PREMIER GUARANTEE®

ON YOUR SITE, BY YOUR SIDE

TECHNICAL MANUAL VERSION 16

Introduction,
Main Changes and
Contents

The Premier Guarantee Technical Manual Version 16 is produced for the purposes of identifying what Functional Requirements are applicable to the design and construction of buildings to be covered by our Warranty.

This Manual is applicable to all new Warranty projects* where an offer of Warranty has been made on or after the 1st April 2024, and it applies throughout the UK, unless otherwise stated. This Manual incorporates additional revisions over the previous version (see the 'Main Changes to this Version of the Technical Manual' page).

*Please refer to the relevant policy coverage. The Manual is not applicable to projects covered under Completed homes, Self-Build and Commercial policies but can be used as a guide to build to.

The structure of the Technical Manual

The Manual is divided into Sections relating to a specific Building Part / Element of the building.

At the beginning of each Section, the applicable **Functional Requirements** are provided. These are followed by **supporting guidance**, providing solutions to meeting the Functional Requirements.

All the Sections are listed on the 'Contents' page of this Manual.

The Manual concludes with the Appendix Sections for:
- Finishes
- Coastal Locations
- Materials, Products, and Building Systems
- Conversions and Refurbishment projects

A digital version of this Manual, and individual Sections, are available on our website.

Functional Requirements

Specific Functional Requirements are provided at the start of each Section of the Manual. These are fundamental requirements which must be complied with in all cases to achieve Warranty standards.

They are broken down into three specific Technical Requirements covering:
- Workmanship
- Materials
- Design

Where applicable, a statement identifying the 'Limitations of Functional Requirements' may be provided.

Supporting Guidance

Supporting guidance is provided to offer acceptable solutions for meeting the Functional Requirements in each Section of the Manual based on best practice solutions which are acceptable to us.

If an alternative solution is proposed which is not covered in the supporting guidance, it must still meet the Functional Requirements and be agreed with the Warranty Surveyor prior to construction of that element.

Premier Guarantee will accept work that meets relevant Building Regulations except where our Warranty requires a higher standard to be met (e.g. durability / minimum service life).

Whilst this Manual supports the Functional Requirements with guidance solutions, these primarily relate to low rise construction (buildings of 5 storeys or lower – including the ground floor level). For projects being managed by our Major Projects team it is suggested that you contact your Major Projects Manager to discuss any nuances of specific requirements relating to your development.

The Manual does not apply to:
- Construction elements which are not covered by specific Building Part / Appendix Sections.
- Health and safety matters relating to building operations.
- Planning matters.

The Manual is not for the purpose of showing compliance with relevant Building Regulations.

The images produced within the Guidance are strictly in relation to our Warranty requirements and are for illustrative purposes only. Please refer to the relevant Building Control Body to ensure the project detailing achieves compliance with relevant Building Regulations.

Structural Design requirements

For our Warranty purposes, structural design shall be carried out by suitably qualified persons in accordance with British Standards and Codes of Practice i.e. Chartered Civil or Structural Engineers whose status (including professional indemnity insurance) is accepted by us.

On this basis we will, throughout this Manual, just refer to the term 'Engineer'.

Note:
- In Scotland, the Engineer will require to be independent of the Builder and specialist sub-contractor.
- The Structural design must take account of the durability and service life requirements stated within the Functional Requirements to each Section.
- The structural design must also take account of our Tolerances requirements.

The difference between Building Control and Warranty

Warranty approval is not an approval that replaces approval of a Building Control Body, it is in addition too, to enable Warranty risk matters to be managed over the Warranty period of cover.

The Building Regulations may apply in and around buildings. These requirements are intended to protect people's safety, health and welfare. They also set standards for accessibility, water use, energy use and security. The supporting approved documents give further guidance for many common building situations. They contain statutory guidance on how to meet the requirements of the Building Regulations.

Warranty provides a latent defects insurance on the home for a 10 year period (please refer to the relevant policy version). Therefore to minimise the potential for claims during cover, Warranty looks at the expected service life and durability of materials used and from claims experience identifies key additional requirements for construction to ensure defects are kept to a standard risk.

So whilst construction may meet Building Regulations, we may ask for additional requirements to satisfy the Functional Requirements of the Warranty Technical Manual.

Note: As the regulations are the minimum legal requirements our standards are based upon them, but as stated above at times we may require a higher standard than the minimum.

If you have concerns about performance relating to meeting the Building Regulations, please seek guidance from your relevant Building Control Body. Our Functional Requirements are limited to Warranty matters only.

The most significant changes are as follows:

Section 1 Ground Conditions:

- The guidance on Ground Conditions has been updated to make it easier to understand. We have produced a new easier to use flow chart and introduced guidance for a basic ground investigation which is required where the phase one site investigation does not flag any hazards.
- Design 1 of the Functional Requirements now states that all site investigations must be dated within 5 years of construction starting on site.

Section 2 Basements:

- Design 1 of the Functional Requirements has been updated to now state ‘Elements that are integral to the waterproofing structure of basements including foundations, walls and floors shall be designed by an Engineer to support vertical loading, resist horizontal loading and surcharges including the influence of nearby trees and topography’.

Section 3 Foundations:

- We have combined sub section 3.1 (Foundations - Mass Fill) and sub section 3.2 (Foundations - Strip) from the previous Technical Manual into one new sub section called ‘Foundations - Mass Fill and Strip’.
- New guidance on vibratory ground improvement is provided to take into account latest industry practices.
- Our ‘Foundations - Trees and Clay’ section has the following changes:
  - The ‘Changes in level’ guidance has been updated to make it easier to understand.
  - We have a new table which outlines where heave precaution should be used in varying situations.
  - New guidance provided for where rafts are proposed in shrinkable / expandable soil within the influence of trees.
  - Updated guidance on strip and mass fill foundations in non-shrinkable soils overlying shrinkable soils.
  - The guidance within the section as a whole has been consolidated.
- We have introduced new guidance on flexible and rigid retaining walls.
- We have new guidance on helical (screw) piles.

Section 4 Ground Floors:

- Updated guidance on stepped party walls is provided.

Section 6 External Walls:

- The limitations of the Functional Requirements has been updated to now clarify: Means of escape, passive and active systems are not covered by the Warranty.
- Design 1 of the Functional Requirements has been updated to now state that external walls shall be designed and constructed so that they meet the requirements of the Building Regulations.
- The table for ‘Suitable cavity wall construction depending on exposure, for use with full fill cavity insulation’ has been updated based on latest industry practices.
- We have updated our guidance on lateral restraint to make it clearer.
- Updated requirements for breather membranes in the timber frame and light gauge steel frame sections.
- We have clearer guidance on what we categorise as open and closed panel timber frame systems.
- The guidance for timber frame differential movement has been updated to make it simpler to understand.
- New guidance on gable spandrel panels is provided.
- New guidance on using light gauge steel frame construction at low level is now provided.
- Our testing requirements for curtain walling systems has been updated.
- A new ‘Provision of information’ is added to the different cladding types in sub section 6.5.
- New requirements for natural stone masonry are provided.

Section 8 External Windows and Doors:

- We have retitled our section on stacked windows to ‘Vertically Stacked Coupled Window Assemblies’ to better reflect the type of window system we are now referring to within the guidance. This includes updated guidance to provide more information on coupling joints, testing requirements, structural integrity, thermal bridging, window sills, accommodating movement and a statement for vertically stacked coupled window assemblies over 5 storeys.
- New requirements for water tightness provided for glazing systems in developments over 6 storeys.

Section 9 Stairs:

- We have new guidance on glazed guarding.

Section 11 Roofs:

- The limitations of the Functional Requirements has been updated to now state ‘Means of escape, passive and active systems are not covered by the Warranty.’.
- We have combined sub sections 11.1 (Roofs – Pitched - Pre-formed Truss) and 11.2 (Roofs – Pitched - Traditional Cut) from the previous Technical Manual and condensed them into one new sub section called ‘Roofs - Pitched Roof Structures’.
- Our guidance for concrete interlocking tiles, plain tiles and slates has also been condensed into one sub section called ‘Roofs - Pitched Roof Coverings (Tiles and Slates)’.
- We have introduced a new sub section titled ‘Panelised Roof Cassettes’.
- Additional guidance is provided for where LR underlays are used on a fully supported material.
- A new table is included to provide guidance on gauge, headlap and permissible pitch for different pitched roof covering types.
- Guidance has been added for additional testing of flat roofs where a test fails.
- Guidance on the vegetation free zone for green roofs has been updated to provide further details to bring it in line with latest industry practices.
- The ‘Provision of information’ for pre-formed trusses and traditional cut roofs now includes:
  - Third party product approval certificate for the roof underlay.
  - Details of the ventilation strategy for the pitched roof in line with the guidance provided in this section and/or BS 55250.

Section 19 Garages:

- New guidance added for ‘Services within a garage’.
- New guidance provided for garage floors. We now recommend garage floors should be laid to a fall and have a step where they’re integral to the house.

Appendix C:

- In the Functional Requirements, Design 1 from our previous Technical Manual has been removed.
- New guidance is provided on the required supporting information for cavity trays and DPC’s.
- New guidance provided for steelwork protection categories in varying environments.
- Guidance added for proprietary products and systems in place of a traditional construction method.
- We now have guidance on what we require for products that do not have a third party certificate.
- Our list for what we expect to see in third party product conformity certificate has been updated.
- Our service life table has been updated to include thermal insulation and breather membranes in vertically framed external walls.

CONTENTS

1. Ground Conditions

Contents

Limitations of Functional Requirements

1. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All samples to be stored and kept in such a way that will not cause inaccuracy when soils are tested.
2. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.

Design

1. The site investigation should be completed at an appropriate level for the risk in accordance with the relevant British Standard. All site investigations must be dated within 5 years of construction starting on site.
2. Site investigation and remedial measures must meet the requirements of Building Regulations and additionally; those standards specifically referred to in the references section in the guidance that follows this Functional Requirement.
3. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.

1.
Ground Conditions

1.1
Site Investigation

Provision of information

A full set of site investigations shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This should include:

1. Phase 1: Geo-environmental Assessment – Desk study and walkover
2. Phase 2: Geo-environmental Assessment – Basic and detailed ground investigation
3. Phase 3: Geo-environmental Assessment – Unforeseen hazards (where applicable)

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Please note, historical reports greater than 5 years may be used as a reference document for the desk study but investigative reports of ground conditions must be undertaken and dated within 5 years of construction starting on site.

Introduction

This section sets out the requirements for an acceptable site and ground investigation. It is intended to be flexible and user-friendly, and includes simple checklists aimed at ensuring compliance.

All sites must have an appropriate level of site investigation which accurately assesses and investigates potential geotechnical and contamination hazards which may affect the development.

To ensure a consistently high standard, all stages of the work should be carried out by an Engineer or Geologist with at least five years' experience of ground and soil engineering. Specifying and using competent qualified personnel will considerably increase the overall industry standard.

Roles and responsibilities

The roles and responsibilities of those parties involved in any development are the owner, developer, builder and self-builder.

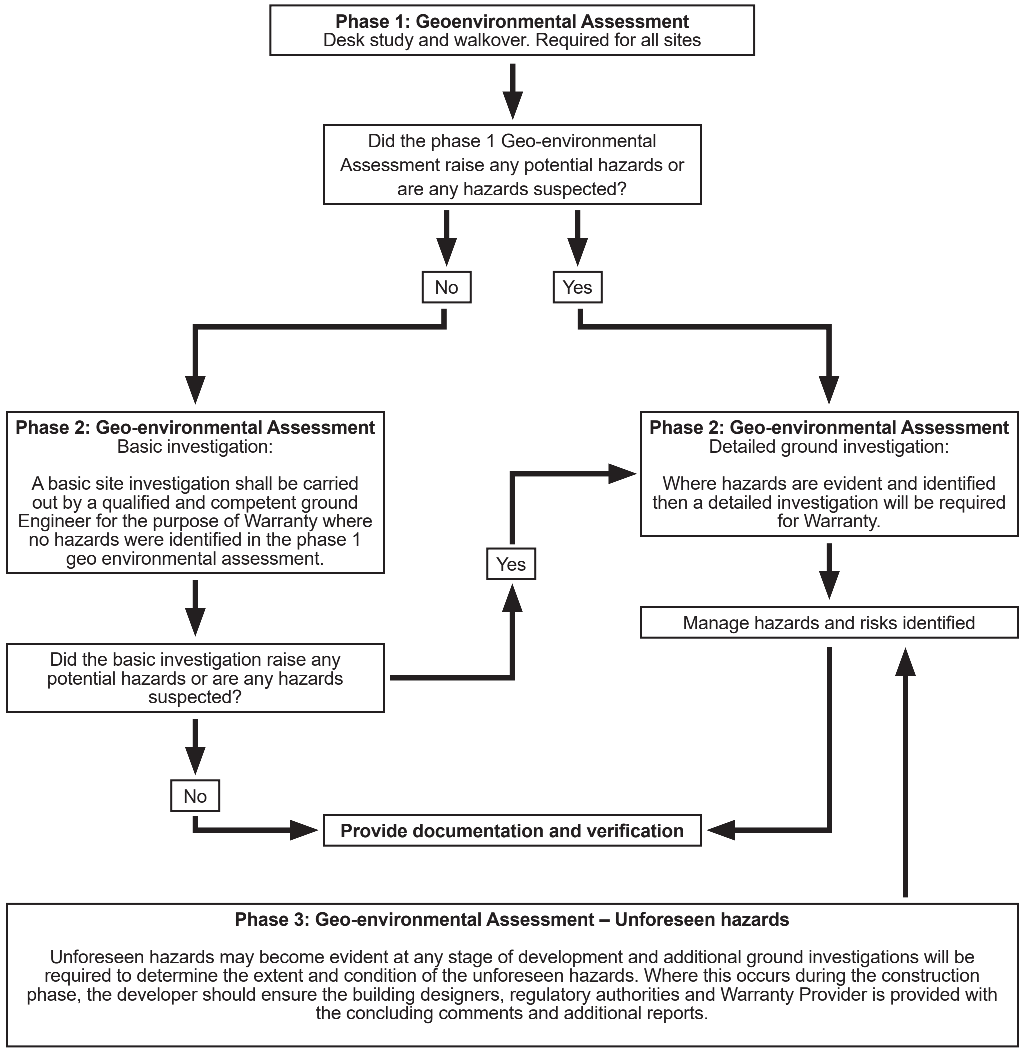
Owner/developer/builder/self-builder
The provision of clear development proposals for the site, and the implementation of a site and ground investigation using appropriately qualified personnel, is now a priority for regulators. These demonstrate that any geotechnical and contaminated land risks can be appropriately and safely dealt with. Specific health and safety responsibilities, in particular, on larger developments reference to the Construction and Design Management (CDM) Regulations compliance is required.

Environmental Health/Contaminated land officer
The provision of advice to the local planning department on technical matters and planning conditions requires the submission of a comprehensive site investigation and an associated risk assessment.

Local Authority Building Control
Building Control is responsible for enforcing the Building Regulations, and will require a comprehensive site investigation.

Health and Safety Executive
The HSE are responsible for health and safety at work, including the CDM Regulations.

Site Investigation procedures flow chart



Introduction

The aim of the Phase 1 Geo-environmental assessment is to identify and assess the potential geotechnical and geo-environmental (contamination) hazards on the site. Since all sites are different, it is important to identify the scope and purpose.

Any issues specifically excluded should also be noted if these might normally be expected as part of the desk study.

The phase 1 Geo environmental assessment should consist of both a desk study and walkover survey and this is required for all developments.

Desk study (required for all developments)

The desk study is essential to all warranty sites. The contents of the report highlights the site location, the geology, hydrogeology (ground water), surface water and flooding, topographical features and past investigations undertaken on or close to the site.

It is an overall collection and examination of existing data brought together from a wide variety of sources. The purpose of the assessment is to indicate the potential hazards at the very early stage of the development and provide the guidance for more detailed exploratory investigations.

A listing of the contents of a Phase 1: Geo-environmental report along with their sources of the data can be found in the checklists within this section.

Key points for a desk study

The following headings are what to expect within a Phase 1 - Geo-environmental assessment – Desk Study report.

Site description
The description should outline the exact extent of the site, and should include the site address the grid reference and elevation above sea level. The boundaries topography of the site should be clearly defined.

Geology and mining
The bedrock geology, any overlying superficial deposits and the effects of weathering should all be described, together with any geological faults that may affect the site. An explanation of the likely ground conditions should be given, together with reference to any other mapped geological features, particularly if there are likely to be any natural cavities or solution features.

In former coalfields, or other areas of mineral extraction, the maps may not always record the presence of old or active workings particularly shallow or surface workings. The likelihood of shallow coal workings affecting surface stability should be established in conjunction with a Coal Authority report. Such reports also record areas that have been affected by the extraction of brine, which is particularly prevalent in the Cheshire area of the UK. Other forms of mineral extraction will require site-specific research possibly requiring investigative or exploratory work.

Solution (soluble) features
Solution features (such as pipes, swallow holes and solution cavities, sometimes loosely infilled with drift deposits) are commonly found in chalk, caused by water draining through the chalk and dissolving it. They can also be found in Limestone and other soluble rocks. The British Geological Survey categorises the five main soluble rocks found in the UK as Chalk, Limestone, Gypsum, Dolomite, and Salt.

The risk of solution features should be addressed in the site investigation report (commonly from an Envirocheck or GroundSure report on geological hazards, both on-site and locally).

Hazard maps are available with different coloured areas representing different levels of risk. Where the risk is moderate or high, special precautions should be taken, which for strip foundations would include careful inspection of the excavation, probing and use of reinforcement to span potential voids.

Ground gases and radon
Potential naturally occurring ground gases and where sites previously used for the industrial, commercial and social use will need to be identified for the purpose of building and environmental protection.

The need to incorporate radon protection measures should be determined by reference to risk maps produced by the Health Protection Agency. Such information is also usually included within commercially available datasets.

Geo-environmental risk assessment and the conceptual site model
A quantitative health and environmental Risk Assessment should be carried out as part of the assessment. The process of a Risk Assessment is set out in Part IIA of the Environment Protection Act 1990, and amended in subsequent legislation.

This act introduces the concept of a pollution linkage, which consists of a pollution (contaminative) source or hazard and a receptor, together with an established pathway between the two. For land to be contaminated, a pollution linkage (hazard-pathway-receptor) must exist; this forms a so-called ‘conceptual model’ of the site.

Hydrology and Hydrogeology
A significant part of the desk study will consider an assessment of flooding risk to the site. The presence of surface water features and drainage should be described, and the overall risks of flooding to the site should be determined, primarily with reference to the Environment Agency flood map data and Local Authority-commissioned strategic flood risk assessments. Flood risk data is continually being updated by the Environment Agency and Local Authority.

The hydrogeology of the site provides an understanding of the transpiration of water below the surface of the ground. Sites where a principle or secondary aquifer and Source Protection Zones are identified are susceptible to pollution of the ground water.

Any ground water or surface water abstraction points ‘downstream’ of the site, particularly any potable (drinking water) abstraction points, should be recorded, as this may have liability implications should the development cause any pollution.

Site history
The history of the site and the surrounding areas is extremely important when assessing the likelihood of contamination or geotechnical hazards.

The influence or impact of off-site past industrial use, (e.g. agricultural use, below ground mining, landfill and quarrying) will depend upon the type of industry, the underlying geology and the topography. However, consideration should normally be given to any such features within a 250m radius of the site (or further where appropriate) with the potential to affect it.

It should be remembered that historical maps only provide a snapshot in time, and care must be taken when interpreting what may have occurred in the intervening years.

Environmental setting
The question as to whether a site poses an actual or potential environmental risk, or is at some external risk from pollution, will be determined by its environmental setting. This will in turn depend upon the site’s topography, geology, hydrogeology and hydrology, amongst other site-specific considerations.

It is necessary to consider other potential sources of contamination, such as pollution control licenses, discharge consents, hazardous sites (COMAH, NIHHIS), pollution incidents, landfills, waste treatment sites and past and current industrial sites.

Geotechnical assessment
Although no intrusive investigation may have been undertaken it should be possible to give preliminary indications in respect of the geotechnical matters

Walkover survey (required for all developments)

This survey is undertaken to identify and verify the potential hazards for construction based upon the findings of the Phase 1 Geo-environmental Desk study assessment of the site and surroundings.

The walkover should be always undertaken by a competent person who can interpret the desk study and relate it to the actual site conditions. Photographs are an essential means of recording the potential hazards.

Potential Hazards that will require further investigation include:

- Topography (physical features)
  - Significant and abrupt changes in slope and site depressions
  - Overburden on slopes
  - Excavation at the bottom of slopes
  - Landslip and subsidence
  - Contamination – tipped or imported harmful material
  - Species, height and spread of tress hedges and scrub
  - Tree and vegetation condition
- Geology (soils and rocks)
  - Ground Conditions – basic soil types and classifications
  - Below surface compressible materials
  - Surface cracking
  - Sudden changes in soil types
- Hydrology (surface water)
  - Waterlogged ground
  - Signs of flooding
  - Aquatic plants and grasses
  - Ponds, water courses and springs
  - Discoloured water - source
- Hydrogeology (ground water)
  - Tree and vegetation – water demand on sub-surface soils
  - Hedgerow and scrub – Dying or sparse
- Historic (local buildings)
  - Damage to buildings or structures - cracking
  - Building movement - tilting
  - Below ground services
- Local Information
  - Local knowledge – mining, landfill, localised flooding
  - Past uses – local history, place and street names

The results

The collation of information from the desk study along with the walkover survey shall be evaluated and recorded by a qualified Surveyor or Engineer. The resulting initial assessment report shall include sufficient details appropriate to the site.

Checklist for Phase 1: Geo-environmental Assessment (Desk Study)

Site Description (and surrounding area of relevance)
- Location, O.S. grid reference and plans
- Topography, levels
- Site layout and main features
- Site infrastructure
- Site description and topography
- Made ground, erosion, cuttings or quarries
- Slope stability
- Evidence of faulting or mining
- Watercourses, seepages or sinks
- Marshy or waterlogged ground
- Type and health of vegetation
- Existing structures and condition
- Existing on-site processes
- Demolished structures/old foundations
- Visual evidence of contamination
- Existing site operations
- Underground and overhead services
- Trees
- Previous site conditions and current use
- Site proposals

Mining
- Past, present and future mining
- Reference to geological sources
- Coal Authority Mining Report
- Register of abandoned mine plans and opencasts
- Shaft register
- Other mining, e.g. sand, sandstone, limestone, brine, etc.

Geology
- Geological maps (1:50,000 and 1:10,000 scale)
- Memoirs
- Technical reports
- Previous site investigations
- Previous laboratory results – Soil sampling
- Engineering geological maps
- Existing trial pit or borehole logs and reports
- Subsidence features

Hydrogeology and hydrology
- Ground water vulnerability
- Aquifer status
- Abstraction licences (within 1km)
- Flood risk, drainage and watercourses (within 1km)

Local Authority consultation
- Building Control, Planning and Environmental Health/Contaminated Land Officer
- Petroleum Officer

Archival research
- Past O.S. mapping and previous on-site and off-site usage possible contaminants associated with former use(s)
- Town plans
- Local history records, books and photographs (where relevant and practicable)
- Aerial photographs (where relevant)
- Archaeological register (where relevant)

Contamination
- Likely contaminants based on past history
- Hazard-Pathway-Receptor scenario
- Preliminary Conceptual Site Model

Environmental database
- Operational and former landfill sites, scrapyards and waste processing sites
- Radon protection measures

Introduction

The outcome of the desk study and the walkover survey will provide the scope for the phase 2 Geo-environmental assessment and involves using a combination of various intrusive techniques depending on the risks identified.

The investigation must be designed to provide the appropriate level of information on ground and ground water conditions on the site, together with identifying potential areas of contamination. The investigation should be undertaken in accordance with the principles of:

- BS EN 1997-1: Eurocode 7 - Geotechnical design - Part 1: General rules.
- BS EN 1997-2: Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing.
- BS 5930 and BS 10175.

The dates of the investigation and the methods used should be stated, with the exploratory trial pit or borehole positions clearly being shown on a drawing.

Basic ground investigation

A basic ground investigation shall:

- Be carried out by a qualified and competent Engineer.
- Be carried out where no hazards were identified in the phase one geo environmental assessment.
- Include an assessment of observations specific to the site.
- Include ground material testing to provide assurance to the warranty provider that sites are free from potential hazards that can influence the design of the building.

Trial pitting
This method enables:

- Soil conditions to be closely examined at any specific point and samples to be taken.
- It gives useful information on the stability of excavations and water ingress.
- Material and any other required ground tests can easily be undertaken in the open trial pit.

The following should be considered where trial pits are proposed:

- They should be at least three times the anticipated foundation depth where possible, or sufficient to prove a founding formation material suitable to support the design loads of the developments structure.
- They should be excavated outside of the proposed foundation area where possible.
- The distance from the edge of the trial pit from a foundation should be at least the proposed foundation depth plus 250mm.
- On completion excavations are normally backfilled.

A detailed ground investigation should be carried out:

- Where the basic investigation reveals potential hazards.
- Where the basic investigation reveals anomalies not previously raised in any site investigation.
- If there are any doubts about the condition of the ground.

Detailed ground investigation

Where hazards are evident, an intrusive investigation will be required. A detailed ground investigation will be required where hazards are evident and identified from:

- The initial scope of the ground investigation.
- Phase 1 Geo-environmental assessment (desk study and walkover survey).
- Basic ground investigation.

The detailed ground investigation shall be undertaken by a qualified Engineer or consultant to determine the nature and the extent of the identified hazard and the risk.

The detailed Phase 2 Geo-environmental assessment shall adopt a clearly defined structured and detailed approach to the investigation for gathering site information and testing and include:

- Basic ground investigation
- Changing development proposals – Usage
- Ground conditions – complexity of materials and stratum
- Influence of foundations on the bearing strata
- Presence of contaminants and ground gases
- Surface and ground water
- Geology, topography and site history

On site intrusive investigation and soil sampling is required for foundation and basement designs which extend further into the ground. Investigations require the use of deeper boreholes and the use of rigs and different sampling will need to be specified.

In order for the development of the site to succeed the liabilities and site hazards will need to be managed and communicated in the detailed Phase 2 Geo-environmental ground investigation report. Further assessment of ground conditions through Investigation may be required to fully address the development objectives.

Types of intrusive investigations
An intrusive investigation may comprise the following:

- Window sampling:
  Window sampling consists of driving a series of 1m and 2m long tubes into the ground using a dropping weight. On completion of each run, the tube is withdrawn. The next tube is then inserted and the process repeated to provide a continuous profile of the ground. On each run, the tube diameter is reduced in order to assist in its recovery. When complete, the borehole is normally backfilled. It is also possible to carry out standard penetration tests (SPT) using the window sampling equipment.

- Shell and auger boring:
  This technique uses a tripod winch and a percussive effect with a variety of boring tools, where disturbed and undisturbed samples can be taken. This is the most suitable method for soft ground investigation as it enables the maximum amount of information to be obtained. However, minor changes in lithology may be overlooked unless continuous undisturbed sampling is used.

  Disturbed samples of soils can be taken for identification and classification purposes. In cohesive soils, 'undisturbed' samples 100mm in diameter can be taken by an open drive sampler for laboratory testing of strength, permeability and consolidation characteristics.

  SPT are used in granular and cohesive materials and in soft or weathered rocks. The resulting 'N' value can be compared to empirical data on strength and relative density. Difficulties in obtaining true 'N' values mean they should only be used as a guide, and not as an absolute value in foundation design.

- Rotary drilling:
  Two main types of rotary drilling can be carried out in rock. Rock coring using a diamond or tungsten carbide-tipped core bit provides samples and information on rock types, fissuring and weathering. Open-hole drilling only produces small particles for identification purposes, and the information gained is therefore limited. The latter is, however, useful as a quick method of detecting major strata changes and the location of coal seams and old workings. Water, air, foam or drilling muds may be used as the flushing medium in either case.

  Rotary open-hole drilling is carried out to determine the existence of any voids or broken ground that could affect surface stability. Due to the risk of combustion, the drilling is normally done using a water flush. On completion, the boreholes are backfilled with bentonite cement. A Coal Authority Licence is required in advance of any exploratory work intended to investigate possible coal workings.

- Geophysics:
  Geophysics can be used in certain situations and is useful where significant anomalies exist in the ground. Ground-penetrating radar is probably the most common for defining near-surface features. The results from geophysics can be variable and, combined with the relative high cost, should be used advisedly.

Strata profile

Full strata descriptions should be given based on visual identification and in accordance with the requirements of:

- BS EN ISO 14688-1: Geotechnical investigation and testing - Identification and classification of soil - Part 1
- BS EN ISO 14688-2: Geotechnical investigation and testing - Identification and classification of soil - Part 2
- BS EN ISO 14689: Geotechnical investigation and testing – Identification, description and classification of rock

Soil description

Samples from boreholes or trial pits should be fully described in accordance with the latest guidance from the British Standards and Eurocodes. They should include colour, consistency, structure, weathering, lithological type, inclusions and origin. All descriptions should be based on visual and manual identification as per recognised descriptive methods.

Mining areas - Key requirements for foundations

Any foundations must be designed to clearly demonstrate that design loads are transferred to known soil strata capable of supporting those loads. Foundations should be designed to ensure that long-term settlement does not exceed 25mm (or 10mm for piles) or 1:500 (differential), unless more stringent criteria are required by the Engineer. It is therefore essential that mine workings past and present are established.

The potential for mine workings and mine entries within an influencing distance of the proposed development should be addressed by an Engineer prior to commencement of works, and in accordance with CIRIA guidance (including CIRIA C758D Abandoned mine workings manual), Coal Authority Technical Guidance Notes (including TGN01/2019) and our “Mining - Structural Requirements” document.

Reference should be made to reports on geological hazards, such as Envirocheck or GroundSure reports, both on-site and locally.

For further guidance on foundation proposals in mining areas, please refer to the Warranty Good practice guide: ‘Mining - Structural Requirements’ available on the Warranty website.

The dates of the investigation and the methods used should be stated, with the exploratory trial pit or borehole positions clearly being shown on a drawing.

Soluble geology - Key requirements for foundations

The foundation scheme shall be designed to clearly demonstrate that the foundations are capable of supporting and transferring the design loads safely to known soil strata that can be demonstrated from the appropriate project Site Investigation report to be capable of carrying the load, using the appropriate soil properties obtained from geotechnical testing. Where there is a moderate to high risk of voids being present, the foundations shall be designed in the first instance to span across a void of at least 5 metres without settlement greater than 25 mm (10mm for piles) or differential settlement tilt greater than 1:500 for low rise buildings unless more stringent criteria are required by the Engineer. For buildings greater than three storeys please contact the Warranty surveyor.

The potential effects of soakaways, leaking drains, run off, etc. on the chalk will need to be considered and addressed in the design.

CIRIA C574: Engineering in Chalk, 2002 gives the following recommendations:

Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures or roads, as indicated below:

- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations.
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipework.
- As the chalk is a vitally important aquifer, the Environment Agency and Local Authority must be consulted when planning soakaway installations where chalk lies below the site, even where it is mantled with superficial deposits.

For further guidance on foundation and drainage proposals in areas where solution features in soluble rocks are present or known to exist, please refer to the Warranty Good Practice Guide: ‘Solution features in soluble rocks’ available on the Warranty website.

Phase 3: Geo-environmental Assessment – Unforeseen hazards (where applicable)

In some cases of intrusive investigations reveal hazards which are unforeseen where further investigation may be required or where the earlier Phase 2: Geo-environmental assessment has been preliminary. The requirement for additional ground investigation is required to determine the extent and condition of this unforeseen hazard.

Unforeseen hazards may also become evident during construction. When such occurrence happens the developer is to ensure that the building designers are notified of the potential hazard. A scope for the additional investigative works is established. The concluding comments of the additional report and the management of the unforeseen hazard is conveyed to the regulatory authorities, designers and the warranty provider.

Checklist for Phase 2: Geo-environmental Assessment (Ground Investigations)

Trial pits
- Strata profile and description
- In-situ gas testing for methane, carbon dioxide and oxygen
- Landfill gas, marsh gas and mine gas
- In-situ shear strength testing
- In-situ Mexe Cone Penetrometer for CBR/in-situ shear strength
- Full description of ground and ground water conditions
- Soakaway testing
- Geotechnical contamination laboratory testing

Boreholes
- Cable percussive, window sampling, dynamic probing or rotary drilling to BS 5930
- Use of British drilling association accredited drillers
- Full description of ground and ground water to BS 5930
- Installations for long-term gas and water monitoring (if required)
- Geotechnical laboratory testing (BS 1377) and contamination testing if suspected by accredited laboratories

Other methods of investigation
- Geophysics
- Cone penetrometer

Recommendations for reports

Foundations and retaining walls
- Foundation type, depth, bearing capacity and settlement
- Ease of excavation
- Sulphate/acidity/concrete class
- Shrinkage/heave
- Effect of vegetation, including building Near trees
- Buoyancy or flotation effects
- Ground improvement options, e.g. Piling, Vibro, compaction, etc.

Mining
- Precautions for foundations in respect of past or future mining
- Treatment of shallow mine workings
- Capping of shafts

Landfill/mine gas/Radon
- Requirements for long term monitoring
- Protection measures for structure
- Venting measures

Road construction
- CBR of subgrade and its preparation
- Sub-base type and thickness
- Excavation of unsuitable material
- Soil stabilisation
- Frost susceptibility

Drainage and excavations
- Ground water regime including de-watering
- Use of soakaways
- Support and ease of excavation
- Rock levels
- Use of sheet piling, diaphragm, bored piles and ground anchors

Earthworks
- Compaction characteristics
- Surcharging and self-settlement
- CBR at formation level
- Slope stability and slope stabilisation
- Suitability of excavated material for re-use

Contamination
- Full assessment of contamination testing
- Hazard-Pathway-Target scenarios/Conceptual Site Model
- Risk assessment and liability
- Precautions or remediation of contamination

Further investigation
- Is further investigation needed?
- Nature of further investigation

Site - gas monitoring

Methane is the dominant constituent of landfill gas, and can form an explosive mixture in air at concentrations of between 5% and 15%. Thus, 5% methane in air is known as the Lower Explosive Limit (LEL). Concentrations less than this do not normally ignite. Carbon dioxide can also be a potential problem, especially where it occurs in concentrations greater than 1.5%.

In-situ gas tests should be carried out in the boreholes on completion, and in probe holes made in the sides of the trial pits. Testing is with a portable meter that measures the methane content as its percentage volume in air. The corresponding oxygen and carbon dioxide concentrations are also measured. Care is needed with this, since the rapid mixing and dilution of any gases within the atmosphere can occur very quickly.

A more accurate method used to monitor over the longer term consists of gas monitoring standpipes installed in boreholes. These typically comprise slotted UPVC pipework surrounded by single sized gravel. The top 0.5m to 1m of pipework is usually not slotted and is surrounded by bentonite pellets to seal the borehole. Valves are fitted and the installations protected by lockable stopcock covers normally fitted flush with the ground. Monitoring is again with a portable meter and is usually done on a fortnightly or monthly basis, with at least six visits being appropriate for most sites.

The risks associated with the gases should be considered in accordance with documents such as:

- BS 8485: Code of Practice for the characterisation and remediation from ground gas in affected developments.
- CIRIA Report C665 Assessing risks posed by hazardous ground gases to buildings.

Soil strength

Hand vane and MEXE cone penetrometer tests can be carried out in trial pits in order to assess the strengths and CBR values of made ground, soils and heavily weathered bedrock materials.

Soakaways

If sustainable drainage is being considered, soakaway testing should be carried out. This is preferably done in trial pits, with the aim of intersecting permeable soils or naturally occurring fissures within bedrock.

Soakaway testing involves filling the trial pits with water from a bowser or such like, and measuring the fall in water over time. Where possible, two tests should be carried out to allow the immediate surrounding ground to become saturated. By knowing the dimensions of the trial pit, the permeability and/or rate of dissipation can be calculated.

Soakaway test results obtained from small hand-dug pits or shallow boreholes should be treated with caution.

Geotechnical

Soil testing should be carried out to BS 1377: Methods of test for soils for civil engineering purposes, and the laboratory used should be recorded and conducted by an approved UKAS laboratory. Normally, the results are summarised and the full results appended.

Contamination

As with the investigation, the sampling should be under the full-time direction of either a Engineer or Geologist. All the recovered soil samples should be screened on-site for any visual or olfactory evidence of contamination, including the presence of Volatile Organic Compounds (VOCs). Samples should be selected from the trial pits and boreholes based on those most likely to be contaminated, and those that will give the most appropriate indication of the spread of any contaminants. The samples should be stored in either glass or plastic containers and where necessary kept in cooled conditions. Testing should be carried out by a UKAS accredited laboratory, in accordance with the Environment Agency's Monitoring Certification Scheme; MCERTS performance standards.

The aim of this is to make a preliminary assessment of the level of any contamination on the site, in order to determine if there are any significant risks associated with contaminants in respect of both human health and the environment, including controlled waters. In addition to the soil, ground water samples should be tested where appropriate.

Natural or in-situ moisture content

The natural or in-situ moisture content of a soil is defined as the weight of water contained in the pore space, expressed as a percentage of the dry weight of solid matter present in the soil. Soil properties are greatly affected by the moisture content and the test can help provide an indication of likely engineering behaviour.

Liquid and plastic limits

Two simple classification tests are known as the liquid and plastic limits. If a cohesive soil is remoulded with increasing amounts of water, a point will be reached at which it ceases to behave as a plastic material and becomes essentially a viscous fluid. The moisture content corresponding to this change is arbitrarily determined by the liquid limit test. 'Fat' clays, which have a high content of colloidal particles, have high liquid limits; 'lean' clays, having low colloidal particle content, have correspondingly low liquid limits. An increase in the organic content of clay is reflected by an increase in the liquid and plastic limits.

If a cohesive soil is allowed to dry progressively, a point is reached at which it ceases to behave as a plastic material, which can be moulded in the fingers, and becomes friable. The moisture content of the soil at this point is known as the 'plastic limit' of the soil.

The water content range over which a cohesive soil behaves plastically, i.e. the range between the liquid and plastic limits, is defined as the plasticity index.

A cohesive soil with natural water content towards its liquid limit will, in general, be an extremely soft material, whereas a cohesive soil with natural water content below its plastic limit will tend to be a firm or stiff material.

Particle size distribution

Knowledge of particle size distribution is used to classify soils and indicate likely engineering behaviour.

BS EN ISO 14688-1 defines soils in relation to their particle size, as shown below:

Boulders >200mm Cobbles 200mm-63mm	Coarse sand 2mm-0.63 Medium sand 0.63mm-0.2mm Fine sand 0.2mm-0.063
Course gravel 63mm-20mm Medium gravel 20mm-6.3mm Fine gravel 6.3mm-2mm	Coarse silt 0.063mm-0.02mm Medium silt 0.02mm-0.0063mm Fine silt 0.006mm-0.002mm
	Clay <0.002mm

Bulk density

The bulk density of a material is the weight of that material per unit volume, and includes the effects of voids whether filled with air or water. The dry density' of a soil is defined as the weight of the solids contained in a unit volume of the soil.

Permeability

The permeability of a material is defined as the rate at which water flows through it per unit area of soil under a unit hydraulic gradient.

Consolidation characteristics

When subjected to pressure, a soil tends to consolidate as the air or water in the pore space is forced out and the grains assume a more densely packed state. The decrease in volume per unit of pressure is defined as the 'compressibility' of the soil, and a measure of the rate at which consolidation proceeds is given by the 'coefficient of consolidation' of the soil. These two characteristics, Mv and Cv, are determined in the consolidation test, and the results used to calculate settlement of structures or earthworks by a qualified person.

Strength characteristics

The strength of geological materials is generally expressed as the maximum resistance that they offer to deformation or fracture by applied shear or compressive stress. The strength characteristics of geological materials depend to an important degree on their previous history and on the conditions under which they will be stressed in practice. Consequently, it is necessary to simulate in laboratory tests, the conditions under which the material will be stressed in the field.

In general, the only test carried out on hard rocks is the determination of their compressive strength, but consideration must also be given to fissuring, jointing and bedding planes.

The tests currently used for soils and soft rocks fall into two main categories. First, those in which the material is stressed under conditions of no moisture content change, and second, those in which full opportunity is permitted for moisture content changes under the applied stresses. Tests in the first category are known as un-drained (immediate or quick) tests, while those in the second category are known as drained (slow or equilibrium) tests. The tests are normally carried out in the tri-axial compression apparatus, but granular materials may be tested in the shear box apparatus.

The un-drained tri-axial test gives the apparent (cohesion) Cu and the angle of shearing (resistance) Øu. In dry sands, Cu = 0 and Øu is equal to the angle of internal friction, whereas with saturated non-fissured clays Øu tends to 0 and the apparent cohesion Cu is equal to one-half the unconfined compression strength Qu. On site, the vane test gives an approximate measure of shear strength.

For some stability problems, use is made of a variant of the un-drained tri-axial test in which the specimen is allowed to consolidate fully under the hydrostatic pressure, and is then tested to failure under conditions of no moisture content change. This is known as the consolidated un-drained tri-axial test. Pore water pressures may be measured during this test, or alternatively a fully drained test may be carried out. In either case, the effective shear strength parameters C' and Ø' can be obtained, which can be used to calculate shear strength at any given pore water pressure.

Compaction

The density at which any soil can be placed in an earth dam, embankment or road depends on its moisture content and on the amount of work used in compaction. The influence of these two factors can be studied in compaction tests, which can determine the maximum dry density (MDD) achievable at a certain optimum moisture content (OMC).

California Bearing Ratio (CBR) test

In flexible pavement design, knowledge of the bearing capacity of the sub-grade is necessary to determine the thickness of pavement for any particular combination of traffic and site conditions. The quality of the subgrade can be assessed by means of the CBR test, or approximately by the MEXE cone penetrometer.

Chemical tests

Knowledge of the total soluble sulphate content and pH of soils and ground water is important in determining the protection required for concrete or steel in contact with the ground. Other specialist tests may be carried out on sites suspected of being contaminated by toxic materials.

References

British Standards Institution
- BS 1377: Methods of test for soils for civil engineering purposes (Parts 1 to 8)
- BS 3882: British Standard specification for topsoil
- BS 5930: British Standard Code of Practice for Site Investigations
- BS 8485: British Standard Code of Practice for the characterization and remediation from ground gas in affected developments
- BS 10175: British Standard Code of Practice for the investigation of potentially contaminated sites
- BS EN 1997-1: Eurocode 7 - Geotechnical design - Part 1: General rules
- BS EN 1997-2: Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing
- BS ISO 14688-1: Geotechnical investigation and testing - Identification and classification of soil - Part 1
- BS ISO 14688-2: Geotechnical investigation and testing - Identification and classification of soil - Part 2
- BS ISO 14689-: Geotechnical investigation and testing – Identification, description and classification of rock
- BS8004: British Standard Code of Practice for Foundations

BRE
- Radon: Guidance on protective measures for new dwellings, BR 211
- Protective measures for housing on gas-contaminated land, BR 414, 2001
- Cover systems for land regeneration, 2004
- Concrete in aggressive ground, Special Digest SD1, 3rd Edition, 2005
- BRE IP 5/97: Building on Fill – collapse compression on inundation

CIEH
- The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)

CIRIA
- Assessing risks posed by hazardous ground gases to buildings, CIRIA C665
- Shaft friction of CFA piles in chalk 2003, CIRIA PR 86
- Engineering in chalk 2002, CIRIA C574
- CIRIA C758D Abandoned Mine Workings Manual

DoE
- CLR Reports 1-4
- Waste Management Paper No. 26A, Landfill Completion: A technical memorandum…
- Waste Management Paper No. 27, Landfill gas: A technical memorandum…

DEFRA
- Contaminated land report CLR 11, 2002 (7-10 withdrawn)
- R & D Publications TOX 1 - 12, 14, 16 - 25
- R & D Publications SGV 1, 3, 4, 5, 7, 8, 9, 10, 15 and 16 (withdrawn)
- Improvements to contaminated land guidance - Outcome of the “Way Forward”, 2008
- Exercise on soil guideline values, 2008
- Guidance on the legal definition of contaminated land, 2008

DETR
- Circular 02/2000. Contaminated land, 2000
- Guidelines for environmental Risk Assessment and management, 2000

Environment Agency
- Guidance for the safe development of housing on land affected by contamination, 2000
- Guidance for waste destined for disposal in landfills, Version 2, 2006
- Protective measures for housing on gas-contaminated land remediation position statements, 2006
- Guidance and Monitoring of Landfill Leachate, Groundwater and Surface Water
- Human Health Toxicological Assessment of Contaminants in Soil (Science Report SC050021/SR2), 2008
- Updated Technical Background in the CLEA Model (Science Report SC0520021/SR3)
- Using Soil Guideline Values, 2009

HMSO
- Environmental Protection Act 1990
- Environment Act 1995
- UK Water Supply (Water Quality) Regulations 2000
- The Water Act 2003

Institution of Civil Engineers
- Contaminated Land: Investigation, Assessment and Remediation (2nd Edition)
- Specification for Piling and Embedded Retaining Walls

Joyce, M.D.
- Site Investigation Practice, 1982

London District Surveyors Association
- Notes for the design of straight shafted bored piles in London Clay

OPDM
- Planning Policy Statement 23: Planning and Pollution Control Annex 2: Development on Land Affected by Contamination

2. Basements

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Only basements described in the Policy document are covered by this Section.
4. The reference to a basement in this Technical Manual is a structure that is constructed partly or wholly below ground. For Warranty purposes this can include foundations, retaining basement walls, floors and below ground roof decks (including podium and transfer decks), sub-base drainage, sumps, light wells and pavement lights at or below ground level, that are included within the defined basement.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. Elements that are integral to the waterproofing structure of basements including foundations, walls and floors shall be designed by an Engineer to support vertical loading, resist horizontal loading and surcharges including the influence of nearby trees and topography.
2. Basements shall be appropriately designed to ensure that they adequately provide suitable barrier(s) against contaminants, ground gases, surface and ground water.
3. At least 8 weeks before the commencement of the basement, the Developer shall provide a structural waterproofing design and specification for protecting the below ground environment of the basement and include a site investigation report.
4. All basements must be designed and constructed to resist water penetration to the habitable areas of a basement and include a combined system of waterproofing protection. The only exception to not providing two forms of waterproofing protection is where defined in the supporting technical guidance and confirmed prior to commencement.
5. The waterproofing design must be provided by a suitably qualified Waterproofing Design Specialist e.g. Certificated Surveyor in Structural Waterproofing (CSSW). The Waterproofing Design Specialist must:
    a. Have an understanding of hydrogeology and soil mechanics.
    b. Be competent for the proposed scheme complexities.
    c. Provide a design philosophy which clearly sets out the desired grade of the environment to be achieved. The design philosophy should clearly set out how the specified design will provide the required environmental grade based on the specific hydrogeology and ground conditions of the site.
    d. Co-ordinate the proposals from the design team to provide a site specific design.
    e. Ensure there is a continuity provided between the basement and the above ground damp proof course constructions.
6. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
7. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.
8. Type C systems and drainage systems necessary the waterproofing design must be maintainable.

2. Basements

2.1 General Requirements

Introduction

All basements and below ground structures will need to be evaluated on a project specific basis for performance against the required environmental grade prior to any work commencing on site. The Developer must provide evidence to us that the water proofing design is appropriate for the risk.

Provision of information

1. The Developer is to provide, **at least 8 weeks before the commencement** of the basement, evidence to us of a **waterproofing design specification** for protecting the below ground environment of the basement and include as a minimum:
   a) A site specific waterproofing design philosophy provided by a suitably qualified Waterproofing design specialist.
   b) A site investigation report (Phase 1 & 2 Geo-Environmental Assessment Report - see the 'Ground Conditions' section of this Technical Manual) to identify the risks, for which the waterproofing design is to be based on.
   c) Specify the 'Environmental Grade' requirement for below ground structures in accordance with BS 8102.
   d) Site level survey drawings highlighting existing site features.
   e) Proposed general arrangement drawings identifying all the plots and location of any below ground storey levels, lift pits and basements.
   f) Drainage layout plans showing maintainable drainage runs, access provisions and outfalls (this includes all drainage relating to the structural waterproofing proposals).

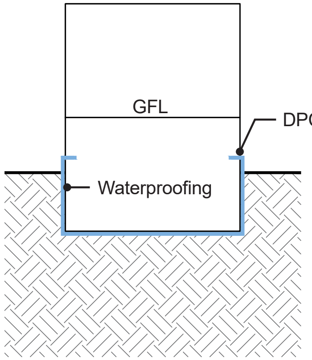
2. Additional supporting information will be required **prior to the work commencing** on site and must include, but not limited to:
   a) Waterproofing materials – Systems and material specification for the Design Strategy including sump(s) and pump(s) specification.
   b) Site specific detailing for waterproofing of all construction jointing and service penetrations.
   c) Below ground drainage provisions e.g. below slab - internal drainage systems, surface and foul water, storm water attenuation tanks, etc.
   d) Drainage provisions to hardstanding features e.g. light wells and flush pavement lights.
   e) Landscaping - Intensive roof, podium deck and transfer decks – drainage and waterproofing provisions (see also the 'Roofs' section of this Technical Manual).
   f) Construction and structural waterproofing methodology e.g. Engineers foundation design, walls, floor(s) and roof slab design, temporary and permanent works.
   g) Evidence of a competent approved installer for the structural waterproofing works.

3. **On completion of the works** the following documentation will need to be provided.
   a) Sump pump(s) commissioning certificate.
   b) Operations and Maintenance manual for maintainable systems installed including land drains.

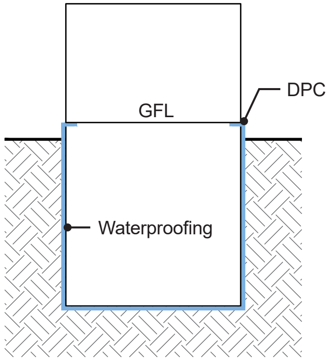
The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Examples of structures wholly or partially below ground

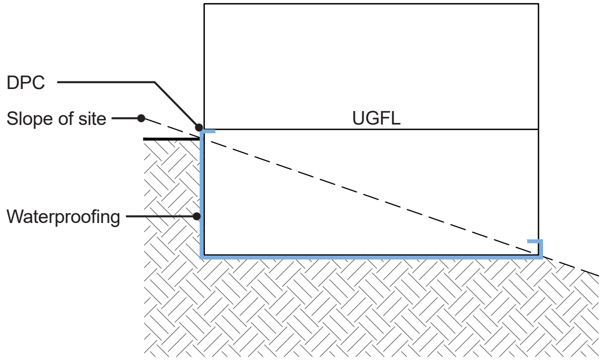
A basement can be a structure that is constructed partly or wholly below ground. The following show examples of basements / structures that will require water proofing.



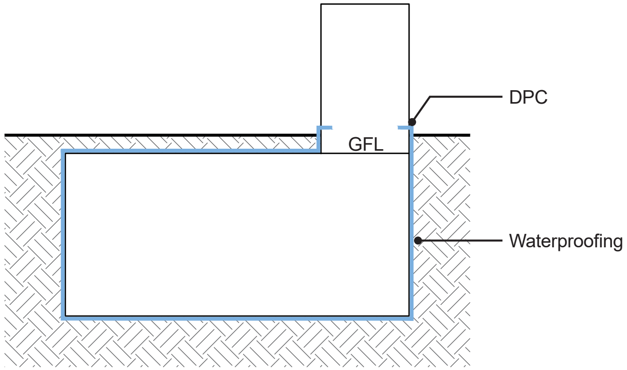
Storey partially below ground



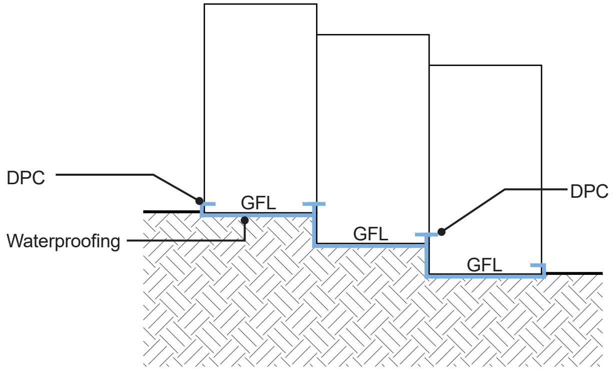
Storey wholly below ground



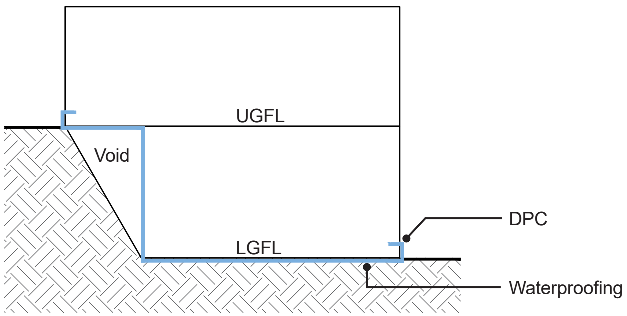
Semi-basement on 3 sides



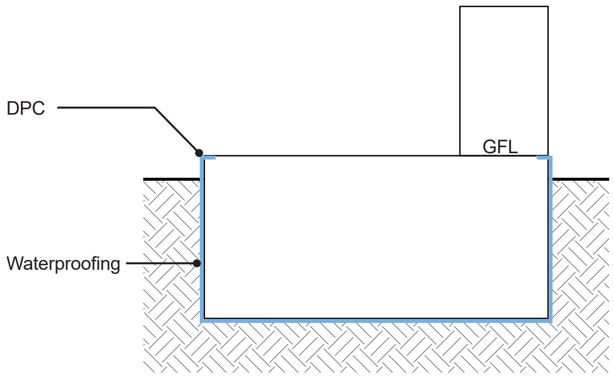
Buried roof



Stepped site



Split level



Podium above ground

The waterproofing design

The waterproofing design must be appropriate for the specific environment required and be provided by a suitably qualified Waterproofing Design Specialist (WDS) e.g. Certificated Surveyor in Structural Waterproofing (CSSW).

Evidence of the site investigation reports, along with a site specific waterproofing design philosophy must be provided by a suitably qualified Waterproofing Design Specialist **8 weeks** before the commencement of the basement construction.

The Waterproofing Design Specialist must be appointed early in the design stage to coordinate with the other members of the Design team for the project.

The early involvement of a Waterproofing Design Specialist is an important consideration because the waterproofing design typically has an influence on other elements of the structural and/or architectural design.

The Design team should include:
- The Developer.
- Waterproofing Design Specialist: To provide an integrated waterproofing solution to the specified environmental grade.
- Structural Engineer: Responsible for all the structural elements for the development.
- Geotechnical specialist: To provide ground information of the site including geology, hydrology, hydrogeology and topography.
- Drainage consultant: To provide guidance for the water control of ground and surface water including Sustainable Urban Drainage system (SUDS) provisions across the development site.

Risk based design

The proposed waterproofing should be appropriate to the risk.

The Waterproofing Design Specialist must take account of the:
- Information contained in the site investigation report to identify the risks associated with geology, hydrology, hydrogeology and topography for the specific project and not a generic approach.
- The ‘Environmental Grade’ required.
- The existing and proposed site levels and any features which may impact on the areas of building below ground level.
- Drainage, both new and any retained elements, relating to the structural waterproofing proposals.
- Information provided by other members of the Design team and co-ordinate to ensure the waterproof design can be achieved.

The Developer should ensure:
- The Design team provides a coordinated design, based on the waterproofing design.
- The workmanship of the trades / contractors involved during the construction stage will achieve the waterproofing design requirements.
- Any changes to the waterproofing design or associated construction ‘proposed’ during the construction phase, must be reverted to the waterproofing design specialist to confirm the design will still be appropriate and the waterproofing design updated.

The approach detailed within BS 8102 involves assessment of a given site to determine the characteristics that influence risk. With the benefit of knowledge gained through this investigation and assessment, suitable designs for dealing with the risk of water ingress, gases and contaminants can then be devised and constructed.

Note:
1. Where relying on the use of a waterproofing product manufacturer’s standard details, they typically disclaim design responsibility, so it is incumbent on the Waterproofing Design Specialist to ensure that such details are correct and appropriate for the site and structure or offer suitable variation.
2. For our Warranty purposes, it must be assumed that the basement will be exposed to a full height of water during the design life of the building.
3. The design must include a combined system of waterproofing protection (unless otherwise stated within this guidance).

Site investigation to determine ground conditions

The degree of water present within the ground and the propensity for water-logging to occur over the lifetime of a structure is a principal driver in assessing risk and the waterproofing system required. Simplistically, if a basement is constructed into a permanently high water table then the degree of protection will necessarily be greater than a similar structure constructed into a generally dry site.

Therefore:
- An assessment of a site must be based on the results of the site investigation report and other site-specific factors.
- Seasonal variations in the water table must be accounted for unless long-term monitoring is undertaken.
- Where standing water levels are not noted during a pre-start site investigation, the drainage characteristics of the ground must receive particular attention.
- Soils with low permeability represent a risk of water-logging or encouraging a ‘perched water table’, where water stands temporarily or permanently within the ground against a structure. Arguably this affects more properties with basements versus the true water table level.

Other factors such as site topography and building orientation may have an impact on the propensity for pressure to come to bear against a below ground structure and should also receive consideration.

Further guidance on the drainage characteristics associated with different types of ground maybe found within The Basement Information Centre (TBIC) Basements: Waterproofing – BS 8102 Principle Considerations 4.3.

Ground gases and contaminants must also be considered within the risk assessment for the waterproofing design. The Waterproofing Design Specialist may need to consult with an Engineer with suitable knowledge and experience with ground gases and contaminants.

While the Site investigation report (Geo-Environmental reports) assess the risk and guides the waterproofing design, an equally important consideration is the intended use of the space and the consequences in the event that water penetration should occur. For example, in properties where the consequences of water penetration would be severe, such as in a habitable space, an accessible and maintainable system must be considered and provided.

It could be derived that based upon site investigation reports, the risk of water pressure ever occurring is low. However given the effects of climate change, burst water mains or sewers, or any other topographical features e.g. ponds, watercourses, etc., there still remains a risk of water coming to bear on the structure.

In summary:
- Evidence of the site investigation reports, along with a site specific waterproofing design philosophy must be provided by a suitably qualified Waterproofing Design Specialist **8 weeks** before the commencement of the basement construction.
- The site investigation reports assesses the risk and guides the design, but it should always be assumed that some degree of water pressure will come to bear on the structure during its lifetime.

The water resisting structure

The principle is to consider and design robustly for expected water pressures that the structure and waterproofing must resist, based upon the site investigation reports and site risk assessment. Design considerations may also be influenced by sub-surface drainage by which the degree of water on the structure could be reduced.

The ability of the structure to provide resistance to water penetration has a bearing on the various forms of waterproofing. Retaining walls in plain or reinforced masonry provide comparatively little resistance to the penetration of water under pressure because of:
- The porosity of masonry materials.
- The existence of bed and perpendicular joints.

The flow of water (seepage) through reinforced concrete may be controlled by structural design (reinforcement) or concrete mix design. While concrete itself is relatively impermeable, the degree to which water is excluded will be greatly influenced by crack sizes and the detailing of construction joints and service penetrations.

Defects and remedial measures

Waterproofing Design Specialists are to consider the probability that systems may be inadequately installed and defects may occur as a result of poor workmanship, or that defects may be present in the supplied materials.

Designing on the assumption that a system will not be totally perfect or free of defects, necessitates that consideration is given to the feasibility of repairing those defects at construction stage. A remedial repair strategy should be included within a design.

For our Warranty provision, where a Grade 3 environment is required, combined protection must be provided, consisting of 2 systems recognised by BS8102.
An accessibility and reparability option is essential and should form part of any structural waterproofing design.

Similar strategies for repair of all other grades should include an appropriate reparation strategy as part of any waterproofing design proposal.

Stability and durability

The construction elements that support a building below the ground e.g. foundations, walls, floors, etc., shall be designed to structurally resist movement from the applied loads and surcharges both from above and below the ground. The structure should also be suitably durable for the below ground environment.

Design considerations shall be informed by the:
a) Geo-environmental report (Phase 2).
b) Structural design.
c) Expected structural movement e.g. deflection, surcharge of loads.
d) Below ground environment.
e) Durability of materials.
f) Waterproofing co-ordination.

Geo-environmental report (Site Investigation report)
A report will establish the nature of the ground conditions and the potential hazards. In some locations, existing underground services or utilities may also impact on the design.

Structural design
Analysis of the applied loadings should be considered in the design of the structure, and shall include for:
- Loading from the superstructure and other parts of the building.
- Lateral forces from retained ground, ground water and surcharges.
- Ground movement and the effect of trees.
- Buoyancy and ground heave.
- Temporary loading conditions e.g. the effects of site traffic, proximity of heavy plant placement.

Expected structural movement
Movement of the structure is determined by the limitations of the waterproofing system applied to ensure that the performance design and level of water tightness is achieved. Specified tolerances of movement should be provided where appropriate.

A movement joint in any below ground structures should be avoided wherever possible. Where the Engineer deems such a movement joint is of necessity, the design of the joint should ensure both service performance requirements and water tightness.

Movement joints shall not be concealed. This is to allow for adequate inspection and accessibility for maintenance.

Below ground environment
Building spaces below ground level which include the foundations for the whole building shall be designed by an Engineer and consider:
- Site topography and site characteristics.
- Trees in relation to the foundations.
- Ground conditions.
- Nearby buildings.
- Identified site hazards.

Durability of materials
The below ground structure should be designed to be durable against the identified site hazards found in the ground investigation and include for the effects of:
- Freeze-thaw actions.
- Dispersal of water on the structure.
- Aggressive chemicals in the ground.

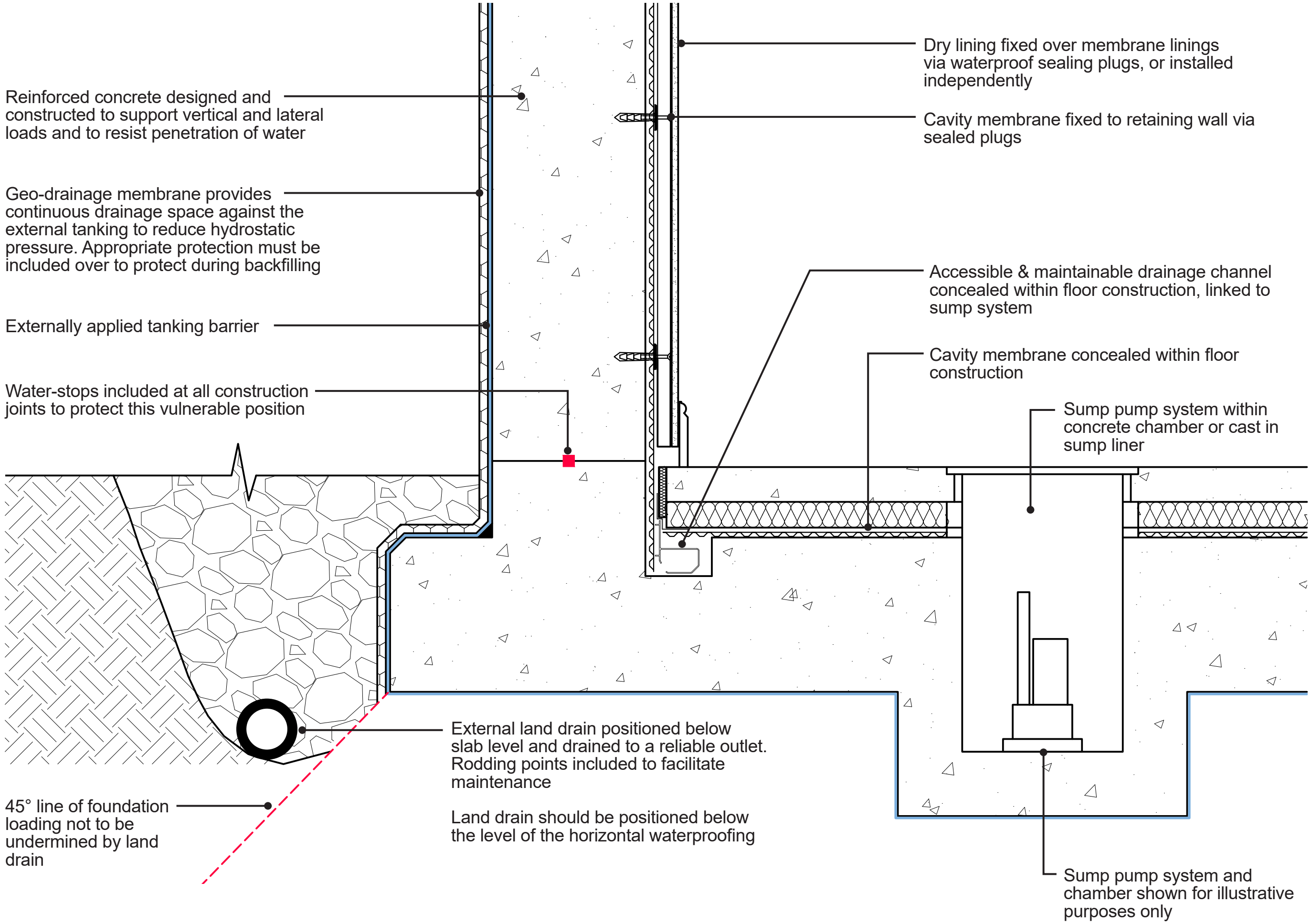
Waterproofing co-ordination
The design of the waterproofing must consider the impact of any proposed application of waterproofing materials applied to the structure, and this requires co-ordination with the appointed Design team.

Forms of waterproofing

BS 8102 refers to three forms of waterproofing protection:

- Type A Barrier protection (can be referred to as 'tanking'). Barrier membranes must be fully bonded.
- Type B Structurally integral protection.
- Type C Drained protection (can be referred to as 'water management').

Example of combined waterproofing A, B, and C



Intended use and required standard of environment

Usage dictates the required performance grade of an internal environment, e.g. how 'dry' a given below ground space must be in order to be suitable for a notified usage.

The Waterproofing Design Specialist should therefore consider how this will be achieved in a particular site and structure. Reference to Table 2, from BS 8102, provides four definitions of environmental grades (Grades 1a, 1b, 2 and 3). The table below provides guidance for use on our Warrantied projects. Application of these performance levels are subject to the exclusions within the relevant applicable Policy document:

Grade	Example of structure	Performance level
1a	Enclosing structure of underground car parking[1], underground refuse stores, cycle stores, external light well enclosures.	Seepage and damp areas from internal and external sources are tolerable, where this does not impact on the proposed use of below ground structure. Internal drainage might be necessary to deal with seepage.
1b	Non habitable use: e.g. Enclosing structure of underground car parking[2], plant rooms[3], lift pits[4].	No seepage. Damp areas from internal and external sources are tolerable (dependent on intended use).
2	Non habitable use: e.g. Enclosing structure of underground car parking[5], plant rooms[6], lift pits[7], access stairs and lobbies serving non-habitable storeys.	No seepage is acceptable. Damp areas as a result of internal air moisture/condensation are tolerable; measures might be required to manage water vapour/ condensation e.g. ventilation might be required.
3	Habitable accommodation: e.g. Enclosing structure to ventilated residential and commercial areas including offices, restaurants, leisure facilities, associated access stairs and lobbies serving habitable storeys or habitable spaces within non-habitable storeys.	No water ingress or damp areas is acceptable. Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use.

Notes:
1. Standard car parking environment where seepage and damp areas from internal and external sources are tolerable.
2. Parking structures where no seepage is acceptable.
3. A room containing equipment which supplies building services, and remain unaffected in their operation within a damp environment e.g. water tanks and pipework, sprinkler system pumps and pipework, etc.
4. A lift pit containing structure or working components of the lift remaining unaffected in their operation by the presence of dampness.
5. Private car parking where no seepage or dampness through the structure is acceptable.
6. A room containing equipment which supplies building services, and may be affected in their operation by the cumulative effects of dampness e.g. electrical components and services, generators, communication systems, etc.
7. A lift pit containing electrical equipment and/or working components and may be affected in their operation by the cumulative effects of dampness.

To assist with quantifying an acceptable level of moisture ingress, the following definitions of water tightness are provided for Warranty purposes.

- Damp: When touched, a damp patch may leave a slight film of moisture on the hand, but no droplets of water or greater degrees of wetness are left on the hand. On a concrete surface a damp patch is discernible from a darkening of the colour of the concrete.
- Beading: Beading of water is the state in which individual droplets of water (held by surface tension effects) form on the surface of the wall and adhere to the wall. The water beads do not coalesce and do not flow.
- Weeping (seepage): Weeping of water is the state in which droplets of water form on the surface of the wall and coalesce with other droplets. The coalesced water does not remain stationary on the wall surface, but instead flows down the wall.

These definitions are taken from the publication 'Specification for piling and embedded retaining walls'.

Grades of waterproofing protection

- All waterproofing design specialists should clearly define the environmental grades being applied to the spaces within any basement storey as part of their waterproofing strategy.
- Any form of habitable space is considered as Grade 3, where water penetration is unacceptable. Appropriately designed environmental control measures must be included to control vapour introduced by occupation, and thereby preventing problems of condensation.
- Any space designed to Grade 2 (e.g. plant and store rooms), where water penetration is not acceptable, does not require the inclusion of ventilation. However some degree of ventilation is recommended, even in basic storage space, to avoid condensation related issues.
- For developments with underground car parking, the grade of waterproofing should be clearly defined as part of the waterproofing design. Depending on the design criteria, the degree of seepage or dampness (water tightness) that can be tolerated for this particular end use needs to be established and agreed with all interested parties, including the Warranty Surveyor at the design stage.

For our Warranty provision, where a Grade 3 performance is required, a combined system of waterproofing protection must be provided.

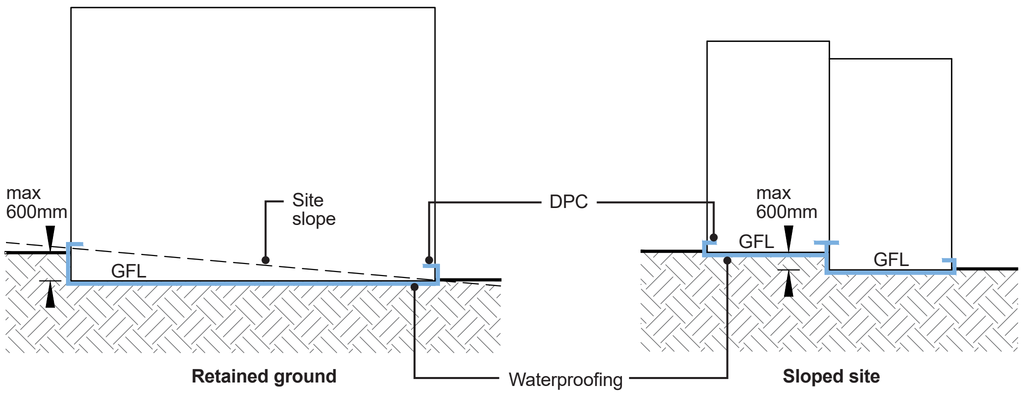
However; in the following specific circumstances only, a single form of waterproofing protection where a Grade 3 performance is required, may be acceptable subject only to:

- On shallow stepped / gentle sloping sites where only part of the structure could result in retaining ground above the lowest finished floor level but in no situation greater than 600mm.
- And, the water table being proven to be permanently below the lowest floor level.

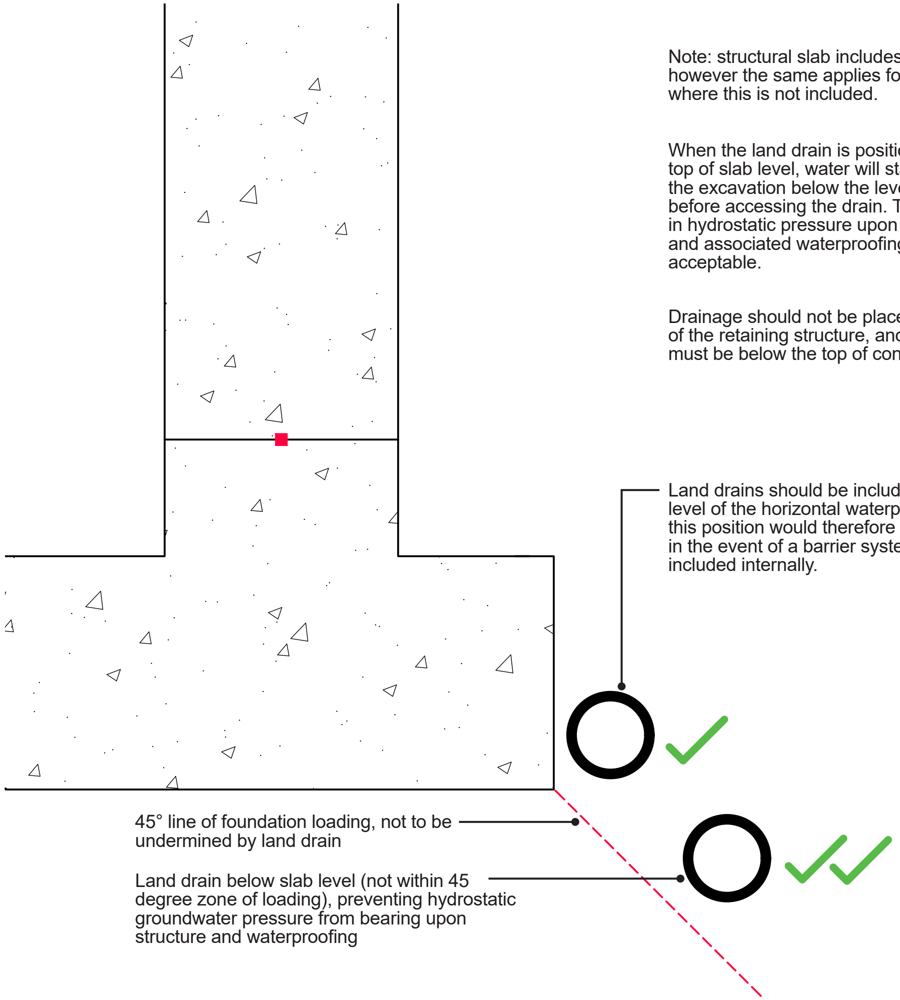
In these circumstances, the site conditions must be proven to not result in an unacceptably high risk and the consequences of failure are substantially low. This must be substantiated by a site investigation report and agreed with the Warranty provider before commencing work on site.

A site specific design proposal must be provided before commencement of construction on site, to demonstrate the proposed waterproofing solution (Type A, B or C) is appropriate for the ground conditions (based on the site investigation report). This will include for the wall and floor waterproofing proposals.

Such scenarios are limited to the above described and as shown in the below images.



Land drain positioning and external drainage



Note: structural slab includes ‘toe’ detail, however the same applies for structures where this is not included.

When the land drain is positioned above top of slab level, water will stand within the excavation below the level of the drain before accessing the drain. This can result in hydrostatic pressure upon the structure and associated waterproofing. This is not acceptable.

Drainage should not be placed on the heel of the retaining structure, and the invert must be below the top of concrete.

Land drains should be included below the level of the horizontal waterproofing and this position would therefore be acceptable in the event of a barrier system being included internally.

Exclusion of surface water

Surfaces external of the basement structure at ground level can act to limit or attenuate penetration into vulnerable positions, i.e. the more permeable excavated and backfilled ground directly around the basement structure. The inclusion of surface and cut-off drains which remove standing water away from the vulnerable areas are also of benefit.

Sub-surface drainage

The use of land drainage can act to remove water from around the structure, thus alleviating pressure and should be considered in all cases to reduce the risk of water ingress where practical.

However, the use of land drainage may not be viable on all sites, examples being:

- Where there is no available location to discharge collected ground water.
- Where high water tables and permeable ground conditions make it impractical to sufficiently remove the quantities of water present.
- Restrictions on the site curtilage due adjacent buildings close to or on the site boundary.
- Draw down, i.e. affecting the stability of other structures by the introduction of a land drain.

Depending on the required ‘environment’, if land drainage is not feasible, a combination of at least two systems in order to mitigate the risk of water ingress will need to be adopted. The waterproofing design specialist will be required to provide a solution specific to the site conditions.

Notwithstanding such conditions, the provision of effective land drains is often an economic means of greatly reducing risk and must be included where viable.

The following considerations apply:

- Perforated land drains must be surrounded in clean graded stone and wrapped in a suitable geo-textile filter fabric to reduce the risk of clogging. This is particularly important in fine granular and clay soils where land drains are susceptible to clogging.
- Rodding points must be included (ideally at changes in direction) to facilitate maintenance, which will allow the system to function in the long term (this particularly applies to land drains where there is no viable access for repair). This maintenance should be undertaken at suitable intervals (annually as a minimum), with the detail of this being written into the documentation passed to homeowners.
- Land drains must be positioned at a low enough position to prevent pressure from bearing upon the structure and waterproofing.
- The use of geo-drainage membranes applied to the external face of a retaining wall can provide a continuous drainage space external of the structure, which assists in encouraging water to drain down to the level of the land drains without pressuring the structure.
- Land drains must link to a reliable point of discharge. Where sump pump systems are employed, the implications of power cuts should be considered in that land drains may in such scenarios not function as intended. The effectiveness of battery back-up systems, where employed in sumps servicing land drains, should be considered in relation to assessment of the likely degree of ground water.
- Land drains must not be directly linked to soakaways by gravity, unless it is not possible for water to surcharge, i.e. where the top of the soakaway is below the level of the actual land drains.
- Where land drains are included this should be in association with a permeable stone backfill compacted in layers, which also encourages water to drain down to the level of the land drains without perching and pressuring the structure.
- The use of maintainable land drains is a necessity when employed in association with some forms of inaccessible/external tanking systems, i.e. where the structure itself provides little resistance. In such cases if it is not feasible to include reliable land drains, alternative methods of waterproofing must be used.

The Warranty Surveyor is to be supplied with design details where external land drainage is included.

Please note: Where combined forms of waterproofing are required, the inclusion of land drainage is not considered an additional type of protection and a combination of type A, B or C protection should be used.

Introduction

The environmental grade of waterproofing should be clearly defined as part of the waterproofing design strategy. Depending on the design criteria, the degree of dampness that can be tolerated for this particular end use needs to be established and agreed with all interested parties, including the Warranty Surveyor at the design stage.

Where lift pits are constructed at the same time as foundations are excavated, consideration for waterproofing is often not considered. Lift pits serve two purposes:

a) Providing a fixing platform for construction of the shaft.
b) Housing for the lift mechanisms and associated plant, and facilitating future servicing of the lift.

To have water in a lift pit whilst working is uncomfortable and the humid internal environment can affect other building elements and finishes due to damp rising up the walls. This can lead to:

- Corrosion of fixings.
- Damage to the lift mechanism.
- Lift failures and breakdowns.
- Health and safety related issues.

It is therefore a requirement that seepage from ground water does not occur and that the lift pit remains free from water.

This applies to lift pits in isolation or as part of a larger waterproofed scheme.

Design considerations

Construction method
As lift pits are the first to be constructed, the developer is to provide the design of the waterproofing systems before any construction commences on site. For more information, please refer to the ‘Provision of information’ in this section.

Fixings
Within the lift pit there may be machinery plant associated with the operation of the car and guide rails which will require fixity to the structure. The effect on the chosen waterproofing method should be fully considered e.g. when structurally integral waterproof concrete has been specified for the slab and walls then proprietary self-sealing waterproof plugs should be specified.

Workmanship
Waterproofing materials are specialised materials and do require knowledge and training for their placement on a below ground structure such as a lift pit. A specialist installer should be considered depending on the degree of risk / impact of failure.

2.
Basements

2.2
Waterproof Protection Systems

Combined protection

This guidance is for Type A Barrier (tanked) protection system of structural waterproofing.

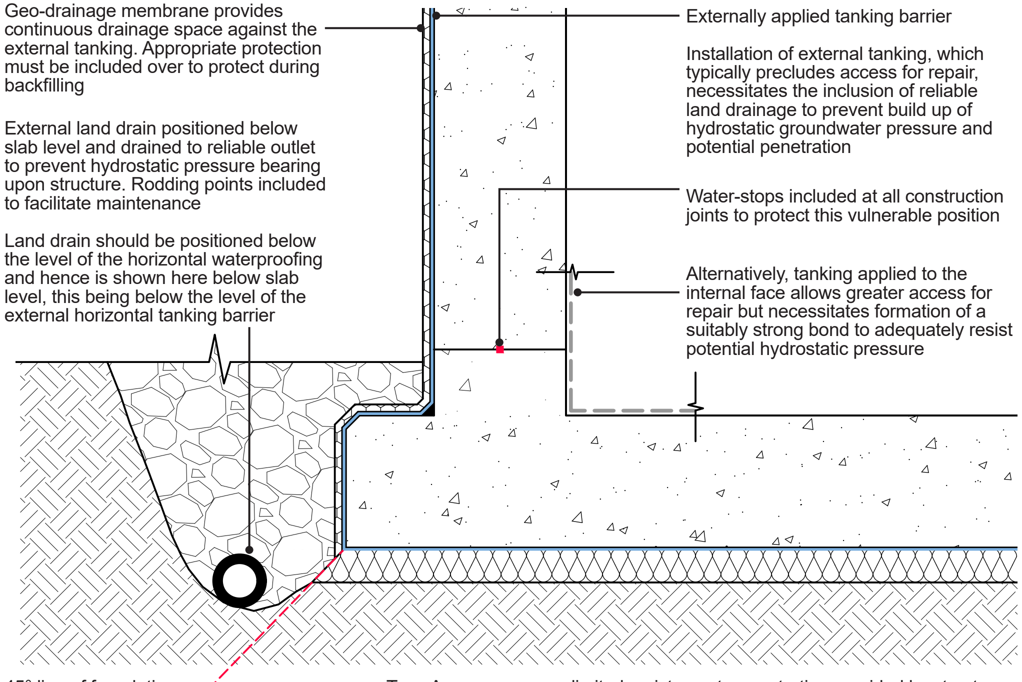
A combination of BS 8102 waterproofing protection systems may be required to lower the risk, or where the consequences of a system failure are considered great. Combined BS 8102 systems should always be employed where site conditions would result in an unacceptably high risk when employing a single system.

Type A barrier protection

This form of waterproofing relies on the adhesion of a physical barrier material applied on or within the structure, often where the structure itself provides little resistance to the penetration of water.

