CONSTRUCTION FIXINGS association

CI/Sfb
Xt6
July 2002

CFA Guidance Note:
Undercut Anchors

SUMMARY
Operating principle – mechanical interlock

- ❏ *Approved for use in cracked concrete*
- ❏ *Setting free of expansion stresses*
- ❏ *Visual indication of correct setting*
- ❏ *3 attachment configurations available*
- ❏ *Carbon and stainless steel versions*
- ❏ *Special versions for use in thin stone panels*
- ❏ *Specifiable via software or data sheets*
- ❏ *Some types suitable for use in dense stone*
- ❏ *Good resistance to dynamic loads*

1 INTRODUCTION

Central to the demanding requirements of European Technical Approvals[1,2] for metal anchors used in safety related applications is the recognition of the likelihood of concrete being cracked. Anchors must demonstrate their ability to function correctly in cracks up to .5mm wide. This has lead to the development of many innovative solutions, some based on existing anchor configurations, as well as the birth of a totally new type – the Undercut system.

This Guidance Note describes the operating principles of current designs and outlines aspects of selection and installation which should be taken into account.

The pace of development of anchoring systems is such that new designs are likely to be introduced which are not covered here. Resin Bonded Undercut anchors for instance are dealt with in the Guidance Note: Bonded anchors. The general principles will still apply but, in common with all anchor types, each must be specified and installed strictly according to the manufacturer's instructions relating to that product.

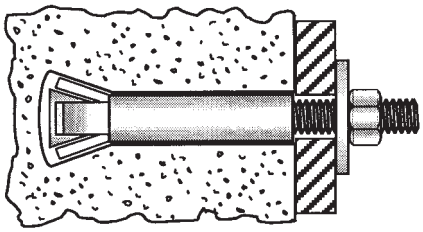
2 DESCRIPTION

Operating Principle

Undercut anchors are designed specifically for use in concrete although some may be used in dense stone.

Common to all undercut anchors is the principle of establishing a positive mechanical interlock within the concrete. This is achieved by opening segments of the anchor shell over a tapered part of the shank and into an undercut shape formed in the concrete either by a separate drilling technique or by the anchor itself during installation.

This interlock ensures that, unlike some types of expansion anchor, the mode of failure is always by a concrete cone generated from the base of the anchor. This means the anchor is as strong as the concrete will allow and that the anchor will work even when set in a crack which opens after the anchor is installed.



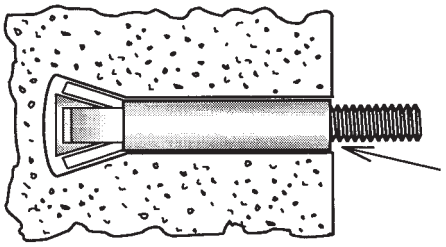
Undercut principle gives stress free setting

Performance

As undercut anchors fail by concrete cone failure their load capacity is directly related to embedment depth which may therefore be shallower for undercut anchors than for other anchor types offering similar strength. [Internal thread versions (see below) may need high tensile bolts to match anchorage strength in non-cracked concrete.]

Visual check of setting

Undercut anchors have different systems to give a visual indication that the anchor is correctly set. One is shown below. In others hammering the sleeve down over the taper leaves visible marks in the top of the sleeve.



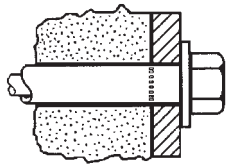
Shell flush with surface shows anchor is set

3 RANGES AVAILABLE

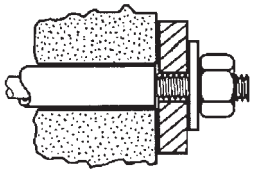
Anchor diameters are available from M6 to M20 in zinc plated carbon steel and A4 stainless steel versions.

Attachment Configurations

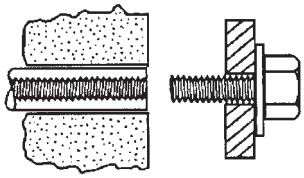
Most undercut anchors are made in three attachment configurations as shown below



Through Sleeve



Projecting Stud



Internal Thread

4 TYPICAL APPLICATIONS

Undercut anchors' abilities to work in cracked or non-cracked concrete, together with good dynamic resistance and the variety of attachment configurations and finishes, make them one of the most versatile types of anchor.

