Guidance Note:
Anchors for Steeplejacking

1 INTRODUCTION

1.0 Background

This Guidance Note has been compiled jointly by the Association of Technical Lightning & Access Specialists Ltd[1] (Atlas) and the Construction Fixings Association[2] (CFA).
It covers the use of drilled in anchors used for steeplejacking operations.

1.1 Scope

There are three areas of Steeplejacking operations that involve anchoring: laddering, scaffolding and winching operations. Laddering is dealt with below but only in terms of supporting the loads occurring during normal use. Loads on the ladder resulting from a fall arrest situation are not covered here. Within scaffolding there are two aspects: the fixing of independent frames to structures such as chimneys, which is dealt with here, and conventional scaffolding which is adequately covered by the NASC/CFA Technical Guide TG4:04[3] *Anchorage systems for scaffolding*. Some aspects common to both are repeated here.

The stability of a ladder or scaffold structure is dependent, among other things, on the security of the anchors used to tie it back. That security depends on anchors being correctly ***selected*** and ***installed*** and, where necessary, ***tested***. This Guidance Note sets out the factors to be considered to achieve this. Guidance is given for designers, in order that they can specify appropriate anchors and testing regimes, and also for installers to help them install and test anchors correctly.

This guidance is given in good faith but where particular anchor types are discussed the guidance from the manufacturer concerned must take precedence. No liability can be taken by either ATLAS or CFA for any adverse consequences arising from this guidance being followed.

1.2 Terminology

In this Guidance Note the terms listed are taken to have the following meanings:

Allowable load	The load which may be applied to an anchor in practice; it may be the manufacturer's recommended load or a load determined from tests on site – whichever is the lower.
Anchor	A component installed in the building structure to transfer the necessary forces between the tie and the building structure, it may be temporarily or permanently fixed into the structure.
Anchorage	The combination of anchor and the immediately surrounding base material on which the anchor depends in order to transfer the relevant forces.
Masonry unit	Individual brick, block or stone within a masonry wall.
Tie	A component used to connect the scaffold structure with the building structure via an anchor
Tie assembly	The combination of tie and anchor
Working load	Actual load to be applied to the anchor according to the design (service load). In the absence of other guidance these will need to be calculated from first principles.

2 ANCHOR SELECTION

In selecting an anchor for any application some basic principles must be observed. These are elaborated in a CFA Guidance Note[4] but the key points as they affect steeplejacking are summarised here.

2.1 General

Aspects which need to be considered in selecting anchors for steeplejacking are:

- The base material
- Suitability of the structure
- Working load compared to allowable load
- The way loads are transferred through the ties and the direction they are applied – tension, shear, bending or a combination.
- The need for testing
- The potential for corrosion

2.2 Suitability of base material

Anchors must be suitable for the base material concerned. The suitability of typical anchors used for steeplejacking is indicated in section 7.0 but the manufacturer's advice must always take precedence.
Where suitability is not clear e.g. the strength of the base material is unknown, as is often the case with old brickwork and stonework, then preliminary tests should be carried out as described in section 4.1.
The condition of some substrates changes significantly at different locations. This is especially true for chimneys where the strength changes at height due to absorption of airborne pollutants and at increasing embedment depth due to pollution migrating from the inner face. On steeples and chimneys weathering affects substrate strength differently around the circumference. These changes affect both the strength of masonry units and mortar joints and must be taken into account both at the initial selection stage (by for instance increasing safety margins) and during erection by additional testing. Changes in substrate strength are often indicated by changes in the effort required in drilling.

2.3 Suitability of the structure

The suitability of the structure to sustain the loads transferred from the scaffold or ladder must be checked by a competent person. Load testing as described in section 4.1 only assesses the strength of the anchor locally in the base material and not the integrity of the structure. On chimneys and similar structures the use of a tensioned wire rope or strap may be the preferred means of securing the scaffold to avoid the problem of individual anchors or masonry units failing.
The distance of an anchor from the top of a structure is of critical importance and must be carefully considered taking into account the condition of the base material. A significant height of masonry above the fixing will usually be needed to sustain the loads imposed by scaffold frames or laddering, see 3.2.1.
The structural thickness must also be adequate to enable anchors to be set properly and develop full strength. Drop-in anchors in particular need a significant depth behind the anchor to avoid cracking due to setting stresses - check manufacturer's data. The depth of the structure may usefully be determined by a test drilling before any preliminary tests are carried out or anchors installed. Cavity structures are unlikely to be strong enough for most uses. If in doubt get an opinion from a structural engineer.

2.4 Anchor loads

2.4.1 General

The key points to take into account are:

- The applied or design load must be less than the allowable load (as defined above).
- The direction of loading must be taken into account in this assessment.

2.4.2 Design loads, allowable loads and design approach

Most anchor manufacturers quote Recommended (Safe Working) Loads for concrete and some for other base materials. These loads may be used as the allowable load for the selection of anchors against the working load as long as the base material of the structure concerned is known to be at least as strong as that quoted.

Manufacturers' recommended loads quoted for concrete may not be used for masonry. If no load data exists or the strength of the base material is in doubt, e.g. masonry, old concrete or substrates that have deteriorated, then preliminary tensile tests should be carried out to check suitability and determine the allowable load for the particular structure, see section 4.1. Where the allowable load, either as quoted by the manufacturer or as determined from tests, is less than the working load then the number of anchors must be increased pro-rata.

Many anchors are gaining European Technical Approvals (ETAs) and CE marking. This means anchors have been thoroughly proven against the most rigorous testing regime[6]. Load capacities quoted in ETAs are based on ultimate limit state approach with partial safety factors quoted in the ETA; this involves a partial safety factor being applied to the applied load. Care must be taken in using quoted load values or entering data into software to make sure that the values used are compatible with the working loads of the scaffold design. For instance where, in the traditional anchor design approach, the "Applied load" would be compared with the "Recommended load". In the new approach the "Design Action" will be compared with the "Design resistance" with appropriate partial safety factors being taken into account. If in doubt refer to the manufacturer. Further guidance on this subject can be obtained from the CFA website[2].