A variety of considerations apply:

- Suitability of the substrate, primarily applicable where cementitious products are applied internally in that the bond between the product and the substrate on which it is applied, must be sufficient to resist hydrostatic ground water pressure.
- The requirement for preparation of substrates to accept membranes and cementitious materials.
- Movement which in rigid barrier protection systems may encourage cracking through which water may penetrate, where pressure comes to bear on the structure.
- Loading, where hydrostatic pressure is applied to the structure as a result of exclusion of the barrier protection system e.g. structures must be designed to resist loads applied to them.
- Continuity, in that systems must be 'continuous'. A gap in a barrier system represents a point at which water under pressure can penetrate.
- 'Buildability', namely whereby sheet membrane products are proposed with the consideration being the practicality of wrapping a flat sheet around complex three dimensional shapes, such as external corners and beneath raft slab thickened toe details.
- Application – surfaces on which barrier protection systems are applied must be sufficiently prepared to gain maximum bond strength. Also temperature and weather conditions must be considered when application is made.



Type A assumes no or limited resistance to penetration provided by structure. However, risk is reduced where employing structures with greater or total water resistance (combined protection).

Commentary on Type A barrier protection

- Whilst BS 8102 advises that 'reparability' must be considered, the use of external adhesive membrane systems on permeable constructions is precluded, unless employed in association with long-term strategies for preventing ground water from pressuring, e.g. serviceable land drains.
- External systems have a greater implication, in that accessibility for repair is typically impractical post-construction and where combined with relatively permeable wall constructions, makes it difficult to confidently determine the point of a defect externally, because water can track within the wall construction to show itself internally at a position not local to the external defect.
- Internal systems have the benefit of greater accessibility meaning that repair is more feasible. Where this system is chosen, the strength of the substrate, its surface preparation and the bond of the waterproofing system are critical considerations and need to be properly considered by the waterproofing specialist.
- The correct use of land drains assists to minimise the potential for hydrostatic pressure coming to bear on to the structure.
- Risk will be lessened by using a 'fully bonded' system, where the bond is such that water cannot track along between the structure and barrier product, in association with a structure of lesser permeability which would allow localised repair to be undertaken.
- Product guarantees, quality assurance schemes and product certification does not negate the Functional Requirement that a waterproofing design specialist is required to provide a suitable waterproofing design.

Other considerations

Ground gases and contaminants
Aggressive ground conditions may require the inclusion of a suitable ground barrier to protect the structure appropriately. Specialist advice must be sought in respect of dealing with ground gases, and designers are advised to check current standards at the time of construction for suitable guidance.

Existing structures
Waterproofing existing structures differs from new construction in that designers must work within the confines of the existing structure. However, many of the same considerations apply in that the required standard of environment appropriate to usage must be created and maintained in the long term.

Interface with external wall damp proof courses
Whichever type of waterproofing system is deemed appropriate, there must be a continuation provided with the horizontal damp proof courses above ground level. Waterproofing materials used must be compatible with the damp proof course components and adequately lapped and bonded.

The Waterproofing Design Specialist should take responsibility for this junction as part of the barrier protection design.

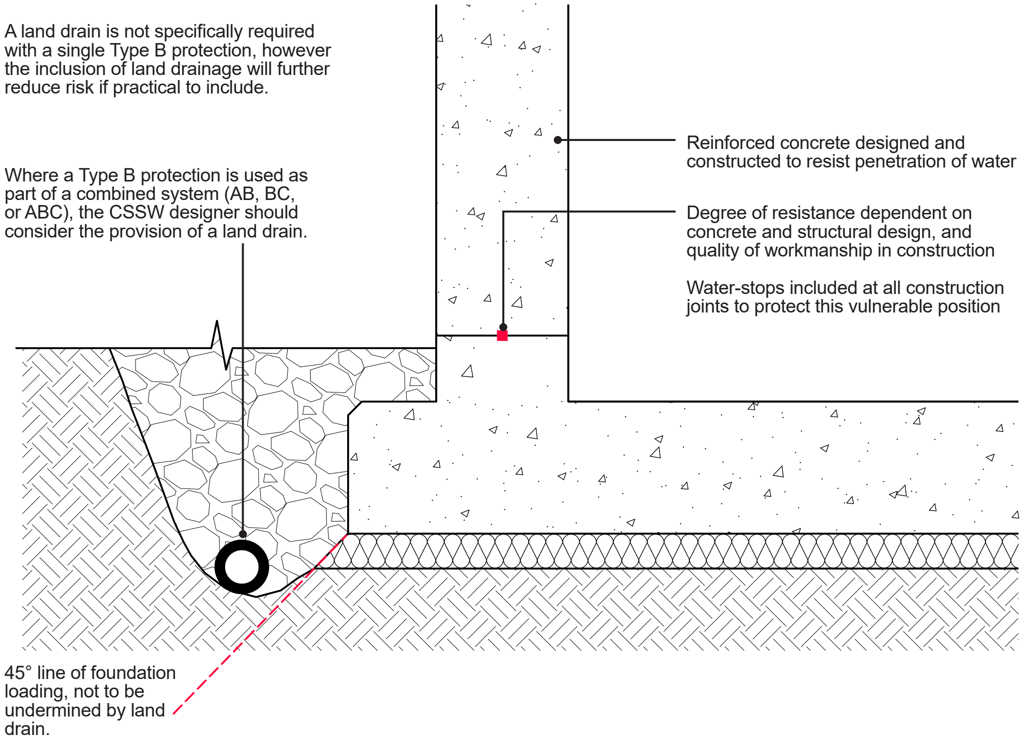
Combined protection

This guidance is for Type B Structurally integral protection.

A combination of BS 8102 waterproofing protection systems may be required to lower the risk, or where the consequences of a system failure are considered great. Combined BS 8102 systems should always be employed where site conditions would result in an unacceptably high risk when employing a single system.

Type B structurally integral protection

Type B Structurally integral protection also relies on the exclusion of water, but employs the structure itself as opposed to fully bonded barrier products. Type B Structurally integral protection is formed using reinforced concrete.



Concrete without additives and including typical levels of steel reinforcement (with cracking <0.3mm); whilst providing good resistance to the penetration of water, is likely to seep under hydrostatic pressure, and as such is not suitable in isolation unless forming basic (non-habitable, non-storage) standards of environment. Further guidance can be found on controlling crack widths in BS EN 1992-3 and CIRIA publication C766: Control of cracking caused by restrained deformation in concrete.

As with any structure that aims to entirely block out water, this must be free of defects which would otherwise allow water to penetrate. In achieving this, the following must be considered:

- Structural design and specification of materials (based in part on-site assessment).
- Water stop detailing at construction joints.
- Service penetration detailing.
- Appropriate specialist site supervision to ensure high standards of workmanship.
- Good placement and compaction.
- Curing.

Particular consideration must be given to the formation of construction joint details, which form a typical weak point in Type B structures. Furthermore, specialist supervision is required on site during construction.

Systems which function by excluding water cannot be tested until ground water pressure comes to bear. Therefore, it may be advantageous where external water pressure does come to bear prior to completion, so that any areas of seepage can be remedied during construction.

Commentary on Type B protection

- With regard to appraisal of repair, this method has a benefit in that; the point of penetration is typically the point of the defect or pathway through which water penetration occurs. Coupled with the impermeable nature of the structure generally, this allows localised repair to be undertaken via resin injection, grouting and associated repair methods.
- The main consideration is locating the point of any penetration, and it is therefore beneficial where reasonable access to the concrete structure remains viable.
- Product guarantees, quality assurance schemes and product certification does not negate the Functional Requirement that a waterproofing design specialist is required to provide a suitable waterproofing design.

Other considerations

Ground gases and contaminants
Aggressive ground conditions may require the inclusion of a suitable ground barrier to protect the structure appropriately. Specialist advice must be sought in respect of dealing with ground gases, and designers are advised to check current standards at the time of construction for suitable guidance.

Existing structures
Waterproofing existing structures differs from new construction, in that designers must work within the confines of the existing structure. However, many of the same considerations apply in that the required standard of environment appropriate to usage must be created and maintained in the long term.

Interface with external wall damp proof courses
Whichever type of water proofing system is deemed appropriate, there must be a continuation provided with the horizontal damp proof courses above ground level. Water proofing materials used must be compatible with the damp proof course components and adequately lapped and bonded.

The waterproofing design specialist should take responsibility for this junction as part of the barrier protection design.

Combined protection

This guidance is for Type C Drained protection.

A combination of BS 8102 waterproofing protection systems may be required to lower the risk, or where the consequences of a system failure are considered great. Combined BS 8102 systems should always be employed where site conditions would result in an unacceptably high risk when employing a single system.

Type C drained protection

Type C – Drained protection system are often referred to as water management systems as they collect and remove any seepage of water occurring through the structure. This method of protection differs from Type A and Type B, which provide barriers to water penetration.

The structure

- The 'structure' provides the primary resistance to the presence of ground water pressure. The Type C drained protection system is designed to mitigate the risk by removing any minor water seepage occurring through the structure and in doing so maintains the required internal environment.
- An assessment of the structure is required to ensure it provides the primary level of water resistance by the waterproofing design specialist.

Internal drainage
The internal drainage system comprises of three elements:

- A drainage channel detail recessed into the floor construction at the perimeter of basement slab with the basement wall.
- A means of water discharge, which in a basement fully below ground, requires a sump pump system or in a sloping site may be through a gravity drain..
- Vapour barrier drainage membranes included above or internal of the drainage system which isolate the internal environment from the damp substrates behind.

Whilst the cavity membrane perimeter drainage channel is intended only to deal with seepage it could discharge to a deeper fixed drains to drain out via gravity. The potential risk of surcharge from blocked external drains is high and therefore the system must be protected by a non-return valve on the drainage outfall. The details of its position and accessibility for maintenance must be provided in the operations and maintenance manual for maintainable systems.

Drained protection systems are reliant on their ability to remove seepage water and so the mechanism by which water is removed requires careful consideration. The extent of seepage water penetration also has a bearing on the capacity required, with the degree of penetration being influenced by the permeability of the structure and the ground water conditions externally.

Notwithstanding the above, the capacity of such systems to remove water must be adequate to deal with a worst-case scenario and should be engineered with this in mind to provide a suitably low-risk system.

- Sump pump systems must include mechanical redundancy (dual mains powered pumps) to protect against pump failure and also sufficient battery back-up protection to protect in the event of a power cut.
- Each pump within a given system should have independent direct spur RCD/power supply so that in the event of an issue with a pump the others will still have power. Direct spur is advised to prevent accidental turning off by homeowners.
- A Commissioning certificate for the pump system should be provided upon completion.
- Drainage systems typically discharge into surface water gullies at external ground floor level, and an overflow detail must be formed at the point of discharge to allow water to spill out externally in the event of drains blocking or surcharging.
- Systems can drain by gravity to low ground externally, i.e. where properties are part retaining and constructed into sloping sites. As with pumped systems, if connecting to mains drains, an overflow detail must be employed to allow water to spill externally in the event of an issue.
- Internal drained protection systems must include drainage channels local to the external wall floor junctions which facilitates maintenance and allows systems to function and protect in the long term. Where larger footprints are involved, cross floor channels must be included, ideally local to construction joints where the structure is more vulnerable to ground water penetration.

Maintenance

Type C Systems must be maintained annually as a minimum. The detail of this requirement must be included in the documentation provided to the homeowner who will then be responsible for ongoing operation and maintenance of the system. The ongoing maintenance should include:

- The service records of the maintenance of the system.
- Accessibility to drainage channels and sumps are available at all times.
- That the drainage channels and sumps are checked at the service intervals to ensure they are clear and free of any free lime build up.
- Ensure that the electrical supply, battery back-up and alarm systems are fully operational at all times.

Free lime

Water moving over and through new concrete walls and floors leaches free lime within the early life of the structure, and suitable treatments should be applied to concrete to minimise this.

- The waterproofing design specialist should provide a specification of the treatments to be used appropriate for the particular construction and made available to the Warranty Surveyor.
- Where basements are formed under existing buildings in conjunction with new under pinning works; the choice of dry packing should be carefully specified and a waterproof expanding type mortar is recommended to help avoid free lime occurrences.
- Substrates should be clean and free of loose or friable materials prior to the application of membrane linings.

General

- Flood testing of a system should be undertaken during construction to check efficiency and that water flows freely to the discharge point. Testing in this manner to prove that the system functions as intended, is a key benefit of this method of waterproofing and must be part of the process.
- Systems creating a habitable space require the inclusion of vapour barrier drainage membranes within the wall and floor construction.
- Where elements of the drained protection system are included within cavities, the cavities must be kept clear of mortar snots and debris.
- Continuity of the structure must be considered because the resistance to water provided by a given structure is reduced by apertures through which water can freely move. Examples could include holes present within existing buildings, or in new construction where land drains are linked to sump pump systems, with the sumps being installed internal of the retaining shell, e.g. in light wells, thus providing a pathway for water to enter.
- Temporary 110v pumps should be included during construction to address water penetration as necessary; 240v systems should be installed and commissioned as soon as viable once the 240v supply is installed.
- Systems must not link directly by gravity to soakaways where any of the previously stated scenarios occur, and because of the danger of back-flow of water through the pipes or water-logging of the local ground above slab/DPM level. However, where such conditions are not present, sump pump systems may be employed to lift water up to ground level externally, discharging into gullies linked to soakaways. This detail should be designed by the Waterproofing Specialist.

Commentary to Type C

In consideration of the repair of defects, the inclusion of drained protection systems internally, generally are recognised systems that can be accessed for system performance and localised repair. However, this may be lessened where systems are sandwiched within the structure, e.g. within cavities.

- Part of the underlying rationale of drained protection is that water is removed continuously, so that it does not collect and removes pressure upon cuspate membrane linings installed over the drainage. If water does not place pressure upon these membranes, then the incidence of any defects within them is generally of no consequence, maintaining the efficiency of the drainage in the longer term.
- Product guarantees, quality assurance schemes and product certification does not negate the Functional Requirement that a Waterproofing Design Specialist is required to provide a suitable waterproofing design.

Other considerations

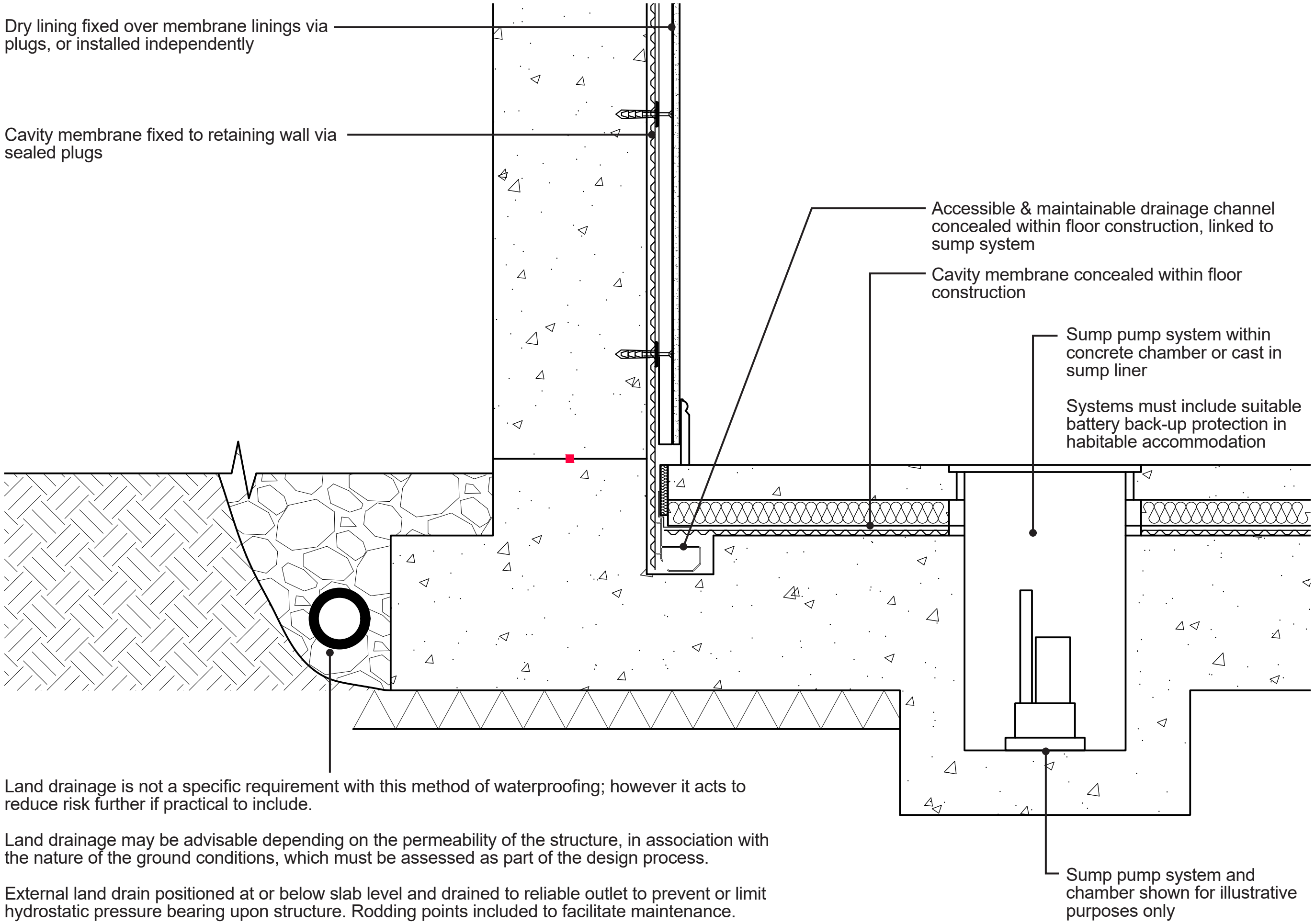
Ground gases and contaminants
Aggressive ground conditions may require the inclusion of a suitable ground barrier to protect the structure appropriately. Specialist advice must be sought in respect of dealing with ground gases, and designers are advised to check current standards at the time of construction for suitable guidance.

Existing structures
Waterproofing existing structures differs from new construction in that designers must work within the confines of the existing structure. However, many of the same considerations apply in that the required standard of environment appropriate to usage must be created and maintained in the long term.

Interface with external wall damp proof courses
Whichever type of protection system is deemed appropriate, there must be a continuation provided with the horizontal damp proof courses above ground level. Waterproofing materials used must be compatible with the damp proof course components and adequately lapped and bonded.

The Waterproofing Design Specialist should take responsibility for this junction as part of the barrier protection design.

Type C drained protection



Land drainage is not a specific requirement with this method of waterproofing; however it acts to reduce risk further if practical to include.

Land drainage may be advisable depending on the permeability of the structure, in association with the nature of the ground conditions, which must be assessed as part of the design process.

External land drain positioned at or below slab level and drained to reliable outlet to prevent or limit hydrostatic pressure bearing upon structure. Rodding points included to facilitate maintenance.

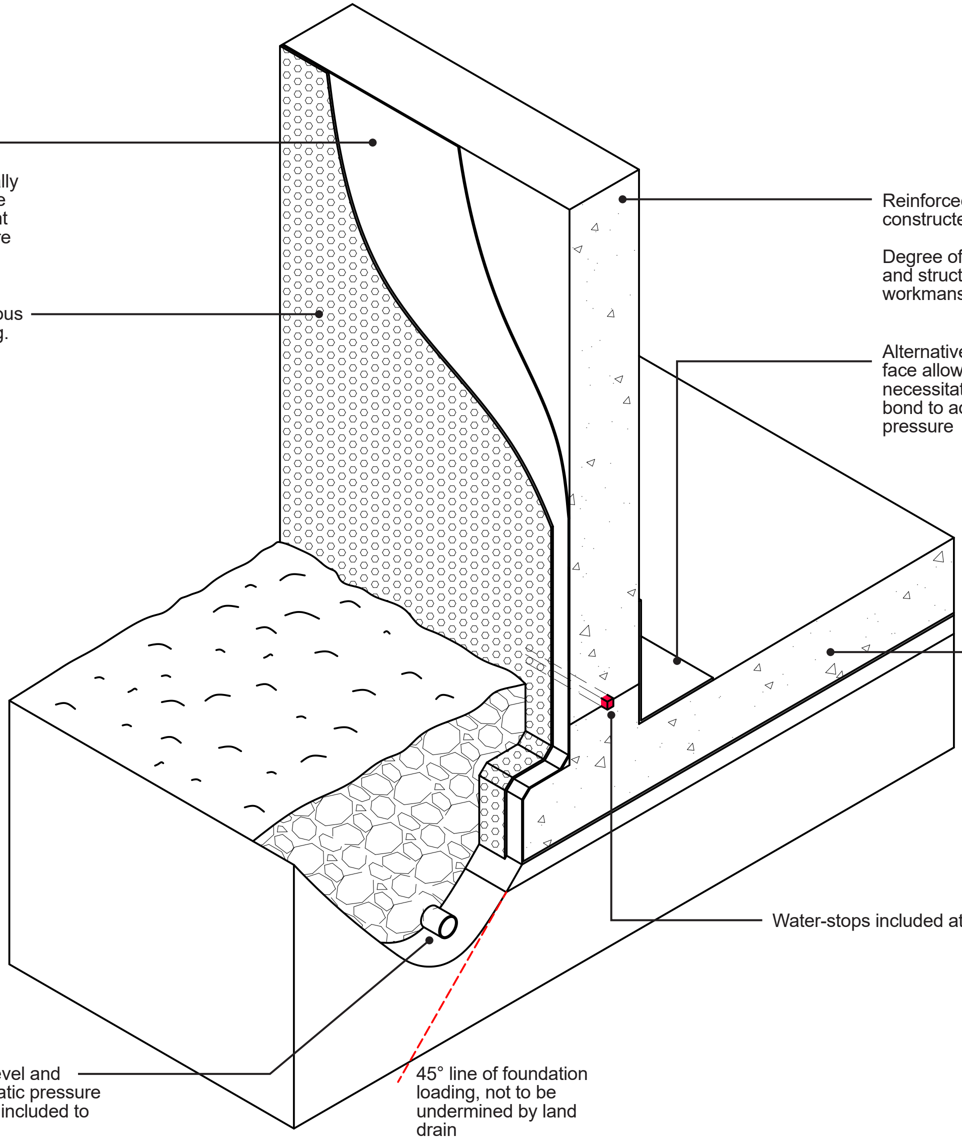
Land drain positioned at the side of the slab remains below the level of internal slab membrane.

WATERPROOF PROTECTION SYSTEMS: Typical example of a combined system - Type A+B

Externally applied tanking barrier.

Installation of external tanking, which typically precludes access for repair,necessitates the inclusion of reliable land drainage to prevent build up of hydrostatic groundwater pressure and potential penetration

Geo-drainage membrane provides continuous drainage space against the external tanking. Appropriate protection must be included to protect during backfilling



Reinforced concrete designed and constructed to resist penetration of water

Degree of resistance dependent on concrete and structural design, and quality of workmanship in construction

Alternatively, tanking applied to the internal face allows greater access for repair but necessitates formation of a suitably strong bond to adequately resist potential hydrostatic pressure

Type A assumes no or limited resistance to penetration provided by structure,however risk is reduced where employing structures with greater or total water resistance (combined protection)

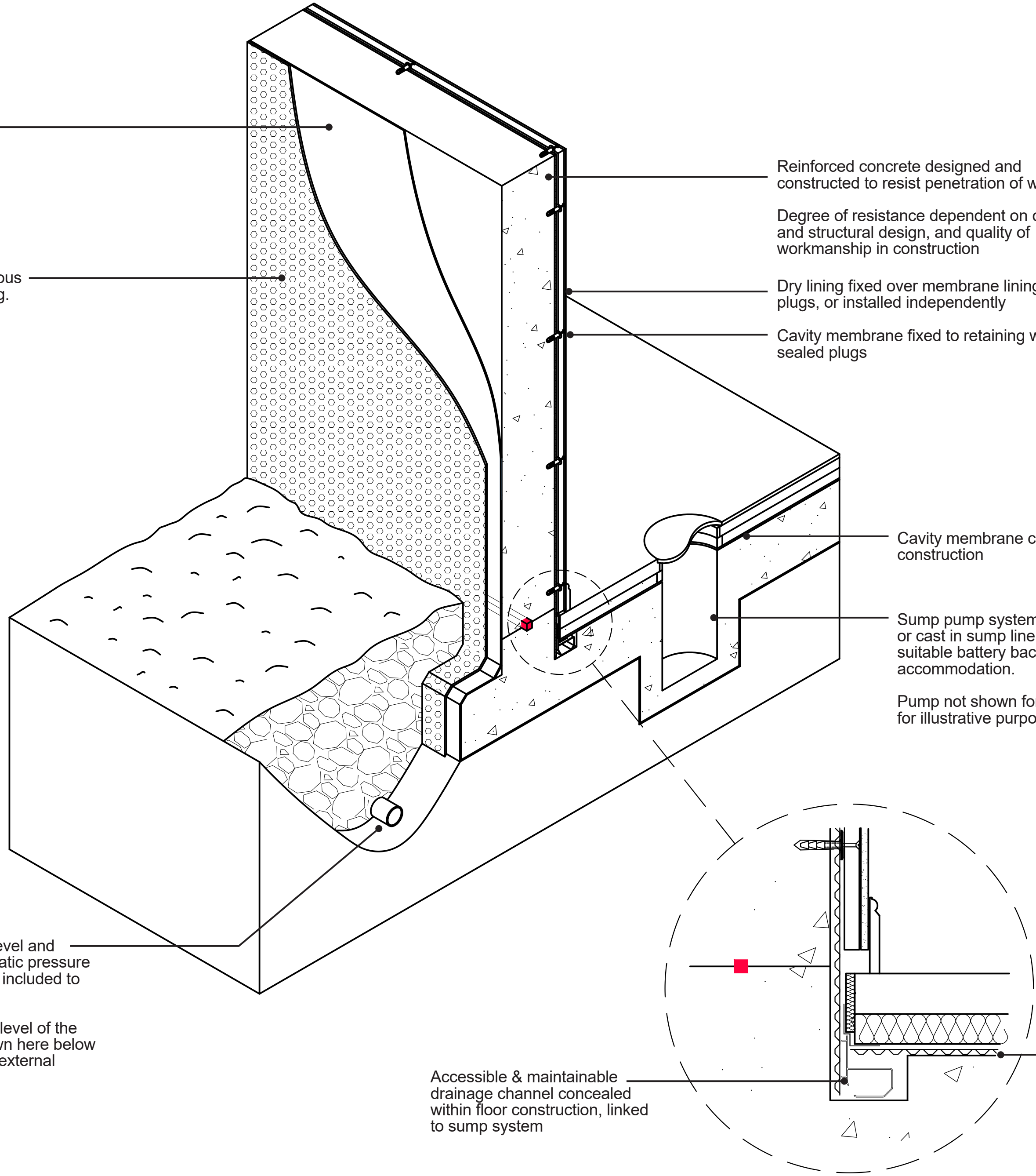
Water-stops included at all construction joints

External land drain positioned below slab level and drained to reliable outlet to prevent hydrostatic pressure bearing upon the structure. Rodding points included to facilitate maintenance.

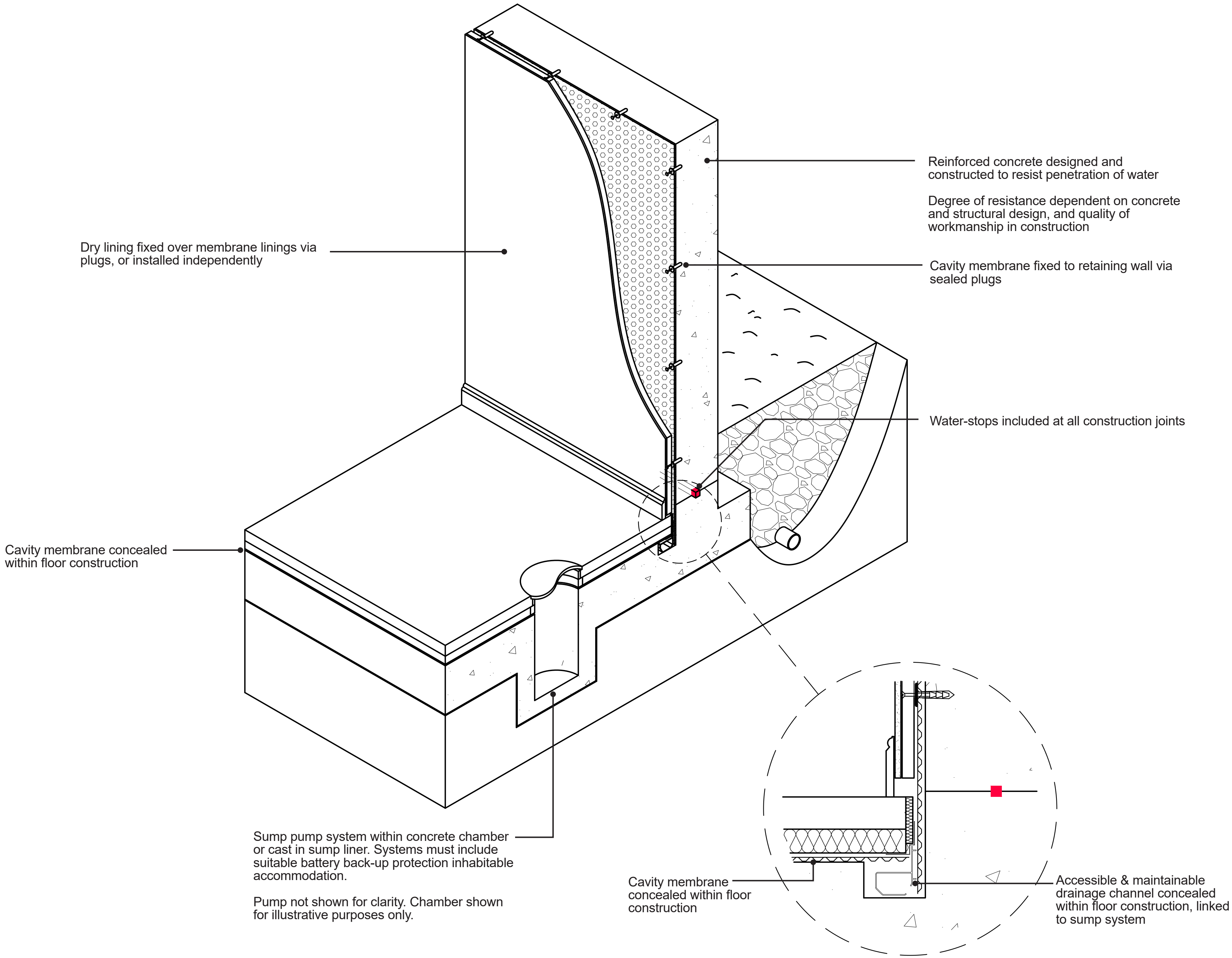
Land drain should be positioned below the level of the horizontal waterproofing and hence is shown here below slab level, this being below the level of the external horizontal tanking barrier.

45° line of foundation loading, not to be undermined by land drain

WATERPROOF PROTECTION SYSTEMS: Typical example of a combined system - Type A+C



WATERPROOF PROTECTION SYSTEMS: Typical example of a combined system - Type B+C



3. Foundations

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. Ground improvement schemes should be appropriately tested to confirm that the completed works meet design specifications. The testing regime must be agreed with the Warranty Surveyor prior to commencement of work (applicable to: 'Engineered Fill' and 'Vibratory Ground Improvement' only).
2. The Developer shall ensure that adequate quality control procedures are in place. The quality control and testing must identify that site work meets the design intention. All procedures should be auditable and available for inspection (applicable to: 'Engineered Fill' and 'Vibratory Ground Improvement' only).
3. Foundations should be of a suitable depth in order to achieve a satisfactory level of performance.
4. Excavations for foundations shall be accurate in line, width and depth, and suitable for the type of foundation which form the basis of the design.
5. All work is to be carried out by a technically competent person in a workmanlike manner.
6. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.
7. Pile foundation schemes must be tested to confirm that the installation meets the design requirements.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. A site investigation report should be completed at an appropriate level for the risk in accordance with the relevant British Standard.
2. A detailed design by an appropriately qualified person should be supplied and provide the following information (applicable to: 'Engineered Fill' and 'Vibratory Ground Improvement' only):
    a. Depth of original soil types below the structure.
    b. Details of any filled ground and its suitability to accept ground improvements techniques.
    c. Gas generation or spontaneous combustion from ground conditions.

   The investigation must be endorsed by the Specialist Foundations Contractor.
3. The foundation type and depth must be suitable to resist movement due to the influence of nearby trees.
4. Piled foundation designs must be supported by structural calculations provided by an Engineer. Calculations for full piling systems must be provided by, or endorsed by, the piling specialist.
5. Raft foundation designs must be supported by structural calculations provided by an Engineer.
6. Evidence must be provided to demonstrate the foundation design meets the requirements of Building Regulations.
7. The design and specification shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
8. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.

3.
Foundations

3.1
Mass Fill and Strip

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Site investigation report appropriate for the site specific conditions (please note, a minimum phase one desktop study is required in all circumstances).
2. Where the ground is contaminated a full design package including details of all materials to be used along with a remediation report will be required.
3. Full set of detailed drawings including:
   a) Foundation layouts.
   b) Section drawings showing depth and width of foundations.
   c) Layout drawings showing position of trees in proximity to any foundations.
   d) Location of any services in close proximity to the foundations.
   e) Details of movement joints, junctions or steps in the foundations.
   f) Details of heave precaution requirements.
4. Full set of structural calculations and drawings.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Limitations of guidance

The following situations are not covered by this guidance:

- Mass filled foundations and strip foundations for buildings other than dwellings.
- Buildings greater than three storeys.
- Foundations on filled ground.
- Mass fill foundations and strip foundations where foundation depths exceed 2.5m.

Design

Mass filled and strip foundations shall be designed to ensure that the building is appropriately supported at all times without excessive settlement. This foundation type should only bear onto original ground, where it does not, the foundation should be designed by a Structural Engineer and appropriately reinforced. It is therefore important that site conditions are appropriately assessed prior to the building design. Please see the ‘Ground Conditions’ section.

For ‘low rise structures’, the foundations should be designed to ensure a maximum settlement of 25mm is not exceeded.

In relation to differential settlements, a design limit for maximum tilt of 1/500 is appropriate for the load case, 100% Dead load plus 30% superimposed live load. Where it is clear 100% superimposed live loads will occur for long periods of time, differential settlement checks shall be carried out for 100% Dead and 100% superimposed live load. More stringent values may be required due to the particular circumstances (e.g. medium and high rise structures).

Influence of trees in clay

Foundation design should take into account influence from nearby trees. Where construction is to take place in cohesive soils and trees are/were/will be present:

For mass fill foundations:

- If the foundation depth is greater than 1.5m, then heave protection will be required.
- Where foundation depths exceed 2m, short bored piles with ground beams or piled rafts slabs are recommended. All pile designs should be undertaken by an Engineer.
- Foundation depths required to exceed 2.5m are beyond the scope of the online foundation depth calculator and must be a piled engineered solution.

For strip foundations:

- Where construction is to take place in cohesive soils and trees are/were/will be present, and the foundation depth is required (using the online foundation depth calculator) to exceed 1.5m, heave protection will be necessary and strip foundations will not be suitable. Mass fill or short bored piles should be adopted (see the ‘Foundations - Mass Fill’ and ‘Foundations - Piles’ guidance).

Further guidance can be found in the ‘Foundations - Trees and Clay’ section.

Minimum foundation dimensions

- Mass fill and strip foundations should be of a 600mm minimum width for external walls and must take loadings and ground conditions into account. For widths that are less than 600mm for the external wall, an engineer design must be provided.
- For single leaf internal walls up to 150mm thick, foundations may be reduced in width to 450mm ensuring that a 150mm projection either side of the internal wall is provided.
- The minimum thickness of strip foundations should be 150mm.
- Foundations should be situated centrally below the wall.

Foundation depths

The depth of all foundations should be determined by specific site conditions. All foundations must bear onto virgin stable subsoil and, except where strip foundations are founded on rock. The foundations should have a minimum depth of 450mm, measured from finished ground level to their underside, to avoid the action of frost. This depth however, will commonly need to be increased in areas subject to long periods of frost or in order that loads are transferred to suitable ground.

Where trees are situated close to a proposed building founded on a clay soil, the foundation depth/design will be affected; further guidance is available in the ‘Foundations - Trees and Clay’ section. In clay soils with a plasticity index greater than or equal to 10%, foundations should be taken to a depth where anticipated ground movement will not impair the stability of any part of the building, taking into account the influence of vegetation and trees on or adjacent to the site. The depth to the underside of foundations on clay soils should not be less than 750mm, as measured from finished ground level, and depths may need to be increased in order that loads are transferred to suitable ground.

For minimum depths of foundations in cohesive soils where trees are/were/will be present, please use the online foundation depth calculator. Further guidance can be found in the ‘Foundations - Trees and Clay’ section.

Minimum foundation depths

Modified plasticity index (x)	Volume change potential	Minimum foundation depth (m)
40% and greater	High	1.00
20% to less than 40%	Medium	0.9*
10% to less than 20%	Low	0.75*
Note: *If the modified plasticity index is not confirmed, the minimum foundation depths should be 1m.		

The Plasticity Index may be used without modification; for soils comprising of pure clays, with 100% of particles less than 425µm, the Plasticity and Modified Plasticity Indexes will be the same. The adoption of the Modified Plasticity Index in mixed soils, such as glacial till, however, may result in a more economical design.

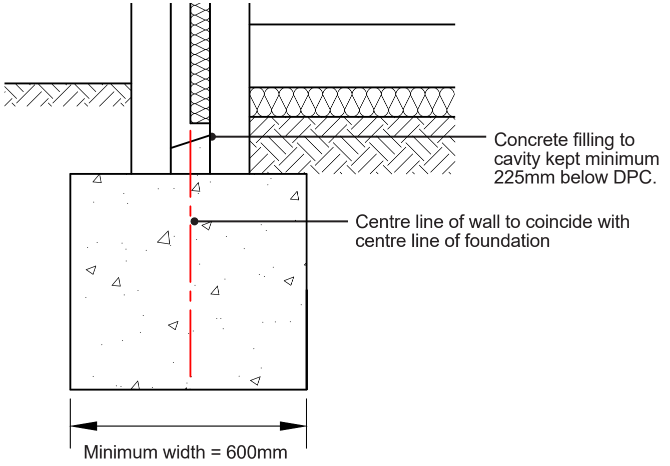
Flexible and rigid retaining walls

Flexible retaining walls
For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls should not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

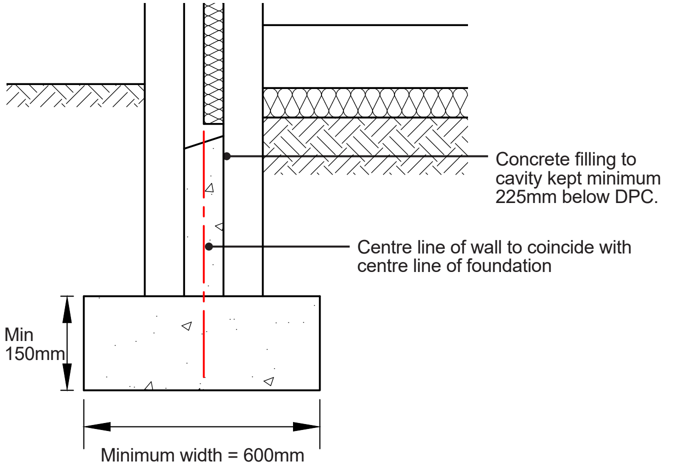
Rigid retaining walls
Where rigid retaining walls are specified which support the foundations of a building, an Engineers design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

Typical mass filled foundation



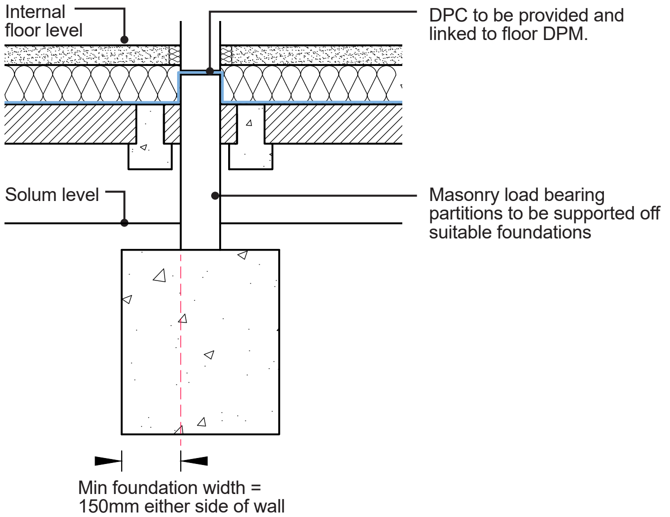
Depth of foundation (below ground level) to be taken to:
- Suitable virgin sub-soil.
- A depth that gives sufficient bearing and protection from frost.
- When building on cohesive soils, is at a depth that is not under potential influence of nearby trees.
- Below the invert level of any adjacent drain/sewer.

Typical strip foundation



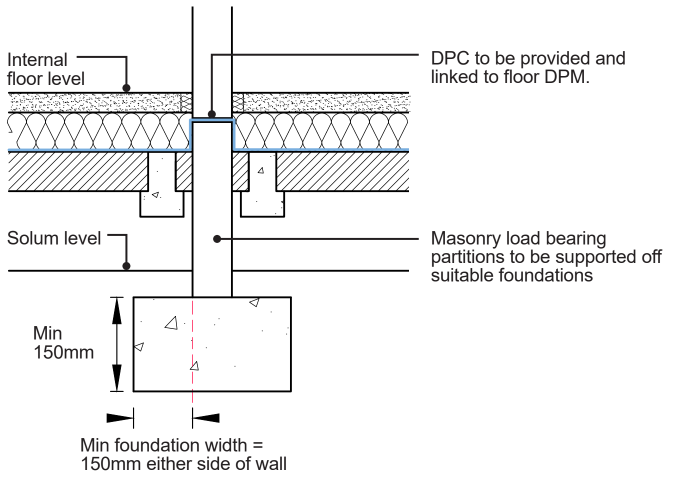
Depth of foundation (below ground level) to be taken to:
- Suitable virgin sub-soil.
- A depth that gives sufficient bearing and protection from frost.
- When building on cohesive soils, is at a depth that is not under potential influence of nearby trees.
- Below the invert level of any adjacent drain/sewer

Internal wall foundation (mass fill)



- Foundation to be centrally located under the wall.
- The foundation width should be in accordance with the relevant Building Regulations.

Internal wall foundation (strip)

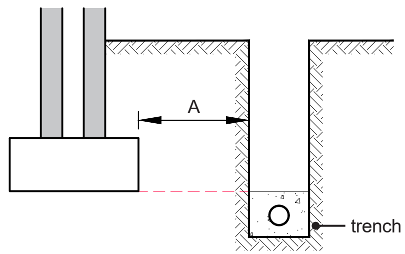


- Foundation to be centrally located under the wall.
- Width of strip foundation to ensure a 150mm minimum projection either side of the wall is provided.
- The thickness of the strip foundation should be at least 150mm.

Protecting pipes adjacent to foundations

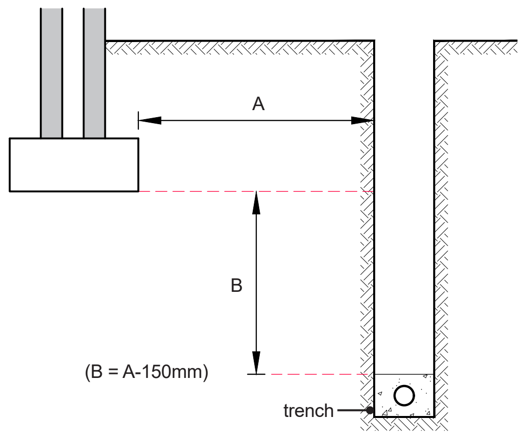
Where it is not physically practical to locate drains so they are not impacted by foundation loads, the pipes should be protected. Examples of how the pipes may be protected are given below:

Scenario 1 - where A is less than 1m



Where the trench is within 1m of the foundation, the trench is to be filled with concrete up to the lowest level of the foundation.

Scenario 2 - where A is 1m or greater



Where the trench is 1m or further from the foundation, the trench is to be filled with concrete up to measurement B as shown above.

Mass fill and strip foundations must be:

- Constructed to a depth which will not be affected by nearby drainage or other services.
- Any drain or service pipe must not pass through the base of the foundation. Where such services are at the same level, the base of the foundation must be stepped below and the drain/services sleeved through the substructure wall above.
- Existing ground water drains should be diverted to a suitable outfall.

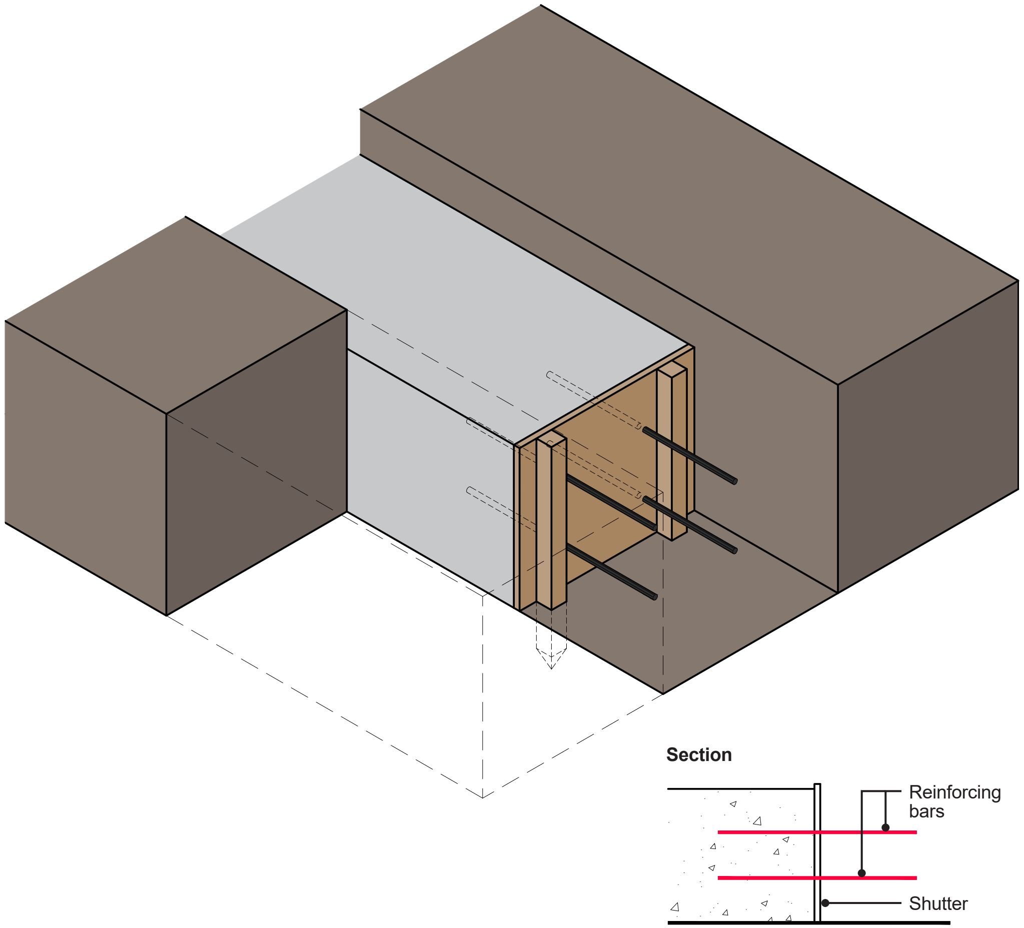
Reinforcing

Mass fill and strip foundations should be reinforced where necessary to suit localised ground conditions. Reinforcement, if needed, should be clean and free from loose rust and should also be placed correctly. Bars, of an appropriate size, should be supported to guarantee that they are 75mm above the base of the foundation, or as indicated in the design. They should be secured at laps and crossings. If in doubt about any soft spots, the Engineer's advice should be taken prior to placing the concrete.

Foundation joints

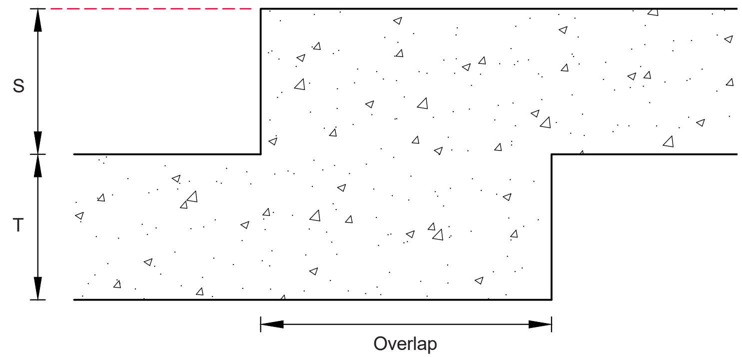
If construction joints are necessary, they should not be positioned within 2m of a corner or junction in the foundation. All shuttering should be removed before work progresses beyond the construction joint.

Using reinforcement bars across a joint



Steps in foundations

Steps in foundations must not be of a greater dimension than the thickness of the foundation. Where foundations are stepped (on elevation), they should overlap by twice the height of the step, or 1m whichever is the largest.



Mass foundations:
The overlap should not be less than:
- 2 x S, or
- 1m

whichever is the largest.

Strip foundations:
The overlap should not be less than:
- 2 x S, or
- T (max 500mm), or
- 300mm,

whichever is the largest

Excavation

- Excavations should be to a depth that gives sufficient bearing and protection from frost damage.
- To avoid damage caused by frost, the depth of the foundation(s) in frost-susceptible ground should be at a minimum of 450mm below ground level. If the finished ground level will be above the existing ground level then, the foundation depth should be calculated from the existing, not finished, ground level.
- Where the depth of mass fill or strip foundations is in excess of 2.5m, they must be designed by a Chartered Structural Engineer in accordance with current British Standards and Codes of Practice. For trench fill, it is imperative to check that the finished foundation level is correct and horizontal. It will be difficult to adjust for discrepancies in the small number of brick courses between foundation and DPC level.
- Prior to concreting, excavations should be 'bottomed out' to remove any debris that may have fallen into the trench; the excavations should be free from water, and if it has been left open for a long period of time, further excavation may be required to a non-weathered strata.

Note: It is important that Health and Safety obligations are met and that excavations are appropriately supported to prevent collapse.

Setting out foundations

The accuracy of setting out foundations should be checked by set controlled trench measurements, including their location relative to site borders and neighbouring buildings. Levels should be checked against benchmarks, where appropriate. In particular, for excavations check:

- Trench widths
- Trench lengths
- Length of diagonals between external corners

Walls should be located centrally upon the foundation, unless specifically designed otherwise. Any discrepancy in dimensions should be reported promptly to the designer. Resulting variations should be distributed to all concerned with site works, including the Warranty Surveyor.

Standards referred to:

- BS 8004 Code of Practice for foundations and Eurocode
- BS 5950-1 Structural use of steelwork in buildings and Eurocode
- BS 6399 Loadings for buildings and Eurocode
- BS 8103 Structural design of low rise buildings and Eurocode
- BS 8110 Structural use of concrete and Eurocode

3.

Foundations

3.2

Piles

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

To be submitted prior to commencement on site
1. Desk study, investigative and interpretive Site Investigation Report(s) (to at least 5m below the pile toe) with associated geotechnical testing sufficient for pile design including DS / ACEC requirements for buried concrete, heave and shrinkage.
2. Foundation drawings, pile layouts and pile schedule (with pile reference numbers and loadings).
3. Engineer's specification for piling works to include the allowable pile settlements and testing requirements.
4. Calculations for the substructure and for the derivation of the load on each pile.
5. Pile design calculation (for vertical, horizontal, tensile and heave forces) to geotechnical parameters in site investigation report. This should include the pile designer's written confirmation that the site investigation is adequate to ensure that the pile design complies with British Standards. This should also include confirmation, justification, type and number of any preliminary and/or working pile load tests required to satisfy the design.

To be submitted prior to construction continuing over the piles
6. Pile installation logs (with pile numbers cross-referenced to the pile layout drawing), including details of re-strikes, rock sockets, rig telemetry records, and concrete volume.
7. Concrete mix details and cube test results for the concrete used in the piles with tabulated results.
8. Integrity testing of all concrete piles with interpretive summary and conclusion.
9. Dynamic load testing results with analysis of long-term settlement, interpretive summary, and conclusion. The correlating static load test for each differing length, load and diameter must be included (and the relevant boreholes if the static testing was undertaken at a different site).
10. Static load test results.
11. Pile Designers interpretive summary and conclusion on completion of the works.

Please note: In the absence of approval, works are proceeding at the Developer's own risk.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Piled foundations

Piles are used to transfer loads from buildings to the supporting ground and are utilised in a wide range of applications where conventional strip footings are inappropriate. They are particularly employed where soft or loose soils overlay strong soils or rocks at depths that can be reached conveniently by driving or boring. They are often the most economical type of foundation when very heavy loads must be supported or uplift forces need to be resisted. Large piles are extremely useful for limiting the settlements of large structures on deep stiff clays; smaller versions can provide appropriate foundations for houses and other small buildings on stiff clays liable to shrinkage and swelling.

Limitations of guidance

The following situations are beyond the scope of this guidance.
- Innovative foundation systems that do not have third-party approval or accreditation.
- Piling systems where the structural design is not endorsed by the Specialist Piling Contractor.

Influence of trees in clay

Foundation design should take into account influence from nearby trees. Where construction is to take place in cohesive soils and trees are/were/will be present:
- Suitable heave precautions should be included in the design details for the protection of the piles, and
- Ground beams or piled raft slabs.
- The piles must be deep enough to cater for heave.

For more information on this, please see the 'Foundations - Trees and Clay' section.

Pile classification

Piles of many different types and methods of installation have been developed to suit the wide variety of soils. Piles generally fall into two main types:
- Bored and dug, including short bored and secant (replacement piles).
- Driven and jacked piles, steel, concrete and timber (displacement piles).

How piling systems work

There are two groupings of piles, based on the way that they transfer loads to the ground:
- End bearing piles derive the greater part of their support from bearing forces at the base. They act largely as columns transferring loads through soft deposits, usually to dense granular soil or rock at the foot of the pile.
- Friction piles on the other hand, develop most of their support from friction between the shaft and the soil, usually firm clay.

Choosing the right piled solution

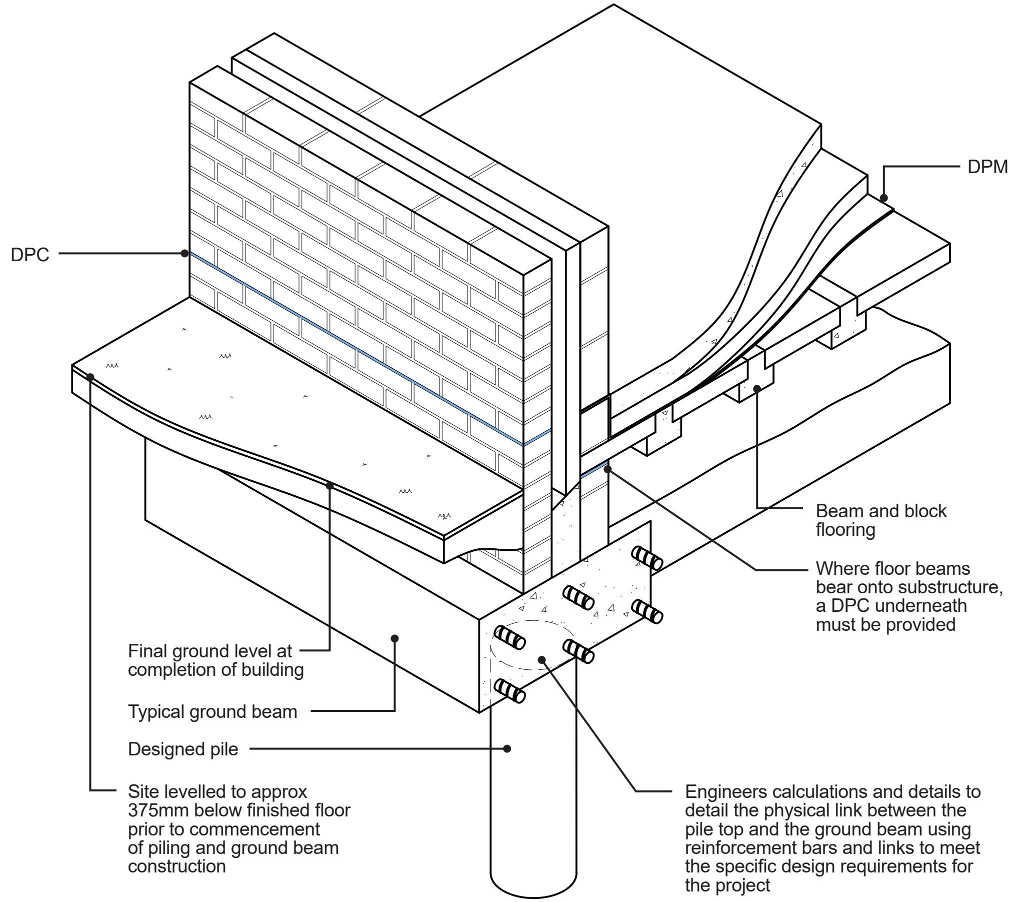
The choice of piling system to support the structure will depend entirely upon the ground conditions. It is important to have the appropriate site investigation works carried out to determine depths of filled ground, the bearing capacity of soils, soil type and any existing workings or services that may clash with pile locations.

Note: For further guidance on ground condition assessments, please refer to the 'Ground Conditions' section.

Analysis of the site investigation report should be completed by a Specialist Piling Contractor and Structural Engineer, as they are best placed to design the most economical piling system.

Piles are particularly appropriate for heave sites (trees removed), for which they are strongly recommended.

Pile layouts can be readily designed to accommodate an individual plot. A good design will seek to achieve cost savings in foundation excavation and materials.



Alignment of piles

The Piling Contractor should take care to ensure that the piles are installed vertically and pile tops are correctly aligned to support the foundation system.

An acceptable level of tolerance is for a pile to be offset in plan from the theoretical position by no more than 75mm, with vertical alignment no worse than 1m in every 75m (1:75).

Ground beams/piled raft slabs

Piles should be capped with an appropriate ground beam system or slab. There should be adequate connections between the beam or slab to the pile to ensure that the loads are transmitted effectively. The beam/slab should be adequately anchored to the pile to resist uplift on sites that are susceptible to heave. All external, internal, partition and party walls can be accommodated using this system. The foundation design should be supported by structural calculations provided by an Engineer or Specialist sub-contractor.

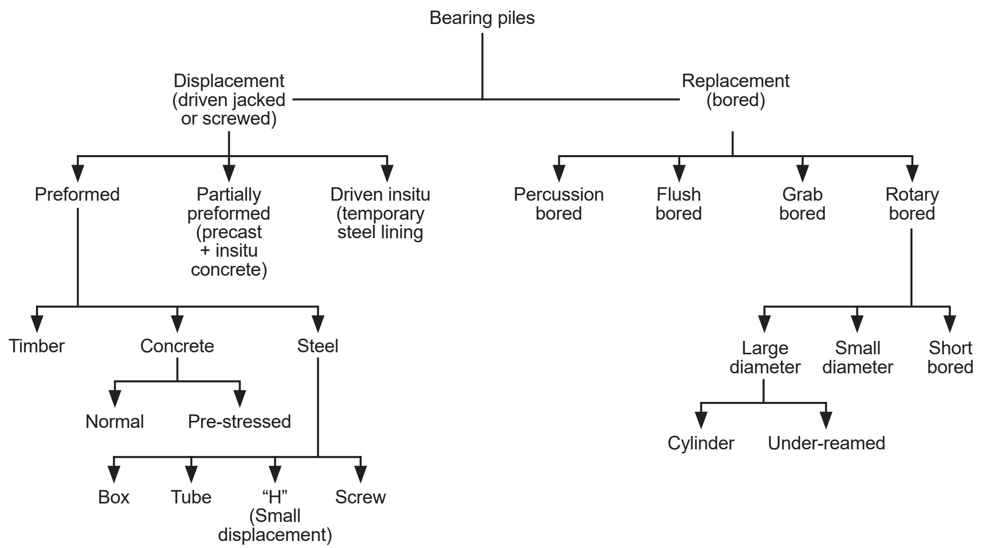
Pile construction records

Pile construction records should be made available for all piles installed. The records should include the following information:

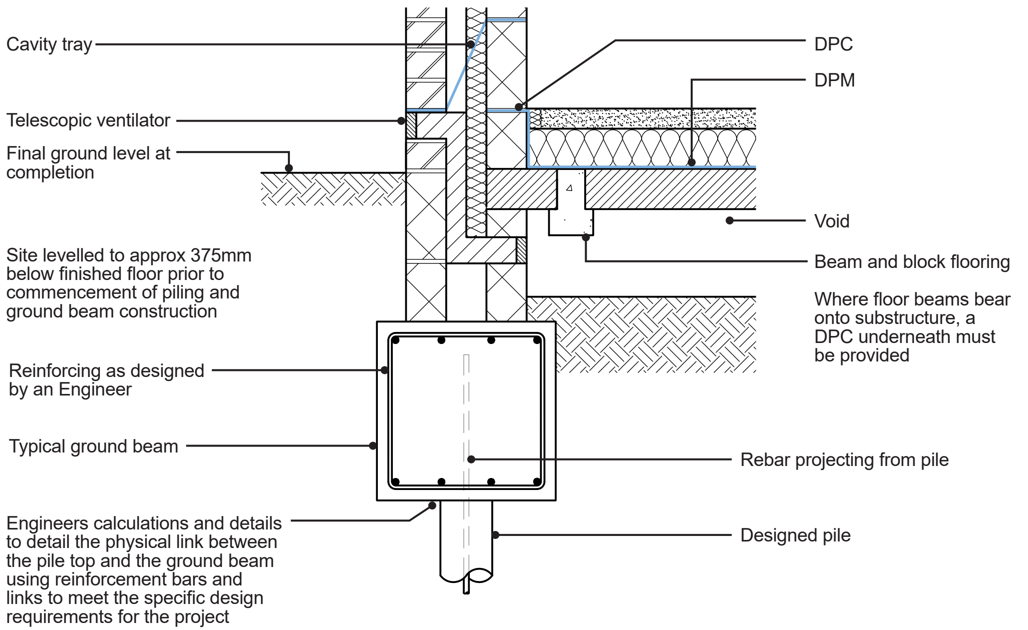
- Pile type (driven steel tube, driven precast concrete, Continuous Flight Auger (CFA), open hole auger bored, etc.).
- Pile dimensions (diameter or width/breadth).
- Pile depth.
- Driving records from driven piles, including hammer type, weight, drop height, sets, hammer efficiency.
- Up to date pile driving hammer energy efficiency test certificate.
- Pile verticality confirmation, which should be no more than 1:75 from vertical.
- 28 day concrete test cube results for cast insitu piles.
- Concrete mix design certificates for piling concrete from all suppliers – where piles are cast insitu.

For CFA and concrete screw piles, the Warranty Surveyor should be given the computer output for concrete volume and rig performance.

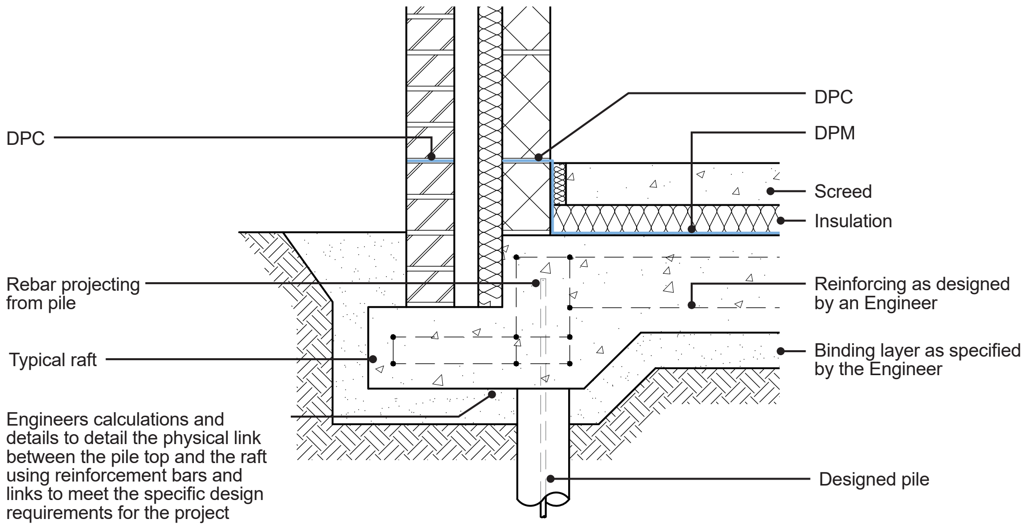
The range of piling types (BRE publication)



Pile and beam



Piled raft



Key requirements

The piling scheme shall be designed to clearly demonstrate that the piles are capable of supporting and transferring the foundation design loads safely to known soil strata that are, in turn, capable of supporting the pile loads using the appropriate soil parameters obtained from geotechnical testing and contained in the appropriate site investigation report. The piles shall be designed in accordance with BS 8004:2015 and shall ensure that long term settlement does not exceed 10mm or 1:500 (differential, between adjacent piles) at working load and 15mm at 1.5 times working load, unless more stringent criteria are required by the Engineer.

Pile installation record sheets shall show clearly that all piles installed have achieved sufficient depth with respect to the pile design calculations. Where there is any doubt concerning the depth of the piles, as a result of any encountered voids or boulders, or there is any other reason to suspect under-performance, the capacity of the questionable piles shall be demonstrated by means of static load testing and it shall be confirmed by the Engineer that the piles are fit for purpose.

Reference documents

- BS EN 1997-1 Eurocode 7: Geotechnical design (EC7)
- BS 8004 - Code of practice for foundations
- BS EN 1997-2 - Ground investigation and testing
- BS 5930 - Code of practice for ground investigations
- ICE Specification for piling and embedded retaining walls (3rd edition)
- London district surveyors association (LDSA) - Guidance notes for the design of straight shafted bored piles in London clay
- PERKO, H.A. Helical piles – a practical guide to design and installation. Hobokon, New Jersey: John Wiley, 2009, ISBN 978 0 470 40479 9
- BS EN 1993-5: Eurocode 3: Design of Steel Structures – Part 5: Piling

Geotechnical site investigation

A detailed, site specific, interpretive, Phase 2 Geotechnical Site Investigation should take place and be in accordance with BS 5930 / BS EN1997-2 and extend to depths beneath the pile toe of at least 3 x pile diameter or 5m or the smallest plan dimension encompassing the pile group (whichever is the greatest). Refer to ‘Published Minimum Requirements for Site Investigation’ by the Federation of Piling Specialists (July 2013). Generally, boreholes should be at centres of 10m to 30m for structures and at a minimum of 3 points, but closer borehole spacing’s should be used where there are site-specific hazards (e.g. soluble soils, mining features etc.) or where there are large variations in soil properties.

The investigation should include sufficient geotechnical testing throughout the length and beneath the pile to enable an accurate geotechnical design of the pile in accordance with proven design methods.

If the Site Investigation is found to contain insufficient information to verify the proposed design of the piles, the pile designer should request additional investigation and testing e.g. additional boreholes to the above depth, as considered necessary to establish the required geotechnical parameters.

Pile design

A pile layout drawing and pile load schedule should be prepared by the Engineer, indicating the pile reference numbers, all loadings to which each pile will be subjected and details of connections between piles and the substructure. Calculations should clearly demonstrate how the load on each pile was derived.

The piles shall be designed in accordance with BS8004/BSEN1997-1 and shall ensure that long term settlement does not exceed 10mm or 1:500 (differential, between adjacent piles) at working load and 15mm at 1.5 times working load, unless more stringent criteria are required by the Engineer.

In all cases, a geotechnical and structural design should be carried out to current standards in order to produce a Geotechnical Design Report to confirm the required pile length, reinforcement etc. and to reflect the ground conditions as confirmed by the site specific Site Investigation Report. The pile design should prove that the pile can support all compressive, horizontal, tensile, heave and negative skin friction forces.

The skin friction adhesion factor (α) should be in accordance with BS 8004 (clause 6.4.1.2.3). An adhesion factor greater than 0.5 will not be acceptable unless supported by maintained static load tests on 1% of working piles.

BS 8004 (clause 6.1.1) and BS EN1997-1 (clause 7.4.1) permits pile design to be carried out one of the following options:

1. Geotechnical/Static pile design based on soil parameters from the site investigation and appropriate safety factors.
2. The results of dynamic load tests (provided they have been verified by static load tests in comparable situations).
3. Pile driving formula (provided they have been verified by static tests in comparable situations).

If the results of appropriate static load testing are not available for the site, then only option 1 can be used as the basis of design. In this case, all driven piles should be installed to the lengths indicated in the static pile design calculation and representative dynamic tests with settlement analysis (e.g. CAPWAP) carried out (typically 3% to 5% per static pile design), but this may need to be increased if there are any concerns regarding the pile installation or if required by the Engineer.

However, if the piles cannot be driven to the lengths indicated in the static pile design (as is often the case), then reliance switches to dynamic tests and/or dynamic formulae, both of which need to be verified by previous evidence of acceptable performance in static load tests on the same type of pile, of similar length and cross section and in similar ground conditions (the static load tests don’t necessarily need to have been carried out on the particular site), as required by BS 8004:2015.

A pile schedule should be produced indicating the pile numbers (referenced to the drawings), pile loads, pile type and diameter, pile length, required rock socket length, and details of required reinforcement. Piles for new developments should be not less than 150mm diameter or equivalent.

Alternative pile types and design methods

If alternative pile types or non-standard design methods are being considered, please contact the Warranty Surveyor prior to commencement of piling.

Additional design requirements for helical (screw) piles

Helical (or Screw) piles are manufactured steel foundations that are rotated into the ground to support structures. The basic components of a helical pile include the lead, extensions, helical bearing plates, and pile cap.

The following design requirements should also be considered for helical (screw) piles:
- Helical piles should be designed and installed in accordance with BS 8004:2015+A1:2020 Annex A and ICE Specification for Piling and Embedded Retaining Walls (SPERW).
- The helical pile designer/supplier should demonstrate clearly in calculations which design method has adopted i.e. plugged shaft or individual plate method. Adopted soil parameters shall be derived from an adequate site investigation.
- Tension piles shall also include a soil wedge check.
- Shaft resistance shall be ignored when deriving the pile design resistance.
- Building near trees. Shaft adhesion in the zone of tree influence shall be calculated. Sufficient tension capacity should be provided to resist heave forces. No helix shall be installed in the heave zone.
- A structural design of all component’s including helix, helix welds, connections to the ground beams/foundation system etc. shall be provided.
- The helix should be spaced at a minimum of 1.5 times the shaft diameter.
- Helix diameters shall be no greater than those above.
- Corrosion protection. A 60 year design life based on section loss shall be demonstrated. Cathodic protection, galvanise or other coating will not be acceptable.
- The GA/Fabrication drawings and schedules for the piles/pile components shall be provided and identify the steel grade (Minimum J0), helix numbers and setting out as a minimum.

Pile design factor of safety for all Piles construction

The factor of safety is dependent on the extent of site investigation, design method/code/standard, confidence in the design, the proposed pile load testing regime, and should be in accordance with design method being used.

Additional pile design factor of safety (geotechnical) for helical (screw) piles
Design Factors of safety shall be based on Eurocode design (BS EN 1997-1:2004+A1:2013). Resistance factors shall be based on R4 values for a driven pile as per Table A.NA.6.

Lateral load capacity and displacement shall be based on industry-accepted methods in line with cl.6.4.5 of BS 8004:2015 including elasticity theory, p-y curves, subgrade reaction models, or any other approved numerical models.

Flexible and rigid retaining walls

Flexible retaining walls
For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls should not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

Rigid retaining walls
Where rigid retaining walls are specified which support the foundations of a building, an Engineers design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

BS EN 1997-1 Partial factors depending upon load testing undertaken (for bored or continuous flight auger piles)

Direction of load	Load tests	Partial factor for shaft resistance	Partial factor for base resistance	Model factor
Compression	None	1.6	2.0	1.4
	WPT only	1.4	1.7	1.4
	PPT and WPT	1.4	1.7	1.2
Tension	None	2.0	-	1.4

BSEN1997-1 Partial Factors depending upon load testing undertaken (for driven piles)

Direction of load	Load tests	Partial factor for shaft resistance	Partial factor for base resistance	Model factor
Compression	None	1.5	1.7	1.4
	WPT only	1.3	1.5	1.4
	PPT and WPT	1.3	1.5	1.2
Tension	None	2.0	-	1.4

WPT: Working Pile Test.
PPT: Preliminary Pile Test.
Refer to BSEN1997-1 for full tables and commentary.

Note: It is not acceptable to adopt a higher factor of safety in place of an adequately detailed Site Investigation.

The guidelines contained in LDSA guidance should be used for the design of straight shafted bored piles in London clay.

Piling in rock/boulders

If rock sockets are required by the pile design, then the achievement of such sockets during pile installation should be demonstrated. Where there are boulders, it needs to be demonstrated that piles are not founded on, or partly on, boulders. It is advisable to ensure that piles are taken down through strata containing cobbles/boulders. Pre-drilling may be required.

“Rig refusal” will not be accepted in the event that design rock socket lengths are not achieved, In the event of this, static load testing and additional site investigation and geotechnical testing will be required.

Piling in chalk

Reference should be made to CIRIA PR86 and CIRIA C574 for pile design and installation. Where the risk of solution features as obtained from a Groundsure or Envirocheck hazard map is moderate or high (i.e. not low), probing should be carried out at each pile location in accordance with CIRIA PR86. Piles should be designed to take into account the risk of a solution feature around, adjacent or beneath the pile (refer to clause 7.10.2 of CIRIA C574). Should concrete flows significantly exceed the volume of the pile during installation (suggestive of a solution feature/void), measures should be taken immediately to mitigate the risk e.g. additional probing, deeper piles, relocation of piles, load testing etc.

On sites previously classified as low risk, should a potential solution feature be encountered during excavation/inspection/construction of the foundations, the foundation design should be amended accordingly to ensure that the soils within the feature are not required to provide long term support to the foundations. This will likely involve, as considered appropriate, those steps undertaken on sites with a moderate and high risk of the presence of solution features.`

Piling in ground subject to cavitation

Where the ground is subject to potential cavitation as a result of gypsum dissolution, brine dissolution etc., the pile design and installation should take into account any existing and future cavitation. As such, some form of redundancy may need to be considered within the design to counteract any unknown conditions. As the presence of solution features cannot be readily identified during the installation of the piles, it is recommended that probing be undertaken at each pile location. Geophysical investigation or similar is recommended in order to locate existing cavities.

Piling over mine workings

With regard to piling over or near to historical mine workings reference should be made to CIRIA SP32 and CIRIA C758D. Piles are not generally suitable unless founded below the grouted horizons. When piling adjacent to existing mine entries, assurance needs to be provided that adequate competent rock is available, that stipulated rock sockets are achieved and that piles will not be affected by any potential future collapse or partial collapse of the mine entry.

Piling in made ground

Piles terminating in, or relying on, made ground/fill are not acceptable.

Pile installation and testing

Piles should be installed and tested to ensure that they meet the design requirements. The Engineer shall review all pile installation records and testing results and advise on remedial works to address any unusual results or failures.

Pile installation records (logs)

Copies of the site-recorded pile installation records (logs) shall be provided for each pile indicating the pile number (correctly referenced to the drawing), pile load, pile length, reinforcement details and any sleeving requirements.

For driven piles, the first pile driven should record the number of blows for the first 100mm of each metre of depth, and the set (including dates) achieved during installation and on re-strike should be indicated.

Should driven piles vary considerably in length across short distances, then the pile installation should be immediately re-assessed and details (including subsequent results of further investigation and a plot of pile lengths on the pile layout drawing and sections) submitted to the Warranty Surveyor for review. Installing piles to “rig-refusal” or reference to the limitations of the piling rig shall not be accepted as the sole proof of adequacy of the pile length. If the pile static design lengths are not being achieved on site, then static pile load tests may be required in order to ensure compliance with the British Standards and/or carrying out additional site investigation to prove the adequacy of the pile.

Re-strikes shall be carried out on driven piles (typically at a rate of 10%) following a suitable time allowance. If sets have relaxed on re-strike, the adequacy of the piles shall be re-evaluated (e.g. by additional testing).

Rig telemetry should be recorded, stored and provided as a matter of course for projects with continuous flight auger (CFA), sectional flight auger (SFA) or continuous helical displacement (CHD) piles.

Concrete mix and cube test results

Concrete mix details and cube test results for the concrete used in the piles shall be provided with tabulated results, similar to that in Concrete Advice Note No.30 (The Concrete Society) Tables 1 and 3. Delivery records, cross referenced to the pile layout/numbers, should also be kept for possible future reference. The Engineer shall review all concrete cube testing results and, in the case of any unusual results or failures, advise on any remedial works proposals necessary.

Pile integrity testing

The integrity of the full depth and cross-section of all CFA, SFA, CHD, bored piles (including retaining walls) should be established by integrity testing using recognised methods. Should integrity testing indicate anomalies, then the Engineer should advise on the remedial measures proposed and seek agreement with us. It is recommended that such agreement is obtained prior to work continuing.

Note: Integrity testing should not be considered as replacement for sufficient site investigation or other types of testing, particularly static load testing. 100% of such piles shall be integrity tested.

Dynamic load testing

Dynamic load testing shall be carried out in accordance with BS 8004 and shall include analysis of long term settlements. There should be adequate site investigation to 5m below the pile toe as required by the British Standards.

BS 8004 (clause 6.1.1) & BS EN1997-1 (clause 7.4.1) permits pile design to be carried out by one of the following options:

1. Geotechnical/Static pile design based on soil parameters from the site investigation and appropriate safety factors.
2. The results of dynamic load tests (provided they have been verified by static load tests in comparable situations).
3. Pile driving formula (provided they have been verified by static load tests in comparable situations).

If the results of appropriate static load testing are not available for the site, then only option 1 above can be used as the basis of design. In this case, all driven piles should be installed to the lengths indicated in the static pile design and representative dynamic tests with settlement analysis (e.g. CAPWAP) are carried out (typically 3% to 5% per static pile design but this may need to be increased if there are any concerns regarding the pile installation or if required by the Engineer).

However, if the piles cannot be driven to the lengths indicated in the static design (as is often the case), then reliance switches to dynamic tests and/or dynamic formulae, both of which need to be verified by previous evidence of acceptable performance in static load tests on the same type of pile, of similar length and cross section and in similar ground conditions (the static tests don’t necessarily need to have been carried out on the particular site), as required by BS 8004.

Static load testing

Preliminary Pile Tests (PPT): Maintained load (ML) testing up to the unfactored ultimate resistance (commonly defined as settlement equivalent to 10% of the pile diameter) in accordance with BS 8004, SPERW, or other accepted standards; normally carried out before work starts on site or at the very beginning of a project.

Working Pile Tests (WPT): Maintained load (ML) testing up to at least 1.5 times working load in accordance with BS 8004, SPERW, or other accepted standards. Working Pile Tests shall be carried out at a rate of 1 per 100 piles or part thereof (not less than 1%).

Note: Where there are large variations in substrata revealed either by the Site Investigation or during the construction of piles, load tests should be carried out in each zone and the level of testing reassessed accordingly for each design situation. Similarly, load testing should reflect the various pile lengths and loadings.

If there are queries with regard to anything not covered within this document and/or it is intended that the Site Investigation, pile design, installation or testing is to deviate from the above guidance, then please contact the Warranty Surveyor for agreement prior to commencement.

Helical (screw) pile installation and testing

Installation
The following should be considered during the installation of helical (screw) piles:

- Installation must be undertaken by an installer approved by the specialist manufacturer/system promoter.
- Site welding is not permitted.
- Whilst installation may be informed by the Capacity-to-Torque Ratio the installed lengths shall achieve the geotechnical design length. Failure to do so may lead to the pile being rejected.

Testing
During installation and following completion of the works, the pile designer will also be required to undertake the following:

- Oversee any pile load tests including the static load test undertaken in accordance with the ICE ‘Specification for Piling and Embedded Retaining Walls’, as specified by the Engineer.
- Validate installation of the piles through submission of a report confirming review of the pile installation logs to confirm that the piles have been installed into suitable stratum, to the required torque and have the required design capacity, satisfactory undertaking of the pile load test/s, installation is to tolerances set out within the system installation guidance, and confirmation that all components utilised were supplied by the specialist manufacturer.
- Static load test piles shall be in accordance with the design factors of safety adopted.

3.
Foundations

3.3
Raft

Provision of information

A full set of design drawings, calculations and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Phase 1 Desk Study Report and Phase 2 Geotechnical Site Investigation Reports including site-specific recommendations for raft foundations (and allowable bearing pressures) to ensure long term settlement does not exceed 25mm or 1/500 (differential).
2. Structural drawings:
   a) GA and RC drawings, including a drawing register sheet.
   b) Details of internal and external thickening to cater for loadings and the effects of frost.
   c) Details of any insulation beneath the raft.
3. Structural calculations:
   a) Demonstrating that the ground bearing pressure does not exceed the allowable value specified in the Site investigation report. Localised areas of higher bearing pressures (e.g. beneath load-bearing walls, thickening or point loads) should be considered.
   b) Demonstrating that the raft (i.e. the thickening, slab and beams) can span a 3.0 metre ‘soft spot’ and cantilever 1.5 metres.
   c) Demonstrating the adequacy of any insulation beneath the raft (in relation to loadings, creep and groundwater). The insulation must have appropriate 3rd party approval certification and compressive creep must be limited to a maximum 2% reduction for a 50/60 year period.
4. Plans and details of the proposed raft showing reinforcing positions and a bar schedule, to be used by the reinforcing steel supplier and installer.
5. Confirmation that all made ground and organic matter beneath the foundation has been or shall be removed/replaced with appropriate material, or treated.
6. Details of engineered granular fill below the raft (including its depth and lateral extent, ensuring a 45º spread from the edge), along with its compaction specification, testing and Geotechnical Engineer’s validation. Where Manual for Highway Works (MHW) specification for engineered granular fill is indicated, details shall conform with MHW Volume 1 Series 600 Earthworks Cl:610 ‘Fill to Structures’.
7. Calculations demonstrating how the depth of granular fill has been determined to cater for the effects of heave and shrinkage (if shrinkable soils are present).
8. Details of any ground treatment (e.g. vibro treatment, cement-lime stabilisation etc.).