Suitable applications include the following:

- Structural connections including shockproof connections in earth-quake zones. Steel fabrications such as staircases and ladders.
- Dynamic loadings including motors, fans, cradle runways, gates, roller shutter doors, holding down machinery, signs and lighting columns, guard rails.
- Cladding elements to edge beams, curtain walling.
- Fixing services of all types especially to ceiling and deck undersides.

5 SELECTING UNDERCUT ANCHORS

Undercut anchors are expected to be selected in accordance with Design Methods as outlined in the Guideline for European Technical Approvals (ETAG) [1] Annex C.
This Design Method, known as the Concrete Capacity (CC) method, is relatively complex so most manufacturers are expected to make selection easy by providing prompted selection on CDRom. Factors which will be taken into account in this process are as discussed in the Association Guidance Note "Anchor selection". They include concrete strength and condition (i.e. cracked or non-cracked), anchor spacings, edge distances, structural thickness, the nature of the applied load, fixture thickness, finish in relation to corrosion conditions etc. Manufacturers also offer technical advice services who will check selections against the relevant parameters or make the selection for you.

Deciding whether or not an area of concrete is cracked or non-cracked can be done in one of two ways. In the UK National Guidance has been determined to help engineers decide, without calculation, which areas of structures may be considered cracked or non-cracked[3] . This document may be downloaded from the BBA website. Otherwise detailed stress calculations must be carried out. Choosing an anchor with an approval for cracked concrete obviates the need to check concrete status but if no such check is carried out then the load values for cracked concrete must be assumed (they are lower than for non-cracked) and a cost penalty may be incurred.

Once an anchor is specified then an alternative anchor should not be allowed unless all relevant performance parameters are checked and found to be at least equivalent to the specified anchor.

6 INSTALLING UNDERCUT ANCHORS

The installation of undercut anchors is always different from conventional anchors and must be carried out in accordance with the manufacturer's instructions using the prescribed equipment which should be maintained in good condition. On no account should setting equipment from one type be used to install anchors of another.

There are two phases to installing undercut anchors:

– Forming the hole with its undercut shape and
– Setting the anchor

Hole forming

Undercut designs currently employ three different techniques to form the undercut shape.

Pre – drilling

Within this category there are two techniques.

a) A special drill forms the cylindrical hole and is then manipulated to form the undercut.
b) A "Stop" or "Collar" drill (a conventional hammer drill bit with an integral collar to limit hole depth) is used to drill a cylindrical hole and a special drill is then used to establish the undercut.

Some specialised types for deep installations use diamond drilling for initial hole forming.

Self undercutting - rotary

A stop drill is used to establish the cylindrical hole shape. The anchor is mounted on a special adaptor and spun into the hole using a hammer drill; special teeth on the anchor itself form the undercut shape.

Self undercutting - percussion

A stop drill is used to establish the cylindrical hole shape. The anchor is then hammered into the hole using a special adaptor and sharp edges on the shell form the undercut as it is driven over the tapered shank.

"Stop" or "Collar" drill used in many types of undercut

Anchor setting

Most current undercut anchors are set by the shell being displaced over an outwardly tapered cone. Usually this is done by hammering via a special adaptor.

Correct setting can be checked visually see section 2.

Different setting methods may involve different clearance requirements around the anchor at the point of installation.

References

[1] ETAG 001 Guideline for European Technical Approval of Metal Anchors for use in concrete. European organisation for Technical Approvals (EOTA) 1997.
British Board of Agrément, PO Box 195, Bucknalls Lane, Garston, Herts. Tel 01923 665300

[2] CFA Guidance Note: European Technical Approvals for Construction Fixings.

[3] Use of anchors with ETAs – UK Guidance – Distinction between cracked and non-cracked concrete. Download from BBA website (pdf format) : www.bbacerts.co.uk

This is one of a free series of Guidance Notes published by the **Construction Fixings Association**
For more information contact:
The Secretary **Construction Fixings Association**
C/O Institute of Spring Technology
Henry Street
Sheffield
S3 7EQ
Tel 0114 2789143
Fax 0114 2755573
e-mail: info@fixingscfa.co.uk