THE MIDFIX GUIDE TO A COMPLIANT BS 8539 FIXING INSTALLATION

MIDFIX

Introduction.

The guidance within this paper is designed to raise awareness of the issues around fixings selection and installation and if followed should ensure a reduction in risk associated with poor selection and installation.

Before we look at BS 8539:2012 it is important we fully understand why fixings/anchors are so important.

Why Are Anchors/Fixings Important

The complexity of this subject, in which relatively low-cost work carried out with respect to materials and installation, presents significant difficulties to all involved in terms of management and quality assurance. This guide aims to alert readers to some of the dangers involved, some of the technical challenges to be addressed and the need for firm guidance in its widest sense.

It must be recognised that fixings which cannot be later inspected, presents a potential high risk.

This guide will also look at some of the reasons "safety critical" fixings all too often fail. (Safety critical as defined within BS 8539:2012 – The risk of failure that causes risk to human life and/or significant economic loss).

Within the building services industry fixings are important because:

1. They are often the "weak" link
2. They are often at the interface between parts that are the responsibility of different parties
3. They are often sensitive to workmanship
4. Their design may be complex and poorly understood
5. They may deteriorate over time and their deterioration may not be easily seen or identifiable
6. They may be concealed by finishes or shrouds, which may mask deterioration, poor installation, or even missing fixings
7. The failure of one fixing may trigger the failure of other fixings as they take more load, leading to a progressive collapse
8. Partly due to their low cost they are often left to the "last minute" before ordering, resulting in very little thought going into the selection process.

It is important to note that the performance of the fixing will depend not only on the performance of the fixing, but also, potentially, such issues as:

1. The performance of the surrounding structure and how the loads are applied to the fixing
2. The effect of the bracket on the fixing
3. Effects at the fixing arising from additional loads such as cable pulling etc.
4. Movements arising from various effects such as thermal expansion etc.

The difficulty of understanding and calculating these effects and more should not be underestimated.

When fixings are selected it is important to take into account the role they play, how they are procured and how they are installed. All these points and more could affect the performance of the fixing.

The above decision-making process is often complicated even further by procurement and contracting arrangements. Potential barriers to successful performance could include:

1. Different parties may be involved with designing the support structure and the fixing.
2. The actual materials involved in the supporting structure are often different
3. The party purchasing the fixings may substitute cheaper products than have been specified
4. The strength of the fixing may have been compromised by reduced strength or thickness of substrate.
5. After installation, the fixing may become hidden.
6. Additional loads are often added by alternative parties without consultation

The question to ask is:

If challenged, can you demonstrate that the structure you have installed can take the service load applied to it, and that the supports and fixings are fit for purpose?

The question is not implying the fixing/bracket will collapse, its asking can you demonstrate (evidence) the install.

BS 8539:2012 Overview.

Taking all the above, and more, into account BS 8539 was introduced in 2012. It is the "Code of practice for the selection and installation of post-installed anchors in concrete and masonry"

It highlights the responsibility for each stakeholder, namely the:

- Designer
- Specifier (may be the designer)
- Contractor – Installer
- Contractor – Supervisor
- Supplier
- Tester

Each of the above has specific management tasks to ensure that the correct anchor has been:

- Selected correctly (SELECT)
- Procured and sourced correctly (SUPPLY)
- Installed correctly (INSTALL)
- Tested correctly if needed (TEST)

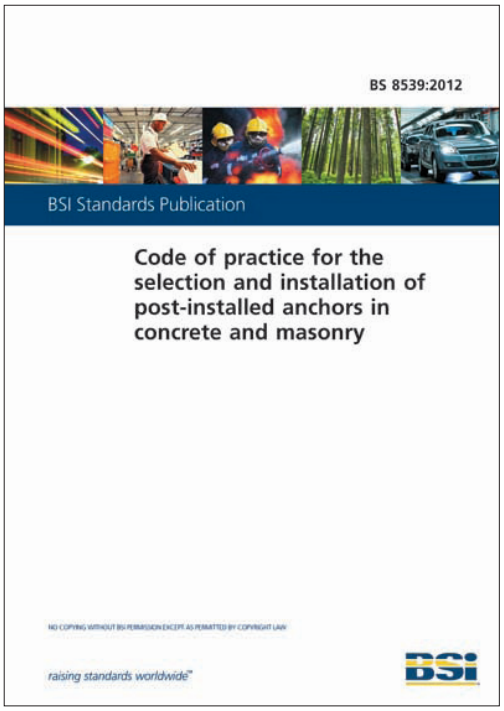
Adherence to the standards ensures a reduction in risk associated with poor selection and installation.