Please note: if there are queries with regard to anything not covered or it is intended to deviate from the above guidance, then please contact the Warranty Surveyor for agreement prior to commencement. Following acceptance of the proposals, please refer back to the Warranty Surveyor if anything is subsequently discovered on site, which affects the design and/or construction of the raft.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Limitations of guidance

Rafts are not considered an accepted method of foundations where the ground conditions are susceptible to heave or shrinkage (e.g. where trees are present or have been removed) unless appropriate measures have been taken to mitigate the effects of heave or shrinkage. For further clarification, please refer to the ‘Foundations - Trees and Clay’ section.

Introduction

A raft foundation consists of a reinforced concrete slab, whose thickness and stiffness are designed to spread the applied wall and column loads over a large area and reduce differential settlement gradients.

For domestic applications, rafts are often built with thickened perimeters to provide protection against frost heave, in which case they are effectively trench fill foundations with integral ground bearing floor slabs. Down stand edge beams also serve to stiffen the foundation’s structure.

Rafts are used where it is necessary to limit the load applied to the underlying soil or to reduce the effects of differential foundation movements due to variable soil conditions or variations in loading.

Materials

Materials and workmanship should meet the requirements set out in the ‘Appendix C - Materials, Products, and Building Systems’ section.

Ground conditions

Raft foundations are usually designed for sites with variable ground conditions with low ground bearing capacities. It is therefore important to complete a suitable Site Investigation to meet the requirements of the ‘Ground Conditions’ section and ascertain the bearing capacity and suitability of the ground.

Structural design

Structural calculations should be provided by an Engineer, confirming that the raft design is suitable for bearing onto the ground and that the ground bearing capacity safely supports the structure and it will limit long term total and differential settlements to acceptable levels.

Key requirements

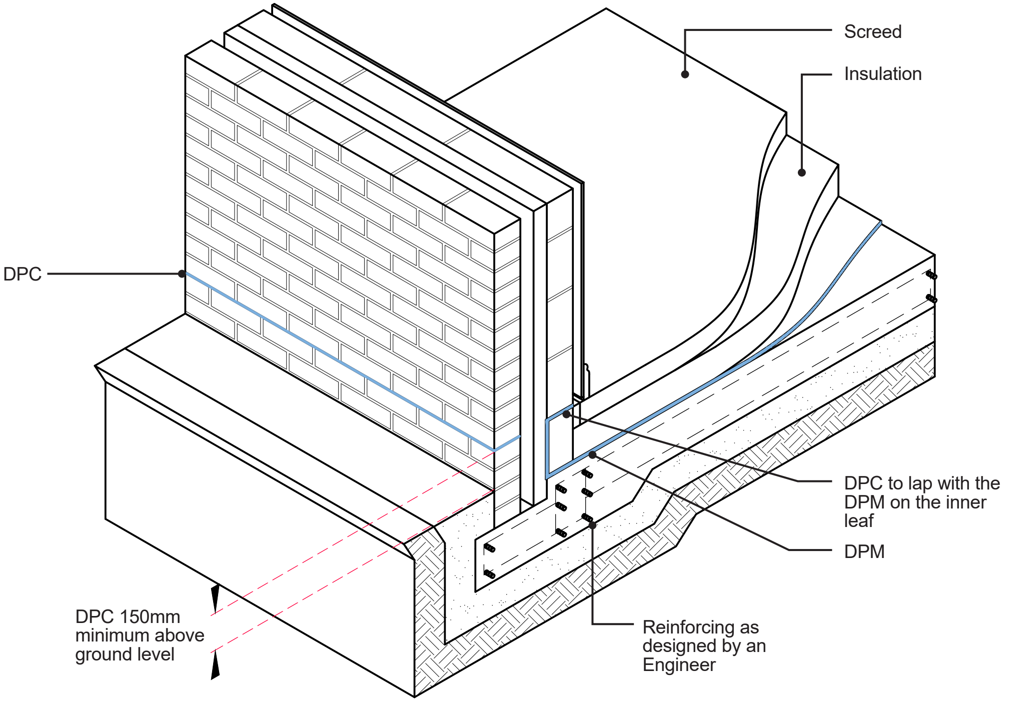
The raft foundations shall be designed to clearly demonstrate that the rafts, insulation and any treated ground are capable of supporting and transferring the foundation design loads safely to known soil strata that are, in turn, capable of supporting the loads, using the appropriate soil properties obtained from geotechnical testing and contained in the appropriate Site Investigation report. The rafts shall be designed in accordance with BS 8004:2015 and shall ensure that long term settlement does not exceed 25mm or 1:500 (differential), unless more stringent criteria are required by the Engineer.

Thermal insulation products below the structural raft

Where thermal insulation products are used below the structural raft they should:

- Meet the requirements of BS EN 1606 Thermal insulation products for building applications.
- Meet BS EN 13163 (for EPS insulation).
- Meet BS EN 13164 (for XPS insulation).
- The Engineer should ensure that the design limits ‘compressive creep’ to a maximum 2% reduction for a 50/60 year period.
- The insulation product must have third party product approval certification for use below a structural raft foundation (including below external walls).

Typical raft foundation



Damp proof membranes (DPM), damp proof courses (DPC), and floor finishes

The raft foundation and the junction with the wall should be appropriately constructed to resist ground moisture penetration.

A DPM can be placed beneath the raft, wrapped around the external toe and lapped into the internal DPC. However, this detail can be difficult to implement on-site, and puncturing of the membrane can commonly occur when placing reinforcing. The preferred method is to place the DPM on top of the raft slab beneath the floor insulation or screed.

Stepped membranes

DPM should be continuous where floors are stepped, a waterproof specialist must select an approved waterproof membrane to meet the requirements of BS 8120 to provide a continuous barrier that is compatible with the floor DPM/DPC.

Damp proofing

Damp proof courses (DPC)
DPC's should be of a flexible material that is suitable for its intended use and the DPC should have appropriate third-party certification. Blue brick or slates will not be accepted as a DPC.

DPC's should be laid on a mortar bed and correctly lapped at junctions and corners. The depth of lap should be the same as the width of the DPC.

DPC's should not bridge any cavities unless it is acting as a cavity tray. Where a cavity tray is required (e.g. over a telescopic floor vent) please refer to the 'External Walls' section for cavity tray, weep holes and stop end requirements.

Damp proof membranes (DPM)
A DPM should be provided beneath all ground-supported slabs or cast in-situ reinforced slabs. DPM's should be linked to the DPC and be a minimum 1200g polythene. Other DPM's may be considered if they have appropriate third-party certification and are installed in accordance with the manufacturer's instructions.

Cavity trays
For guidance on cavity trays, please refer to the 'External Walls' section.

Concreting of floors

Prior to concreting, any water or debris that may have collected on top of the DPM should be removed. Expansion joints should be provided and constructed in accordance with the Engineers design.

Bricks and blocks below ground

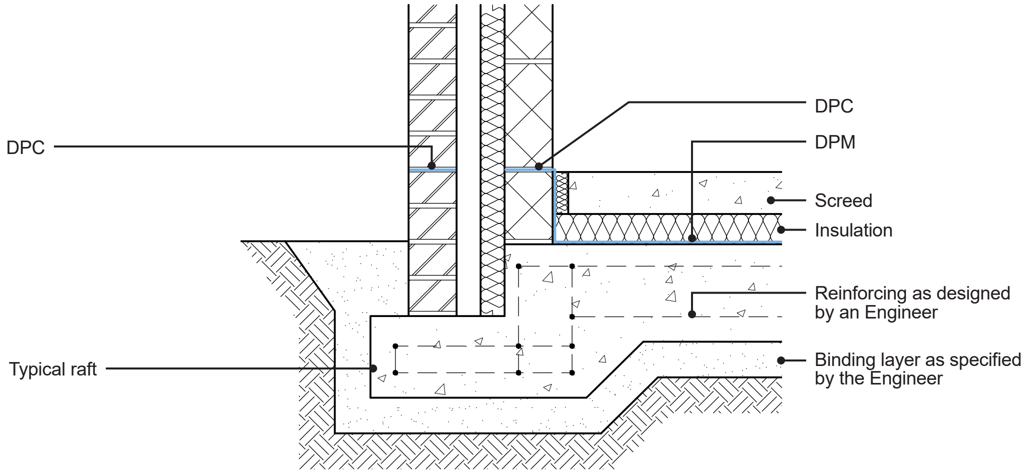
The selected bricks should be appropriately durable against saturation. See 'Appendix C - Materials, Products, and Building Systems' for further guidance.

If there are sulphates in the ground and/or there is ground water present, confirmation by the manufacturer that the brick or block is suitable for use below ground should be provided.

Reference documents

- BS EN 1997-1 - Eurocode 7: Geotechnical design (EC7)
- BS 8004 - Code of practice for foundations and Eurocode
- BS EN 1997-2 - Ground investigation and testing
- BS 5930 - Code of practice for ground investigations
- Manual for Highway Works Volume 1 Series 600 Earthworks

Typical raft foundation design



Ducts and sleeving

Any service penetrations that pass through the raft should be appropriately sleeved to protect the service duct. Service duct positions should be planned and indicated on drawings to prevent reinforcing bars from being cut, unless the structural design has catered for this.

Flexible and rigid retaining walls

Flexible retaining walls
For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls should not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

Rigid retaining walls
Where rigid retaining walls are specified which support the foundations of a building, an Engineers design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

3.
Foundations

3.4
Engineered Fill

Provision of information

A full set of design drawings, calculations and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Site Investigation Reports including site-specific recommendations for foundations to ensure long term settlement does not exceed 25mm (10mm for piles) or 1/500 (differential).
2. Structural drawings:
   a) Site layout plan including proposed finished floor levels for all plots.
   b) Topographical survey confirming existing ground levels. Subsequent site level surveys indicating areas where earthworks are required to achieve final construction levels. If piling or ground improvement techniques are to be adopted, piling platform and/or vibro platform levels are required.
   c) GA and RC drawings, including a drawing register sheet.
   d) Piling & Vibro layout drawings (if applicable), including a drawing register sheet.
   e) The design of the dwellings should allow a degree of articulation with movement joints sufficient to accommodate the maximum allowable differential settlement above, also at thresholds and service entries.
3. Structural calculations:
   a) Demonstrating that the ground bearing pressure does not exceed the allowable value specified in the Site Investigation Report.
   b) Piled foundation calculations (please refer to the ‘Piling Good Practice Guide’ available on our website).
   c) Vibro foundation calculations (please refer to the ‘Piling Good Practice Guide’ available on our website).
4. Earthworks Specification including:
   a) Confirmation that works are supervised by a suitably experienced independent Chartered Geotechnical Engineer.
   b) Proposals for load testing to determine the expected long-term settlement and differential settlement of the fill. Please note: We consider that plate load tests do not confirm the expected long-term performance of the ground.
   c) Allowable bearing pressures, expected settlement and differential settlement.
   d) Consideration of the effects of slag, burnt shale and expansive soils.
   e) Consideration of self-weight settlement of the fill.
   f) Collapse compression analysis in accordance with BRE IP5/97.
   g) Details of any ground treatment (e.g. vibro treatment, cement-lime stabilisation etc.).
5. Geotechnical validation report including:
   a) Confirmation that all made ground and organic matter was removed.
   b) Details of formation levels prior to filling works.
   c) Depths of all cut and fill carried out across the site with levels linked to the original site investigation.
   d) Details demonstrating compliance with Clause 610 of the Specification for Highway Works (for structural fills).
   e) Details and locations of all tests and interpretation by the Geotechnical Engineer.
   f) Confirmation of the bearing capacity achieved by the earthworks and confirmation that long-term settlement will not exceed 25 mm or 1:500 differential settlement.

If there are queries with regard to anything not covered within this document and/or it is intended to deviate from the above guidance, then please contact the Warranty Engineers for agreement prior to commencement. Following acceptance of the proposals, if anything is subsequently discovered on site, which affects the design and/or construction, please contact the Warranty Surveyor immediately.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Limitations of guidance

The following situations are beyond the scope of this guidance:

- Where the original ground or sub-strata is unstable or will continue to settle.
- Sites with soft clays with a low bearing capacity (Undrained cohesion = 30kN/m^2 or less).
- Filled ground where high levels of voids are anticipated.
- Clay fill, where the water will influence the foundation or where collapse may occur.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty Surveyor or a suitably qualified and experienced expert.

Fill or made ground can be divided into 2 main types:
1. Engineered Fill: When placed as part of the construction process and carried out to an engineered specification to high standards with good quality control and adequate engineering supervision, then risks can be assessed and may be quite small.
2. Non-Engineered Fill/Made Ground: Risks associated with sites covered with existing fill are more difficult to assess and short of complete excavation, the risks cannot be fully quantified. Therefore, alternative foundation solutions where loads can be transferred to competent strata are required.

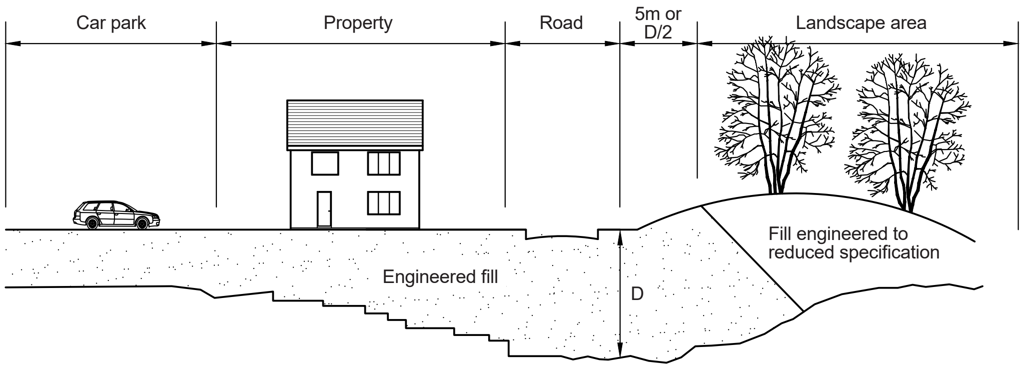
Engineered fill

Generally cohesive/granular homogeneous material specifically selected to replace either made ground or infill voids left by other processes is adopted. Fill has been divided into 2 further categories. These are:

- Shallow fill (i.e. less than 2.5m depth below ground level).
- Deep fill (i.e. greater than 2.5m).

For further guidance on foundation types suitable for building on ‘Shallow’ and ‘Deep’ fill, please refer to our Warranty good practice guide ‘Building on Fill’ which can be found on the website.

Typical engineered fill construction - Figure 1



Design of engineered fill

Careful selection of the material and controlled placement should ensure that the engineered fill forms an adequate foundation material; however, in some circumstances, significant ground movements can occur.

A specification for engineered fill shall be prepared, covering materials, compaction, workmanship and validation testing. This specification shall be prepared by an Engineer.

Engineered fill should be designed and placed in accordance with recognised good practice, as noted in the references at the end of this section.

Engineered fills used to produce suitably shaped landforms for structures should be constructed to high standards to minimise the risk of ground movements causing damage to property built on shallow foundations.

In designing and specifying a fill to form a foundation for buildings, the following technical requirements should be established:

- A well-constructed excavation, safely executed, with all soft and hard spots removed and made reasonably dry and well drained.
- Sound fill without undesirable material and capable of compaction as specified, provided with starter and capping layers as necessary.
- Placement and compaction to ensure that the performance of the fill will meet required criteria as a foundation fill.
- Appropriate monitoring; the Designer must ensure that all work can be carried out safely as required by the Health and Safety Executive Construction Design and Management Regulations.

Fill selection

Fill should be clearly categorised into material that may and may not be used: unsuitable fill, general fill, restricted fill and special fill. Fill materials must not present an environmental or health hazard.

Unsuitable fill should not be used at any location on the site.

General fill is all material except that which is unsuitable, restricted or special, and is normally the majority of the material used. It may include natural soils as well as some waste products.

Restricted fill is material that would be general fill except that it contains minerals hostile to the built environment. It can include natural materials such as pyritic shales, sulphate-bearing clays and waste materials, including burnt colliery discard and steel slag. Its use is precluded where ground water could rise to the underside of the deepest foundation, or where it is rejected for pollution reasons. For some developments, such as housing with gardens, restricted fills would include fills that are harmful to people.

Special fill is high-quality material, such as well-graded natural sands and gravels, crushed rock or clean demolition rubble. Its use will often have to be reserved for specifically defined purposes, such as a capping layer or backfill to retaining walls. Where possible though, granular soils should be used as general fill since these materials drain readily and consolidate quickly. The smaller the predominant particle size, the longer the potential time required for consolidation under the self-weight of the fill.

Materials considered to be unsuitable for use as fill are:

- Swamp or marsh land materials.
- All organic or part organic materials.
- Materials subject to spontaneous combustion.
- Colliery shales, ironstone shales and similar materials which have the potential for expansion due to oxidation of pyrites.
- Frozen materials or materials which are frost susceptible.
- Any materials which have a higher moisture content than the maximum permitted for such materials as defined in the specification.
- Clays with high plasticity index exceeding 55%.

The following materials require testing to ensure their suitability for use as fill to support structural foundations and slabs, or as backfill to associated trenches:

- Acid wastes.
- Reactive materials.
- Materials that include sulphates (e.g. gypsum).
- Organic materials.
- Toxic materials.
- Materials that cause noxious fumes, rot, undue settlement or damage to surrounding materials.

The sample tests should be carried out by a suitably qualified person and it may be necessary to take a number of samples to identify the material characteristics of the fill accurately.

End product criteria

The greatest threats to successful in-service performance are:

- Collapse settlement due to inundation of dry or inadequately compacted fills.
- Excessive consolidation settlement of wet compressible fill.
- Heave or settlement of clay fill due to climatic changes or vegetation.

These ground movements depend on moisture movement, so by reducing the voids in a fill, the opportunities for excessive in-service movements should be restricted. A maximum allowable air-voids content of 5% is a suitable criterion for most clay fills. However, specifying a 5% air-voids content is insufficient, as this value may easily be achieved by adding water to the fill without increasing compactive effort.

A suitable alternative control method is to specify a minimum acceptable density as a proportion of the maximum dry density measured in a standard laboratory compaction test. Limits on moisture content are also required.

If the fill is too wet, there could be excessive consolidation settlement and if the fill is too dry, it might be vulnerable to collapse compression.

Placing engineered fill

A successful engineered fill requires not only an appropriate specification but also adequate control during placement. All the work must be carried out with due regard to safety, as required by the Construction Design and Management Regulations.

Site preparation and disposition of fill

The site should be cleared of all topsoil and other unsuitable material.

Soft spots and hard spots, such as derelict foundations, should be removed together with ponds and surface water from depressions. Removing water by pumping may be necessary when filling some excavations below the ground water level.

When a variety of material types are used as fill, they should be deposited in horizontal layers across the site. If there is only a limited amount of good granular material, it will be best to use it in layers interspersed between layers of poorer cohesive fill.

The fill thickness should be reasonably constant beneath a structure to minimise differential settlement.

Feather-edges, resulting in foundations set partly on fill and partly on natural ground, should be avoided, and the site worked in such a way that structures are located either directly on natural ground or directly over fill of a consistent thickness.

If fill is to be placed over sloping natural ground, some stepping of the ground formation level will be necessary. Construction over the face of a quarry or an opencast mining high wall should be avoided.

Special measures may have to be taken by providing flexible connections for services at the location of high walls and by thickening construction for service and estate roads.

If the natural ground on which the fill rests is soft and compressible (for example, layers of peat or soft clay), the surface of the fill may settle appreciably and unevenly as a result of the weight of the fill consolidating the soft layers below. This settlement will, of course, be additional to that resulting from the compression of the fill itself.

Sensitive structures may warrant a surface (or capping) layer formed from special fill compacted to more onerous standards than the underlying fill. This should help minimise the differential settlement suffered by the structure.

Where landscaped or other non-load bearing areas form part of a development, they need less compaction than the load-bearing areas. There should be a transition zone around the load-bearing area, as shown in Figure 1.

Flexible and rigid retaining walls

Flexible retaining walls
For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls should not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

Rigid retaining walls
Where rigid retaining walls are specified which support the foundations of a building, an Engineers design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

Fill placement

Fill should be placed in horizontal layers, with each layer separately compacted.

For a given item of plant, compaction performance will be determined by fill layer thickness, fill moisture content and the number of passes of the compaction equipment. There are however, other factors such as the need to avoid excessive handling.

Whenever possible, site trials should be undertaken to determine the correct criteria. Some general information about placing fills is given in BS 6031.

Each layer should be of a thickness that allows the compactive energy to spread throughout the layer, producing the specified fill density and low air-voids content. Loose layers with a thickness greater than 250mm are unlikely to be satisfactory for earth fills compacted to support low rise structures. It may be necessary to use layers of 200mm or less.

Moisture content at the time of placing a fill is fundamental to subsequent performance, particularly where the fill contains a large proportion of fine grained cohesive material. If the fill is too dry, there is the possibility of heave or collapse settlement; if it is too wet, there is the possibility of insufficient strength and high compressibility. It will be difficult to achieve air-voids content of 5% or less when the moisture content is low. In the same way that the addition of too much water can detract from the performance of engineered fill, soil can be over compacted.

Granular soils and cohesive soils drier than optimum, when rolled excessively, become over-stressed and what should have been a firm compacted surface becomes a loose tilth. This should be avoided whenever possible. Where a fill containing a large proportion of fine grained cohesive material (for example, clay) is used, filling during wet weather should be avoided.

Quality control and testing of fill during placement

Quality control procedures should be implemented to ensure compliance with the specification. The nature of the control procedure will depend on the type of specification adopted.

The end product specification requires an appropriate type and quantity of testing of the fill during placement to ensure that the desired end product is being achieved. Depending upon the type of contract, quality control may be the responsibility of the Engineer or of the contractor working under the supervision of the Engineer.

Control parameters should be the same as those determined during the site investigation stage. Both design and control parameters must be reproducible, a term that denotes the range within which measurements made on the same fill by different operators using different equipment should agree.

The following are the most significant control parameters:

- Moisture content, in respect of an optimum moisture content established at the Site Investigation stage.
- Dry density, in respect of the already established maximum dry density.
- Air-voids content, which depends on moisture content and dry density.
- Un-drained shear strength, which is an alternative to monitoring moisture content and dry density for clay fills.

The laboratory compaction tests and the associated field control tests are suitable for a wide range of fill types and form the most generally applicable approach. For cohesive soils, un-drained shear strength forms an alternative basis for specification and control testing. However, different methods of measuring the un-drained shear strength, such as the unconfined compression test and the vane test, can give significantly different values. The measured value of cohesion can be sensitive to a detailed test procedure, such as the rate of shearing.

It is important for the method of testing to be strictly specified. Where a cohesive fill contains gravel, it may not be possible to obtain sufficiently undisturbed samples for strength tests. On larger sites, employing in-situ methods, such as the cone penetrometer (BS 1377: Part 9), could be considered.

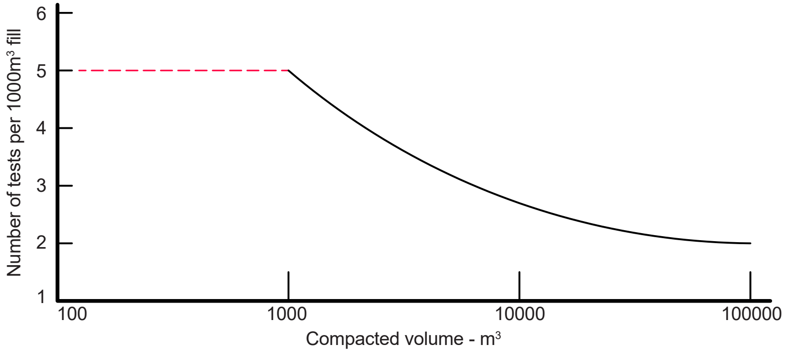
Small sites are generally more difficult to work than large sites, as finished work may be damaged more easily in confined working areas and deficiencies in site preparation usually reflect more readily in poorer quality compaction than on larger sites. Consequently, it is necessary to test more frequently on a small site than on a large one.

A suggested minimum test frequency is presented in Figure 2. However, each site should be judged on its own merits, with careful note taken of any problems revealed during site investigation. In very variable or difficult conditions, more frequent testing may be required. Tests in visually doubtful areas, and re-tests of failed areas, should be carried out in addition to those recommended in Figure 2.

Modern compaction control requires laboratory and field testing during the Site Investigation, and during, and possibly following, the earthworks. The results of this work must be recorded, collated and presented to demonstrate the quality of the operation. The required documentation includes:

- Summary of the specification requirements and the end product in terms of the selected geotechnical parameters for the various fills (based on-site investigation information).
- List of the required suitability tests; one form to be completed for each borrow pit under investigation.
- Suitability test results for each borrow pit.
- List of the required control tests.
- Results of the control tests on each fill type, layer or area, as appropriate.
- A list of post-compaction monitoring requirements.
- The results of post-compaction monitoring; all completed forms should be signed and dated by the person responsible and a list prepared of any required action or remedial work to be carried out.

Number of tests - figure 2



Monitoring of fill performance - post compaction

Monitoring provides a check on the performance of the fill after compaction and is particularly important where vulnerable structures are to be built or foundation loading is unusually large. It is also required where the fill is relatively deep or substantial ground water rise within the fill is expected.

Monitoring techniques include:

- Surface levelling stations to measure the settlement of the fill surface.
- Magnet extensometers to measure the settlement of incremental depths of fill.
- Standpipe piezometers to measure the rise in the ground water table in the fill after placement.
- Load tests for direct estimation of settlement of surface layers produced by loadings.

Surface levelling stations are easy to install and very effective. By optical levelling of the stations, measurement can be made of the total vertical movement of the fill upon which they rest, together with any movement of the underlying natural ground. Although this is unlikely to be large if all soft material has been removed prior to compaction. Levelling stations should be sufficiently robust to resist damage due to construction traffic. A round headed bolt cast into a 1m concrete cube set 300mm into the fill has been found to be effective.

Magnet extensometers are unlikely to be necessary in shallow-depth fill. Standpipes or piezometers will be of advantage if there is reason to suspect that ground water will rise into the fill at any time in the future, with consequent settlement.

Relevant British Standards and guidance documents

Relevant British Standards Codes of Practice and authoritative documents include:

- BS 6031 Code of Practice for earthworks
- BS 1377: Part 9 Methods of tests for soils for civil engineering purposes. In-situ tests
- BS 10175 Investigation of potentially contaminated sites - Code of practice
- BS EN 1991 Actions on structures
- BS EN 14731 Execution of special geotechnical works. Ground treatment by deep vibration
- BS EN 1997-1 General rules
- BS EN 1997-2 Ground investigation and testing
- BS EN ISO 14688 Geotechnical investigation and testing - Identification and classification of soil
- BS EN ISO 14689 Geotechnical investigation and testing - Identification and classification of rock
- BS EN ISO 22476 Geotechnical investigation and testing - Field testing
- BR 391 Specifying vibro stone columns
- Institute of Civil Engineers (ICE) specification for ground treatment: Notes for guidance, 1987
- CIRIA C572: Treated ground: Engineering properties and performance, 2002
- CIRIA C573: A guide to ground treatment, 2002
- BRE 424: Building on fill: Geotechnical aspects
- BRE Information Paper 5/97: Collapse compression on inundation

Introduction

The following guidance outlines recognised good practice in relation to building on fill. The structural design and construction should be in accordance with the Functional Requirements of this Technical Manual and recognised publications from British Standards, Eurocodes, CIRIA, BRE and ICE.

Key requirements

The foundation scheme shall be designed to clearly demonstrate that the foundations are capable of supporting and transferring the design loads safely to known soil strata that can be demonstrated from the appropriate project site investigation reports to be capable of carrying the load, using the appropriate soil properties obtained from geotechnical and load testing.

Groundwork shall be designed and validated by an Engineer to ensure that settlement will not exceed 25 mm (10mm for piles) or differential settlement tilt greater than 1:500 for low-rise buildings unless more stringent criteria are required by the Engineer.

Partial depth foundation solutions where either piles or ground improvement techniques (i.e. vibro stone columns, vibro concrete columns etc.) terminate in the fill material, and do not penetrate to naturally occurring competent strata below, are not acceptable.

Untreated made ground/fill material is inherently variable in nature and unpredictable when considering its settlement properties. Foundations proposing to bear upon untreated made ground/fill as a formation for strip, trench or raft type foundations are unacceptable.

Testing

Testing is carried out to confirm that the ground improvement works meet the design criteria. The tests are usually completed to determine the ground bearing capacity.

The Engineer shall require the specialist contractor to verify that the ground treatment has been completed to a satisfactory standard. This will usually include carrying out suitable testing to establish the degree of ground improvement, its load-bearing characteristics and settlement potential.

These tests may include:

Plate tests
This test will not determine the design but will allow for an assessment of the workmanship on the stone columns. Plate tests should be carried out on stone columns or treated ground at a frequency of at least one test per day per rig.

The plate tests should be carried out with a 600mm diameter plate and minimum test load of 11 tonnes.

Mini zone tests
A mini zone test (dummy footing) can be used as a limited substitute for zone tests. The test should be applied to at least two stone columns and the area of foundation they support. To be useful, mini zone tests should be continued for long enough to establish the presence of creep behaviour.

Mini zone tests (dummy footing) should be carried out at a rate of one test per 1000m2-3000m² of treated ground, along with penetration tests at a rate of one test for 20-50 stone columns, or one test for not more than 500m² of treated ground, with a minimum of one test per structural unit. Alternatively, in the absence of penetration tests, one test per ten houses (with a minimum of two tests per site) would suffice.

Zone tests
An isolated pad or strip footing is used to test up to eight stone columns and the intervening ground. Loadings, which should simulate the building loads, are held for 24 hours at predetermined stages to examine creep behaviour.

In-situ tests
Where vibration will improve the ground itself, e.g. granular materials, then in-situ testing is appropriate. The improvement can be assessed when the test results are compared with the in-situ test results recorded during the pre-treatment investigation.

Trial pits
Trial pits can be excavated around trial stone columns to prove that they are fully formed and to the required depth and diameter. This is a destructive test, and allowance should be made accordingly.

On completion of the treatment, the Engineer is to confirm that the treated ground has achieved the anticipated condition assumed in the design, and provide evidence in writing to the Warranty Surveyor.

Reference documents

- Current regional Building Regulations
- BS EN 1997-1 - Eurocode 7: Geotechnical Design (EC7)
- BS 8004 - Code of Practice for Foundations
- BS EN 1997-2 - Ground Investigation and testing
- BS 5930 - Code of Practice for Ground Investigations
- BS 1377-9 - Methods of test for soils for civil engineering purposes. In-situ tests
- BRE IP 5/97 - Building on Fill: collapse compression on inundation
- BRE Building on Fill 3rd edition: geotechnical aspects
- Department of Transport Specification for Highway Works, Part 2, Series 600 Earthworks
- Warranty Good practice guides, to ensure long term and differential settlement criteria remain compliant:
  - Raft Foundations (Long term settlement 25mm and 1/500 differential)
  - Piling (Long term settlement 10mm and 1/500 differential)
  - Vibro ground improvement (Long term settlement 25mm and 1/500 differential)

3.
Foundations

3.5
Vibratory Ground Improvement

Provision of information

A full set of design drawings, specifications, calculations and site investigation reports shall be made available to the Warranty Provider and all other interested parties. Items 1-3d should be submitted prior to commencement of vibro treatment on site. In the absence of approval, works are proceeding at the Developer's own risk. Items 3e-3g shall be submitted as soon as they become available, prior to construction continuing over the vibro stone columns.

1. Phase 1 Desk Study Report (including Groundsure) and Phase 2 Geotechnical site investigation reports with appropriate geotechnical testing.
2. Structural Engineers foundation drawings and design calculations. Strip footings should be designed for the specified bearing pressures and be designed to span between vibro stone columns.
3. Vibro stone columns:
   a) Written confirmation from the vibro designer that the ground conditions are suitable for vibro treatment and that the site investigation report is adequate for the purposes of the design and installation of stone columns. Deepening of foundations in respect of trees/clay soils to be taken into account.
   b) Vibro stone column layout drawings.
   c) Vibro design calculations confirming full-depth of made ground and soft/loose natural strata.
   d) Confirmation of proposed testing regime (i.e. plate and dummy footing tests etc., see notes below). A minimum of 1% of stone columns should be subject to dummy footing test.
   e) Vibro installation logs (with vibro column numbers referenced to the vibro layout drawing). Logs should include date, column number, depth, diameter, weight of stone, confirmation of the platform level in relation to the finished floor levels and site investigations and details demonstrating that all low-strength/loose natural strata (SPT<10) and all made ground/fill have been suitably treated.
   f) Copies of all testing carried out (with the locations referenced to the drawings) and interpretation of test results.
   g) Written confirmation from the vibro designer that the as-built installation has achieved the required bearing capacity and settlement characteristics.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

Vibratory ground improvement techniques are generally used to increase load-bearing capacity and reduce settlements to acceptable limits within undisturbed natural soils and filled ground.

Soft soils can be reinforced to achieve improved specification requirements, whilst slopes can be treated to prevent slip failure, both natural soils and made ground can be improved.

The ground must be suitable for vibratory ground improvement and designed in-accordance with recognised methods (e.g. Priebe). The treatment must extend through the full extent of the filled or poor ground and reach natural competent ground.

Foundations supported by vibratory ground improvement techniques require a coordinated design by an Engineer and specialists who are experienced with this type of construction.

Limitations of guidance

The following situations are beyond the scope of this guidance:

- Where the original ground or sub-strata is unstable or will continue to settle.
- Sites with soft clays with a low bearing capacity (Undrained cohesion = 30kN/m^2 or less).
- Filled ground where high levels of voids are anticipated.
- Clay fill, where the water will influence the foundation or where collapse may occur.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty Surveyor or a suitably qualified and experienced expert.

Desk study and site investigation

All projects will require a site specific phase 1 desk study report (including Groundsure or similar) and a phase 2 geotechnical site investigation reports with appropriate geotechnical testing.

A site specific geotechnical site investigation should take place and be in accordance with BS 5930/EC7 and extend into adequate strata beneath the filled or poor-strength strata above. The investigation should include enough geotechnical testing to enable accurate geotechnical design of the vibro stone columns in accordance with proven design methods.

The scheme shall be designed to clearly demonstrate that the foundations and treatment of the ground with vibro stone columns are capable of supporting and transferring the foundation design loads safely to known natural soil strata'

The foundations and vibro stone columns shall be designed in accordance with BS 8004:2020 and shall ensure that long term settlement does not exceed 25mm or 1:500 (differential) at working load, unless more stringent criteria are required by the Engineer.

The developer shall obtain written confirmation from the Engineer and specialist contractor that the site is suitable for the proposed ground improvement system, and that all detrimental factors associated with the site and the proposed development have been taken into account.

The results of the investigation should be presented to the Warranty Engineer prior to the commencement of work on site.

Desk study and site investigation results

Properties of the natural materials under the site
The site investigation should determine the depths and properties of the natural materials under the site, including the presence of geological hazards, cavities, mine-workings and associated features, rocks or soils that may dissolve or erode when water passes over them.

Through the process of a site investigation, it should first be established by the Engineer or suitably qualified specialist that the ground is capable of being improved by a vibratory ground improvement technique.

Extent of any areas of made ground on the site
The extent of any areas of made ground on the site should be established, including its history, composition and behaviour.

A site specific geotechnical site investigation should take place and be in accordance with BS 5930/EC7 and extend into adequate strata beneath the filled or poor-strength strata above.

Materials susceptible to heave or shrinkage
The extent of any shrinkable materials or materials susceptible to heave (clays, slag, burnt shale etc.) should be established. The necessary Atterberg tests and swelling tests should be conducted as appropriate.

Constituent materials
The proportions, compaction and distribution of the constituent materials throughout its depth should be established.

The investigation should include enough geotechnical testing to enable accurate geotechnical design of the vibro stone columns in accordance with proven design methods.

Fill materials
The grading and particle size distribution of fill materials should be established. See Conditions acceptable for treatment.

Existing or redundant services
The presence and extent of any existing or redundant services and drains should be investigated, and the associated backfill to the excavations. In addition, the effect that any proposed sustainable drainage system (SUDS) or soakaways might have on the ground conditions should be identified.

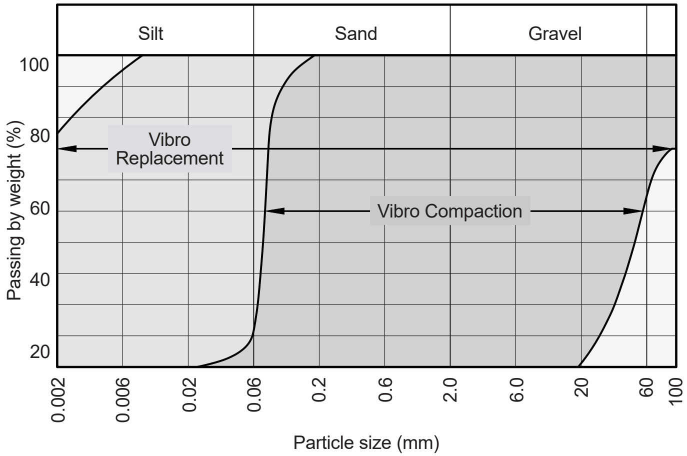
Ground water
The investigations should identify the presence, level and nature of any ground water, and if it is likely to rise and cause heave or collapse by saturation.

Contaminated substances
Contaminated substances including any potential for gas generation from fill materials such be identified. Any potential for combustion from contaminated substances should also be identified.

The Engineer should supervise the site investigation, taking account of the findings of the desk study, and first establish whether there are any contaminated substances or gases present.

Existing obstructions
It should also be established at an early stage whether the site has previously contained any buildings or structures, and whether they have been completely removed, including basement walls, floor slabs, etc.

Conditions acceptable for treatment



Reproduced from ICE Manual of Geotechnical Engineering: Volume II with kind permissions from ICE Publishing Limited.

Unsuitable ground conditions

For Warranty purposes, the following ground conditions are not considered suitable for vibratory ground improvement.

- Highly shrinkable clays with a plasticity index greater than 40%.
- Soft clays with undrained shear strength less than CU = 30kPa.
- Ground with a peat layer greater than 200mm should be viewed as unsuitable. Multiple peat layers with a combined depth greater than stone column diameter are unsuitable. In addition, variations in peat thickness may cause differential settlements.
- Voided fill ground created by landfill or with concrete rubble or brick fill of unsuitable grading.
- Non-engineered fill material may result in the following:
    - Original ground or sub-strata is unstable or will continue to settle.
    - The location and mobility of ground water within or entering the fill – as this has the potential to trigger inundation settlement (if the fill has not been previously saturated).
    - Inundation settlement (also known as collapse compression) – associated with the permeation of water into poorly compacted fills and partially saturated fills with a high air voids ratio. Refer to BRE IP 5/97.
- Degradable material - organic material where the percentage per volume may cause excessive settlement to foundations.
- Ground gases including carbon dioxide and methane - Stone column installation will involve stone compaction, however, remaining voids can act as vertical vents to dangerous gases.

Ground conditions and other factors that may increase the complexity of vibratory ground improvement

- Shrinkable material with volume change potential (VCP). If the presence of shrinkable soils is suspected, and no testing data is available to verify the VCP then high volume change potential should be assumed.
- VCP Soils with a modified plasticity index greater than 10%. The installation of Stone Columns in cohesive material should consider any adverse effects on existing structures and site drainage.
- For all soil types, stone columns can transmit water down to lower fills causing softening and inundation of the fill materials.
- Deepening of foundations and heave precautions need to be assessed in accordance with the guidance within our ‘Foundations’ section of this Technical Manual regardless of the vibro treatment.
- Partial depth treatment of filled ground:
    - Sites designated for partial treatment will be considered on a case-by-case basis.
    - Engineer to consider the combined performance of both treated and untreated zones considering overall settlements.
    - Partial-depth treatment of loose/low-strength natural soils (SPT <10, cu < 40kPa) and partial-depth treatment of made ground/fill is not acceptable.
- Obstructions - buried structures including drainage.
- Variations in the density of material to be treated.
- Variations in ground water - long or short term alterations to ground water levels that may cause settlement or heave of existing buildings.

Limitations of treated ground

Buildings and long blocks with sensitive finishes should be avoided in areas with considerable variations in ground conditions.

In the case of stone columns, the un-cemented stone particles develop end bearing and skin frictional stresses. This process requires the soil surrounding the stone column to provide adequate lateral stresses to counter excessive bulging.

Soil types, such as peat and other weak materials, which include variations in thickness, may cause differential settlements.

Where the above limitations are found on site, the Engineer should:

- Determine foundation loads.
- Confirm the safe bearing pressure and settlement characteristics required.
- Compare design requirements with Interpretative Soil Investigation.
- Discuss viability of proposals and assess viable alternatives with specialist contractor.
- Submit proposals to the Warranty Provider at the earliest possible opportunity.

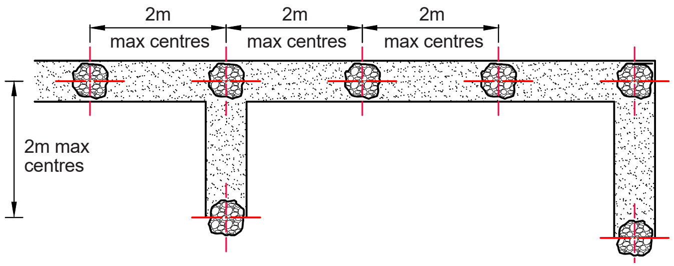
Installation

A suitably qualified competent person should ensure:

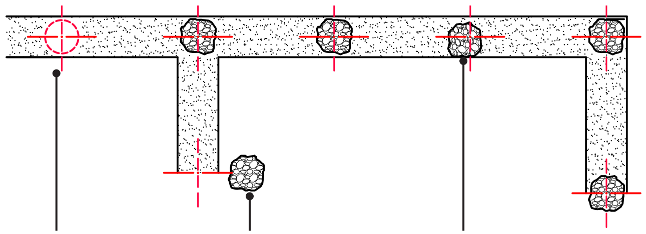
- There is appropriate site supervision and testing to achieve the required foundation design using vibro stone columns.
- Stone columns are located at the intersection of adjacent reinforced spread foundations.
- The minimum depth of stone columns is achieved.
- Any missing stone columns are replaced.

All installation criteria, including location and depth, are checked by suitably qualified competent person prior to the specialist plant leaving the site.

Stone columns can be centrally positioned under the foundation. For wider foundations, stone columns can be installed in a predetermined staggered arrangement under the spread foundation.

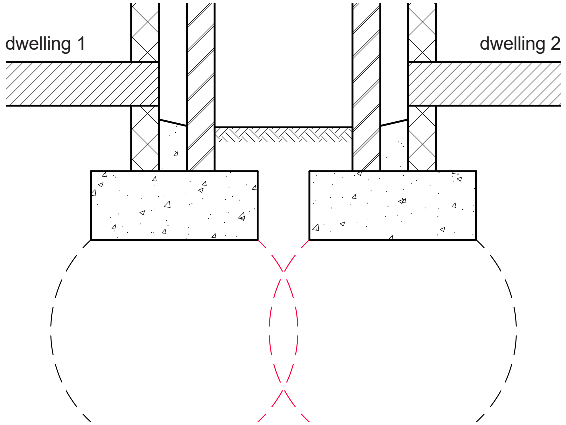


Stone columns which are misaligned by more than 150mm (centre to centre) in any direction should be replaced.



Adjacent foundations and services

- Design of vibratory ground improvement should consider adjacent foundations. Volume of soil treated should allow for the interaction of pressure bulbs and the resulting combined stresses.
- Service or drainage trenches - minimum clearance between foundations and excavations should be greater than depth of trench excavation minus the depth to the bottom of the concrete spread footing.

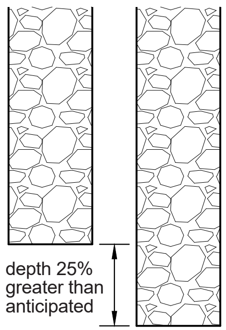


interaction of adjacent foundations

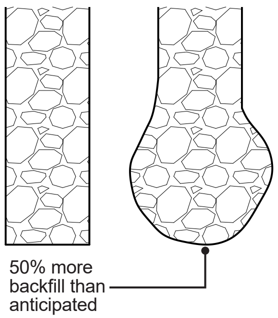
Actions on unforeseen events

The following events should be reported to the design team/specialist contractor and Warranty provider as soon as possible.

Where there is a reduction in treated depth in excess of 25%.



Where there is a significant increase in the quantity of backfill in comparison with similar treated depths.



Design team/specialist contractor should submit recommendations to the builder and Warranty provider.

On completion of the treatment, the Engineer is to confirm that the treated ground has achieved the anticipated condition assumed in the design, and provide evidence in writing to the Warranty Engineer.

Foundations

Foundations on sites with vibratory ground improvements should either be of a reinforced strip or raft type. Both foundations will require a full design by an Engineer.

Foundation drawings and calculations should be prepared by the Engineer indicating the required bearing capacity and settlement characteristics for the purposes of design of vibro stone columns.

Foundations should be sized for the specified safe bearing pressures and be designed to span between the centres of the vibro stone columns.

The designer/engineer should ensure the following:

- RC foundations must be a minimum RC25/30 or FND concrete.
- Foundations shall be designed to span between vibro stone columns and must incorporate top and bottom reinforcement.
- Bottom profile of concrete foundations is located a minimum 600mm bgl and founded on firm material of adequate bearing capacity.
- For ‘low rise structures’ foundations should be designed for maximum settlements of 25mm.
- In relation to differential settlement, a design limit for maximum tilt of 1/500 is appropriate. More stringent values may be required due to the particular circumstances (e.g. medium and high rise structures).

Irrespective of the provision of vibro stone columns, foundation depths and heave precautions must be in-accordance with the guidance provided in this Technical Manual, in respect of trees/clays, whilst ensuring that the vibro treatment is not detrimentally affected by deepening of the foundations. Further guidance can be found in the ‘Foundations - Trees and Clay’ section.

Fill materials

The following materials require testing to ensure their suitability for use as fill to support structural foundations and slabs, or as backfill to associated trenches:

- Acid wastes.
- Reactive materials.
- Materials that include sulphates (e.g. gypsum).
- Organic materials.
- Toxic materials.
- Materials that cause noxious fumes, rot, undue settlement or damage to surrounding materials.

The sample tests should be carried out by a suitably qualified person, and it may be necessary to take a number of samples to identify the material characteristics of the fill accurately.

Sources of fill material

Where the material is of a stable and uniform type from one source, the testing regime may be reduced. However if the material is variable, or from a number of sources, then regular inspections and/or testing may be required.

Recycled aggregate or other building materials, such as crushed brick, should only be used following an inspection by the Warranty Surveyor.

Colliery shale and any other residue from mineral extraction or industrial process bi-products should only be used with specialist approval.

Testing and validation of vibratory ground improvement techniques

Testing should be carried out across the full site and cover all of the various ground conditions to confirm that the ground improvement works meet the design criteria. The tests are usually completed to determine the ground bearing capacity.

The Engineer shall require the specialist contractor to verify that the ground treatment has been completed to a satisfactory standard. This will usually include carrying out suitable testing to establish the degree of ground improvement, its load-bearing characteristics and settlement potential. The testing also needs to be compatible with the following:

- Ground composition.
- Quality of the site investigation.
- Foundation design and depth of treatment.

Testing foundation performance

Plates tests and any combination of the following - zone tests, dummy footing tests and/or pre- and post-treatment investigation - should be used on sites where any of the following apply:

- The treated ground consists of variable types of fill.
- The treated ground includes either peat, silt or clay.
- The ground water level is less than 1.5 x the foundation width below the bearing level.
- Partial depth treatment of fill.
- Variable depth of ground beneath each building.
- The ground to be treated exceeds 6m in depth.

The combination of testing requirements maybe reduced (with prior agreement with the Warranty provider) where the following criteria apply:

- The ground to be improved is well graded and granular.
- There is a low static ground water level that is greater than 1.5 x the foundation width below bearing level.
- The treatment has been taken to a depth below the foundation that is greater than 1.5 x the foundation width and this depth is confirmed with site logs.
- The ground is fill, and is treated to its full depth.
- Uniform ground beneath each building.
- Installation Site logging including print outs from in-cab monitoring is available.
- The site investigation is undertaken to a depth of at least 1.5 x the depth of the treatment.

Test	Description	Notes
Plate Tests	600mm diameter plates loaded to 3 x WL or 11 tonnes, whichever is greater. Minimum rate of 1 test per rig per day.	Plate tests alone may not provide a direct indication of the anticipated settlement of the completed structure. Usually they cannot be considered as the sole means of load testing.
Dummy Footing Test	1500 x 600mm plates loaded to at least 1.5 times Working Load (kPa) for a minimum period of 13 hours. Minimum rate of one per week.	The test should be applied to at least two stone columns and the area of foundation they support.
Penetration Test	Rate of one per (20 to 50) stone columns or one test for not more than 500sqm with a minimum of 1 test for each structural unit.	Penetration tests will not be required if dummy footing tests are carried-out at the recommended rate.
Trial Pits	Trial pits can be excavated around stone columns to prove they are fully formed to the required depth and diameter.	This is a destructive test and therefore allowance should be made accordingly.

Flexible and rigid retaining walls

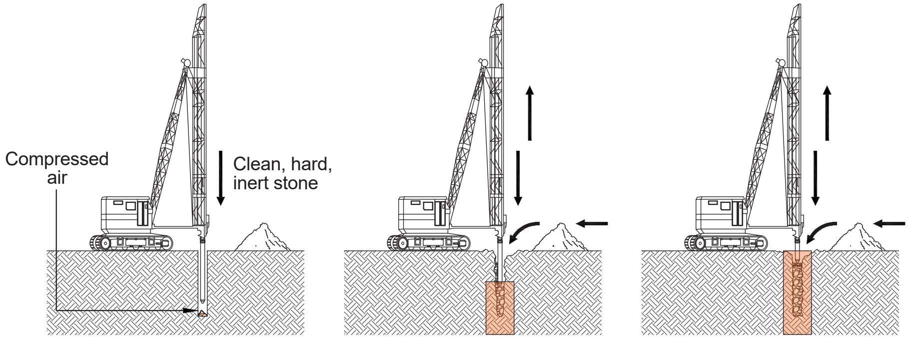
Flexible retaining walls
For the purposes of Warranty, flexible retaining walls may be defined as walls that support soil laterally whilst allowing deformations of the unsupported edge of the flexible retaining wall. Examples of flexible retaining walls include gabion, crib, block, timber or modular retaining wall systems.

Flexible retaining walls should not be used to support the structure of the property, garages, roads, drives, car parking areas or drainage systems.

Rigid retaining walls
Where rigid retaining walls are specified which support the foundations of a building, an Engineers design must be provided to confirm capable of maintaining stability for a period of at least 60 years and all works to the rigid retaining wall should be completed prior to works for the foundations of the property starting.

There are two vibratory techniques commonly used in the UK. These are known as the ‘dry bottom feed’ and ‘dry top feed’ methods; a third technique, less frequently used in the UK, is known as the ‘wet bottom feed’ method.

Vibratory techniques: dry bottom feed method



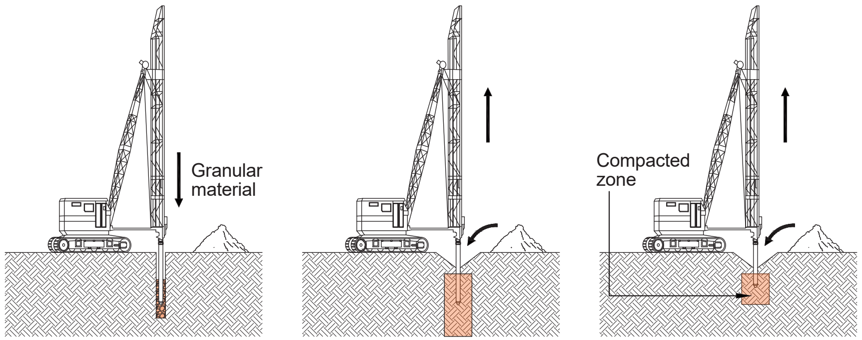
Void is formed as vibrator displaces the ground

Stone backfill is placed into void during withdrawal of vibrator

Continuous stone column formed

The dry bottom feed method is used in weaker soil conditions or where there is a high water table and the borehole is liable to collapse between vibroflot insertions. The vibroflot penetrates using its mass, air flush and vibration, but at design depth, the stone is introduced via a hopper into a pipe fixed to the side of the vibroflot. The stone usually 40mm in size, exits the pipe at the tip of the vibroflot and reaches the bottom of the borehole. The stone is then compacted into the surrounding soil by repeated withdrawal and insertion of the vibroflot.

Vibratory techniques: dry top feed method



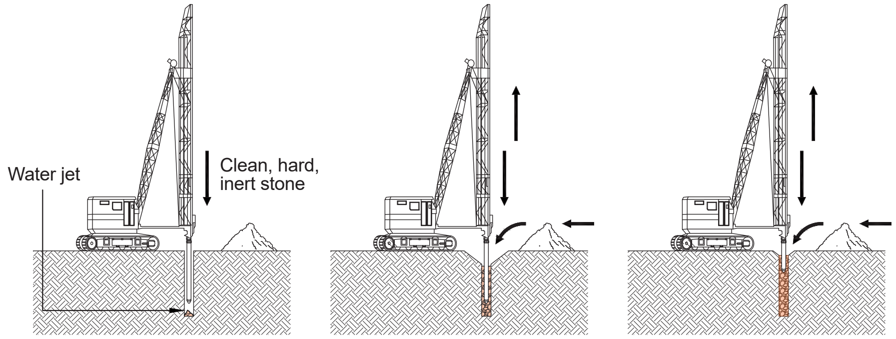
Vibrator displaces the ground

Granular material is placed into the bore

Existing ground is compacted

In the dry top feed method, the vibroflot penetrates the weak soil or fill again using its mass, air flush and vibration to form a borehole. Once refusal or design depth is reached, the vibroflot is removed and stone fill is introduced into the bore, with the ‘charge’ typically 500mm-800mm deep. The vibroflot is re-inserted and ‘packs’ the stone into the surrounding strata. Successive charges of stone are added and compacted, bringing the column up to working level. Typically, the stone grading is 40mm-75mm.

Vibratory techniques: wet bottom feed method



Void is formed as vibrator displaces the ground

Stone backfill is placed into void during withdrawal of vibrator

Continuous stone column formed

Where the ground contains fines and silts, water jetting from the tip of the vibroflot is used to remove loose materials and form a cavity for charges of stone to be added to replace and densify the soft ground. The carbon footprint of this activity is generally less than with comparable piling solutions.

References

British Standards, codes of practice and good guidance relevant to vibratory ground improvement include the following:

- BS EN 1997-1:2004 + A1:2013 - Eurocode 7 Geotechnical Design (EC7).
- BS 8004:2015 + A1:2020 Code of Practice for Foundations.
- BS EN 1997-2:2007 Ground Investigation and testing.
- BS 5930: 2015 + A1:2020 Code of Practice for Ground Investigations.
- BS 6031 Code of Practice for earthworks.
- BS 1377 Part 9 Methods of tests for soils for civil engineering purposes. In-situ tests.
- BS 10175 Investigation of potentially contaminated sites - Code of Practice.
- BS EN 1991 Actions on structures.
- BS EN 14731 Execution of special geotechnical works. Ground treatment by deep vibration.
- BS EN 1997-1 General rules.
- BS EN 1997-2 Ground investigation and testing.
- BS EN ISO 14688 Geotechnical investigation and testing - Identification and classification of soil.
- BS EN ISO 14689 Geotechnical investigation and testing - Identification and classification of rock.
- BS EN ISO 22476 Geotechnical investigation and testing - Field testing.
- BR 391 Specifying vibro stone columns (BRE).
- BRE Information Paper 5/97 Collapse compression on inundation.
- BRE 424 Building on fill: Geotechnical aspects.
- CIRIA C572 Treated ground: Engineering properties and performance, 2002.
- CIRIA C573 A guide to ground treatment, 2002.
- ICE Specification for ground treatment: Notes for guidance, 1987.
- ICE Manual of geotechnical engineering: Volume II.

3. Foundations

3.6 Trees and Clay

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Where trees are present, have been recently removed and/or are to be newly planted a site plan will need to be provided to show the tree and hedgerows that have influence on any foundations.
2. Details of tree species and their height.
3. Site investigation report appropriate for the site specific conditions. The volume change potential of the soil must be noted in the site investigation report.
4. Detailed foundation design with reference to trees which are present, recently removed and newly planted and the site specific site investigation report.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

The following guidance is provided for foundation design when building near trees, hedgerows or shrubs.

Limitations of guidance

The following situations are beyond the scope of this guidance, and will require a site-specific assessment by a suitably qualified and experienced expert:

- Foundations with depths greater than 2.5m within the influence of trees in cohesive soils (note: Mass Fill or Piled Foundations should be adopted).
- Ground with a slope greater than 1:7.
- Man-made slopes, such as embankments and cuttings.
- Underpinning.
- Engineered foundation designs.

Each development site has its own specific characteristics, and where conditions do not clearly fall within the guidance given, clarification should be sought from the Warranty Surveyor or a suitably qualified expert.

The nature of the problem

The roots of all vegetation take water from the soil to make good the water lost from the leaves. If the soil contains clay, it will shrink as it dries (desiccates), or swell if it rehydrates. If the shrinking or swelling extends below the foundations, they will subside or heave in response. If the movements are in excess of those that can be tolerated by the building, then damage is likely to occur.

Although all vegetation can cause soil drying, the roots of trees extend deeper and further and are thus particularly prone to causing damage. Large shrubs can also root to considerable depths, but their influence is more localised. Herbaceous plants and grass can also cause soil drying down to 1.5m, and may require clay heave precaution measures to be installed to foundations.

Damage is best avoided by increasing foundation depth to below the level where significant changes in moisture content are likely to occur. Root barriers are not acceptable as an alternative solution.

This guidance defines the depths that are required and the most suitable types of foundations. The extent of soil drying can be variable and unpredictable. The guidance within this section seeks to minimise the risk by striking a balance between the extent of risk and the costs of increasing foundation depth.

The extent of risk depends on:

- The plasticity index of the soils.
- The potential for the tree species to cause clay soil desiccation.
- The height of the tree.
- The proximity of the tree to the foundations.
- The likely climatic conditions in the locality.
- The removal of trees growing in clay soils.

These factors are considered in greater detail in the following sections.

The soil

Soils may be broadly classified into two types:

- Cohesive soils comprise mainly of clay soil particles. Clay soils display plastic soil behaviour (they swell and shrink, dependent upon climatic conditions, tree root influence and other extraneous conditions – local excavations, burst water mains etc.) and will remain intact if placed into water. As they dry, they will become stiffer, and will eventually crumble if dried beyond a certain point. Potentially, these soils can damage foundations, if not engineered to take account of clay heave and shrinkage.
- Non-cohesive soils, comprising of gravels, sands and silts with perhaps a minor proportion of clay sized soil particles and will break up if placed in water. They are not subject to significant swelling or shrinkage.

The clay component of cohesive soils can vary widely; very few soils are pure clay, but they contain varying quantities of gravel, sand or silt. Clay soils are defined by their particle size (less than two microns), and it is only these clay particles that will shrink or swell. The particles are made-up of a complex molecular lattice structure that is capable of absorbing water.

If, the clay molecular lattice is not saturated it will swell when additional water is introduced. If, the clay molecular lattice is drying out, then it will shrink.

The potential of soil to swell or shrink can be determined by simple tests to determine moisture content , plastic limit (the moisture content below which it changes from being plastic and mouldable, and starts to crumble) and liquid limit (the moisture content above which it changes from being plastic, and starts to flow like a liquid). The plastic and liquid limits can be determined by Atterberg laboratory tests in accordance with BS 1377. The difference between the plastic and liquid limits is the plasticity index; the higher the plasticity index, the greater the potential volume changes.

Unless there is clear evidence that a cohesive soil is not present, Site Investigations will be required to determine the soil type to at least the depth of potential influence of adjacent trees. Usually, trial holes are an acceptable method for determining the soil strata, but specialist Site Investigation reports are preferred if available.

Soil samples should be taken from at least two depths, at 1.5m and 2.5m (or the base of the trial hole, whichever is the shallower), and sent to a soil laboratory for determination of plastic and liquid limit (and thus plasticity index). In addition, the moisture content of the samples is usually determined. The highest value of plasticity index should be used for determining foundation depth. Also see ‘Limitations of guidance’ at the start of this section.

Made-up ground
This refers to land or ground created by filling in a low area with non-original soils or other fill material. Often, such created land is not suitable for building without the use of specialist foundations. If there is high clay content within the made-up ground, then specialist foundations may require additional heave protection. It is also important to establish the depth of the made-up ground, because if it is a relatively shallow depth, the original soil below may be cohesive and within the zone of influence of the tree.

Potential of trees to cause soil drying

Tree species
Tree species differ in the ability of their roots to grow and exploit the available water in a cohesive soil, particularly if it has high clay content. This is commonly referred to as their ‘water demand’. Species such as Oak, Poplar and Eucalyptus are deemed as high water demand as they are particularly efficient at exploiting clay soils, rooting to considerable depth. A few species only rarely cause damage and are deemed of low water demand, whilst the majority fall into the moderate category.

Hardwood species tend to have a broad spreading root system, extending considerable distances laterally as well as to depth. By contrast, the influence of most conifers is more localised, but just as deep. A few species (of both hardwoods and conifers) have intermediate characteristics. The guidance takes account of the different patterns of rooting, but it must be emphasised that the distribution of roots can be variable, meaning the guidance should not be taken as indicating a ‘zone of influence’ of a tree.

Many Local Authorities will require a Tree Survey and Arboricultural Method Statement as part of the planning application. This will usually serve to identify all relevant trees both on and off-site. If a tree cannot be identified, it must be assumed to have high water demand (deep rooting).

Height of tree
The amount of water taken by the roots relates to the leaf area and the vigour of the tree. With open grown trees, height is usually considered the best indicator of leaf area. The greatest water uptake occurs as the tree reaches maturity, and so ‘mature height’ is the determining factor. Individual trees within a group or row will have a smaller leaf area, but as they compete with each other, the mature height of the individual trees remains the relevant factor.

Although some trees are managed as pollards or are subject to periodic reduction to control their size, unless such treatment can be assured in the future, mature height should be used.

The mature heights of common tree species are provided in our online foundation depth calculator. Mature height should be used unless an Arboricultural report is obtained, indicating that a lesser height is appropriate for the conditions of the site.

Proximity
The closer the tree, the deeper the potential influence, and the guidance indicates the required foundation depth at any distance. The parts of the foundations closest to the tree require the greatest depth, but if preferred can be stepped down for more distant parts.

Measurement should be taken from the centre of the trunk to the nearest part of the foundations. If preferred, foundations depths can be stepped down at greater distances, by measurement to other locations around the building.

Foundation Depth Calculator

Foundation depth (see also 'Limitations of guidance' at the start of this section) can be determined using the foundation depth calculator found on our website. The depth of foundation is determined by inputting the:

- Plasticity index of soil.
- Tree type (this will determine the water demand of the tree).
- Mature height of the tree will automatically be determined.
- Distance of the relevant tree to the nearest part of foundations and distances elsewhere if stepping foundations.
- Allowance for climatic conditions.

Internal walls should also be taken to a suitable depth to avoid the effects of heave.

Where the foundation depth calculator identifies a minimum depth exceeding 1.5m, strip foundations must not be used. Mass fill or piled foundations must be adopted.

Foundation depth should be determined on the basis of the individual tree that requires the greatest depth.

Foundation design

Depths in excess of 2.5m
Where the required foundation depths, are in excess of 2.5m, foundations must be designed by a suitable expert, i.e. an Engineer, taking account of the likely effect of soil movement on the foundations and substructure. Bored piles with ground beams or piled raft slabs are recommended, and may prove to be the most economical form of construction. Bored piles are an essential requirement for depths in excess of 3m. See the 'Foundations - Piles' section for further information.

Foundation depths less than 2.5m
Mass fill foundations are likely to be most economic at depths below 1.5m, but can be economic to depths up to 2.5m. However, bored piles are recommended.

For foundation depths in excess of 2m, bored piles with ground beams or piled raft slabs are recommended. All pile designs should be undertaken by a suitable expert, i.e. an Engineer. See the 'Foundations - Piles' section for further information.

Foundation depths to allow for proposed tree planting

Where there is a landscape plan specifying future tree planting, foundation depths should be calculated on the basis of the proposed species of tree and its proximity. If no species has been specified, they should be assumed to be high water demand.

Even if no tree planting has been specified, it is advisable to allow for reasonable future tree or shrub planting, or for the growth of self-seeded trees or shrubs, as shown in column 2 of Table 1.

If the building design or location is such that no tree planting is likely at any time in the future, minimum foundation depths, as shown in column 3 of the table 1, should be used.

Table 1: Minimum foundation depths

Plasticity index	Minimum depth to allow for reasonable future tree/shrub planting (m)	Minimum depth if no future tree/shrub planting likely (m)
40% and greater	1.50	1.00
20% to less than 40%	1.25	0.90
10% to less than 20%	1.00	0.75

Where the foundation depth calculator identifies a minimum depth exceeding 1.5m, strip foundations must not be used. Mass fill or piled foundations must be adopted.

As foundation depth depends on the proximity of the tree, the depth* (see also 'Limitations of guidance' at the start of this section) can be reduced in steps with increasing distance. Steps should be in accordance with the 'Foundations - Mass Fill and Strip' section.

Trees removed prior and during construction

If trees have been removed prior or during construction, then precautions must be taken to allow for the effects of rehydration and subsequent swelling of the soil. The design should be prepared on the assumption the tree is still present.

- Where the height of the removed trees is known, the foundation depth should be determined using the foundation depth calculator. Alternatively, if the height of a removed tree is more than 50% of the target mature height then the mature height should be used. Whereas if the height of the removed tree is less than 50% of the target mature height then use the actual height.
- If the identity is not known, it should be assumed the trees were deciduous with a high water demand, and if actual height is not known, it should be assumed to be 28m.
- Heave protection should be provided as per the guidance where trees remain.

Alternatively, the foundations and heave protection should be designed by an engineer taking into account the recommendations of this guidance, the site investigation report conclusions and recommendations incorporated from both a registered arboriculturalist and geo technical consultant reports. The design should be submitted before work commences on site.

Heave precautions

Where heave precaution is required, compressible material should be used. The compressible material must have appropriate third party accreditation for its use and should be positioned in accordance with Table 2.

Table 2: Position of heave precaution in various situations

Situation	Position of heave precaution
External mass fill and pier foundations (1)	Inside faces of external wall foundation that are greater than 1.5m in depth (2) All faces of pier foundations that are greater than 1.5m in depth (2)
Internal mass fill foundations (1)	None required
External wall ground beams for pier or piled foundations	Inside face and underside to all external ground beams
Internal ground beams for pier or piled foundations	Underside of all internal ground beams
Piled raft foundations	Underside of all piled raft foundations

Notes:
1. Or trench fill.
2. Where required based on the Tree (see guidance on Foundation depth calculator).

The material must be capable of being compressed to allow for vertical and lateral swelling, in accordance with column 3 of Table 3.

Ground bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5m (unless a ground bearing raft is adopted designed using our guidance).

For mass fill foundations, a suspended floor construction should be used (e.g. cast in-situ concrete, precast concrete or timber). This must incorporate either a clear minimum void of a specified depth under the suspended floor or a proprietary compressible material/void former below the underside of the floor construction.

Strip foundations will not be suitable where heave precautions are required.

Note: the compressible material/void former must have a third party approval for use in this situation.

The depth of the void should be in accordance with Table 3, or if a compressible material is used, it should be capable of compressing to provide a void of this thickness. The manufacturer's specifications must be checked to establish the actual thickness of compressible material required to both accommodate movement and be able to compress to the dimensions in Table 3.

Varying foundation depths

As foundation depth depends on the proximity of the tree, the depth* (see also 'Limitations of guidance' at the start of this section) can be reduced in steps with increasing distance. Steps should be in accordance with the 'Foundations - Mass Fill and Strip' section.

Table 3: Minimum void dimensions for foundations, ground beams & suspended floor slabs

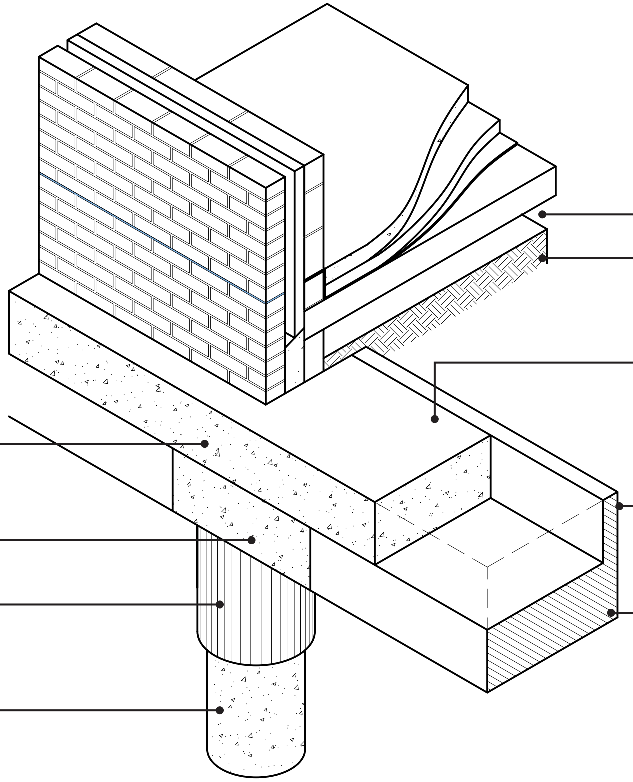
Volume change potential	Plasticity index	Void dimension against side of ground beam and foundation	Void dimension underground beams, suspended in-situ concrete ground floor & piled raft slabs	Void dimension under suspended precast concrete and timber floors(1)
High	40% and greater	35mm	150mm	300mm
Medium	20% to less than 40%	25mm	100mm	250mm
Low	10% to less than 20%	0mm	50mm	200mm

(1) Under suspended floors, the void dimension is measured from the underside of beam or joist to ground level and includes 150mm ventilation allowance.

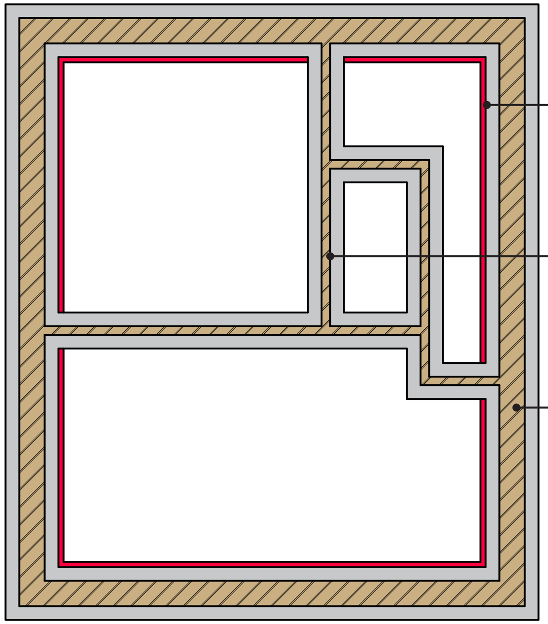
Please note: Void formers consist of materials that collapse to form a void into which the clay can swell. The compressible material/ Void former should have appropriate third party certification demonstrating their suitability as specified. The void dimension is the 'remaining void' after collapse. The thickness of the void former should be in accordance with the manufacturer's recommendations.

Typical foundation designs to allow for heave are shown in the following details.

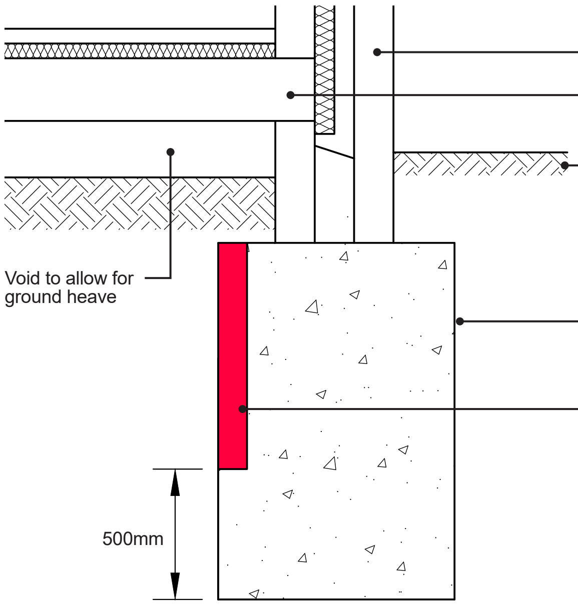
Heave protection - Section through pile and beam foundation



Plan of heave protection to a mass filled foundation



Heave protection - Section through a typical mass filled foundation

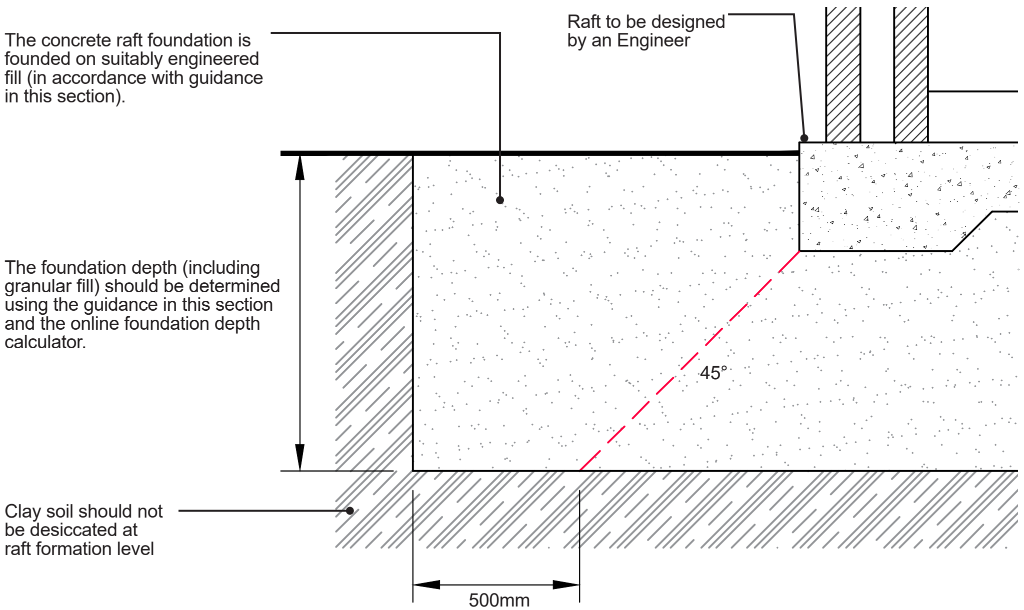


Raft foundations in clay soils susceptible to heave/shrinkage

Where a raft foundation is proposed in shrinkable / expandable soil within the influence of trees (existing, removed or proposed), it will be acceptable only if it is designed to meet the following conditions:

- It is designed by an Engineer and the stiffness of the raft is sufficient to avoid damage to the superstructure and services of the building for the design life of the building.
- Clay should not be desiccated at raft formation level unless it can be demonstrated the residual long term clay heave uplift will be no more than 25mm under the SLS load case: dead load plus 30% superimposed live load.
- Settlement, heave and tilt shall be compatible with the structure without causing structural damage. In general, settlement should not exceed 25mm and differential settlement gradients, across the raft, should not be steeper than 1/500. However, if the structure is engineered to be serviceable with total settlements and differential settlement gradients greater than these figures, then this solution will be considered on a case by case basis using suitable geo-structural analysis. The analysis shall be conducted for the SLS load case: dead load plus 30% superimposed live load.
- The foundation depth (including engineered fill) should be determined using the guidance in this section and the online foundation depth calculator, and;
- The concrete raft foundation is founded on suitably engineered fill and in accordance with the following:
  - The depth of granular fill shall be based on a minimum of 50% of the depth as calculated using the Foundation Depth Calculator for strip/mass fill foundations and is not more than 1.25m deep (measured from the original ground level where ground levels have not been altered). Please refer to our ‘Foundations – Trees and Clay – Changes in level’ section where ground levels are altered.
  - The fill must bypass any made ground and be placed directly on natural ground.
  - The fill should be fully compacted in layers in accordance with the Engineer’s specification ensuring a minimum dry density of 95% and max air voids of 5%. Where the depth of granular fill is greater than 1000mm a site specific earthworks specification and validation report, including testing will be required.
  - The ground level shall be taken as existing or proposed whichever is more onerous.
  - The fill should extend a minimum distance beyond the concrete footprint by a distance equal to a 45° line taken from the underside of concrete plus 500mm. If external buried services are installed on the perimeter of the raft foundation and are below the 45° notional bearing pressure dispersal line, then suitable measures must be taken to ensure the raft ground bearing pressures are transmitted, effectively, to the lower soils e.g. specify concrete bed and surround of services up to the notional 45° bearing pressure dispersal line.
- All materials on the perimeter and 1 metre inside of the raft must be non-frost susceptible for a depth of 450mm from finished external perimeter ground level.
- Services to the building should be designed to accommodate any settlement, heave or tilt.
- Under the raft footprint, services shall be have a concrete bed and surround and be hung from the soffit of the raft.

Where the foundation calculator depth is greater than 2.5m the design condition is outside the guidance of this Technical Manual and should not be used. An Engineer design or alternative foundation type will be required.

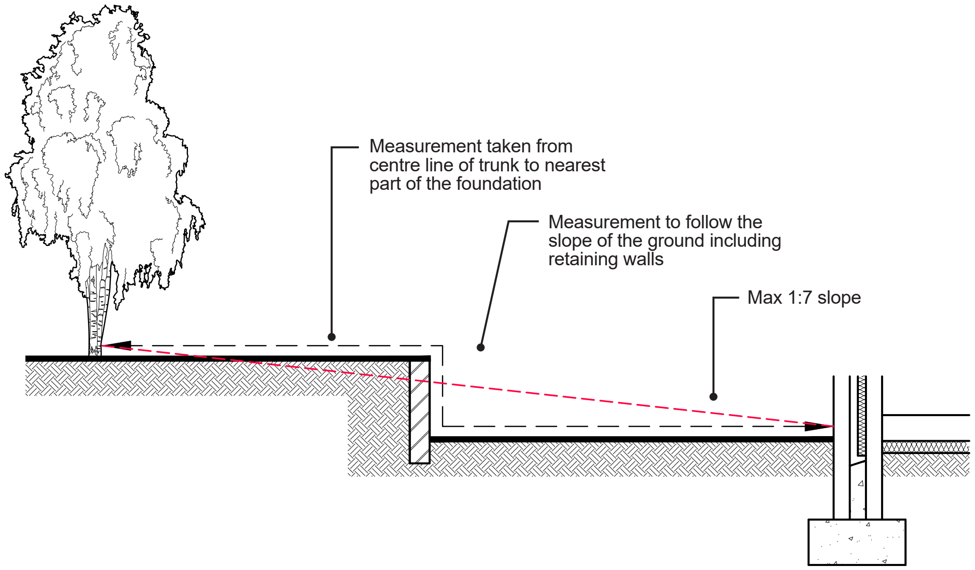


Sloping sites

If the slope is:
- Greater than 1:7, foundations should be Engineer designed.
- For slopes less than 1:7, distance should be measured down the angle of the slope.

Note: If there is a retaining wall, include the height of the retaining wall in the distance.

Measuring foundation distance on sloping sites



Protection for drains

In addition to the requirements of the 'Drainage' section, drainage near trees should incorporate additional provisions. Where there is a volume change potential within the ground, the provisions include:
- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.
- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

Strip and mass fill foundations in non-shrinkable soils overlying shrinkable soils

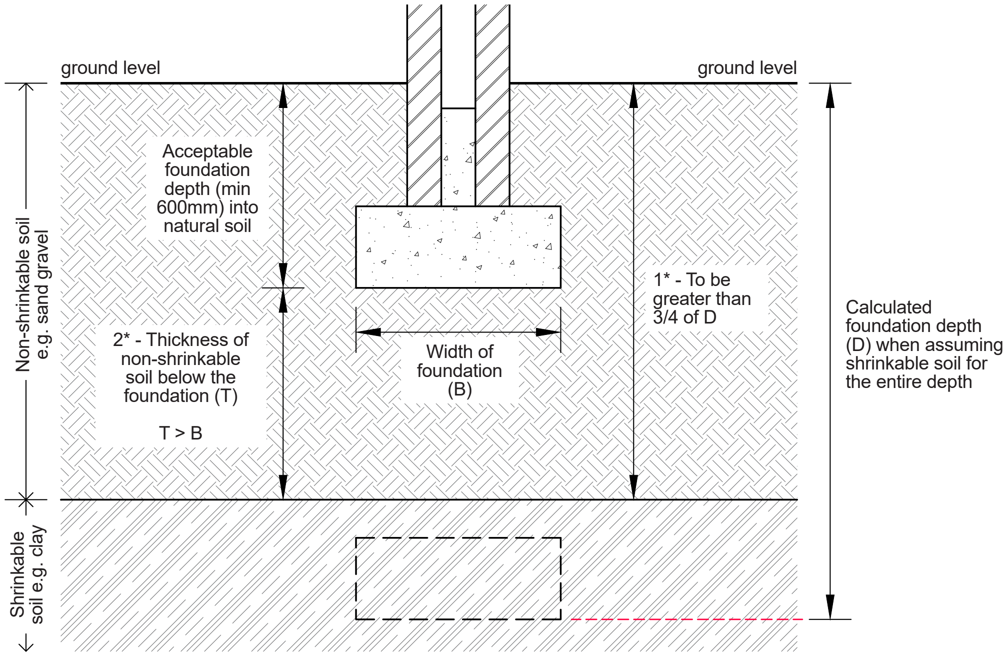
When a sufficient depth of non-shrinkable soil overlies shrinkable soil, the foundation depth can be assessed on the non-shrinkable material provided conditions 1 to 3 below are satisfied.

First, calculate the minimum foundation depth (D), assuming the soil type is shrinkable and under the influence of trees. This depth is taken from ground level.

Condition 1* - Ensure the thickness of the non-shrinkable soil, as measured from the ground level, is greater than 3/4 of dimension D (as shown below).

