Building Engineering Services Association
Guide to Good Practice for:

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BUILDING ENGINEERING SERVICES ASSOCIATION

Supports and Fixings

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SCOPE

This guidance covers supports and fixings usually found in commercial/non-domestic premises and facilities where employees and the public are potentially at risk. The specification is not intended for residential premises, although some of its provisions will apply. This specification makes use of terms “should”, “shall” and “must” when prescribing procedures:

- The term “must” identifies a requirement by law at the time of publication.
- The term “shall” prescribes a procedure, which it is intended to be complied with, in full and without deviation.
- The term “should” prescribes a procedure, which it is intended to be complied with unless, after prior consideration, deviation is considered equivalent or better.

Publication and review
User feedback on the content or the requirements of the guidance will be welcomed to assist in the ongoing development of this document.
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Notes
Manufacturing techniques are continually subject to change and improvements and in respect of proprietary methods and devices this guide does not preclude their use if they can be demonstrated to the system designer to be equally satisfactory. Where there is divergence between the requirements of and the manufacturer’s recommendations for proprietary methods and devices, the latter shall take precedence.

This document is based on knowledge available at the time of publication and is meant for general purposes, not for reliance on in relation to specific technical or legal issues, in which case you should always seek independent advice. No responsibility of any kind for any injury, death, loss, damage or delay however caused, resulting from the use of the advice and recommendations contained herein, is accepted by the authors or others involved in its publication (including the Building Engineering Services Association).

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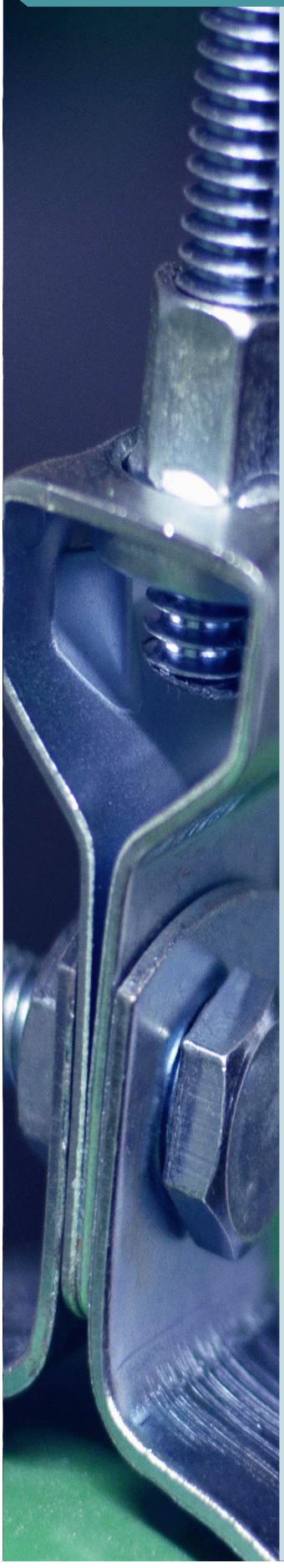


SECTION 1

Background

Supports and fixings are critically important but often overlooked element of building services engineering design and installation. They are often considered as commodity items where procurement decisions are made solely on price, or worse still, changed on site without any knowledge of the implications. In addition, they are often installed by individuals without the requisite competence or the correct tools.

This approach is fundamentally flawed and makes it is very difficult to demonstrate that the supports and fixings have been correctly designed and installed and therefore fit for purpose. There have been many instances where suspended services have collapsed as a result of a failure in the design, procurement or installation. There are also examples of failures of supports for roof mounted plant because wind or snow loading were not considered during the design.

In order to address the failings associated with fixings into concrete, a British Standard code of practice; BS 8539 was published in 2012 which provides a framework for managing the process of concrete anchor design, specification, installation and testing. Although widely circulated, the uptake of this code of practice has been slow. The underlying principles of BS 8539 are that supports & fixings require consideration and planning at design stage as well as accurate specification during procurement and installation by competent individuals.

The purpose of this technical guidance document is therefore to address these issues and provide best practice guidance for design, specification, installation and testing of supports & fixings for mechanical services systems in buildings.

SECTION 2

DESIGN

Supports and fixings for mechanical systems may not be upper most in the minds of construction professionals during the initial design stages. However, it is important that certain aspects are addressed by the designer at this stage in the process.

