

CFA Guidance Note: Heavy Duty Expansion Anchors (Thick Walled Sleeve Anchors)

Summary

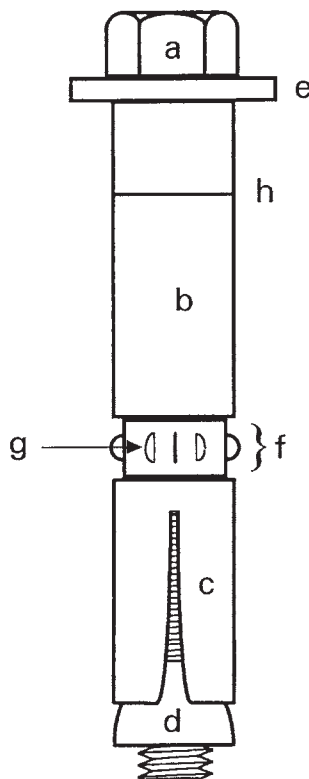
Operating principle – Torque controlled expansion
Attachment configuration – Through sleeve¹⁾

- Strongest type of drilled construction fixing
- High strength in tension and shear
- Through fixing simplifies setting out
- Torque controlled expansion for installation confidence
- Many versions available including stainless steel
- Specifiable via data sheets or software
- Suitable for concrete only
- Approvals available for cracked concrete and dynamic loads

1 INTRODUCTION

Since the early 1970's the strongest type of drilled-in construction fixing has been the Heavy Duty Expansion Anchor. This **Guidance note** sets out to help specifiers and users of fixings for safety critical applications appreciate the benefits and limitations of this type of anchor and get the best out of them at both selection and installation stages.

2 DESCRIPTION



2.0 TYPICAL COMPONENTS

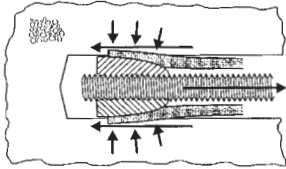
- a 8.8 Grade bolt – for high strength in tension**
Conventional bolt head shown. Projecting thread and countersunk versions also available. Projecting thread types allow the removal and replacement of the fixture without disturbing the expansion arrangement. With special bolts they may be used for stand-off fastenings. Countersunk versions give a flush finish. Torque indicating types are available.
- b Thick walled shear sleeve – for high strength in shear**
Load transfer from the fixture to the concrete in shear is made via this thick sleeve.
- c Expansion sleeve – machined or pressed**
The expansion sleeve can be either a single component, with 3 or 4 axial slots to permit expansion, or separate segments retained by a clip.
- d Expansion cone – specially shaped for progressive expansion**
The radiused profile featured on many products facilitates expansion in the latter stages of setting as resistance to expansion increases.
- e Thick washer – for clamping and pull over strength**
High forces are transmitted through a thick washer. This enables clamping of the fixture and prevents it pulling over the bolt head. See figure in section 2.1.
- f Anti-rotation feature – helps setting**
Shown here as part of the plastic crush feature but may be part of the steel expansion sleeve. Helps stop the expansion cone from rotating while the bolt is being turned so the cone will be pulled into the expansion sleeve to expand it. Also helps retain the anchor in overhead applications before setting.
- g Collapse feature – caters for small gaps under fixture**
To ensure the fixture is clamped against the base material the reaction force of the sleeve must be eliminated, or reduced to a minimum, after setting has started. This is achieved by means of a "Collapse" feature. This may be either a separate element or an integral part of the expander or shear sleeves. Since this element is redundant after setting, plastic may be used without affecting the fixing's ability to withstand heat. This feature ensures that no gap exists between the fixture and base material.
- h Depth mark – also shows fixture thickness**
A groove on the shear sleeve indicates maximum fixture thickness and minimum embedment depth.

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2.1 OPERATING MECHANISM

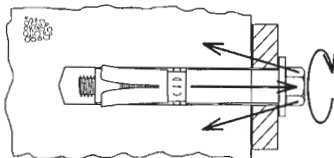
Combined keying and friction from torque controlled expansion.

