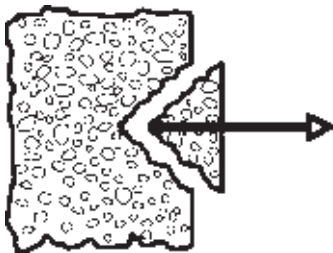


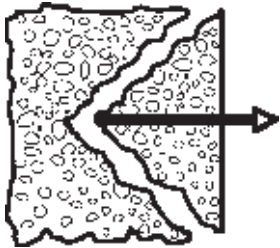
Undercut anchors

In this article Mark Salmon explains the raison d'être for these premium anchors, where they can be used, the differences in working principles and how to get your slice of the action.

When we talk about "Anchoring" something into concrete we are usually trying to just fix something to that piece of concrete. If we could do it without drilling a hole into the concrete by, for instance, simply applying a couple of dabs of "Wonderglue" to the surface then we would. And for very light loads that would probably be fine but as soon as we are trying to fix something heavier than a bag of sugar we need to get into the concrete itself. If we imagine the strongest possible fixing in a piece of concrete it will be one which – if we pull it to failure – will detach a complete cone of concrete.



Concrete Cone failure – you can't get better than that



The deeper the cone the stronger the fixing

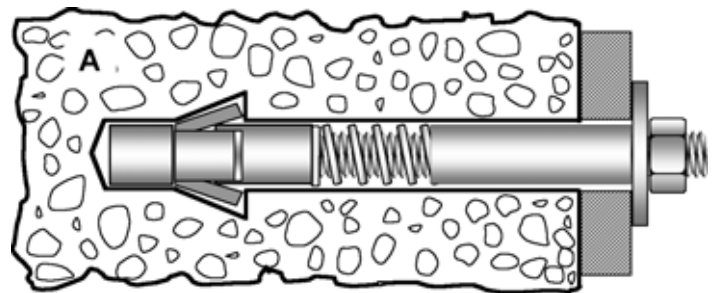
So this is what we are trying to achieve when we drill a hole into the concrete and insert an anchor. With expansion anchors we put a mechanism into the hole that will expand against the sides of the hole to grip by a combination of friction and keying effect. If the anchor is well designed it will produce the ideal cone failure but at the expense of strong compression forces in the concrete. These stresses limit how close we can set anchors together and how close to edges. Undercut anchors achieve the holy grail of cone failure without expansion stresses. They do this by forming an interlock within the concrete itself. The illustrations below show two alternative approaches with undercuts made in opposite directions. Before talking about the differences between the two I need to introduce another reason for undercut anchors. Cracks. Concrete cracks. There are several causes. Primary among these is the load imposed on the structure. This causes stresses. If they are compressive stresses the concrete can cope with them – it's strong in compression. But if they are tensile stresses, as they are on the underside of a beam or slab, it won't cope at all well and will crack. The causes of cracking are well understood by the people who design concrete structures (or at least by the people who lay down the codes by which concrete structures are designed) so the cracking is limited by reinforcement. Note I say "Limited" rather than "Prevented altogether" – that is just about impossible. Incorporation of the right amount of reinforcement

will limit surface crack widths to about 0.3mm in the worst case in normal structural concrete. The ability of an anchor to function properly if set in a crack depends very much on the design of the anchor. Undercut anchors have arguably the best capability of coping with cracks although it must be acknowledged that the majority of anchors awarded European Technical Approvals for use in cracked concrete are expansion anchors and even some resin anchor systems have gained such approvals.

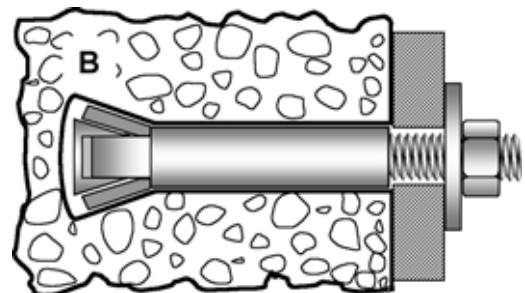
But the large, sometimes massive, interlock formed by an undercut anchor in the concrete means that undercut anchors span the cracks and carry the highest possible loads in cracked concrete.

So how do they work?

The approach shown in illustration A is arguably the stronger as it establishes a wider base for the potential cone failure. It requires a special drilling technique to produce the reverse undercut and is usually used with significant embedment depths. It is capable of extremely high loads and is used in a wide variety of applications including crash barriers and safety fences, lighting columns and, as shown in the photo, the reinforcement of existing concrete structures, in this case for the refurbishment of an office block built in the 1960s. The wide undercut area means this type has a capability in the very wide cracks which may result from seismic actions so this type is also used in nuclear power plants which must be earthquake resistant. The high potential load capacity means that in certain applications, such as safety fences or lighting columns located adjacent to motorways, the mode of failure can be determined by the designer to be bolt failure to ensure that, in the case of an accident, the bolt rather than the concrete will fail. This makes reinstatement a much easier process.



Specialist undercut anchor for extremely high loads and severe applications including seismic shock



Conventional undercut anchor for use in cracked concrete including dynamic loading

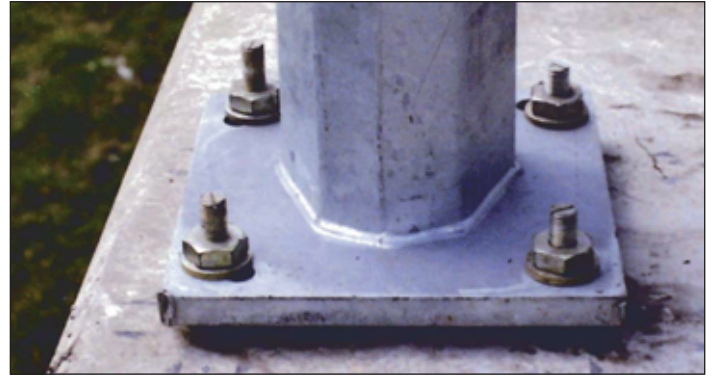


Illustration B is the approach more commonly used for more general purpose anchoring problems. The undercut shape is achieved by several different mechanisms. It may be produced by the basic drilling operation. A special drill bit is used to drill the hole. Once it reaches the required embedment depth it is manipulated by the operator in a circular motion to achieve the undercut shape.

There are also self undercutting systems. A conventional cylindrical drill bit is used to produce the hole, sometimes to a controlled depth. The undercut shape is then produced either by the action of tightening the bolt, which draws the tapered cone into specially profiled segments which bite into the concrete, or by the action of hammering the shell of the anchor over the tapered cone, again forcing specially shaped segments into the concrete.

Although a projecting stud version is illustrated here they are also available in through fixed versions with sleeves and internally threaded socket versions to accept hex bolts. These anchors are used in a wide variety of applications utilising the benefits of high load capacity, close edge and spacing limits, good dynamic performance and use in cracked concrete. They range from fixing cladding elements to stadium seating, from structural connections to holding down machinery, from fixing fans to highway signs and potentially anything fixed to the underside of a concrete slab or ceiling – the list is endless.

For the distributor undercut anchors present the opportunity to differentiate yourself from others who may not offer this solution.



Motorway lighting column fixed close to an edge with undercut anchors

They require a good understanding of their capabilities and installation processes but once specified the premium nature of the product and its associated installation equipment should make the extra effort well worthwhile. The manufacturers of undercut anchors all provide excellent technical support – it's there to be used. As usual there is a Guidance Note on the CFA website at www.fixingscfa.co.uk

Undercut anchors used to reinforce a 1960s concrete structure

