sizes M8, M10, M12, M16, M20, M24, M27 and M30.

Validité du :  
au :  
Validity from / to:

01/10/2002  
01/10/2007

Usine de fabrication :  
Manufacturing plant:

[Place where anchor is manufactured]

Le présent Arrêté technique européen contient :  
This European Technical Approval contains:

13 pages incluant 5 annexes faisant partie intégrante du document.

13 pages including 5 annexes which form an integral part of the document.

**Generic type of anchor:**  
Torque-Controlled anchor, Undercut anchors, Deformation-Controlled anchor, Bonded anchor, etc. Information also provided on material, anchor diameter and approved base material.



Organisation pour l'Agrément Technique Européen  
European Organisation for Technical Approvals



The next seven pages form standard EOTA text applicable to the approval and use of anchors, in accordance with European Communities Directives and ETAG guidance documents.

## I LEGAL BASES AND GENERAL CONDITIONS

1. This European Technical Approval is issued by the Centre Scientifique et Technique du Bâtiment in accordance with:
  - Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products<sup>1</sup>, modified by the Council Directive 93/68/EEC of 22 July 1993<sup>2</sup>;
  - Décret n° 92-647 du 8 juillet 1992<sup>3</sup> concernant l'aptitude à l'usage des produits de construction;
  - Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals set out in the Annex of Commission Decision 94/23/EC<sup>4</sup>;
  - Guideline for European Technical Approval of « Metal Anchors for use in Concrete » ETAG 001, edition 1997, Part 1 « Anchors in general » and Part 5 « Bonded anchors ».
2. The Centre Scientifique et Technique du Bâtiment is authorised to check whether the provisions of this European Technical Approval are met. Checking may take place in the manufacturing plant (for example concerning the fulfilment of assumptions made in this European Technical Approval with regard to manufacturing). Nevertheless, the responsibility for the conformity of the products with the European Technical Approval and for their fitness for the intended use remains with the holder of the European Technical Approval.
3. This European Technical Approval is not to be transferred to manufacturers or agents of manufacturer other than those indicated on page 1; or manufacturing plants other than those indicated on page 1 of this European Technical Approval.
4. This European Technical Approval may be withdrawn by the Centre Scientifique et Technique du Bâtiment pursuant to Article 5 (1) of the Council Directive 89/106/EEC.
5. Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of the Centre Scientifique et Technique du Bâtiment. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.
6. The European Technical Approval is issued by the approval body in its official language. This version corresponds to the version circulated within EOTA. Translations into other languages have to be designated as such.

<sup>1</sup> Official Journal of the European Communities n° L 40, 11.2.1989, p. 12

<sup>2</sup> Official Journal of the European Communities n° L 220, 30.8.1993, p. 1

<sup>3</sup> Journal officiel de la République française du 14 juillet 1992

<sup>4</sup> Official Journal of the European Communities n° L 17, 20.1.1994, p. 34



## II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

### 1 Definition of product and intended use

#### 1.1. Definition of product

The [manufacturer's Anchor] with anchor rod in the sizes M8 to M30 is a bonded anchor made of galvanised steel, which is placed into a drilled hole previously filled with a capsule of resin, hardener and quartz sand or corundum. The threaded rod is driven into the capsule with a drilling machine. The rotation of the threaded rod allows the mixing of the different capsule elements.

For the installed anchor see Figure given in Annex 1.

#### 1.2. Intended use

The anchor is intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106/EEC shall be fulfilled and failure of anchorages made with these products would compromise the stability of the works, cause risk to human life and/or lead to considerable economic consequences. Safety in case of fire (Essential Requirement 2) is not covered in this ETA. The anchor is to be used only for anchorages subject to static or quasi-static loading in reinforced or unreinforced normal weight concrete of strength classes C 20/25 at least to C50/60 at most according to ENV 206: 2000-12. It may be anchored in non-cracked concrete only.

The anchor may only be used in concrete subject to dry internal conditions.

The anchor may be installed in dry or wet concrete or in flooded holes excepting sea water (use category 2) for diameters from M8 to M27, and only in dry or wet concrete for diameter M30 (use category 1).

Installation	Substrate		
	Dry concrete	Wet concrete	Flooded hole
M8 to M27	Yes	Yes	Yes
M30	Yes	Yes	No

All the diameters (i.e. from M8 to M30) may be used overhead.