2.4.3 Loading direction

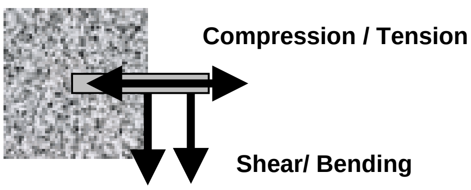


Figure 1 Possible loading directions.

Loads may be applied to anchors in a variety of ways – tension, compression, shear, bending or a combination. Their capacity in these directions varies significantly.

Tensile loads

Most manufacturers publish recommended loads in tension for concrete and some for masonry materials also.

The following equation must be satisfied:

$$N_{app} \leq N_{rec} \qquad \text{Equation 1}$$

Where N_{app} = Applied tensile load and
N_{rec} = Recommended tensile load

Shear loads

Most manufacturers publish recommended shear loads for concrete only. If the shear loads are critical and the base material is other than concrete then site testing may be required, especially if the base material is likely to be of low strength e.g old brickwork or stonework. However testing in the shear direction is awkward and time consuming. In such cases displacement is often the limiting service condition rather than ultimate load. Contact the manufacturer of the proposed fixings for advice.

The following equation must be satisfied.:

$$V_{app} \leq V_{rec} \quad \text{Equation 2}$$

Where V_{app} = Applied shear load and V_{rec} = Recommended shear load

Combined tensile and shear loads.

When anchors are subjected to a combination of tensile and shear loads it is not enough simply to compare applied and allowed tensile and shear loads independently (as in equations 1 and 2 above). A special check of the overall capacity must be carried out to ensure the fixing will not be overloaded, one approach is shown below (Equation 3); refer to the specific manufacturer for theirs.

In addition to equations 1 and 2 the following equation must be satisfied:

$$\frac{N_{app}}{N_{rec}} + \frac{V_{app}}{V_{rec}} \leq 1.2 \quad \text{Equation 3}$$

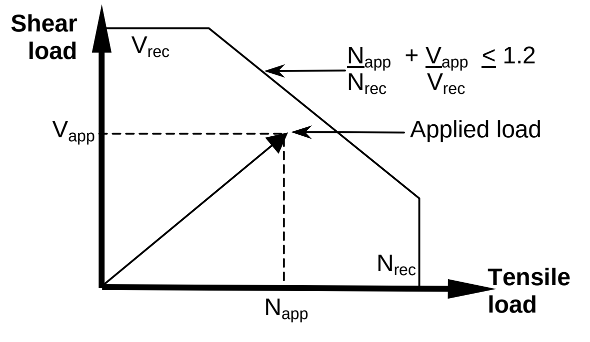


Figure 2 Combined load check

Compression loads
If compression loads are to be sustained check with the manufacturer that the proposed anchor is suitable. They may require more material behind the anchor than for tensile loads.

Bending loads
For an application involving bending loads check with the manufacturer for suitability and for allowable bending moments. Most anchors are very weak in bending. The best approach is to avoid applying loads in bending. One way to do this is to apply lateral loads via brackets. See Annex 2 for a discussion on the design of brackets for scaffold frames.

3 INSTALLING ANCHORS

3.1 General

It is important to be able to demonstrate that all anchors have been correctly installed. This means that anchors should be installed only by trained personnel using the correct tools and strictly in accordance with the anchor manufacturer's instructions. Proof tests, as described in section 4.2, should be carried out on all jobs and the results recorded.

Key aspects of installation are:

- Drill holes to correct diameter and depth
- Clean holes thoroughly – important for all anchors but particularly for resin anchors – for which holes should be cleaned by both brushing, with a round stiff brush the diameter of the hole, and blowing, using a large volume pump.
- Set in accordance with the manufacturer's setting instructions using the correct tools
- Allow resin anchors to cure for the curing time recommended for the ambient temperature.
- Tighten to the recommended installation torque using a calibrated torque wrench.

Hole dimensions can be critical.

Hole diameter must be right to ensure the anchor works and gives the expected performance.
Hole depths in particular must be specified carefully in drawings or on method statements as this affects not only the capacity of the anchor but the ability of ties using bolts to engage properly.

The importance of hole depth.

For many anchor types hole depth is important. With drop-in anchors for instance the anchor must be set at the right depth. Too shallow and the tie will not seat against the structure, too deep and the bolt will not engage sufficiently. Follow the manufacturer's instructions.

The thickness of any render should be added to the embedment depth to give the required hole depth and the anchor set deeper by the thickness of the render.
Internally threaded (socket) anchors, i.e. drop-in or resin sockets, when used with ringbolts, should be set back from the surface, by about 20mm, in order to provide some support to the junction of the thread and solid part of the ring bolt shank, it also allows space for a cap to give a weather tight seal.

Inserting bolts or ringbolts into sockets.

Full anchor strength will only be transferred if the bolt is engaged sufficiently. At least six full turns should be engaged without excessive force. If a bolt or ringbolt is tightened against the thread run-out the shell of the anchor may be weakened and shear off. Once ringbolts are fully inserted they should be turned back to align them with the tube.

Drilling effects

Powerful drilling machines used on rotary hammer in masonry with soft mortar joints may shake the masonry unit out of the mortar. Pay special attention to this and check with extra trial or proof tests. Drilling on rotary only may avoid this effect.