While true anchor failures are thankfully quite rare, failures of suspension occur all too frequently. In our experience this is down to two main issues:

1. The anchor was installed incorrectly.
2. The anchor was selected incorrectly.

Following BS 8539:2012 helps alleviate these two issues because, for every safety critical anchor we require evidence that the proposed fixing/anchor will achieve the applied load and that the operatives and supervisors responsible for the installation are trained and competent.

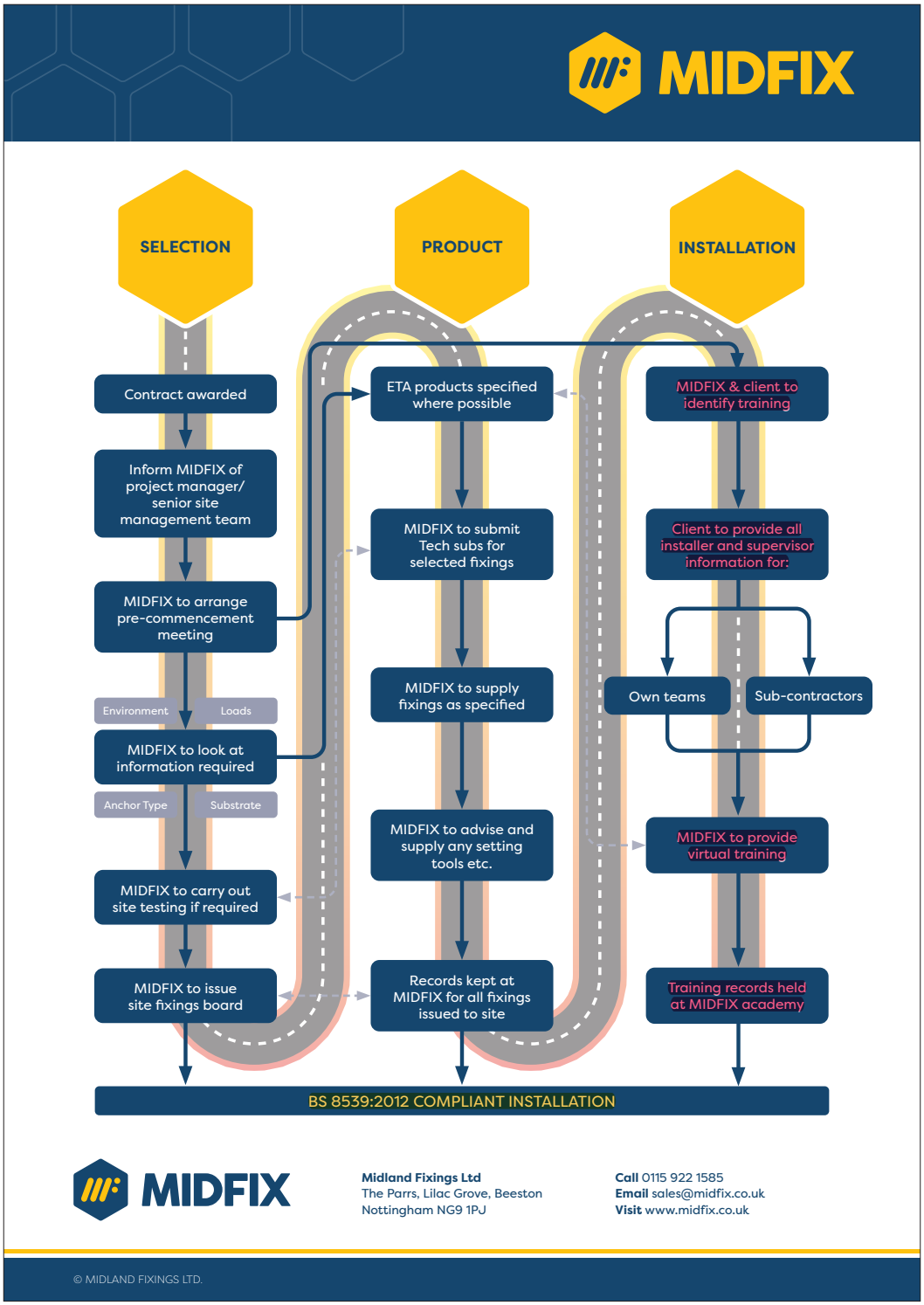
It is important that all sites are aware that fixings manufacturers and distributors often receive requests for unnecessary "pull-out" testing due to a misunderstanding of BS 8539:2012.