Condition 2* - Ensure the thickness of the non-shrinkable soil below the foundation (T) is greater than the width of the foundation (B) (as shown below).

Condition 3 - Ensure all other relevant requirements in the 'Foundations' section of the Technical Manual are met.



Changes in level

Where the ground level is raised or reduced, and trees are remaining, removed or proposed, the guidance in one of the below scenarios should be followed. In all instances, ensure all other relevant requirements in the ‘Foundations’ section of the Technical Manual are met.

Scenario 1: Existing trees are remaining and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the deeper foundation from either:

- The result of the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height. This result should be measured from the **original** ground level; **or**,
- The result of the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

Scenario 2: Existing trees are to be removed and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on:

- The result of the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height. This result should be measured from the **original** ground level.

Scenario 3: New trees are proposed and the original ground level is raised

If ground levels are raised within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the deeper foundation from either:

- The minimum foundation depth as given in column 3 of ‘Table 1: Minimum foundation depths’ in the ‘Foundations – Trees and Clay - Foundation depth and heave precaution requirements’ section of the Technical Manual. This result should be measured from the **original** ground level; **or**,
- The result of the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

Scenario 4: Existing trees are remaining and the original ground level is reduced

If ground levels are reduced within the influencing distance of trees, the minimum foundation depth should be based on:

- The result of the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

Scenario 5: Existing trees are to be removed and the original ground level is reduced

If ground levels are reduced` within the influencing distance of trees, the minimum foundation depth should be based on whichever provides the deeper foundation from either:

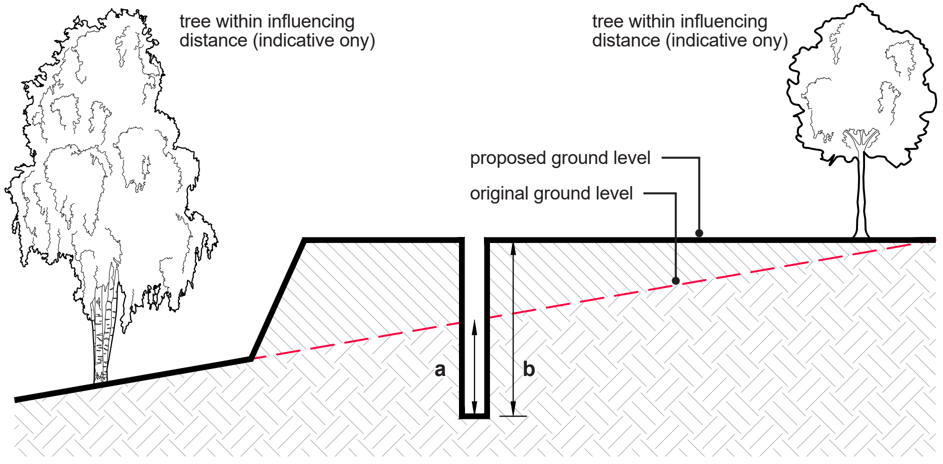
- The result of the Foundation Depth Calculator when using the existing height of the tree or the mature height in instances where the existing height is currently at least 50% of the expected mature height. This result should be measured from the **original** ground level; **or**,
- The minimum foundation depth as given in column 3 of ‘Table 1: Minimum foundation depths’ in the ‘Foundations – Trees and Clay - Foundation depth and heave precaution requirements’ section of the Technical Manual. This result should be measured from the **proposed** ground level.

Scenario 6: New trees are proposed and the original ground level is reduced

If ground levels are reduced within the influencing distance of trees, the minimum foundation depth should be based on:

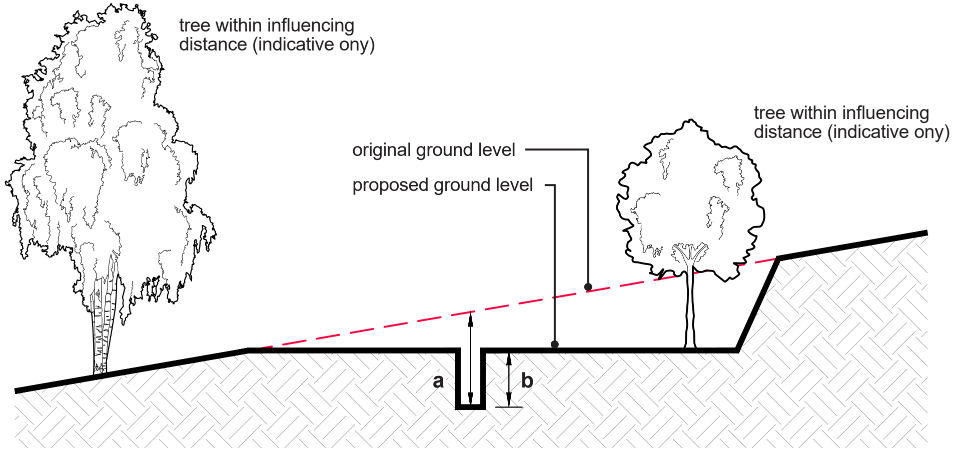
- The result of the Foundation Depth Calculator when using the mature height of the tree. This result should be measured from the **proposed** ground level.

Where to measure when the original ground level is raised



Key
a = foundation depth measured from the original ground level.
b = foundation depth measured from the proposed ground level.

Where to measure when the original ground level is reduced



Key
a = foundation depth measured from the original ground level.
b = foundation depth measured from the proposed ground level.

4. Ground Floors

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. Certification is required for any specialist's works or systems completed by an approved installer.
2. All workmanship must be within the tolerance requirements set out in this Technical Manual.
3. All work is to be carried out by a technically competent person in a workmanlike manner.
4. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
5. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
7. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. Ground floors shall be designed and constructed so that they:
    a. Provide a suitable surface for normal dwelling activities;
    b. Are structurally sound;
    c. Are durable and resistant to moisture passing into the internal environment of the building;
    d. Have an adequate thermal performance;
    e. Prevent the entry of hazardous substances from the ground into the building.
2. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
3. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
4. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

4.
Ground Floors

4.1
Suspended Ground Floors

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. For beam and block floor systems, manufacturer's floor layout drawings and calculations.
2. For cast in-situ suspended concrete slab:
   a) An Engineer's full set of structural calculations.
   b) Details on how the slab is to be reinforced.
   c) Details of the concrete mix to be used.
3. For suspended timber ground floors, an Engineer's full set of structural calculations.
4. For proprietary suspended pre-cast insulated concrete floor systems, third party certification for proprietary suspended pre-cast insulated concrete floor systems.
5. For all floor systems:
   a) Plan details showing dimensions, levels and locations of incoming service penetrations.
   b) Details indicating the depth and position of below ground services.
   c) Details of junctions between DPM and DPC.
   d) Ventilation provision should be detailed by the designer.
   e) Details indicating the locations of all load and non-load bearing walls.
   f) Manufacturer's third party certification for the proposed insulation to be used within the floor.
   g) Details of underfloor heating systems where being used.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Influence of trees and clay

In clay soils if the foundation depth is greater than 1.5m, allowance should be made in the design for heave. This must incorporate either a clear void of a specified minimum depth under the suspended floor, or a proprietary compressible material/void former below the underside of the floor construction. Please refer to the 'Foundations – Trees and Clay' section for further guidance.

Site preparation

Beam and block floors and proprietary suspended pre-cast insulated concrete floor systems
All topsoil and organic matter should be removed from beneath the suspended floor.

Cast in-situ suspended concrete slabs
The material below the proposed floor slab should be compacted sufficiently to support the slab during the pouring and curing stages. Any backfill material should not contain any organic matter, or contaminants that could react with the concrete or be susceptible to swelling, such as colliery waste.

Ground gases

Ground floors must be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

Contaminants should be identified within the site investigation report and the recommendations provided within the report should be followed. Please refer to the 'Ground Conditions' section for further guidance.

Insulation

In all circumstances, insulation within the floor construction should be chosen to take the following into account:

- The insulation should be durable enough to withstand loadings, moisture and any ground contaminants.
- The insulation should comply with relevant Building Regulations.
- The floor insulation should be compatible with wall insulation.
- Any risk of thermal bridging is mitigated, especially at junctions with the floor and wall. The following can be considered at design stage:
  - Installing perimeter insulation to floors.
  - Linking floor and wall insulation.
  - Extending cavity wall insulation below floor slab level.

Damp proof courses (DPC)

DPC's should be laid on a mortar bed and correctly lapped at junctions and corners. The depth of lap should be the same as the width of the DPC.

DPC's should be of a flexible material that is suitable for its intended use, and the DPC should have appropriate third-party certification.

DPC's should not bridge any cavities unless it is acting as a cavity tray. Where a cavity tray is required, please refer to the 'External Walls' section for cavity tray, weep holes, and stop end requirements.

Suitability of beam and block floors

All beam and block flooring systems must have appropriate third-party certification.

The manufacturer's details and specification for the floor must include:

- Structural calculations for the floor indicating depth and centres of the precast floor beams.
- The minimum specification of walls supporting the beam and block floor.
- Specifications for the blocks infilling between the beams, including compressive strength and thickness of the block.

All beam and block floors shall be installed ensuring that the following standards are met:

- The floor beams must be laid reasonably level and onto suitable solid and level bearings.
- Floor beams and blocks are grouted together using cement/sand slurry with a mix ratio of 1:6 respectively.
- The beam and block floor should not be used to support load-bearing walls.
- All walls should be built off an appropriate foundation, as indicated in the 'Foundations' section.
- A suitable mortar bed is required where block work between the floor beams bear onto load-bearing walls, e.g. perimeter walls.
- Holes must not be made through the floor beams and any service penetrations should pass through the holes made in the infill blocks. Any gaps around service penetrations should be filled with concrete (ST3) mix before screeding.

Where beam and block floors are to be installed to areas with higher potential point loads such as garages, additional reinforcing of the screed will be required to distribute loads effectively. This reinforcing should be of at least an 'A' mesh quality, and the screed should be thick enough to give an appropriate depth of cover.

Proprietary suspended pre-cast insulated concrete floor systems

Where proprietary suspended pre-cast insulated concrete floor systems are proposed, they must:

- Be designed by an Engineer with loads calculated in accordance with BS EN 1991-1-1; and,
- Have a third party product approval certificate for its use; and,
- Where gas membranes are required, the gas membrane must have a third party product approval certificate for use with the proposed floor system.

Cast in-situ suspended concrete slab

Structural design
A cast in-situ suspended concrete slab should be designed by an Engineer with loads calculated in accordance with BS EN 1991-1-1.

The structural design should include the following information:

- Adequacy of walls that support the concrete slab (intermediate and perimeter walls).
- Suitable thickness, correct durability of concrete and correct provision of reinforcing.
- Provision of anti-crack reinforcing to the perimeter of floors.

Cast in-situ suspended concrete slab - Concreting of floors

Prior to concreting, any water or debris that may have collected on top of the DPM should be removed.

The depth of concrete will vary depending upon the load conditions and the span of the floor. The overall reinforced concrete slab design should be designed by an Engineer.

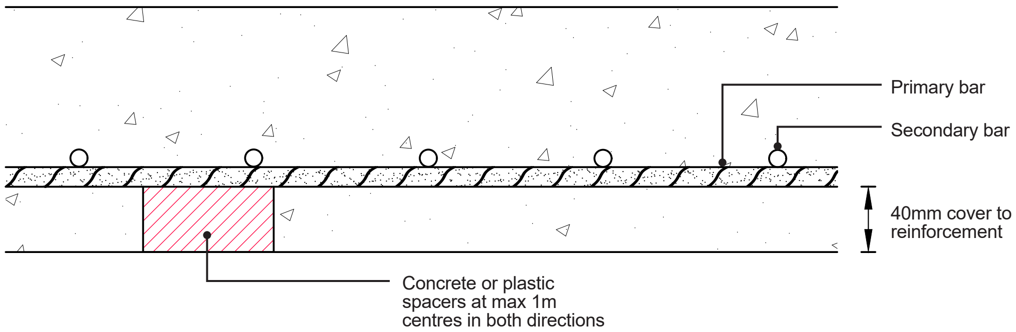
- The reinforced concrete should have a minimum strength of RC35 and be ready mixed and delivered on-site.
- Site mixing of concrete is not considered suitable for concrete suspended floors.
- The poured concrete should be lightly vibrated and well tamped to ensure that no voids are left within the floor slab.

The floor slab should be appropriately shuttered around its perimeter to enable a cavity to be formed between it and the external wall. The shuttering can be expanded polystyrene (which is removed once the concrete has set) or a proprietary shuttering system.

The suspended floor construction must be laid reasonably level and onto suitable solid and level bearings.

Cast in-situ suspended concrete slab - Floor reinforcing cover and support

The main reinforcing bars must have a minimum concrete cover of 40mm. Suitable spacers should be provided to support the reinforcing prior to concreting.



Standard of fabric reinforcing

Reinforcing fabric should be free from loose rust, oil, grease, mud and any other contaminants that may affect the durability of the concrete. Reinforcing fabric should be of a ‘B’ mesh grade. This can be identified by the size of the primary and secondary bars. Primary bars are spaced at 100mm centres and secondary bars are placed at 200mm centres, as indicated in Table 1.

Table 1: Standard ‘B’ mesh reinforcing details

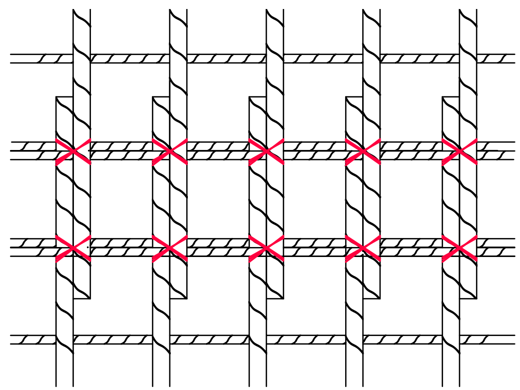
BS Reference	Primary Bar			Secondary Bar		
	Size (mm)	Spacing of bars (mm)	Area (mm²/m)	Size (mm)	Spacing of bars (mm)	Area (mm²/m)
B1131	12	100	1131	8	200	252
B785	10	100	785	8	200	252
B503	8	100	503	8	200	252
B385	7	100	385	7	200	193
B283	6	100	283	7	200	193
B196	5	100	196	7	200	193

Table 2: Minimum laps for reinforcing

Minimum laps for main reinforcing bars in fabric mesh (1)	
Fabric Type	Minimum lap (mm)
B1131	500
B785	400
B503	350
B385	300
B283	250
B196	200
Note: (1) A minimum lap of 300mm is required for secondary reinforcing bars.	

Lapping of reinforcing

It is accepted that reinforcing can consist of a number of sheets that can be joined together as identified in Table 2. The depth of cover may need to be increased to maintain minimum cover depending on the thickness of mesh reinforcing. All loose reinforcement that acts as part of the reinforcing layers must be adequately tied together.



Resistance to ground moisture

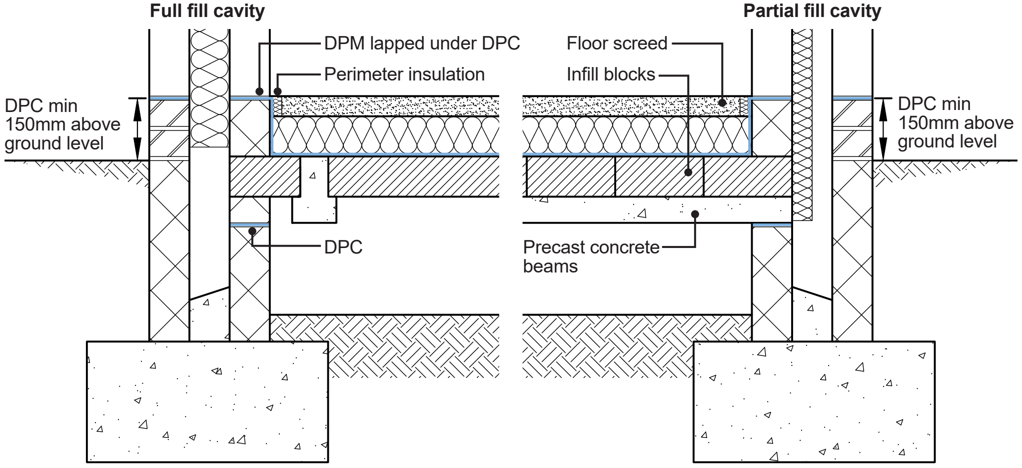
The suspended ground floor system shall be designed to prevent water ingress and this can be achieved by providing a DPM.

Damp proof membrane (DPM) requirements

Where DPM's are specified, the following considerations must be observed:

- The DPM should be a minimum thickness of 1200g polythene.
- The DPM must be linked to the DPC with a minimum 100mm overlap.
- DPM sheets should be overlapped by at least 300mm.
- DPM's must be carefully protected where folded up the perimeter walls, and lapped under the DPC particularly at door openings.
- Temporary protection should be given whilst exposed.
- The DPM should not be cut at the floor junction as this will prevent correct lapping with the DPC.
- The DPM should be provided beneath the screed or insulation. A number of insulation products require an additional DPM to protect the surface of the insulation. It is important that this additional membrane is incorporated in these situations.
- For suspended beam and block floors and proprietary suspended pre-cast insulated concrete floor systems the floor void beneath the floor system should be appropriately vented, ensuring that a cross flow of air between two external walls is achieved.

Other DPM's may be considered if they have appropriate third-party certification and are installed in accordance with the manufacturer's instructions.



Notes:

- Insulation must be installed to meet the manufacturer's installation requirements and relevant Building Regulations.
- Where the solum level is below the external ground line, suitable drainage provision to avoid build-up of ground water must be provided. Where the ground below the floor is to be drained, the design must be provided by an Engineer with relevant experience. The design must be based on site specific site investigation that meets the requirements of our 'Ground Conditions' section.
- DPCs must be provided under bearings of precast floors

Conditions to be satisfied where the DPM is to be omitted

Where no DPM is incorporated into the suspended ground floor system, the following provisions will apply:

- The sub-floor void must be ventilated as per the guidance provided within this section.
- DPCs must be provided under bearings of precast floors.
- The ground below the floor must be effectively drained if excavated below external ground levels.

Where the ground below the floor is to be drained, the design must be provided by an Engineer with relevant experience. The design must be based on site specific site investigation that meets the requirements of our 'Ground Conditions' section.

Sub-floor ventilation requirements

Sub-floor ventilation should be provided below suspended beam and block ground floors, proprietary suspended pre-cast insulated concrete floor systems and suspended timber floors and this should be provided with ventilators on at least two opposing sides of the external wall with air bricks appropriately ducted in accordance with the manufacturer's instructions.

Air bricks should be situated at least 75mm from the external ground level.

Internal walls should be constructed with sufficient openings to ensure cross-flow ventilation is maintained. All internal walls must have air bricks to allow the free flow of air, or be built using a honeycomb technique.

Void ventilation should be provided to whichever gives the greater opening area:

- 1500mm^2 per metre run of external wall.
- 500mm^2 per m^2 of floor area.

Please note, the typical net ventilation area for the air brick will vary by air brick manufacturer.

A minimum ventilation void of 150mm should be provided below the underside of all suspended ground floors. A larger void will be required for shrinkable soils where heave may take place:

- Low volume change potential – 200mm void dimension.
- Medium volume change potential – 250mm void dimension.
- High volume change potential – 300mm void dimension.

The void dimension is measured from the underside of beam to ground level and includes 150mm ventilation allowance.

Party wall junctions

At party wall junctions, where required, the floor should have appropriate sound and fire resistance in accordance with the relevant Building Regulations.

Durability of suspended timber ground floors

To prevent the decay of timber joists, the suspended timber floor should be constructed in such a way that:

- All joists and wall plates are above the DPC level.
- A minimum void of 150mm is provided between the joists and oversite.
- Air bricks are provided to give adequate cross ventilation to the floor void.
- Joists have adequate bearings and do not protrude into the cavity.

Detailing of suspended timber ground floors

All floor joists must be of a suitable durability and strength grade (minimum C16), be of the correct size and stress grade and be laid at the correct specified centres as indicated on plans and specifications. The joists should have consistent dimensions and be securely nailed to timber wall plates.

The floor joists must be laid reasonably level and onto suitable solid and level bearings.

Please refer to the ‘Tolerances’ section for guidance on levelness and deflection limits of floor joists. There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

Joists at the junction with the external and party walls should be supported on suitable joist hangers and be adequately strutted at mid-span.

Floor joists can be supported internally by sleeper walls. Sleeper walls should be built off an adequate foundation if the ground is of suitable bearing strata, or can be built of a reinforced thickened slab where designed by an Engineer.

Sizing of floor joists

For advice on ‘sizing of certain timber members in floors for dwellings’, the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by TRADA. Note: Reference should be made to the version of the TRADA document current at the time of construction of the floor/timber or roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General: Common rules and rules for buildings.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by an Engineer.

Joists should be restrained at supports using tightly fitted strutting.

Stepped floors

For lower ground floors on sloping sites and semi basements timber suspended ground floors are not recommended.

Concrete oversite

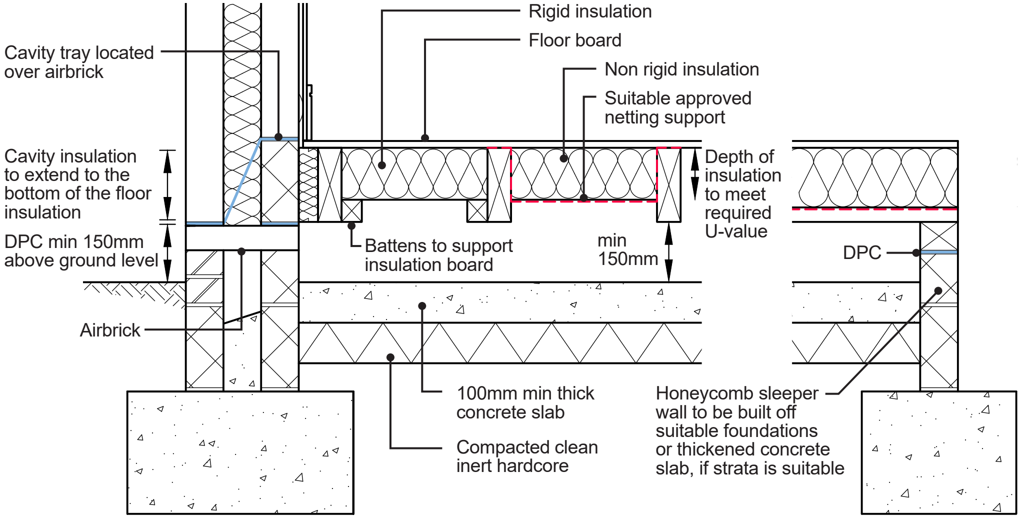
A suitable oversite should be provided at least 150mm below the timber suspended floor.

The oversite should be either:

- 100mm thick concrete over-site (GEN 3) on well-compacted hard core, or;
- 50mm thick concrete over-site on a 1200g DPM laid on 25mm sand blinding and well-compacted hard core.

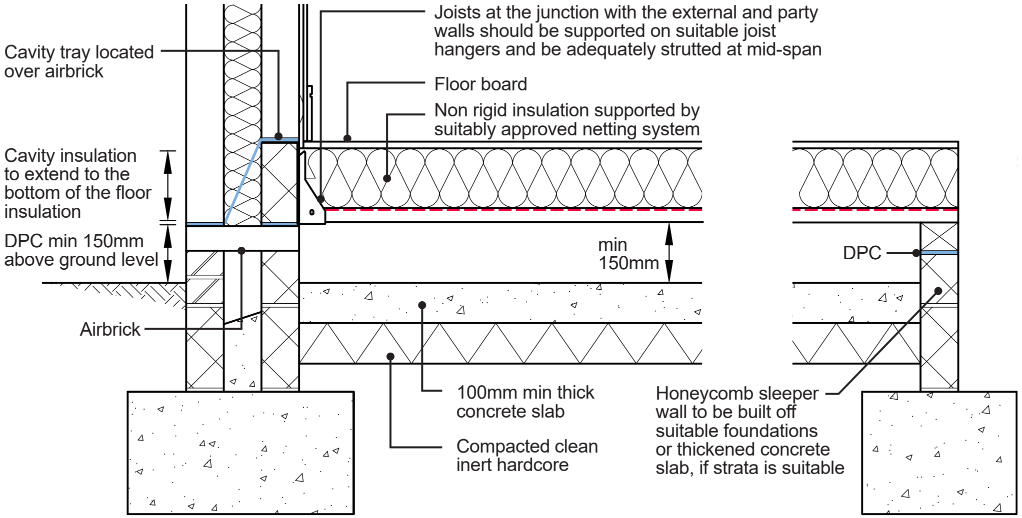
For sites that are susceptible to gas migrations, the oversite should incorporate gas protection measures designed by a suitable specialist.

Suspended timber ground floor running parallel to wall



Note: If ground conditions consist of clay soils and trees are, were, or likely to be present, the void under must allow for heave potential in the solum

Suspended timber ground floor bearing onto an external wall



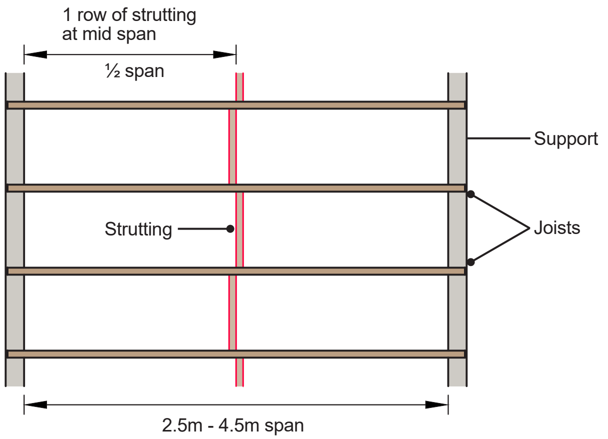
Note: If ground conditions consist of clay soils and trees are, were, or likely to be present, the void under must allow for heave potential in the solum

Strutting or bridging of solid timber floor joists

Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3 or by a proprietary system.

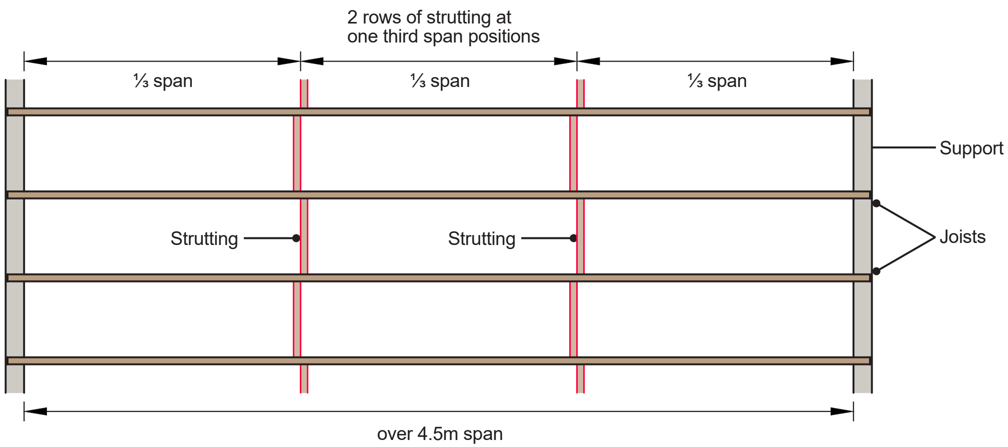
Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists; or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

Strutting of joists with a span between 2.5m and 4.5m



Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3 or by a proprietary system.

Strutting of joists with a span over 4.5m



Where the span of a floor joist or flat roof joist is more than 4.5m, two rows of strutting at ⅓ the span position will be necessary.

Deflection of floors

For timber floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness of floors and deflection limits. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

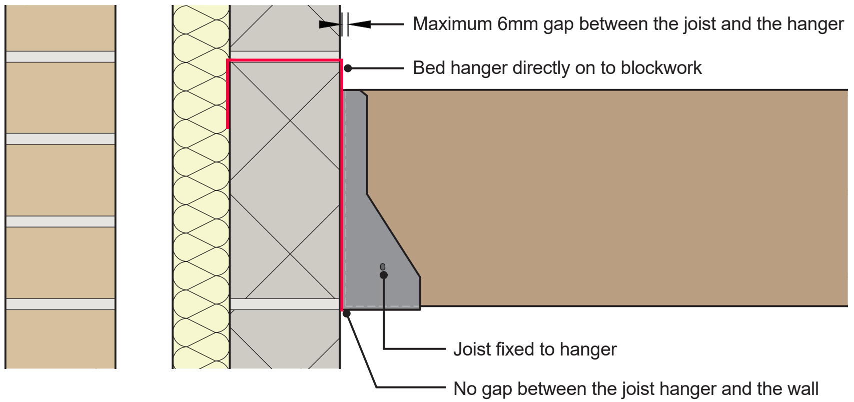
Where the joists are supported on joist type hangers

It is necessary to ensure that:

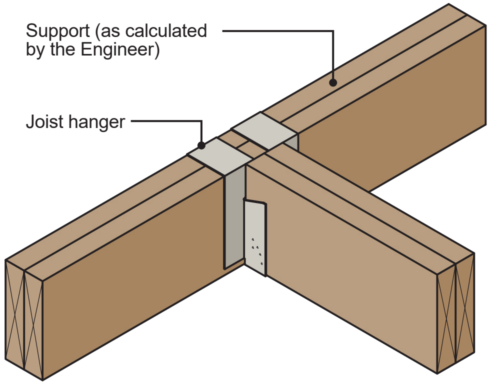
- The hanger is bedded directly on the masonry and there is no gap between the hanger back-plate and the face of the masonry.
- At least 450mm of masonry is provided above the hanger or as per manufacturer's requirements.
- Hangers are spaced at centres of floor joists included in the design.
- The hanger is suitable for the loadings and masonry strength.

Do not:

- Apply load while the mortar is still green and has not gained sufficient strength.
- Use brick courses in block walls under joist hangers as the thermal insulation of the wall may be reduced unless similar units to the blocks are used.



Typical trimming detail

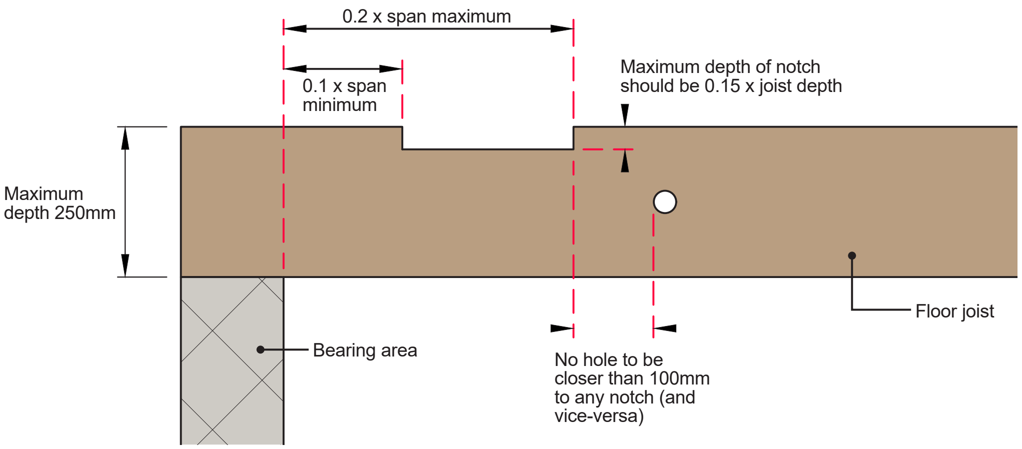


Joists should have a minimum end bearing of 90mm, unless joist hangers are used, where a 35mm bearing is acceptable (subject to the manufacturer's details).

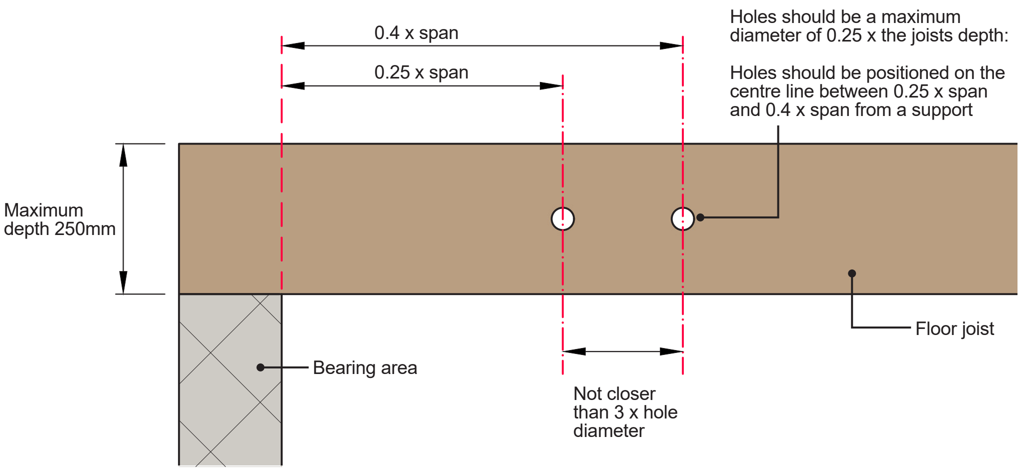
Double joists should be bolted together at 600mm centres using minimum 10mm diameter bolts with large washers that will prevent the bolt head and nut from penetrating the joist. It is recommended that the bolting of double joists is along the centre line of joists. Suitably sized trimmer joists shall be provided around floor openings.

Trimmed openings may be needed around chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection; timber trimmers around openings should consist of at least two members and be designed by an Engineer.

Permissible areas for the notching of joists



Permissible areas for the drilling of joists



Notching and drilling in solid timber joists

Requirements for notching and drilling of solid timber joists (further guidance can be found in BS 8103, TRADA span tables, BS EN 1996 and PD 6693-1).

This guidance is for joists up to 250mm deep, notching and drilling for joists exceeding this depth should be designed by the Engineer.

Notches: Notches should be made in between 0.1 and 0.2x span. Notches should be no deeper than 0.15x depth of the joists in this area e.g. for a 250mm deep joist, the maximum notch depth should not exceed 35mm.

Holes: Holes should be drilled on the centre line of the joist. Holes should be between 0.25 and 0.4 x the span. Holes should be a maximum diameter of 0.25x the joists depth and kept apart by at least 3x the diameter. The maximum hole diameter should not exceed 65mm.

Note: Notches and holes should be a minimum of 100mm apart.

The table below gives an indication of the areas in a joist which are suitable for notching and drilling.

Typical permissible zones for notching and drilling of solid timber joists

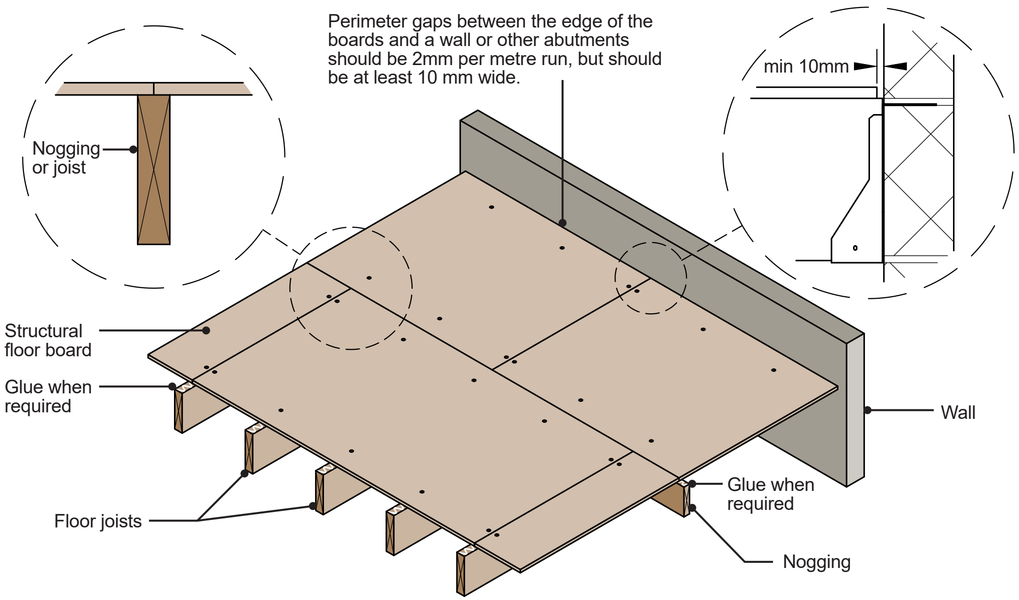
Span (m)	Notches to be taken out only within these zones (m)		Holes only to be drilled within these zones (m)	
1.5	0.15	0.3	0.375	0.6
2	0.2	0.4	0.5	0.8
2.5	0.25	0.5	0.625	1
3.0	0.3	0.6	0.75	1.2
3.5	0.35	0.7	0.875	1.4
4	0.4	0.8	1	1.6
4.5	0.45	0.9	1.125	1.8
5	0.5	1	1.25	2

General requirements

Where structural floor boards are specified, the following should be taken into account:

- They should be specified in accordance with the 'Minimum thickness for structural floor boards' table, guidance within this section, and the relevant British Standards.
- Fixings should be in accordance with the manufacturer's recommendations, where this is not provided, the guidance within this section or BS 8103-3 should be used.
- Where gluing is required, boards should be glued to the joists and between board joints, using a suitable polyvinyl acetate (PVAc) adhesive.
- Square edged boards should be supported on all edges by joists or noggings.
- Tongue and groove boards should be laid:
  - With long edges at right angles to joists.
  - So that short edges are supported on joists or noggings or they should be cut back to form a butt joint over a joist.
  - So that long edges at room perimeters are supported on a joist or noggings.
- Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10 mm wide.

Typical floor board arrangement



Minimum thickness for structural floor boards

Structural floor boards should be specified in accordance with the below table[1].

Structural floor board type	400mm joist centres	450mm joist centres	600mm joist centres
Softwood floor boarding	16mm	16mm	19mm
Particle board (chipboard)	18mm	18mm	22mm
Oriented strand board (OSB)	15mm	15mm	18mm/19mm
Plywood boarding	15mm	15mm	18mm/19mm
1. This table applies to normal domestic loads (imposed loads of 1.5 kN/m^2).			

Protection against weather

Structural floor boards that are built in as the work proceeds and left exposed to the elements will be subjected to various issues, especially during prolonged periods of precipitation. As such, we require these floor boards for timber joists (both engineered and traditional) to have a third party approval certificate from a UKAS accredited body which covers weather resistance for the period of time the boards are to be left exposed on site.

Any boards that are left exposed beyond the period stated in the third party approval certificate should be replaced.

Softwood floor boarding

- Softwood floor boarding should be specified in accordance with BS EN 13353 and BS 1297.
- Maximum moisture content at the time of fixing should be between 15%-19% (this may be reduced when installing in heated spaces, see BS 8103-3 for further details).
- All boards must be double nailed or secret nailed to each joist using nails that are at least three times the board depth.

Particle board (chipboard) and oriented strand board (OSB)

- Particle board should be type P5 to BS EN 312 or OSB boards should be type 3 or 4 to BS EN 300.
- Maximum moisture content at the time of fixing should be 12%.
- Flat headed annular-ringed shank nails or screws should be used.
- All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater.
- The diameter of the fixing should be a minimum of 0.16 times the thickness of the board.
- Fastenings should be spaced at centres not more than 150 mm along both continuously supported edges and 300 mm along the intermediate supports.
- Fastenings should be at least 8 mm from the edge of the board.
- Nail heads should be punched 2-3mm below the surface of the board and screws should pre-drilled and countersunk.
- Fixings in service class 2 fixings should be corrosion resistant.
- A 3 mm gap should be left between each square edge boards.

Plywood boarding

- Plywood boarding should be specified in accordance with BS EN 636.
- Maximum moisture content at the time of fixing should be 12%.
- Plywood boarding should be laid so that the grain within the face is at right angles to the supporting elements.
- Fixings should be spaced at a maximum of 150mm around the outer perimeter of the boards, with fixings a maximum of 300mm apart at intermediate supports.
- An expansion gap of a minimum of 2mm should be allowed between each panel

Plywood boarding: Minimum fixing nails

	Plain wire nails	Annular ring shank nails
Minimum diameter	3.35mm	3mm
Minimum length	65mm	50mm
Minimum penetration	40mm	32mm

4.
Ground Floors

4.2
Ground Supported Slab

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Plan details showing dimensions, levels and locations of incoming service penetrations.
2. An Engineer's full set of structural calculations for the floor construction.
3. Details indicating the depth and position of below ground services.
4. Details of junctions between DPM and DPC.
5. Manufacturer's third party certification for the proposed insulation to be used within the floor.
6. Details of underfloor heating systems where being used.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Influence of trees and clay

Ground bearing slabs should not be used in ground conditions where heave can occur or where the foundation depth is greater than 1.5m. Under these circumstances a suspended floor construction should be used.

Site preparation

The ground beneath the floor should be stripped of all topsoil, organic matter or tree roots prior to filling and compaction.

Suitable hard core would include inert quarried material such as limestone or granite. Recycled aggregates may be used, which include crushed concrete or broken brick; however, these must be completely free of contaminants and plaster and should be delivered to site from a supplier that has a quality audit process in place.

Materials available as a result of any site demolition should not be used as hard core beneath floor slabs unless specifically agreed by the Warranty Surveyor and only then if it can be demonstrated that the material is completely free of contaminants and plaster.

Hard core should be placed and compacted in 150mm nominal layers and be fully consolidated using a mechanical compactor. A ground supported concrete floor will not be acceptable where the depth of the hard core exceeds 600mm and an alternative suspended ground floor construction must be used. Hard core material should not be saturated and should be taken to ensure that the new walls are not disturbed by compaction of the hard core.

All services placed under the floor construction must be suitably protected and sleeved where penetrating through the floor slab. DPM's must be correctly sealed around these penetrations.

Ground gases

Ground floors must be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

Contaminants should be identified within the site investigation report and the recommendations provided within the report should be followed. Please refer to the 'Ground Conditions' section for further guidance.

Concreting of floors

Prior to concreting, any water or debris that may have collected on top of the DPM should be removed. Concrete should ideally be ready mixed and be of at least GEN1 (see 'Appendix C - Materials, Products, and Building Systems: Concrete - Cold weather working and minimum specification' for further information). Expansion joints should be provided in accordance with 'Appendix C - Materials, Products, and Building Systems' section.

The floor must be laid reasonably level.

Damp proof courses (DPC)

DPC's should be laid on a mortar bed and correctly lapped at junctions and corners. The depth of lap should be the same as the width of the DPC.

DPC's should be of a flexible material that is suitable for its intended use, and the DPC should have appropriate third-party certification.

DPC's should not bridge any cavities unless it is acting as a cavity tray. Where a cavity tray is required, please refer to the 'External Walls' section for cavity tray, weep holes, and stop end requirements.

Damp proof membranes (DPM)

A DPM should be provided beneath all ground-supported slabs. DPM's should be a minimum thickness of 1200g polythene and linked to the DPC with a minimum 100mm overlap. DPM sheets should be overlapped by at least 300mm. DPM's must be carefully protected where folded up the perimeter walls, and lapped under the DPC particularly at door openings. Temporary protection should be given whilst exposed. The DPM should not be cut at the floor junction as this will prevent correct lapping with the DPC.

Membranes should be laid either onto a concrete slab or onto a minimum 5mm sand blinding (if laid below a floor slab).

Other DPM's may be considered if they have appropriate third-party certification and are installed in accordance with the manufacturer's instructions.

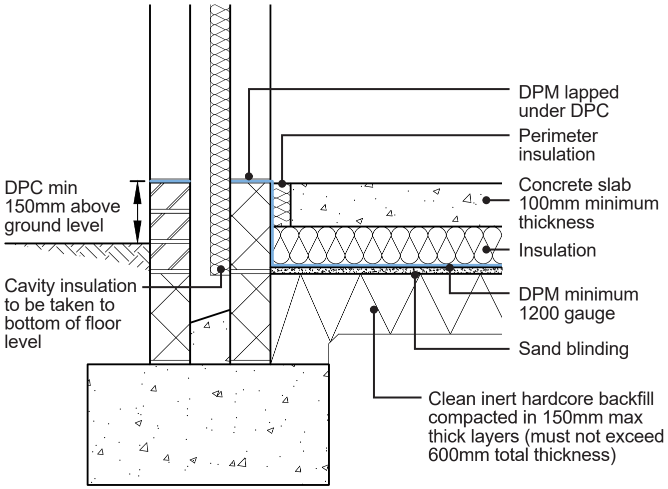
Insulation

Insulation that is to be provided to ground floors can be placed either above or below the concrete slab.
In all circumstances, insulation within the floor construction should be chosen to take the following into account:

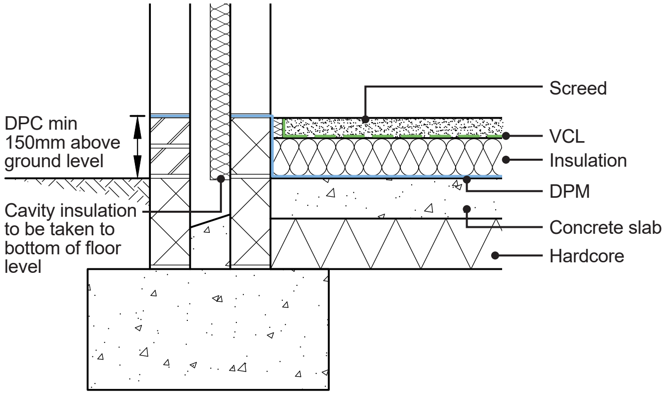
- The insulation should be durable enough to withstand loadings, moisture and any ground contaminants.
- The insulation should comply with relevant Building Regulations.
- The floor insulation should be compatible with wall insulation.
- Any risk of thermal bridging is mitigated, especially at junctions with the floor and wall. The following can be considered at design stage:
  - Installing perimeter insulation to floors.
  - Linking floor and wall insulation.
  - Extending cavity wall insulation below floor slab level.

Note: A number of insulation products require an additional DPM to protect the surface of the insulation. It is important that this additional membrane is incorporated in these situations.

Ground bearing floor - insulation below slab



Ground bearing floor - insulation above slab



General notes

- If ground conditions consist of clay soils and trees that are, were, or are likely to be present, a suspended floor construction should be used.
- Insulation must be installed to meet the manufacturer's installation requirements and relevant Building Regulations.

4.
Ground Floors

4.3
Stepped Floors, Screeds and Underfloor Heating Requirements

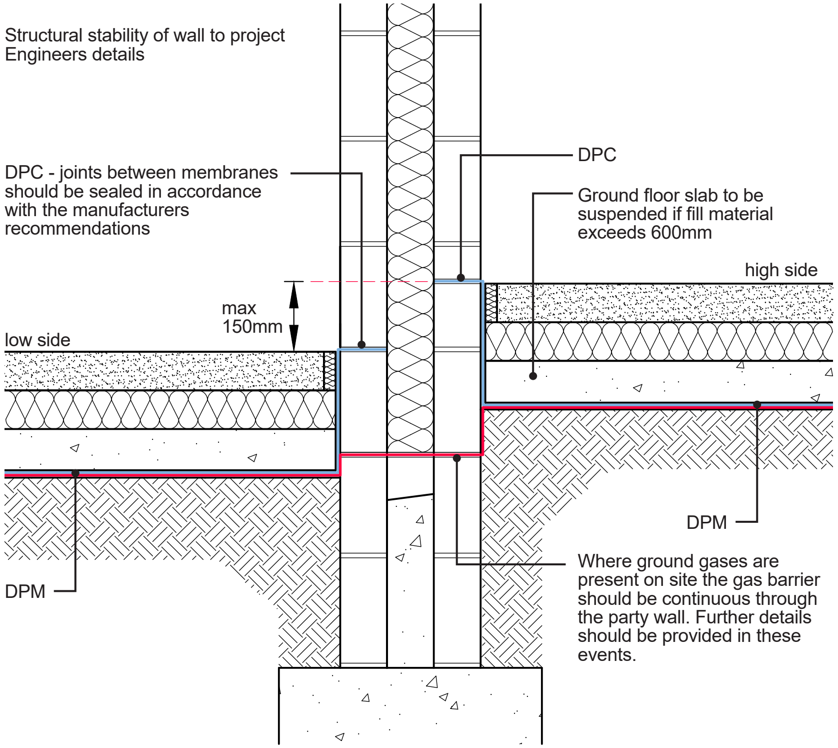
Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor screeds including thickness and mix.
2. Details of substrates to which the screeds will be laid upon.
3. Details of proposed curing times and environmental constraints.
4. Details of underfloor heating systems where being used.
5. Where stepped party walling is proposed we require a full design proposal along with third party product conformity product approval certificates where applicable.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Stepped party walls up to 150mm



Where a difference between finished floor levels of adjacent ground slabs internally or at a party wall does not exceed 150mm and the external ground levels of the perimeter external walls are a minimum of 150mm below the DPC in all locations, a waterproofing specialist solution is not required, however on sites where ground gases are present it is important that the continuity of the gas barrier is maintained through a party wall.

Stepped party walls over 150mm and up to 600mm

For our Warranty provision, where a Grade 3 performance is required, a combined system of waterproofing protection must be provided.

However; in the following specific circumstances only, a single form of waterproofing protection where a Grade 3 performance is required, may be acceptable subject only to:

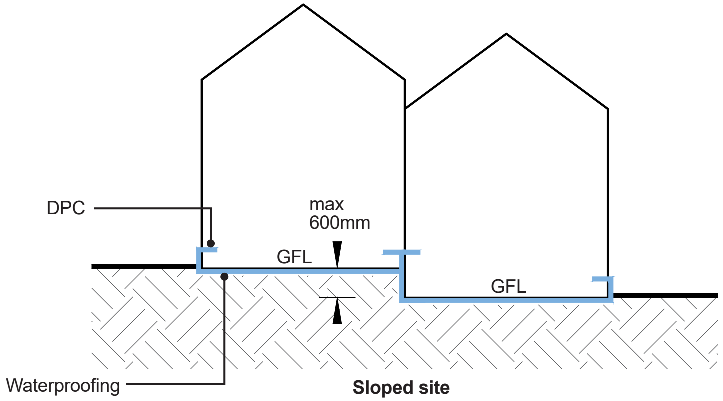
- On shallow stepped / gentle sloping sites where only part of the structure could result in retaining ground above the lowest finished floor level but in no situation greater than 600mm.
- And, the water table being proven to be permanently below the lowest floor level.

In these circumstances, the site conditions must be proven to not result in an unacceptably high risk and the consequences of failure are substantially low. This must be substantiated by a site investigation report and agreed with the Warranty provider before commencing work on site.

A site specific design proposal must be provided before commencement of construction on site, to demonstrate the proposed waterproofing solution (Type A, B or C) is appropriate for the ground conditions (based on the site investigation report). This will include for the wall and floor waterproofing proposals.

Any product proposed in such solutions must hold a suitable third party product conformity certification.

Such scenarios are limited to the above described and as shown in the below image.



Sloped site

Stepped party walls exceeding 600mm

Where the difference between finished floor levels exceeds 600mm, the guidance of the 'Basements' section should be referred to.

Screeds

Traditional floor screeds consist of sand and cement. If the ratios and properties of these screeds are not correctly controlled; cracking, peeling or collapse of the screed will occur (due to being too strong/weak).

Proprietary screeds typically are pre-blended to achieve greater consistency and strength and more suitable over larger areas. As such where the floor area exceeds 50m^2 only a proprietary screed installed by the screed manufacturers trained installers will be accepted.

Screeds should be fit for purpose, have a suitable finish and be of an appropriate thickness and provide a reasonably level surface.

Curing

Screeds should be cured naturally and should not be covered for at least three weeks.

Background surfaces

Background surfaces where screeds are being supported should meet the following requirements:

- **Bond**
  Background surfaces for bonded screeds should provide an adequate mechanical key. If necessary, cement grouting or a bonding agent should be specified to provide adequate adhesion. Where bonded screeds are used, mechanical means of preparing the concrete should be used to create an adequate bond between the substrate and the screed.

- **Moisture protection**
  The floor design should ensure that moisture from the ground does not enter the dwelling.

- **Adequate support**
  Substrate structures must be adequately constructed to provide adequate support to the screed.
  (Note: Timber floor constructions are not suitable to support screeded finishes).

- **Screed mix**
  Cement and sand screeds should have a mix ratio of between 1:3 and 1:4½.

Proprietary additives should have been assessed and have third-party certification.

The minimum thicknesses of screeds are as follows:

Screed thickness requirements

Surface	Minimum thickness at any point (mm)
Laid monolithically with base	12
Laid and bonded to a set and hardened base	20
Laid on a separating membrane (e.g. 1000g polyethylene)	50
Laid on resilient slabs or quilts (screed reinforced with galvanised wire mesh)	65

Where service pipes are bedded in the screed, the screed should be deep enough to provide at least 25mm of screed cover over service pipes, insulation and reinforcing.

Maximum areas of screed

Screeds should be laid room by room. Unreinforced screeds should have a maximum area of 40m^2. Expansion joints should be provided and consistent with joints in the floor slab below.

Finishing of screeds

Screed should provide an even surface as appropriate, as defined in the 'Tolerances' section. Concrete floor slabs may be suitably finished to serve directly as a wearing surface without the need for an additional topping, in accordance with the recommendations of BS 8204. If required, surface sealers or hardeners should only be used in accordance with the manufacturer's instructions.

Anhydrite (liquid) screeds

If an anhydrite screed is used, it must be sealed before the application of any cement based floor finish adhesive is proposed. Anhydrite screeds can be difficult to identify once laid, if the screed type cannot be identified the screed should be fully sealed as a precaution to prevent the possibility of the floor finish adhesive de-bonding from the screed.

The floor screed should be fully dry before the sealant is applied. The screed drying time will depend on the thickness and type of screed.

A decoupling membrane is also recommended as this can reduce the stress on the fixed floor finish layer.

Insulation

Insulation below screeds should have enough compressive strength to support the screed. DPM's should be installed in the correct positions, as indicated by the insulation manufacturer's instructions. Sound insulation should be installed in accordance with the manufacturer's instructions.

Constructing screeds over all substrates:

- Substrates must be level with no pockets or high spots to ensure the thickness of the screed remains even.
- Where screeds are laid over insulation; the insulation must be tightly butted together and level.
- Screeds must be correctly mixed.
- Screeds must not be walked on during the drying period.
- Screeds must not be constructed during cold periods (below 5°C).
- Movement joints will be required across door thresholds.
- Movement joints are required if bay sizes exceed 40m² with a maximum of 8m on any one side.
- Movement joints are also required where joints exist or a change of span occurs e.g. beam and block floors.
- The screed must be ready to accept any floor finishes (see guidance below for over insulated substrates).

Drying times

- With cementitious levelling screeds, one day should be allowed for each millimetre of thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness (BS 8204).
- Polymer modified screeds: strictly follow the manufacturer's specifications and recommendations.
- The developer should keep an accurate record of the screed drying times elapsed before any fixed floor finish is constructed on top is laid and the Warranty surveyor may ask for this information.

Note: The moisture contents of levelling screeds onto which particular floorings are to be laid and methods for measuring moisture content are given in BS 5325, BS 8201, BS 8203 and BS 8425.

Building services

Where building services pass through the screed e.g. underfloor heating, allowance should be made for thermal movement between the screed and the service (so that service pipes can resist chemical attack from the screed).

Additional steps where constructing screeds over concrete substrates

Where a concrete slab is insulated from below and a finishing screed is required to the top surface:

- The concrete substrate slab must be of the correct thickness and not less than 100mm thick.
- Concrete substrate must be adequately dried out and not wet. See drying time guidance.
- Surfaces of hardened in situ concrete bases for bonded screeds should be roughened (Scrabbled) and cleaned to remove laitance and to expose cleanly, but not loosen, the coarse aggregate particles.
- Brushing to remove laitance from a fresh concrete base is inadequate preparation before laying a bonded screed and is not recommended.
- Remove all loose debris, dirt and dust by appropriate means, preferably with vacuum equipment.
- Carry out the preparation of the surface with as little delay as is practicable before the screed is laid so as to reduce the risk of contamination.
- The surface of the prepared slab must be reasonably level to avoid deviations in thickness's of the screed.

Constructing screeds over insulated substrates with under floor heating (UFH) system

1. Provision and construction of movement joints

Movement joints should be provided in the floor screed / fixed floor finish where floor heating is provided in the following places:

- Between independently controlled heating zones.
- Between heated and unheated areas of screed.
- Additional joints should be considered in areas of high thermal gain e.g. large conservatories or glass atria.

Bay joints should be formed using rigid joint formers where possible, which can be placed during the preparation phase and will remain in place during operation. The joint former should be 5mm lower than the finished screed depth to allow a smooth transition in height between bays.

- All joints in the screed should extend through to any subsequent bonded floor covering.
- Joint positions should be specified prior to the installation of the screed and full consultation between all parties including the main contractor, underfloor heating installer, finished flooring installer and the screed installer should take place to determine appropriate locations.
- Movement joints should be carried through the subfloor to the floor finish and all applied layers terminated either side of the joint.
- The joint should be filled with a suitable flexible filler and a proprietary cover strip applied to cover the joint. Grout must not be used.
- Movement joints should not be bridged by any resilient, textile or other adhered floor finish.
- Movement joint covers may be flush, surface mounted or bedded in mortar and metal, metal with a rubber insert or PVC.

2. Provision of edge strip perimeter expansion joint

When incorporating under floor heating (UFH):

- Screeds should be isolated at all edges, abutments and columns to allow for movement due to thermal loadings.
- The floor screed and finished floor manufacturers guidance to be followed particularly when incorporating under-floor heating to determine the minimum thickness of edge strip required to allow for expansion. Typically, between 6-15mm may be required.
- The joint can be concealed by the skirting.
- These joints must be left empty, or else filled with a compressible material.
- Movement joints must not be filled with grout.

3. Screed drying time

- The drying time allowed must be calculated for the proposed depth of screed, taking account of the environmental conditions present e.g. temperature and humidity. Where polymer modified type screeds are being used the manufacturer's requirements must be strictly followed for the actual depth of screed. Surface finishes placed on a screed too early will fail.
- Drying times for polymer modified screeds could potentially be different to cementitious screeds.
- All subcontractors involved with the screed and floor finishes (including installation of underfloor heating systems) must follow the installation requirements and not deviate or change materials.
- The screed should not be walked on until fully cured.

4. UFH testing and commissioning

- Ensure there are no joints in the heating system loops.
- UFH systems should be commissioned before floor finishes are applied. This will add to the total time before any floor finish can be applied.
  Note: If floor finishes are installed prior to the UFH being turned on and commissioned, any residual moisture in the floor is driven to the surface of the screed and can potentially cause delamination of the floor finish.
  Pressure testing of the system does not constitute commissioning of the system. The heat source has to be in place and operating in order to deliver the correct temperatures.
- The UFH system must be commissioned in accordance with the manufacturer's recommendations by their approved installers. A commissioning certificate will be required.

5. Moisture testing of the screed where floor finishes are proposed

- Moisture testing should be carried out after the commissioning of the UFH system but before any floor finishes are laid.
- Where UFH is not installed, moisture testing of the screed should still be carried out before floor finishes are installed.
- Moisture testing is carried out using a suitable approved method such as a flooring hygrometer or carbide bomb test. Due to the potential inaccuracies of using hygrometers at high humidity levels, a direct measurement should be used such as Carbide Bomb or oven dried sample.
- The base is deemed to be sufficiently dry when the relative humidity, as measured by a surface mounted flooring hygrometer/probe is 75% RH or less. For the use of a flooring hygrometer, reference should be made to Dampness testing in BS 5325, BS 8203, BS 8425 and BS 8201.
- If underfloor heating is present in the base, the heating must be switched off 96 hours prior to any hygrometer test being carried out.
- The hygrometer must be allowed to remain in position until full equilibrium has been established. This is generally considered to be 72 hours but could be longer over thick sections and considerably longer on power floated concrete.

6. Screed preparation for finishes

- The top surface of screeds may require to be scored, sanded or keyed in preparation to accept the primer and floor finish.
- Sanding, keying etc. of the screed surface allows the penetration of primers. It also provides a "key" for the adhesive to grip onto.
- The surface must then be cleared of dirt and debris prior to primers being applied.
- Any primers and adhesives must not be applied until the screed has fully hardened and dried out. Drying times vary depending on the type of screed.
- Surfaces to receive fixed floor finishes should be rigid, dimensionally stable, flat with no dips and rises, sound, clean and free from laitance, paints, salts, grease, dust and any contamination which may prevent adhesion.

7. Adhering to the manufacturers' process during the installation of the flooring finish

All the relevant manufacturers recommendations should be followed which will identify timelines to adhere i.e:

- Removing the laitance by sanding to provide a key for the primer and/or adhesive.
- Commissioning the underfloor heating before installing the fixed floor finish.
- Allowing the UFH system to cool down for at least 48 hours before installing the fixed floor finish.
- Moisture testing to confirm the dryness of the screed before installing the fixed floor finish.
- Ensuring the time from screed completion to installing the fixed floor finish commencement is calculated and adhered to.
- Ensure the fixing of the finished floor finish has stabilized before walking on. Some finishes require typically 12 -24 hours dependent on environmental conditions.
- Ensure the UFH system is not turned on for at least 48 hours after any adhered floor finish is completed.
- If an anhydrite screed is used, it must be sealed before the application of a cement based floor finish adhesive if proposed in conjunction with a finished floor surface covering.

8. Exceeding the maximum 27°C floor temperature

The underfloor heating system must be correctly commissioned to ensure temperature fluctuations are avoided and potential damage to the floor finishes.

BS 8203 Code of Practice for the Installation of Resilient Floor Coverings states: When used with many flooring materials underfloor heating can cause problems if the temperature at the interface between the subfloor and flooring exceeds 27°C, or is subject to rapid fluctuations in temperature.

Where a resilient floor covering is proposed: 'the temperature should never exceed the agreed maximum of 27°C at the underside of the floor covering (the adhesive line).

Note: UFH designers may refer to this as the 'interface' temperature.

Please Note: BS EN 1264 - 2 refers to a max 29°C however for Warranty purposes a maximum 27°C is to be followed.

9. End user information

End users must be aware of how to use an UFH system, as these need to be operated differently than other heating systems both for in use and to avoid damage to screeds and finishes.

5.
Drainage

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. Drainage systems should be laid strictly in accordance with the design requirements.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. Drainage materials must meet a recognised standard such as a Eurocode or British Standard.
2. Below ground drainage systems should be backfilled with suitable materials so as not to cause any damage to the drain by loading or crushing.
3. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
4. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
5. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. The outfall drainage from any sewerage treatment plant or septic tank, should discharge to a suitable outfall that has been given full consent to do so, in writing from the appropriate regional agency.
2. Drainage layouts and systems must be supported by a full design package identifying drainage diameter sizes, gradients and outfalls.
3. All drainage services shall be designed, constructed and installed so that:
   a. They do not adversely affect the structural stability of the building.
   b. They do not adversely affect the durability or compromise the weather proof envelope.
   c. They prevent the entry of hazardous ground substances, external moisture or vermin.
   d. They are constructed using non-hazardous materials.
   e. They are durable and robust.
   f. They are safe and convenient in use.
   g. Liquid and solid waste is discharged safely and efficiently to a suitable outfall.
   h. The systems are adequately accessible for inspection and cleaning.
   i. They are designed so that the risk of blockages is reduced.
   j. The system is adequately vented.
   k. Noise transmission from pipes is reduced to a minimum.
4. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.

5. Drainage

5.1 Above Ground - Foul Drainage

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
2. Position of ventilation to the foul drain.
3. Specification of drainage pipes and supports.
4. Location and size of cold water storage cisterns and hot water storage cylinders.
5. Hot and cold water pipe runs.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Above ground soil and waste drainage systems

Drainage shall be designed, constructed and installed so that:

- Pipework should be designed to meet the requirements of relevant Building Regulation requirements or BS EN 12056-Parts 1, 2 and 5, and be installed following the guidance in BS 8000 - 13.
- Connected to a suitable underground foul drainage system.
- The materials and components used for sanitary pipework, e.g. pipes, fittings and fixing accessories, should conform to appropriate European Standards or European Technical Assessments (ETAS). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Sanitary pipework should be installed in accordance with manufacturer's recommendations.
- Pipework used externally must be suitable for exposure to sunlight without early degradation. Proof of use for external exposure must be provided.
- Do not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

All above ground plumbing systems need to be designed to allow the unobstructed flow of waste water from an appliance to the underground drainage system. To achieve this, the points below should be noted at the design and installation stages:

- Provide rodding access facilities at all changes of direction.
- Avoid bends, connections and changes of direction in the wet part of the above ground drainage system.
- Pipe sizes are adequate to take the expected rate of discharge and load at suitable gradients with the minimum of direction changes.
- 75mm deep seal traps should always be used, except:
  - On a WC where a 50mm depth of water seal can be used, or,
  - Where an appliance on the ground floor discharges directly into a trapped gully.
- Pipe sizes should not exceed the dimensions for diameter against pipe length.
- Pipes should be laid at gradient 1:80 or better and adequately supported to prevent sagging and back falls.
- Sanitary pipework must be adequately supported (see Table 1).
- Provision for expansion in the pipework must be given both in vertical pipes and branch/waste pipes (see Table 2).
- Any admittance valve fitted to the system should be located above the highest flood level of any appliance connected to that stack pipe.
- Enclosures to air admittance valves should be adequately ventilated.
- The highest point of a drainage system (head of run) should always be vented to the external air.
- A soil or ventilation pipe should extend at least 900mm above an opening if it is less than 3m away from an opening into the building.
- The drains are adequately protected from ground loads and movement in the building structure.
- Drains and pipes passing through the external waterproof envelope of the building or through the underground walls must be suitably sealed to prevent vermin ingress and dampness.
- Sound insulation will be necessary where soil pipes pass through room's to the underground connection. This can be achieved by:
  - Encasing the pipework within a boxed in framework with a minimum 15kg/m^2 board covering or,
  - Wrapping the pipework with mineral wool fibre at least 25mm thick, throughout the height of the pipe - up to the highest ceiling level.

Table 1: Max distance between sanitary pipe supports

Pipe material	Normal pipe size (mm)	Vertical pipes (m)	Low gradient pipes (m)
Plastics (any type)	32 to 40	1.2	0.5
	50	1.2	0.6
	75 to 100	1.8	0.9
	150	1.8	1.2
Cast iron	All sizes	3.0	3.0
Copper	25	2.4	1.8
	32 to 40	3.0	2.4
	50	3.0	2.7
	65 to 100	3.7	3.0
Galvanised steel	25	3.0	2.4
	32	3.0	2.7
	40 to 50	3.7	3.0
	65 to 75	4.6	3.7
	100	4.6	4.0

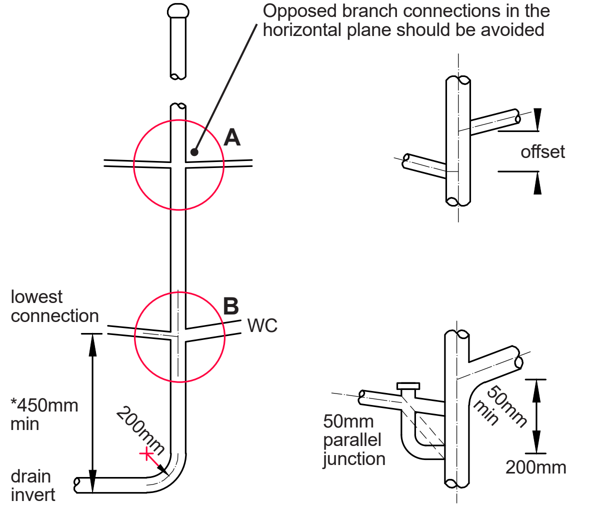
Table 2: Design for thermal movement in runs of waste pipes

Fitting type	Movement provision
Push fit	Push fit joints should be assembled with clearance for expansion. Check expected movement and relate to number of joints
Solvent-welded joints	Provide 'push-fit' couplings at calculated intervals, but not exceeding 1.8m

Notes:
1. The manufacturer's recommendations should be followed in respect of provision of movement (Polypropylene pipe work can expand more than UPVC pipework for the same length).
2. Ensure 'push-fit' joints are lubricated before assembly with specified lubricant that is approved for the pipe type.
3. Sleeve wastes through walls to permit pipe movement.

Position of connections to soil stacks

A branch creates a no connection zone on a stack. No other branch may be fitted such that its centre line falls inside a zone, but its centre line may be on the boundary of the zone.



Key

A - Opposed connections without swept entries not exceeding 65mm should be offset:
- 110mm on a 100mm stack
- 250mm on a 150mm diameter stack

Opposed connections larger than 65mm (without swept entries) should be offset at least 200mm irrespective of stack diameter. Unopposed connections may be at any position.

B - Angled connection or 50mm diameter parallel junction where a branch discharge pipe would enter the WC no connection zone.

Note: A waste (branch discharge pipe) manifold may be a suitable alternative.

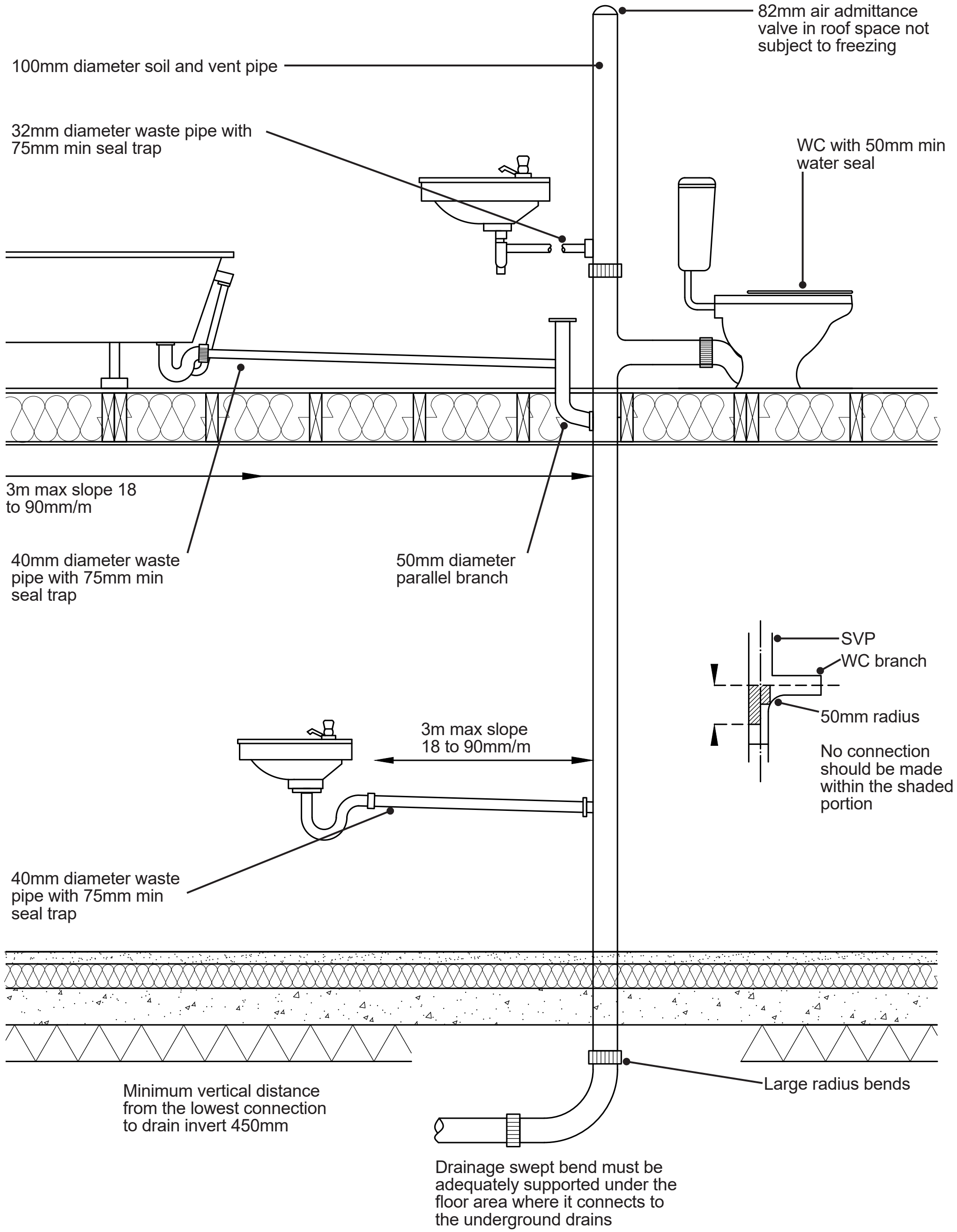
*this should be increased in buildings over 3 stories.

Openings for pipes in fire resisting floors and walls

Pipes which pass internally through fire resisting floors and walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through floors and walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

For pipes passing through compartment walls or floors, guidance supporting the Building Regulations in the relevant UK nation will need to be consulted for additional provisions.

Single stack system: Air admittance valves



Air admittance valves

Air admittance valves provide a means of ventilation to the drainage system to prevent the loss of water seals in traps. They are suitable for use in buildings, e.g. bungalows, houses, multi-storey flats, and they only allow air to enter the drainage system. Their use does not avoid the need to ventilate the drainage system adequately.

Where air admittance valves are used to terminate soil pipes, they should comply with Building Standards. Admittance valves must have a current third party product approval and be used within the scope of that approval certificate.

Valves within the building should be:
- Positioned in areas that are not liable to freezing.
- Positioned in areas with adequate ventilation. Note, where the pipes and valve are boxed in, adequate means of ventilation will be required by means of grilles or gaps. The amount of ventilation provided should be at least 2500mm² or whatever specified by the manufacturer.
- Accessible for maintenance.

If the discharge stack provides the only ventilation to septic tanks or cesspits, the connecting drain is subject to periodic surcharging or is fitted with intercepting traps, air admittance valves are not suitable for providing ventilation in these circumstances.

Sanitary fittings

Wash basins (WHB), baths, bidets, shower trays:
- Should be securely fixed with appropriate non rusting fixings.
- Floors should be capable of carrying the weight of the appliance.
- Excessive packing must be avoided.
- Must be connected to the drainage system and where applicable an appropriate water supply.

Where WC's, WHB's, baths and shower units are installed; where tiling is installed around these appliances, flexible waterproof mould resisting flexible sealant should be used to accommodate any movement between the appliance and tiles.

Baths and shower units should be correctly supported so that when in use the fittings will not deflect excessively and pull on the mastic seal.

Floor joists should be doubled up under the bath locations. Where heavier baths (e.g. cast iron baths or similar) are proposed, the floor joists must be designed to take the additional loadings and joist feet located over the joists.

Additional requirements where the development is within a coastal location

Where developments fall under the coastal location definition (see 'Appendix B - Coastal Locations') the following additional requirements should be met, and where elements of the sanitary drainage may be subject to the outside atmosphere, the following conditions will apply.

Corrosion
The materials should be suitably protected against corrosion, see 'Appendix C - Materials, Products, and Building Systems' for further information.

Fixings
External fixings that are exposed to weathering, moisture and corrosive environments or applications where concentrations of corrosive agents may accumulate should be made from high grade austenitic stainless steel (e.g. A4) or a protective coating suitable for the corrosion category described in the table 'the classification of environmental corrosion conditions' in 'Appendix C - Materials, Products, and Building Systems'.

Durability
External soil and waste pipes must be suitable for the environmental conditions. Please refer to the manufacturer's specifications to confirm durability. Discolouration of dark plastic goods may be unavoidable in coastal locations.

Due to the environment, certain materials and particularly the finishes may require on-going maintenance in order to keep a satisfactory finish e.g. external SVP. In these circumstances it will be the building owner's responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided.

Macerators and pumps

When installing macerators and such pumps to above ground drainage the following must be considered:
- The electrical installation must be carried out by a qualified person.
- The system must be installed in accordance with the manufacturer's guidance.
- The system should be flushed through several times after installation and prior to first use.
- The client will need to be provided with details of appropriate maintenance, servicing and cleaning for the system on completion of the installation.

5.
Drainage

5.2
Above Ground -
Storm Drainage

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Areas of roof drained to each gutter.
2. Downpipe and/or drainage hopper positions from roof.
3. Positions of hazards e.g. Flues, opening windows/doors.
4. Location of below ground storm drainage connections.
5. Rodding access provision.
6. Downpipe outlet positions - avoiding potential water ingress/splashing of external walls etc.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Provision of gutters and downpipes

Drainage shall be designed, constructed and installed so that:

- Roof water gutters and downpipes designed to meet the requirements of relevant Building Regulation requirements and BS EN 12056-3 The exception would be where we require a higher standard.
- Connected to a suitable underground drainage system.
- Materials and components for rainwater goods, e.g. gullies, pipes, fittings and fixing accessories, should conform to appropriate European Standards or European Technical Assessments (ETAS). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Rainwater goods should be installed in accordance with manufacturer's recommendations.
- Pipework used externally must be suitable for exposure to sunlight without early degradation. Proof of use for external use must be provided.
- Do not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

When designing roof drainage systems it is normally impracticable to guard against very infrequent extremely heavy rainfall events. The design should achieve a balance between the cost of the roof drainage system and the frequency and consequences of flooding. The effective design area of a drained roof / balcony area should be determined using Table 1.

If the roof area is greater than 6m², a roof will need to be provided with rainwater gutters and rainwater downpipes (RWP) that meet the minimum size requirements shown in Table 2.

Where a roof area is less than 6m², thought should also be provided to the provision of rainwater drainage of such roof areas e.g. dormer roofs so as to ensure rainwater will be effectively disposed and not cause potential for damage and resulting water ingress into the building. Note: Roof areas e.g. flat roofs, which are less than 6m² will still require to be laid to a fall.

Table 1: Calculation of roof area

Type of surface area	Effective design area
Balcony areas	Plan area
Flat roof plan	Area of roof
30° roof pitch plan	Area x 1.29
45° roof pitch plan	Area x 1.5
60° roof pitch plan	Area x 1.87
Pitched roof over 70° or any wall	Elevational area x 0.5

Table 2: Gutter sizes and outlet sizes

Max effective roof area (m²)	Gutter size (mm diameter)	RWP outlet size (mm diameter)	Flow capacity (litres/sec)
6	-	-	-
18	75	50	0.38
37	100	63	0.78
53	115	63	1.11
65	125	75	1.37
103	150	89	2.16

Gutters

- Gutters should be laid to a nominal gradient of between 1mm over 1 metre and 3 mm over 1 metre where practicable.
- The gradient of an eaves gutter shall not be so steep that the gutter drops below the level of the roof to such an extent that water discharging from the roof will pass over the front edge of the gutter.
- Gutters must be adequately supported and not sag: Fascia or rafter brackets should be typically no more than 1 metre apart or as recommended by the manufacturer.
- Additional support for gutters will be required at angles, corners, and outlet positions.
- Gutters should be laid so that any overflow in excess of the design capacity - caused by extreme conditions such as above normal rainfall, will be discharged clear of the building. On flat roofs, balconies, valley gutters and parapet gutters, additional outlets may be necessary.
- In areas where snow lies on roofs, the front edge of the gutter should not be higher than the projected line of the roof, unless snow guards or other precautions are used.

General requirements for above ground storm drainage

The above ground storm system needs to be designed to allow the unobstructed flow of storm water from the drained roof area to the underground drainage system. To achieve this, the points below should be noted at the design and installation stages:

- Pipe and gutter sizes should be adequate to take the expected rate of discharge, and are laid at suitable gradients with the minimum of direction changes.
- Discharge of gutters into downpipes can be substantially improved by the careful location of downpipes:
    - Locating downpipes at end quarter positions will double the flow capacity if more than one downpipe is required.
    - The downpipe should be located within 200mm of the change in direction in order to maintain the flow capacity of the gutter where changes in the line of the gutter occur.
- Where the design incorporates valley gutters or parapet gutters, the design should be carried out in accordance with BS EN 12056.
- Ensure that joints in gutters, gutter outlets and downpipes are sealed in accordance with the manufacturer's recommendations.
- Gutters and downpipes must be installed to allow for thermal movement. Joint gaps must be to the manufacturers recommendations.
- Downpipes must be installed plumb and supported at regular centres throughout the height of the pipework.
- Outlets should be correctly positioned relative to gullies.
- Sanitary pipework must not be connected/discharge into the storm drainage system.
- Pipework shall not reduce in diameter in the direction of flow, except in the case of siphonic systems.
- Siphonic roof drainage systems should be designed in accordance with BS EN 12056-3.
- Rainwater pipes from higher roof levels should not discharge onto a lower flat roof or balcony.
- Where a rainwater downpipe discharges into a gully, it should terminate below the gully grating but above the water seal, preferably by the use of a back inlet.

Additional requirements for pitched roofs

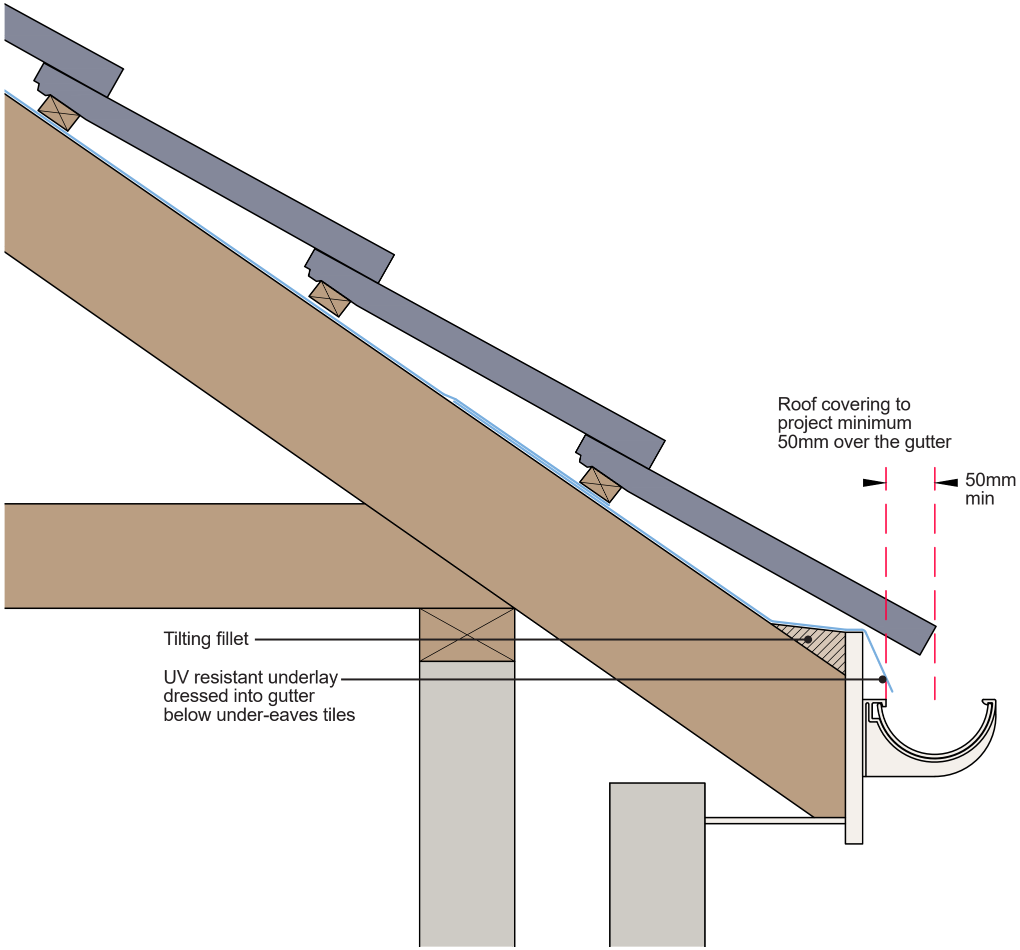
(Please also refer to the 'Roofs' section)

- Gutters should be fixed with the centre line vertically below the edge of the roof covering. Pitched roof UV resistant underlay should dress over the gutter.
- Gutters must be designed to deal with concentrated loads e.g. from nearby downpipes discharging water from higher level roof areas such as dormers.