The anchor may be used in the following temperature ranges :

Temperature range : -40°C to +80°C (max short term temperature +80°C and  
max long term temperature +50°C)

Temperature range : -40°C to +120°C (max short term temperature +120°C and  
max long term temperature +72°C)

The provisions made in this European Technical Approval are based on an assumed intended working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

## 2 Characteristics of product and methods of verification

### 2.1 Characteristics of product

The anchor in the sizes of M8 to M30 corresponds to the drawings and provisions given in Annexes 1 to 3. The characteristic material values, dimensions and tolerances of the anchor not indicated in Annexes 2 and 3 shall correspond to the respective values laid down in the technical documentation<sup>5</sup> of this European Technical Approval. The characteristic anchor values for the design of anchorages are given in Annexes 4 and 5.

Each anchor is marked with the company label, the nominal diameter of the threaded part of the rod and the embedment depth according to the description given in annex 1. Each capsule is marked with the company label, the commercial name and the nominal diameter of the threaded rod.

The anchor shall only be packaged and supplied as a complete unit, capsules being packed separately from threaded rods, washers and nuts.

### 2.2 Methods of verification

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 has been made in accordance with the « Guideline for European Technical Approval of Metal Anchors for use in Concrete », Part 1 « Anchors in general » and Part 5 « Bonded anchors », on the basis of Option 8.

*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 UE Construction Products Directive, these requirements need also to be complied with, when and where they apply.*

## 3 Evaluation of Conformity and CE marking

### 3.1 Attestation of conformity system

The system of attestation of conformity 2 (i) (referred to as system 1) according to Council Directive 89/106/EEC Annex III laid down by the European Commission provides:

a) tasks for the manufacturer:

1. factory production control,
2. further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan.

b) tasks for the approved body:

3. initial type-testing of the product,
4. initial inspection of factory and of factory production control,
5. continuous surveillance, assessment and approval of factory production control.

<sup>5</sup> The technical documentation of this European Technical Approval is deposited at the Centre Scientifique et Technique du Bâtiment and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.



## 3.2. Responsibilities

### 3.2.1. Tasks of the manufacturer, factory production control

The manufacturer has a factory production control system in the plant and exercises permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer are documented in a systematic manner in the form of written policies and procedures. This production control system ensures that the product is in conformity with the European Technical Approval.

The manufacturer shall only use raw materials supplied with the relevant inspection documents as laid down in the prescribed test plan<sup>6</sup>. The incoming raw materials shall be subject to controls and tests by the manufacturer before acceptance. Check of incoming materials such as nuts, washers, threaded rods, resin, hardeners... shall include control of the inspection documents presented by suppliers (comparison with nominal values) by verifying dimension and determining material properties, e.g. tensile strength, surface finish.

The manufactured components of the anchor shall be subjected to the following tests:

- Dimensions of components:  
Threaded rod (total length, nominal diameter, marking), washer (diameter, thickness), capsules (diameter, length, wall thickness, marking), nuts (diameter, good functioning).
- Material properties: Threaded rod (yielding and ultimate tensile strength), nuts (proof load), resin (composition, viscosity), hardener (composition, viscosity).
- Mass of materials included within the capsule.
- Thickness of the electroplated treatment of the elements.
- Visual control of completeness of the anchor.
- Visual control of the aspect of capsules.

The frequency of controls and tests conducted during production is laid down in the prescribed test plan taking account of the automated manufacturing process of the anchor.

The results of factory production control are recorded and evaluated. The records include at least the following information:

- designation of the product, basic material and components;
- type of control or testing;
- date of manufacture of the product and date of testing of the product or basic material and components;
- result of control and testing and, if appropriate, comparison with requirements;
- signature of person responsible for factory production control.

The records shall be presented to the inspection body during the continuous surveillance. On request, they shall be presented to the Centre Scientifique et Technique du Bâtiment.

Details of the extent, nature and frequency of testing and controls to be performed within the factory production control shall correspond to the prescribed test plan which is part of the technical documentation of this European Technical Approval.

<sup>6</sup> The prescribed test plan has been deposited at the Centre Scientifique et Technique du Bâtiment and is only made available to the approved bodies involved in the conformity attestation procedure.