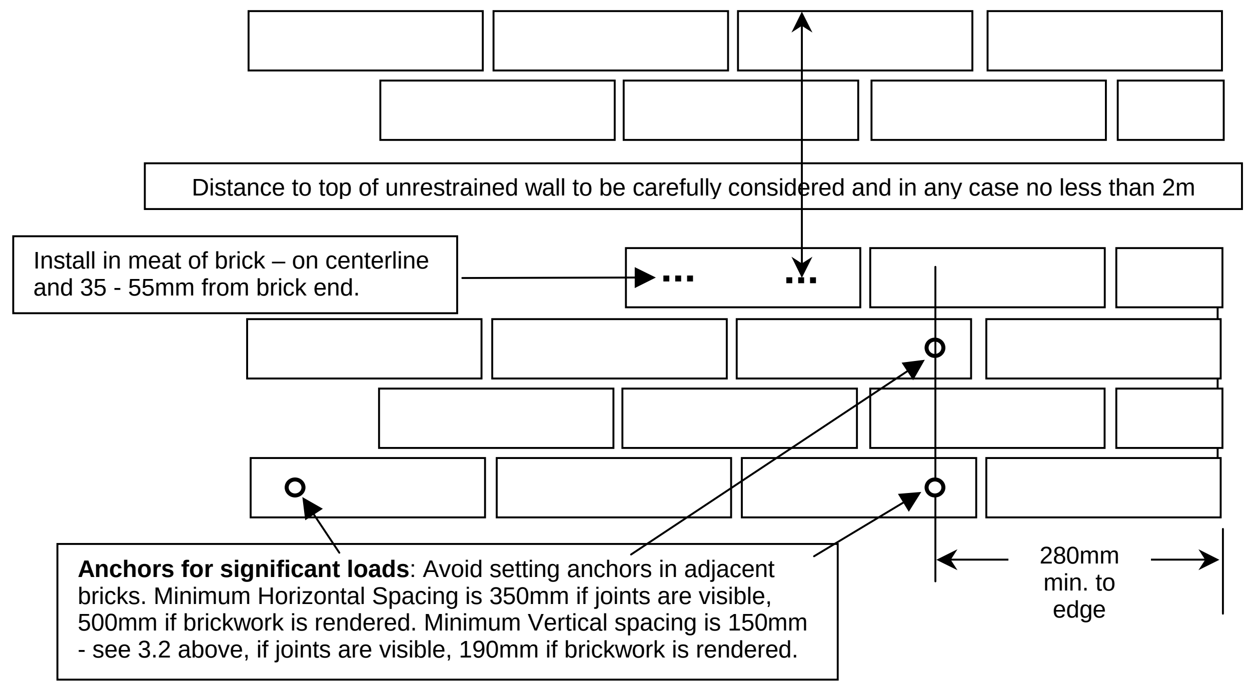
3.2 Anchor positioning

All anchors need a minimum amount of the base material around them to achieve full performance.
The recommendations of the anchor manufacturer should be followed regarding close edge distances and spacings between anchors used in pairs or groups. Most manufacturers publish comprehensive data for concrete. In the absence of similar guidance for masonry the following rules may be applied. Fixings should be located at least one full masonry unit from a vertical edge, in brickwork this means at least 280mm. Two anchors should never be installed in the same masonry unit and for significant loads not even in adjacent units. This means horizontal spacing in brickwork of 350mm, if mortar joints are visible, and 500mm if not. Equivalent vertical spacings are 150mm and 190mm. The distance of the topmost fixing below the top of a masonry structure is critically important. For masonry in reasonable condition a distance of 2m should be adequate but careful consideration must be given in all cases especially if masonry units or mortar joints have deteriorated due, for instance due to pollution.

3.2.1 Positioning in masonry

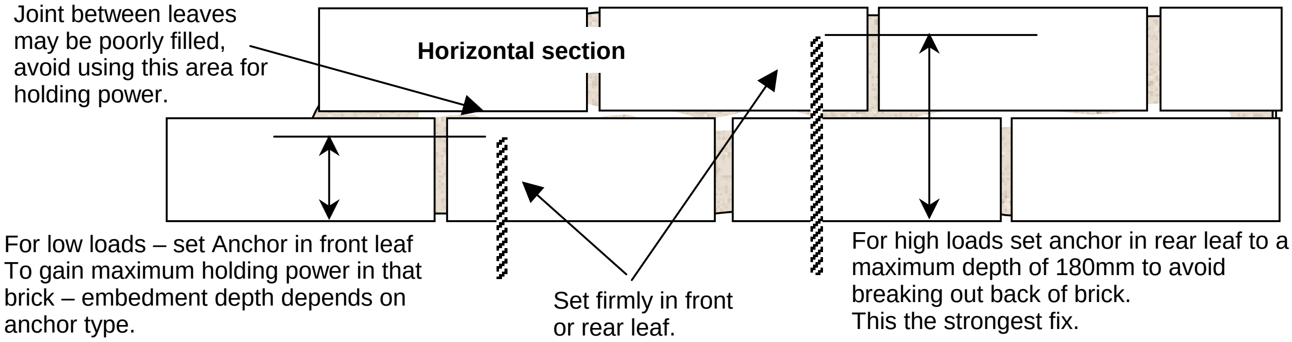
The diagram below outlines the guidance on positioning anchors in brickwork. Similar principles apply to stonework., e.g. not setting anchors in the same stone nor, ideally, in adjacent stones and avoiding locating them in the edge stone. These rules may be relaxed if stones are large. Obviously the spacing between anchors is only an issue for brackets using groups of two or more anchors.

Figure 3 Anchor positioning guidelines for brickwork.



3.3 Embedment depths for anchors in solid brickwork

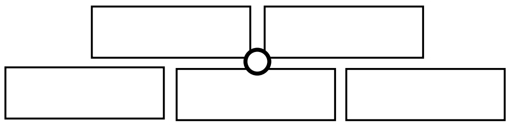
For low loads [e.g. laddering - not including fall arrest] set anchors to a depth that will gain maximum strength in the brick in the front leaf. Hole depths will vary with anchor type. For higher loads [e.g. fixing scaffold frames] into solid (9") brickwork set the anchor well into the rearmost brick. This is the strongest fix as it gains strength from the front leaf. Maximum hole depth for anchoring into the rear brick of 9" structures is 180mm. Any deeper risks breaking the back of the brick out under the drilling action. Avoid setting the anchor with its effective embedment in the joint between leaves.



For 14mm nylon plugs set into the front brick use a 70mm long plug and drill to a depth of 90mm. Deeper setting into the rear leaf may be achieved with a long plug and screw combination or with a long screw with the standard plug set back into the remote leaf.