Ensure gutters are:

- Adequately supported to prevent sagging.
- Laid to a fall towards the outlets.
- Have stop ends fitted.

Tile edge over gutter centre line



Additional requirements for flat roofs and balconies

(Please also refer to the 'Roofs - Flat Roofs' and 'Roof Terraces and Balconies' section)

- To ensure effective drainage of the 'roof area', balcony decking or other finish laid over the water proof roof covering must not restrict water flow to the rainwater outlets e.g. decking supports must not be laid across the fall of the roof.
- Flat roofs and balconies must be designed and constructed to have a finished fall (allowing for deflection in the construction) of no less than 1:80.
- The roof area should fall away from a wall that contains any door/window opening and a minimum upstand of 150mm provided between the waterproof decking and the underside of the opening.
- Tapered insulation and 'crickets' must only be designed and manufactured by the insulation manufacturer (not cut to fall on site).

Rainwater outlets must be:

- Recessed and not stand proud above the flat roof water proof covering; to ensure water will flow freely into the outlet.
- Be accessible for maintenance (any decking above the outlet must easily be removable).
- Sized and be of sufficient numbers and position to deal with the local rainfall intensity in accordance with BS EN 12056-3.
- There must be 2 outlets (or one outlet plus one overflow) where the flat roof/balcony has an upstand to all sides.
- Drainage from roof gardens should enable inspection and access to the outlet and shall incorporate means of excluding soil and debris from entering the roof drainage system.
- Drainage outlets formed through parapet walls must be constructed with secondary protection to prevent water ingress into the wall structure.
- Drainage outlets formed through parapet walls in timber framed construction where the outer leaf is masonry; Must allow for shrinkage in the timber frame i.e. the frame will settle but the outer leaf will not, therefore a backfall could result in the outlet.

Additional requirements where the development is within a coastal location

Where developments fall under the coastal location definition (see 'Appendix B - Coastal Locations') the following additional requirements should be met, and where elements of the surface water drainage may be subject to the outside atmosphere, the following conditions will apply.

Corrosion
The materials should be suitably protected against corrosion, see 'Appendix C - Materials, Products, and Building Systems' for further information.

Fixings
External fixings that are exposed to weathering, moisture and corrosive environments or applications where concentrations of corrosive agents may accumulate should be made from high grade austenitic stainless steel (e.g. A4) or a protective coating suitable for the corrosion category described in the table 'the classification of environmental corrosion conditions' in 'Appendix C - Materials, Products, and Building Systems'.

Durability
External surface water drainage components must be suitable for the environmental conditions. Please refer to the manufacturer's specifications to confirm durability. Discolouration of dark plastic goods may be unavoidable in coastal locations.

Due to the environment, certain materials and particularly the finishes may require on-going maintenance in order to keep a satisfactory finish e.g. gutters and downpipes. In these circumstances it will be the building owner's responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided.

Openings for pipes in fire resisting floors and walls

Pipes which pass internally through fire resisting floors and walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through floors and walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

For pipes passing through compartment walls or floors, guidance supporting the Building Regulations in the relevant UK nation will need to be consulted for additional provisions.

5.
Drainage

5.3
Below Ground -
General Requirements

5.3.1 BELOW GROUND - GENERAL REQUIREMENTS: Access points and backfill requirement

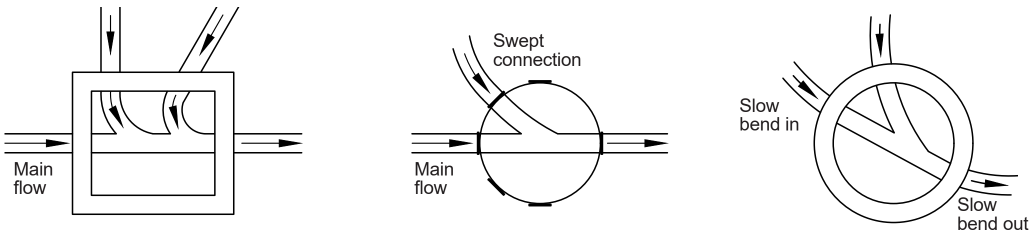
Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

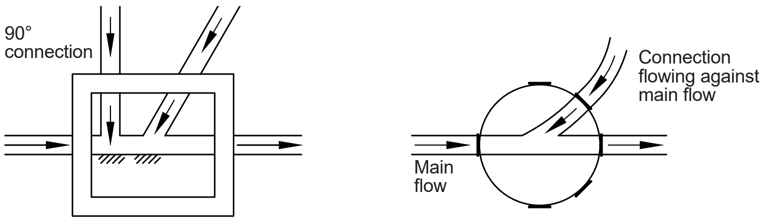
1. Position of soil stacks.
2. Location of foul drain connections and drainage runs.
3. Location of suitable outfall.
4. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
5. Where existing drains are retained, a CCTV survey will be required.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Swept connections into flow of drains – Acceptable



Swept connections into flow of drains – Not Acceptable



Access and connections

Suitable access must be provided to every length of drain to allow rodding access to deal with potential blockages.

Depending on the depth and position of the drain, one of the following should be provided:

- Rodding eye - capped extensions of pipes.
- Access chamber - small chambers on (or an extension of) the pipes but not with an open channel.
- Inspection chamber - chambers with working space at ground level.
- Manhole - deep chambers with working space at drain level.

The installation of access points must not impede the flow of waste and allow connections onto main runs to be in the direction of flow and not against it.

Access points must be provided:

- On or near the head of each drain run, and,
- At a bend and change of gradient, and,
- At a junction unless each run can be cleared from an access point (some junctions can only be rodded through from one direction).

Minimum dimensions for access fittings, inspection chambers and manholes can be referenced in the guidance supporting the relevant Building Regulations.

Construction of access points should be with one of the following materials (see table 2) and must be capable of containing the foul water under working and test conditions.

Inspection chambers and manholes should have removable non-ventilating covers of durable material (such as cast iron, cast or pressed steel, precast concrete or plastics) and be of a suitable strength for its location e.g. access points on driveways will require heavier duty covers than those in a garden.

Small lightweight covers should be secured to deter unauthorised access.

Access points within buildings should have mechanically fixed airtight covers.

Drainage system covers

Drainage system access point covers in hard standing areas should be level with the adjacent ground level.

Access covers in garden areas should not be covered over by the soil/turf.

Materials for access points

Materials - access pipe	British Standard
Inspection chambers and manholes:	
Clay bricks and blocks	BS 3921
Vitrified clay	BS EN 295, BS 65
Concrete - precast	BS 5911
Concrete - in-situ	BS 8110
Plastics	BS 7158
Rodding eyes and access fittings (excluding frames and covers)	As pipes ETA or Third party product approval certificates

General backfill

In normal circumstances, the excavated material from the trench will be appropriate for backfilling above the chosen material. General backfill materials must be free from:

- Boulders.
- Building rubble.
- Timber.
- Vegetable matter.

Backfill needs to be positioned in layers not deeper than 300mm, and must be well compacted. When compacted backfill is at least 450mm above the crown of the pipe, only mechanical compacting should be used.

Below ground drains should not be supported on ground or fill that is susceptible to movement without adequate provision being made to:

- Maintain minimum design gradients.
- Protect against backfall.
- Protect against leakage.

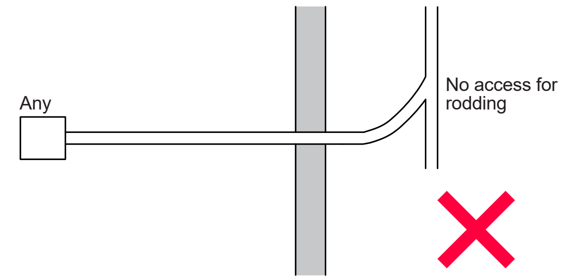
Bricks, blocks or other hard material should not be used as temporary or permanent supports for below ground drains.

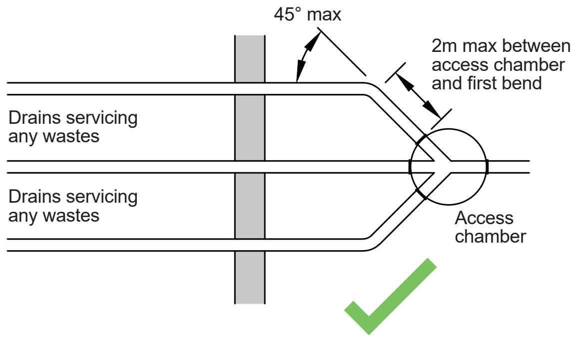
Junctions in drains under buildings

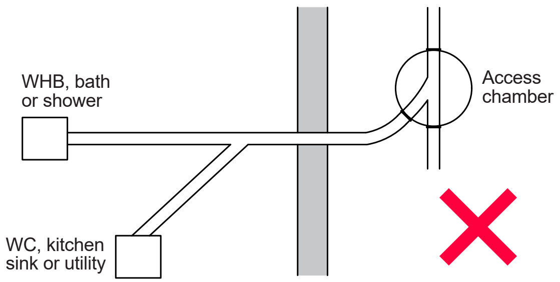
Drains under a building must be laid in straight runs – slight curves can be accepted, providing the length of the run can be effectively cleaned by the use of rods. Having junctions under a building makes it difficult to clear any blockages, however they can be accepted in some very limited circumstances.

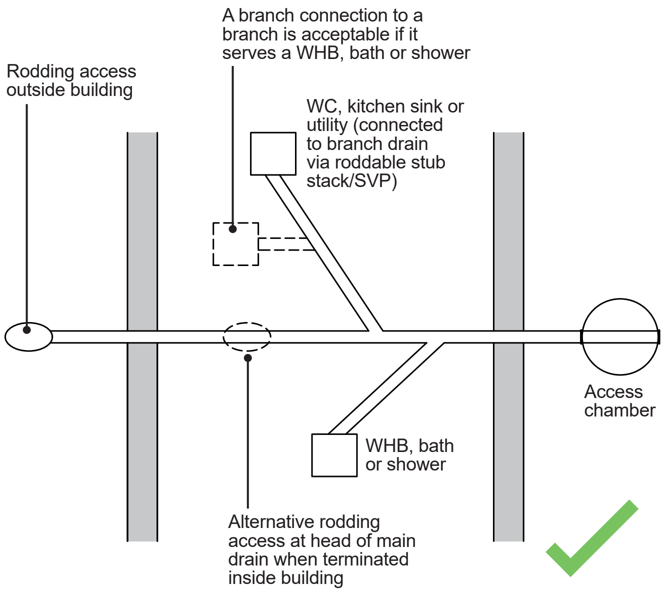
If Y-Junctions are used, they should only be used in the following circumstances:

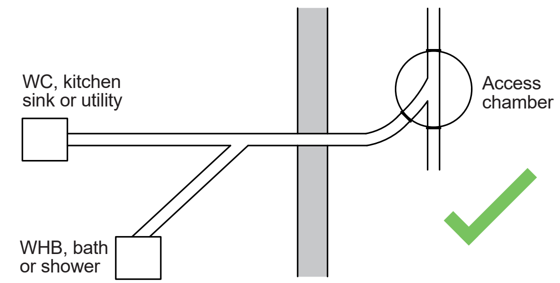
- Where the branch drain discharges lightly soiled waste such as a wash hand basin, shower or bath, a Y junction may be used to connect to another drain under the building.
- The main drain should extend the full length of the building and external rodding access is provided at both ends of the main drain (see diagram for further details.
- If this is not achievable, an alternative rodding access point can be provided of the head of the main drain which terminates inside the building.
- Branch drains carrying heavily soiled waste are provided with a roddable stub stack. This should not involve removing any sanitary fittings or boxing (so an access plate should be provided).











Additional requirements for drains near trees

Drainage near trees should incorporate additional provisions where there is a volume change potential within the ground. The provisions include:

- Increased falls to cater for any ground movement.
- Deeper and wider backfill of granular material.
- A drainage system that is capable of movement should heave and shrinkage occur.
- Drainage pipes should not be encased in concrete.
- Additional clearance is required where drains pass through the structure of a building to allow for additional movement.

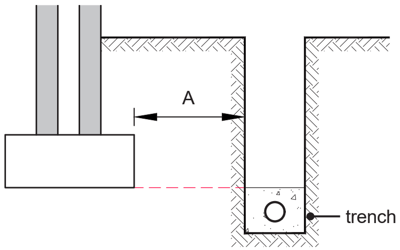
Drains adjacent to foundations

Drains are to be located so that foundation loads are not transmitted to pipes. Where drainage trenches are located near to foundations, foundation depths should be increased or the drain re-routed further from the foundations.

Protecting pipes adjacent to foundations

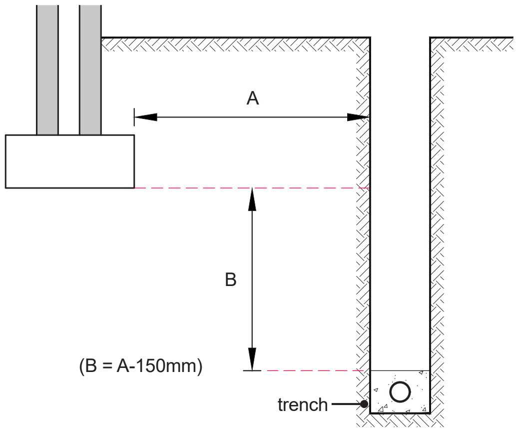
Where it is not physically practical to locate drains so they are not impacted by foundation loads, the pipes should be protected. Examples of how the pipes may be protected are given below:

Scenario 1 - where A is less than 1m



Where the trench is within 1m of the foundation, the trench is to be filled with concrete up to the lowest level of the foundation.

Scenario 2 - where A is 1m or greater



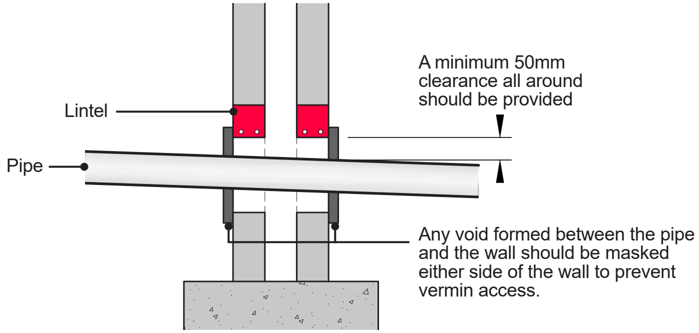
Where the trench is 1m or further from the foundation, the trench is to be filled with concrete up to measurement B as shown above.

Drains and services passing through walls

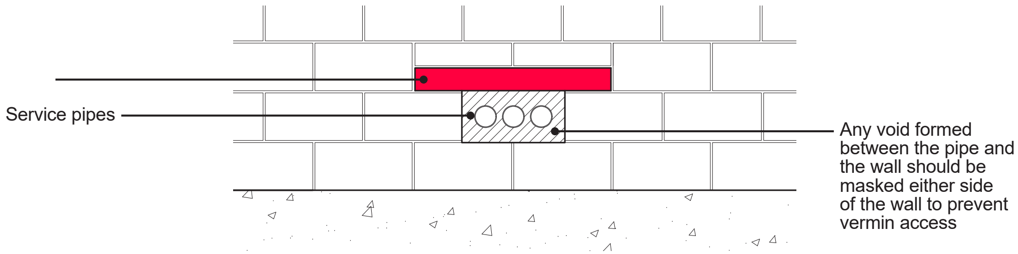
Walls should accommodate movement where drains pass through substructure by:

- Providing a minimum 50mm clearance all around.
- A sleeve with a 50mm clearance.
- (If built in) A connection on both sides of the wall to pipes with flexible joints located no more than 150mm from the face of the wall.
- Any void formed between the pipe and the wall should be masked either side of the wall to prevent vermin access.

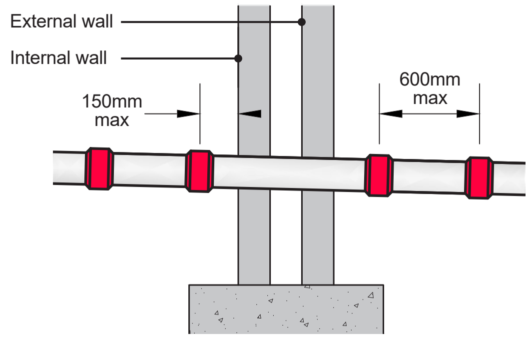
Lintel openings over pipes



Lintel opening for service pipes



Flexible jointed pipes (rockers) either side of built in pipe



Where pipes are built-in, a connection on both sides of the wall to pipes with flexible joints located no more than 150mm from the face of the wall.

5.
Drainage

5.4
Below Ground - Foul Drainage - to Mains Sewer

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Position of soil stacks.
2. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Drainage shall be designed, constructed and installed so that:

- Foul drainage systems should be designed to meet the requirements of relevant Building Regulation requirements or BS EN 752 and be installed following the guidance in BS 8000-14.
- Discharges to a suitable outfall which is:
    - Sewer maintained by the Local sewerage undertaker or,
    - A suitable private foul drainage/sewer system (1) that leads to an adopted sewer.

  Note: (1) Connections to private foul drainage systems will require agreement of the owners of such drain/sewer.
- Materials and components used for foul water drainage systems, e.g. pipes, fittings and fixing accessories, inspection chambers etc. should conform to appropriate European Standards or European Technical Assessments (ETAs). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Pipework, fittings, inspection chambers etc. should be installed in accordance with manufacturer's recommendations.
- Drains and pipework etc. must be durable and suitable for use underground.
- The installation of drainage/pipework does not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

Outfalls

All below ground foul drainage systems need to be designed to allow the unobstructed flow of waste water to a suitable approved outfall. To achieve this, the points below should be noted at the design and installation stages:

- Foul water drainage systems only take foul waste from a property or properties and will include waste water from sinks, toilets, showers, baths, dishwashers and washing machines. These systems discharge into Local Authority sewers, then pass through sewage treatment plants. Storm water should be discharged to a separate storm water disposal system so as to avoid treatment plants treating large volumes of storm water needlessly.
- Drainage from impervious surfaces such as drives, paths and hard standings must drain to a suitable rain water drainage system.
- The drainage system, including manholes, gullies, pipe connections, etc. should be protected from damage throughout the course of the construction works.
- Drainage trench excavations should be taken down to solid ground, but when this is not possible, the drainage system should be designed to accommodate any movement and made-up ground with a well-compacted backfill to the required formation levels.
- Where ground movement is likely to occur, flexible drainage systems should be provided, e.g. filled sites, mining areas and sites with shrinkable clay.
- Where possible, avoid passing adjacent to tree roots. Adequate precautions should be taken where this cannot be avoided, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer.
- Where existing drains are retained, a CCTV survey will be required.

Installation of underground drains

The depths of drains and the protection provided over them needs to be adapted to the traffic normal for the location, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer. Requirements are as follows:

- Pipes should be laid to an even gradient (see table 1), and significant changes in gradient should be combined with an access point.
- Pipes should be laid in straight lines, but may be laid to slight curves, providing the length of drain can be effectively cleaned by the use of rods.
- Connections should be to inspection chambers or manholes, but connections to junctions are acceptable if access is provided to clear blockages. In all cases, discharge should be in the direction of flow.
- Bends should be positioned in, or adjacent to, terminal fittings, inspection chambers or manholes, and at the foot of discharge stacks. Bends should have as large a radius as practicable.
- The system should be ventilated at or near the head of each main drain to allow free passage of air throughout; the maximum length of any branch serving a single appliance being 6m, and for a group of appliances, 12m.
- Where appliances are not fitted with integral traps at the point of discharge, a trap must be provided using either a trapped gully or low back trap.

Table 1: Recommended minimum gradient of drains

Peak flow (litres/sec)	Pipe size (mm)	Minimum gradient	Maximum capacity (litres/sec)
<1	75 100	1:40 1:40	4.1 9.2
>1	75 100 150	1:80 1:80(1) 1:150(2)	2.8 6.3 15
Notes: (1) Minimum of 1 WC (2) Minimum of 5 WC's			

5.
Drainage

5.5
Below Ground - Foul Drainage - to Septic Tank

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Position of soil stacks.
2. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
3. Position of any septic tank or cesspool in relation to adjacent buildings.
4. Results of percolation tests where treated effluent disposal is through field drains or soakaways.
5. Where drainage fields are used, we would require:
    - Details of their layout, including length and depth.
    - Details of the trench width.
    - Site investigation report confirming the ground is suitable for a drainage field.
6. Where soakaways are used:
    - Location of the soakaway in relation to any adjacent buildings.
    - Site investigation report confirming the ground is suitable for a soakaway.
    - Soakaway design to BRE 365.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Drainage shall be designed, constructed and installed so that:

- Foul drainage systems should be designed to meet the requirements of relevant Building Regulation requirements or BS EN 752:2017 and be installed following the guidance in BS 8000-14.
- Discharges to a suitable outfall which is:
    - For septic tanks: the ground conditions and water table movements must be suitable to allow the installation. Percolation tests will be required and the Warranty Surveyor given the opportunity to appraise.
    - Has consent in writing from the appropriate regional agency; to allow discharge to or near a watercourse or river.

  Note: Consent means a clear confirmation in writing that they will allow discharge to the designated outfall for the period of Warranty cover.
- Materials and components used for foul water drainage systems, e.g. pipes, fittings and fixing accessories, inspection chambers, septic tanks etc. should conform to appropriate European Standards or European Technical Assessments (ETAs). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Pipework, fittings, inspection chambers, septic tanks etc. should be installed in accordance with manufacturer's recommendations.
- Drains and associated pipework etc. must be durable and suitable for use underground.
- The installation of drainage or pipework does not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

Outfalls

All below ground foul drainage systems need to be designed to allow the unobstructed flow of waste water to a suitable approved outfall. To achieve this, the points below should be noted at the design and installation stages:

- Foul water drainage systems only take foul waste from a property or properties and will include waste water from sinks, toilets, showers, baths, dishwashers and washing machines. These systems discharge into septic tank. Storm water should be discharged to a separate storm water disposal system so as to avoid septic tanks treating large volumes of storm water needlessly.
- Drainage from impervious surfaces such as drives, paths and hard standings must drain to a suitable rain water drainage system.
- The drainage system, including manholes, gullies, pipe connections, etc. should be protected from damage throughout the course of the construction works.
- Drainage trench excavations should be taken down to solid ground, but when this is not possible, the drainage system should be designed to accommodate any movement and made-up with a well-compacted backfill to the required formation levels.
- Where ground movement is likely to occur, flexible drainage systems should be provided, e.g. filled sites, mining areas and sites with shrinkable clay.
- Where possible, avoid passing adjacent to tree roots. Adequate precautions should be taken where this cannot be avoided, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer.

Installation of underground drains

The depths of drains and the protection provided over them needs to be adapted to the traffic normal for the location, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer. Requirements are as follows:

- Pipes should be laid to an even gradient (see table 1), and significant changes in gradient should be combined with an access point.
- Pipes should be laid in straight lines, but may be laid to slight curves, providing the length of drain can be effectively cleaned by the use of rods.
- Connections should be to inspection chambers or manholes, but connections to junctions are acceptable if access is provided to clear blockages. In all cases, discharge should be in the direction of flow.
- Bends should be positioned in, or adjacent to, terminal fittings, inspection chambers or manholes, and at the foot of discharge stacks. Bends should have as large a radius as practicable.
- The system should be ventilated at or near the head of each main drain to allow free passage of air throughout; the maximum length of any branch serving a single appliance being 6m, and for a group of appliances, 12m.
- Where appliances are not fitted with integral traps at the point of discharge, a trap must be provided using either a trapped gully or low back trap.

Table 1: Recommended minimum gradient of drains

Peak flow (litres/sec)	Pipe size (mm)	Minimum gradient	Maximum capacity (litres/sec)
<1	75 100	1:40 1:40	4.1 9.2
>1	75 100 150	1:80 1:80(1) 1:150(2)	2.8 6.3 15
Notes: (1) Minimum of 1 WC (2) Minimum of 5 WC's			

Septic tank systems - treatment plants

If you are not on main line drainage then you will have either a septic tank or cesspit; ordinarily, the foul waste will run to one of the above tanks while the rain water is usually kept separate to help the action of bacteria and enzymes in the tank. The outfall from the septic tank should either run to a designed drainage field or possibly straight to a river or brook; you will often find the rain water system tapped onto the outlet of a septic tank to help dilute any effluent that may pass through the system.

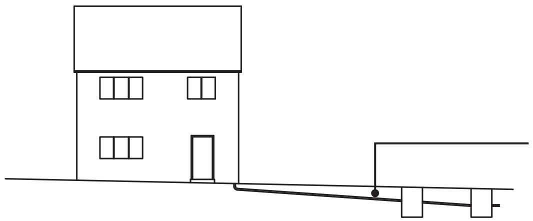
Any septic tank or other sewerage treatment system that is intended to have an outfall to a water course should have full consent to do so, in writing from the Environment Agency (England and Wales), NIEA (Northern Ireland) or Local Authority (Scotland). This consent should clearly allow the discharge to occur for a minimum period of 15 years and should be made available upon request.

Storm water should not discharge into the septic tank or water treatment plant and should be directed to a suitably designed soakaway or sewer.

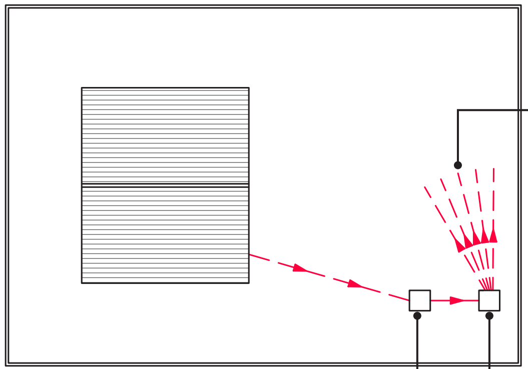
Percolation drainage fields for treatment and outfall drainage plants should not be situated uphill of dwellings.

Where the septic tank or treatment plant discharges to a soakaway, drainage field or mound suitable percolation tests should be provided in conjunction with the drainage design. The test should be carried out with at least two trail holes. The average figure from the tests should be taken. The test should not be carried out during abnormal weather conditions such as heavy rain, severe frost or drought.

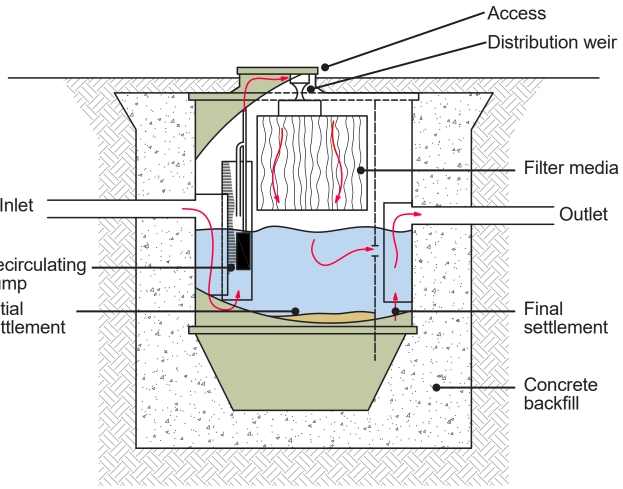
Typical sewage treatment plan (section)



Typical sewage treatment plant (plan)



Typical sewage treatment plant



Septic tanks

Septic tanks should only be used in conjunction with a form of secondary treatment (e.g. drainage field, drainage mound or constructed wetland).

Septic tanks should be sited at least 7m from any habitable parts of the building and downslope. Septic tanks should have a minimum capacity of at least 2,700 litres below the level of the inlet, for up to 4 users. The size should be increased by at least 180 litres for each additional user.

Where they are to be emptied using a tanker, the septic tank should be sited within 30m of a vehicle access provided that the invert access does not exceed 3m below the level of vehicle access. Where the depth of the invert access exceed 3m this distance may need to be reduced.

Where possible tanks should not be located beneath vehicle access points unless adequate precautions are undertaken.

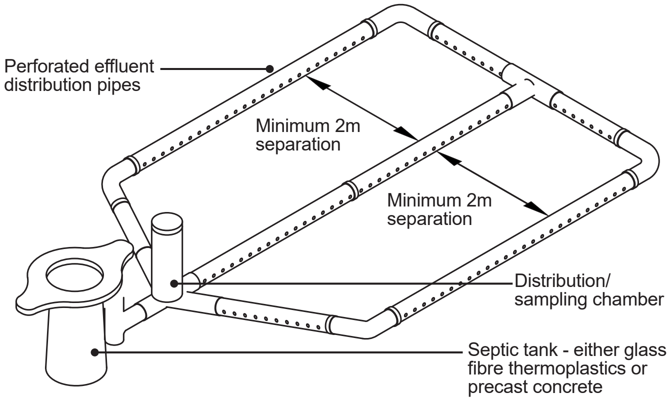
Septic tanks should be designed and constructed in accordance with the relevant Building Regulations.

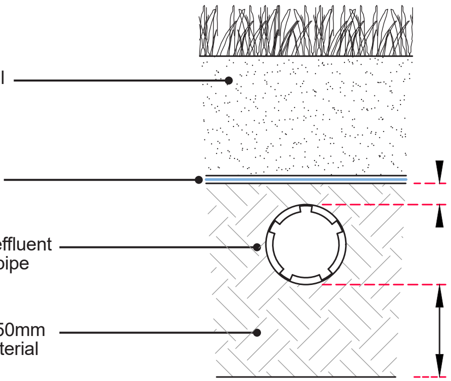
Drainage fields and drainage mounds

A drainage field or mound serving a wastewater treatment plant or septic tank should be located:

- At least 10m from any watercourse or permeable drain.
- At least 50m from the point of abstraction of any ground water supply and not in any zone 1 groundwater protection zone.
- At least 15m from any building.
- Sufficiently far from any other drainage fields, drainage mounds or soakaways so that the overall soakage capacity of the ground is not exceeded.

Drainage field





Packaged treatment plants

- The discharge from the waste water treatment plant should be sited at least 10m
- Away from watercourses and any other buildings.
- Treatment plants should be type tested in accordance with BS 7781.
- Where packaged treatment plants require power to operate it should be able to adequately function without power for up to 6 hours or have uninterruptible power supply.
- Packaged treatment plants should have suitable 3rd party accreditation.

5.
Drainage

5.6
Below Ground -
Storm Drainage -
to Mains Sewer

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Location of rainwater down pipes.
2. Location of slotted drainage channel systems.
3. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Drainage shall be designed, constructed and installed so that:

- Storm drainage systems should be designed to meet the requirements of relevant Building Regulation requirements or BS EN 752 and be installed following the guidance in BS 8000-14.
- Discharges to a suitable outfall which is:
  - A soakaway or other infiltration system if ground conditions (1) and site location permit, or,
  - A watercourse that has consent in writing from the appropriate regional agency; to allow or limit the rate of discharge. Consent from the EA, NIEA or LA means a clear confirmation in writing that they will allow discharge to the designated outfall for the period of Warranty cover, or,
  - Sewer maintained by the Local sewerage undertaker, or,
  - A suitable private storm drainage/sewer system (2) that leads to an adopted sewer.

  Note:
  (1) For soakaways: the ground conditions and water table movements must be suitable to allow the installation to function correctly all year round. Percolation tests will be required and the Warranty Surveyor given the opportunity to appraise the results before the installation goes ahead.
  (2) Connections to private storm drainage systems will require agreement of the owners of such drain/sewer.

- Materials and components used for storm water drainage systems, e.g. pipes, fittings and fixing accessories, inspection chambers etc. should conform to appropriate European Standards or European Technical Assessments (ETAs). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Pipework, fittings, inspection chambers, etc. should be installed in accordance with manufacturer's recommendations.
- Drains and pipework etc. must be durable and suitable for use underground.
- The installation of drainage/pipework does not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

Outfalls

All below ground storm drainage systems need to be designed to allow the unobstructed flow of storm water to a suitable approved/tested outfall. To achieve this, the points below should be noted at the design and installation stages:

- Storm water drainage systems only take storm/surface water from a property or properties and will include water from roofs, drives, paths and certain hard standing areas. These systems discharge into Local Authority sewers, soakaways or water courses. Foul drainage must not be connected to these systems.
- Impervious surfaces can drain to a permeable area within the garden providing it is free draining.
- The storm drainage system must be designed for the rainfall intensities as recommended in the applicable relevant Building Regulations. This should include allowance for where hard standing areas are also being drained into the storm water drains.
- Silt traps should be incorporated where hard standings are being drained into the storm system to avoid build-up of material in the underground drains.
- Oil interceptors should be should be installed on car parks, or other areas where there is likely to be leakage or spillage of oil.
- The drainage system, including manholes, gullies, pipe connections, etc. should be protected from damage throughout the course of the construction works.
- Drainage trench excavations should be taken down to solid ground, but when this is not possible, the drainage system should be designed to accommodate any movement and made-up with a well-compacted backfill to the required formation levels.
- Where ground movement is likely to occur, flexible drainage systems should be provided, e.g. filled sites, mining areas and sites with shrinkable clay.
- Where possible, avoid passing adjacent to tree roots. Adequate precautions should be taken where this cannot be avoided, in accordance with the recommendations of the relevant Building Control body and the pipe manufacturer.

Installation of underground drains

The depths of drains and the protection provided over them needs to be adapted to the traffic normal for the location, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer. Requirements are as follows:

- Pipes should be laid to an even gradient (see table 1), and significant changes in gradient should be combined with an access point.
- Pipes should be laid in straight lines, but may be laid to slight curves, providing the length of drain can be effectively cleaned by the use of rods.
- Connections should be to inspection chambers or manholes, but connections to junctions are acceptable if access is provided to clear blockages. In all cases, discharge should be in the direction of flow.
- Bends should be positioned in, or adjacent to, terminal fittings, inspection chambers or manholes, and at the foot of discharge stacks. Bends should have as large a radius as practicable.

Table 1: Minimum gradient of drains

Pipe diameter (mm)	Minimum gradient
100	1:80
150	1:150

5.
Drainage

5.7
Below Ground -
Storm Drainage -
to Soakaway

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Location of rainwater down pipes.
2. Location of slotted drainage channel systems.
3. Proposed drainage layouts including invert levels, gradients, pipe diameters, location of inspection chambers and rodding points.
4. A site investigation confirming the ground is suitable for a soakaway.
5. An onsite percolation test confirming the permeability of the ground.
6. Details of soakaway design in accordance with BRE:365.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Drainage shall be designed, constructed and installed so that:

- Storm drainage systems should be designed to meet the requirements of relevant Building Regulation requirements or BS EN 752 and be installed following the guidance in BS 8000-14.
- Discharges to a suitable outfall which is:
  - A soakaway or other infiltration system if ground conditions and site location permit, or,
  - A soakaway or other infiltration system if ground conditions and site location permit. For soakaways: the ground conditions and water table movements must be suitable to allow the installation to function correctly all year round. Percolation tests will be required and the Warranty Surveyor given the opportunity to appraise the results before the installation goes ahead.
- Materials and components used for storm water drainage systems, e.g., pipes, fittings and fixing accessories, inspection chambers etc. should conform to appropriate European Standards or European Technical Assessments (ETAs). Where no relevant European Standard or ETA exists, British Standards or British Board of Agrément Certificates should be used.
- Pipework, fittings, inspection chambers, etc. should be installed in accordance with manufacturer's recommendations.
- Drains and pipework etc. must be durable and suitable for use underground.
- The installation of drainage/pipework does not adversely affect the structural stability of the building.
- Prevent the entry of hazardous ground substances, external moisture or vermin.
- Are constructed using non-hazardous materials.
- Are safe and convenient in use.

Outfalls

All below ground storm drainage systems need to be designed to allow the unobstructed flow of storm water to a suitable approved/tested outfall. To achieve this, the points below should be noted at the design and installation stages:

- Storm water drainage systems only take storm/surface water from a property or properties and will include water from roofs, drives, paths and certain hard standing areas. These systems discharge into Local Authority sewers, soakaways or water courses. Foul drainage must not be connected to these systems.
- Impervious surfaces can drain to a permeable area within the garden providing it is free draining.
- The storm drainage system must be designed for the rainfall intensities as recommended in the applicable relevant Building Regulations. This should include allowance for where hard standing areas are also being drained into the storm water drains.
- Silt traps should be incorporated where hard standings are being drained into the storm system to avoid build-up of material in the underground drains.
- Oil interceptors should be should be installed on car parks, or other areas where there is likely to be leakage or spillage of oil.
- The drainage system, including manholes, gullies, pipe connections, etc., should be protected from damage throughout the course of the construction works.
- Drainage trench excavations should be taken down to solid ground, but when this is not possible, the drainage system should be designed to accommodate any movement and made-up with a well-compacted backfill to the required formation levels.
- Where ground movement is likely to occur, flexible drainage systems should be provided, e.g. filled sites, mining areas and sites with shrinkable clay.
- Where possible, avoid passing adjacent to tree roots. Adequate precautions should be taken where this cannot be avoided, in accordance with the recommendations of the relevant Building Control Body and the pipe manufacturer.

Layout of land drains

Drain runs on sloping sites need to be positioned perpendicular to the fall of the site. Land drains should be positioned adjacent to paths, drives and outbuildings. The pipe soffit should be positioned at least 400mm below the finished ground level, and the backfill consolidated to the same degree of compaction as the adjacent soil.

Soakaways

Soakaways are a simple way of dispersing surface and storm water in circumstances where connection to the storm water sewer system is not feasible or unnecessary. A soakaway is basically a system that loses water rather than collects water. Soakaways are part of the Sustainable Urban Drainage Systems (SuDS) technologies that handle storm water at the source rather than leading it into the public sewer systems.

Soakaways can only be considered in permeable conditions. A suitable site must be:

- In a location lower than the area being drained.
- At least 5m away from any building (BS 8301).
- Situated so that it will not saturate the foundations of any structure.
- Situated so that the base of any soakaway/infiltration system is permanently above the water table.
- Situated far enough away from other soakaways/infiltration systems to ensure that the capacity of those other systems and the ground itself is not impaired.
- Situated so that there is no risk of contamination from pollutants.

Sustainable urban drainage systems (SuDS)

Developments proposing to use other types of Sustainable Urban Drainage Systems (SuDS) should follow the guidance found in 'SuDS Manual' (a design manual published by CIRIA). The developer should also confirm if the Planning consent for the project imposes any additional requirements which may impact on the design of the sustainable drainage systems (SuDS). Any surface water drain, soakaway or other infiltration system (including a SuDS system) which is intended to discharge to a water course should have consent to discharge in writing from the appropriate regional agency.

Installation of underground drains

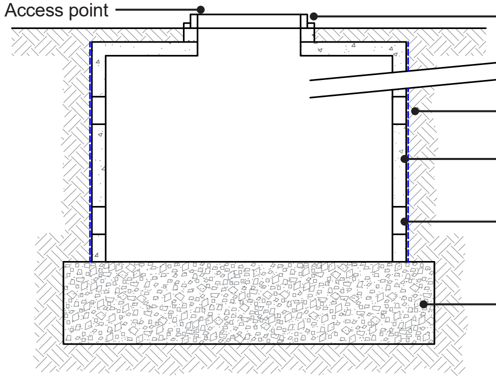
The depths of drains and the protection provided over them needs to be adapted to the traffic normal for the location, in accordance with the recommendations of the relevant Building Control body and the pipe manufacturer. Requirements are as follows:

- Pipes should be laid to an even gradient (see table 1), and significant changes in gradient should be combined with an access point.
- Pipes should be laid in straight lines, but may be laid to slight curves, providing the length of drain can be effectively cleaned by the use of rods.
- Connections should be to inspection chambers or manholes, but connections to junctions are acceptable if access is provided to clear blockages. In all cases, discharge should be in the direction of flow.
- Bends should be positioned in, or adjacent to, terminal fittings, inspection chambers or manholes, and at the foot of discharge stacks. Bends should have as large a radius as practicable.

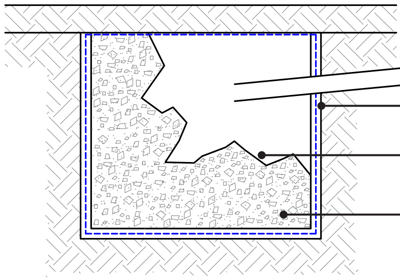
Table 1: Minimum gradient of drains

Pipe diameter (mm)	Minimum gradient
100	1:80
150	1:150

Chamber-type soakaway



Typical soakaway design



Soakaways where chalk is prevalent

For sites where chalk is prevalent, the CIRIA C574 Engineering in Chalk 2002 publication gives the following recommendations:

Concentrated ingress of water into the chalk can initiate new dissolution features, particularly in low-density chalk, and destabilise the loose backfill of existing ones. For this reason, any soakaways should be sited well away from foundations for structures or roads, as indicated below:

- In areas where dissolution features are known to be prevalent, soakaways should be avoided if at all possible but, if unavoidable, should be sited at least 20m away from any foundations.
- Where the chalk is of low density, or its density is not known, soakaways should be sited at least 10m away from any foundations.
- For drainage systems, flexible jointed pipes should be used wherever possible; particular care should be taken for the avoidance of leaks in both water supply and drainage pipe work.
- As the chalk is a vitally important aquifer, the Environment Agency and Local Authority must be consulted when planning soakaway installations where chalk lies below the site, even where it is mantled with superficial deposits.

6. External Walls

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. Evidence will be required to confirm that an 'approved installer' for external wall cladding systems has undertaken the work if required by the terms of the manufacturer or third party certifications.
2. Any multiple occupancy building (which includes flats /apartment accommodation) must have fire stopping and cavity barriers completed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.
3. All work is to be carried out by a technically competent person in a workmanlike manner.
4. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. Steel frames and lintels should be appropriately treated to prevent corrosion.
2. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
3. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
4. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
5. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window / door or 'decorative external cladding' (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
6. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
7. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
8. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
9. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. External walls shall be designed and constructed so that they:
    a. Are structurally sound;
    b. Are durable and resistant to moisture;
    c. Have an adequate thermal performance;
    d. Prevent the entry of hazardous substances from the ground into the building;
    e. Meet the requirements of the Building Regulations.
2. Framed structures must be supported by structural calculations completed by an Engineer. The design and construction must meet the Building Regulations.
3. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
4. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
5. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

6. External Walls

6.1 Traditional Masonry Cavity Wall

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of all proposed materials to be used in the construction of the external wall.
2. A full set of detailed drawings, including:
   a) Plan layouts indicating dimensions, movement joints, position and size of openings, buttressing walls, etc.
   b) Elevations with dimensions shown.
   c) Junction details showing position of DPC's, cavity trays, other building elements such as roofs, floors, etc.
3. Engineers calculations and drawings for elements of load bearing masonry.
4. Masonry cladding and support systems. To include general arrangement drawings, sections and site specific supporting calculations (including a drawing register).

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Structural design of walls

A method of meeting the requirements of the Warranty is to design and construct walls to the relevant Building Regulations depending on the region. For example, in England and Wales, the masonry units should be built in accordance with Approved Document A (Structure). Alternatively, justification of design by an Engineer can be used as a solution.

Dealing with areas of high exposure to frost and wind-driven rain

The design and construction of masonry cavity walls should be suitable for the site specific exposure location. For further information on determining the exposure for the site location please see BS 8104 and BR 262 for further guidance.

The suitability of full fill cavity insulation in exposure locations

The following table outlines the minimum cavity widths for full fill insulation types in varying exposure locations.

Suitable cavity wall construction depending on exposure, for use with full fill cavity insulation

		Minimum insulation thickness (mm)		
Exposure category	**Suitable wall construction (max 12m in height)**	**Built-in insulation**	**Retro-fill (other than UF foam) - Blown in mineral wool, polystyrene beads etc.**	**Urea Formaldehyde Foam - UF foam**
Very Severe (Exposure zone 4)	Any wall with impervious cladding	50	50	50
	Fair-faced masonry with impervious cladding to all walls above ground storey	100	125	Not permitted
	Any wall fully rendered (2)	75	75	Not permitted
	Fair-faced masonry (1)	150	150	Not permitted
Severe (Exposure zone 3)	Any wall with impervious cladding or render (2)	50	50	50
	Fair-faced masonry with impervious cladding or render (2) to all walls above ground storey	50	75	50
	Fair-faced masonry (1)	75	75	Not permitted
Moderate (Exposure zone 2)	Any wall with impervious cladding or render (2)	50	50	50
	Fair-faced masonry with impervious cladding or render (2) to all walls above ground storey	50	50	50
	Fair-faced masonry	50	75	75
Sheltered (Exposure zone 1)	Any wall with impervious cladding or render.	50	50	50
	Fair-faced masonry with impervious cladding or render to all walls above ground storey	50	50	50
	Fair-faced masonry	50	50	50

Notes:
(1) In very severe exposure locations, fair-faced masonry with full fill cavity insulation must have a cavity width of at least 150mm and the insulation must have third party accreditation to confirm it can be used in this scenario.
(2) Render on an external leaf of clay bricks (F2, S1 or F1, S1 designation bricks BS EN 771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation.

- This table covers walls where the external leaf does not exceed 12m in height.
- The exposure category of the building is determined by its location on the map showing categories of exposure to wind-driven rain (see the 'External Walls – Claddings' section and also BRE Report 262).
- Fair-faced masonry includes clay, calcium silicate and concrete bricks and blocks and dressed natural stone laid in an appropriate mortar, preferably with struck, weathered or bucket handle joints. Cavity walls of random rubble or random natural stone should not be fully filled.
- Recessed mortar joints should not be used.

Additional requirements in a coastal location

Where developments are within a coastal location additional Warranty requirements should be met.

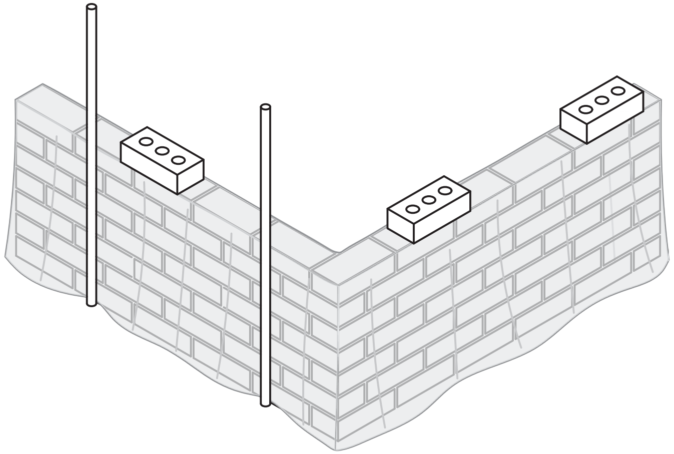
For the purpose of this Technical Manual we are considering sites within 5km inland from the shore line or sites located in 'tidal' estuarine areas where they are within 5km of the general shoreline.

Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.

Protection of masonry

All new masonry work should be protected during construction by covering it to ensure that walls are not allowed to become saturated by rainwater, dry out too quickly in hot weather, are protected against frost attack, the risk of efflorescence and line staining and movement problems are reduced.

Any temporary cover should not disturb the new masonry.



Working in adverse weather

Precautions should be taken when necessary to maintain the temperature of bricks, blocks and mortar above 2°C. The use of anti-freeze as a frost resistant additive in mortar is not permitted. Please refer to ‘Appendix C - Material, Products, and Building Systems’ for further guidance.

During prolonged periods of hot weather, when masonry units can become very dry, absorbent clay bricks may be wetted to reduce suction. Low absorption bricks, i.e. engineering bricks, should not be wetted. For calcium silicate and concrete units, the mortar specification may need to be changed in order to incorporate an admixture.

Brick and block suitability

Bricks and blocks should:
- Be capable of supporting proposed loads.
- Comply with BS EN771 and PD 6697.
- Have appropriate compressive strength in accordance with the Building Regulations.

Exposure
Facing bricks must have a suitable level of durability and particular attention should be paid to the brick’s resistance to frost and moisture. Further information can be found in ‘Appendix C - Material, Products, and Building Systems’.

Colour variation of bricks
There is usually a variation in the colour of bricks of the same style. To prevent patching of colour, it is recommended that at least three packs of bricks are opened at any one time and mixed randomly to ensure that the wall is of an even colour.

Frogs and perforations
Frogged bricks have a depression in the face of the brick. Normally, they should be laid with the major depression, or frog, facing up so that it is fully filled with mortar during laying. This ensures optimum strength, helps to increase the mass of the wall (to give good sound insulation) and prevents the possibility of standing water within the structure, which could freeze. Bricks with a directional surface texture are intended to be laid frog up.

Care should be taken with the use of perforated bricks where the exposure rating of the wall is high, as water retention/collection has been found to exist in the perforations.

Efflorescence
Efflorescence is a white deposit on the face of masonry brought about by water moving through the wall, dissolving soluble salts and depositing them when the water evaporates during drying out.

Efflorescence is best prevented by:
- Keeping all units dry prior to use.
- Protecting the head of newly constructed work with some form of cover to prevent saturation.

Frost attack
Frost attack can occur through the repeated action of rain water freezing and thawing. When water turns into ice, there is increase in volume which can eventually cause stresses to masonry units and lead to spalling. This can be avoided by specifying freeze/thaw resistant bricks in areas that are prone to prolonged periods of saturation.

Common influences which can lead to frost attack include:
- The freeze/thaw resistance of the masonry units.
- Saturation of the masonry.
- Degree of exposure to wind driven rain.
- Localised protection from other buildings, topography, roof overhangs, coping or capping.

The following details can reduce persistent wetting and lessen the risk of frost attack:
- Parapet walls should have a coping or capping (for further guidance on parapet walls, see ‘External Walls - Parapets’).
- Sills and coping should have a weathered upper surface.
- Paths around the building should drain away from walls to avoid saturating brickwork.
- Masonry and mortar specification should be in accordance with PD 6697
- As a quick guide, Freeze/thaw resistant masonry units should be selected using the recommendations in the following table.

Freeze/thaw resistance categories:

Freeze/thaw resistance category	**Possible use case***
F2 – Severe exposure to freeze/thaw	Can be used in normal building situations and all exposures to wind driven rain. F2 rated masonry units should be used: ▪ Below DPC. ▪ Brickwork plinths. ▪ Chimneys. ▪ Capping, coping and sills.
F1- Moderate exposure to freeze/thaw	Provides a moderate freeze/thaw resistance and in general F1 rated masonry units can be used between DPC and eaves. However they should not be used in areas of severe or very severe exposure to wind driven rain or elevated sites.
F0 – Passive exposure to freeze/thaw	Not freeze/thaw resistant – should not be used externally unless completely protected by impermeable cladding

Please note, the possible use cases are not an exhaustive list. In all situations, confirmation of suitability of the masonry unit for the intended use must be confirmed by the manufacturer of the masonry units and reference to PD 6697.

The following should also be considered in relation to the freeze/thaw of brickwork:

- External painted finishes on brickwork has the potential to trap moisture and as such the manufacturer should be consulted to ensure the decorative finish will not have a detrimental impact on brickwork durability.
- Masonry units with low soluble salts should be specified where there is a risk of brickwork being persistently wet.
- Most concrete bricks have a strength of $22N/mm^2$ and are durable in most situations and are equivalent to frost resistance class F2 for clay bricks. For copings and sills, bricks with a compressive strength of $36N/mm^2$ should be used.
- Concrete blocks used in the outer leaf without protective cladding or render must have a compressive strength greater than $7.3N/mm^2$ or have a density of at least $1,500kg/m^{3.}$
- In Scotland, all clay bricks used externally should be frost-resistant, F2, S2 or F2, S1 to BS EN 771-1 and all concrete bricks used as facings should be 22 N/mm^2 to BS EN 771-3.
- In areas of severe and very severe exposure to wind driven rain, the following should be specified:
  - Clay facing bricks which are frost-resistant F2, S2 or F2,S1 to BS EN 771-1.
  - Concrete bricks with a minimum strength of $22N/mm^2$ to BS EN 771-3.
  - Concrete blocks with a minimum density of $1,500kg/m^3$ or compressive strength greater than $7.3N/mm^2$.
  - Calcium silicate masonry units must be confirmed to be F2 rated to BS EN 771-2 by the manufacturer.
  - Most types of aircrete blocks with render.

If there are any doubts about the suitability of facing bricks in areas of severe frost exposure, written clarification by the brick manufacturer confirming the suitability of the brick should be provided.

Reclaimed bricks
Due to difficulties in testing the durability of the exact batch proposed to be used, reclaimed bricks should not be used for Warranty purposes.

Mortar

General
A mortar type above DPC should be chosen in accordance with the guidance given in the ‘External Walls’ and ‘Appendix C - Material, Products, and Building Systems’ sections, or as recommended by the brick or block manufacturer. To ensure adequate durability, strength and workability, lime and/or air entraining plasticisers may be added to cement in accordance with the manufacturer’s recommendations. Cement and sand alone should not be used unless a strong mix is specifically required by the design.

Batching
Keep batching and mixing equipment clean to avoid contamination with materials used previously.

Mixing
Our preference is, that mortar should be mixed by machine, or use ready mixed retarded mortars. Mortar should be carefully and consistently proportioned and then thoroughly mixed using a mechanical mixer, except for very small quantities. Quality control procedures must be in place where non-ready mixed mortars are used.

Recessed mortar joints
Recessed mortar joints should be avoided where:
- Bricks are not frost resistant unless the brick manufacturer has confirmed their use for that particular location.
- The development is on steep sloping ground, facing open countryside or within 8km of a coast or large estuary.
- Bricks are perforated closer than 15mm to the face.
- There is no reasonable shelter from driving rain, e.g. from buildings or groups of trees within 50m and of similar height to the home.
- The cavity is to be fully filled with cavity insulation.

TRADITIONAL MASONRY CAVITY WALL: Substructure external walls, DPC, DPM and gas barrier arrangements

Key points: Construction below DPC

1. Brickwork and blockwork must be selected to have suitable durability for its use in the wall construction in accordance with BS EN 771-1 and PD 6697.
2. Mortars below DPC are exposed to higher levels of saturation and therefore require higher durability classification (see BS EN 998-2).
3. Cavities below ground should be filled with concrete ensuring there is a minimum gap of 225mm between DPC and the top of concrete.
4. Concrete for cavities should be GEN 1 grade and a consistence class S3.
5. External ground levels should be a minimum of 150mm below DPC.
6. The compressive strength of the masonry units must meet the requirements of the Building Regulations.

Damp proof courses (DPC)

1. DPC's should be of a flexible material, be suitable for the intended use, the DPC should have appropriate 3rd party certification. The installation specification of DPC's should follow good design practice in accordance with BS 8215.
2. Blue bricks or slate will not be accepted as a DPC.
3. DPC's should be laid on a mortar bed and correctly lapped at junction and corners. The depth of the lap should be the same width as the DPC.
4. The DPC should not bridge any cavity unless it is acting as a cavity tray where a cavity is required (e.g. over a telescopic floor vent).
5. Damp proof membranes should be lapped with the DPC a minimum overlap of 100mm. DPM's should be at least a minimum 1200 gauge thickness.

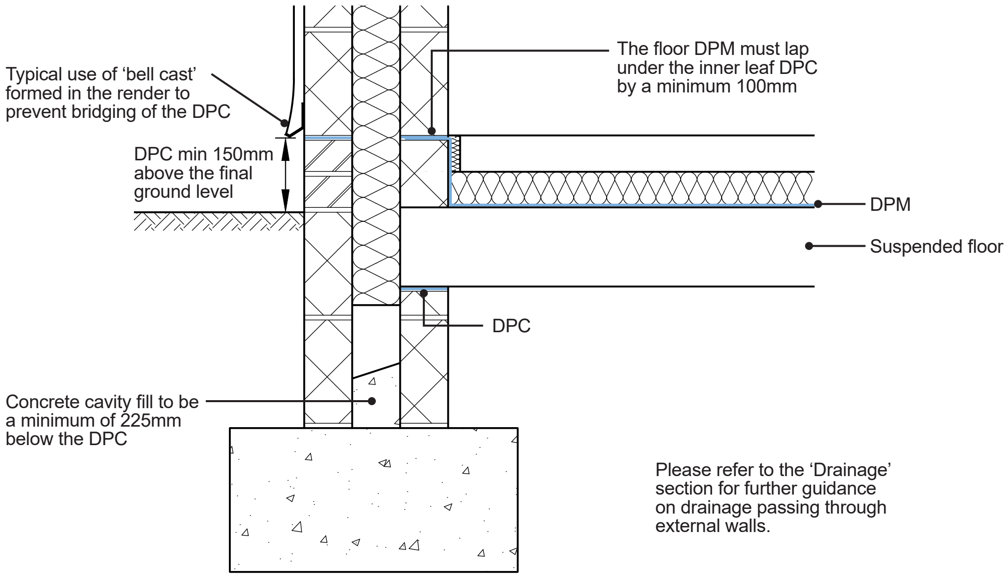
Rendering below DPC

1. Rendering below DPC should only be carried out using a specialist render manufacturer's specification. No render system should bridge the DPC and a proprietary uPVC bead or stainless steel bead should be used above and below where the renders meet at the DPC.
2. DPC should extend through the rendering system in between the bellcast beads or render stop system.
3. For bellcasts, uPVC beads or stainless steel beads are acceptable.

Note: For further guidance on the application of render please refer to the 'External Walls - Render' section.

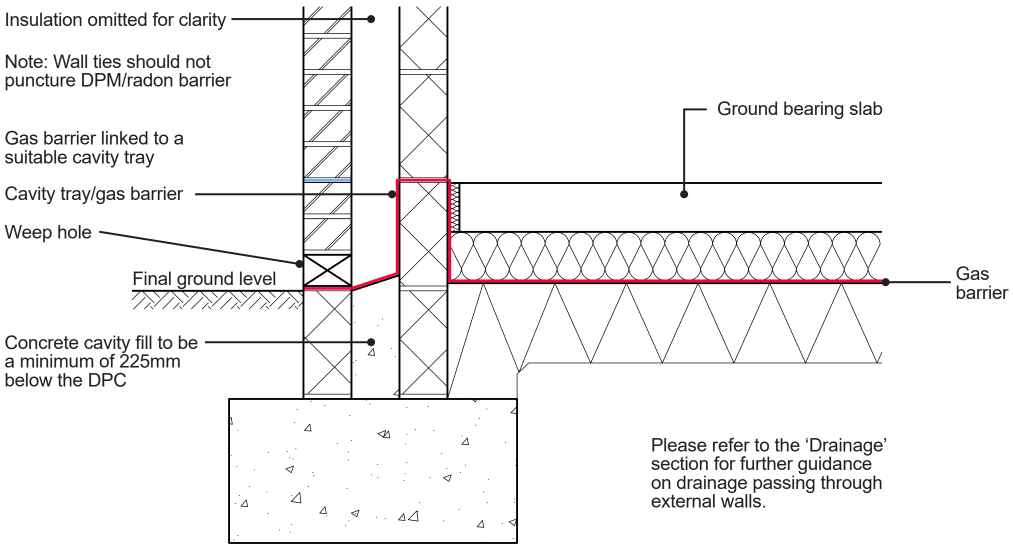
DPC and DPM arrangement: Suspended floor

Example shown with a rendered wall



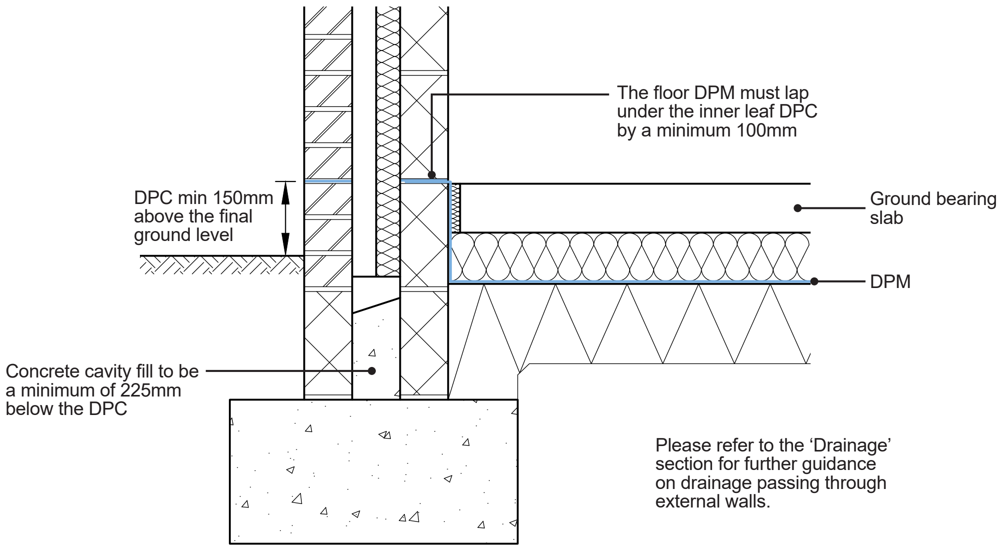
Please refer to the 'Drainage' section for further guidance on drainage passing through external walls.

Typical gas barrier arrangement: Traditional ground bearing slab



Please refer to the 'Drainage' section for further guidance on drainage passing through external walls.

DPC and DPM arrangement: Traditional ground bearing slab



Please refer to the 'Drainage' section for further guidance on drainage passing through external walls.

All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building Control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

Cavities

A traditional masonry wall should be constructed using an inner and outer leaf, and a cavity should be provided between them, which meet the following provisions:

- The cavity should have a minimum width of 50mm.
- It is to be kept clear from mortar snots to ensure the cavity is not bridged.
- The two leaves should be appropriately tied.
- The cavity can be fully or partially insulated, depending on exposure to wind driven rain. For partial fill insulation, a minimum clear residual cavity of 50mm should always be provided. Further information can be found in BS 8104.
- A 75mm minimum residual cavity will be required to partial fill insulated cavities in very severe exposure locations.
- Bricks should be capable of supporting proposed loads.
- Bricks should comply with BS EN771 and PD 6697.

Cavity barriers

- Cavity barriers should be provided in the external cavity at all compartment walls and floor junctions.
- Cavity barriers should have suitable third party accreditation.

Rendering on a masonry background

The walls which are to be rendered should be examined for excessive moisture content prior to rendering and suitable to receive rendering. Rendering should only be completed if the outside temperature is at least 2°C. There should be no frost within the construction and rendering should not take place where freezing weather conditions are expected before curing.

Ensure that all joints are finished flush with the surface to avoid shade variations.

The wall construction should not include dissimilar materials that may increase the potential of cracking due to differential thermal movement and effects that the different suction that each type of background material may create.

To control suction, always apply a specialist sealer key coat or suitable render preparatory coat. Allow a minimum of 48 hours for the key coat to fully dry before applying the next coat.

Note: For further guidance on the application of render please see the 'External Walls - Render' section.

Thermal insulation

Thermal insulation for cavity walls should be inserted to a high standard of workmanship to avoid poor insulation performance and to prevent dampness migrating to the inside of the building:

- Insulation should have appropriate third party certification and be installed in accordance with the manufacturers instructions.
- Insulation should not be cut or pierced to accommodate wall ties, unless increased centres at reveals or expansion joints are required.
- The wall ties should coincide with insulation joints.
- Partial fill insulation should be clipped or retained to the inner leaf using proprietary fixings in conjunction with wall ties.
- For full fill cavities, mortar joints to facing brickwork should not be recessed.
- Render on an external leaf of clay bricks (F2, S1 or F1, S1 designation bricks BS EN771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation. Partial fill cavity insulation should be adopted.

Chases in masonry walls

Chases in masonry walls for service pipes and cables should be avoided. Where unavoidable, chases should:

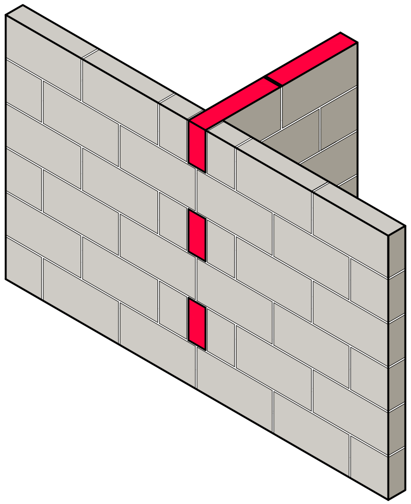
- Only be made in solid masonry (not hollow blocks).
- A horizontal chase must not exceed 1/6 the thickness of the single leaf.
- A vertical chase must not exceed 1/3 the thickness of the wall.

Bonding internal walls to external cavity walls

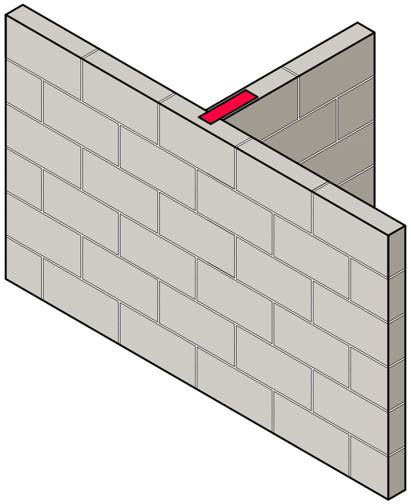
Bonded walls in brickwork are comparatively easy to construct, but this can be more difficult with blockwork, so either:

- Tooth every alternative course, or butt and tie.
- Where blocks are of a different density, always use a butted joint; party walls carry the separating wall through and butt up the inner leaf using a proprietary bed joint, reinforcement or suitable ties at each block course.

Block bonding internal masonry walls to the inner leaf



Block bonding internal walls to the inner leaf using ties



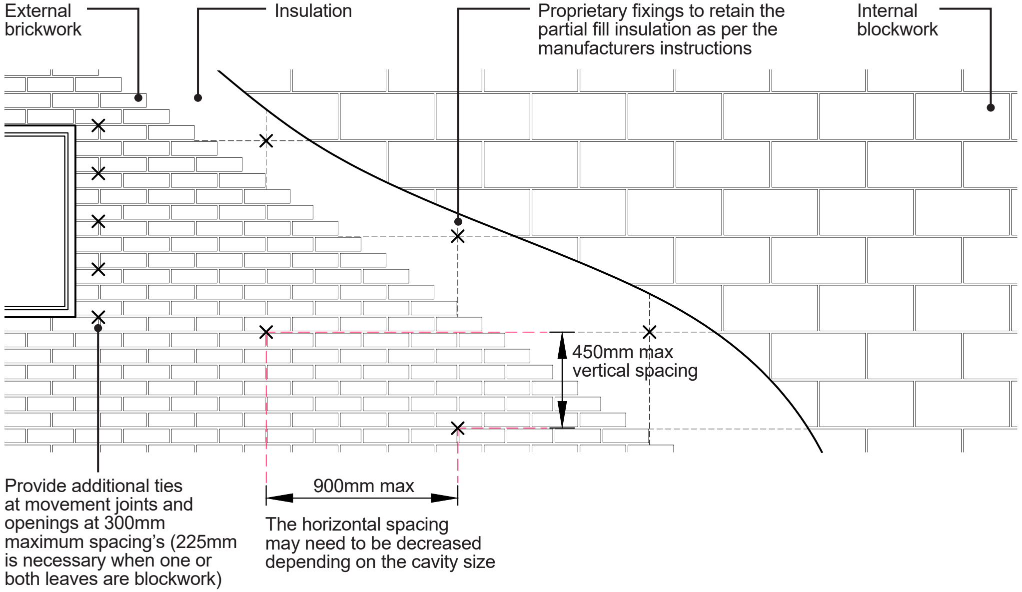
Suitability and spacing of wall ties

Unfilled or fully filled cavities		Spacing of ties	
Width of cavity	Recommended tie	Horizontal	Vertical
50mm to 75mm wide	Butterfly Double triangle Vertical twist Proprietary ties	900mm	450mm (increased to 300mm at reveals and movement joints)
75mm to 100mm wide	Double triangle Vertical twist	900mm	450mm (increased to 300mm at reveals and movement joints)
100mm to 150mm wide	Vertical twist	900mm	450mm (increased to 300mm at reveals and movement joints)
Greater than 150mm	Wall tie specification and design to be provided by an Engineer, or in accordance with appropriate third-party certification. Design will be determined by location and site-specific conditions.		

Notes:

- The design of wall ties for cavity wall construction will need to consider the site specific conditions and location of the masonry panels on the building façade.
- Proprietary ties must have appropriate third-party certification.
- Proprietary insulation retaining clips compatible with the tie should be used where the cavity is partially filled.

Spacing of wall ties (brick outer leaf shown)

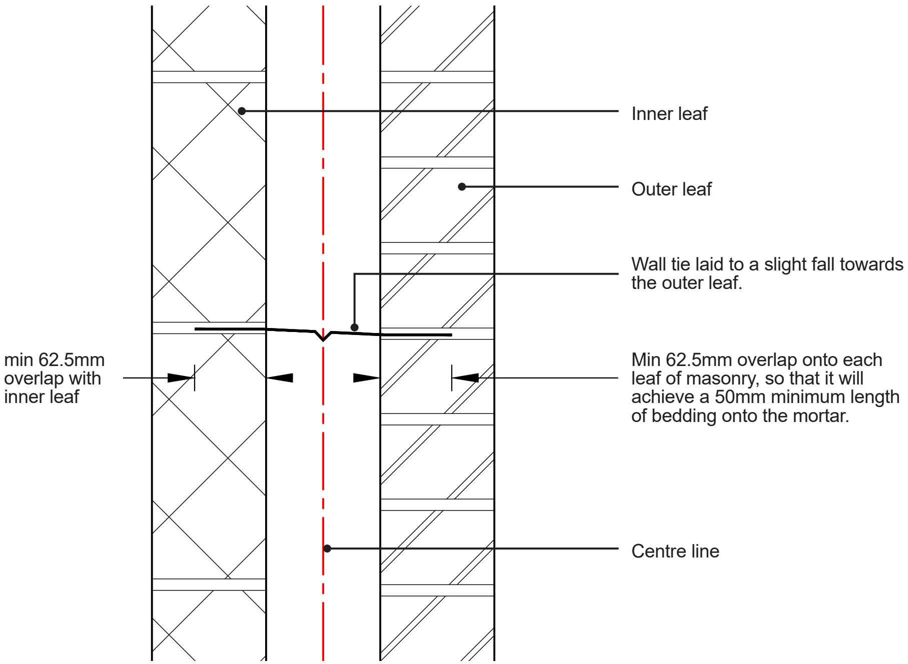


Wall ties

Wall ties should meet the following provisions:

- Stainless steel wall ties should always be used.
- The overall length of the wall ties must be long enough to ensure there is at least a 62.5mm overlap onto each leaf of masonry, so that it will achieve a 50mm minimum length of bedding onto the mortar.
- Wall ties should be laid to a slight fall towards the outer leaf and have the ability to hold insulation against an internal leaf for partial fill scenarios.
- Where a partial fill cavity insulation solution is proposed, a 50mm minimum residual cavity is to be provided.
- Wall ties should be in a staggered or in a diamond pattern.
- Wall ties should be installed at a minimum density in accordance with BS EN 1996 -1-1. This should not be less than 2.5 ties per m^2 and may increase with cavity width.
- It is important to note that only BS EN 845-1 type wall ties or specifically manufactured (and tested) party wall ties are permitted in cavity separating walls between dwellings to reduce the transfer of sound.

Wall tie provision



Movement joints

- Vertical movement joints should be provided to the outer leaf of cavity walls as indicated in the table below. The first joint from a return should be no more than half the dimension indicated in the table.
- The movement joints must be continued through the render construction and an appropriate weather resistant seal provided to prevent moisture ingress to behind the render finish.
- Movement joints below the DPC should also be provided at major changes in foundation level and at changes in foundation design.
- Wall ties should be provided at 300mm maximum vertical spacing either side of the expansion joint, and within 225mm horizontal spacing of the movement joint.
- For any given wall elevation where there is a mix of masonry e.g. brickwork external leaf lower level with a rendered block upper level, the requirement of a full height movement joint should be based on the shorter spacing requirement e.g. for the blockwork at 6m not brickwork at 12m.
- Compressible filler, such as polyurethane foam, should be used to form the joint and be sealed to prevent water penetration.
- Fibreboard or cork are not acceptable materials for forming movement joints in masonry.
- When sealants are used in proximity with stone it is important to select a non-oil-based sealant to help prevent any staining to the stone.
- Elastic sealants (Type E) are suitable as they allow for reversible movement. Where a back-up material is used to control the sealant depth, it will also provide a compressible space into which the sealant can deform.

Where a backing material is used, the following must be considered:
- The material is compatible with the sealant.
- It will not adhere to the sealant, preventing cracking within the sealant.
- Provides sufficient density to allow the sealant to be applied.
- Allows sufficient flexibility so not to impede lateral movement (compressible to about 50% of its original thickness), fibreboard is not acceptable.

Note: Where traditional cavity masonry walls or masonry cladding is specified for concrete/(hot rolled) steel framed buildings, horizontal movement joints should be provided with the use of shelf angles at vertical centres in accordance with current design standards. They should be capable of accommodating at least 1mm movement per continuous meter of vertical clay masonry. Shelf angles should not be fixed back to a timber framed or LGSF structures. Please refer to the 'External Walls – Timber Frame' or 'External Walls – Light Gauge Steel Frame' sections for further guidance on accommodating differential movement.

Spacing of movement joints

Material	Normal spacing	Joint thickness
Clay brickwork (2)(3)	12m (Spacing up to 15m may be possible if sufficient restraint is provided - consult designer)	15mm
Calcium silicate	7.5-9m	10mm
Concrete brickwork (1)	6m	10mm
Concrete blockwork (used in outer leaf)	6m	10mm
Natural stone masonry	15-20m (4)	10mm

Note: It is not normally necessary to provide movement joints to the internal leaf of cavity walls, but it should be considered for rooms with unbroken lengths of wall in excess of 6m.

In all circumstances, manufacturer's guidance for the spacing and sizing of movement joints should be considered.

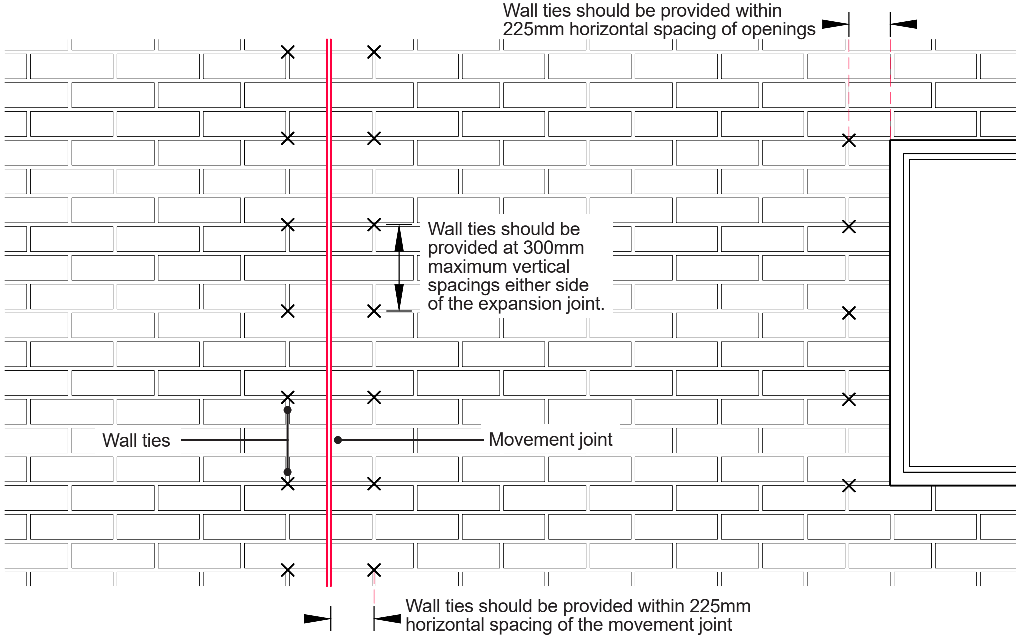
The first joint from a return should be not more than half the dimension indicated in the table. Movement joints are not acceptable in solid party or separating walls; however, where cavity wall construction is adopted, offset movement joints with a solid rubber compressible strip may be acceptable.

1. Where openings are over 1.5m, masonry bed joint reinforcement should be considered.
2. For unrestrained masonry such as parapets and free standing walls, vertical joint spacing should be reduced to 5m-6m centres and be 1.5m from corners.
3. For clay brickwork, a variation can be accepted if the Engineer designs to PD6697.
4. Located no more than 7.5m from an external corner.

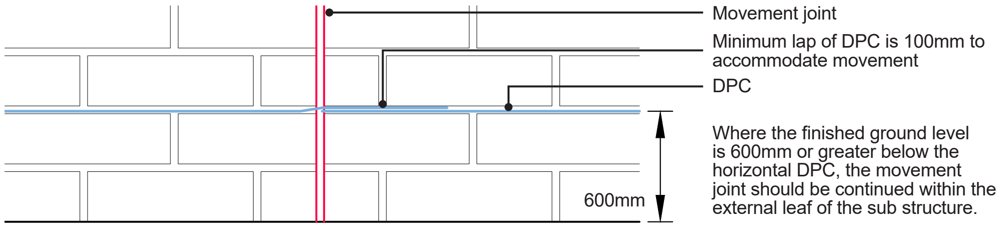
Bed joint reinforcement

Bed joint reinforcement may be required to critical areas to accommodate stresses such as above and below window openings. The Engineer may require this to be provided as part of the overall design specification. Where provided, they will be in addition to movement joints, not instead of. Bed joint reinforcement potentially can increase spacings of movement joints subject to the Engineer's specification.

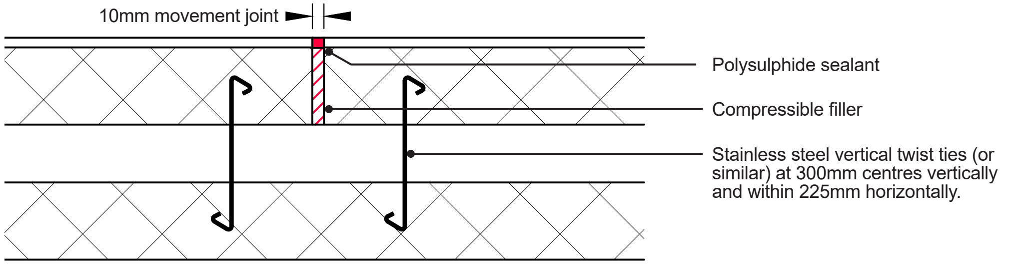
Wall ties in proximity to movement joints and windows (shown with brickwork)



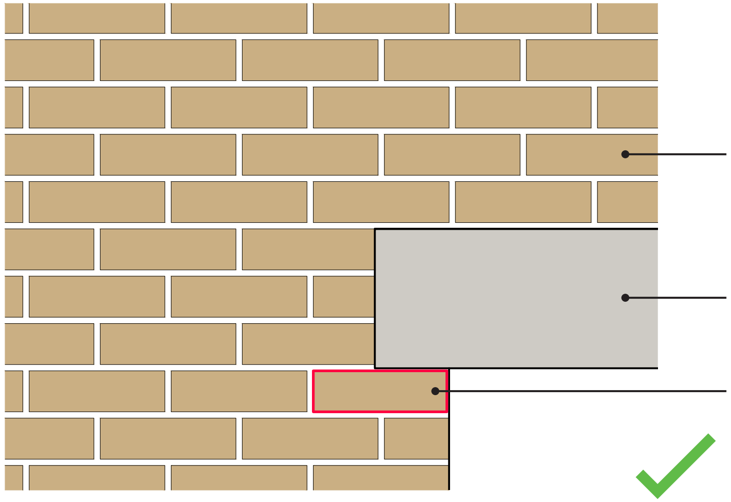
Movement joints below DPC



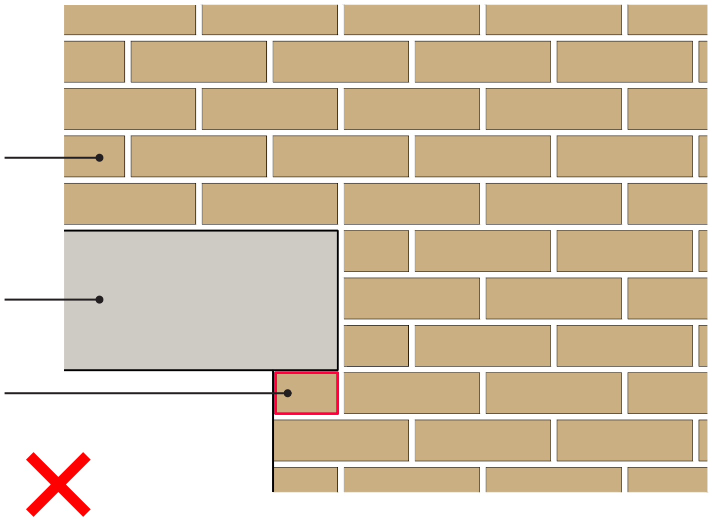
Typical movement joint detail



Correct method of brick bond around lintels



Incorrect method of brick bond around lintels



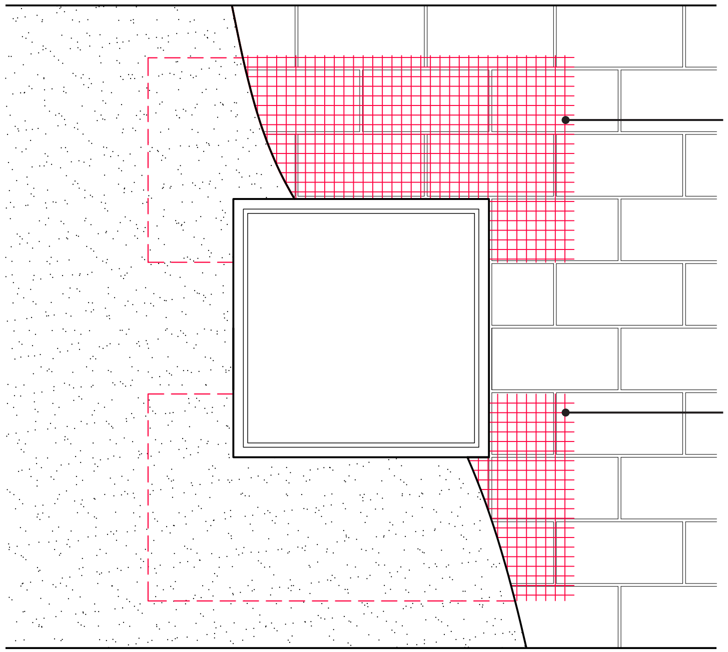
Lintels

- The lintel should be the correct length and width for the opening and cavity width, the bearing length should be at least 150mm.
- Do not let masonry overhang lintels by more than 25mm.
- Continuity of the masonry bond should be maintained at supports for beams and lintels.
- Lintels should be insulated to prevent excessive thermal bridging.
- Concrete or steel lintels are appropriate for use in supporting masonry walls; support for masonry walls should not be provided by timber lintels or beams (Oak or any species).
- Lintels should be provided over recessed meter boxes.
- Lintels must comply with relevant thermal requirements.