### 3.2.2. Tasks of approved bodies

#### 3.2.2.1. Initial type-testing of the product

For initial type-testing the results of the tests performed as part of the assessment for the European Technical Approval shall be used unless there are changes in the production line or plant. In such cases the necessary initial type-testing has to be agreed between the Centre Scientifique et Technique du Bâtiment and the approved bodies involved.

#### 3.2.2.2. Initial inspection of factory and of factory production control

The approved body shall ascertain that, in accordance with the prescribed test plan, the factory and the factory production control are suitable to ensure continuous and orderly manufacturing of the anchor according to the specifications mentioned in 2.1. as well as to the Annexes to the European Technical Approval.

#### 3.2.2.3. Continuous surveillance

The approved body shall visit the factory at least once a year for regular inspection. It has to be verified that the system of factory production control and the specified automated manufacturing process are maintained taking account of the prescribed test plan.

Continuous surveillance and assessment of factory production control have to be performed according to the prescribed test plan.

The results of product certification and continuous surveillance shall be made available on demand by the certification body or inspection body, respectively, to the Centre Scientifique et Technique du Bâtiment. In cases where the provisions of the European Technical Approval and the prescribed test plan are no longer fulfilled the conformity certificate shall be withdrawn.

### 3.3. CE-Marking

The CE marking shall be affixed on each packaging of anchors. The symbol « CE » shall be accompanied by the following information:

- identification number of the certification body;
- name or identifying mark of the producer and manufacturing plant;
- the last two digits of the year in which the CE-marking was affixed;
- number of the EC certificate of conformity;
- number of the European Technical Approval;
- use category (ETAG 001-1 Option 8);
- size.

## 4 Assumptions under which the fitness of the product for the intended use was favourably assessed

### 4.1. Manufacturing

The anchor is manufactured in accordance with the provisions of the European Technical Approval using the automated manufacturing process as identified during inspection of the plant by the Centre Scientifique et Technique du Bâtiment and the approved body and laid down in the technical documentation.



## 4.2. Installation

### 4.2.1. Design of anchorages

The fitness of the anchors for the intended use is given under the following conditions:

The anchorages are designed in accordance with the « Guideline for European Technical Approval of Metal Anchors for Use in Concrete », Annex C, Method A, for bonded anchors under the responsibility of an engineer experienced in anchorages and concrete work.

For the verifications given below according to annex C the following shall be observed :

- For the verification "concrete cone failure" (clause 5.2.2.4, Annex C of the ETAG,  $N_{Rk,c}$  shall be determined according to (1) and (2) : the smaller of the values according to (1) and (2) is decisive.

(1)  $N_{Rk,c}$  according to equation (5.2), annex C of the ETAG

where :  $N_{Rk,c}^0$  according to Table 5 Annex 4

$s_{cr,N}$  and  $c_{cr,N}$  according to Table 5 Annex 4

$\psi_{ucr,N} = 1,0$

(2)  $N_{Rk,c} = 0,75 \times 15,5 \times h_{ef}^{1,5} \times f_{ck,cube}^{0,5}$

where :  $N_{Rk,c}^0$  according to Table 5 Annex 4

$s_{cr,n} = 3 h_{ef}$  and  $c_{cr,n} = 1,5 h_{ef}$

$\psi_{ucr,N} = 1,0$

- For the verification "splitting failure due to loading" (clause 5.2.2.6, Annex C of the ETAG),  $N_{Rk,sp}$  shall be determined according to (3).

(3)  $N_{Rk,sp}$  according to equation (5.3), Annex C of the ETAG

where :  $N_{Rk,c}^0$  according to Table 5 Annex 4

$s_{cr,N}$  and  $c_{cr,N}$  according to Table 5 Annex 4

$\psi_{ucr,N} = 1,0$  and  $\psi_{h,sp} = 1,0$

- For the verification "concrete pryout failure" (clause 5.2.3.3, Annex C of the ETAG),  $N_{Rk,c}$  for equation (5.6), Annex C of the ETAG shall be determined according to (1).

Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored.

The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to support, etc.).