3.4 Fixing into joints in masonry

When fixing into brickwork the anchor should ideally be located in the solid portion of the brick rather than into the mortar joint. Drilling on centreline and 35 – 55mm from the end of the brick keeps plenty of meat around the fixing while giving best chance of avoiding a frog. There are occasions when fixing into the brick itself is either problematic; e.g. when it has deep frogs, or not even allowed; e.g. for aesthetic reasons. In this case the following approach may be sanctioned by the responsible engineer if approved by the manufacturer of the fixings:



- Choose an anchor with a diameter of at least the width of the mortar joints.
- Fix into the base of the junction between bed and perpendicular joints – as shown.
- PRELIMINARY tests must be carried out (as in section 4.1) and PROOF tests (as in sections 4.2) but with an increased rate of 1 in 10 of the whole job.

4 TESTING ANCHORS.

Site tests are needed for two purposes:-
"Preliminary" tests are used to check suitability of a particular fixing in the base material and to determine allowable loads. "Proof" tests are needed to check the quality of installation of the chosen anchors.

Note – all tests described here are tensile tests relating to tensile anchor loads. Shear tests may be required if recommended shear loads are unavailable in the base material concerned but are awkward to carry out. Refer to the manufacturer or the Construction Fixings Association[2] for advice regarding shear test procedures.

4.1 Preliminary tests.

These are to be carried out wherever there is any doubt about the suitability or allowed load capacity of proposed anchors in a particular base material. They should therefore not be necessary in concrete for which safe load data should be available.
These tests are carried out on sample anchors in the same base material but away from areas which will be used and must not be used in the job.

5 tests should be carried out in each different base material of the project.

5 anchors shall be loaded in tension to a load of 2 x the tensile working load,

If all test anchors take the test load without slip then the anchor may be used in that base material for the required tensile load.
Should any anchor fail during this test then all 5 anchors should be loaded to failure. The failure load is taken as the maximum load reached during the test or the load at approximately 1mm movement in the case where an anchor pulls out of the base material. The allowable load is determined as the lowest of either a) the average value divided by 3 or the b) lowest value divided by 2 or c) the design load.

Alternatively a larger size of the same anchor type or a different anchoring system can be tried but this must also be subjected to the preliminary test.
(Careful load application is needed during tests to failure to minimise damage to the structure.)
Note: Allowable loads determined from tests on one job should never be considered suitable for the design of another job unless the base material is known to be identical. An example is included in Annex 4.

When brickwork or stonework is weak then secondary means of restraint should be considered.

4.2 Proof tests.

These are needed to check that anchors to be used in the job have been installed correctly.
They should be carried out on all projects.
This guidance applies to all new jobs and to structures with previously installed anchors.
A sample of anchors to be used, chosen at random throughout the job, shall be tested to a load of at between 1.25 and 1.5 times the tensile working load. It is assumed that the allowable load of the anchor is in all cases greater than or equal to the working load. The pass criterion is that no significant movement of the anchor is apparent; a visual check only is sufficient.
A minimum of 3 anchors shall be tested and at least 5% (1 in 20) of the total job. If any one anchor fails to satisfy this test requirement then the reason for failure should be investigated and the rate of proof testing at least doubled. (i.e. at least 6 and 1 in 10 overall). If any more anchors fail this test then all anchors must be tested, the overall safety margin is in doubt and the specification and installation method should be reviewed before the anchors are passed for use.

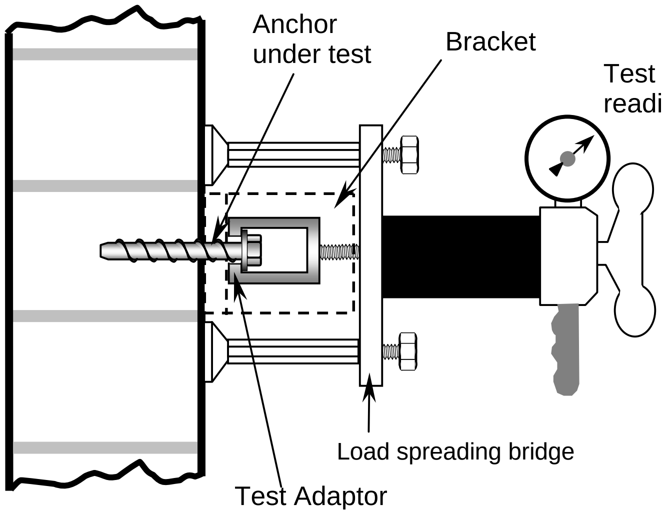
Site tests should be carried out by suitably competent and trained personnel using a test meter with a gauge calibrated within the last twelve months to an accuracy of $\leq$ 5%. Test equipment should apply the load through suitable couplers and be arranged such that the reaction loads are taken sufficiently far from the anchor so as not to influence the result, in masonry this means ensuring the feet of the bridge do not rest on the masonry unit being tested.

Table of proof test sample

Total ties on the job	number of proof tests
0 – 60	3
61 – 100	5
101 – 120	6
121 – 140	7
141 – 160	8
161 – 180	9
181 – 200	10
200 – 220	11
221 – 240	12
241 – 260	13

4.3 Site testing procedures

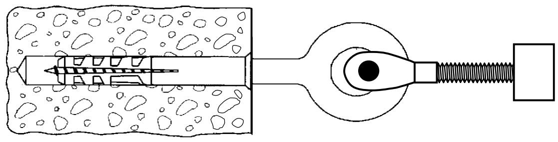
The **Construction Fixings Association** Guidance Note - "Procedure for site testing construction fixings" contains guidelines for site tests in concrete. Test anchors should be installed strictly in accordance with the manufacturer's recommendations. Test results should be formally recorded and retained with documentation relating to the project.



Self tapping screw shown being tested in place through a bracket. The fixing is backed off to allow the test adaptor to locate under its head. The feet of the bridge are spaced far enough apart to span bricks when testing in brickwork.