MIDFIX SSIT (Select, Supply, Install, Test)

Process flow to a compliant installation:

The scope of this document is to provide practical guidance for all building services contractors and Principal contractors, working on projects with regards to the correct selection and installation onsite of typical M&E anchors. The following correct selection and installation procedures are to ensure a safe and secure connection that will safely support the structure under its full working load.



We will now consider each step:

SELECTION

For a fixing to be selected correctly for a given application there are several areas of due diligence which need addressing and this starts at the CONTRACT AWARDED stage.

Contract Awarded

It is quite common within building services to leave the anchor selection process to the last minute and expect the site installation teams to make the decision. As you will see from reading this guidance this is not only incorrect, but is where most of the issues arise from. By leaving very little time, if any, to select the correct fixing we also leave no time for training and testing. Every stakeholder needs to raise the awareness of fixings to a point where they are on the pre-commencement list of things to do. This will enable the correct anchor to be selected, any installer training to be implemented and finally all testing requirements can be considered.

STAGE 1

At the contract awarded stage inform MIDFIX of:

- Project managers
- Contract managers
- Senior site team members
- If sub-contracting a contact within the principal contractor responsible for the fixings policy

STAGE 2

Once all parties are known MIDFIX will arrange an initial fixings strategy meeting. This will look at the basic project requirements and agree on a working committee. From here we will book a pre-commencement meeting on site.

STAGE 3

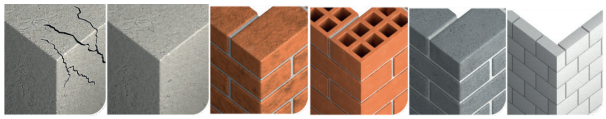
The Pre-Commencement Meeting

At this point it should be possible to identify most of the fixings required for the M&E install. MIDFIX will consider the following points:

- Substrates
- Loads
- Environment
- Approvals
- Type of install
- Fixings principles
- Training requirements
- Testing requirements

Substrate:

Common Base Materials/Substrates



Reinforced Concrete, Precast Concrete, Beam & Block, Hollowcore Slab, Hollow Brick, Porotherm, Aerated Block, Natural Stone etc.

NB – If you cannot positively identify the base material MIDFIX will require access to site to carry out allowable load testing.

Typical example of substrate found on site:

Cracked Concrete.

Usually found overhead, but not exclusively. BS 8539:2012 notes that only cracked approved anchors should be used in this substrate. Therefore, great care needs to be taken when selecting anchors, particularly overhead. If unsure consult with the main contractor or consulting engineer. If still unsure BS 8539:2012 recommend we assume the concrete to be cracked.

Reinforced Concrete.

Care needs to be taken not to hit the reinforcing bar while drilling. If reinforcing bar is struck, drilling must stop and advice taken as altering the location or embedment depth can effect the load capacity of the anchor.

Hollow-core Slab.

This is a popular flooring slab that requires special approvals, especially when fixing overhead. Care needs to be taken to ensure fixing into the correct location on the slab which is into the hollow. This will avoid striking the tension bars located in the webs.

Composite Rib Decking.

A very common decking option. Dedicated fixings using the entrant are available depending on the decking manufacturer. If these are not available or you need to fix away from the entrant this base material lends itself well to a number of mechanical anchors such as concrete screws.

Loads:

At this stage MIDFIX will liaise with all parties to look at actual applied loads within the project. Within M&E there are many different load possibilities combined with bracket types so MIDFIX look for “worst case” applied loads and carry out the selection process from this point.