2.1 It is the responsibility of the mechanical designer to calculate the weight of building services systems in order to obtain approval from the structural engineer that the structure is able to support the weight of the plant and distributed services. This should take place at RIBA stage 2 and no later than RIBA stage 3. Refer to BSRIA BG6 ref 2.3.5

Specifically:

1. The weight of suspended mechanical and electrical services. Structural slabs are usually designed with allowances for suspended services, however, for heavily serviced buildings or where services are at their heaviest, it is always prudent to check and obtain approval.

2. For roof mounted plant and equipment, confirmation that the roof structure has been designed to accommodate the weight of heavy items of mechanical plant, including where applicable any requirements for plinth or upstand details.

It may be necessary to restrain roof mounted plant and equipment depending on the calculated wind and snow loads.

Consideration needs to be given to how external roof plant and services are supported as it may be necessary to brace them to a suitable anchor point.

Fig. 1 Multi services gantry on external plant deck.

SECTION 3

SPECIFICATION

Supports and fixings products and systems should be specified in collaboration with structural engineers and fixings manufacturers. To enable them to be correctly selected and specified, the following factors need to be considered:

3.1 Loading

For suspended services, the loading should be calculated by the designer and should include the total weight of all services, including water, thermal insulation and the self-weight of the support system.

3.2 Base material fixing suitability

For fixings into concrete, it will be necessary to establish the intended specification including whether the concrete is cracked or non-cracked. Cracked concrete is where the structure is in tension which leads to a certain amount of pulling away from the anchor inserted into it. Uncracked concrete is in the compression zone and therefore grips more tightly against any fixing inserted into it. Anchors inserted into non-cracked concrete have greater capacities than those into cracked concrete. Tension and compression can be caused by bending and so it is difficult without a detailed knowledge of the structure to know if the concrete is subject to tension and cracked or compression and uncracked.

Therefore, unless the structural designer can advise with certainty, it should always be assumed that concrete is cracked.

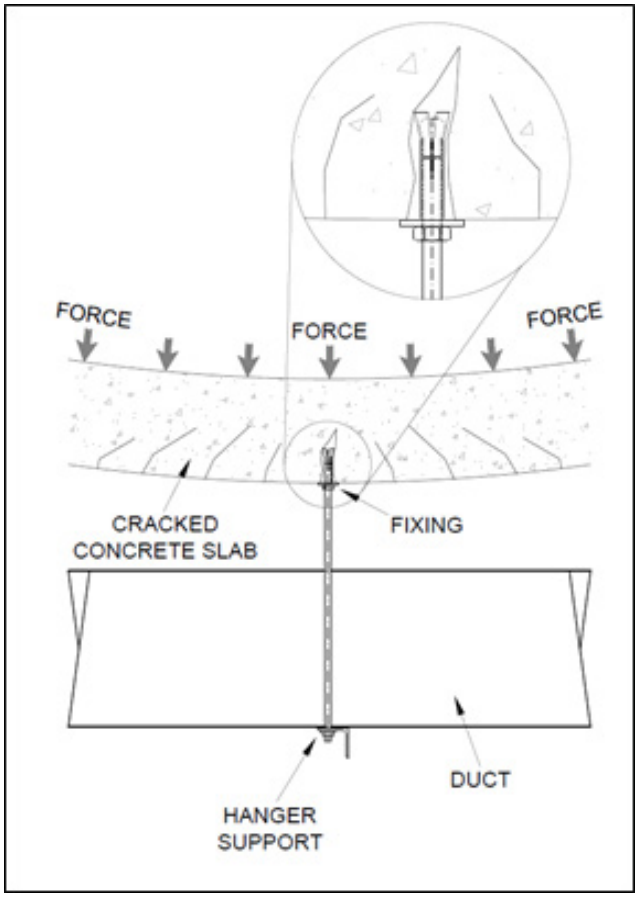


Fig. 2 Diagram showing a cracked concrete floor slab

For fixings to roof purlins in lightweight steel framed buildings, it is important to agree the preferred purlin fixing solution. Subject to approval from the structural engineer and purlin manufacturer, the preferred fixing solution is usually to drill through the web. Fixings to purlin lips should generally be avoided.

For fixings into metal deck composite floors, the standard approach is to use a wedge anchor. Wedge anchors should not be used for fire rated applications.