Figure 4 Typical test rig arrangement for bracket fixings

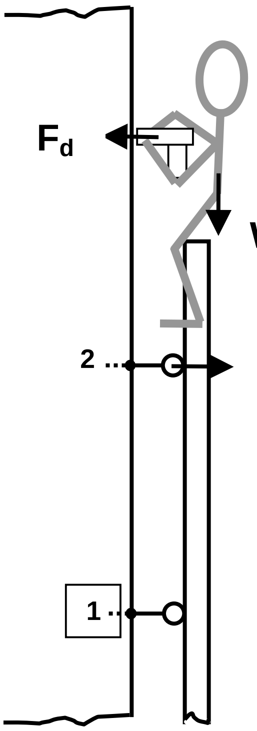
Figure 5 Test adaptor for eye type fixings



Adaptors are available to enable any anchor for steeplejacking to be tested.

5 LADDERING

Figure 6 Forces through ladder tie anchor during normal use.



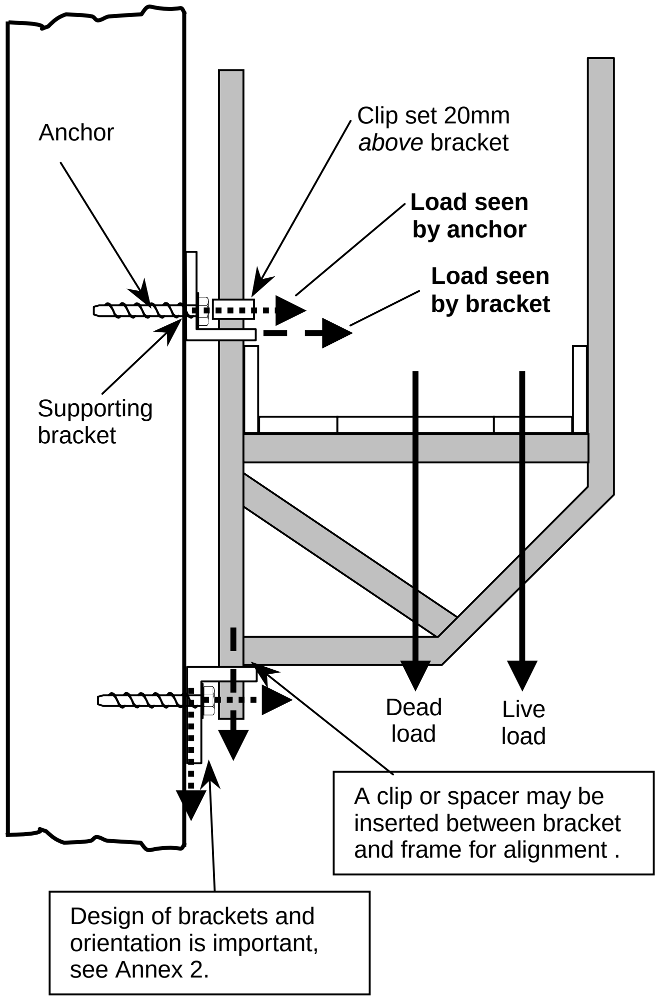
In this section only the restraint of the ladder against loads imposed during normal use are taken into account. Loads due to the arrest of a fall are not considered. This is due to the wide variation in technique used within the industry. If the ladder is used as part f the fall arrest system then an assessment must be made of the loads involved. Ideally this should involve both calculations and drop tests in worst case scenarios. BS EN 795[X] contains details of a suitable drop test arrangement.
Several assumptions are made. The most fundamental is that the ladder is arranged such that the vertical forces applied through the ladder, however they are generated, e.g. from its own weight or that of a worker on it, are taken through the frame of the ladder directly into the ground or are supported by some other anchoring system. The ties used to restrain the ladder back to the structure are therefore assumed to take horizontal forces only.

In order to assess the suitability of a fixing for the restraint of ladders the forces acting on the fixing must be accurately assessed or estimated in such a way as to assure an adequate safety margin.

Where ladders are fixed to inclined surfaces, e.g. on church spires or cooling towers, the effect on loadings must be taken into account.

Example calculations are shown in Annex 1.

Figure 7 Typical arrangement of scaffold frame



6 SCAFFOLD FRAMES

In order to select an appropriate anchor it is necessary to know the magnitude of applied loads. The diagram shows the simplest arrangement of bracketry to support a scaffold frame in order to illustrate the process. The dead and live loads are shown with solid arrows ⟶ these result in loads as seen by the brackets, shown – – ▶. These loads in turn are transferred to the anchors, and are shown ······▶ . Examples of calculations for two different arrangements are shown in Annex 2, along with some worked examples.