Turning the bolt draws the expander cone into the expander sleeve forcing its segments against the concrete which is deformed in the process.



Resistance to being pulled from the concrete is offered by a combination of friction and keying effect.

In common with all torque controlled expansion anchors an equilibrium condition exists between the tension in the



bolt and the resulting clamping force through the fixture. The bolt tension is directly related to the tightening torque which is affected by

the friction conditions between the bolt thread and expansion cone and between bolt head (or nut) and washer. Some manufacturers employ low friction coatings to modify these relationships. The manufacturer's installation torque is therefore set to achieve two objectives: 1) to ensure the clamping force exceeds the Recommended Tensile Load by a margin that will cater for long term relaxation (which affects all fixings) and 2) to protect the bolt material from being over stressed. It is therefore vital with Heavy Duty Expansion anchors, which are specified for load bearing applications, that the Recommended Installation Torque is applied.

Shear resistance is provided by the combination of thick shear sleeve and, in bolt head types, the solid part of the bolt shank.

Heavy Duty Expansion Anchors exhibit follow-up expansion, as do all torque controlled anchors. This means that an increase in applied load beyond the residual clamping force, *i.e. well beyond the Recommended Tensile load*, will simply pull the expander cone into the expansion sleeve thus setting the anchor further.

Follow-up expansion also comes into play in tension zones of concrete which, under normal design codes, may be subject to cracking. The anchor simply expands further to support the load as the crack opens (within limits of predictable crack widths). Some makes are approved to work in cracked concrete.

3 TYPICAL APPLICATIONS*

All high load and safety critical applications into concrete including cracked concrete

Structural connections – support of new floors from existing structures, holding down steel structures, support and restraint of heavy cladding, staircases, balustrades.

Dynamic loads – machinery, and crane rails.

Shock loads – safety fences and crash barriers.

*Refer to the manufacturer for approval of all safety critical applications, especially those involving dynamic and shock loads for which different loading criteria may apply.

4 SELECTION^[1]

All manufacturers offer technical support

Selection can be made against catalogue data or using software available from several manufacturers.

Base material suitability

All are suitable for concrete, some for cracked concrete. Some anchors are recommended for natural stone – take care regarding base material strength and positioning within masonry units, refer to the manufacturer. Site tests may be needed.

Application limits

Heavy Duty Expansion anchors induce high expansion stresses in the concrete as a result of which, if tested to their very high ultimate tensile loads, failure is by the fracture of a large cone of concrete. Therefore to specify full performance the manufacturer's Critical Edge and Spacing dimensions (C_{cr} and S_{cr} , see [1]) must be maintained. For applications in slim columns and beams, where dimensions are restricted, reduced performance may be used down to minimum edge and spacing dimensions (C_{min} and S_{min}). This design (Kappa) method, using reduction factors for each reduced dimension, is featured in an example based on a Heavy Duty Expansion anchor in [1]. It is gradually being replaced by the Concrete Capacity (CC) method, in which the anchor group is considered as a whole and the design resistance is related to the projected area of concrete used, see [1] and [3]. This is a complex procedure for which the manufacturer's design method must be followed.

Other factors which must be taken into account include the direction and nature of loading, minimum structural thickness, concrete strength, fixture thickness and clearance hole diameter, compatibility of fixture and anchor materials, corrosion conditions and operating temperatures etc.

5 INSTALLATION

No special tools

Normal drilling

Torque setting ensures clamping force

In common with all construction fixings correct installation can be assured by following the manufacturer's instructions^[2]. Installation of Heavy Duty Expansion Anchors is relatively straight forward as they are through fixed (even bolt projecting types) and require conventional cylindrical holes produced by normal rotary hammer drilling. Thorough hole cleaning is recommended, as for most fixings, as is tightening to the correct torque, see section 2.1. Hole depths are usually quoted for the maximum fixture thickness for a particular anchor length so hole depths must be increased for thinner fixtures.

[1] CFA Guidance note: Anchor Selection

[2] CFA Guidance note: Anchor Installation

[3] CFA Guidance note: European Technical Approvals for Construction Fixings

This Guidance note is one of a series published by the
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