Where fire rated fixings into metal deck composite floors are required, it may be

possible to drill into the base concrete, however a check will need to be made that the effective edge distance and minimum embedment depth for the anchor can be achieved based on anchor manufacturer requirements. The edge distance and embedment must consider the soffit profile, an example solution to this is given below.

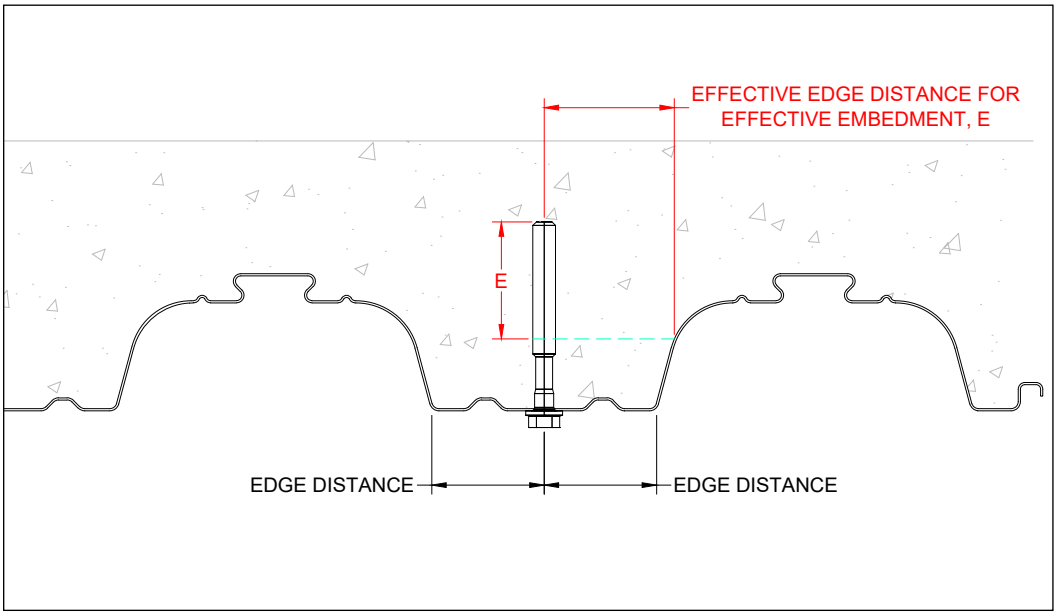


Fig. 3 Sketch showing trapezoidal composite metal deck profile with concrete anchor drilled into substrate

WATCH IT!
There are several composite metal deck floor systems, each with slightly differing profiles and slots. Always consult with floor system manufacturer and the fixing manufacturer to establish whether drilling into the concrete provides an acceptable solution.

When encountering poor quality concrete, or other substrates such as brick or potted soffits, it may be necessary to use a resin or chemical fixing.

The manufacturer should be contacted to arrange an on-site test to BS 8539 to ensure that the fixing is fit for purpose. Great care should be taken to ensure that the hole is blown and brushed out to the manufacturer's instructions to ensure that the hole is clean. Any dust or residue left in the drill hole can prevent the resin from bonding with the substrate correctly.

3.3 Environment

Certain environments can be corrosive and this needs to be taken into account when supports and fixings products and systems are specified. Examples include:

- External plant areas
- Swimming pools
- Coastal locations
- Tunnels

When corrosion is a risk, alternative finishes such as hot dip galvanised (HDG) or stainless steel will need to be considered. Manufacturers advice should always be followed.

Stress corrosion cracking of stainless steel is likely to be an issue in chlorinated environments.

Particular attention should be applied to roof fixings made through weatherproof cladding and that a path for rainwater is not instigated through the cladding and insulation to the pipe surface, causing corrosion.

Fig. 4 Bracket penetrating weatherproofing leading to corrosion

3.4 Fire rating

For specific applications it may be a requirement to ensure that supports and fixings systems are specified to be able to withstand a prescribed fire exposure period or rating.

This is an evolving subject and at the time of writing, there isn't a UK test standard or associated industry guidance for fire rating of supports and fixings as a single system.

Best practice examples where fire rated supports & fixings will be required are as follows:

A) Multi-service supports carrying mechanical and electrical services including power supplies to life safety, fire fighting and other critical applications.