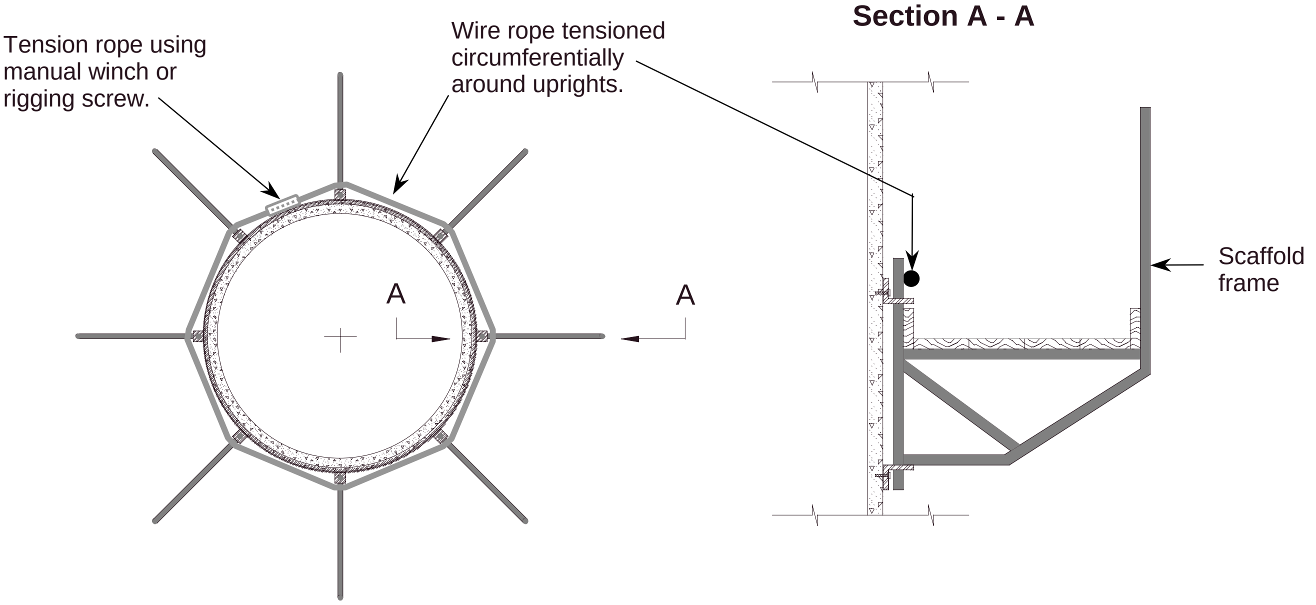
In this example the loads resulting from the dead and live loads are assumed to make the frame tend to rotate about the bottom edge of the bottom bracket resulting in a tensile force on the upper bracket. In calculations only one bracket is assumed at the top as only one bracket can be in contact with the upright at once. Any clips set on the upright above the upper bracket should be set with a clearance above the bracket to avoid a shear load being imposed at this point. If an additional bracket is used above the top bracket for added security this should be ignored in calculating the loads on the brackets but its effect, in terms of anchor spacing, must be taken into account. The anchor supporting the bottom bracket is required to support both tensile and shear loads which may overload anchors fixed into masonry. This problem may be overcome by different bracket design, including the use of two anchors, as discussed in Annex 2. Suitable bracket details are shown in Annex 5.
The application of both tensile and shear loads to an anchor requires the consideration of the anchor capacity in a special way as described in section 2.4.3. - Equation 3.

Obviously the most critical anchor here is the one supporting the bottom bracket as this not only takes both tensile and shear loads but the shear component is assumed to be equal to the combined dead and live loads. The selection and installation of this anchor are both therefore vitally important. Equally important is the location of the topmost anchor with respect to the top of the structure. There must be enough mass above this anchor to ensure that it can support the load and that the structure will not be destabilised by this load or by any stresses exerted into the base material by the anchor itself (see 3.2.1).

6.1 Wire reinforcement of Scaffold Frames

If a wire rope is tensioned circumferentially around the external face of the vertical members of the frames immediately after installation and before any loading takes place this will greatly reduce the tension loading on the anchors of the upper bracket.

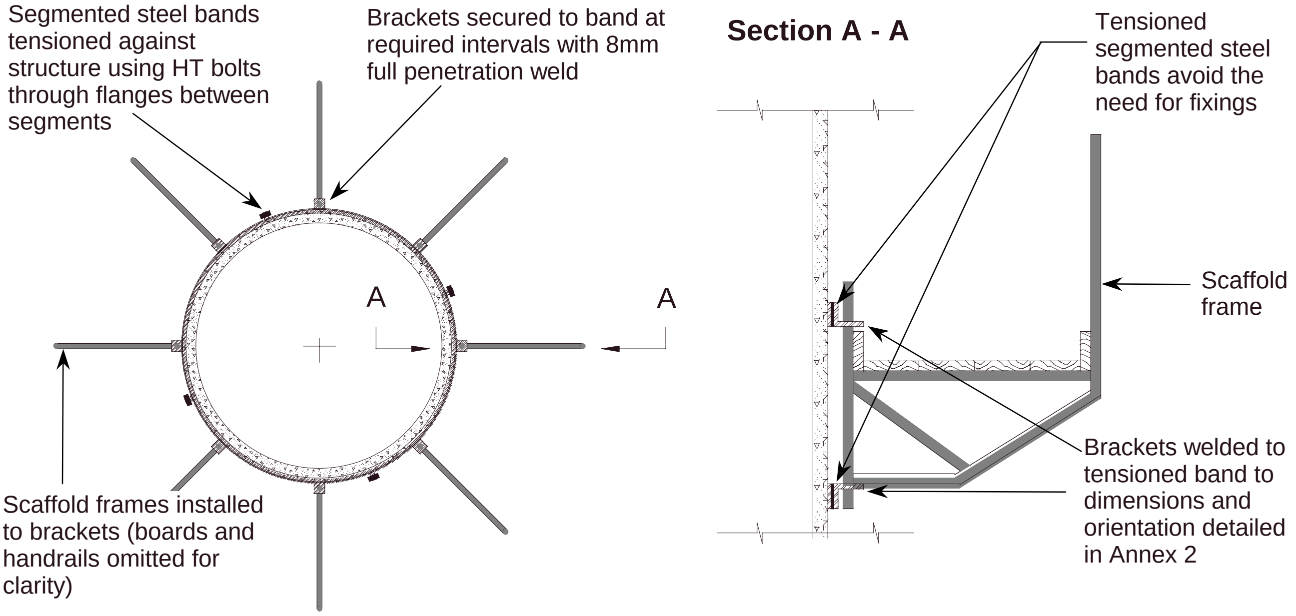
Figure 8 Scaffold frame with circumferential wire reinforcement.



6.2 Scaffold frames attached using tensioned steel bands.

In structures of weak masonry one method of avoiding the need for fixings altogether is the use of segmented steel bands which are tensioned around the structure and onto which the brackets supporting the frame are welded. The use of long High Tensile steel bolts to join flanges between sections enables the circumference of the band to be tailored to that of the structure at the required height. A separate design exercise is needed to validate the detail design.

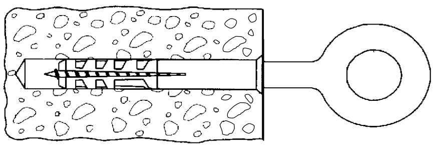
Figure 9 Arrangement of segmented steel bands



7 ANCHOR TYPES

The anchors discussed here are those currently used within the industry and considered suitable with the qualifications outlined. Other types may be equally suitable.