Do not:

- Support lintels and beams on short lengths of cut blocks or make-up pieces.
- Apply load to lintels or beams before the masonry supporting has hardened.

Typical mesh reinforcement around openings



Rendering adjacent to openings

- For bellcasts and other beads uPVC beads or stainless steel beads are acceptable.·
- Renders will be reinforced as a minimum with an appropriate certified alkaline resistant fibreglass mesh at corners of all openings and penetrations. For substrates that are prone to movement, an appropriate certified alkaline resistant fibreglass mesh will need to incorporated throughout the substrate.·
- Ensure that drips and throating to sills, coping, etc. project a minimum of 40mm beyond the face of the finished render above the DPC.

Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	**1.5m – 3.0m***	**3.0 – 4.5m****
Upvc –white	5	5	7.5
Upvc-non-white	7.5	7.5	11
Timber	5	5	5
Steel	4	5	6
Aluminium	5	5	7.5

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

Window and door frames should be installed in accordance with the manufacturer's instructions.

Please refer to the 'External Windows and Doors' section for further guidance on window and door installations.

Finishing trims

The use of proprietary surface fixed finishing trims e.g. D-moulds, should be undertaken only as part of a designed junction between window and door framing and the surrounding opening. For further guidance on the use of finishing trims please refer to the 'External Windows and Doors' section.

The Building Control Body should be consulted for guidance on thermal compliance.

Checked rebates

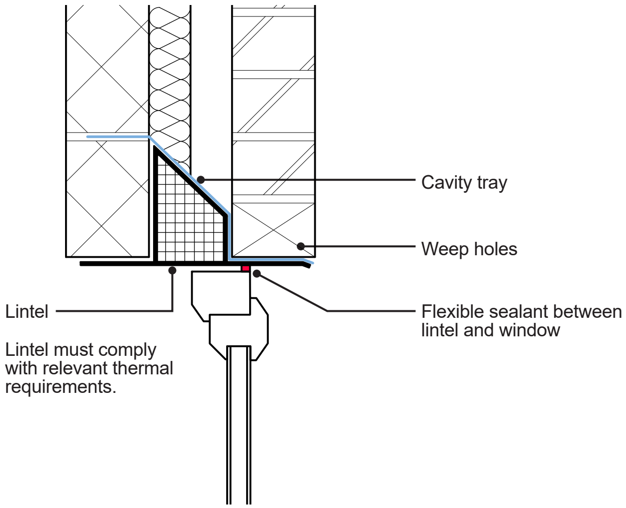
Checked (rebated) reveals are required in Scotland, Northern Ireland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

A suitable DPC must be provided at all window and door openings to prevent the passage of damp to the internal finishes. A third party certified cavity closure may be used.

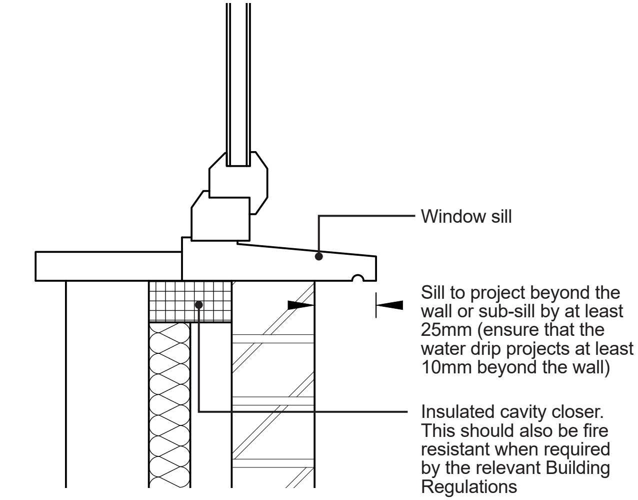
The following illustrations show accepted practice for forming weather resistant openings and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

The following illustrations show accepted practice for forming weather resistant openings and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

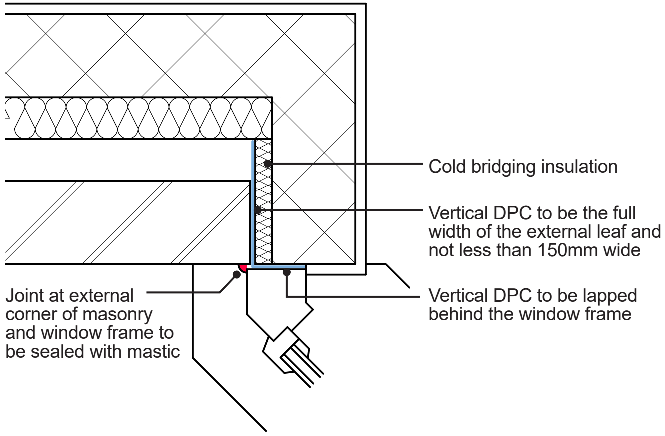
Typical vertical section through window head



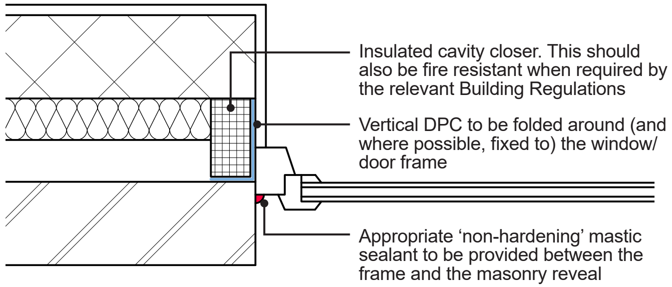
Typical vertical section through window sill



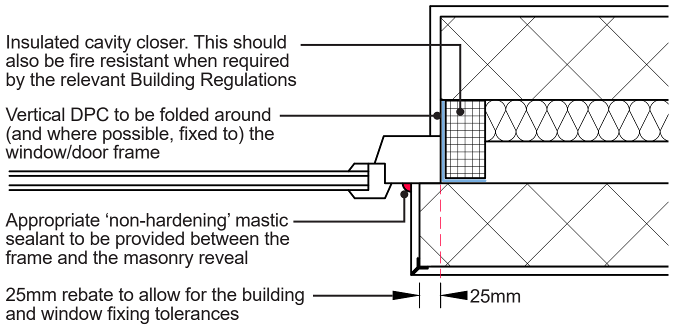
Bay window detail



Typical window reveal (normal exposure)



Typical rebated window frame detail



When installing window/door frames in a checked rebate, allow for the frame to be deeper:
- To allow for opening lights to open clear of the masonry/render, and,
- Where rendered, the render will need to extend beyond the 25mm of masonry.

Cavity trays

Cavity trays, associated weep-holes and stop-ends prevent the build-up of water within a cavity wall and allow the water to escape through the outer leaf. They are used in conjunction with lintels above openings, to protect the top surface of cavity insulation at horizontal cavity barriers and where the cavity is bridged.

Cavity trays must:

- Comply with relevant Building Regulations.
- Have third party certification or be to a relevant BS or BS EN code appropriate for the intended use. Polyethylene DPC's should not be used as a cavity tray. Please refer to 'Appendix C' for further guidance.
- Be provided at all interruptions likely to direct rain water across the cavity, such as rectangular ducts, lintels and recessed meter boxes.
- Be provided above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding.
- Be provided above lintels in walls in exposure zones 3 and 4. In zones 1 and 2 where the lintel is not corrosion-resistant and not intended to function as its own cavity tray.
- Be provided continuously above lintels where openings are separated by short piers.
- Be provided above openings where the lintel supports a brick soldier course.
- Be provided directly above openings that are under a compartment floor with a cavity barrier and cavity tray already present.
- Rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.
- Be proprietary preformed cavity tray systems at stepped and lower storey abutments and around corners in low rise cavity masonry walls.

Ring beams or floor slabs that partially bridge the cavity, e.g. when dimensional accuracy cannot be guaranteed, should be protected by a continuous cavity tray, especially when full fill cavity insulation is employed.

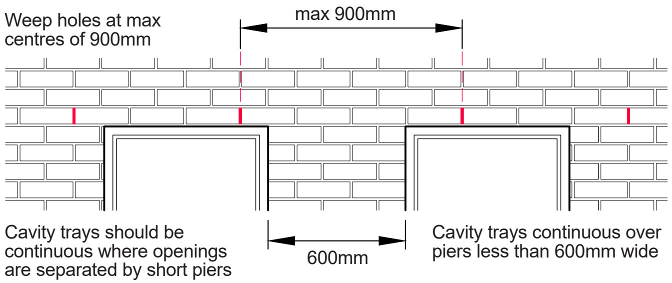
Weep-holes

- Weep-holes must be installed at no more than 900mm centres to drain water from cavity trays and from the concrete cavity infill at ground level. When the wall is to be cavity filled, it is advisable to reduce this spacing.
- At least two weep-holes must be provided to drain cavity trays above openings.
- Weep-holes will be required in rendered masonry cavity walls for Warranty purposes.
- Weep-holes in exposure zones 3 and 4 should be designed to prevent ingress of wind-driven rain.

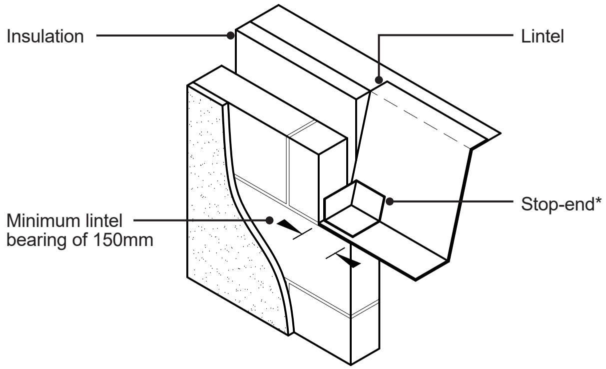
Other perforations of the building envelope

Proprietary elements, such as ventilators, soil pipes, etc. which perforate the building envelope should be installed and sealed to prevent ingress of moisture or vermin in accordance with the manufacturer's instructions. External meter boxes should be of a type approved by the Service Supply Authority and provided with a cavity tray and a vertical DPC between the back of the box and the wall.

Continuous cavity tray over two openings and a small pier



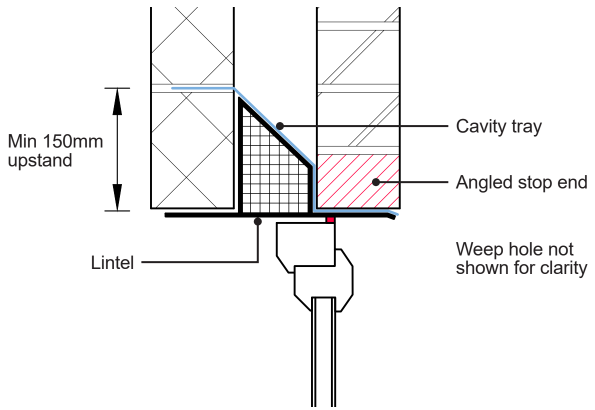
Stop end to cavity tray



*Stop-ends need to be bonded to the cavity tray material or clipped to the lintel, so that a stop to the structural cavity of at least 75mm high is provided. Normally, the stop-end is located to coincide with the nearest perpend to the end of the cavity tray.

Stop-ends can be formed by sufficiently turning up the end of a DPC tray into the perpend joint. Surplus mortar should be removed from cavities and wall ties cleared of mortar droppings and debris as the work proceeds.

Stop end in relation to cavity tray and lintel

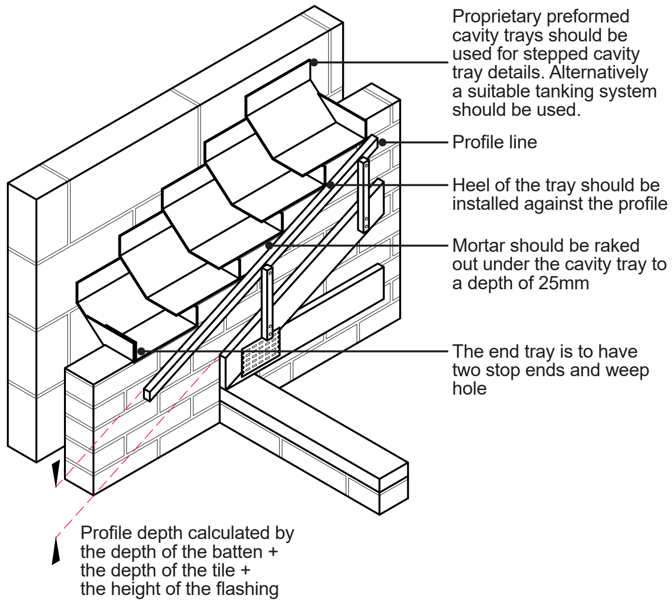


Note: Lintel must comply with relevant thermal requirements.

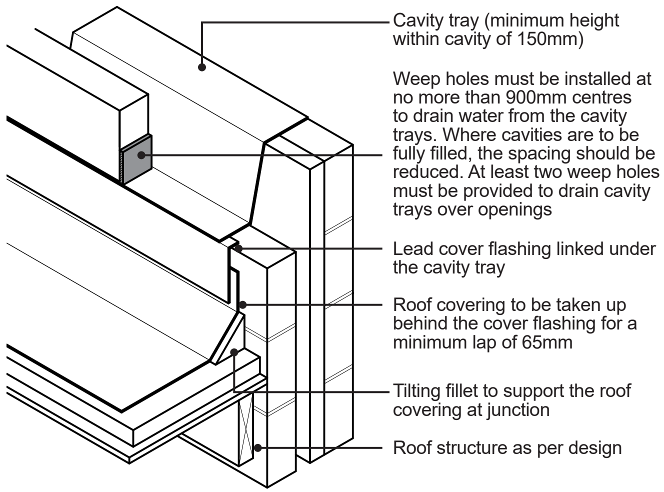
Installation of stepped cavity tray

Stepped cavity trays are required at all pitched (stepped) roof abutments with external cavity walls, e.g. attached garages or staggered terraces.

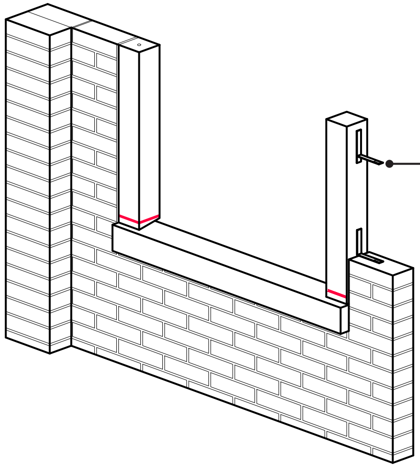
A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



Flat roof abutment cavity tray construction



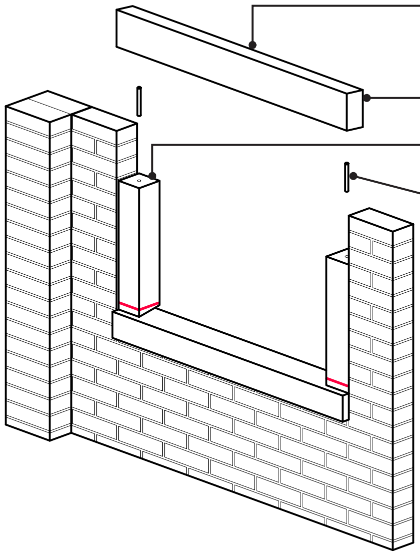
Stone jamb mullion fixing to walls



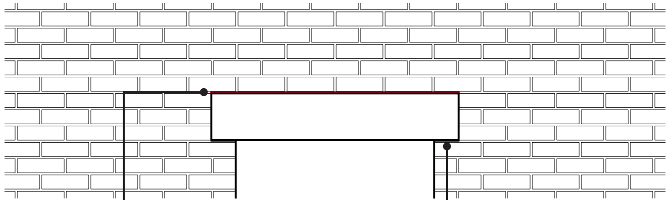
Stone jambs, mullions, and heads should not project into the cavity and insulated cavity closers should be inserted to prevent cold bridging.

Stone jambs and mullions should be fixed at the top and bottom with stainless steel pins. Stainless steel frame-type cramps can also be used to give extra stability at jambs.

Joining stone jambs to sills and head



Stone head



Cast stone heads

A cavity tray must be provided above all heads as this not only discharges water to the outside face of the masonry, but also acts as a slip plane. A slip plane will be required at the end of the cast stone head as well as a soft joint between the top of the head and the steel support lintel.

Cast stone heads should be manufactured in accordance with BS 1217, confirmation of this should be provided to the Warranty Surveyor upon request.

Cast stone jambs and mullions

Stainless steel dowels in the sides of jambs should be bedded into adjacent mortar joints as the masonry is constructed.

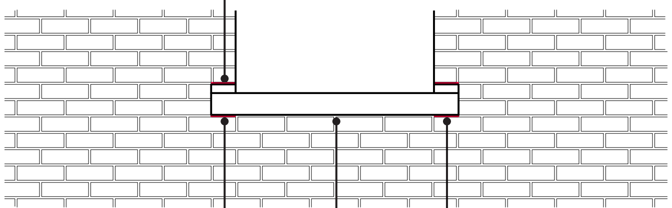
Cavity Trays

When stone heads are being used, it is advisable to double up the cavity trays - with one above the stone head to provide stop-ends and weep holes.

Mortar

The mortar for use with stone should comply with the relevant British Standards for sand, lime, and cement as set out in BS 5390

Stone sill



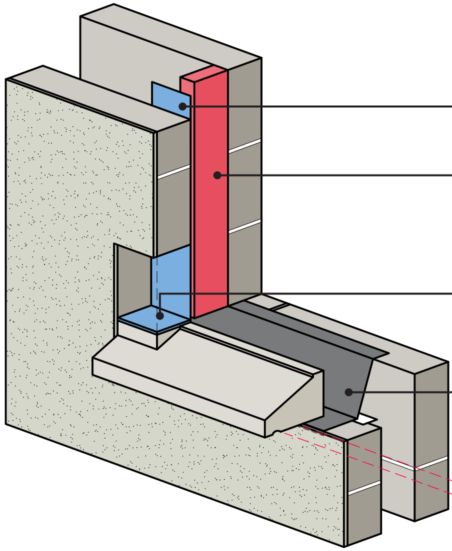
Sills

The DPC should be overlapped by the vertical DPC at the jambs and should be turned up at the back and ends for the full depth of the sill.

The mortar bed below sills should be trowelled smooth, allowed to set, cleaned off, and then a DPC laid over. The open section below the sill should be sealed with a flexible material only on completion of the structure.

To control water penetration through joints in window surrounds, e.g. at junctions between jambs and mullions and sills, rectangular and T-shaped water bars should be provided.

Stone sill with insulated cavity closer



Note: The insulated cavity closer should also be fire resistant when required by the relevant Building Regulations.

Cast stone window/door surrounds

Where cast stone butts up to other materials, allowance must be made to accommodate differential movement e.g. where cast stone abuts clay brickwork, a slip surface between the stone and clay brickwork.

Lateral restraint

Walls should be adequately restrained at floors in accordance with the relevant Building Regulations. Restraint can be provided by lateral restraint straps, restraint type joist hangers or other forms of restraint proven by an Engineer.

Floors, including timber, block and beam, and roofs should provide lateral restraint to all walls running parallel to them by means of 30mm x 5mm galvanised or stainless steel restraint straps at a maximum 2m centres.

No straps are necessary in buildings, up to and including two storeys where:

- Joists are at maximum 1.2m centres and have at least 90mm bearing on supported walls or 75mm bearing on to a timber wall plate.
- Concrete floors that have a minimum 90mm bearing on supported wall.
- Restraint type joist hangers are used as described in BS 5268: 7.1.

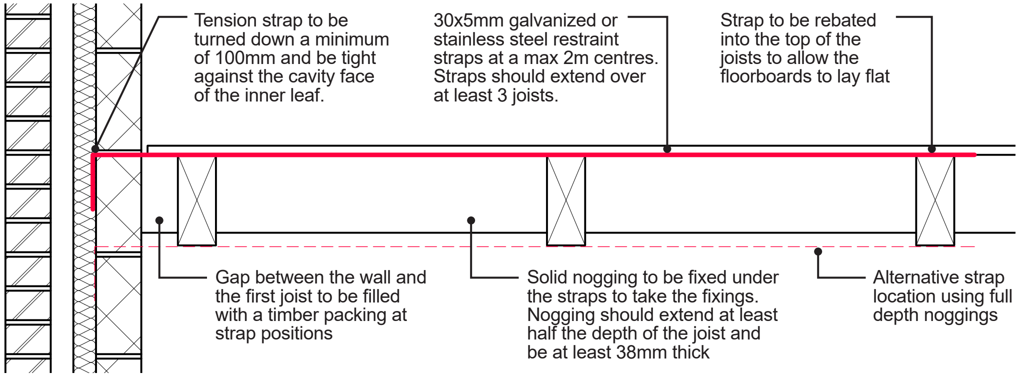
Timber joists
Where joists run parallel to a wall, restraint straps should:

- Be fixed at 2m centres and should pass at least 3 joists.
- Be supported on noggings.
- Be fixed to timber members with steel 50mm long × 5mm diameter wood screws or by 100mm×4mm (8SWG) round nails at not less than 110mm centres with a minimum of four fixings of which at least one fixing should be in the third joist, or in a nogging beyond the third joist.

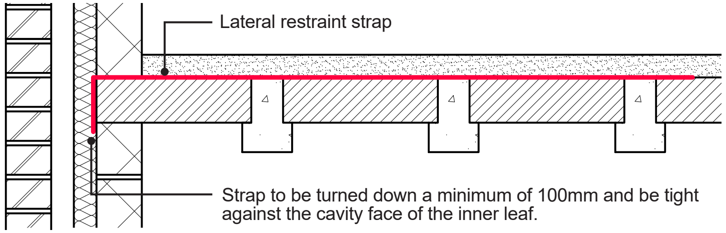
Concrete beams or planks
Where concrete beams or planks run parallel to the wall, the restraint straps should:

- Be spaced at 2m centres.
- Extend at least 800mm or up two beams, whichever is greater.
- Be tight against the face of the inner leaf wall and be turned down a minimum 100mm.
- Have their fixing specification designed by an Engineer.

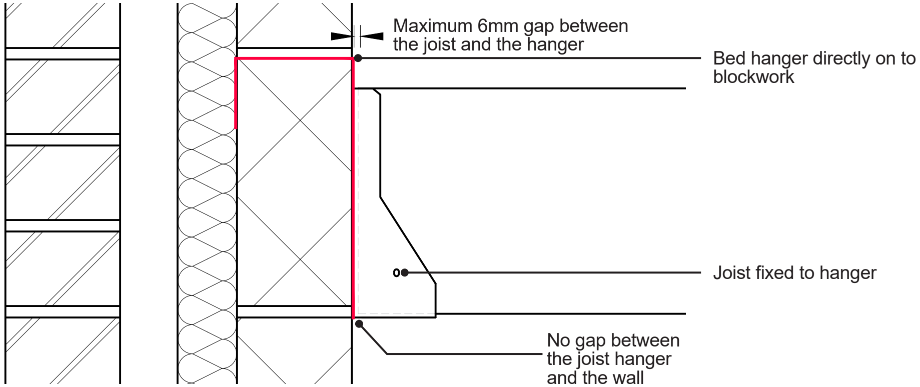
Lateral restraint of walls (timber floors)



Lateral restraint of walls (beam and block floors)



Restraint type joist hanger



It is necessary to ensure that:

- The hanger is bedded directly on the masonry and there is no gap between the hanger back-plate and the face of the masonry.
- At least 450mm of masonry is provided above the hanger.
- Hangers are spaced at centres of floor joists included in the design.
- The hanger is suitable for the loadings and masonry strength.

Do not:

- Apply load while the mortar is still green and has not gained sufficient strength.
- Use brick courses in block walls under joist hangers as the thermal insulation of the wall may be reduced unless similar units to the blocks are used.

TRADITIONAL MASONRY CAVITY WALL: Lateral restraint of walls at roof level

Restraint of walls

Walls should be adequately restrained at ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Restraint type joist hangers.
- Lateral restraint straps.
- Other forms of restraint proven by an Engineer.

Where joists or concrete planks are used to provide lateral restraint they should have a minimum bearing of 90mm or have restraint straps at 2 centres where joists or concrete planks are parallel to the walls.

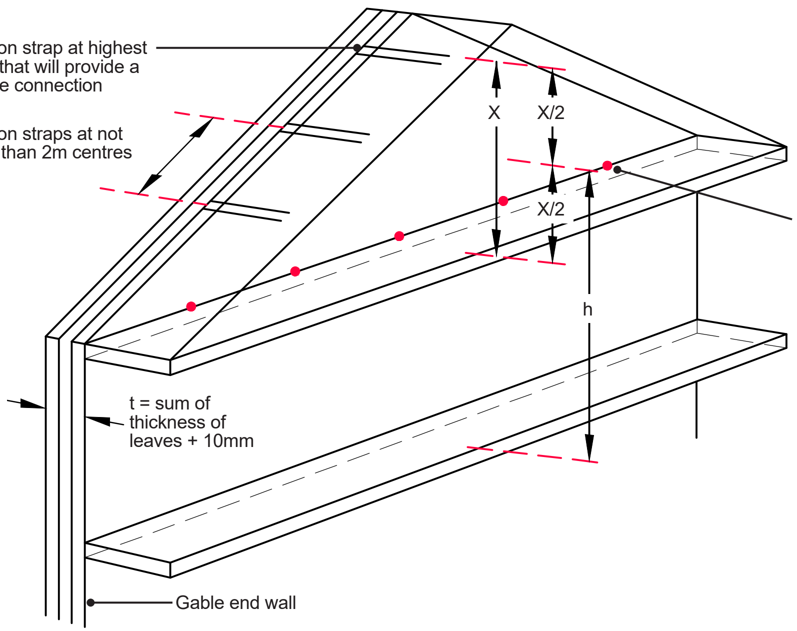
Timber joists
Where joists run parallel to a wall, restraint straps should:

- Be fixed at 2m centres and should pass at least 3 joists.
- Be supported on noggings.
- Be fixed to timber members with steel 50mm long × 5mm diameter wood screws or by 100mm×4mm (8SWG) round nails at not less than 110mm centres with a minimum of four fixings of which at least one fixing should be in the third joist, or in a nogging beyond the third joist.

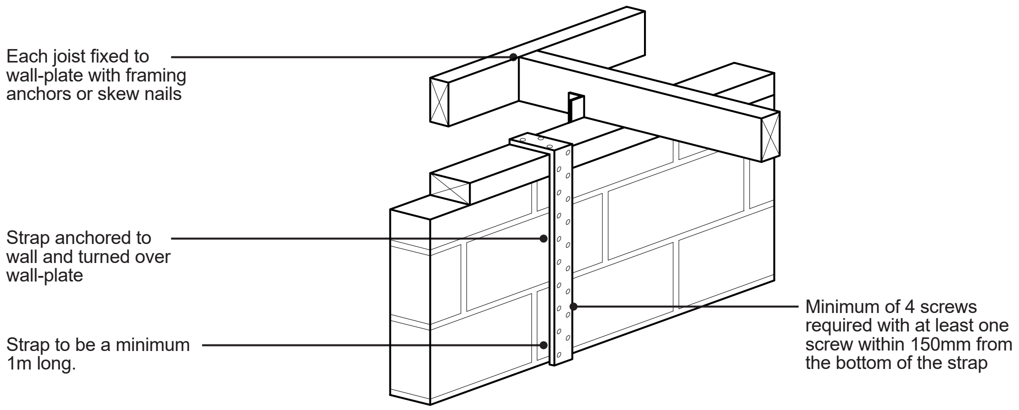
Concrete beams or planks
Where concrete beams or planks run parallel to the wall, the restraint straps should:

- Be spaced at 2m centres.
- Extend at least 800mm or up two beams, whichever is greater.
- Be tight against the face of the inner leaf wall and be turned down a minimum 100mm.
- Have their fixing specification designed by an Engineer.

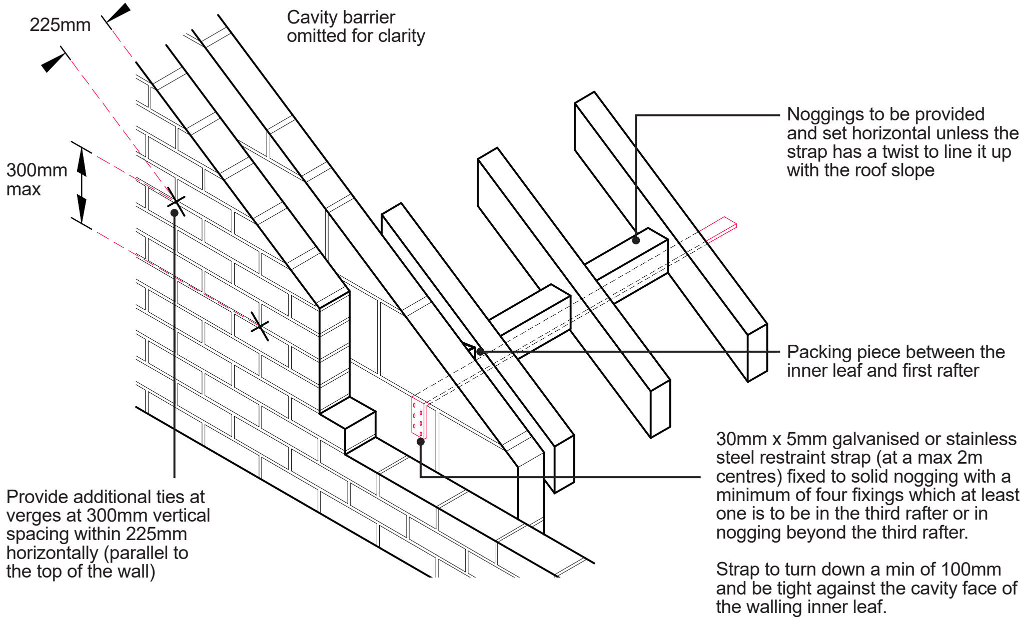
Tension strap location



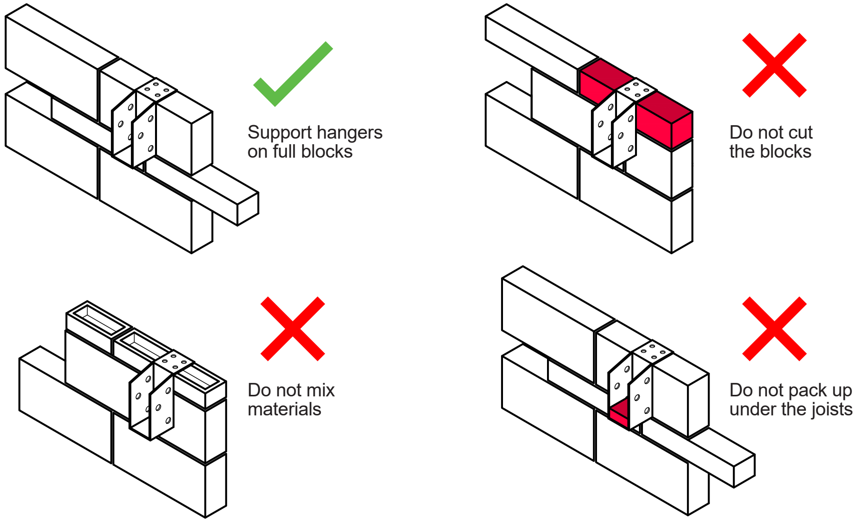
Vertical strapping at eaves - flat roofs



Rafter/gable wall detail



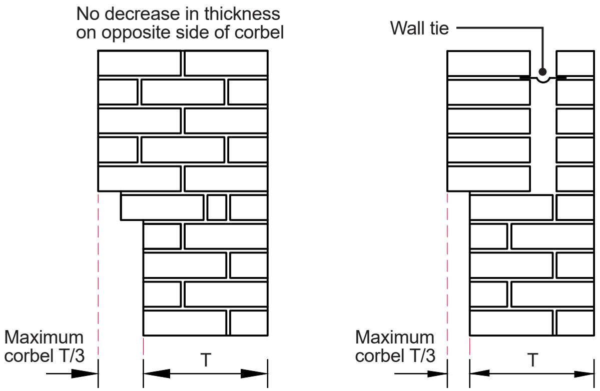
Correct use of hangers



Corbelling and architectural brick detailing

The extent of corbelling of masonry should not exceed that indicated in the image to the right, unless supported or reinforced. Reinforced corbels should be designed by an Engineer.

Where architectural brick detailing is specified, the brick manufacturer should confirm the expected durability of the product in the proposed use will meet our Warranty service life requirement of 60 years.



Chimneys

If the chimney is in a severe exposure zone the cavity should extend around the outside of the stack and be continuous up to roof level, as per BS 5628, Part 3. Where the chimney breast is gathered in, the lower projecting masonry should be protected with a suitable capping and cavity trays. A 50mm cavity at the back of the chimney breast is maintained to prevent rainwater penetration.

A specialist render system and mortar should be employed for parapets, chimneys, retaining walls and walls below DPC level.

Further guidance can be found in the ‘Chimneys and Flues’ section.

Eaves detailing for rendered walls

The eaves detail should extend past the masonry to provide protection to the top joint of the render and prevent rainwater percolating behind the render.

New elements connecting to existing structures

Where residential developments are attached to existing buildings, and the existing elements form part of the new structure; these must meet the Functional Requirements of the Warranty. The details below give some guidance on the minimum information and standards required to meet the Functional Requirements.

Party wall

It is highly likely that improvements to an existing wall are necessary to meet the requirements of the Warranty. This may include underpinning, injected DPC and internal linings.

Where a wall is shared by two or more owners, the requirements of the Party Wall etc. Act may apply. This is separate legislation with different requirements to the Building Regulations or Warranty requirement.

Further guidance on the Party Wall etc. Act can be found on the Planning Portal website www.planningportal.gov.uk

Separating walls

The separating wall between the new and existing building must meet the relevant requirements of the Building Regulations.

The existing walls should prove to be structurally stable and resistant to water penetration.

Existing foundations

The existing walls and their foundations for retained structures must be suitable to support any proposed increased loading resulting from the construction of the new building.

Foundations to the existing wall should be exposed and assessed for suitability to support additional loadings. It is important to protect existing foundations at all times, and care must be taken not to 'undermine' existing foundations when clearing the site or reducing levels.

Where existing foundations require underpinning, a design by an Engineer should be provided and approved by the Warranty Surveyor prior to work commencing on-site.

The existing wall should also be appraised to determine whether it is structurally stable and suitable to support additional loadings.

Damp Proof Course (DPC)

An effective DPC should be present in the existing wall, linked to the new DPC and damp proof membrane (DPM) of the new building.

Acceptable existing DPC's are considered as:

- A continuous felt or proprietary DPC material.
- A chemically injected DPC supported by an insurance-backed guarantee.
- A slate DPC is considered acceptable if the existing wall incorporates an independent wall lining system to the inner face of the new building.

The new DPC should lap the existing DPC by at least 100mm.

Existing and new structure junctions

At the junction of the existing and new structures, detailing should allow for differential movement without cracking. Any settlement should be limited to 2mm-3mm, which would not normally adversely affect the roof covering.

In order to prevent excessive differential movement, the new building should have the same foundation type as the existing building. Where the foundation types are different, e.g. new building pile and beam, existing building traditional strip foundation, the new building should be completely independent of the existing building.

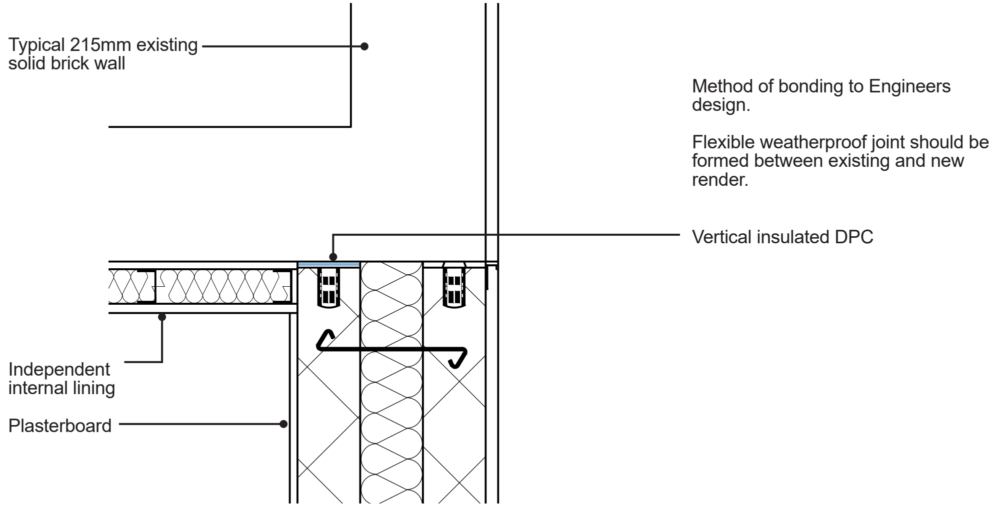
New wall junctions

The junction of the new walls to the existing walls must ensure that dampness cannot track back into the new building or the existing building.

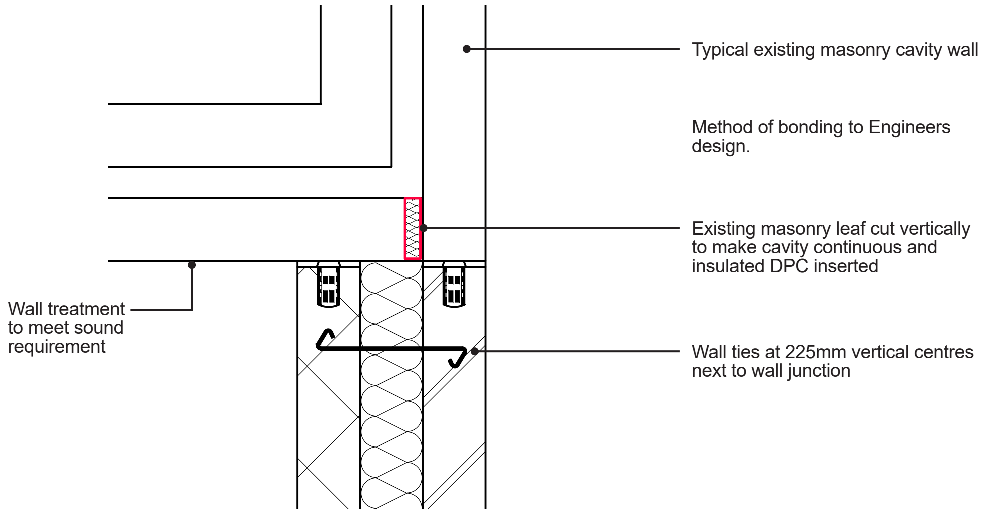
The detailing of this junction is critical to ensure that moisture ingress does not occur between the new and existing walls.

Typical acceptable details are indicated below.

Bonding new walls to existing solid masonry wall



Bonding new walls to existing masonry cavity wall



Introduction

Gable spandrel panels can be used as a continuation of the internal skin of masonry cavity blockwork.

The panels must be designed to resist wind loadings acting on the end walls and also loads applied by the claddings.

It is important that all spandrel panels, supporting structures and fixings, are designed by an Engineer to withstand all applied vertical and horizontal loads, on a site by site basis and not a generic solution.

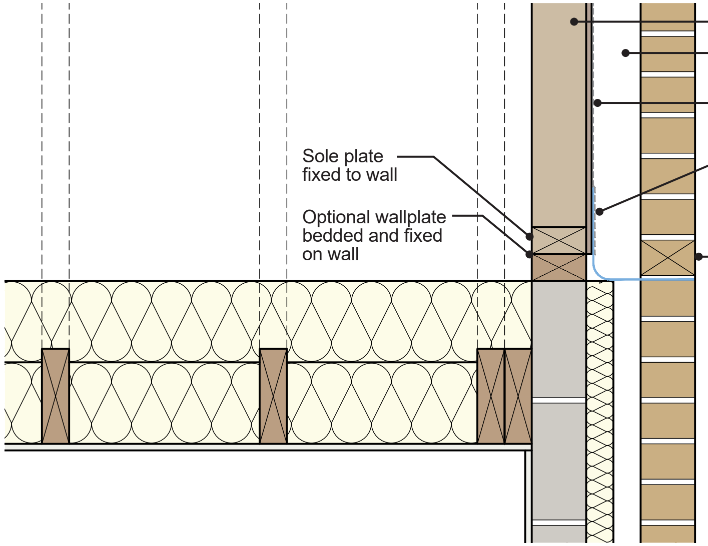
Providing a drained and vented cavity

Gable spandrel panels must incorporate a sheathing board, breather membrane and maintain a minimum of a 50mm clear cavity. Full fill cavity insulation with not be acceptable for Warranty as this prevents the spandrel panel frame from being able to dry out. The stud positions should be clearly marked on the breather membrane to assist in correct installation and positioning of wall ties.

Where blown full fill insulation is being used in the masonry cavity wall, there should be a way of ensuring:

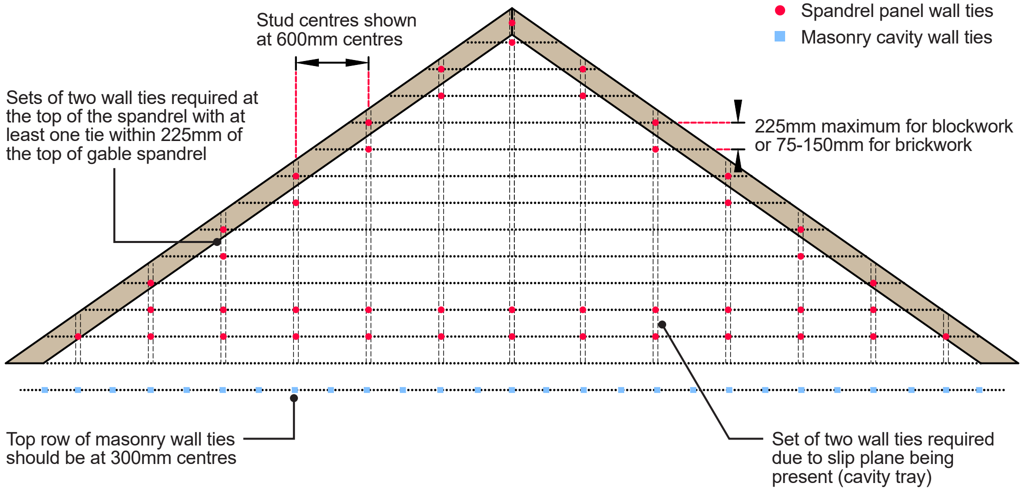
- The insulation does not deform the cavity tray at the base of the spandrel panel.
- The insulation does not spread into the spandrel panel cavity frame area.

This may be achieved by incorporating a non-deformable cavity closure or a rigid preformed cavity tray.



Wall tie locations

Wall ties between the spandrel panel and brick or block outer leaf should have the ties fixed into the timber vertical studs of the spandrel panel. The spacing of wall ties should be increased at the top of the wall and where a potential slip plane is present (horizontal cavity trays at the base of the spandrel panel).



Notes:

- For the general spandrel panel area, wall ties should be at every stud centre and at 450mm max vertical centres.
- The stud positions should be clearly marked on the breather membrane to assist in correct installation of wall ties.
- Block coursing shown in the above image. Wall tie spacings to be determined by the Engineer.

Fire considerations

Fire spread from gable end spandrel panels is dependent on a number of factors and its distance from relevant boundaries. Advice should be sought from your Building Control Body for further information.

Where the gable spandrel panel provides support for the roof structure, there may need to be consideration for fire resistance, further information should be sought from the Building Control Body.

Lateral restraint

Spandrel panels require lateral restraint at rafter level and along the base of the panel. Lateral restraint could be provided by:

- Timber members (e.g. the longitudinal bracing secured to the spandrel with timber ledgers/noggings), fixed into at least two studs within the panels.
- Metal restraint straps fixed to the panel and to noggings, or timber bracing fixed across the trusses.

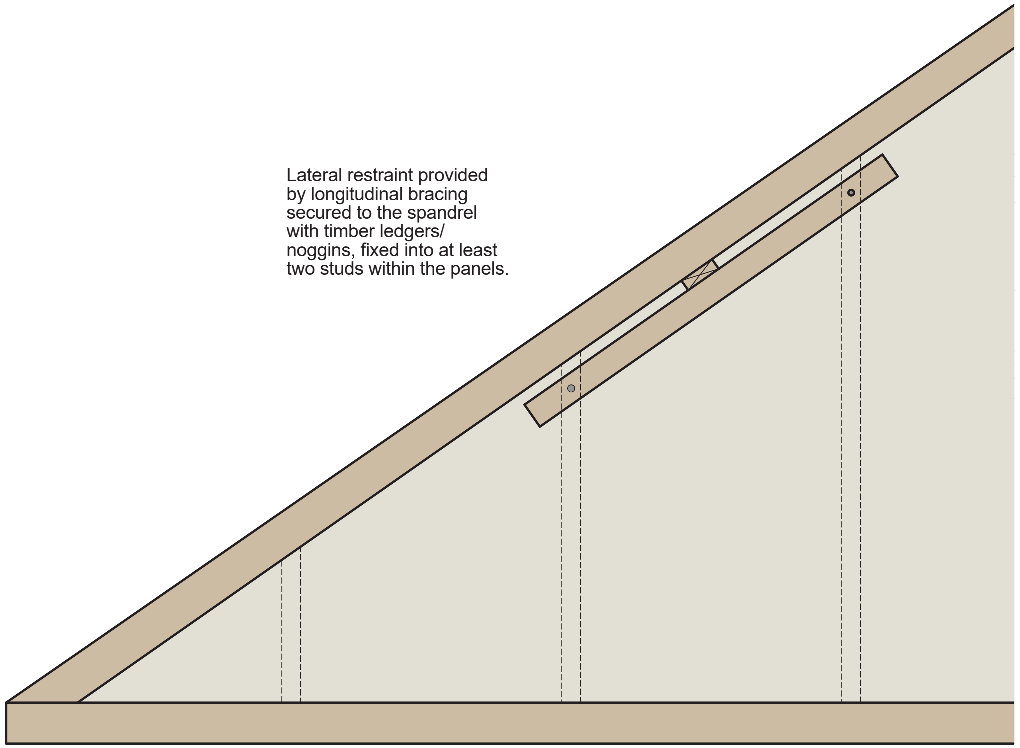
Gable spandrel panels must resist wind loads acting on the gable end walls and loads transferred from elsewhere e.g. from the roof structure, bracing etc. These loads are transmitted through the panel from the roof structure, bracing etc. via lateral restraints.

The restraint of the panels, should be designed by an Engineer to withstand all applied vertical and horizontal loads, on a site by site basis to suit the structural requirements of each project. The design and supporting calculations should be provided to the Warranty Surveyor.

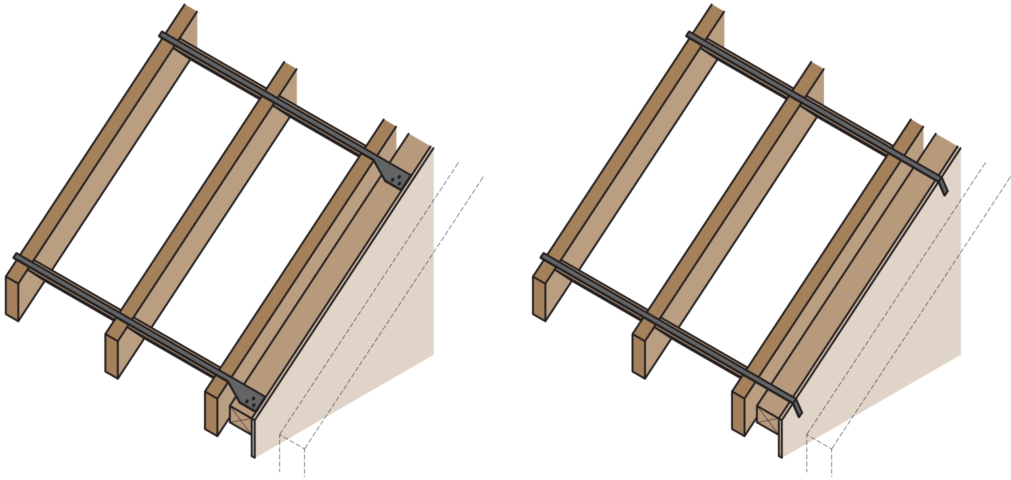
Other points to consider:

- Intermediate restraint may also be necessary for larger panels.
- Restraint straps should be located at a minimum 2m centres and should pass at least 3 trusses.
- Restraint strap to be fixed to a panel stud, with fixings capable of resisting a minimum 8 kN force (based on restraint straps at maximum centres).
- A timber blocking piece is typically required be required between the truss and spandrel panel.

Lateral restraint provided by longitudinal bracing



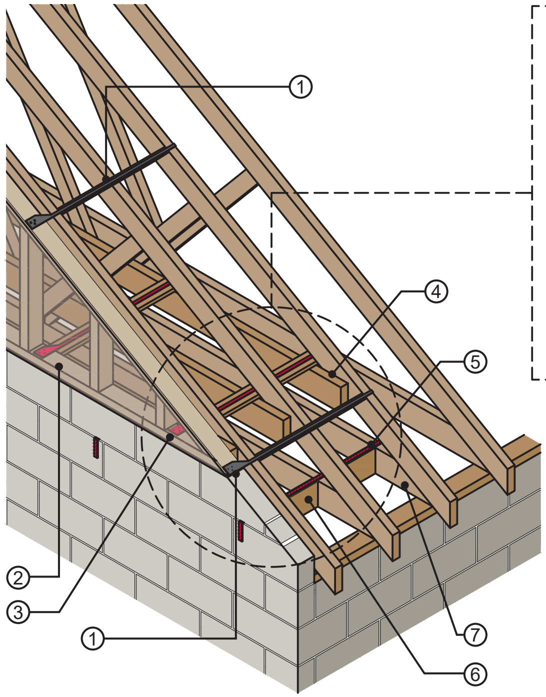
Metal restraint straps fixed to the panel and to noggings

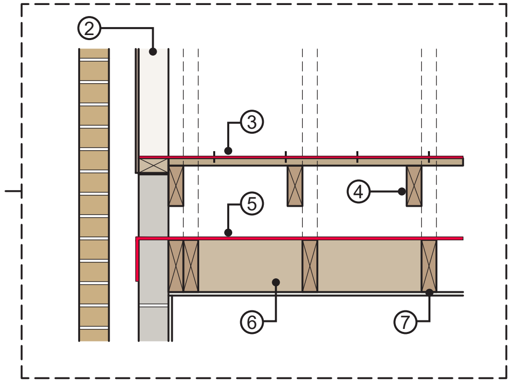


Low level restraint

At low level, lateral restraint is required along the ceiling joists.

Where the blockwork wall extends above the ceiling joists, lateral restraint is required for both the masonry wall and at the base of the spandrel panel as shown.





1. Metal restraint straps fixed to the panel with timber noggins under (38mm wide minimum).
2. Spandrel panel.
3. Metal restraint straps fixed to the panel sole plate and to timber longitudinal binder.
4. Timber cross member fixed to trusses to support longitudinal binder.
5. Metal restraint strap built into masonry wall.
6. Timber noggins minimum 38mm wide.
7. Ceiling joist.

6.
External Walls

6.2
Timber Frame

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

Accredited timber frame systems
1. Details of the manufacturer's relevant accreditation (BM TRADA, STA, etc.). The accreditation must cover design, manufacturing and erection of the timber frame panels (not just for joists or trusses).
2. A full set of detailed drawings, including:
   a) Plan layouts indicating dimensions.
   b) Elevations with dimensions shown.
   c) Junction details showing position of DPC's, cavity trays, other building elements such as roofs, floors, etc.
   d) Detailed drawings showing sole plate levels in relation to external ground levels for all elevations and how soleplate and timber frame is to be ventilated.
3. Details of proposed breather membranes and VCL's to be used.
4. Engineers drawings, calculations and fixing schedules for each connection made on site (framing, sheathing, structural connections, membranes, etc.) ` number, spacing and method of fixing.
5. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
6. Details of any cladding material fixed back to the timber frame including type, size, location of fixings provision of cavities. Where masonry cladding is present on the external leaf, details of wall tie and movement joint provision.
7. Where insulation in the external wall makeup are to be fitted on site we would require details of proposed insulation to be used.

Please note, closed panel systems must be sent to our Warranty Innovations team for approval.

Non-accredited timber frame
Please note: this construction type is limited to a maximum of five plots per project.

Points 2–7 for accredited timber frame systems must be satisfied, in addition to:

1. Provide full structural calculations for each house type to Eurocode 5 (BS EN 1995-1-1).
2. Designs to account for any fixed non-timber components (e.g. sheathing boards), which may impact on the stability if shrinkage of the frame is not accounted for.
3. An independent third party Engineer must inspect each plot once erected and prior to any closing up. They must then provide a sign-off sheet at completion for the waterproof envelope confirming the timber frame construction meets the Eurocode as-built.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Design requirements

The guidance within this section refers to timber frame panels which are manufactured off-site under factory conditions. Such systems must have appropriate quality assurance systems in place for their design, manufacturing and erection.

Structural design

Wind, roof and floor loads should be considered in the design and all timber frame structures should be designed in accordance with Eurocode 5.

Please note, designers should not mix and match codes or standards.

Open and closed timber framed panels

Factory assembled timber frame panels for the purposes of Warranty, can be categorized as either open panel or closed panel.

Open panel systems
Open panel systems for the purposes of Warranty includes the following elements:
- External breather membrane and sheathing board,
- Insulation internally between the studs, and,
- A transparent Vapour Control Layer (VCL) which is left unfixed in order that the connections between panels can be viewed upon inspection.

Open panel systems must satisfy the guidance within this section.

Closed panel systems
Closed panel timber frame systems, for the purposes of Warranty includes the following elements:

- With or without external cladding (external claddings for timber frame panels must have a drained and vented cavity as outlined within this section),
- External breather membrane and sheathing board,
- Insulation internally between the studs,
- A non-transparent vapour control layer secured over the inside face of the panel,
- Plasterboard inner finish installed.

Closed panel timber frame systems should be assessed and accepted by the Warranty Innovations Team prior to manufacture and before a Warranty quote applied for.

Quality assurance systems

All timber frame Designers, Manufacturers, and Erectors should possess current certification from at least one of the following quality assurance schemes:
- The BM TRADA Q-Mark Timber Frame Elements Certification Scheme.
- Gold or silver members of the Structural Timber Association.
- ISO 9001 to cover the design, manufacturing and erection of the timber frame panels.
- CE/UKCA marking.
- CATG - Frame Mark.
- Other relevant third party quality assurance scheme.

Notes:
- The level of membership may need to be clarified as some levels may not meet the above requirements.
- The following must be satisfied where timber framed panels do not have a quality assurance system in place (max 5 plots per project):
  - Provide full structural calculations for each house type to Eurocode 5 (BS EN 1995-1-1).
  - Designs to account for any fixed non-timber components (e.g. sheathing boards), which may impact on the stability if shrinkage of the frame is not accounted for.
  - An independent third party Engineer must inspect each plot once erected and prior to any closing up. They must then provide a sign-off sheet at completion for the waterproof envelope confirming the timber frame construction meets the Eurocode as-built.

Bespoke site assembled timber frame

For the purposes of Warranty, bespoke site assembled timber frame is where the timber frame structure is entirely built on-site (not factory assembled). Projects proposing to use bespoke site assembled timber frame are limited to 5 plot per project. The developer must:
- Provide full structural design calculations for each house type, confirming the design meets Eurocode 5 (BS EN 1995-1-1), and,
- Ensure the design accounts for any fixed non timber components (e.g. sheathing boards, claddings, parapets, junctions with other structures) which may impact on the stability if shrinkage of the frame is not accounted for, and,
- Ensure an independent Engineer (not the design Engineer) monitors the design, installation, erection and completion of the timber frame system and provide a sign off statement at completion of the waterproof shell confirming that the timber frame construction has been installed:
  - In accordance with the design and fixing specification.
  - In accordance with the structural calculations.
  - With all structural timbers appropriately preservative treated in accordance with BS 8417.
- Satisfy the Warranty Surveyor that the materials/products used are suitable and meet the requirements of the Technical Manual (e.g. timber treatment, tolerances, drained and ventilated cavity, etc.).

SIP construction

Structurally Insulated Panels (SIPs) are a form of stressed skin composite panel. Where SIP's are specified, some of the requirements for a timber framed building found within this section will apply (such as breather membrane, VCL and ventilation requirements). However SIP's will also have more enhanced requirements such as the need for independent third party accreditation (this does not include evidence of a quality assurance system). Please refer to 'Appendix C' for further guidance on SIP's.

Oak construction

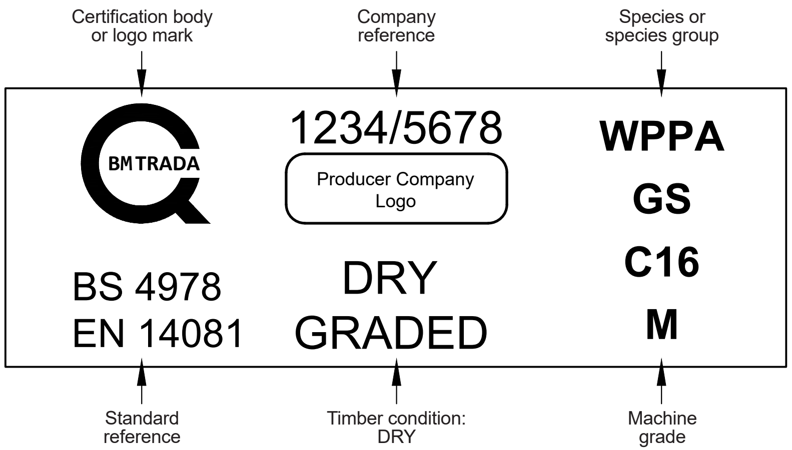
The guidance within this section is primarily for conventional timber frame open panel systems made off-site under factory conditions; oak used as a structural element will not be acceptable and bespoke one off oak frame buildings will not be acceptable. See 'Appendix C' for further details.

Timber specifications

Grading of structural timber
All structural timber whether machine or visually graded shall be graded in accordance with BS EN 14081: Timber structures - Strength graded structural timber with rectangular cross section.

All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.

Typical grading stamp



Preservative treatment of structural timber

All load-bearing timber components shall be either naturally durable or preservative treated in accordance with BS 8417: Preservation of wood code of practice. Sole plates and load-bearing timber studwork are considered to be in 'Use Class 2'. Sole plates are normally considered to be included in 'Service Factor Code C', while load-bearing timber studwork is included in 'Service Factor Code B'.

All structural timber should be treated with a preservative suitable for the 'Use Class' and 'Service Factor' applicable to its use.

Where treated timber is cut, the exposed end will not be protected by the original preservative treatment. When treated timbers are cut in the factory or on site, the cut ends shall be re-treated with a preservative compatible with the original treatment used, this treatment should be coloured to allow easy checking on site.

Timber moisture content

All structural timber components should be at a moisture content of 20% or less at the time of manufacture. Once panels are manufactured, they should either be stored in a covered storage area, or loosely covered with a water proof sheet material.

Manufacturing tolerances

The following are our manufacturing tolerances that timber frame manufacturers' must adhere to:

- Length: +3mm, -3mm.
- Height: +/-2mm.
- Diagonals should be equal, acceptable deviation is +/-5mm.
- Opening dimensions: 0mm, +5mm.

Thermal bridging

Wall panels and their junctions should be designed to minimise thermal bridging, whilst meeting structural requirements. All voids within the wall panel should be insulated to ensure thermal continuity is maintained and any small gaps which cannot be insulated effectively should be avoided.

Site preparation and erection

Pre-commencement
To allow the building to be constructed as designed all necessary drawings, specifications and fixing schedules shall be provided to site before work commences.

Foundations
It is important that the tight tolerances for timber frame are understood, getting the location and level of the foundation correct is one of the most important parts of the build process.

The foundations or upstands that support the timber frame should be set out to the dimensions noted on the timber frame drawings:

- Within +/-10mm in length, width and line.
- Diagonals should be within +/-5mm up to 10m, and +/-10mm more than 10m.
- Levelled to +/-5mm from datum.

Timber frame delivery and storage

Timber frame components should be:

- Carefully unloaded to avoid damage or distortion of components.
- Stored off the ground on an adequate number of level bearers.
- Loosely covered with a waterproof membrane to allow protection from moisture while allowing ventilation if they are not to be used for a prolonged period.
- Unwrapped if tightly bound in polythene and loosely recovered with a waterproof membrane to allow ventilation.
- Below 20% moisture content.
- Confirmed as square by sample checking for equal diagonal measurements, lengths and heights.
- Handled and stored with particular consideration to moisture damage where insulation and VCL are incorporated.

Timber frame erection

Wall panel erection tolerances
Wall panels should be erected to the tolerances as per the 'Tolerances' section:

- +/-10mm from plumb per storey height.
- +/-10mm from plumb over the full height of the building.
- +/-3mm from line of sole plate, with maximum +/-5mm deviation from drawing.
- +/-5mm from line at mid height of wall panel.
- Inside faces of adjacent wall panels should be flush.
- Adjacent wall panels should be tightly butted.

Dealing with areas of high exposure to frost and wind-driven rain

The design and construction of external walls should be suitable for the site specific exposure location.

For further information on determining the exposure for the site location please see 'Appendix C - Materials, Products, and Building Systems - Determining the sites exposure to wind driven rain'.

Key points: Construction below DPC

1. Brickwork and blockwork must be selected to have suitable durability for its use in the wall construction in accordance with BS EN 771-1 and PD6697.
2. Mortars below DPC are exposed to higher levels of saturation and therefore require higher durability classification (see BS EN 998-2).
3. Cavities below ground should be filled with concrete ensuring there is a minimum gap of 225mm between DPC and the top of concrete.
4. Concrete for cavities should be GEN 1 grade and a consistence class S3.
5. External ground levels should be a minimum of 150mm below DPC.
6. The compressive strength of the masonry units must meet the requirements of the relevant Building Regulations.
7. The timber frame, sole plate and/or bottom rail must not be used below external ground levels or in a basement storey.

Setting out of masonry

Where the soleplate overhangs and a masonry outer leaf is specified, the setting out of the masonry should take the sole plate overhang into account and maintain a 50mm cavity from the face of the sheathing board to the back of the masonry.

Damp proof course (DPC)

1. DPC should be of a flexible material, be suitable for the intended use, the DPC should have appropriate 3rd party certification. The installation specification of DPC's should follow good design practice in accordance with BS 8215.
2. Blue bricks or slate will not be accepted as a DPC.
3. DPC's should correctly lapped at junction and corners. The depth of the lap should be the same width as the DPC.
4. Any DPC which is not acting as a cavity tray should not encroach into the cavity space, as there is a potential risk for this to provide a position for mortar snots or debris bridging the cavity leading to moisture penetration issues.
5. Damp proof membranes within the floor structure should be lapped with the DPC under the sole plate by a minimum of 100mm. The DPC at sole plate level should also provide 100mm lap to any AVCL provided within the wall panel. Configurations for this damp proofing and air-tightness arrangement should appropriately designed.

Drainage and ventilation

Cavity drainage and ventilation in masonry cladding should:

- Achieve at least 500mm^2 per metre run, which equates to a whole brick open perpend every 6th brick length.
- Be fitted in the brick or block course below the lowest timber sole plate above external finished ground level and below DPC.
- Maintain a clear cavity with care taken to reduce mortar droppings at the base of the wall.

Weep-holes alone are unsuitable for timber frame construction, and open perpends should be used.

Proprietary open perpends must be used. Proprietary open perpend inserts are available with insect screening incorporated. Their equivalent open area must be considered and installation centres reduced accordingly.

Where a horizontal a cavity barrier is specified at intermediate floor levels, cavity trays and proprietary open perpends must be specified to maintain cavity drainage and ventilation above the cavity barrier.

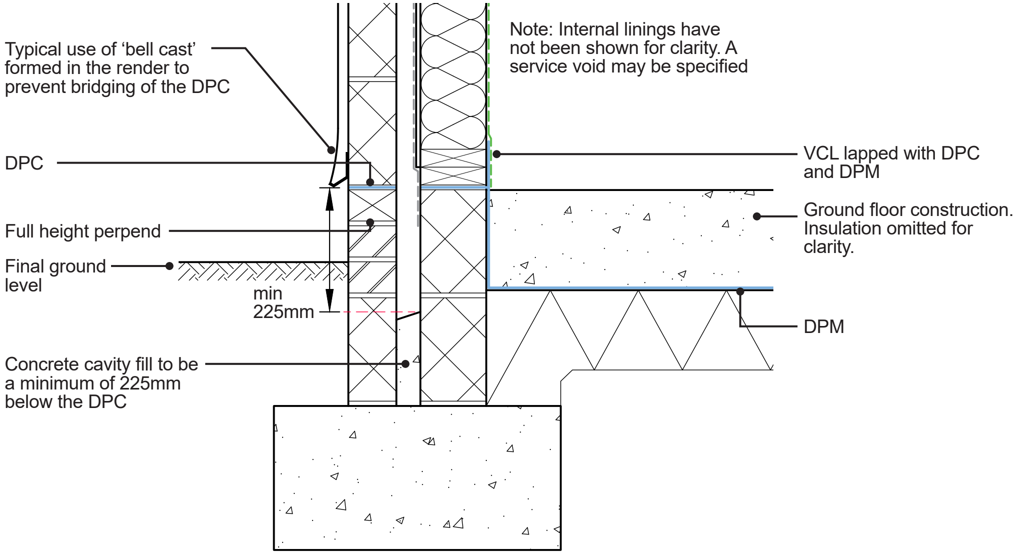
Cavity trays at DPC level
Cavity trays must not be specified at DPC level between the external masonry cladding and the timber frame as it can impede on the drainage and ventilation requirements for the timber frame.

Where a cavity tray is proposed at DPC level, proprietary open perpends must be used above and below the cavity tray to provide:

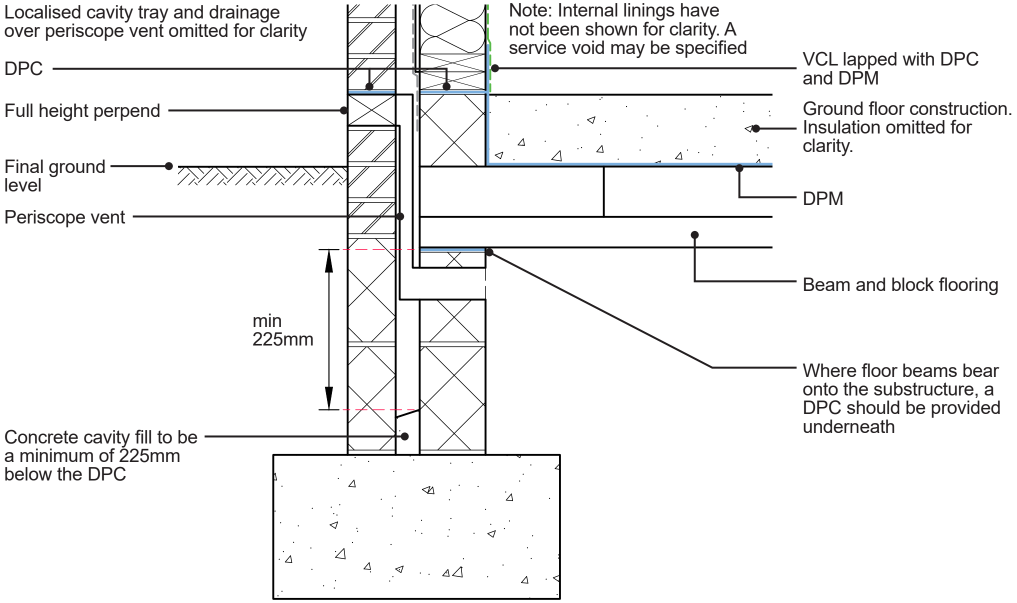
a) Drainage and ventilation to the timber frame above the cavity tray, and,
b) Ventilation to the sole plate below the cavity tray.

Where flexible DPC materials are to be used as a cavity tray, they should have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012. They should also have third-party certification (BBA or similar UKAS accredited body) confirming their suitability for use as a cavity tray.

Ground supported floor - no sub-floor ventilation (shown with rendered masonry)



Suspended floor with ventilation provision



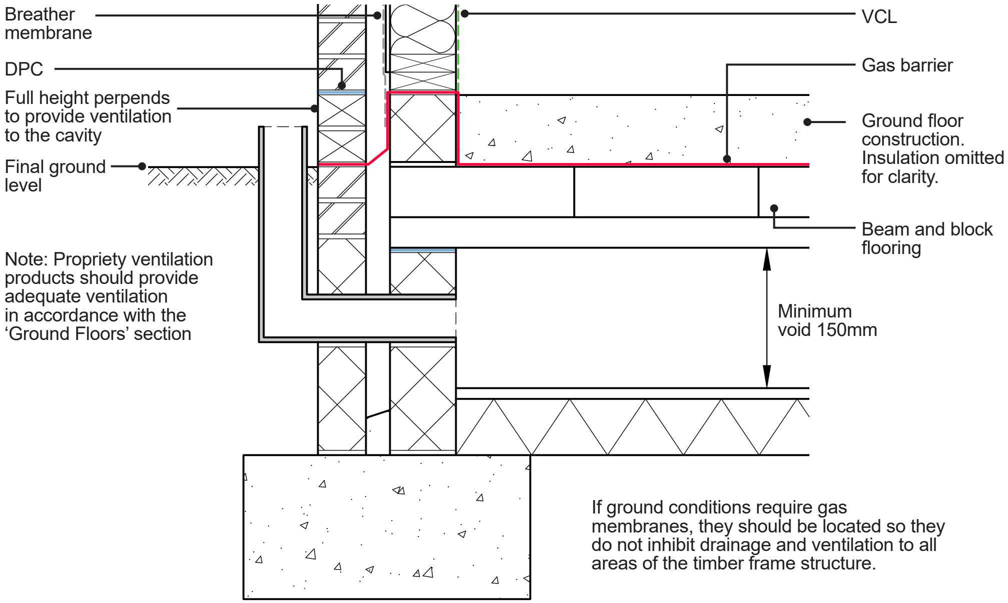
All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building Control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

TIMBER FRAME: Typical gas membrane details

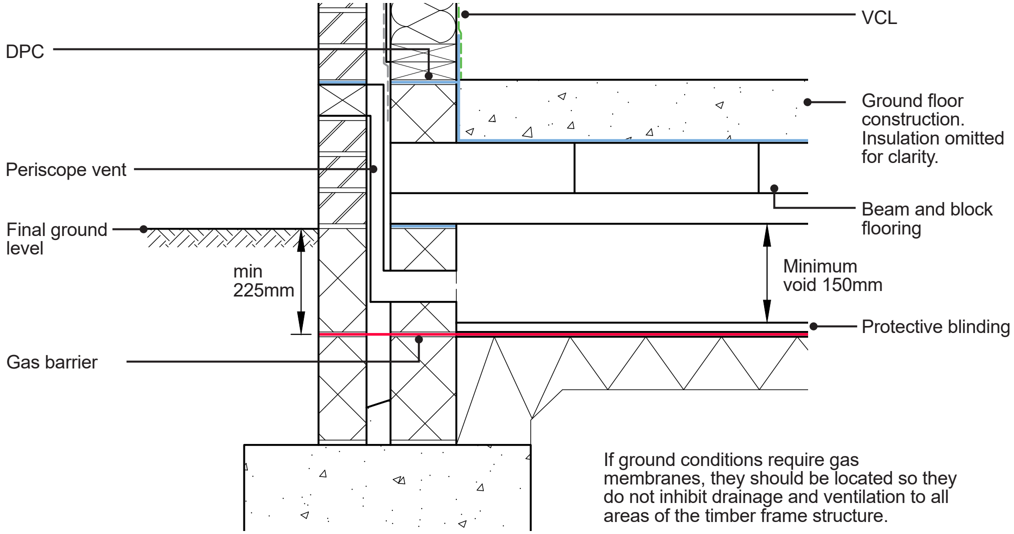
Ventilation for timber frame structures

For timber frame structures early consideration of ventilation and drainage is key. Radon barriers should be positioned in such a way to not impair or restrict ventilation to any part on the timber frame structure.

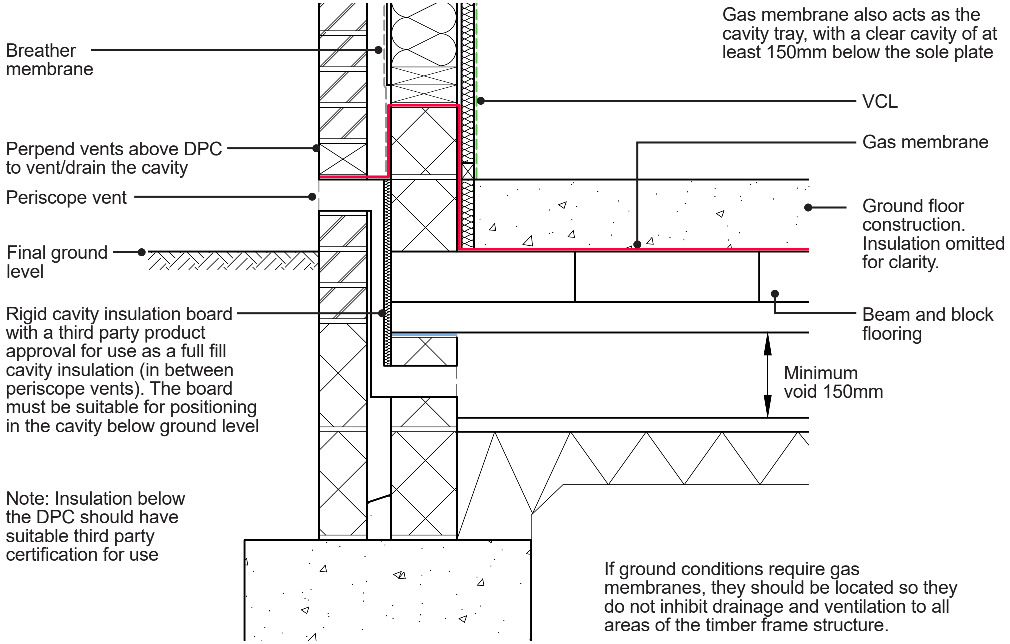
Possible gas membrane detail



Possible gas membrane detail



Possible gas membrane detail with raised sole plate



All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building Control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

Sole plates

The sole plate is the first structural timber component installed on site. Its purpose is to set out the building, transfer loads to the foundations and provide a level base for erecting the wall panels. All structural timber should be located at least 150mm above finished external ground level, except for localised ramping (incorporating satisfactory drainage and ventilation detailing) for level threshold requirements.

The sole plate should be accurately levelled, located, and securely fixed to the substructure as specified by the Engineer. Where no sole plate is specified, the following guidance applies equally to wall panel bottom rails. Timber sole plates should be preservative treated in accordance with BS 8417. Further information on timber treatment can be found in 'Appendix C - Materials, Products, and Building Systems'.

Location
Sole plates should:

- Be located so that all structural timber is at least 150mm above external ground level. The use of a masonry foundation kerb upstand may be an appropriate method to achieve this.
- Be levelled to +/-5mm from datum.
- Not overhang or be set back from the substructure by more than 12mm on a 89mm sole plate and 20mm for a 140mm sole plate. Ledges formed by the frame being set back from the supporting base should be protected from moisture by a membrane.
- Be set out within +/-10mm in length and in line within +/-5mm, as defined by the timber frame drawings.
- Diagonals should be within +/-5mm up to 10m, and +/-10, for more than 10m.

Note:
1. Internal and party wall timber sole plates should not be installed below internal finished floor level.
2. Localised level access provision should follow guidance in the 'Driveways and Paving' section. Infinity patio type scenarios are not acceptable for Warranty unless suitable drainage provision acceptable to us is provided between the external wall and the ground finishes.
3. Where the soleplate overhangs and a masonry outer leaf is specified, a 50mm cavity must always be maintained.

Damp Proof Course (DPC)
A DPC should:

- Be located directly below all timber sole plates.
- Overlap at DPC junctions by at least 100mm.
- Be located flush to the outside edge of the sole plate.
- Provide 100mm lap to any AVCL provided within the wall panel.

Fixings
Fixings should:

- Be installed to the Engineers specification.
- Not damage the substructure or sole plates during installation.
- Be placed to provide adequate lateral restraint at door openings.
- Be specified with consideration for use with gas membranes where appropriate.
- Sole plates should be fixed to foundations with shot fired nails, proprietary sole plate fixings, anchors, brackets, or straps, as specified by an Engineer.
- If holding down straps are used, they should be stainless steel grade 1.4301 steel to BS EN 10088

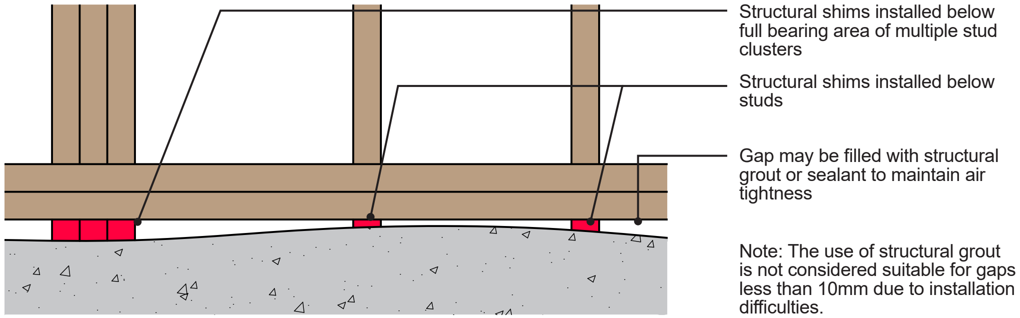
Ventilation to sole plate area
Regardless of the cladding system used, a cavity with provision for drainage and ventilation should be provided between the cladding and the timber frame ensuring that adequate ventilation provision is provided to all areas of the timber frame including the sole plate.

Packing
Structural shims or grout may be required under sole plates to level them and transfer vertical load. Longer fixings may be needed to allow for the size of the gap. Structural grout is difficult to install into gaps less than 10mm and therefore shims are preferred.

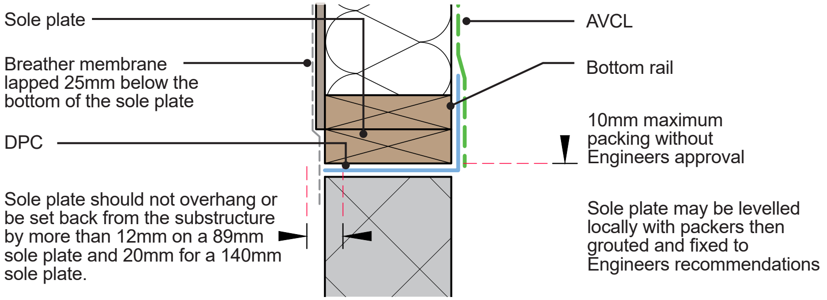
Structural shims
Structural shims should be position below all timber studs and be of the same cross section. Lightweight window packers should not be used.

Structural grout
Structural grout should be as per an Engineers specification. The use of structural grout is not considered suitable for gaps less than 10mm due to installation difficulties.

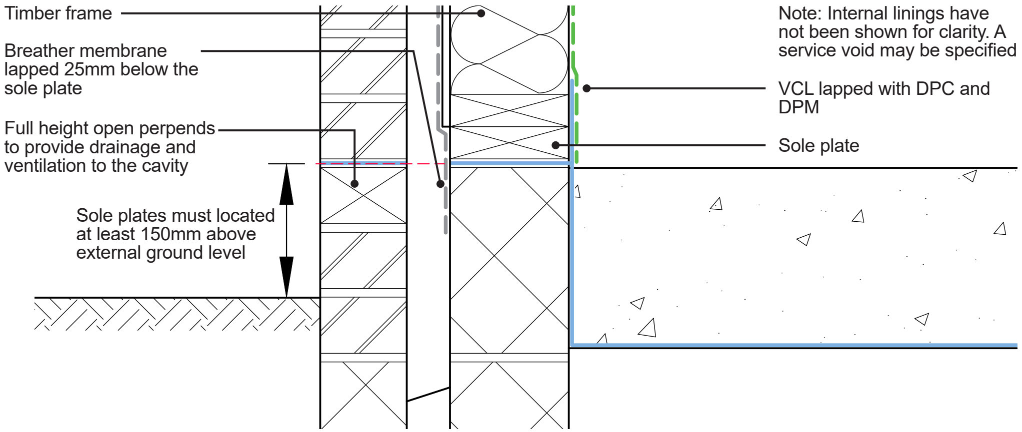
Packing of sole plates



Locating sole plates



Sole plate/foundation junction



All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building Control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

Timber frame wall panels

Timber frame external wall panels shall:

- Be manufactured in accordance with the Engineer's design.
- Consist of solid timber studs and rails.
- Have studs at a maximum of 600mm centres and a minimum width of 37mm.
- Be braced with a structural sheathing board.