MIDFIX will need to understand:

- Worst case applied loads for given areas
- Type of load, static, dynamic etc.
- Distribution of load over the bracket
- Etc

For some critical areas MIDFIX may need to liaise with the designer.

Designers and MIDFIX must ensure that:

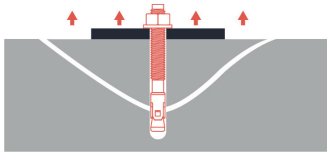
The design should take into account the design considerations listed below and supply all the necessary information to the specifier:

a) Ability of the structure to support the applied loads

b) Concrete conditions

c) Robustness, redundance* and progressive collapse

If the designer is not the specifier, they must supply all the necessary information to enable the specifier to correctly select and specify all anchors/fixings.



*Redundance
For fixings, “redundance” means the ability to transfer loads to other fixings, should a fixing fail or start to fail.

Environment:

Often overlooked, the environment the fixing is being asked to work in plays an important part in the selection process.

Corrosive Environments

The below ISO 9223 classification table helps identify potential corrosive issues with regards to the environment the anchors are being asked to perform in.

Class	Impact	Interior	Exterior
C1	Very Low	Heated spaces with low relative humidity and insignificant pollution, e.g. offices, schools, museums	Dry or cold zone, atmospheric environment with very low pollution and time of wetness, e.g. certain deserts, central Arctic/Antarctica
C2	Low	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution, e.g. storage, sport halls	Temperate zone, atmospheric environment with low pollution (SO2< 5 µg/m3), e.g.: rural areas, small towns. Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, sub-arctic areas
C3	Middle	Spaces with moderate frequency of condensation and moderate pollution from production process, e.g. food-processing plants, laundries, breweries, dairies	Temperate zone, atmospheric environment with medium pollution(SO2: 5 µg/m3 to 30 µg/m3) or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides, subtropical and tropical zones with atmosphere with low pollution
C4	High	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools	Temperate zone, atmospheric environment with high pollution(SO2: 30 µg/m3 to 90 µg/m3) or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas without spray of salt water, exposure to strong effect of de-icing salts, subtropical and tropical zones with atmosphere with medium pollution
C5	Very High – Industry	Spaces with very high frequency of condensation and/or with high pollution from production process, e.g. mines, caverns for industrial purposes,unventilated sheds in subtropical and tropical zones	Temperate and subtropical zones, atmospheric environment with very high pollution (SO2: 90 µg/m3 to 250 µg/m3) and/or important effect of chlorides, e.g. industrial areas, coastal areas, sheltered positions on coastline
CX	Very High	Spaces with almost permanent condensation or extensive periods of exposure to extreme humidity effects and/or with high pollution from production process, e.g. unventilated sheds in humid tropical zones with penetration of outdoor pollution including airborne chlorides and corrosion-stimulating particulate matter	Subtropical and tropical zones (very high time of wetness),atmospheric environment with very high pollution (SO2 higher than250 µg/m3), including accompanying and production pollution and/or strong effect of chlorides, e.g. extreme industrial areas, coastal and offshore areas with occasional contact with salt spray

Care needs to be taken when looking at high corrosive areas such as Swimming pools & Tunnels. There are specific factors within these environments which have to be taken into consideration especially in the context of stainless steel.

Following the example of a swimming pool environment normal grades of stainless steel when used in this environment for parts under stress such as load bearing elements and fixings, are liable to failure through stress corrosion cracking. This is induced by the corrosive chlorinated compounds deposited as condensation on their surfaces which can quickly lead to failure of the part. EN 1993 1-4 specifies special grades of highly corrosion resistant stainless steels that must be used for such components in swimming pool environments.

Typical finishes available:

- Zinc
- HDG
- Zinc Flake
- Stainless (various grades)

Galvanic Corrosion

Galvanic corrosion occurs when two different metals are in contact in a corrosive environment. One of the metals can experience an accelerated corrosion rate due to the self-induced current by electrical potential between the two dissimilar metals in contact with an electrolyte. In order to prevent this we can:

1. Select metals/alloys as close together on in the galvanic series
2. Avoid unfavourable area contact of small anode and large cathode
3. Insulate dissimilar metals where possible
4. Apply coatings, with caution.