It is common practice, particularly in large commercial buildings for mechanical and electrical services to be installed on a common support system (often known as a trapeze arrangement). However, if any of the electrical services are providing power supplies to life safety, fire-fighting and other critical applications, BS 8519 requires the support system should have a fire survival time equal to that of the cables it supports and for the same defined fire conditions.

Therefore, where it isn't possible to provide a separate dedicated support system for life safety, fire-fighting and other critical applications, it will be necessary to perform a check to prove (as far as practicable) that the multi-service support has the required fire rating. BS 8519, Annex E.2 provides guidance on the maximum allowable tensile stress (N/mm2) for steel drop rods at fire durations of 30 minutes, 1 hour and 2 hours.

In addition, it will also be necessary to ensure that the base material fixing (anchor) is also suitably fire rated. Fixing manufacturers should always be consulted to establish fire rated fixing specification based on the calculated applied load. The maximum recommended loads are published on the European Technical Assessment (ETA). It should be noted that most fixings into concrete will have a significant load de-rating under fire conditions and this will need to be taken into account.

WATCH IT!
Identify the loading of the metal trapeze under fire conditions. It can often be as low as 25% of normal load when under heat.

Fig. 5 Multi-service support bracket carrying mechanical and electrical services

Fig. 6 Multi-service modules

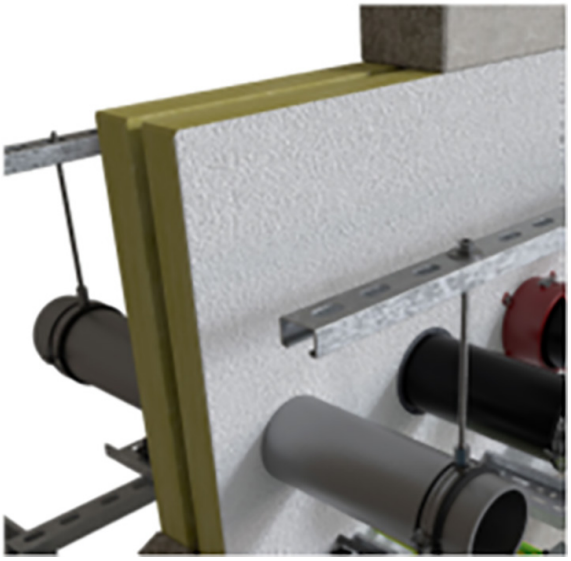
B) Designated fire escape routes
Where suspended services are located within a designated means of escape (as identified on the fire strategy) supports and fixings systems should provide the same level of fire performance as the escape route itself.

C) Fire stopping of service penetrations either side of compartment walls as part of a manufacturer tested and approved fire stopping solution.

The distance to the centres of the supports for the services on either side of the penetration seals must be same as or less than those covered by the fire test, technical evaluation (assessment) or certification evidence provided by the manufacturer.

The supports required for maintaining the fire performance of penetration seals are in addition to the general supports. Further information about support of services can be found in the ASFP Red Book - Fire Stopping and Penetration Seals for the construction industry, section 3.18, and ASFP Advisory Note 8 - On-site guide to installing fire-stopping.

Fig. 7 Fire rated pipework supports either side of compartment wall in accordance with the manufacturer tested and approved fire stopping solution.



(Courtesy Warrington Fire Ltd)

It should be remembered that where services pass through fire barriers and compartment walls, they should be installed in accordance with a manufacturer tested and approved standard solutions. This is likely to have an impact on the spacing of services.

Further information on passive fire stopping can be found within the new guide - Fire Stopping of Service Penetrations - Best Practice in Design and Installation.

3.5 Support spacing

Support spacing for pipework and ductwork services should be provided in line with manufacturers recommended support distances. In the absence of manufacturer specific information, vertical and horizontal support spacings for copper and steel pipework shall be based on BESA publications TR20 - The Installation and Testing of Pipework Services, and DW144 - Specification for Sheet Metal Ductwork.

Where multi-service brackets or modules are used, support spacings should be based on the service with the most onerous requirements.

3.6 Thermal expansion

In addition to static loads, pipework movement as a result of thermal expansion and contraction may also impose additional active loads onto supports. This is very much dependant on the pipework expansion design strategy.

It is recommended that a pipework expansion specialist is engaged at design stage to assist with an expansion design and advise on any implications for supports.

3.7 Approvals

BS 8539 specifies that wherever possible, ETA rated anchors should be used for any fixings into concrete. ETA (European Technical Assessment) is a harmonised independent set of tests and standards adhered to by all reputable anchor manufacturers.