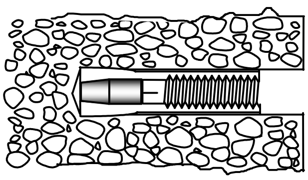
7.1 Nylon anchors with screw in eyes



These anchors, using a 14mm diameter nylon plug 70mm long combined with a special screw eye, are sold as a scaffold tie system (for which use comments can be found in TG4:04[3]) and are also particularly suitable for laddering as long as only tensile loads are applied due to restraint - as discussed in section 5 and Annex 1. They work in concrete, brickwork and stonework. The plug exerts a lower stress on masonry than do metal expansion anchors. Plugs manufactured in nylon grade "PA6" are well proven for this application, other types of plastic should only be used if they have characteristics proven to be similar to PA6. Screw eyes are available in different lengths but the shortest feasible length should always be used to minimise the risk of bending loads being applied. The screw eye can be unscrewed after dismantling of the ladder leaving no components to corrode.. The internal eye diameter is typically 22 - 24mm. Tests have shown this system to work reasonably well in mortar joints of up to 12mm (See section 3.4). Plugs are not normally considered to be re-usable (even when left in the structure). Screw eyes (most of which come from a common source) should not be re-used as they have been known to break on removal (but not during use). Failures of any sort should be reported to the manufacturer.
Before use in elevated temperatures, e.g. on chimneys which are in operation, then the upper service temperature limit of the nylon plug must be checked with the manufacturer.

Installation points to watch.
- ❑ *Take care to drill holes to full depth (plug length + 10mm) and clean holes thoroughly.*
- ❑ *Take care not to over tighten the eye into the anchor as this may strip the thread formed in the plug or overstrain the eye material.*

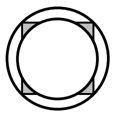
7.2 Drop-in anchors



"Drop-in" internally threaded, hammer set expansion socket anchor - for concrete

Scaffold ringbolt in Drop-in anchor

The traditional drilled in scaffold tie anchor. The M16 size is used with M16 scaffold ringbolts. Drop-in anchors are designed for use in concrete. Safe working loads of M16 drop-in anchors vary from 9.0 kN to 12.6 kN – check with the manufacturer, especially when used as a heavy duty tie for a capacity of 12.2kN. They must not be set too close to an edge or the shock loads induced by the hammering action during setting may induce cracks. Typical minimum edge distances recommended by manufacturers for M16 drop-in anchors in concrete with no edge reinforcement are 220 – 230mm. This distance may be reduced with suitable edge reinforcement at the discretion of the responsible engineer following discussions with the manufacturer. In such cases proof testing should be carried out. Care should be taken when installing into columns or the edges of floor slabs to ensure fixings are installed on centreline.
Some types show a witness mark on the shell when correctly expanded. For these types proof tests may be considered unnecessary as long as a similar sample of all anchors (1 in 20 and at least 3) are inspected at random, for the mark, with the results recorded.

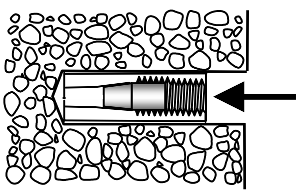


Example of witness mark with correct setting on certain types of anchor.

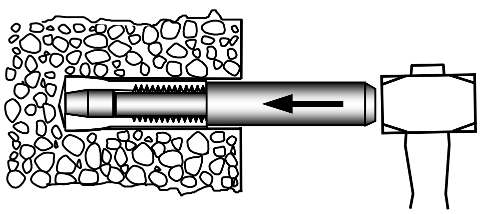
<u>Drop-in anchors are not recommended for steeplejacking purposes in brickwork or stonework.</u>

Installation points to watch.
- ❑ These are expanded by hammering a pre-assembled expander plug to the base of the anchor using a special setting punch.

- ❑ Only when the shoulder of the punch meets the shell of the anchor is it fully expanded. Drop-in anchors must not be set by screwing in a ringbolt or other bolt, the anchor is not threaded far enough for this method to expand the anchor. If a bolt or ringbolt is tightened against the thread run-out the shell may be weakened and shear off. Once ringbolts are fully inserted they should be turned back to align them with the tube.

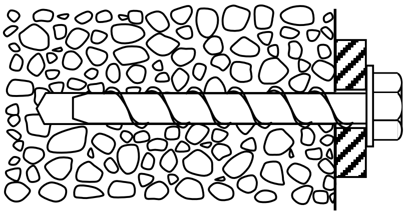


Anchor pushed to base of hole

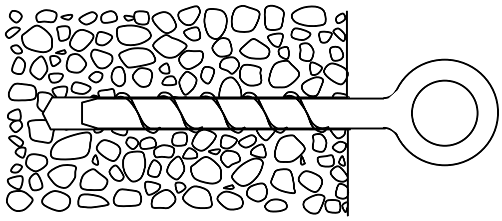


Expander plug hammered fully home using special punch.

7.3 Self tapping screw anchors



Self-tapping screw anchors may be used in concrete or hard brickwork or stone.
← Bolt type, for use with brackets for scaffold frames
Eye type → for laddering

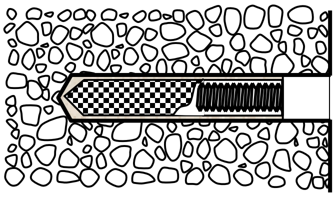


Self-tapping screw anchors are easy to install as they cut their own thread in a pre-drilled hole. They may be removed leaving nothing in the structure to corrode. Some are considered re-usable but thread cutting surfaces will wear so they should only be re-used once or twice – check the manufacturer's policy – proof loading rates should be doubled on re-used anchors, see 4.2. Hex bolt versions as shown are available up to 20mm diameter and are suitable for use with scaffold brackets. 12mm diameter screws may have recommended loads in concrete in excess of 6.1kN (the design load for a standard duty scaffold tie) but may not do so in brickwork. Using a larger diameter - up to 16mm - or a deeper embedment, i.e. a longer screw, may increase capacity sufficiently.
Eye type versions are available with a shank diameter up to 12mm and internal eye diameter of 18mm and may be used for laddering but are less suitable for use in mortar joints than nylon plugs systems.