Approvals:

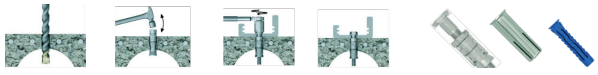
BS 8539 states that if a fixing with an ETA is available then it should be used. What is an ETA?

An ETA stands for European Technical Assessment. The anchor manufacturer sends its anchors for pre-testing to a harmonised set of standards. Once the anchor in question has received its approval, the information within the document can be used by designers and installers in order to provide safe and secure connections on site. This information can also then be used by the installer for testing purposes or engineers for creating a design to show proof that the anchor is fit for purpose and can achieve the loads required. BS 8539:2012 states an ETA anchor should be used where one is available. It is also an important document when it comes to the supply of the product to site. Please see supply section for details.

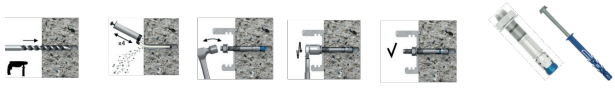
Type of Installation:

There are two general types of installation and MIDFIX will consider which is more appropriate for the project.

The preinstalled FLUSH fixing, eg



The THROUGH fixing, eg



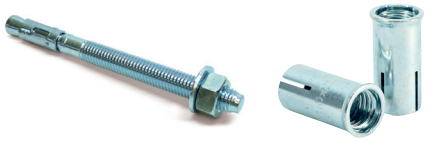
Fixing principles:

In order to select a fixing, it is important to understand how and why it works.

All anchors work on either one of the following principles or a combination of them:

- Expansion
- Undercut/Interlock
- Bonding

Typical fixings used in building services include:

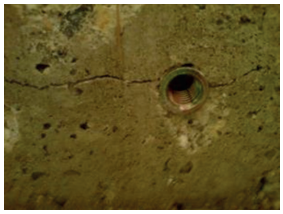


Through-bolts and deformation controlled (drop in) anchors work through expansion and rely on friction due to the expansion to resist the load applied.

Concrete screws rely on the interlock principle. The undercut created by the flutes creates the resistance required.

Resin anchors, typically used as problem solvers in M&E, reply on a combination of bonding and interlock to achieve the resistance required

It is important to understand how the different principles effect substrates. An example is installing an expansion type anchor too close to an edge or in low strength substrate may result in the expansion forces set up by the anchor overwhelming the substrate:



Particularly with expansion type anchors spacing needs to be considered carefully:

Training Requirements:

Please see separate section on TRAINING.

STAGE 4.

Site testing requirements.

As per BS 8539:2012, site testing is not required if anchors have an ETA and are installed and supervised by competent operatives. In situations where manufacturers are unable to provide performance data, e.g. fixing into old substrate material, then site tests should be carried out to determine allowable loads for specific site conditions. Every organisation appointed to carry out either proof or allowable load testing should be accredited by the CFA, Construction Fixing Association, and carry a valid testers card.

The CFA, Construction Fixing Association, sets out a clear and concise testing program. At pre-commencement stage MIDFIX, along with the contractors determine the necessity for testing and if required what type of testing.

There are generally two different types of tests called for within M&E contracting:

- Proof Testing. Often referred to as a pull test. These are carried out after installation by the contractor and they check the quality of the installation.
- Allowable load test. Where the application involved is not covered by a relevant ETA, or the strength and condition of the base material is unknown, with no published data.

Any testing should be carried out by qualified CFA approved testers.

MIDFIX require any test request to be made online via the “My MIDFIX” page. Here the requesting party will supply the information required to request a site test. All site testing carried out to CFA guidelines and the results are posted back online. Whoever requested the testing is notified and they have access to the test report. This enables one central library for all site tests carried out on the given project.

STAGE 5.

Once MIDFIX has agreed with the contractor the fixings and bracketry to be used on site a fixings board will be produced and issued to site. This helps as a visual indicator as to which fixings have been agreed, tested and training issued on.

PRODUCT

STAGE 6

MIDFIX will always default to an ETA anchor where one is available as per BS 8539.

In the case of an ETA anchor not being available MIDFIX will require access to site for allowable load testing prior to the anchor being used on site.

STAGE 7.

MIDFIX will issue technical submissions to site for all ETA anchors selected for use. This will include the actual ETA document.

STAGE 8.