As part of the ETA, anchors are tested in different substrates and varying loads so that performance data can be published and used as part of the specification process.

SECTION 4

STRUCTURAL ENGINEER SIGN-OFF

Once supports and fixings have been correctly selected and specified in conjunction with the manufacturer, all applicable information should be issued to the structural engineer in the form of a technical submission in order to gain approval.

The following information (where applicable) should be contained in the technical submission:

- Point loads
- Fixings into concrete
- Fixings into Bison/hollow slab
- Fixings to purlins and steel beams
- Fixings to decking

SECTION 5

SPECIALIST AND NON-STANDARD BRACKET ARRANGEMENTS

It is advised that an independent structural engineer is consulted for advice concerning specialist and non-standard supports and fixings designs.

Examples include:

- Point loads
- Cantilever bracket arrangements
- Assessment of wind loadings for any external MEP services positioned in exposed locations, to check whether additional fixing/bracing is required
- Assessment of snow loadings

SECTION 6

INSTALLATION

6.1 Installer and supervisor competence

It is essential that installers undergo manufacturer specific installation training before work commences. This may take the form of a toolbox talk on site.

For fixings into concrete, it is a requirement of BS 8539 that all anchors are installed by trained individuals working under competent supervision. Anchor specific training should be delivered by the manufacturer and training records should be retained on site. In order for a supervisor to be deemed to be competent in BS 8539, they should have completed and passed a competent supervisor course such as the course delivered by the Construction Fixings Association (CFA).

For fixings into concrete, it is essential that the minimum allowable edge distance and anchor spacing is understood, any drill holes are cleaned out and correct setting tools are used.

6.2 Torque controlled supports and fixings

Many of the supports and fixings systems used in building services are required to be torqued to a correct setting as specified by the manufacturer.
Examples include:

- Beam clamps and channel nuts used on framing systems and trapeze rods;
- Fixings to purlins, beams and metal deck;
- Torque controlled fixings into concrete.

Torque settings will be published by the manufacturer and will be quoted in Newton Metres (Nm).

Only torque wrenches with current calibration certificates should be used. A record of calibration certificates should be held in conjunction with the wider plant register.

Note: Certain anchor types require impact drivers which can also be set to a required torque.

SECTION 7

TESTING

For fixings into concrete, there are only two types of test, a proof test and a preliminary test.

7.1 Proof test

A proof test is a test carried out on a proportion of fixings to validate the quality of the installation. This is often referred to as a pull test. Proof tests are intended to demonstrate that anchors to be used in service have a modest safety margin without risking their integrity. The tests are not generally appropriate for determining the suitability of an anchor in a particular base material, or for determining its allowable resistance. The minimum number of proof tests is 2.5% (1 in 40 anchors).

Proof testing, to validate the quality of installation, might not be necessary if approved anchors are installed by trained operatives working under supervision. The recommended procedure for proof testing is defined in BS 8539, section B.3.

7.2 Preliminary Test

A preliminary test is a test carried out on site to determine the allowable resistance (maximum working load), in the case where no characteristic resistance or recommended resistance is available. To determine the allowable resistance the fixing must be tested to failure. Preliminary testing is only required on refurbishment projects or where the specification of the substrate is unknown.

Preliminary testing should be undertaken on spare anchors which will be not be used on a project and should be located away from the working anchors.

7.3 Torque setting validation

Post installation torque validation checks should be undertaken on 2.5% (1 in 40) of all torque controlled supports and fixings systems. In the event that a bracket or applicable fixings is found to be incorrectly torqued or not torqued at all, a further 2.5% (1 in 40) should be inspected. Should further failures be found, the inspection rate should be increased to 100% of the brackets, supports and applicable fixings. Verification of torque settings for concrete anchors should take place taking account of the mechanics of torque relaxation. Torque relaxation of fixings in concrete can be expected to be around 20% reduction within the first 48 hours following installation.

SECTION 8

WIRE SUSPENSION SYSTEMS

8.1 In certain applications, steel wire suspension systems may offer a cost effective and quicker alternative to traditional trapeze systems, particularly for light weight, single service applications. However, they need careful consideration on multi-service supports and in applications where there is a fire rating requirement. UK manufacturers are typically able to offer various grades of stainless steel and zinc systems, all with different properties. Careful application specific selection is therefore essential.