Provision of cavities to all framed structures

All timber and light steel frame external wall panels must be provided with a drained cavity between the cladding and the structural frame. In addition; the cavity will be required to be ventilated for timber framed external walls. The frame should also be protected by a suitable third party approved breather membrane. Breather membranes should be of minimum Class W2 zero leakage in accordance with BS EN 13859, higher Class W1 will be requested when used in areas of high exposure to wind driven rain or where rain penetration of the cladding is expected.

Fixings and junctions

All fixings are to be installed to the Engineer's specification, unless otherwise justified:

- Junctions of wall panels and sole plates/head binders should not occur together.
- Head binder laps should wherever possible occur over a stud, preferably at least 600mm from the panel junction.
- Wall panel to wall panel connections should be a maximum of 300mm centres.
- Bottom rail to sole plate fixings should be one or two per stud bay.
- Wall panels should be adequately braced during erection to maintain tolerances.
- Disproportionate collapse components and fixings must be installed if specified.
- Multiple stud clusters which are considered structural (e.g. point load-bearings) should be designed by an Engineer.
- Point loads must be transferred down through wall panels and floor zones to foundations.
- Special considerations should be given to protecting closed panels from exposure to moisture during delivery, storage and erection.
- Engineered timber components should not be exposed to moisture for longer periods than those stated by the manufacturer.
- Roof trusses/rafters should be adequately fixed to wall panels.
- Floor joists should be nailed down to wall panels.
- If no head binder is present, floor joists must bear directly over studs.
- Waistbands and alignment of floors over walls should remain within tolerances for wall panels.

Timber framing components and structural sheathing boards may be fixed with:

- Nails.
- Staples.

Nail fixings should be:

- Austenitic stainless steel.
- Galvanised.
- Sherardized.

Staple fixings should be austenitic stainless steel or similar.

Openings

All openings including doors, windows, flues and ventilation ducts should be designed and constructed to maintain structural performance.

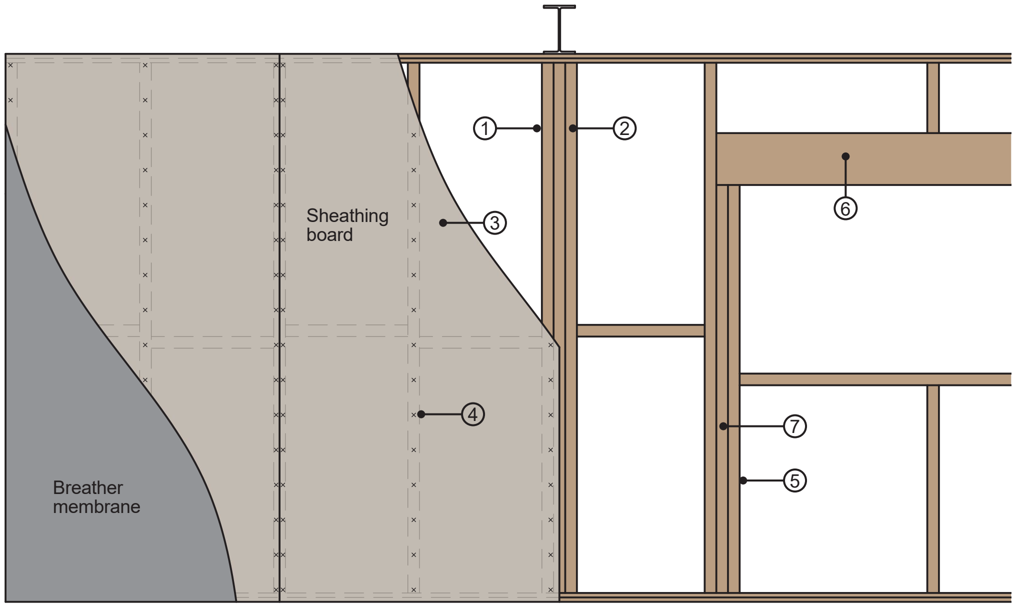
Sheathing boards

Sheathing boards are fixed to the timber frame in order to provide racking resistance to the structure. Structural sheathing board materials may be any of the following:

- Orientated strand board (OSB).
- Plywood.
- Impregnated soft board.
- Other board material with suitable third-party certification.
- All wood-based panel products should comply with BS EN 13986: Wood-based panels for use in construction characteristics, evaluation of conformity and marking.
- OSB should be grade 3 or 4 in accordance with BS EN 300: Oriented Strand Boards (OSB) - Definitions, classification and specifications.
- Plywood should be at least Class 2 Structural in accordance with BS EN 636: Plywood Specifications.
- Impregnated soft boards should be Type SB.HLS in accordance with BS EN 622-4: Fibreboards, specifications and requirements for soft boards.
- Non timber based boards must have third party accreditation that has been approved by the Warranty provider.

Please note: We do not accept the use of MgO boards.

Typical wall panel



1. All structural timber whether machine or visually graded shall be in accordance with BS EN 14081: Timber structures - Strength graded structural timber with rectangular cross section. All load-bearing solid timber studs, rails, binders and sole plates should be of a minimum dry graded C16.
2. Any point load imparted onto the timber frame should be transferred down through the building to the foundations with the use of multiple studs, as required by the Engineers design. If these are not installed during the manufacture of the panels the requirement for installation must be clearly conveyed to site.
3. Wood-based board materials used for sheathing should be fixed to the studwork frame leaving a 3mm minimum gap between boards to allow for moisture-related movement.
4. The fixings securing the structural sheathing board to the timber studwork wall panels provide racking resistance as calculated by the Engineer. The sheathing board shall be fixed to the timber studwork in strict accordance with the Engineer's fixing schedule. Fixing centres should not exceed 150mm around the perimeter of the board and 300mm centres in the field of the board. Sheathing fixings must not be over-driven through the face of the sheathing board.
5. Studs should be provided around window and door openings and adjacent to movement joints to allow the installation of wall ties or other cladding fixings. They should be accurately cut to length and bear tightly against the wall panel top and bottom rails.
6. A lintel may be required where openings do not fall between studs unless the vertical load is adequately transferred by other elements.
7. Lintels will require support of cripple studs. All structural timber should be treated with a preservative suitable for the 'Use Class' and 'Service Factor' applicable to its use.

Breather membrane

A breather membrane is a water-resistant moisture vapour permeable membrane used to provide secondary protection from moisture once the building is complete and may be used to provide temporary weather protection during construction.

The timber frame structure should always be protected by a breather membrane facing the external wall cavity. A breather membrane must always be installed irrespective of the external sheathing board product.

Breather membranes should:

- Have appropriate third party product approval.
- Have a vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens.
- Be a minimum Class W2 or better in accordance with BS EN 13859-2.
- Be a minimum Class W1 in areas of very severe exposure, where liquid water penetration of the cladding is anticipated or where the membrane is likely to be left exposed during construction.
- Be capable of resisting water penetration.
- Be durable to resist site damage when wet.
- Be self-extinguishing.
- Be securely fixed to protect the outside face of the timber frame structure with austenitic stainless steel staples.
- Be placed on the outside of the timber structure and any external insulation adjacent to the external wall cavity.
- Be trimmed to leave 25mm lap below the lowest timber sole plate.
- Be repaired if damaged.
- Have the location of solid timber studs clearly marked on the outer face of the breather membrane to ensure that cladding fixings are installed into solid timber.

Breather membranes should be lapped by a minimum of 100mm at horizontal joints, and a minimum of 150mm at vertical joints. Vertical joints should be staggered at regular intervals where possible. The breather membrane should be lapped to deflect moisture away from the timber frame structure (upper layers over lower layers).

Breather membranes should be fixed using austenitic stainless-steel staple nails at the following centres:

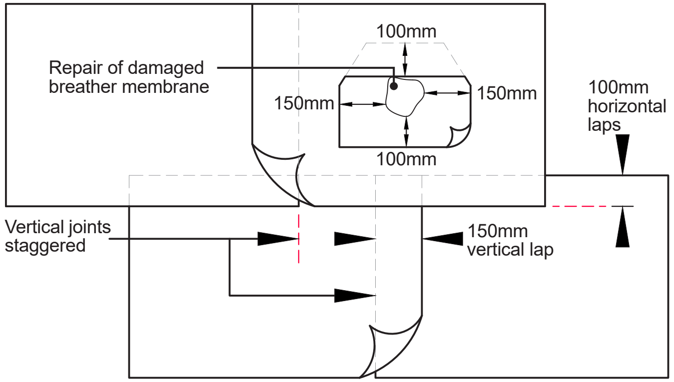
- Horizontal
  - Panel centres - 600mm max.
  - Horizontal membrane joint - 150mm.
  - Head and base of panels - 150mm.
- Vertical
  - 300mm centres vertically (may be increased to a maximum of 500mm when verified with third party certification).
  - Vertical membrane joint - 150mm.
  - Ends of panel - 150mm.
- Around openings - 150mm.

If breather membranes are trimmed flush with the edges of wall panels, additional strips of breather membrane, at least 300mm wide, should be supplied and site fixed over panel junctions.

Breather membranes providing temporary protection

Where the breather membrane is used to provide the temporary protection, the daylight exposure and durability aspects must be taken into account. Extended exposure to UV light can lead to premature failure of the membrane, the exposure period should therefore be kept to a minimum. Regardless of the artificial age testing, under certain conditions such as heavy rainfall followed by freeze thaw conditions, the membrane should not be exposed for more than a few days. If a membrane has to be left without a wall and/or roof covering for a period of time when adverse rainfall and weather is expected, a ventilated tarpaulin or similar protective sheeting may be used to protect the membrane until such time that the final wall/roof structure can be completed. The transport and storage of wall/roof panels should not rely on the breather membrane to provide weather protection.

Lapping and repair of breather membrane



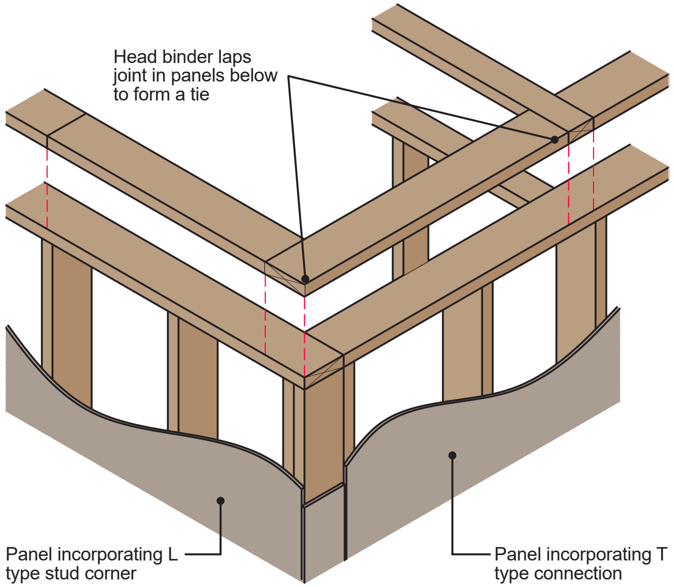
Services

In addition to general provisions for the installation of services, the following are of particular note for timber frame construction external walls:

- The routing and termination of services should not affect the fire resistance of the structure.
- Electrical services are to be rated for their location with consideration for insulation.
- Wet services are not to be installed on the cold side of the insulation.
- Service penetrations through the VCL should be tight fitting to reduce air leakage and the passage of moisture vapour.
- Avoid running electrical services in the external wall cavity, except for meter tails.
- Services should be protected with metal plates if they pass within 25mm from face stud.
- Adequate allowance for differential movement to occur without causing damage should be provided for rigid services rising vertically through a building.
- Services that pass through the external wall cavity and provide an opening (such as flues/vents) should be enclosed with a cavity barrier and protected with a cavity tray.

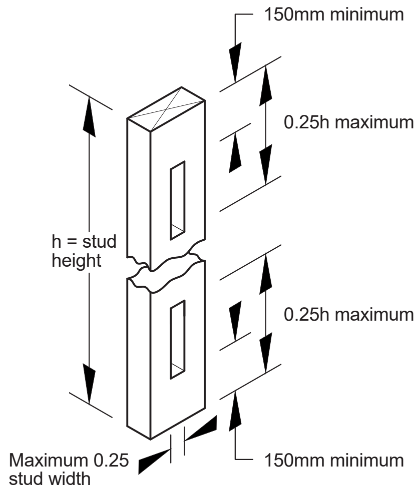
Head binder lapping - Timber frame

- Head binder butt jointed over stud or lintel which is fixed to the underside of the top rail.
- Head binder nailed to frames. Fixings determined by timber frame engineer's calculations.

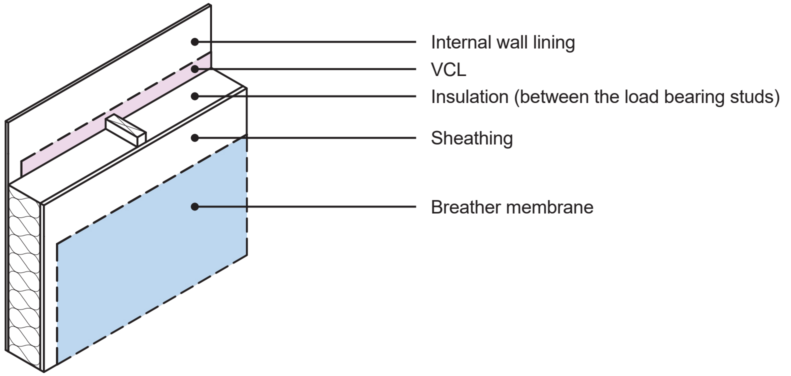


Drilling of studs

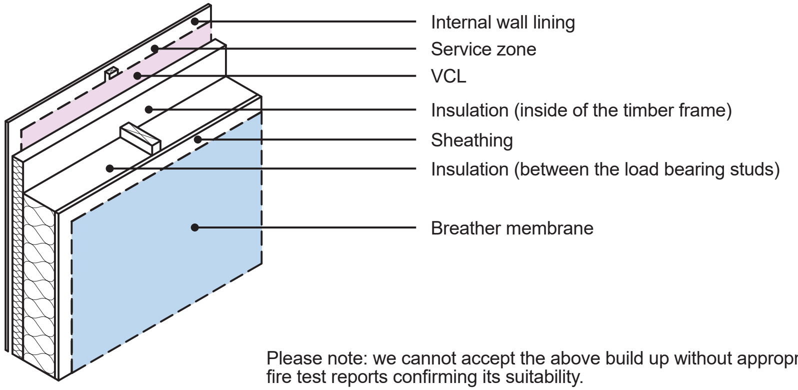
Drilling on centre line only. Hole diameters should not be greater than 0.25 the stud width and hole centres should not be closer than 4d (d = hole diameter).



Conventional wall with insulation between studs

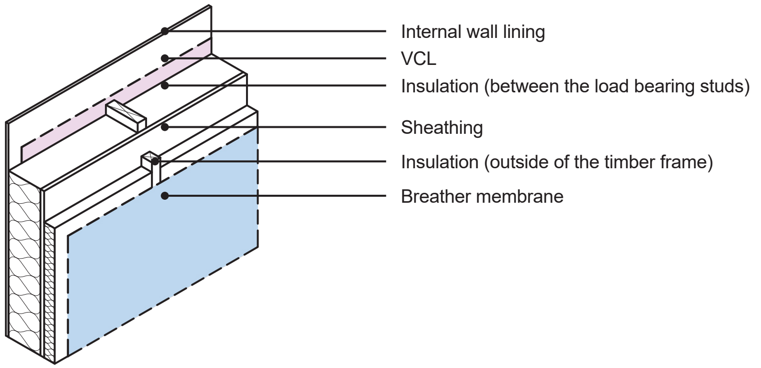


Continuous internal insulation



Please note: we cannot accept the above build up without appropriate fire test reports confirming its suitability.

Continuous external insulation



Insulation materials

Insulation materials should be chosen with consideration for their breathability and interaction with the timber frame.

All thermal insulation products used should have appropriate third party certification.

Insulation may be specified in any or all of the following locations:

- Between the load-bearing studs.
- On the outside of the timber frame.
- On the inside of the timber frame.

Insulation installed to the outside of the timber frame structure should have third-party certification for this application and retain a minimum of a clear 50mm cavity. The outer layer of insulation should also be covered with a breather membrane adjacent to the cavity.

External walls should be subject to U-Value and condensation risk calculations. A wall build up will be considered satisfactory if there is no calculated risk of surface or interstitial condensation at any time of the year, and it fulfils the minimum national requirement for thermal performance.

Special consideration should be given to condensation risk where non-breathable insulation products are installed on the outside of the timber frame structure. Joints between foil faced external insulation boards, must not be taped as this forms a vapour control layer on the cold side of the insulation.

Depending on the specification of insulation materials to be added to the structural frame, timber battens may be required to support the insulation or allow fixing of plasterboard linings, or external cladding to achieve the specified period of fire resistance.

Insulation installed within stud voids

If insulation is specified between external walls studs all voids shall be filled with insulation to maintain the thermal envelope of the building. When noggins or boards are installed between studs to support services or heavy fittings the void behind them shall be fully insulated.

Insulation should not be installed until the structural timber frame is below 20% moisture content and the building is weather tight, as wet insulation can retain moisture. If closed panel timber frame is specified, additional care must be taken to protect the panels from exposure to moisture during construction, with moisture content checks carried out before full closure.

Note: The above also applies equally to insulated party wall cavities. There needs to be consideration for how party wall insulation is to be kept dry during the build process.

Insulation installed within the external wall cavity

If external wall insulation is to be used:

- Insulation should be installed in a manner to maintain its stated performance by minimising gaps that lead to thermal bridging and air washing.
- Insulation should be covered with a breather membrane to ensure that external wall cavity moisture does not become trapped in or between the insulation and the timber frame.
- Cavity trays should be fixed and lapped behind the cavity facing breather membrane by 100mm to deflect cavity moisture away from the timber frame.
- Allowance should be made for differential movement to occur at floor zones.
- Cavity barriers should be tightly fitting; depending on the type of insulation used, cavity barriers may need to pass through the insulation, back to solid timber within the timber frame structure behind to remain effective in a fire.
- It should not retain or transmit moisture to cause the timber structure to exceed 20% moisture content.
- Stud locator marks should be transferred onto the outer face of the breather membrane adjacent to the external wall cavity.
- Wall ties should transfer loads to the timber frame structure. To achieve this, wall ties will typically need to be installed through the external insulation rather than bearing onto it.
- Joints between foil faced insulation boards must not be taped.

Vapour control layer (VCL)

A VCL is a moisture vapour-resistant material located on, or near, the warm side of the thermal insulation. Its purpose is to restrict the passage of moisture vapour through the structure of the wall and mitigate the risk of interstitial condensation.

The VCL may take the form of:
- A vapour control plasterboard comprising a metallised polyester film bonded to the back face of the plasterboard.
- A minimum 125 micron thick (500 gauge) polythene sheet.
- A third-party approved proprietary vapour control membrane product.

Subject to a favourable condensation risk analysis, a novel or reverse wall construction may not require the use of a high moisture vapour-resistant vapour control membrane.

For Warranty purposes, the boundary conditions for a condensation risk analysis should be as follows:
- 60% relative humidity.
- External temperature -2°C.
- Internal temperature 21°C.

A VCL should not be installed until the structural timber frame is below 20% moisture content and the building is weather tight.

Installation of a VCL
A sheet membrane (polythene or proprietary) VCL should be:
- Securely fixed to and cover all areas of the timber frame external walls, including all sole plates, head binders, and lapped/sealed fully into window/door reveals.
- Lapped and sealed by at least 100mm at joints.
- Lapped and sealed over studs, rails or noggins.
- Sealed around service penetrations.
- Lapped and sealed with DPM/DPC at the junction with the ground floor/foundation by a minimum of 100mm.

Note: Small holes in the VCL should be sealed with a suitable self-adhesive tape. If a proprietary membrane is being used, the manufacturer's proprietary sealing tape should be used. Larger holes should be re-covered to lap over adjacent studs and rails.

Vapour control plasterboard should be:
- Fixed in accordance with the plasterboard manufacturer's installation guidance.
- Tightly cut and fitted around service penetrations.
- Discarded if the vapour control backing is damaged.

Wall linings

The internal lining of the timber frame wall may be required to perform four functions:
- Provide the finish or a substrate to accept the finish on the inner face of the wall.
- Contribute to the racking resistance of the wall.
- Contribute to the fire resistance of the wall.
- Contribute to the acoustic performance of the wall.

Wall linings are typically:
- Gypsum plasterboard.
- Fibre reinforced gypsum board.
- Cement bonded particle board.

Lining materials must satisfy all relevant performance criteria, e.g. fire resistance, acoustic performance and have relevant third-party certification.

Please note: we do not accept the use of MgO boards.

Plasterboard

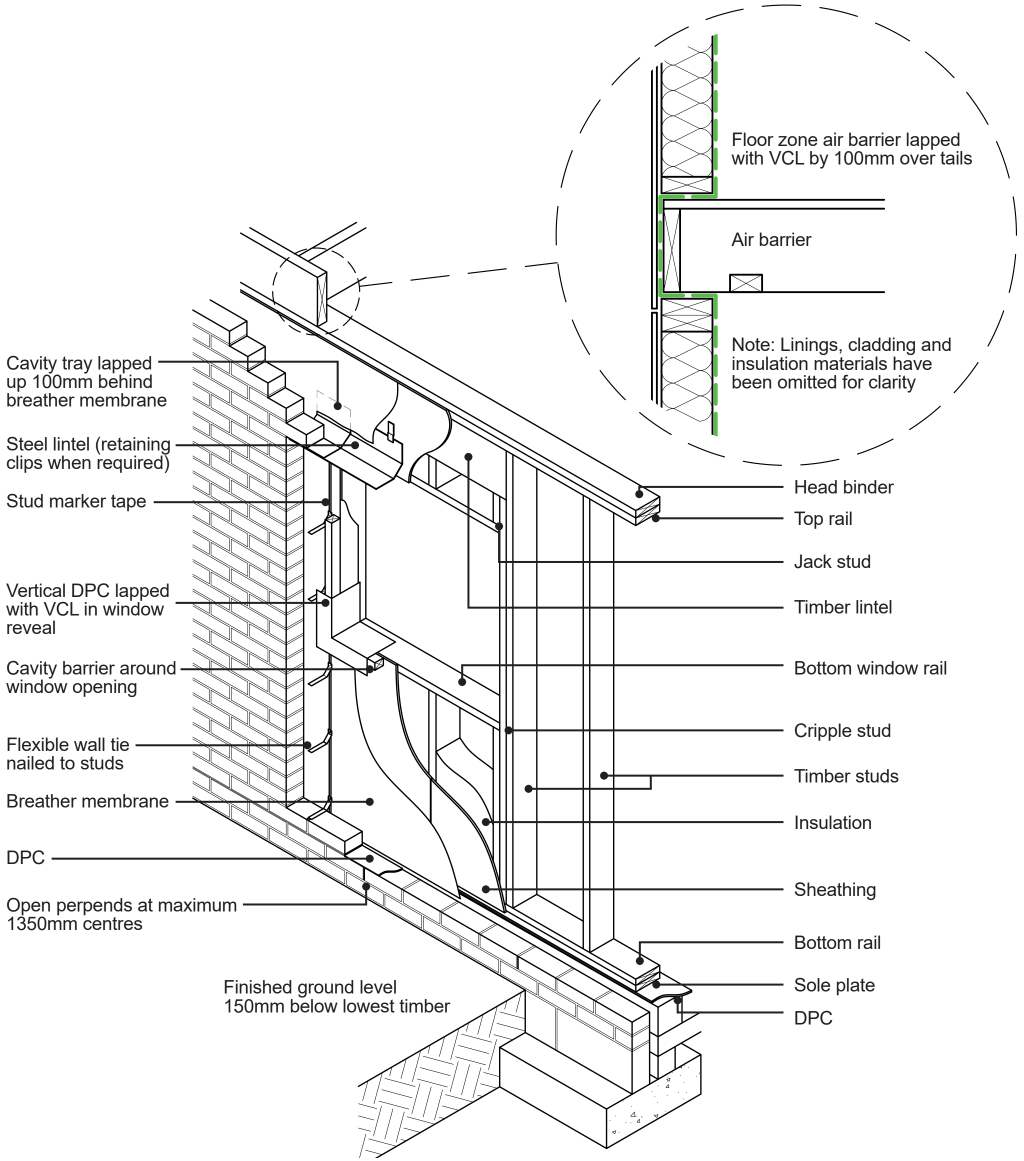
Installation
In order to provide the specified period of fire resistance, the plasterboard must:
- Protect all areas of the timber frame structure.
- Have all edges supported by timber studs or rails.
- Be fixed in accordance with the plasterboard manufacturer's guidance.
- Be cut and tightly fit around service penetrations.
- Have junctions of wall and ceiling linings detailed to maintain continuity.
- Be installed using the specified number of layers to achieve the required fire resistance.
- Have all joints staggered when installing multiple layers.

When fixing plasterboard linings:
- Each layer must be fully and independently fixed.
- Fixings of the correct length and centres should be installed in accordance with the plasterboard manufacturer's installation instructions.
- Walls requiring plasterboard to provide racking resistance should be clearly identified with plasterboard installed to the Engineer's specification or the plasterboard manufacturer's specification, whichever is more onerous.

Air leakage

Detailing and installation instructions must be followed to achieve adequate air tightness.

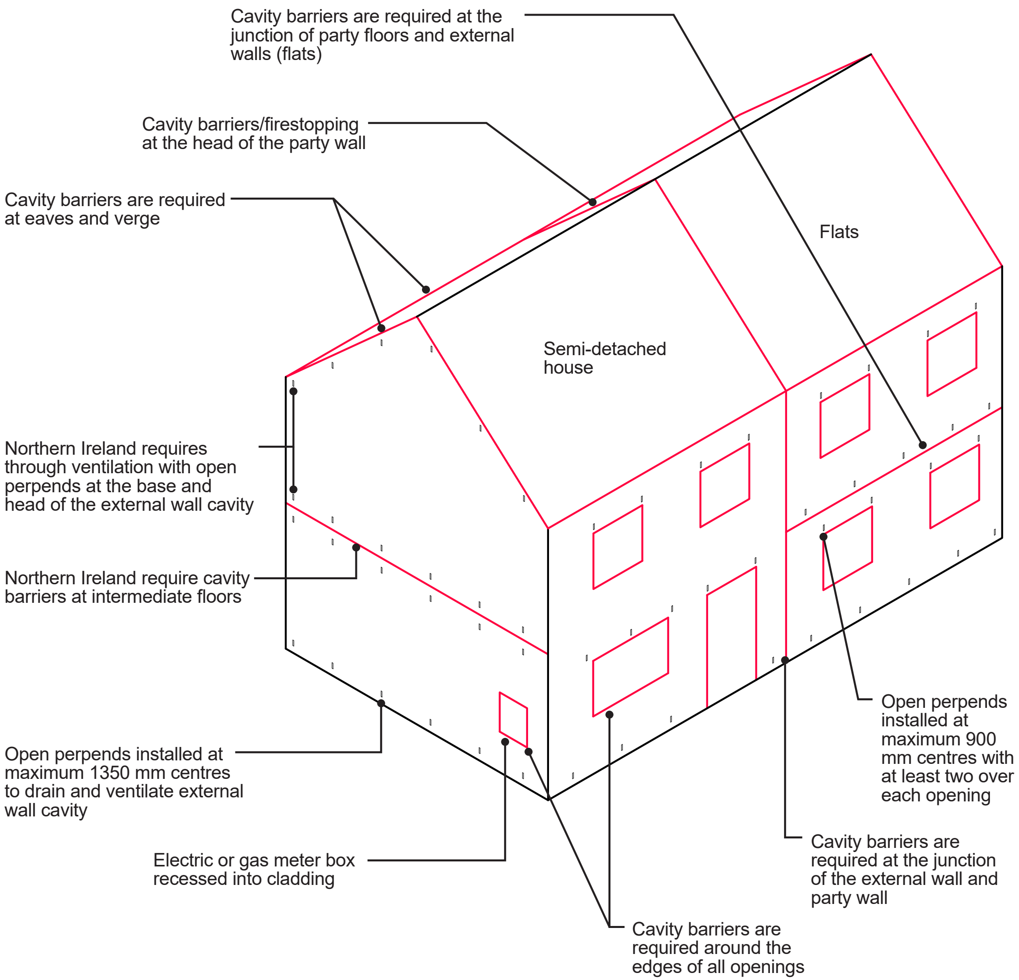
Wall panel with brick cladding



Locations of cavity barriers and open perpends within the external wall

Note: Lightweight cladding systems will require a cavity barrier along the bottom of the cavity.

Note: Cavity barriers may also be required between walls and floors within the building, consult National Regulations for further guidance.



Cavity barrier locations

In England and Wales, cavity barriers shall be installed:

- At the edges of all cavities including around openings, e.g. windows and doors (even if the opening is in close proximity to a compartment floor or intermediate floor level in Scotland and Northern Ireland).
- Between an external cavity wall and a compartment wall or compartment floor.
- Around meter boxes in external walls.
- Around service penetrations in external walls e.g. extract duct or boiler flue.
- To sub-divide extensive cavities; please refer to National Regulations for specific requirements.

Cavity barrier installation

Cavity barriers shall be installed:

- So they fully close the cavity by friction fitting for the designed cavity width.
- Backed by solid timber studs, rails or floor joist at least 38mm wide.
- In accordance with manufacturer or independent certifier's guidance.
- So they are mechanically fixed to rigid construction (for both vertical and horizontal positions).

A cavity tray should be installed directly above a horizontal cavity barrier and lapped up at least 100mm behind the breather membrane (except at eaves and verges).

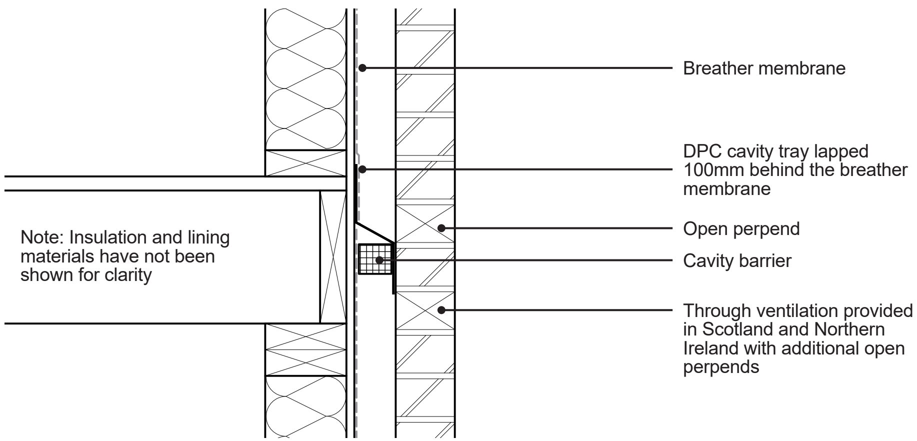
Cavity barriers are required to prevent the spread of smoke and flame within concealed spaces.

Cavity barriers may be constructed from:

- Steel at least 0.5mm thick.
- Timber at least 38mm thick.
- Proprietary 3rd party approved mineral wool product.
- Calcium silicate, cement-based or gypsum-based board at least 12mm thick.
- An independently assessed and certified proprietary product.

Timber cavity barriers should be protected from masonry cladding by the use of a DPC. The cavity face of the barrier should be left uncovered to allow drainage and ventilation of the timber. The use of timber cavity barriers around openings allows for effective sealing to be installed between them and the opening frame.

Cavity tray above horizontal cavity barrier



Masonry cladding

Timber frame external walls should be finished externally with a cladding system, which may take the form of masonry or a lightweight rainscreen system. Regardless of the cladding system used, all external wall claddings should be separated from the timber frame structure by a drained and ventilated cavity. In some locations, for example close to boundaries, national regulations require claddings to provide fire resistance to the structure from the outside in. Where a masonry cladding is proposed the vertical loadings from the masonry cladding must not be supported by the timber frame structure.

Self-supporting masonry claddings

Self-supporting masonry claddings should be connected to the timber frame using walls ties, wall ties should meet the following provisions:

- Comply with BS EN 845: Specification for ancillary components for masonry, ties, tension straps, hangers, and brackets.
- Be constructed from austenitic stainless steel.
- Accommodate all anticipated differential movement.
- The overall length of the wall ties must be of adequate length to provide a minimum 50mm clear cavity. The minimum length of embedment into the external leaf mortar joints should be 50mm.
- Be installed into solid timber studs, not just through sheathing.
- Additional studs should be provided in the timber frame structure for wall ties at vertical movement joints and around openings in the masonry cladding.
- Angled to drain moisture away from the timber frame even after differential movement has occurred.
- Installed at a maximum of 300mm centres vertically and 225mm horizontally around openings and movement joints.
- Installed within 225mm of the head of the wall.
- Wall tie density: For buildings up to three storeys in height wall ties should be installed at a minimum density of 4.4/m² (a maximum of 375mm vertically with studs at 600mm centres and a maximum of 525mm vertically where studs are at 400mm centres). A tie density of 4.4 ties/m² may be suitable for buildings on flat sites within towns and cities anywhere in the UK, except the north western fringes of Scotland and Ireland (where the basic wind speed exceeds 25m/sec) and any areas where the site is at an altitude of 150m or more above sea level. An increased wall tie density may be required in exposed locations or for buildings higher than three storeys in height, the actual performance required for each site location or building should be determined by an Engineer.

Cavity drainage and ventilation in masonry cladding should:

- Be provided with full height open perpends at a maximum of 1350mm centres or equivalent open area.
- Be provided in the brick or block course below the lowest timber sole plate above external finished ground level and below DPC.
- Be provided to ensure drainage and ventilation to each external wall concealed space directly above horizontal cavity barriers/trays.
- Be installed over openings in the external wall cavity e.g. windows and doors at a maximum of 900mm centres.
- Maintain a minimum 50mm clear cavity with care taken to reduce mortar droppings at the base of the wall.

Weep-holes alone are unsuitable for timber frame construction, and open perpends should be used. Proprietary open perpend inserts are available with insect screening incorporated however their equivalent open area must be considered and where this is less than that of an open perpend, there installation centres should be reduced accordingly.

- Cavity drainage and ventilation should provide an open area of not less than 500mm² per metre run:
- At the base of the external wall concealed space.
- Above horizontal cavity barriers/trays.
- Over openings in the external wall cavity, e.g. windows and doors.
- Allowing differential movement to occur while retaining an adequate gap.
- With openings protected by a mesh to prevent the passage of insects.

Masonry cladding - Brick suitability

- Facing bricks must have a suitable level of durability and particular attention should be paid to the bricks resistance to frost and moisture.
- Bricks should be capable of supporting proposed loads.
- Bricks should comply with BS EN771 and PD 6697.
- Frost resistant bricks should be used in areas of prolonged frost.

For further information on the suitability of masonry claddings and installation of stone heads within masonry cladding, please refer to the 'External Walls - Traditional Masonry Cavity Wall' and 'Appendix C - Materials, Products, and Building Systems' sections of the Technical Manual.

Minimum cavity width to timber frame

Timber frame external wall minimum cavity widths	
Masonry	50mm
Render on unbacked lath	50mm
Render on backed lath or board	25mm
Timber	19mm
Tile hanging	25mm

Movement joints

Movement joints should be provided in external masonry cladding in accordance with the 'External Walls - Traditional Masonry Cavity Wall' section of the Technical Manual. Additional timber studs may need to be installed within the timber frame to enable the correct installation of wall ties adjacent to movement joints.

Claddings supported on the timber frame

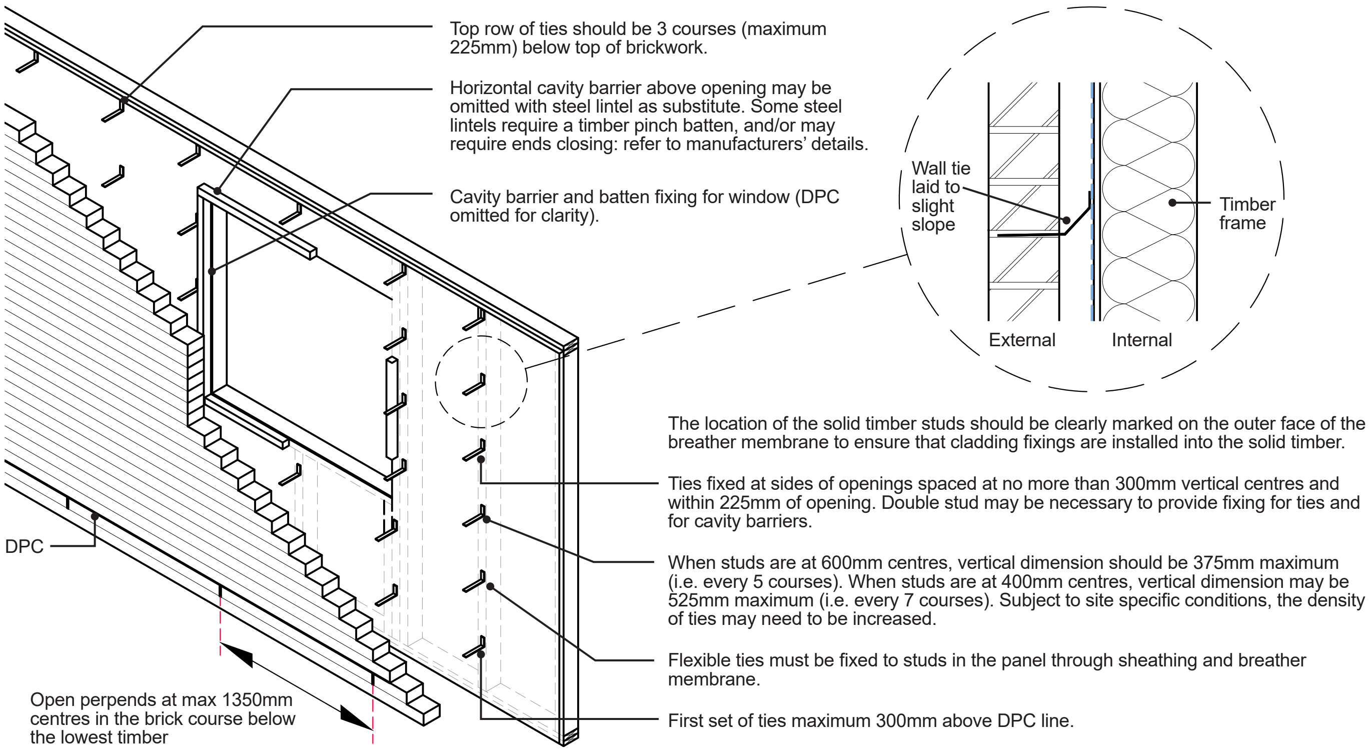
Claddings supported on the timber frame should be connected to it on vertical treated timber battens, or a carrier system, to form a drained and ventilated cavity to all areas of the external timber frame wall. These should be fixed into structural timber not just through the sheathing and to the Engineer's specification.

Cavity drainage and ventilation should provide an open area of not less than 500mm² per metre run:

- At the base of the external wall concealed space.
- Above horizontal cavity barriers/trays.
- Over openings in the external wall cavity, e.g. windows and doors.
- Allowing differential movement to occur while retaining an adequate gap.
- With openings protected by a mesh to prevent the passage of insects.

For additional guidance on claddings supported on timber frame please see the 'External Walls - Render' and 'External Walls - Claddings' section of the Technical Manual.

Location of wall ties



Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	1.5m – 3.0m*	3.0 – 4.5m**
Upvc –white	5	5	7.5
Upvc-non-white	7.5	7.5	11
Timber	5	5	5
Steel	4	5	6
Aluminium	5	5	7.5

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

Please refer to the ‘External Windows and Doors’ section for further guidance on window and door installations.

Please note, gaps under window and door openings will also need to be provided to cater for differential movement between the timber frame and the external brickwork. For further guidance please refer to the ‘External Walls – Timber Frame – Differential Movement’ section of this Technical Manual.

Finishing trims

The use of proprietary surface fixed finishing trims e.g. D-moulds, should be undertaken only as part of a designed junction between window and door framing and the surrounding opening. For further guidance on the use of finishing trims please refer to the ‘External Windows and Doors’ section.

The Building Control Body should be consulted for guidance on thermal compliance.

Openings

All openings including doors, windows, flues and ventilation ducts, should be designed and constructed to maintain:

Fire performance:

- Internal reveals require equal fire resistance to the rest of the structure.
- Window fixing straps should not compromise the integrity of any fire-resistant reveal linings.
- Cavity barriers should be installed in the external wall cavity around the perimeter of openings. They must be mechanically fixed to rigid construction (for both vertical and horizontal positions)
- If profiled steel lintels are used as cavity barriers, triangular gaps behind lintels, which occur at each end, should be closed with careful positioning of adjacent cavity barriers.

Acoustic performance:

- Seal gaps between timber frame wall and the element being installed into the opening.
- The element being installed into the opening may have a minimum acoustic requirement.

Weather tightness and thermal performance, including thermal bridging and air tightness:

- The element being installed into the opening will have a minimum thermal performance.
- Junction between the window/door frame and the opening also has a thermal performance value assigned to it (psi value) designs may incorporate insulated reveals.
- The gaps between the timber frame wall and the element being installed into the opening should be sealed using air sealing tapes, compressible seals or EPDM to promote thermal performance and continuity, weather tightness and air tightness.
- Cavity trays should be installed over the heads of all openings and lapped behind the breather membrane by a minimum of 100mm. A flashing may be acceptable for some types of claddings.
- Lap cavity barrier DPC with internal VCL around openings. Where no DPC is used, breather membrane should be lapped with internal VCL.

Lintels

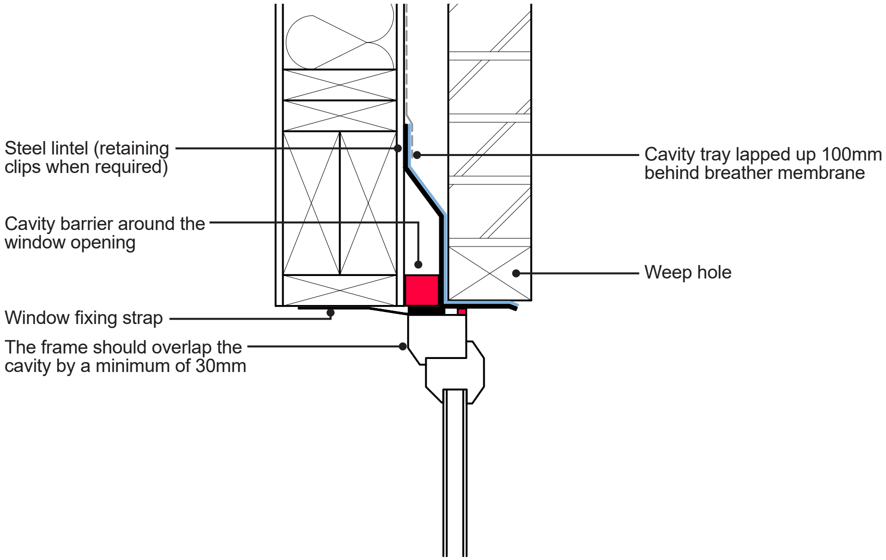
- The lintel should be the correct length and width for the opening and cavity width, the bearing length should be at least 150mm.
- Do not let masonry overhang lintels by more than 25mm.
- Continuity of the masonry bond should be maintained at supports for beams and lintels.
- Lintels must comply with relevant thermal requirements.

Do not:

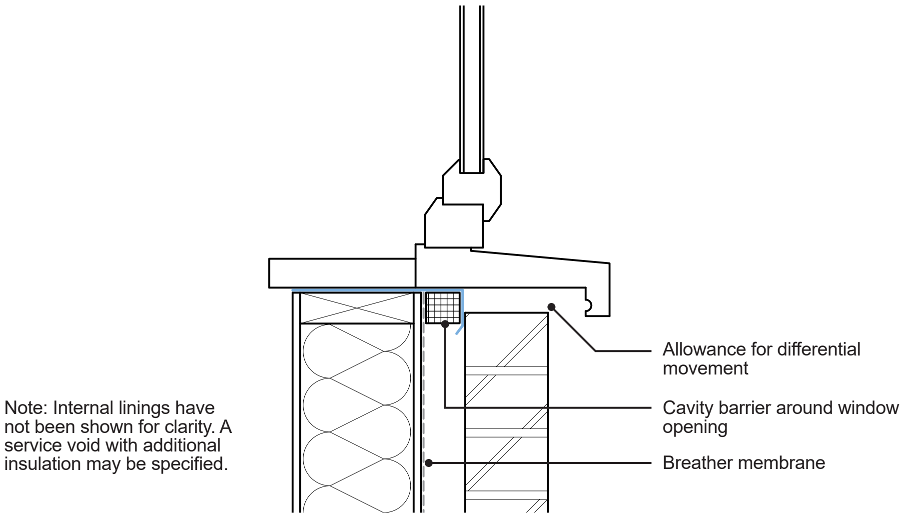
- Support lintels and beams on short lengths of cut blocks or make-up pieces.
- Apply load to lintels or beams before the masonry supporting has hardened.

Further information on the installation of lintels can be found in the ‘External Walls - Traditional Masonry Cavity Wall’ section of the Technical Manual.

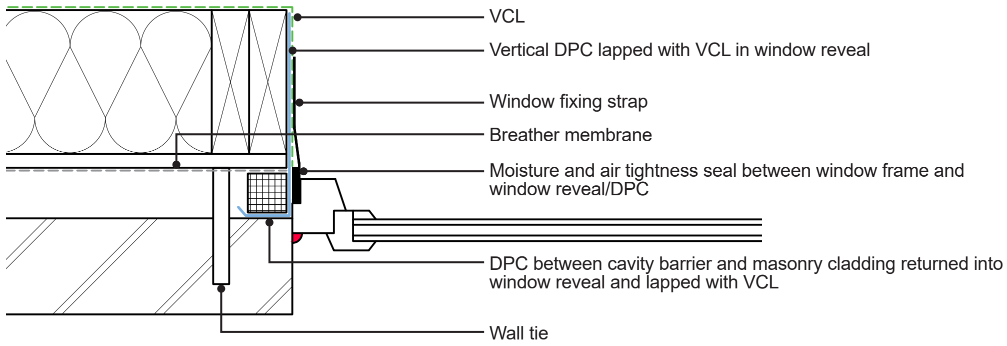
Typical vertical section through window head



Typical vertical section through window sill



Typical window reveal (normal exposure)

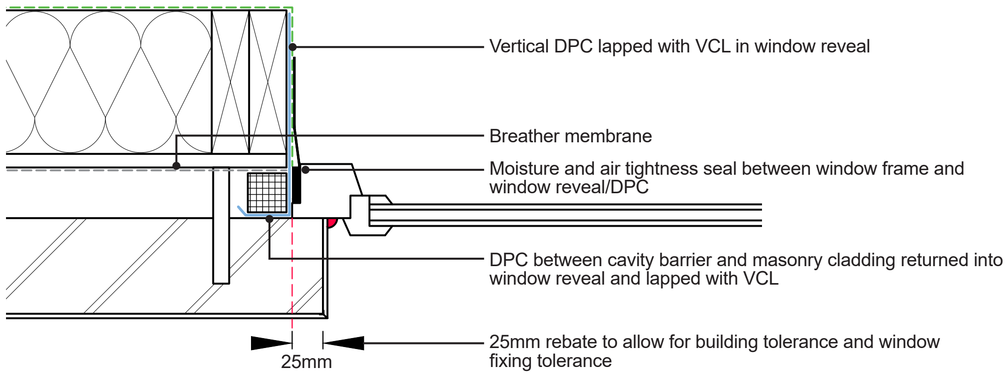


Checked rebates

Checked (rebated) reveals are required in Scotland, Northern Ireland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

For further information on external windows and doors please refer to the ‘External Windows and Doors’ section.

Typical rebated window frame detail - rendered masonry clad



External silicone sealants

The application of silicone sealant around the junction between the window frame and the external leaf masonry should take differential movement into account. The silicone sealants should be checked once differential settlement has occurred and reapplied if required.

Cavity trays

Cavity trays, associated weep-holes and stop-ends prevent the build-up of water within the cavity between the timber frame and external cladding and allow the water to escape through the outer leaf. They are used in conjunction with lintels above openings, where horizontal cavity barriers are fitted to compression and where the cavity is bridged.

Cavity trays must:

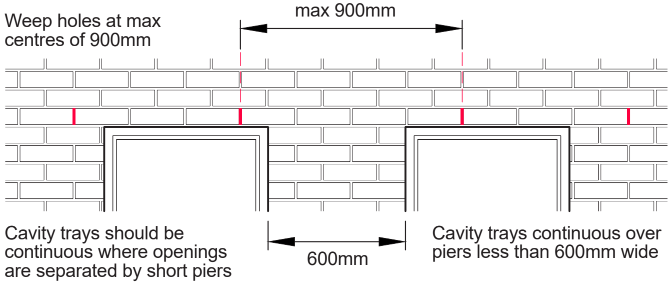
- Comply with relevant Building Regulations.
- Have third party certification or be to a relevant BS or BS EN code appropriate for the intended use. Please note: Polyethylene DPC's should not be used as a cavity tray.
- Be provided at all interruptions likely to direct rain water across the cavity, such as rectangular ducts, lintels and recessed meter boxes.
- Be provided above lintels in walls in exposure zones 4 and 3, and in zones 2 and 1 where the lintel is not corrosion-resistant and not intended to function as its own cavity tray.
- Be provided continuously above lintels where openings are separated by short piers.
- Be provided above openings where the lintel supports a brick soldier course.
- Be fixed and lapped behind the cavity facing breather membrane by 100mm to deflect cavity moisture away from the timber frame.
- Must be proprietary preformed cavity tray systems at stepped and lower storey abutments and around corners in low rise cavity masonry walls.
- Cavity trays must be designed and constructed to allow for differential movement.

Weep-holes

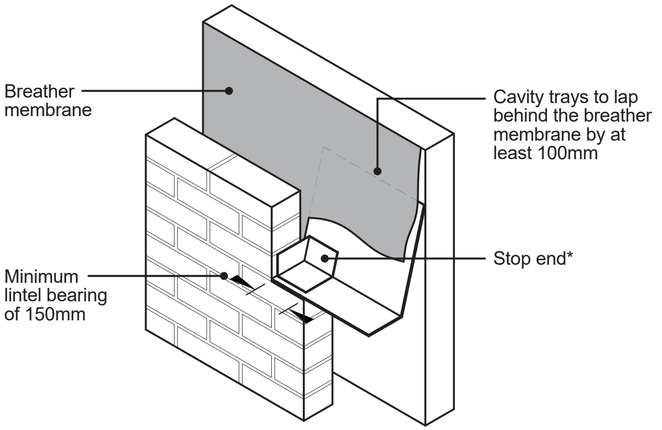
Weep-holes must be installed at no more than 900mm centres to drain water from cavity trays and from the concrete cavity infill at ground level.

- At least two weep-holes must be provided to drain cavity trays above openings.
- Weep-holes in exposure zones 3 and 4 should be designed to prevent ingress of wind-driven rain (including ground level).
- Weep holes will be required in all external cladding, including rendered claddings.

Continuous cavity tray over two openings and a small pier



Stop end to cavity tray

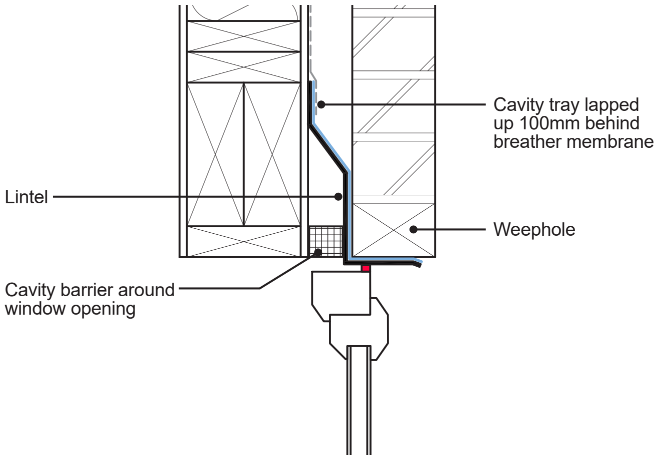


*Stop-ends need to be bonded to the cavity tray material or clipped to the lintel, so that a stop to the structural cavity of at least 75mm high is provided. Normally, the stop-end is located to coincide with the nearest perpend to the end of the cavity tray.

Stop-ends can be formed by sufficiently turning up the end of a DPC tray into the perpend joint. Surplus mortar should be removed from cavities and wall ties cleared of mortar droppings and debris as the work proceeds.

Cavity trays should rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.

Cavity tray and lintel

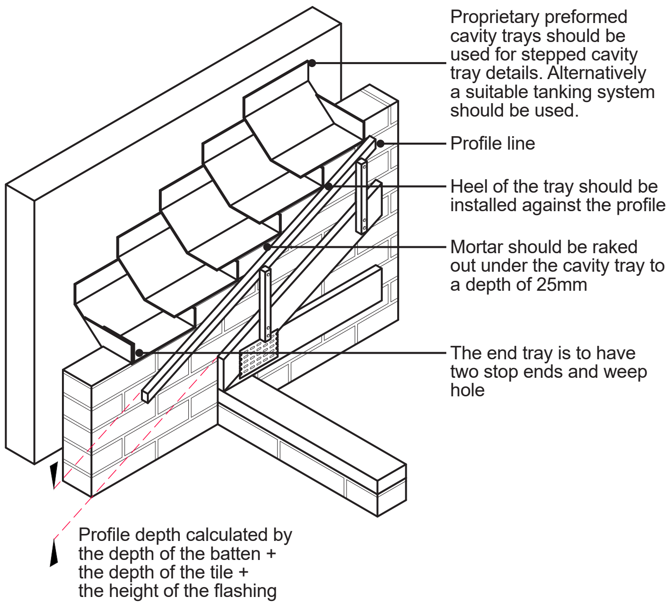


Note: Lintel must comply with relevant thermal requirements.

Installation of stepped cavity tray

Stepped cavity trays are required at all pitched (stepped) roof abutments with external cavity walls, e.g. attached garages or staggered terraces.

A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



Preformed rigid cavity trays should be used for stepped cavity tray details. Stepped cavity trays to lap behind breather membrane by at least 100mm. Additional measures may be needed to ensure the breather membrane adequately laps the tray to prevent moisture ingress behind the stepped cavity tray.

Catering for differential movement

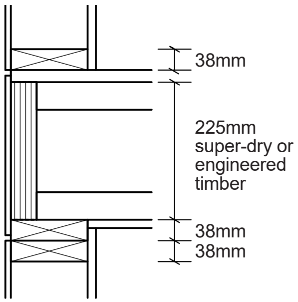
Differential movement can occur with timber framed buildings where the overall height of the timber frame will reduce due to shrinkage as the timber frame dries out predominantly within the first 24 months of completion. Other building components, such as brick and blockwork may increase in height due to thermal expansion and moisture related movement. This differential movement between the cladding and timber frame must be allowed for in design.

Differential movement can also occur in a variety of other locations in and around a building. These may include:

- Windows and doors.
- Balconies and Juliet balconies.
- Openings for services.
- Eaves and verges.
- Cavity wall ties.
- Battens across floor zones.
- Junctions for mixed cladding designs.
- Lift shafts and stair wells of mixed construction.

For a typical softwood timber element, allow a 1% shrinkage across the grain for every 4% reduction in moisture content. This means that 1mm should be allowed for differential movement for every 38mm of horizontal solid timber. This formula does not apply to engineered wood products. Typically, 2mm–3mm of differential movement allowance for compression and settlement of floor joists that use engineered wood products will be sufficient. Shrinkage of the solid timber horizontal plates and rails must still be allowed for however.

Engineered Timber

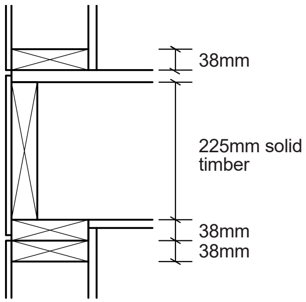


225 mm engineered timber = 2-3mm differential movement depending on tightness of build.

Expect 6mm movement per storey, or 7mm per storey if a locator plate is used on upper stories.

Note: when super-dry timber or engineered timber platform frame ground floor is used, add 3-4mm (depending on tightness of build) to the differential movement allowances quoted.

Solid Timber



225 mm solid timber = 6mm differential movement.

Expect 9mm movement per storey, or 10mm per storey if a locator plate is used on upper stories.

Note: when solid timber platform frame ground floor is used, add 7 mm to the differential movement allowances quoted.

Movement joints should be specified so they:

- Can accommodate the expected amount of shrinkage or expansion safely.
- Can provide a weather resistant and durable joint.
- Are protected with a cover strip where the movement joint is in excess of 35mm.

If fillers or seals are to be installed into differential movement gaps their fully compressed dimension, considering the area of the seal and force required to compress it, must be added to calculate gap size. Materials should be chosen to provide an effective weather tight seal dependent on whether they are to be subjected to compression, expansion, or shear forces. Cover strips may also be used where the movement joint is in excess of 35mm.

Gap sizes should allow for anticipated differential movement while allowing for drainage and ventilation requirements. Insect infestation should be avoided by using screens to cover gaps exceeding 4mm.

Materials or components attached to the structure

Any material or component attached to the timber superstructure that overhangs the brick or blockwork (e.g. cladding attached to the timber frame, window sills, roof eaves, and verges) or projects through the masonry (e.g. balcony supports, flues, extractor fan vents, or overflow pipes) should have a clear gap beneath and at the top of the masonry cladding to allow differential movement to take place, thus avoiding damage to the components or cladding.

Masonry cladding should not be supported on the timber frame structure.

Recommended minimum allowances for differential movement between the timber structure (and ancillary components fixed to it) and masonry claddings

Where masonry cladding is specified for a timber framed building, the building should be designed to ensure that differential movement occurs evenly to external elevations and the internal structure. Site specific calculations should be used to determine movement gap sizes, however in absence of site specific calculations, the below table can be used for buildings up to five storeys.

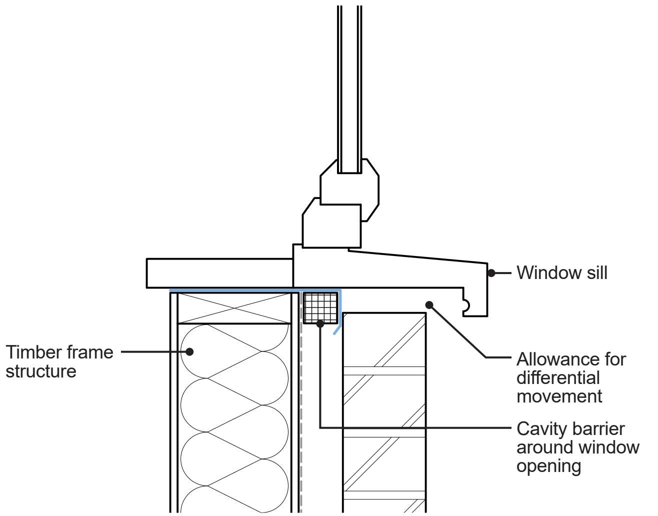
For the purposes of Warranty, a storey is defined as a space between two consecutive floors or between a floor and a roof. The number of storeys should be counted from the lowest external ground level and it should include the ground storey.

Gap location	Differential movement gap size	
	Engineered floor joists*	Solid timber floor joists*
4th storey	45mm	Engineer design required
3rd storey	35mm	45mm
2nd storey	25mm	35mm
1st storey	15mm	20mm
Ground storey or lowest level of timber frame	5mm	5mm

* The compressed thickness of the material used to fill the gap must be added to the dimensions given.

- For eaves and verge, add 5mm to the dimensions given in the table.
- The product used for differential movement must be capable of compressing without causing undue stress to the surrounding construction.
- Where masonry extends continuously below the lowest level of timber, brickwork expansion should also be taken into account.
- Moisture content of all timber must be less than 20%.
- Table is based on a concrete ground floor. Where timber joists are used at ground floor level, 15mm for solid timber joists and 10mm for engineer I-Joists should be added.
- The table assumes outer leaf brickwork with expansion rates no greater than 2.5mm per storey.
- Services that are rigid from the foundations, e.g. soil stack, dry riser, gas and water, require differential movement gaps above the service entry. The gaps should be equal to those recommended for the bottom of openings at the appropriate floor level.
- There should be consideration for differential movement at lift door/thresholds and at the top of self-supporting element such as masonry or steel lift shafts.
- Table based on a maximum depth of timber joists and rim beam/header to be 240mm.
- Single head binder at the eaves. Maximum double sole plates.

Allowance for differential movement at sill



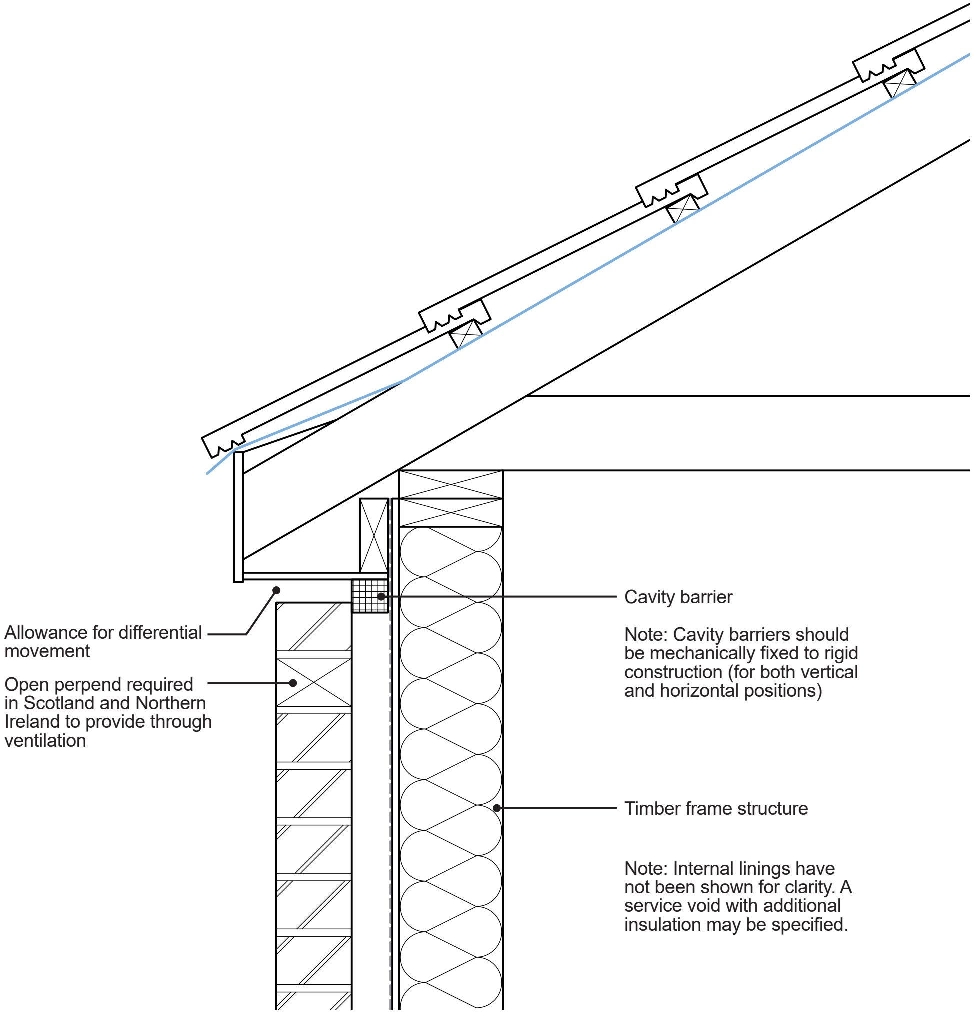
Note: Internal linings have not been shown for clarity. A service void with additional insulation may be specified.

As the window frame will be fixed to the timber frame, as movement occurs a gap at the top of the window / door may open up and will need to be allowed for to prevent water ingress.

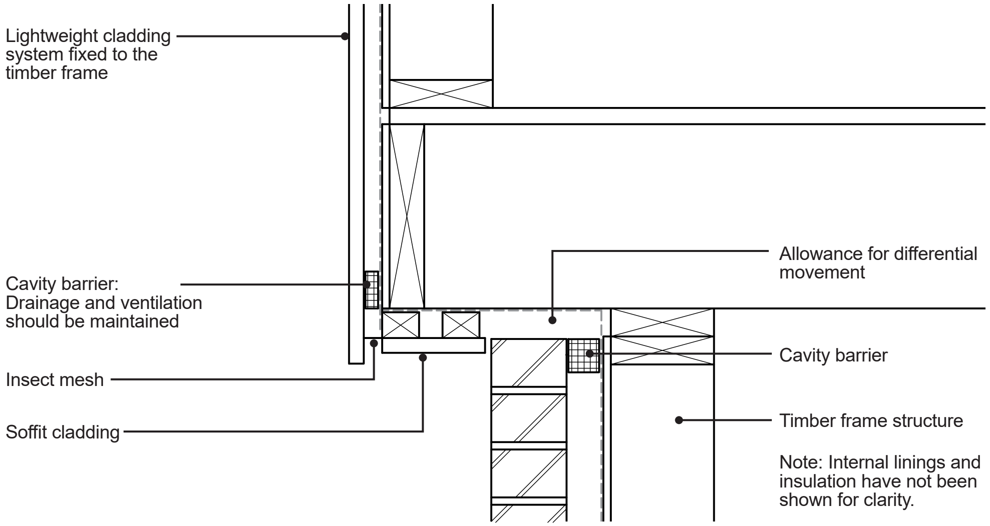
Lift shafts, stairwells and steel posts

Lift shafts and stairwells of mixed construction, and steel posts will require site specific calculations to work out the anticipated differential movement with the timber frame.

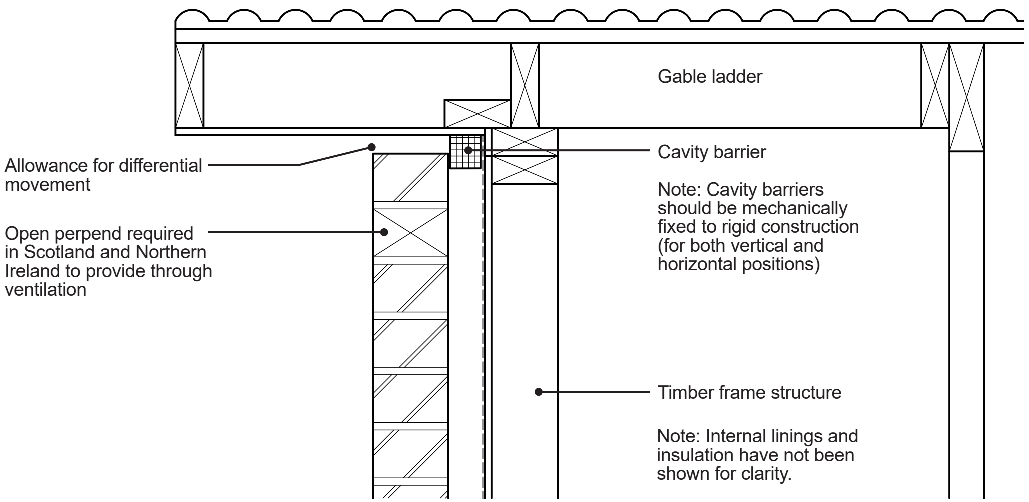
Differential movement at eaves



Differential movement at cantilevered overhang



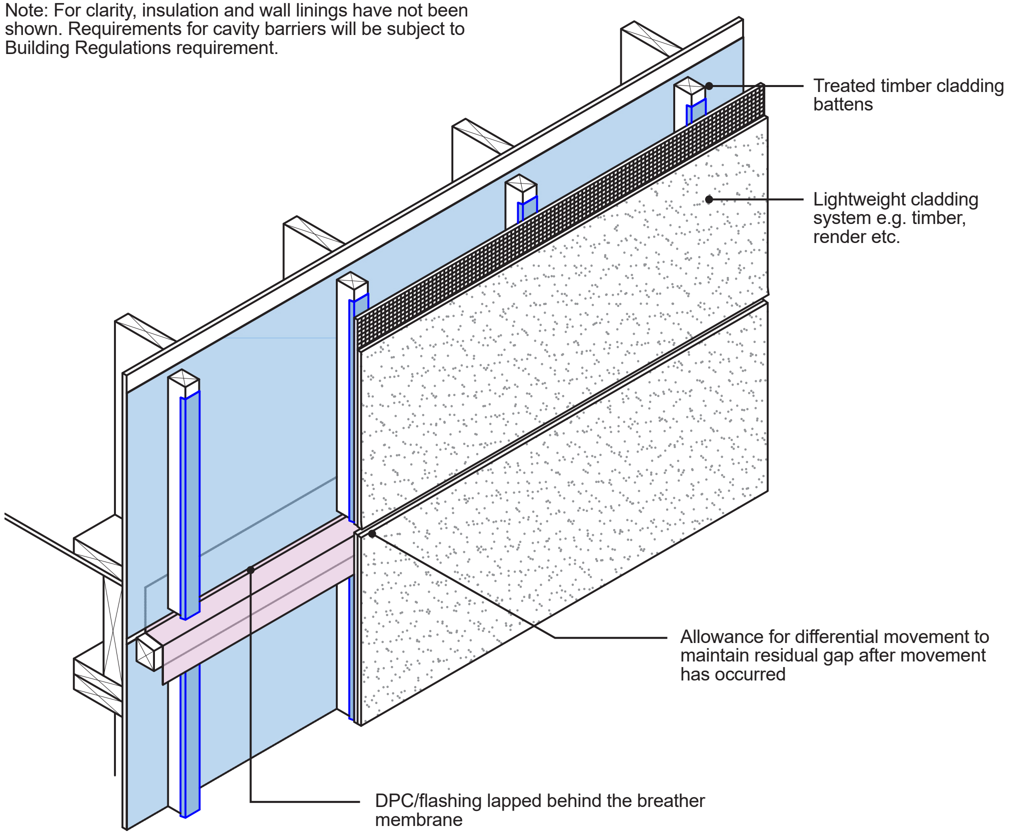
Differential movement at verge



Differential movement at floor zone with cladding supported on timber frame

Horizontal cross grain timber and construction gaps are concentrated at floor zones and this is where the majority of movement occurs. Vertical timber battens or other rigid cladding support systems should not span over the floor zones of timber frame buildings. Gaps should be provided to accommodate anticipated differential movement and the compressed size of any filler. Unlike self-supporting claddings, movement is not cumulative but should be calculated individually for each floor zone using the formula of 1mm for every 38mm of horizontal cross grain timber.

Note: For clarity, insulation and wall linings have not been shown. Requirements for cavity barriers will be subject to Building Regulations requirement.



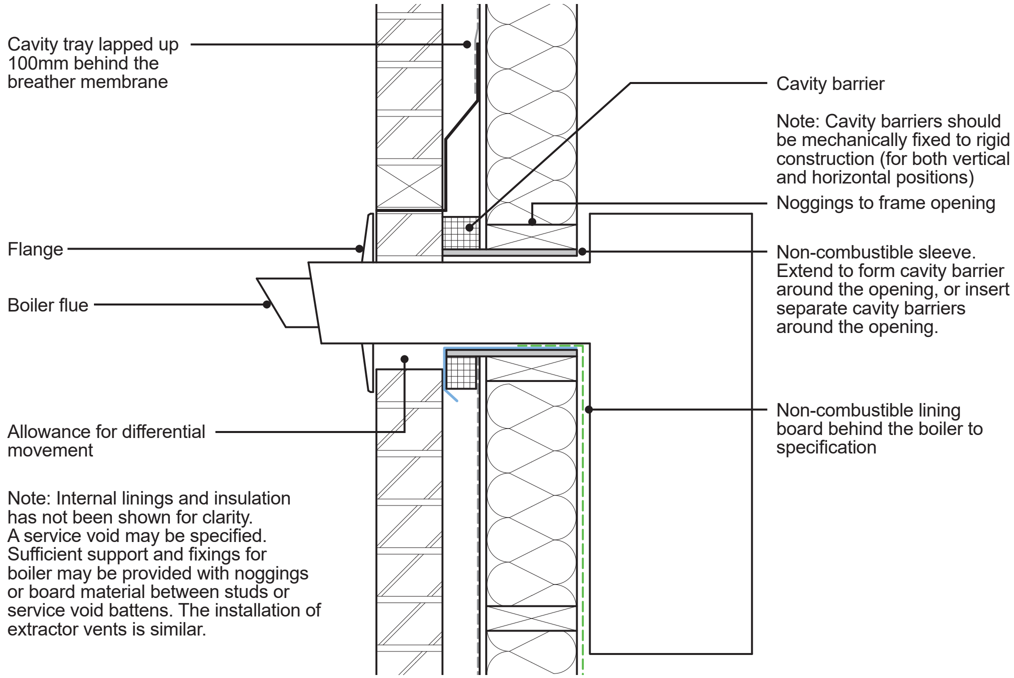
Gap sizes should allow for anticipated differential movement while allowing for drainage and ventilation requirements. Insect infestation should be avoided by using screens to cover gaps exceeding 4mm.

For additional guidance on claddings supported on timber frame please see the ‘External Walls - Claddings’ section of the Technical Manual.

Services

Rigid services within the timber frame structure also require an equal allowance for differential movement, as shown. Examples include copper gas and water pipes, dry risers, internal downpipes, SVP’s, cable trays and blockwork lift shafts. While gap allowances externally are allowed below, for example, a sill, when a branch comes off a rigid stack internally, the gap needs to be left above a service to allow the timber frame to drop around it.

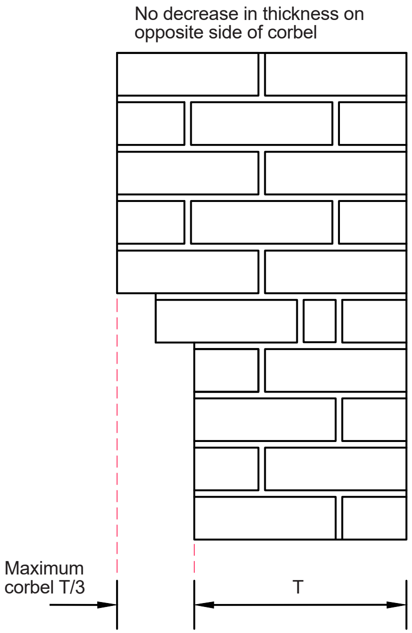
Differential movement at services



Note: Internal linings and insulation has not been shown for clarity. A service void may be specified. Sufficient support and fixings for boiler may be provided with noggings or board material between studs or service void battens. The installation of extractor vents is similar.

Feature brick corbelling and architectural brick detailing

The extent of corbelling of masonry should not exceed that indicated in the below detail, unless supported or reinforced. Reinforced corbels should be designed by an Engineer.



Where architectural brick detailing is specified, the brick manufacturer should confirm the expected durability of the product in the proposed use will meet our Warranty service life requirement of 60 years.

Gable spandrel panels

The gable spandrel panel should be suitably designed to transmit loads to the roof structure and down through the timber frame.

It is important that gable spandrel panels are designed to transmit these loads to the roof structure via lateral restraints and vertically down to the timber frame. A full design with structural calculations be provided.

The timber frame designer should provide details of the lateral resistant to the gable spandrel panel, including details of the restraint used and the fixings should be provided.

6. External Walls

6.3 Light Gauge Steel Frame

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence of SCI stage 1 and 2 certification or evidence of a third party system approval (UKAS or equivalent) for the system and has been assessed by our Warranty Innovations Team.
2. Evidence of an ISO 9001 Quality management system covering the manufacturing of the panels including material supply chain.
3. A full set of detailed drawings, including:
   a) Plan layouts indicating dimensions.
   b) Elevations with dimensions shown.
   c) Junction details showing position of DPC's, cavity trays, other building elements such as roofs, floors etc.
   d) Detailed drawings showing base rail levels in relation to external ground levels for all elevations.
4. Details of proposed breather membranes and VCL's to be used.
5. Engineers drawings, calculations and fixing schedules for each connection made on site (e.g. framing, sheathing, structural connections, membranes etc.) including size, type, number, spacing, method of fixing. Details of the corrosion protection of the fixing should also be provided.
6. Details relating to the securing and fixing of the panels to the substructure and between panels.
7. Details relating to the galvanisation coating of the frame, taking consideration of the anticipated exposure rating and potential aggressive meteorological environments.
8. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
9. Details of any cladding material fixed back to the LGSF including type, size and location of fixings. Where masonry cladding is present on the external leaf, details of wall tie and movement joint provision.
10. Where insulation in the external wall makeup are to be fitted on site we would require details of proposed insulation to be used.
11. A condensation risk analysis should be provided for the external wall makeup.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Building Regulations

All steel frame construction should meet the Building Regulations.

General requirements

The structural design should be in accordance with BS EN 1993-1-3:2006, and imposed loads should be calculated in accordance with BS EN 1991, including dead, imposed and wind loads.

The below points should be satisfied for all open panel LGSF systems.

- A SCI Stage 1 certificate and then Stage 2 project specific assessment certificate (SCI Stage 2 certificate is required for buildings up to 5 storeys high) or evidence of a third party system approval (UKAS or equivalent) for the system and has been assessed by our Warranty Innovations Team.
- A comprehensive full structural design specification and supporting calculations for each house type on the proposed project.
- Evidence of a valid ISO 9001 Quality Assurance Certification (or equivalent) held by the Manufacturer, covering the manufacture of their product/system.
- Manufacturers of structural, load bearing light gauge steel systems should hold certified FPC in accordance with BS EN 1090 to comply with Construction Products Regulations. The certification body should be accredited by UKAS or equivalent ILAC signatory.
- Full details of all claddings and specifications of DPC's, breather membranes, vapour control layers, sheathing boards, insulation, separating wall details, roof and intermediate floor constructions and positioning of ground floors in relation to the surrounding ground levels in order to demonstrate compliance with this section of our Technical Manual.

Please note: All close panel, open panel with pre-installed windows/doors/cladding and modular volumetric systems are required to be reviewed by our Warranty Innovations team.

Actual wall makeup, components, individual products used for the external waterproof, thermal and fire resistant envelope, are outside the scope of the SCI Stage 1 assessment. These elements will still need to meet the requirements of this Technical Manual.

Where a valid Steel Construction Institute (SCI) certificate is provided for the system, the information required in the above five bullet points must still be provided.

In addition to the above where the light gauge steel framing is used to form the structure of the building, the manufacturer will need to confirm how lateral stability will be achieved by the steel frame design. Structural calculations from an Engineer will be required, for all buildings registered for Warranty.

Please note our Warranty does not accept Light Steel Frame systems which rely on racking resistance of the sheathing board. Engineers Design Philosophy must clearly identify how lateral stability will be achieved by the steel frame design. This Engineers Design Philosophy should confirm that the stability system can resist the full horizontal wind and notional loadings, without any assistance from the sheathing board.

Any external wall make up incorporating external cladding, must meet our Warranty requirements in respect of weather resistance. Please see the 'External Walls - Claddings' section for further information.

Any modular or closed panel system or other modern method of construction using light gauge steel framing, must be accepted by our Innovation Department. Please refer to 'Appendix C' of the Technical Manual.

General detailing and specification

All light gauge steel frame framing:

- Should be only used in warm or hybrid construction - including floors, walls, pitched roofs, flat roofs and terraces,
- Must be protected from the external conditions with the use of appropriate wall and roofing membranes.
- Must be located entirely above DPC level and a minimum 150mm above external ground level, the use of a masonry foundation kerb upstand may be an appropriate method to achieve this.
- Walls, upper floors and pitched roof framing, should be pre-galvanised in accordance with BS EN 10346 with a minimum 275g/m^2 zinc coating (Z).
- Ground floor joists and ring beams in such floors should be pre-galvanised to 450g/m^2 zinc coating (Z).
- Positioned below the waterproofing layer of a flat roof, balcony or terrace should be pre-galvanised to a minimum 600g/m^2 zinc coating (Z).
- Where level access requirements result in the floor joists, ring beams and base rails etc. being less than 150mm above external ground level, then these elements should be pre-galvanised to 600g/m^2 zinc coating (Z). Level access arrangements should be kept to a minimum and no more than 15% of the external perimeter of an individual building (e.g. a single plot in a row of terraced homes).
- Load-bearing walls should be designed to support and transfer loads to foundations safely and without undue movement.

Wall panels may provide resistance to racking forces using one or more of the following techniques:

- Internal bracing.
- Cross flat bracing.
- Rigid frame action.

Note: Sheathing board should not be considered as contributing to the racking resistance of the structure.

The design should detail how joints between the wall panels and other elements are to be securely fixed:

- To the structure.
- To adjacent panels.
- To the floors and roof.

The design should ensure that the structure is adequately protected from the effects of moisture.

Exterior claddings should be compatible with the steel frame. Suspended floors should be designed to support and transmit loads safely to the supporting structure without undue deflection.

Services should be adequately protected from damage, walls and floors should resist the spread of fire. Internal walls and floors should be designed to resist the passage of sound adequately.

Corrosion

Steel and fixings should be suitable for the design and adequately protected against corrosion.

Galvanised strip steel should be designated grade S280GD to 450GD to BS EN 10346.

Metal stud framework

The wall panel usually consists of a head rail, base rail (sole plate) and possibly horizontal noggins at mid-height, together with vertical wall studs:

- Recommended site connections include self-drilling, self-tapping screws or 10mm-12mm diameter grade 4.6 bolts. Welding is not recommended on-site.
- Workmanship should comply with BS 8000: 5.
- Framed walls should be accurately aligned, plumb, level without twist and securely fixed to adjacent elements.

Vertical installation tolerances are:

- +/-15mm in overall height of wall 3 storey, or,
- +/-10mm in overall height of wall 2 storey, or,
- +/-5mm in storey height (approx. 2.5m).

Please refer to the 'Tolerances' section of this for further guidance.

A lintel should be provided where one or more studs is cut or displaced to form an opening. A lintel is not required where an opening falls between studs. Non-load bearing walls should have adequate strength and support.