If MIDFIX are selected to supply the fixing they will ensure it is supplied as specified. Should any specification changes be requested MIDFIX will have to follow the change management procedure as laid out in BS 8539.

As a supply partner MIDFIX will ensure:

- The anchor is supplied as specified unless a specific change management procedure has been followed.
- All associated setting equipment is offered to the contractor such as drill bits, hole cleaning equipment, setting tools, torque wrench etc., in order that the installer can install anchors correctly
- The change management procedure is adhered to if asked for alternatives

Ensuring the installer is aware of any setting tools or installation tools is vitally important. Two examples are given below:

1. In order for a deformation controlled (drop in) anchor to be installed correctly the installer must have access to the dedicated setting tool for that given make and length of anchor and a method for cleaning the hole:

2. For the correct installation of a though-bolt the installer must use a calibrated torque wrench. The torque carries out two functions, it sets the anchor and it creates the clamping force required to stop the fixture from moving. Torque controlled anchors suffer from load relaxation so without a torque wrench we cannot install the anchor properly.

INSTALLATION

STAGE 9

During the pre-commencement meeting MIDFIX, along with the contractors, will identify any training requirements.

As stated earlier the biggest variable on site is the quality of the install. In order to raise the standards of installation and to make all stakeholders aware of their responsibilities training is required.

One of the biggest issues associated to “anchor failure” is installation error.

Installer training is probably one of the single biggest impacts you can have on your overall quality of installation. MIDFIX offer various types of training:

BS 8539:2012 Awareness

This is designed to give the contractor as a whole, an overview of BS 8539:2012 and their individual responsibilities therein. This session is recommended before any other training is carried out. This session is available both virtually and face to face.

This course is highly recommended to the contractor as a whole and is promoted during the pre-commencement stage.

There are several situations onsite where the installer/ supervisor should stop work and refer to the site management or engineering before proceeding with any further anchor installation. This practice should be encouraged on site and is another reason we recommend the BS 8539:2012 awareness session. Some typical examples are:

- Rebar – If you strike reinforcing bar whilst drilling
- Tension bars – If you strike tension bars whilst drilling
- If you come across an unknown base material
- If you do not have the required information such as drill diameter and depth to install the anchor
- If you do not have the relevant tools such as setting tools or torque wrenches etc
- If you are asked to install a non-specified anchor

Installer Training

Designed to give the installer all they need to safely and correctly install the specified anchor. The session consists of a theory section followed by a video covering the actual installation sequence. There is an interactive questionnaire at the and where the candidate is required to score a pass mark of more than 80% to qualify. It is recommended these sessions be carried out virtually.

Anchors covered:

- Deformation Controlled
- Concrete Screw
- Through-bolt
- Resin – Cartridge system

Installer training is available via the MIDFIX Academy and can be taken in a unguided programme giving the candidate the ability to sit through the training at a time to suit them. On completion of the interactive questionnaire and assuming they obtain at least 80% during the test they will be issued a training card.

Supervisor Training

More involved the supervisor training consists of the following 4 modules. Each module has to be successfully completed before moving to the next. Only upon completion of all modules will the pass be issued:

a) BS 8539:2012 overview

b) General anchor principles

c) Substrates & Failure modes

d) Installation procedures

It is recommended this course be carried out virtually. Part of the supervisor’s remit should be to inspect and sign off the installation before service loads are applied. The aim of this course is to give the candidate all the information and experience they need to successfully complete the CFA accredited supervisors course.

Due to the nature of the supervisor course and the content this is available as a remote classroom lead course.

Training Cards

Upon successfully completing either the installer training or supervisor training the candidate will be issued with a training card.

The card with show their details plus the type of training undertaken and the anchors they have successfully passed on. The card also has a 2 year time stamp upon when re-training will be required.

The card also shows a QR code, this link will take the card holder to the installation videos on the MIDFIX Academy page.

CONCLUSION:

The above outlined process of:

- Correct Selection
- Correct Supply
- Installation Training
- Testing Policy

Will result in a BS 8539 compliant installation.

Midland Fixings Ltd,
The Parrs, Lilac Grove,
Beeston, Nottingham NG9 1PJ
Call 0115 922 1585
Email sales@midfix.co.uk
Visit midfix.co.uk