SECTION 9

EXAMPLES OF GOOD AND BAD PRACTICE

9.1 Connections to purlin flanges

Purlin clips should be avoided unless permission to fix the applied load has been obtained from the purlin manufacturer and the structural engineer. Subject to approval from the structural engineer and purlin manufacturer, the preferred fixing solution is usually to drill through the web. Fixings to purlin lips should generally be avoided.

Fig. 8

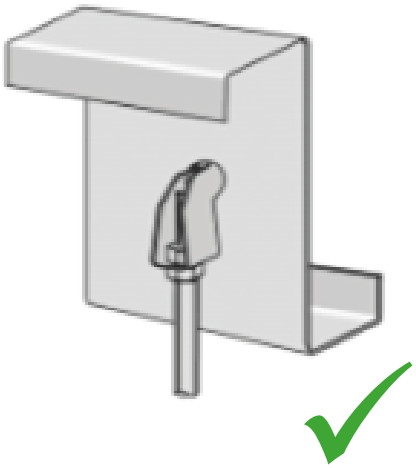
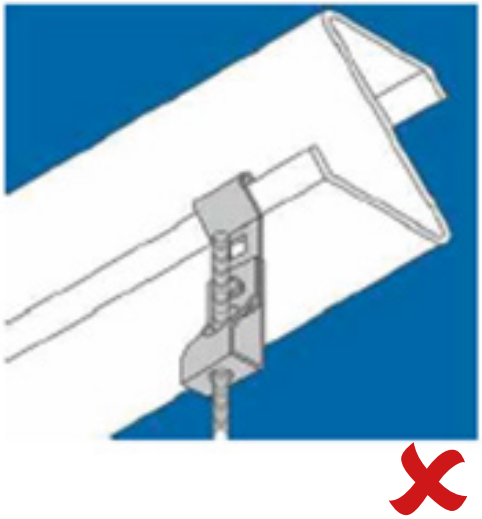


Fig. 9



9.2 Window brackets

Where window brackets are used to fix support systems to main structural steelwork, they must be used in pairs with one each side of the beam.

Fig. 10

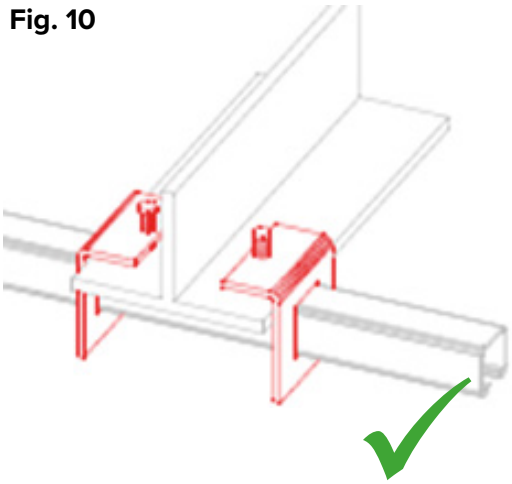
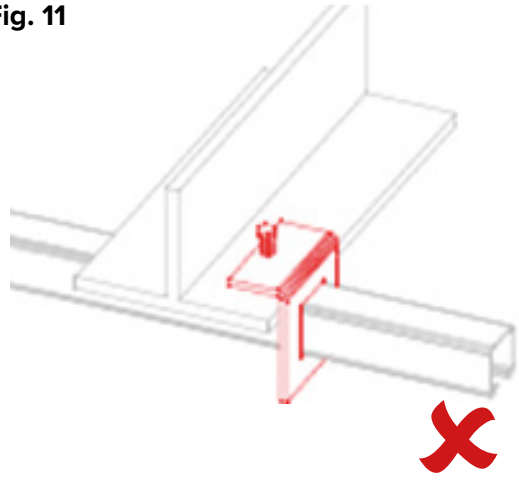