### 4.2.2. Installation of anchors

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

- anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters on the site;
- use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor;
- anchor installation in accordance with the manufacturer's specifications and drawings prepared for that purpose and using the appropriate tools;
- checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range;
- check of concrete being well compacted, e.g. without significant voids;
- clearing the hole of drilling dust : the hole shall be cleaned by at least four blowing operations;

Page 8 of European Technical Approval ETA-05/0789

- anchor installation ensuring the specified embedment depth, that is the appropriate depth marking of the anchor not exceeding the concrete surface or embedment depth control;
- keeping of the edge distance and spacing to the specified values without minus tolerances;
- positioning of the drill holes without damaging the reinforcement;
- in case of aborted hole: new drilling at a minimum distance away of twice the depth of the aborted hole, at a smaller distance if the aborted drill hole is filled with high strength mortar and if under shear or oblique tension load it is not to the anchor in the direction of load application;
- capsule insertion into the drilled hole; connection of the anchor rod with the percussion drill and driving of the anchor rod into the drilled hole with appropriate percussion/rotary action of the drill, using some pressure until the marked line of the anchor rod is reached; during curing time, the temperature of the concrete must not fall below  $-5^{\circ}\text{C}$ .
- application of the torque moment given in Annex 3 using a calibrated torque wrench.

#### 4.2.3. Responsibility of the manufacturer

It is the manufacturer's responsibility to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to in 4.2.1. and 4.2.2. is given to those who are concerned. This information may be made by reproduction of the respective parts of the European Technical Approval. In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

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

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

## 5 Recommendations concerning packaging, transport and storage.

The packaging of capsules in corrugated cardboards is intended to prevent them from knocking against one another and breaking in case of light impacts due normal handling.

To preserve the product characteristics, capsules shall be stocked sheltered from the UV light and within a range of temperatures between  $+5^{\circ}\text{C}$  and  $+25^{\circ}\text{C}$ . All the data concerning storage shall appear clearly on the packaging.

The installation data appearing on the capsules packaging shall indicate that the capsules can be used only with the corresponding threaded rods of the manufacturer and vice versa.

The original French version is signed by

Le Directeur Technique  
J.-D. MERLET



**The anchor may have various markings (on the body of the anchor and/or on the head of the anchor), which assist in identification.**

Assembled anchor and schema of the anchor in use :

1) threaded rod 2) washer 3) hexagonal nut 4) capsule

Marking 1 or 2: { M16 E (electroplated version)  
 Nominal diameter      extra dimension

**If markings are provided (on the body of the anchor and/or on the head of the anchor), they will be detailed here.**

[Manufacturer's Trade Name for anchor]	Annex 1
Product and intended use	of European Technical Approval ETA-05/0789

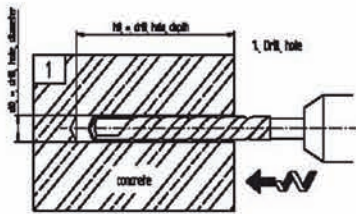
**Material details and installation instructions for particular anchor.**

**Table 1 : Materials**

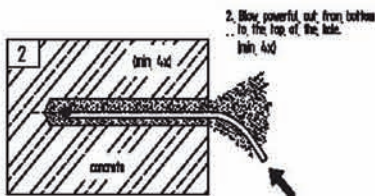
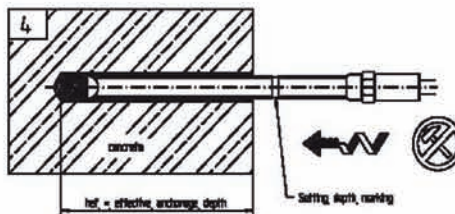
	Size	Production	Material and EN/ISO reference	Coating
Threaded rod	M8, M10, M12, M16, M20, M24, M27, M30	Cold formed or machined	Cold formed: Cq15 or Q St 38-3 DIN 1654 Machined: 9 s Mn 28 k Din 1651	Electroplated with zinc A2G according to DIN EN ISO 4042
Nut	-	-	Steel, DIN EN 20898-2 Class 8	
Washer	-	-	Steel DIN 50961	

In all versions except M8, capsule with vinyl ester resin (without styrene), hardener and quartz sand.  
Version M8 : capsule with vinyl ester resin (without styrene), hardener and corundum.

**Installation Instruction Chemical Anchor**

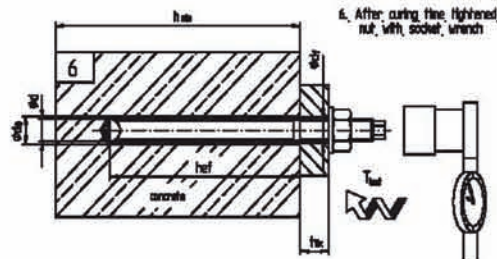


4. Connect the anchor rod with the percussion drill. Using the percussion/rotary action of the drill. Carefully drive the anchor rod into the drill hole. Using some pressure until the marked line of the anchor rod is reached.