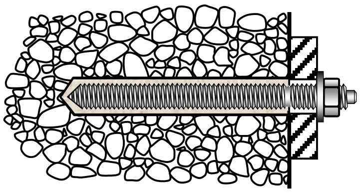
Installation points to watch.

- ❑ The steep self-tapping thread may strip the thread cut in weak or soft base materials if over tightened. Once the head of the bolt type anchor is flush with the fixture it should not be tightened by more than a fraction of a turn to avoid stripping the thread.

7.4 Resin anchors.



Resin socket anchor set in concrete for ringbolts or hex headed bolts. May be used in brickwork – see notes.



Resin stud anchor set in concrete with bracket attached; may be used in brickwork- see notes.

Resin anchors are worth considering when expansion anchors are unsuitable e.g. close to edges in concrete or in solid brickwork or stonework, as they do not stress the base material. They must be allowed to cure before being tightened or loaded. Before specifying a particular type of resin anchor for use on a working chimney it is essential to speak to the manufacturer regarding service temperature limits. Not all resin formulations are suitable for the temperatures involved.

Special internally threaded M16 socket anchors 125mm long have been developed for the attachment of ringbolts in concrete or solid brickwork (they are not suitable for use in cavity construction).
Stud type resin anchors are suitable for direct attachment of brackets.
Anchors set in concrete should ideally be set using spin-in resin capsules and while injection systems may be used in concrete they require more care.
Resin injection systems are ideal for use in masonry. Special mesh sleeve systems are available for use in perforated or frogged bricks. The manufacturer's advice should be followed at all stages.

Installation points to watch

- ❑ Hole cleaning is vital for all resin anchors especially injection systems. BRUSH the hole using a round brush, as well as blowing.
- ❑ With injection systems pump the first trigger pull to waste before injecting into the hole.
- ❑ With all resin anchors allow the full curing time before loading or tightening, this varies with temperature and is usually longer for injection systems.
- ❑ Do not over tighten! Always use a calibrated torque wrench set to the manufacturer's recommended installation torque which should be reached in approximately half a turn from finger tight. . Torque values for concrete should be reduced in weaker materials such as brick or stone – refer to the manufacturer.

8 REMOVABLE AND RE-USABLE FIXINGS

Some anchor types are removable which avoids problems with long term corrosion.
Some are also claimed to be re-usable including some makes of self-tapping screws. Anchors that are re-used should be subject to twice the rate of proof testing (i.e. 1 in 10).
Manufacturers have different policies on this – check with them before adopting a policy of allowing re-use. The feasibility of this practice depends on the anchor type and on the contractor having in place a reliable system for controlling the number of times an anchor is re-used. Some manufacturers recommend that anchors are inspected before re-use but this must be treated cautiously as deterioration in holding power may not be apparent from a visual inspection. If there is any doubt about the suitability of an anchor that has been re-used it should be discarded.
Plastic (including nylon) plugs are not generally regarded as being re-usable.

9 CORROSION OF FIXINGS

Although some steeplejack anchors are temporary fixings normal carbon steel anchors, even if zinc plated, will rust if left unprotected in the structure. Those that are known to be required for repeated use (without removal) over a number of years and those set in listed buildings must be corrosion resistant which normally means stainless steel. Consideration should be given to the location and exposure conditions when selecting the grade of stainless steel to be used. To avoid staining of building surfaces grade A4 should be specified.

Socket anchors set back from the surface may be protected by capping the holes but care must be taken to ensure this will provide a weather tight seal otherwise the anchor will still rust. This will cause unsightly staining on the building and will eventually reduce the strength of the anchorage.

If carbon steel anchors with projecting threads are cut off flush with the surface they will rust and stain the building, eventually the forces generated by the rusting may crack the structural element. This can only be avoided by using stainless steel anchors or anchors which may be unscrewed leaving only the expansion element deep in the structure in which case the hole should be filled with a suitable mortar.

Anchors which are removable or made of non-corroding materials including plastic will avoid potential corrosion problems.

10 TRAINING

In view of the critical nature of all anchoring applications in steeplejacking only operatives trained in all aspects covered in this Guidance Note should install or test anchors.

References:

[1] Association of Technical Lightning & Access Specialists Ltd
4c St Mary's Place,
The Lace Market, Nottingham, NG1 1PH
Telephone: 0115 955 8818 Fax: 0115 941 2238
Email: info@atlas-1.org.uk Website: www.atlas-1.org.uk

[2] Construction Fixings Association
65 Deans St., Oakham, Rutland, LE15 6AF
Tel & Fax: (01664) 474755
E-mail: info@fixingscfa.co.uk Website: www.fixingscfa.co.uk

[3] TG4:04 Technical Guide Anchorages for scaffolding.
Published jointly by NASC and CFA:
National Access and Scaffolding Confederation Ltd.
Carthusian Court, 12 Carthusian St, London, EC1M 6EZ
Telephone: 020 7397 8120 Fax: 020 7397 8121
Email: enquiries@nasc.org.uk Website: www.nasc.org.uk

[4] Guidance Note: Anchor Selection - CFA. This is freely downloadable from the CFA website at www.fixingscfa.co.ukT.

[5] BS 8437:2005 Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace. BSI

[6] ETAs are issued in accordance with the appropriate ETAG (European Technical Approval Guideline). ETAG 001 *Metal anchors for use in Concrete* is downloadable from www.eota.be. A Guidance Note *European Technical Approvals for Anchors used in Construction* is downloadable from the CFA website www.fixingscfa.co.uk.

Annexes

The following annexes are an integral part of this guidance note. They include calculation methods for determining the loads applied to anchors in these applications with worked examples:

Annex 0 Notes common to annexes
Annex 1 Laddering – loads in normal use only
Annex 2 Scaffold frame – working loads
Annex 3 Winch application
Annex 4 Access davit. Loads in normal use and fall arrest
Annex 5 Details of brackets used in calculations