Fig. 11

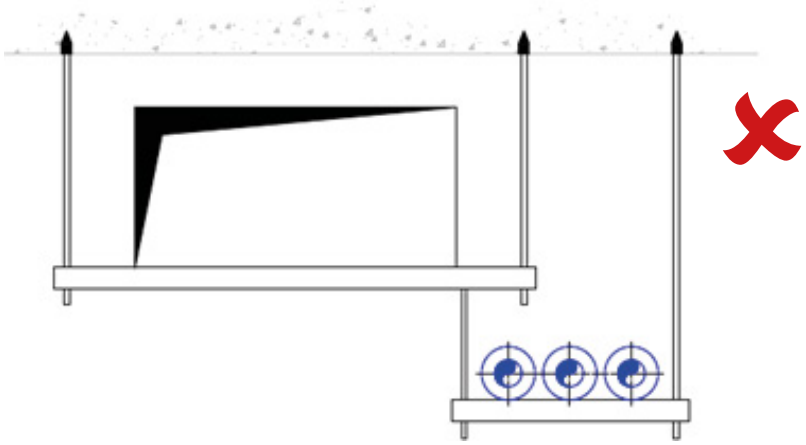


WATCH IT!
If clamping strutted steel or metal channel to intumescent coated steel beams, ensure you have followed manufacturers guidance to allow the coating to expand under its intumescent process

9.3 Overloading of fixings

Fixings can be inadvertently overloaded when additional brackets and supports are installed by follow-on sub-contractors.

Fig. 12



9.4 Complex load paths

Services should be evenly distributed as possible through all supports and fixings. Services hung from other services should be avoided where possible as complex load paths can result in cantilevers and multiple forces acting on the fixing.

Fig. 13

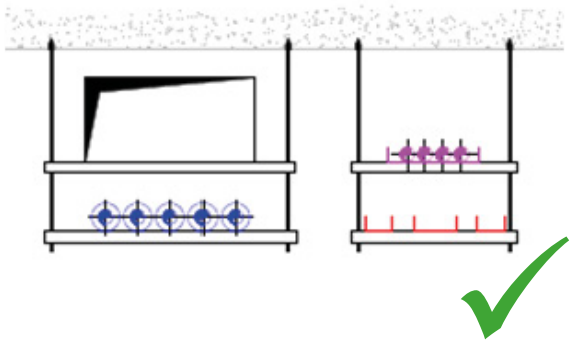
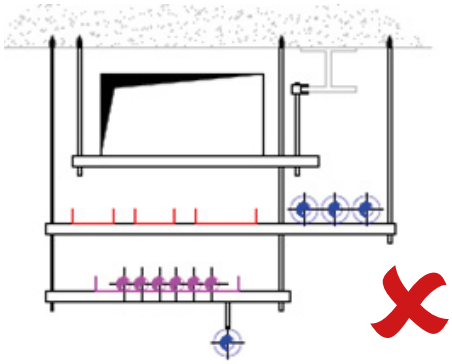


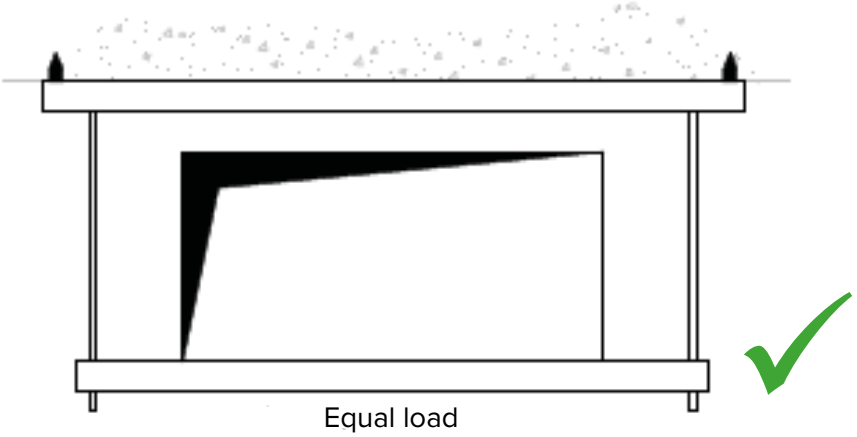
Fig. 14



9.5 Channel header rails

When fixing to channel header rails, ensure load is evenly distributed across the header and ensure length isn't too great between supports.

Fig. 15



Equal load

Fig. 16 Number of fixings insufficient for load.