Temp. in drill hole (°C)	min. curing time
> 20°	10 min
10° - 20°	20 min
0° - 10°	45 min
-5° - 0°	4 h
-20° - -5°	12 h

5. The curing times shown are for dry concrete. In case of wet base material the curing times have to be doubled.



[Manufacturer's Trade Name for anchor]

Annex 2

Materials and setting process

of European Technical Approval  
ETA-05/0789

Table 2: Dimensions

Size	Threaded rod			Capsule	
	Ød [mm]	t (1) [mm]	minL (2) * [mm]	Ød <sub>c</sub> (3) [mm]	L <sub>c</sub> (4) [mm]
M8	8	80	90	9	85
M10	10	90	100	10.5	90
M12	12	110	130	12.5	97
M16	16	125	150	16.5	95
M16E	16	190	215	16.5	120
M20	20	170	195	23	160
M20E	20	240	290	23	215
M24	24	210	240	23	190
M24E	24	290	320	23	255
M27	27	250	280	27.5	210
M30	30	280	315	27.5	260

\* different lengths are possible

(1) embedment depth (2) minimum length of the threaded rod (3) nominal diameter (4) capsule length

Table 3: Installation data

Threaded steel	Ød <sub>0</sub> nominal diameter of the drill bit [mm]	h <sub>0</sub> depth of the hole [mm]	h <sub>ef</sub> effective anchoring depth [mm]	T <sub>inst</sub> Tightening torque [Nm]	h <sub>min</sub> minimum thickness of the concrete slab [mm]	d <sub>r</sub> clearance hole in the fixture [mm]
M8	10	80	80	10	110	9
M10	12	90	90	20	120	12
M12	14	110	110	40	150	14
M16	18	125	125	60	160	18
M16E	18	190	190	60	250	18
M20	25	170	170	120	220	22
M20E	25	240	240	120	300	22
M24	28	210	210	150	300	26
M24E	28	290	290	150	350	26
M27	32	250	250	200	350	30
M30	35	280	280	300	350	33

Table 4 : Minimum spacing and edge distances

			M8	M10	M12	M16	M16 E	M20	M20 E	M24	M24 E	M27	M30
Minimum spacing	S <sub>min</sub>	mm	40	45	55	65	95	85	120	105	145	125	140
Minimum edge distance	C <sub>min</sub>	mm	40	45	55	65	95	85	120	105	145	125	140

<b>[Manufacturer's Trade Name for anchor]</b>	Annex 3  of European Technical Approval <b>ETA-05/0789</b>
Installation data	



Table 5: Characteristic values of resistance to tension loads of design method A

			M8	M10	M12	M16	M16 E	M20	M20 E	M24	M24 E	M27	M30
<b>Steel failure</b>													
Characteristic resistance	$N_{Rk,s}$	[kN]	19	30	44	82	82	127	127	184	184	239	292
Partial safety factor	$\gamma_{Ms}$	-	1,49	1,49	1,49	1,49	1,49	1,49	1,49	1,49	1,49	1,49	1,49
<b>Pullout and concrete cone failure in non-cracked concrete C20/25 to C50/60</b>													
Characteristic resistance* T = -40°C to +80°C	$N_{Rk,p} = N_{Rk,c}^0$	[kN]	16	20	30	50	75	75	95	95	140	140	170
Characteristic resistance* T = -40°C to +120°C	$N_{Rk,p} = N_{Rk,c}^0$	[kN]	12	20	30	40	60	60	95	95	115	115	140
Partial safety factor	$\gamma_{Mp} = \gamma_{Mc}$	-	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16
<b>splitting failure</b>													
Effective anchorage depth	$h_{ef}$	[mm]	80	90	110	125	190	170	240	210	290	250	280
Partial safety factor	$\gamma_{M,sp}$	-	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16	2,16
Spacing	$s_{cr,N}$	[mm]	160	180	220	250	380	340	480	420	580	500	560
	$s_{cr,sp}$	[mm]	180	200	240	280	420	370	530	460	640	550	620
Edge distance	$c_{cr,N}$	[mm]	80	90	110	125	190	170	240	210	290	250	280
	$c_{cr,sp}$	[mm]	90	100	120	140	210	185	265	230	320	275	310

\* according to equation (6.19) ETAG 001 part 5.