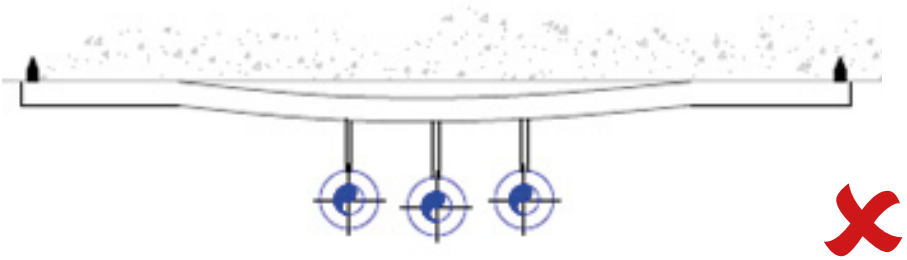
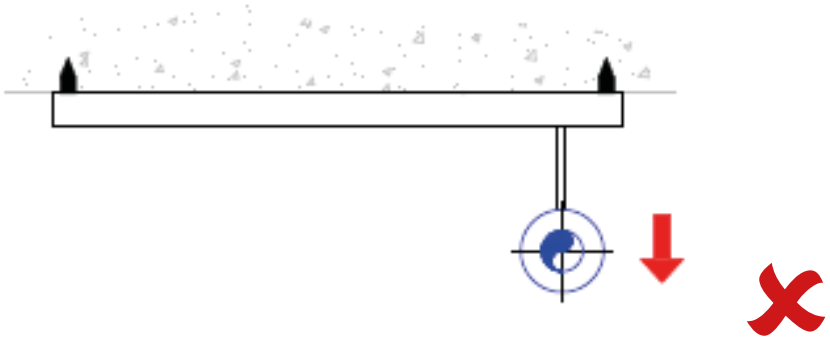


Fig. 17 Uneven distribution when load is closer to one fixing that the other.



9.6 Cantilever loads

Cantilever brackets create significant additional force through the support and fixing and should be avoided unless it has been checked by a structural engineer.

Fig. 18

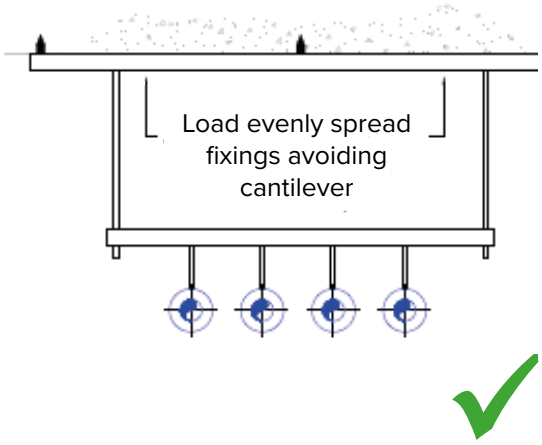
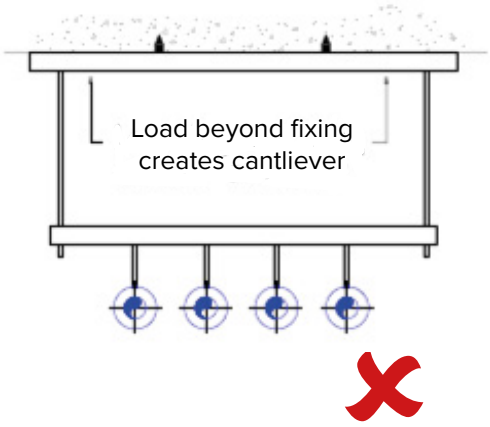


Fig. 19



BIBLIOGRAPHY

The British Standards Institution (BSi)

BS 8539 Code of practice for the selection and installation of post-installed anchors in concrete and masonry.

BS 8519 Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice.

Association of Specialist Fire Protection (ASFP)

Red Book Fire Stopping and Penetration Seals for the Construction Industry

Advisory Note 8 On-site guide to installing fire-stopping.

Royal Institute of British Architects (RIBA)

RIBA Plan of Work The definitive model for the design and construction process of buildings

Building Services Research and Information Association (BSRIA)

BG6 A Design Framework for Building Services

Construction Fixings Association (CFA)

Competent Supervisor Training Course

BESA Publications

DW143 A Practical Guide to Ductwork Leakage Testing

DW144 Specification for Sheet Metal Ductwork - Low, Medium & High Pressure/Velocity Air Systems

DW145 Guide to installation of Fire and Smoke Dampers (Under review)

DW154 Specification for Plastic Ductwork (Under review)

DW172 Specification for Kitchen Ventilation

VG005 Fire Test Standards and the Construction Products Regulation Guidance

TR40 Guide to Good Practice Local Exhaust Ventilation

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