Table 6: Characteristic displacements under axial tension loads

		M8	M10	M12	M16	M16 E	M20	M20 E	M24	M24 E	M27	M30
Characteristic displacement in non-cracked C 20/25 concrete												
Admissible service load :N	[kN]	4	6,6	9,9	16,5	24,8	24,8	31,4	31,4	46,3	46,3	56,2
$\delta_{ND}$ short term	[mm]	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3	0,4	0,3	0,4
$\delta_{N,lt}$ long term	[mm]	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3	0,4	0,4	0,4

[Manufacturer's Trade Name for anchor]

Characteristic resistance and displacements under tension loads – design method A

Annex 4

of European  
Technical Approval  
ETA-05/0789

Table 7: Characteristic values of resistance to shear loads of design method A

			M8	M10	M12	M16	M16 E	M20	M20 E	M24	M24 E	M27	M30
<b>Steel failure without lever arm</b>													
Characteristic resistance	$V_{Rk,s}$	[kN]	7,4	15,0	19,0	40,3	40,3	59,4	59,4	79,2	79,2	107	146
Partial safety factor	$\gamma_{Ms}$	-	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
<b>Steel failure with lever arm</b>													
Characteristic resistance	$M_{Rk,s}$	[N.m]	19	39	68	173	173	338	338	584	584	866	1169
Partial safety factor	$\gamma_{Ms}$	-	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25	1,25
<b>Pry out failure</b>													
Factor in equation (5.6)	k	-	2	2	2	2	2	2	2	2	2	2	2
Partial safety factor	$\gamma_{Mn}$	-	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80
<b>Concrete edge failure</b>													
Effective length of anchor under shear loading	$l_f$	[mm]	80	90	110	125	190	170	240	210	290	250	280
Outside diameter of anchor	$d_{nom}$	[mm]	10	12	14	18	18	25	25	28	28	32	35
Partial safety factor	$\gamma_{Mc}$	-	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80	1,80

Table 8: Characteristic displacements under shear loads

Characteristic displacement in non-cracked C 20/25 concrete		M8	M10	M12	M16	M16 E	M20	M20 E	M24	M24 E	M27	M30
Admissible service load : V	[kN]	3,5	7,1	9,0	19,2	19,2	28,3	28,3	37,7	37,7	51,0	69,5
$\delta_{ND}$ short term	[mm]	1,6	1,6	1,7	1,7	1,7	1,9	1,9	2,0	2,0	2,1	2,2
$\delta_{Nls}$ long term	[mm]	2,4	2,4	2,5	2,6	2,6	2,8	2,8	3,0	3,0	3,2	3,3

<b>[Manufacturer's Trade Name for anchor]</b>	Annex 5 of European Technical Approval <b>ETA-05/0789</b>
Characteristic resistances and displacements under shear loads – design method A	

## APPENDIX C

### Information Sources



## Statutory Provisions

[www.irishstatutebook.ie](http://www.irishstatutebook.ie)

Safety, Health and Welfare at Work Act 2005  
(No. 10 of 2005)

Safety, Health and Welfare at Work (General Application) Regulations 2007  
(S.I. No. 299 of 2007) to 2016

Safety, Health and Welfare at Work (Construction) Regulations 2013  
(S.I. No. 291 of 2013)

European Communities (Construction Products) Regulations 1992  
(S.I. No. 198 of 1992)

European Communities (Construction Products)(Amendment) Regulations 1994  
(S.I. No. 210 of 1994)

## Irish Standards, British Standards, Codes and Other Standards

[www.nsai.ie](http://www.nsai.ie)

I.S. EN 206-1: 2002	Concrete. Specification, performance, production and conformity
BS EN ISO 898-1: 1999	Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs
BS 5080-1: 1993	Structural fixings in concrete and masonry — Part 1: Method of test for tensile loading
BS 5080-2: 1986	Methods of test for structural fixings in concrete and masonry — Part 2: Method for determination of resistance to loading in shear
BS 8110-1: 1997	Structural use of concrete
EN 1990: 2002	Basis of design for structural Eurocodes
EN 1992-1-1: 2003	Eurocode 2: Design of concrete structures - Part 1-1 : General common rules and rules for building and civil engineering structures

DD CEN/TS 1992-4-4  
2004

Design of fastenings for use in concrete Part 1:

## **Health and Safety Authority Guidance**

**[www.hsa.ie](http://www.hsa.ie)**

Guidelines to the Safety, Health and Welfare at Work (Construction) Regulations 2013

## **EOTA Publications**

**[www.eota.be](http://www.eota.be)**

ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Part 1: Anchors in general
ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Part 2: Torque-controlled expansion anchors
ETAG 001, Edition 1997	Guideline for European Technical Approval of metal anchors for use in concrete. Part 3: Undercut anchors
ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Part 4: Deformation-controlled expansion anchors
ETAG 001, Edition 2008	Guideline for European Technical Approval of metal anchors for use in concrete. Part 5: Bonded anchors
ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Annex A: Details of tests
ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Annex B: Tests for admissible service conditions detailed information
ETAG 001, Edition 2007	Guideline for European Technical Approval of metal anchors for use in concrete. Annex C: Design methods for anchorages
ETAG 020, Edition 2006	Guideline for European Technical Approval of plastic anchors for use in concrete and masonry for non-structural applications
EOTA TR029, 2007	Design of bonded anchors

## General

Guideline 89/106/EEC of the Council of 21 December 1988 for harmonising the legal and administrative regulations for building products in the member countries, modified by guideline 93/68/EEC of 22 July 1993, Gazette of the European Community |No. L 40 of 11 February 1989 and L 220 of 30 August 1993

Council Directive 89/106/EEC. Construction products. Interpretative documents, Brussels, 16 July 1993

R. Eligehausen, R. Mallée and J.F. Silva (2006) *Anchorage in Concrete Construction*

Construction Fixings Association's series of guidance notes on anchor-related issues

# INDEX

anchor .....	13	design process .....	11, 15
anchor design .....	43	design resistance.....	16, 56
anchor installer 11, 13, 28, 29, 32, 33, 60, 64		design risk assessment .....	16, 68
anchor manufacturer .....	29, 56	design change .....	69
anchor spacing .....	39	edge distance.....	39
anchor specifier 11, 13, 26, 27, 29, 31, 35, 36, 37, 44, 45, 46, 57, 64, 66, 68, 69		effective embedment depth.....	40
anchor supplier .....	11, 29, 31, 33, 35	EOTA .....	17
anchor types.....	23, 41	essential requirements .....	19, 21
article .....	13	ETA 4, 9, 17, 19, 21, 26, 29, 36, 37, 56, 57, 66	
base material.....	14, 36	ETAG.....	19
bonded anchors.....	25	European Technical Approval.....	4, 30
certification.....	68	fixture.....	17, 54
clearance hole.....	54	global safety factor .....	9, 11, 10, 17
client .....	14	installation instructions.....	30
competent person.....	14, 35, 60	load direction .....	37
computer-aided anchor design software 30, 46		load type.....	37, 40
concrete .....	36	manufacturer's instructions .....	29
concrete capacity method 14, 16, 35 SEE ALSO <b>PARTIAL SAFETY FACTOR</b>		masonry .....	37
concrete strength .....	14	material type.....	56
connection.....	15	non-cracked concrete .....	36
Construction Product Directive .....	15	partial safety factor ... 9, 10, 11, 18 SEE ALSO <b>CONCRETE CAPACITY METHOD</b>	
contractor .....	15, 29, 33, 60, 68, 69	permanent works design certificate....	68
corrosion protection .....	41	permanent works designer.....	18
cracked concrete .....	36	projection .....	54
deformation-controlled anchors .....	24	project supervisor construction stage 18, 29, 34	
design methods.....	35	project supervisor design process 18, 29, 33	

recommended load ..... 16

safety critical situation ..... 4, 18

safety data sheets .....30, 56

Safety, Health and Welfare at Work  
(Construction) Regulations 2013.... 3, 29

sample forms ..... 70

supervision ..... 63

supervisor ..... 63, 64, 68

technical data sheets..... 30

temporary works ..... 18

temporary works design certificate..... 68

torque-controlled expansion anchor ... 23

training ..... 35

types of anchors ..... 13

undercut anchors..... 24



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