Non-load bearing walls should not bridge movement joints in the main structure. A movement joint should be constructed between the frame and any chimney flue or lift shaft to prevent load transfer. Cavity barriers and fire stops should be provided in accordance with relevant Building Regulations, and steel joists should be spaced at centres no greater than 600mm.

Cutting holes in steel frame for services on-site is not recommended without approval from the steel frame designer. Holes, penetrations and cuts should be carried out in factory environments in accordance with the structural design. Holes should be fitted with grommets.

Accommodation of deflection
Infill walls should accommodate anticipated deflection within the primary frame

Determining the site exposure to wind driven rain

For further information on determining the exposure for the site location please see 'Appendix C - Materials, Products, and Building Systems - Determining the sites exposure to wind driven rain'.

Key points: Construction below DPC

1. Brickwork and blockwork below DPC level must be selected to have suitable durability for its use in the wall construction in accordance with BS EN 771-1 and PD 6697.
2. Mortars below DPC are exposed to higher levels of saturation and therefore require higher durability classification (see BS EN 998-2).
3. Cavities below ground should be filled with concrete ensuring there is a minimum gap of 225mm between DPC and the top of concrete.
4. Concrete for cavities should be GEN 1 grade and a consistence class S3.
5. External ground levels should be a minimum of 150mm below DPC.
6. The compressive strength of the masonry units must meet the requirements of the Building Regulations.

Damp proof course (DPC)

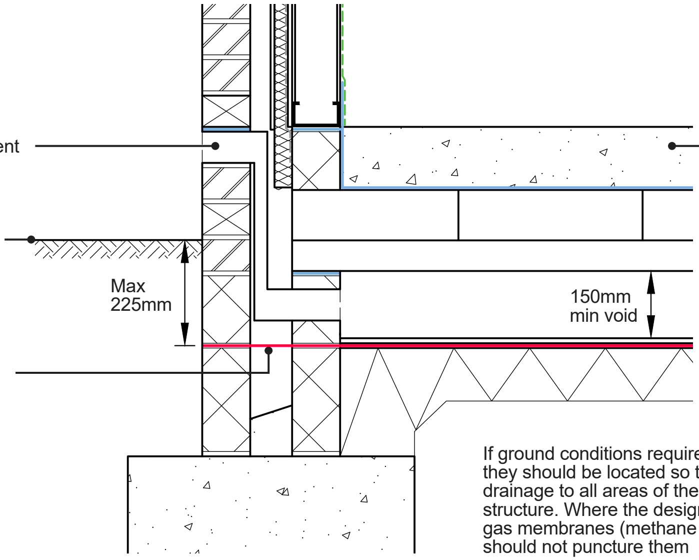
1. DPC's should be of a flexible material, be suitable for the intended use, and should have appropriate 3rd party certification. The installation specification of DPC's should follow good design practice in accordance with BS 8215.
2. Blue bricks or slate will not be accepted as a DPC.
3. DPC's should be laid on a mortar bed and correctly lapped at junction and corners. The depth of the lap should be the same width as the DPC.
4. The DPC should not bridge any cavity unless it is acting as a cavity tray (e.g. over a telescopic floor vent). Please refer to the cavity tray details for further information.
5. Damp proof membranes (DPM) should be lapped with the DPC, and VCL by a minimum overlap of 100mm.

Rendering on masonry walls

1. Rendering below DPC should only be carried out using a specialist render manufacturer's specification. No render system should bridge the DPC and a proprietary uPVC bead or stainless steel bead should be used above and below where the renders meet at the DPC.
2. DPC should extend through the rendering system in between the bellcast beads or render stop system.
3. For bellcasts, uPVC beads or stainless steel beads are acceptable.

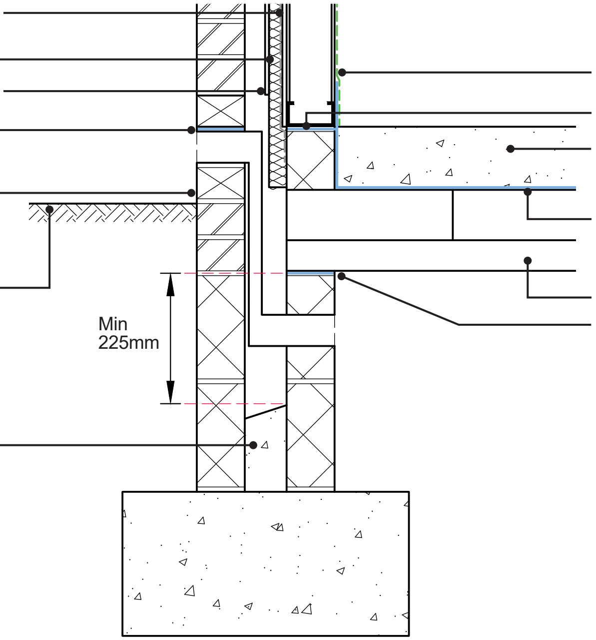
Note: For further guidance on the application of render please see the 'External Walls - Render' section.

Possible gas membrane detail

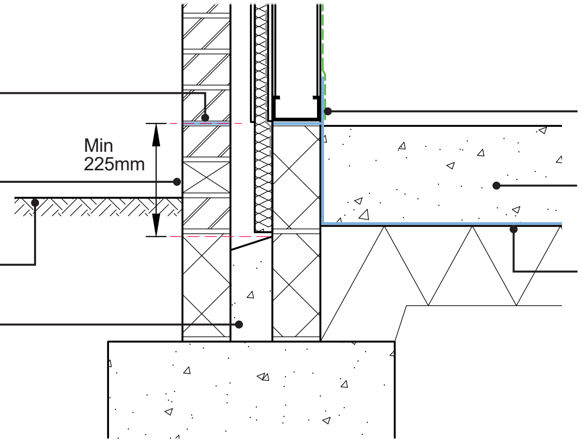


If ground conditions require gas membranes, they should be located so they do not inhibit drainage to all areas of the steel frame structure. Where the design incorporates gas membranes (methane or radon), fixings should not puncture them

Suspended floor with ventilation provision



Ground supported floor - no sub floor ventilation



All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

Site tolerances

It is essential that the accuracy of setting out foundations and ground beams are checked well in advance of materials being delivered to site.

For accurate erection of the frame the following tolerances are required at the level of the base of the wall frame:

- Length of wall frame: +/-10mm in 10m.
- Line of wall frame: +/-5mm from outer face of plate.
- Level of base of wall frame: +/-5mm over complete wall line.

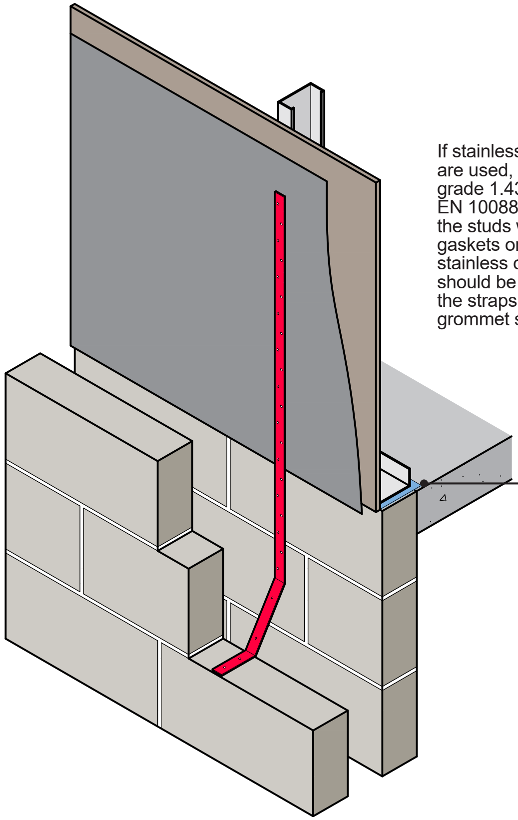
Some packing may be needed to achieve the required tolerances.

Fixing of frames to substructures

The oversite DPM should be attached to the side of the slab and returned under the DPC on which the frame is placed. The DPC/DPM detail requires careful attention to prevent the cavity being bridged and providing a ledge for mortar droppings.

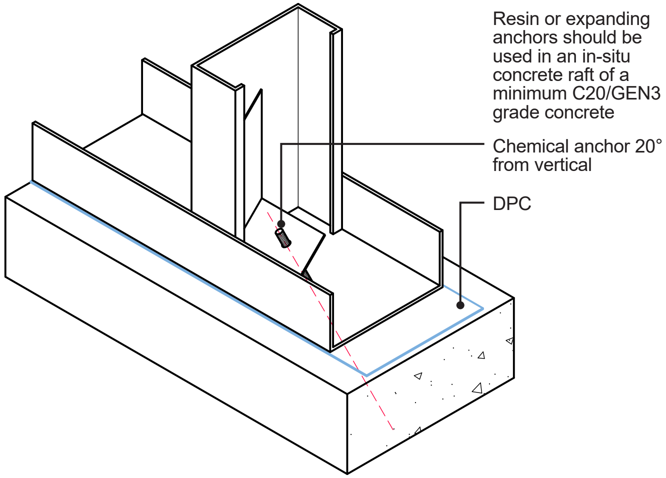
Holding down anchors may be galvanised, or preferably stainless steel straps that are fixed to the stud wall and attached to masonry supports or concrete foundation, or holding down bolts fixed to the concrete slab.

Example of holding down strap

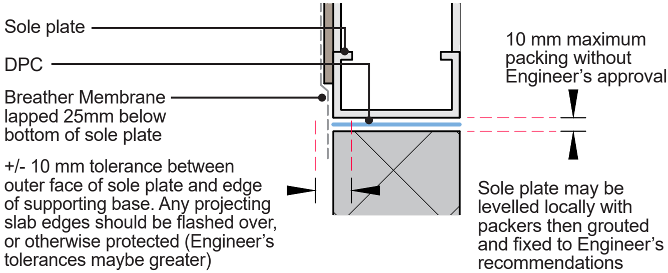


If stainless steel straps are used, they should be grade 1.4301 steel to BS EN 10088 and isolated from the studs with neoprene gaskets or similar. Non-stainless connections should be isolated from the straps with suitable grommet sand washers

Example of frame anchors



Locating sole plates



Location of frame above ground level

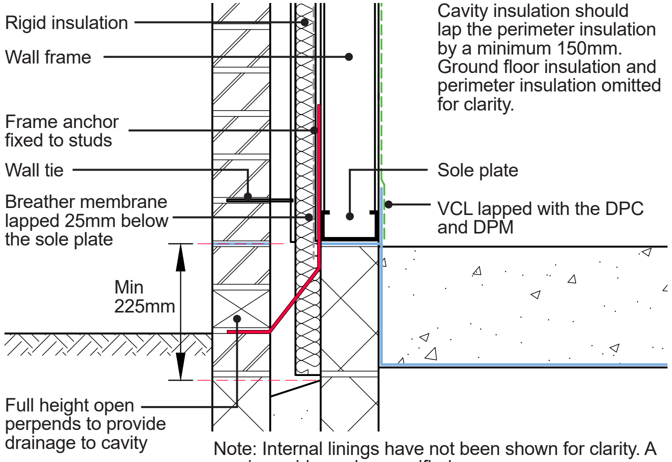
The metal frame should be located entirely above DPC level and a minimum 150mm above external ground level. The use of a masonry foundation kerb upstand may be an appropriate method to achieve this.

Where light steel frame ring beams or floor joists are used in ground floors these should be a minimum of 150mm above ground level and be galvanised to a minimum 450g/m² zinc coating (Z). Alternately where 150mm between ground level (or waterproofing layer of a flat roof, balcony or terrace) and the lowest steel or base rail cannot be achieved, e.g. at localised areas for level access the steel should be galvanised to a minimum 600g/m² zinc coating (Z).

Where level access ramps are required these should only be limited to the entrance door area only (not the entire perimeter). Provision for a slotted drainage channel should be constructed with a gradient away from the door (see the 'External Windows and Doors' section for level threshold guidance).

It is recommended that the inner leaf DPC is turned up approximately 30mm above the screed to protect the bottom of the studs from construction moisture and spillage, and weep-holes are provided at 900mm centres to drain cavities at ground level.

Sole plate/foundation junctions



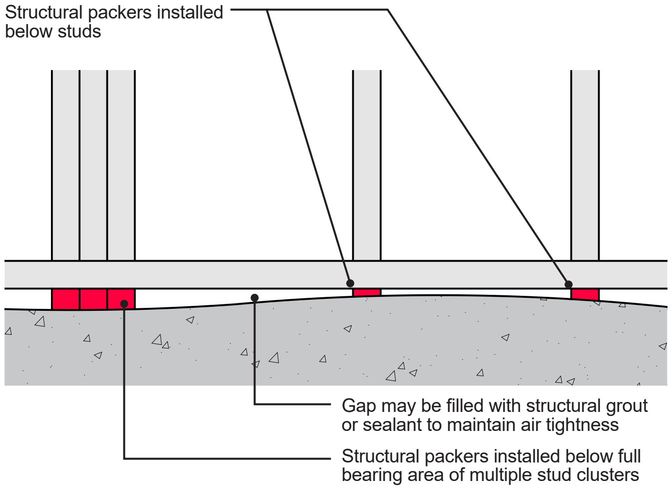
Note: Internal linings have not been shown for clarity. A service void may be specified.

Packing under the steel frame

Structural shims or grout may be required under the steel frames to level them and transfer vertical load. Longer frame to foundation fixing may be needed to allow for the size of the gap.

- Less than 10mm; pack under each steel with pre-galvanised steel shims.
- 10mm-20mm; pack under each steel with steel shims and grout over length of sole plate.
- Over 20mm; refer to the frame designer.

Packing of sole plates



Provision of cavities to all framed structures

Light gauge steel frame external wall panels must be provided with a cavity between the cladding and the structural frame. Where rainscreen cladding systems are specified in front of the LGSF, adequate drainage and ventilation should be provided at the head and base of the rainscreen cladding system. Where masonry cladding is specified in front of the LGSF, the cavity only needs to be drained. With suitable drainage weeps and cavity tray systems. The amount of ventilation required will also depend on the type of sheathing board used and this should be considered as early as possible in the design stage.

The frame should also be protected by a suitable third party approved breather membrane. Breather membranes should be of minimum Class W2 zero leakage in accordance with BS EN 13859, higher Class W1 will be requested when used in areas of high exposure to wind driven rain or where rain penetration of the cladding is expected.

Thermal insulation

Rigid or high density fibre thermal insulation material should be fixed to the outside face of the steel studs to create a 'warm frame' construction.

Insulation installed to the outside of the steel frame structure should have third-party certification for this application and retain a minimum of a clear 50mm cavity.

The outer layer of insulation should also be covered with a breather membrane adjacent to the cavity.

External walls should be subject to U-Value and condensation risk calculations. A wall build up will be considered satisfactory if there is no calculated risk of surface or interstitial condensation at any time of the year, and it fulfils the minimum National Requirement for thermal performance. Special consideration should be given to condensation risk where non breathable insulation products are installed on the outside of the steel frame structure. Joints between foil faced external insulation boards, must not be taped as this forms a vapour control layer on the cold side of the insulation.

Where the condensation risk has been assessed and shown to be negligible additional insulation may be placed between the studs. The additional insulation should be placed in contact with the studs to minimise air gaps and prevent local condensation.

All thermal insulation should hold suitable third party certification.

Breather membranes

A breather membrane should be provided to the 'cold side' of the steel frame. Breather membranes should be capable of allowing water vapour from within the frame to pass out into the cavity and protect the sheathing and frame from external moisture. A breather membrane must always be installed irrespective of the external sheathing board product. Breather membranes should:

- Have suitable third party certification.
- Have a vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens.
- Be a minimum Class W2 or better in accordance with BS EN 13859-2
- Be a minimum Class W1 in areas of very severe exposure, where liquid water penetration of the cladding is anticipated or where the membrane is likely to be left exposed during construction.
- Be capable of resisting water penetration.
- Be durable to resist site damage when wet.
- Be self-extinguishing.
- Be trimmed to leave 25mm lap below the lowest sole plate.
- Be repaired if damaged.

An independent breather membrane may be required to the 'cold side' of the insulation if the insulation is required to be protected.

Breather membranes should be lapped by a minimum of 100mm at horizontal joints, and a minimum of 150mm at vertical joints. Vertical joints should be staggered at regular intervals where possible. The breather membrane should be lapped to deflect moisture away from the structure (upper layers over lower layers).

Breather membranes should be at the following centres:

- Horizontal
  - Panel centres - 600mm max.
  - Horizontal membrane joint - 150mm.
  - Head and base of panels - 150mm.
- Vertical
  - 300mm centres vertically (may be increased to a maximum of 500mm when verified with third party certification).
  - Vertical membrane joint - 150mm.
  - Ends of panel - 150mm.
- Around openings - 150mm.

If breather membranes are trimmed flush with the edges of wall panels, additional strips of breather membrane, at least 300mm wide, should be supplied and site fixed over panel junctions.

Where the breather membrane is used to provide the temporary protection, the daylight exposure and durability aspects must be taken into account. Exposure to UV light can lead to premature failure of the membrane, the exposure period should therefore be kept to a minimum. Regardless of the artificial age testing, under certain conditions such as heavy rainfall followed by freeze thaw conditions, the membrane should not be exposed for more than a few days. If a membrane has to be left without a wall and/or roof covering for a period of time when adverse rainfall and weather is expected, a ventilated tarpaulin or similar protective sheeting may be used to protect the underlay until such time that the roof covering can be completed. The transport and storage of wall/roof panels should not rely on the breather membrane to provide weather protection.

Vapour control layers (VCL)

The VCL may take the form of:

- A vapour control plasterboard comprising a metallised polyester film bonded to the back face of the plasterboard.
- A minimum 125 micron thick (500 gauge) polythene sheet.
- A third-party approved proprietary vapour control membrane product.

Subject to a favourable condensation risk analysis, a novel or reverse wall construction may not require the use of a high moisture vapour-resistant vapour control membrane.

For Warranty purposes, the boundary conditions for a condensation risk analysis should be as follows:

- 60% relative humidity.
- External temperature -2°C.
- Internal temperature 21°C.

Installation of VCLs

A sheet membrane vapour control layer (VCL) should be:

- Lapped and sealed by at least 100mm at joints.
- Lapped over studs, rails or noggins.
- Sealed around service penetrations.
- Lapped and sealed fully into window and door reveals.
- Lapped and sealed with DPM/DPC at the junction with the ground floor/ foundation.
- Able to accommodate differential movements.

Small holes in the VCL should be sealed with a suitable self-adhesive tape. Larger holes should be re-covered with new laps located over adjacent studs and rails.

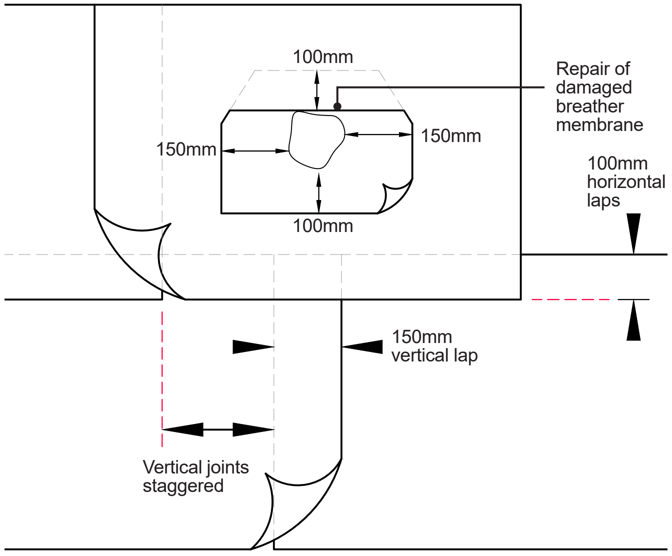
Plasterboard

Plasterboard should be to BS 1230 and not less than:

- 9.5mm for stud spacing up to 450mm, or,
- 12.5mm for stud spacing up to 600mm.

To provide fire resistance fire rated boards should be used and installed in accordance with the manufacturer's instructions.

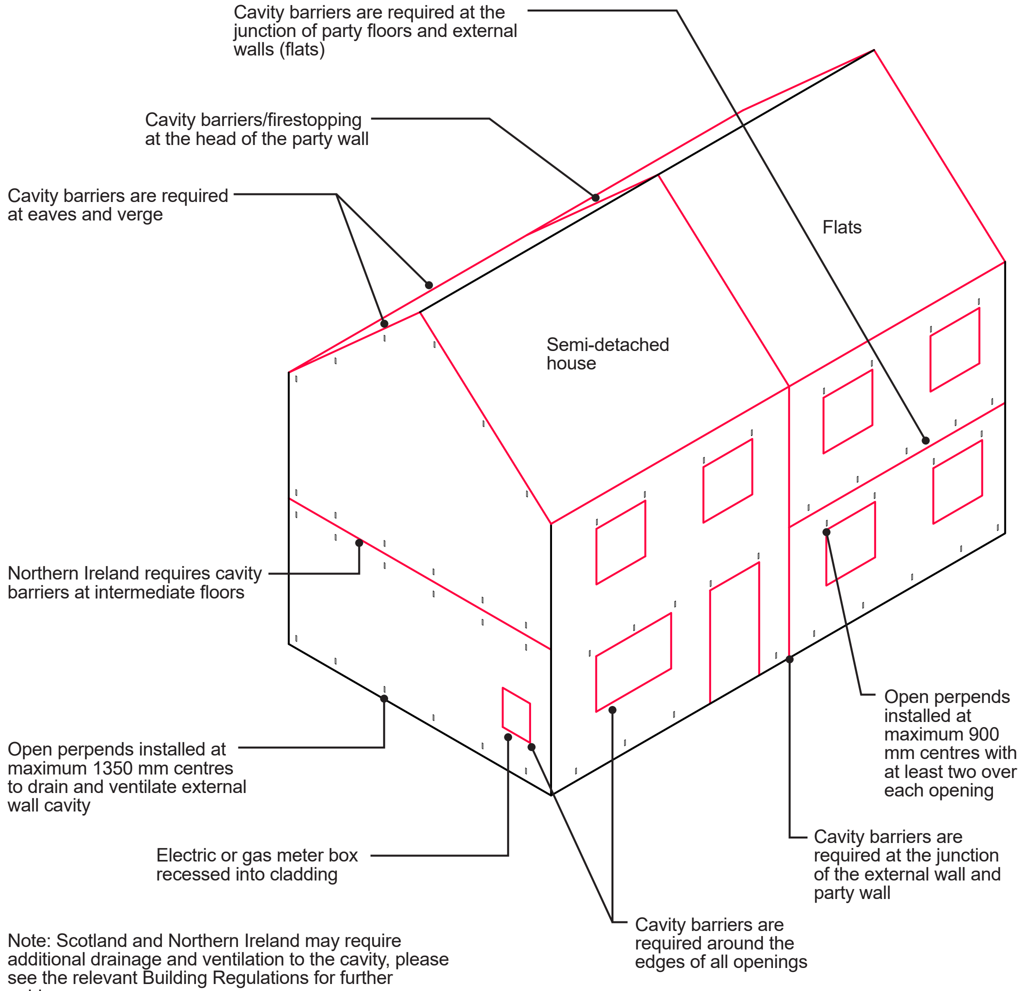
Lapping and repair of breather membrane



Locations of cavity barriers and open perpends within the external wall

Note: Lightweight cladding systems will require a cavity barrier along the bottom of the cavity.

Note: Cavity barriers may also be required between walls and floors within the building, consult relevant Building Regulations for further guidance.



Note: Scotland and Northern Ireland may require additional drainage and ventilation to the cavity, please see the relevant Building Regulations for further guidance.

Cavity barrier locations

In England and Wales, cavity barriers shall be installed:

- At the edges of all cavities including around openings, e.g. windows and doors (even if the opening is in close proximity to a compartment floor or intermediate floor level in Scotland and Northern Ireland).
- Between an external cavity wall and a compartment wall or compartment floor.
- Around meter boxes in external walls.
- Around service penetrations in external walls e.g. extract duct or boiler flue.
- To sub-divide extensive cavities; please refer to relevant Building Regulations for specific requirements.

Cavity barrier installation

Cavity barriers shall be installed:

- So they fully close the cavity.
- So the ends are tightly butted (or adequately lapped in accordance with the manufacturer's instructions) to form a continuous barrier.
- Backed by studs, rails or floor joist.
- In accordance with manufacturer or independent certifier's guidance.
- So they are mechanically fixed to rigid construction (for both vertical and horizontal positions).

A cavity tray should be provided directly above a horizontal cavity barrier and lapped at least 100mm behind the breather membrane (except at eaves and verges).

Cavity barriers are required to prevent the spread of smoke and flame within concealed spaces.

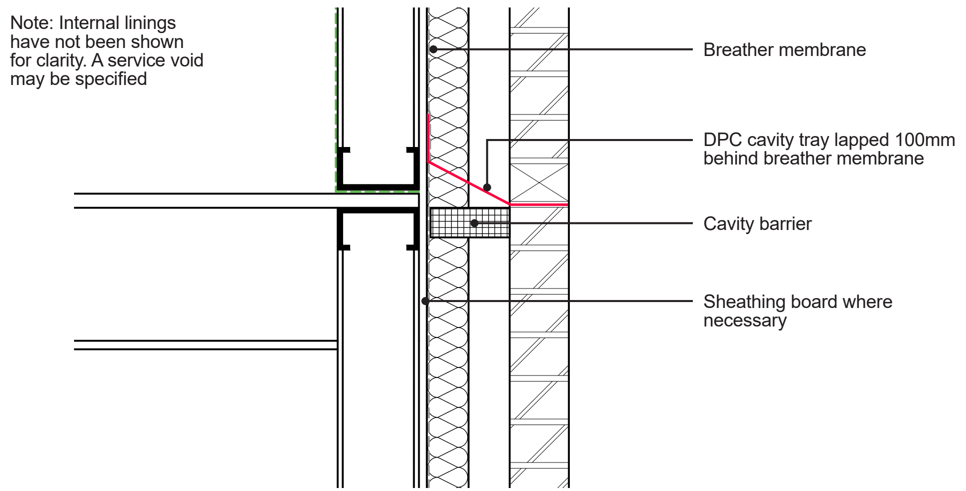
For lightweight claddings, a clear drained (and sometimes ventilated) cavity may need to be maintained so careful consideration will be required when specifying cavity barriers.

It is important that cavity barriers should extend through PIR insulation.

Cavity barriers may be constructed from:

- Steel at least 0.5mm thick.
- Timber at least 38mm thick.
- Proprietary 3rd party approved mineral wool product.
- Calcium silicate, cement-based or gypsum-based at least 12mm thick.
- An independently assessed and certified proprietary product such as an open state cavity barrier.

Cavity tray above horizontal cavity barrier - Steel frame



Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	**1.5m – 3.0m***	**3.0 – 4.5m****
Upvc –white	5	5	7.5
Upvc-non-white	7.5	7.5	11
Timber	5	5	5
Steel	4	5	6
Aluminium	5	5	7.5

Notes:

* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

Please refer to the ‘External Windows and Doors’ section for further guidance on window and door installations.

Please note, gaps under window and door openings will also need to be provided to cater for differential movement between the LGSF and the external brickwork.

Finishing trims

The use of proprietary surface fixed finishing trims e.g. D-moulds, should be undertaken only as part of a designed junction between window and door framing and the surrounding opening. For further guidance on the use of finishing trims please refer to the ‘External Windows and Doors’ section.

Please refer to the ‘External Windows and Doors’ section for further guidance on window and door installations.

The Building Control Body should be consulted for guidance on thermal compliance.

Openings

All openings including doors, windows, flues and ventilation ducts, should be designed and constructed to maintain:

Fire performance:

- Internal reveals require equal fire resistance to the rest of the structure.
- Window fixing straps should not compromise the integrity of any fire-resistant reveal linings.
- Cavity barriers should be installed in the external wall cavity around the perimeter of openings.
- If profiled steel lintels are used as cavity barriers, triangular gaps behind lintels, which occur at each end, should be closed with careful positioning of adjacent cavity barriers.
- Cavity barriers should be mechanically fixed back to the LGSF and to rigid construction (for both vertical and horizontal positions).

Acoustic performance:

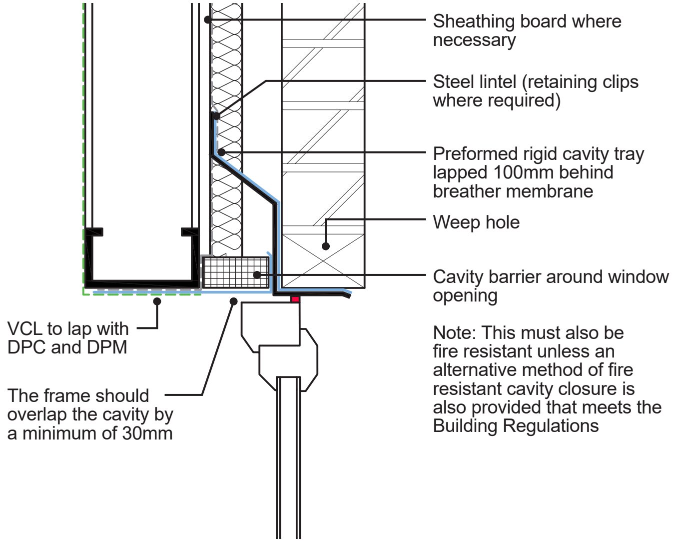
- Seal gaps between steel frame wall and the element being installed into the opening.
- The element being installed into the opening may have a minimum acoustic requirement.

Weather tightness and thermal performance, including thermal bridging and air tightness:

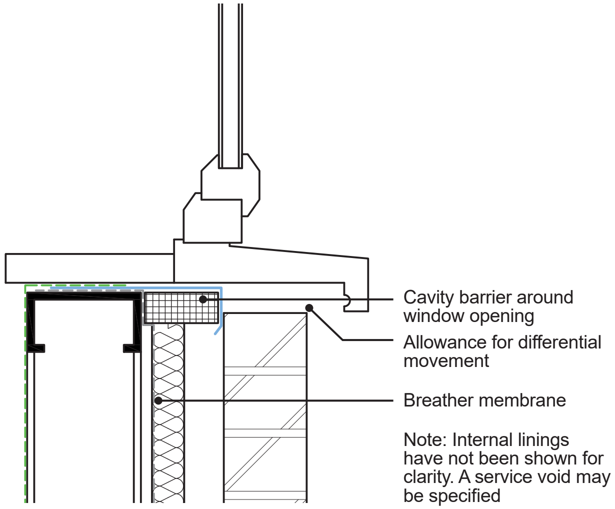
- The element being installed into the opening is likely to have a minimum thermal performance.
- All penetrations in the façade including windows, doors, ductwork etc. must be sealed to the structure and external sheathing board with EPDM or suitable alternative. The sealing membrane must have adequate test data suitable for the project specific wind load and proposed substrate compatibility. Evidence must be provided that the sealant meets the requirements of BS EN 13984.
- Seal gaps between the steel frame wall and the element being installed into the opening to provide thermal performance, weather tightness and air tightness.
- Cavity trays should be installed over the heads of all openings, lapped behind the breather membrane by a minimum of 100mm. A flashing may be acceptable for some types of claddings.
- Lap cavity barrier DPC with internal VCL around openings. Where no DPC is used, breather membrane should be lapped with internal VCL.

Further information on the installation of lintels can be found in the ‘External Walls - Traditional Masonry Cavity Wall’ section.

Typical vertical section through window head

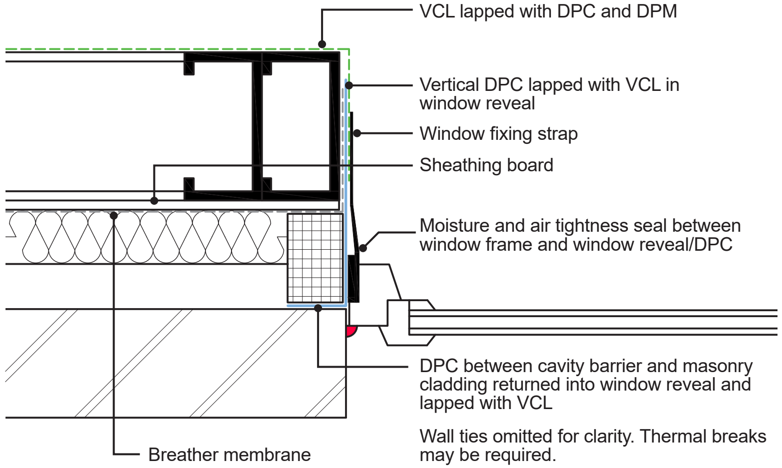


Typical vertical section through window sill



In this instance the steel frame has been shown with an external sheathing board

Typical window reveal detail (normal exposure)

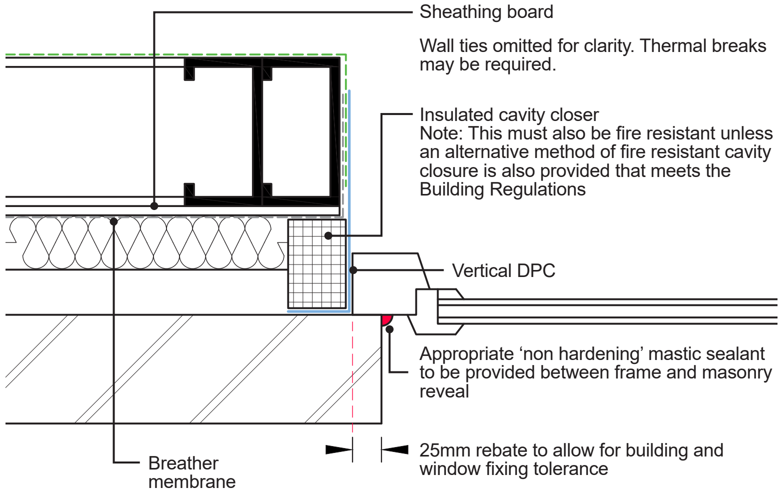


Checked rebates

Checked (rebated) reveals are required in Scotland, Northern Ireland and in any areas of very severe exposure in England and Wales. The frame should be set back behind the outer leaf and should overlap.

For further information on windows and doors please refer to the 'External Windows and Doors' section.

Typical rebated window reveal (very severe exposure)



All of the drawings shown in this sub-section are strictly in relation to our Warranty requirements. Please refer to the Building control Body to ensure the detailing achieves compliance with relevant Building Regulations in respect of thermal and fire requirements.

Cavity trays

Cavity trays, associated weep-holes and stop-ends prevent the build-up of water within a cavity wall and allow the water to escape through the outer leaf. They are used in conjunction with lintels above openings, to protect the top surface of cavity insulation at horizontal cavity barriers and where the cavity is bridged.

Preformed ridged self supported cavity trays are recommended for use in famed structures.

Cavity trays must:
- Comply with relevant Building Regulations.
- Have third party certification or be to a relevant BS or BS EN code appropriate for the intended use. Please note: Polyethylene DPC's should not be used as a cavity tray.
- Be provided at all interruptions likely to direct rain water across the cavity, such as rectangular ducts, lintels and recessed meter boxes.
- Be provided above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding.
- Be provided above lintels in walls in exposure zones 4 and 3, and in zones 2 and 1 where the lintel is not corrosion-resistant and not intended to function as its own cavity tray.
- Be provided continuously above lintels where openings are separated by short piers.
- Be provided above openings where the lintel supports a brick soldier course.
- Be proprietary preformed cavity tray systems at stepped and lower storey abutments and around corners in low rise cavity masonry walls.

Ring beams or floor slabs that partially bridge the cavity, e.g. podium decks or when dimensional accuracy cannot be guaranteed, should be protected by a continuous cavity tray.

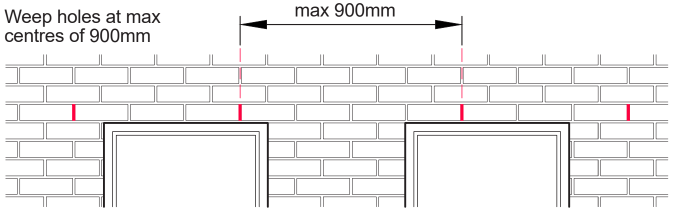
Weep-holes

- Weep-holes must be installed at no more than 900mm centres to drain water from cavity trays and from the concrete cavity infill at ground level.
- At least two weep-holes must be provided to drain cavity trays above openings.
- Weep-holes in exposure zones 3 and 4 should be designed to prevent ingress of wind-driven rain (including ground level).
- Weep holes will be required in all external cladding, including rendered claddings.

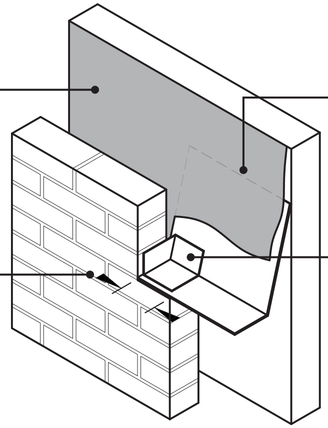
Other perforations of the building envelope

Proprietary elements, such as ventilators, soil pipes, etc. which perforate the building envelope should be installed and sealed to prevent ingress of moisture or vermin in accordance with the manufacturer's instructions. External meter boxes should be of a type approved by the Service Supply Authority and provided with a cavity tray and a vertical DPC between the back of the box and the wall.

Continuous cavity tray over two openings and a small pier



Stop end to cavity tray

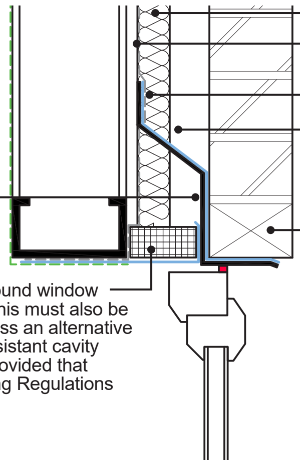


*Stop-ends need to be bonded to the cavity tray material or clipped to the lintel, so that a stop to the structural cavity of at least 75mm high is provided. Normally, the stop-end is located to coincide with the nearest perpend to the end of the cavity tray.

Stop-ends can be formed by sufficiently turning up the end of a DPC tray into the perpend joint. Surplus mortar should be removed from cavities and wall ties cleared of mortar droppings and debris as the work proceeds.

Cavity trays should rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.

Cavity tray and lintel

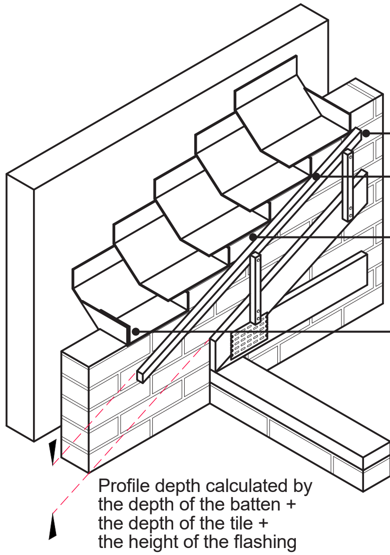


Note: Lintel must comply with relevant thermal requirements.

Installation of stepped cavity tray

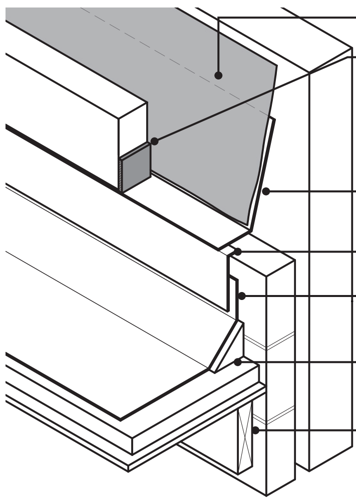
Stepped cavity trays are required at all pitched (stepped) roof abutments with external cavity walls, e.g. attached garages or staggered terraces.

A lead cover flashing should be linked into the cavity tray (lapped in below). Flashing details can be found in the 'Roofs' section.



Preformed rigid cavity trays should be used for stepped cavity tray details. Stepped cavity trays to lap behind breather membrane by at least 100mm. Additional measures may be needed to ensure the breather membrane adequately laps the tray to prevent moisture ingress behind the stepped cavity tray.

Flat roof abutment cavity tray construction



Wall ties

Wall ties should meet the following provisions:

- The wall ties should be tested to BS EN 845-1 and carry a CE marking. The wall tie manufacturer should provide a site specific fixing schedule, which details the centres of the fixings, the type of fixings and the spacing of the wall ties. The wall tie systems should be tested to BS EN 845-1 and carry a CE marking.
- Wall tie density depends on a number of site specific factors and should be considered by an Engineer.
- External skin of brick should be attached to the metal frame with either epoxy coated galvanized ties or austenitic stainless steel ties (to DD140, BS 12, BS 5268, BS 8200).
- Ties are normally fixed in vertical channels, these channels are then fixed through the sheathing board or insulation board to the light gauge steel frame with stand-off screws (screws should be isolated from the channels with neoprene or similar washers).
- The wall tie rails, ties, and fixings, should come as a ‘kit’ supplied by the manufacturer. Wall tie systems made up from off the shelf products will not be acceptable for Warranty.
- The wall tie system ‘channels’ should be fixed to ensure the fixings go into the centre line of the steel frame studs.
- If insulation is to be placed on the cavity face of the steel frame it should be rigid insulation and be compatible with the manufactures requirements of the wall tie rail system. Rigid insulation should not be taped.
- The wall tie length should be long enough to achieve the minimum overlap of the external masonry skin as specified by the manufacturer. This should not be less than 50mm.
- For steel frame external masonry walls, a 50mm minimum residual cavity is to be provided.
- Ties should be spaced at jambs of openings, a maximum of 300mm vertically within 225mm of the masonry reveal. Additional studs may be needed to achieve this.
- Ties should be inclined away from the frame.
- Ties should be fixed to the studs, not the sheathing.
- Ties should accommodate differential movement between the frame and the cladding.
- Top row of ties should be 225mm below top of brickwork (at eaves and verge levels).

Cavities

A masonry cladding to a steel frame must have a separating cavity that meets the following provisions:

- The cavity should have a minimum width of 50mm.
- It is to be kept clear from mortar ‘snots’ to ensure cavity is not bridged.
- An approved wall tie system to tie the masonry leaf to the steel frame must be provided.

Brick suitability

- Facing bricks must have a suitable level of durability and particular attention should be paid to the bricks resistance to frost and moisture.
- Bricks should be capable of supporting proposed loads.
- Bricks should comply with BS EN 771 and PD6697.
- Frost resistant bricks should be used in areas of prolonged frost.

Masonry cladding

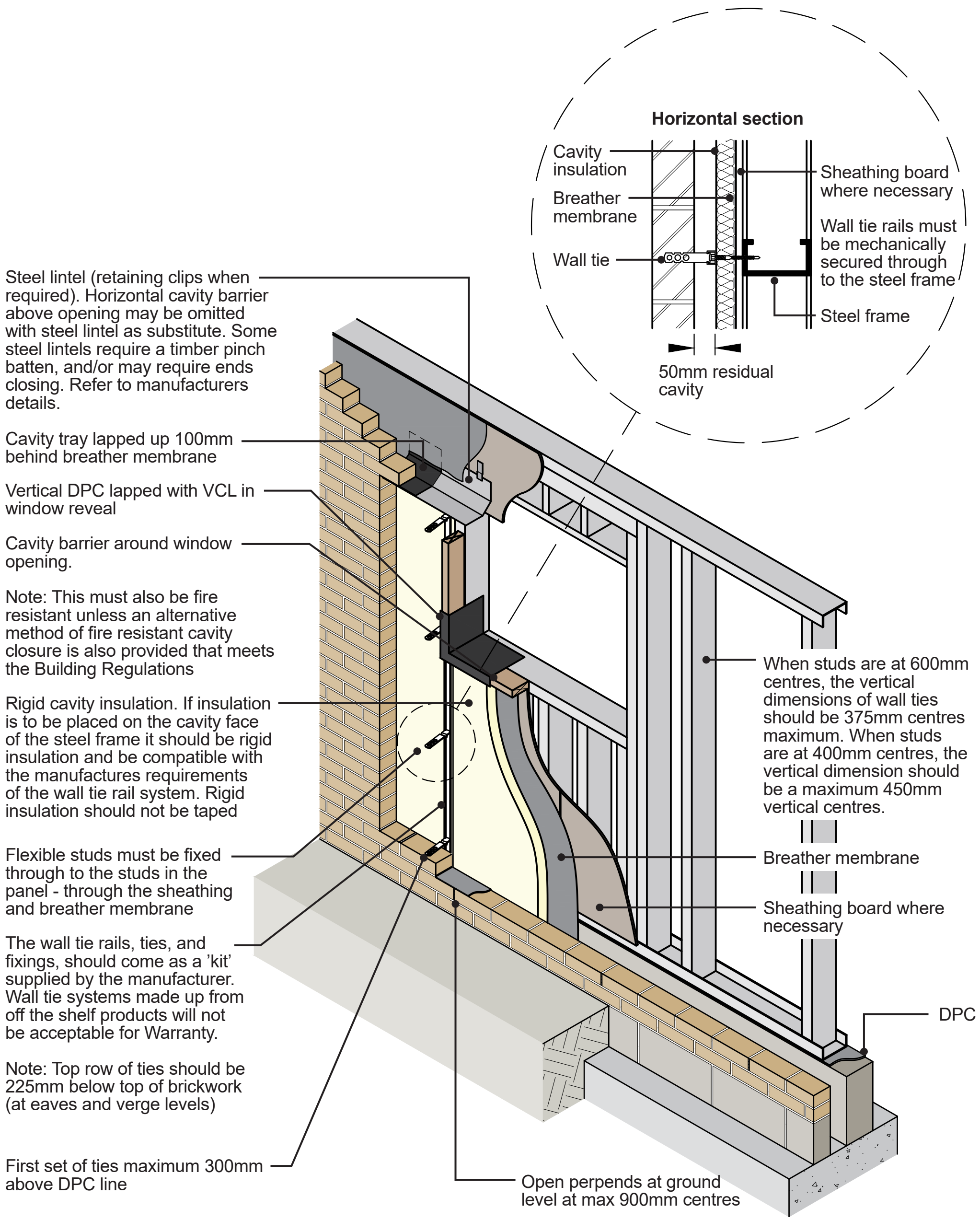
- Cavity trays must be provided above all cavity barriers, windows and door openings, etc.
- Cavity trays should extend 150mm either side of the door or window openings and have stopped-ends.
- A continuous cavity tray should be provided where intermediate floors meet the external wall.
- Soft joints should be provided to allow for differential movement. A gap of 1mm per metre of masonry should be provided at openings and soffits.
- All brick support angles should be installed by the manufacturer or specialist contractor.

For further information on masonry claddings and installation of stone heads within masonry cladding reference should be made to the ‘External Walls - Traditional Masonry Cavity Wall’ section of the Technical Manual.

Movement joints

Movement joints should be provided in external masonry cladding in accordance with the ‘External Walls - Traditional Masonry Cavity Wall’ section of the Technical Manual. Additional timber studs may need to be installed within the timber frame to enable the correct installation of wall ties adjacent to movement joints

Wall panel with brick cladding



6. External Walls

6.4 Render

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

Pre-bagged render
1. A full set of construction drawings detailing the areas to be rendered, location of movement joints and DPC's and subsequent construction details. Drawings must show presence of weep holes to all elevations.
2. Manufacturer's technical information relating to the application and suitability of render to be used on proposed substrates. This should include details on render thickness in accordance with the exposure zone. The specification should also identify the measures proposed to control movement within the back ground substrate and clearly identify the provision of movement joints and any additional reinforcements.
3. Copies of the manufacturer CE/UKCA Marking and declaration of performance relating to the proposed render.
4. Details and classification of render boards where they are proposed (including third party product conformity certificates).
5. Specifications, method statements, etc. relating to the application of renders around services, openings, movement-joints, etc.
6. Ancillary items forming part of the render system (e.g. render beads, stop-ends, etc.).

Site made render*
1. A specification 'Manual' of the proposed design, preparation and application of the render for the proposed project in accordance with BS EN 13914 – 1. The manual should also provide a specification of the render in accordance with BS EN 13914 – 1. This should include details on render thickness in accordance with the exposure zone. The specification should also identify the measures proposed to control movement within the back ground substrate and clearly identify the provision of movement joints and any additional reinforcements.
2. A quality assurance document detailing how quality assurance will be maintained on site in regards to material storage, mixing and application.
3. A full set of construction drawings detailing the areas to be rendered, location of movement joints and DPC's and subsequent construction details. Drawings must show presence of weep holes to all elevations.

*Site made renders are only acceptable on well-prepared **masonry substrates** where strict control over workmanship can be demonstrated and the correct selection of materials can be assured.

Site made render solutions will **not be acceptable** on projects where the render is to be applied on the following substrates:

- Render board.
- Render carriers.
- Hollow clay brick /block units.
- Insulated concrete formwork (ICF).
- Backs of parapets.
- Chimneys.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

This section provides guidance on meeting the functional requirements of the 'External Walls' section of the Technical Manual. It provides guidance on site-made renders and factory made renders.

This rendering section should be read in conjunction with the 'External Walls – Traditional Masonry Cavity Wall', the 'External Walls – Timber Frame' and the 'External Walls – Light Gauge Steel Frame' sections. The guidance in this Section covers the suitability of the render system only and additional guidance may need to be followed in regards to the structure.

The majority of render failures can generally be attributed to poor workmanship, inadequate preparation of substrates, poor detailing or inadequately trained personnel applying the render or failing to follow the correct render specification.

Rendering 'specification' and 'application' should be in accordance with BS EN 998-1 and BS EN 13914-1:2005 respectively and workmanship in accordance with BS 8000. Gypsum based renders are not covered by BS EN 13914 (See Section 1 Scope) and should not be used unless the product holds a third party product approval for the intended use and confirms adequate durability will be achieved.

For Warranty purposes render is generally not considered completely 'waterproof' and therefore water seepage can be expected through the render to the substrate / cavity i.e. The render is only considered as contributing to towards the 'weather resistance' of an external wall and not considered as providing an impermeable cladding. Therefore, all substrates must be constructed to prevent moisture reaching the internal finishes.

Examples of this are:

- The rendering applied to the masonry outer leaf of a masonry cavity wall,
- The rendering applied to a suitable render board or carrier system with a drained cavity. In certain circumstances (e.g. for framed structures) this would also need to be vented to protect the framed structure.

Identification of the site exposure rating

The design and materials used, should be suitable for the site specific exposure location. For further information on determining the exposure for the site location please see 'Appendix C'.

Rendering onto masonry substrates

For Warranty purposes both site made and factory made renders maybe suitable for use on masonry substrates. Although this guidance is mainly focused on traditional masonry cavity wall construction, this would also be applicable to render applied to the external masonry cladding of a timber or steel frame.

For masonry substrates the masonry should be adequately prepared and be of a thickness which would resist damp ingress to the internal finishes based on the recommendations of PD 6697 or BS 5628 Part 3 2005 for the given exposure zone.

Where render is applied to masonry outer leafs to timber frame or light steel frame structures:

- A drained (and vented, if timber/ SIP framed) cavity will be required between the frame and outer leaf and,
- A breather membrane must be provided to protect the main structural frame as a second line of defence.
- A cavity tray will be required over all openings and obstructions in the external wall with weeps and stop ends provided.

Please note: For Warranty purposes weep-holes and a suitable cavity tray should be provided on all rendered masonry cavity walls.

Pre bagged and blended render on masonry substrates

Pre bagged factory made renders are the preferred solution as this ensures consistent mix of render components during installation. However it is still important to ensure correct specification, detailing and application. Pre bagged and blended render must be BS EN 13914-1 for the design and application and be CE/UKCA marked in accordance with EN 998-1 or EN 15824 for specification of the render. Evidence of the CE/UKCA marking and declaration of performance should be provided upon request.

Suitability of the background

The specification should also identify the suitability of the background to support the rendering. The background should provide adequate support for the render and uniform key/suction for adhesion of the rendering.

For the purpose of Warranty:

- Render on an external leaf of clay bricks (F2, S1 or F1, S1 designation bricks BS EN 771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation.
- Direct rendering is not acceptable on high absorption materials e.g. lightweight blockwork, autoclaved aerated concrete blocks, common brick and/or smooth dense substrates e.g. engineering bricks as the moisture can be extracted by the substrate from the wet render which affects its curing and bonding capability.

For both factory made and site made renders the walls which are to be rendered should be examined for excessive moisture content prior to rendering. This is particularly important where the masonry background has no upper limit on its soluble salts content, e.g. N designation clay bricks.

To minimise the potential for differential thermal movement and effects that the different suction that each type of background material may create; the section of walling to receive the render should be constructed using the same type and density of material throughout.

When rendering is required to be applied to wet masonry substrates, a specialist sealer key coat prior to applying the main coat of render should be applied, to control suction and reduce the impact of lime blooming occurring through the render. The key coat should provide a sound substrate and be compatible with the subsequent render system.

To control suction, always apply a specialist sealer key coat or suitable render preparatory coat. Allow a minimum of 48 hours for the key coat to fully dry before applying the next coat.

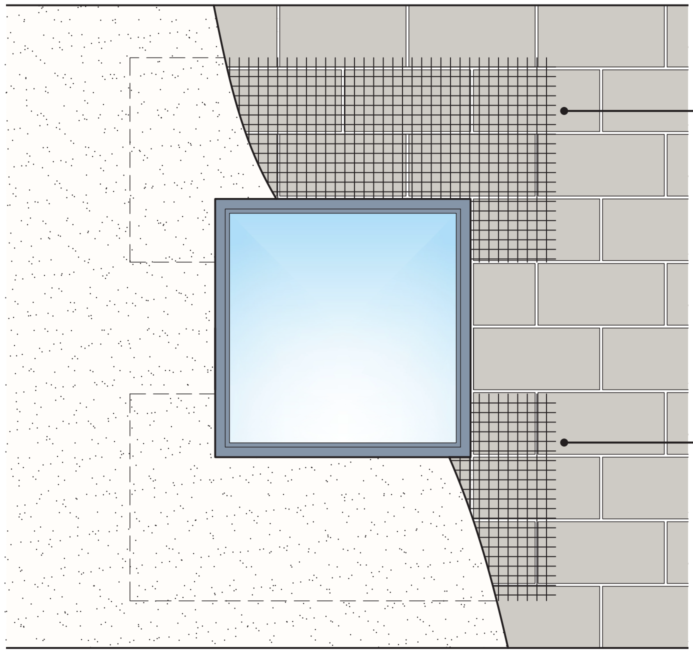
Movement control within the background

The specification should identify the measures proposed to control movement within the back ground substrate and clearly identify the provision of movement joints and any additional reinforcements. Any movement joints within the background should be carried through to the face of the render.

Note: Where recommend by the blockwork manufacturer, cracking of the substrate could be significantly reduced by introducing a specialist proprietary bed joint reinforcement within the mortar joints. This should be provided in accordance with the Engineer's specification.

Ensure that the reinforcement is continuous and joints lapped in accordance with the manufacturer's requirements (generally 450 - 500mm laps and continued around corners). Specialist corner units are likely to be required, check with the manufacturer.

Introducing reinforcement at weak points such as above and below window and doors openings will greatly assist in minimising cracking to these areas. Where possible, the reinforcement should project 600mm beyond the opening.



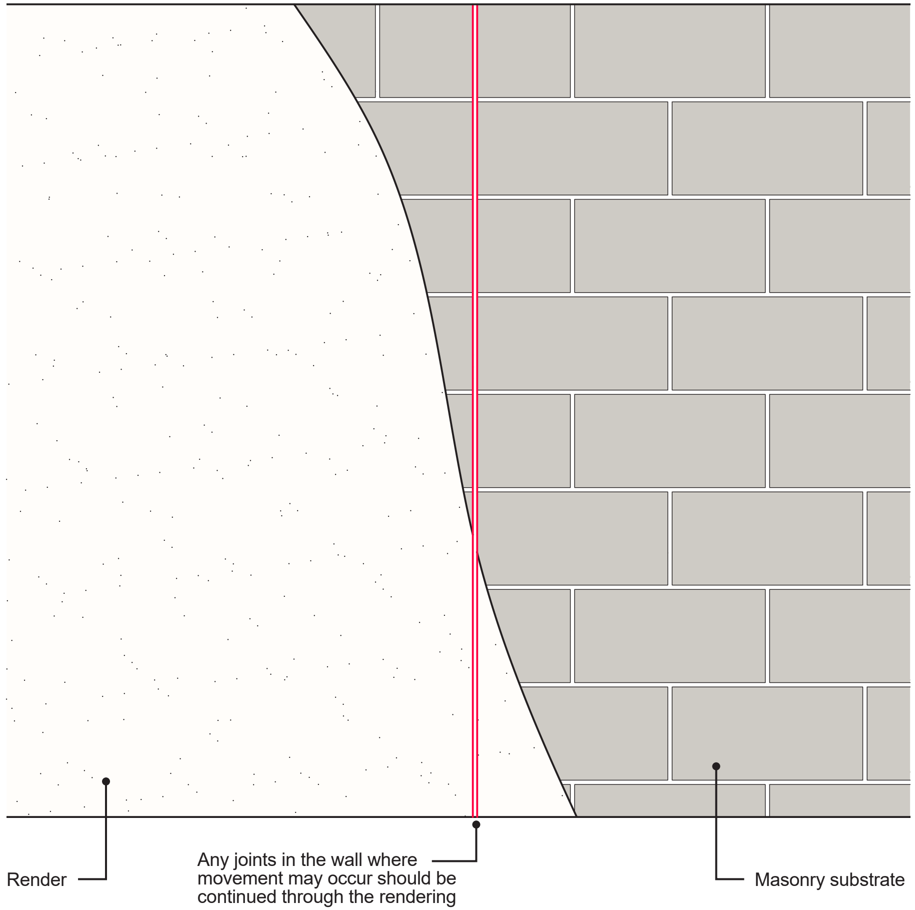
Renders will be reinforced as a minimum with an appropriate certified alkaline resistant fibreglass mesh at the corners of all openings and penetrations.

For substrates that are prone to movement, an appropriate certified alkaline resistant fibreglass mesh will need to be incorporated throughout the substrate.

Reinforcement mesh bedded in the primary render coat. The mesh should be installed as per the manufacturers specification typically extending 200mm beyond the reveals and 500mm above and below the windows, extending 200mm above the sill and below the head.

Where different materials are being rendered over, the incorporation of an appropriate certified alkaline resistant fibreglass mesh will be necessary to assist with the possibilities of differential movement. The mesh must extend sufficiently over the different materials to resist against differential movement.

For any given wall elevation where there is a mix of masonry e.g. brickwork external leaf lower level with a rendered block upper level, the requirement of a full height movement joint should be based on the shorter spacing requirement e.g. for the blockwork at 6m not brickwork at 12m.



Weather conditions

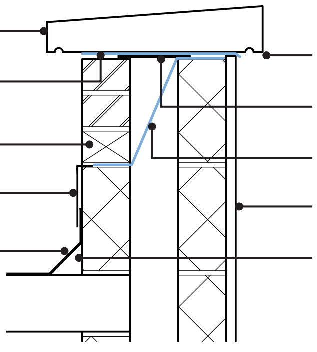
- For exposure zones where the wind driven rain is expected to be more than 75 litres per m² (classed as very severe) then checked reveals will be required. The render applied to the reveal must be of the same thickness as the wall render with an appropriate corner beading provided. A suitable non hardening' mastic sealant must also be provided between window / door frame and masonry reveal.
- Protection must be provided when applying renders in rain or other inclement weather.
- Application should cease in temperature below 5°C or where rapid freezing is considered to be a potential threat.
- When applying in hot weather it is advisable that work coincides with the shaded areas of the building. During longer periods of hot and dry weather, it may be appropriate and necessary to apply an even mist spray of clean water to the substrate before application, and to surface finish for a couple of days afterwards subject to site and weather conditions.
- Cement products should not be applied to substrates which are frost laden or which have recently been subject to prolonged rain.
- Do not render onto saturated substrates as this may affect the bond strength and cause lime bloom (discolouration), salts to occur and patchiness due to uneven suction.
- Local weather and site conditions must be taken into account by the applicator before any cement product is applied.
- Care must be taken to protect cement and synthetic products soon after the application from rapid freezing and heavy rainfall. For other drying conditions i.e. where there is direct exposure to sunlight or drying winds, the render may require to be protected from the elements. This process is important to ensure complete hydration of the products can take place.
- Where an application is not covered in these conditions further advice from the render manufacturer must be sought and submit a suitable manufacturer's specification to the Warranty provider for approval.

Design and application

- The design should identify the areas of the build which may interact with the render e.g. eaves, verge, parapets, cills etc. to ensure the durability of the render system. For example: particular attention should be given to the correct detailing of architectural features which can afford a high degree of protection.
- Notwithstanding wind loadings, the larger the eaves overhang the better. This will provide protection to the top joint and prevent rain water percolating behind the render.
- When ashlar detailing is required, it is recommended that a minimum depth to the back of the ashlar cut should be no less than 15mm and 20 - 25mm for applications in very severe exposure zones or within coastal locations. To achieve this depth, it will require the finished thickness of the main render to be increased to accommodate this feature.
- The specification should identify any abutments between the render and other cladding materials or components. Any joints should be weather tight and allow for differential movement. These details should be provided to the Warranty Surveyor before rendering commences.
- Renders used below DPC, on the backs of parapets, or chimneys must only be considered if the Render Manufacturer provides a site-specific specification for this.
- Renders installed between pedestrian level and 6.0m above ground level will be designed to accommodate higher maintenance and impact loads in accordance with Table 2 of BS 8200.
- All surfaces must be clean, suitably dry and free from anything that may interfere with the adhesion of the material to be applied. The manufacturer's product data sheets should be followed including the manufacturer's surface preparation and suitability checks in full.
- All blockwork mortar joints are to be flush pointed and should be fully cured before the application of the render.
- The quantity of material required for a given area should be of the same batch number or if not the different batches must be thoroughly mixed together to avoid shade variations.
- Full masking must be used to give protection to adjacent areas of work, windows, doors etc. and to give clean straight edges. It should be removed immediately after the finishing coat has dried.
- Carefully remove splashes of material, in particular from glass or aluminium immediately as they may etch the surface and leave a permanent mark.
- Ensure the render being used is suitable for the substrate and is not too strong. Due to shrinkage differentials, avoid applying a thin base coat and a thicker top coat application, as the shrinkage values of a thicker top coat could cause the render to delaminate from the base coat. The same effect is also caused by applying a very hard render over a softer base coat.
- Rendering products should be stored separately from other building and concreting sands.
- For bellcasts, other beads, and stops; uPVC bead or stainless steel bead is acceptable. Angles, stop beads and jointing sections should be secured with drilled or shot-fired fixings, and not with gypsum plaster. In coastal locations UPVC or marine grade stainless steel must be specified. (See 'Appendix B – Coastal Locations: Additional requirements for developments within coastal locations' for further guidance).
- Only clean water should be used for mixing.

Vertical and horizontal flatness
Rendering should have a maximum vertical and horizontal deviation from flatness of +/-4mm in 5m, and is measured in a similar way to straightness on plan and plumb of masonry. See the 'Tolerances' section for further information.

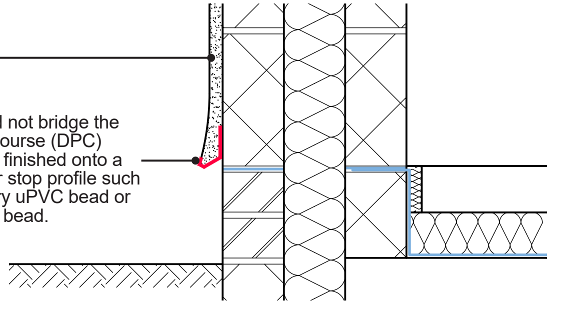
Parapet wall detail



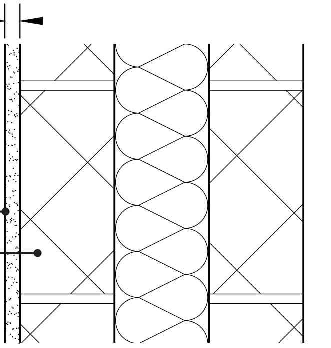
Render and DPC levels

Render should not bridge the DPC, however, where this is unavoidable, the following precautions should be taken:

- Render specified below DPC must only be considered if the Render Manufacturer provides a site-specific specification or where site made render is used, a strong mix (M4) that is sulfate resisting should be used.
- Renders / boards to be used within 150mm of the adjacent ground level, to have third party approval for use in this location.
- There should be appropriate drainage installed along the perimeter or the ground should fall away from the building.
- Adjacent ground surfaces should not promote splashing.

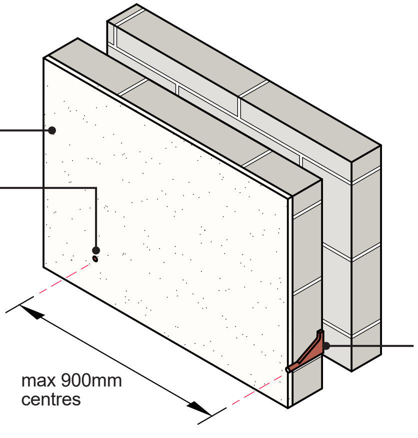


Minimum thickness of render on masonry substrates



16mm is considered the minimum finished thickness of render applied to a masonry wall, either as a single spray coat or as a two coat hand application. Where structures are located in very severe weather rating locations or within coastal locations, the depth of render may need to be increased to a minimum of 20mm and a specialist manufacturer's specification will be required to support this.

Weep holes and render



Weep holes should always be provided to rendered masonry walls in the following circumstances:

- Where cavity trays are specified. Weep holes should be provided at no more than 900mm centres.
- From the concrete cavity infill at ground level.
- For timber framed buildings to provide drainage and ventilation (open perpends should be used).

For further guidance on weep holes, please refer to the 'External Walls – Traditional Masonry Cavity Wall' and 'External Walls – Timber Frame' sections.

Site made render on masonry substrates

Site made renders are only acceptable on well-prepared **masonry substrates** where strict control over workmanship can be demonstrated and the correct selection of materials can be assured.

Site made render solutions will **not be acceptable** on projects where the render is to be applied on the following substrates:

- Render board.
- Render carriers.
- Hollow clay brick /block units.
- Insulated concrete formwork (ICF).
- Backs of parapets.
- Chimneys.

Information to be provided

Where site made renders are proposed, the following information should be provided to the Warranty Surveyor before work begins on site:

- A specification 'Manual' of the proposed design, preparation and application of the render for the proposed project in accordance with BS EN 13914 - 1.
- A specification of the render in accordance with BS EN 13914 – 1 should be provided in the Manual.
- A quality assurance document detailing how quality assurance will be maintained on site in regards to material storage, mixing and application.
- A full set of construction drawings detailing the areas to be rendered, movement control and subsequent construction details.

Design and specification of site made renders

Site made renders are only suitable on masonry substrates. The masonry substrate should be a thickness which should resist damp ingress to the internal finishes based on the recommendations of PD 6697 or BS 5628 item 3 2005.

The exposure zone of the site and proposed build up should be included in the specification. BS 8014 can be used to help identify the exposure zone more accurately. For further information on determining the exposure for the site location please see 'Appendix C - Materials, Products, and Building Systems - Determining the sites exposure to wind driven rain'.

The design and application of the render should be in accordance with BS EN 13914– 1.

The specific render mix should be:

- Appropriate for the intended purpose.
- Be compatible with the background.
- Designed to minimise the risk of de-bonding, cracking and crazing.
- Note: Ensure the render being used is suitable for the substrate and is not too strong. Avoid applying a thin base coat and a thicker top coat application, as this could cause the render to delaminate from the base coat.

Thickness of site made renders

The render coat thickness should be identified within the specification and should be suitable for the exposure zone of the site. Increased thicknesses maybe required in higher exposure zones. This is generally a minimum depth of 16mm for sheltered and moderate exposure zones, or 20mm for severe and very severe exposure zones.

Quality Assurance of site made renders

Poor mixing ratios and low quality materials is often the reason traditional renders fail. Quality control procedures should be in place on site to ensure that materials are stored correctly and the mixing ratio as specified is consistent. A copy of the quality assurance processes together with the Render specification and application Manual should be provided to the Warranty surveyor.

The on-site quality control of site made renders is an important aspect to prevent premature failure of the render system. This section identifies areas that should be included within the quality assurance (QA) process document should be made available to the Warranty surveyor upon request.

The QA process should identify the following:

- The suitable storage of the materials on site;
- Cement should be stored in a dry location and should be in date at the time of use.
- Sand should be stored on boards to prevent contamination from the ground.
- Sand should be adequately protected from external elements – wet sand should not be used.
- Sand should be separated from other aggregates on site to prevent contamination.

The control of the mixing process on site:

- Only potable water should be used for mixing render.
- Identification of a suitable water source on site, where possible water should be drawn directly from the source on site. Storage of the water should be avoided as this increases the risk of contamination.
- Mix ratio should be controlled by volume or weight – Relying on shovels of sand and cement is not acceptable.
- Mechanical mixing only is acceptable, renders should not be hand mixed.
- Renders should be suitably mixed before use.
- Additives should not be used unless specified – additives should be appropriately measured in accordance with the specification and manufacturer's instructions.
- Only products specifically designed as mortar additives will be acceptable.

Render cladding onto timber/steel framed structures

With Timber and Steel frame constructions a drained (and vented cavity for timber frame) should be provided behind the render system on timber/ steel frame construction and a breather membrane must be provided to protect the main structural frame as a second line of defence.

The minimum size of the cavity should be 25mm for both the render board or backed metal lathing applications.

A vertical DPC should be inserted between the metal render carrier and any vertical rail / batten support.

Suitability of render systems

The ‘render system’, including the render and render board, should hold suitable current third party certification. For the purpose of this Technical Manual only pre bagged and blended render will be acceptable.

The third party product approval should clearly detail the limitations of the render system and the suitability of the render system for use in the site specific wind driven rain exposure zone. The Third party product approval certificate for the board must demonstrate the render system will achieve a 15 year minimum life expectancy.

A site specific specification should be provided from the render manufacturer and the render system should only be installed by the render manufacturers trained operatives. Evidence of this should be provided to the Warranty Surveyor upon request.

Fixing of render boards

Render boards should be fixed in accordance with the manufacturers recommendations and the site specific location, consideration should be given to:

- Anticipated wind load
- Pull-out strength
- Pull through resistance
- Anticipated movement

When using external render board you should:

- Fix with the manufacturer’s recommended non-corrosive fixings and all in accordance with the manufacturer’s installation details, ensuring the vertical board joints are staggered and do not follow directly in line with window, door reveals and other openings.
- Gaps between boards should be provided in accordance with the manufacturers recommendations however, care should be taken to ensure there are no excessive gaps between the boards and appropriate weather seals are incorporated against walls and frames.
- Ensure the boards are cut neat and square and the screw heads are recessed just below the surface.
- Take particular note of movement joint requirements and specific application details. Movement joints should be formed in accordance with the manufacturers specification.
- Fixing battens and rails should be installed vertically and not block drainage paths. Battens should be either 25mm x 38mm or 50mm x 50mm, preservative treated (BS 8417 or equivalent, hazard class 2). Fixings and preservatives should be compatible.
- Battens on Timber frame structures should be fixed to each stud with annular ring nails of length at least twice the batten thickness plus the sheathing thickness. Nails should be hot dipped galvanised stainless steel or equally durable.

Movement joints

Where renders spans across an intermediate floor zone in timber frame construction, allow for differential movement due to timber shrinkage by incorporating a movement joint.

Vertical movement joints should be provided at the required intervals. The actual spacing and position of the joints will be determined by the shape of the area to be rendered and generally vertical movement joints should be provided at maximum 5m centres.

Metal render carrier systems

- The carrier system must be Stainless steel in accordance with EN 10088-1 (Austenitic steel) or Zinc coated steel in accordance with EN ISO 16120-2 and EN 10346.
- Where sited in a coastal location a higher grade A4 stainless steel should be used. (Please see ‘Appendix B’ of this Technical Manual).
- For metal lathing, these should be a proprietary BBA, BRE etc. or ETA certified non-corrosive mesh system and must be fully installed in accordance with the mesh system manufacturer to vertical battens at the stud centres.

Movement joints in metal lathing

Large uninterrupted areas of cementitious based rendering on metal lathing should be divided by movement joints into panels at intervals of approximately 5m. The actual spacing and position of the joints will be determined by the shape of the area to be rendered. The panels should have a maximum aspect ratio of 3:1 and maximum intervals of approximately:

- For timber backgrounds, 5m horizontally and every storey height;
- For all other backgrounds, 5m horizontally and vertically.

Cavity barriers

Cavity barriers in external wall voids should be provided in accordance with the relevant Building Regulations. Where cavity barriers are required, they should be correctly fitted without gaps, the cavity filled and fixed with stainless steel staples or equally durable fixings, the settlement joints below the external frames and soffits must be maintained. Cavity barriers should be mechanically fixed to rigid construction (for both vertical and horizontal positions).

Direct rendering onto Insulated Concrete Formwork structures (ICF)

For Warranty purposes a render directly applied to an ICF structure to provide a weather resistant cladding will not be acceptable and alternative solutions must be made.

Typical alternative solutions are:

- A render on a carrier system with a drained cavity behind and a breather membrane provided to provide a second level of defence to the ICF structure, where this solution is required the guidance for render boards should be followed or,
- An Impervious cladding system provided (with appropriate cavity provision as required by the Impervious cladding system), or,
- An independent masonry external cladding with a 50mm minimum cavity is provided. Where this solution is required the guidance for rendering on masonry should be followed.

Direct rendering on external wall insulation systems (EWI)

General conditions
These are systems applied to the exterior walls of existing or new buildings, comprising of an insulant and a protective render finish. The Insulation type can vary from Expanded Polystyrene Insulation (EPS), Extruded Polystyrene Insulation (XPS), Phenolic insulation or mineral wool insulation.

A third party product approval is required for the ‘combined EWI and render system’ and must clarify which Substrate has been assessed for the EWI / EWCS System to be applied too. (I.e. for a masonry or framed substrate) and a full manufacturer’s specification suitable for the substrate must be provided.

Please note: ETA documents do not state the maximum exposure zone the system is tested for. The ETA documents usually only say the system (including the render) improves the thermal performance of the wall and contributes towards weather resistance.

Appropriate beads should be provided in accordance with the combined EWI and render system at openings, corners, angles and interfaces etc. Reinforcement mesh should be accommodated throughout the base coat application with additional reinforcement to vulnerable areas and corners of openings etc. If there are any concerns regarding straight line joints or other areas where there are unusual constructions requirements an additional layer of mesh should be installed to these locations.

Movement within the combined EWI and render system should be accommodated without any reduction in performance and should be constructed in accordance with the manufacturer’s details. Movement joints in the backing substrate should be mirrored through the combined EWI and render system and formed in accordance with the manufacturer’s recommendations.

All external metals must have suitable corrosion protection for the intended environment. Further guidance can be found in ‘Appendix C - Materials, Products, and Building Systems’. For further information please see Appendix B of our Technical Manual which provides further guidance on additional requirements for developments within coastal locations.

Allowance must also be made to ensure window cills adequately project beyond the finished surface of the render to ensure any throating is correctly positioned clear of the finish, and that opening lights / ventilators are correctly installed to allow correct opening without being restricted by the EWI system.

5-6mm is considered the minimum finished thickness of render for applications of specialist insulated render systems. The render thickness will need to be increased where structures are located in very severe weather rating locations, or within coastal locations and a specialist manufacturer’s specification will be required to support this; approved by the Warranty provider.

Render compatibility
Only the render system stated on the third party product approval certificate can be used, we cannot accept any other render system or site made render to be applied to the EWI system.

Key points during installation
The combined EWI and render system must be installed by an approved installer from the EWI manufacturer. Evidence of the installer being approved should be provided to the Warranty Surveyor before works start on site. When installing a combined EWI and render system, the following should be observed:

- The render (either the finish or the base coats) must not be applied onto saturated substrates as this may affect the bond strength and adhesion.
- Protection must be provided when applying the finish render in rain or other inclement weather; to avoid trapping moisture in the system.
- Render coats must not be applied in temperatures below 5°C.
- Vented cavities should not be blocked, nor should any ‘weep holes’.
- Depending on the manufacturer’s specifications, the insulation board may require to be keyed to receive the desired render base coat and reinforcement.

For further guidance on EWI systems, please refer to the ‘External Walls – Claddings’ section.

6. External Walls

6.5 Claddings

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full set of drawings including locations of curtain walling and cladding applications for each elevation and section details showing the external wall makeup.
2. Façade specification and/or full manufacturer's specification.
3. Manufacturer, Engineer or façade contractor must provide site specific wind load calculation for the façade of the building, structural calculations of the curtain wall or cladding system for the project and specified design loads (live and dead load).
4. Bracket and fixing specification for the cladding system including the fixing type, size, spacing and method of fixing to the substrate. Site specific structural calculations of the brackets and fixings for the project are to be provided for the curtain wall or cladding system. Details of corrosion protection and how bi-metallic corrosion is to be mitigated should also be provided.
5. Details of any technical assessment (third party product conformity certificates) and/or test data.
6. Details of proposed cavity barriers to be used including materials, period of fire resistance (in compliance with the project fire strategy), test data for the system including any test data of penetrations through a barrier (e.g. brick shelf support angle brackets), plans and elevations detailing the locations of the barriers in the façade and vertical and horizontal section details at all interfaces.
7. Details of proposed on site testing regimes.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Identification of the site exposure rating

The design and materials used, should be suitable for the site specific exposure location. For further information on determining the exposure for the site location please see 'Appendix C'.

Introduction

This section discusses a range of requirements for different cladding types. It provides information on the cladding only, and additional requirements may be applicable depending on site specific substrate. This section should be read in conjunction with the other sections within the 'External Walls' section.

Curtain Walling

Curtain walling systems should have third-party certification confirming satisfactory assessment and comply with the requirements of the CWCT Standard for Systemised Building Envelopes, including the following sections:

- Part 1: Scope, terminology, testing and classification.
- Part 2: Loadings, fixings and movement.
- Part 3: Air, water and wind resistance.
- Part 4: Operable components, additional elements and means of access.
- Part 5: Thermal, moisture and acoustic performance.
- Part 6: Fire performance.
- Part 7: Robustness, durability, tolerances and workmanship.
- Part 8: Testing.

The CWCT Standard provides detailed guidance on performance and testing which should be adhered to.

Dead and live loads should be transferred safely to the building structure without undue permanent deformation or deflection of any component.

Imposed loads should be calculated in accordance with BS EN 1991. Movement should be accommodated without any reduction in performance.

Fixings and supports should be designed to accommodate specified loads. This must consider the structure it is being fixed to and the product manufacturer's recommendations.

CE/UKCA marking is to be provided for all curtain walling covered by EN 13830 in buildings constructed after July 2013, and will therefore include the following curtain wall types:

- Stick construction.
- Unitised construction.
- Double skin walls.
- Structural sealant glazing.
- Bolted glazing.

The completed system should incorporate cavity barriers and firestops and resist the spread of fire in accordance with the relevant Building Regulations and project fire strategy requirements.

The completed curtain wall system should resist the passage of water to the inside of the building allowing free drainage, not trapping water and should have:

- External and internal air and water seals.
- Drained and ventilated glazing rebates.

Sealants should be specified in accordance with BS 6213 or BS EN 15651 and the performance determined by BS EN 11600 and the manufacturer's recommendations.

The system should be designed to minimise the risk of surface and interstitial condensation by the use of thermal breaks and a continuous vapour control layer. It should be designed to resist the passage of airborne and impact sound within the building with particular attention given to through wall, vertical and horizontal flanking transmission at:

- The edges of separating floors and the interface with the facade.
- The outer edges of separating walls and the interface with the facade.
- The outer edges of partition walls and the interface with the facade.
- The junctions with roof constructions and parapets and the interface with the facade.

Where curtain wall members run uninterrupted past floor slabs and partition walls, consideration must be given to structure-borne sound (impact sound) through the system as well as the chimney effect allowing hot smoke or fire bypassing the slab edge fire barrier in a fire situation. Any fire stopping product should be tested to BS EN 1364-4 for fire stop testing in curtain walls and CWCT TN 98.

The system should comply with BS 7671 requirements for electrical installations for electrical continuity and earth bonding, where it is required to form part of a lightning protection system it must be designed to comply with the requirements of BS 6651.

The risk of bimetallic corrosion should be checked and avoided by the isolation of dissimilar metals. Fixings and finishes to curtain walling must consider the location and corrosion category to ensure corrosion is avoided. Aluminium components must be robustly isolated from cementitious products to mitigate corrosion.

The curtain wall system should not include materials liable to infestation attack by micro-organisms, fungi, insects or vermin.

Packing of brackets to achieve surface tolerance is only permitted in accordance with the manufacturer's recommendations, and shall not exceed the maximum depth stated in the designer's calculations.

All packers for brackets supporting or restraining the curtain wall must be metal. All dead load packers to windows and doors must be suitable to transfer the load.

Testing

The curtain wall system will have either been:

- Tested and provided with a classification given in BS EN 13830, or,
- If the curtain walling is of a custom design, it should be tested to an appropriate standard of CWCT sequence A or B testing when tested at a test pressure of at least 600 pascals by an independent UKAS accredited test facility to ensure that the system meets or exceeds the weather performance classification for the building taking into account the design parameters and project location.

Note: At a test pressure of 600 pascals, an air infiltration rate no higher than 1.5m^3/hr/m^2 for fixed glazed panels is permissible.

Pull out testing
Pull-out or destructive testing of anchors should be carried out in accordance with BS 5080 and the Construction Fixings Association Guidance Note, Procedure for Site Testing Construction Fixings.

The number of fixings to be assessed must be agreed on a project by project basis, as an understanding of the scope and size of the project would determine the number of fixings tested. In addition, if there are varying types of fixings then each type should be tested. If the fixing is the same but the structure varies, then each type of structure should be tested.

BS 5080 requires 5 tests per type, however if a very large project is proposed, this could be increased to give more assurance of installation, e.g. every floor, one per side (e.g. North / East/ South/West). The scope and number of tests must be agreed with the Warranty Surveyor at the commencement of the project, to allow sufficient time for testing to be planned in advance and made available to the Warranty Surveyor when completed.

Site water testing
Site water testing of penetrations to critical joints should be carried out by a UKAS accredited testing company in accordance with CWCT test methods. This is required to check to site workmanship of the building envelope as constructed. Areas and method of testing is to be agreed prior to construction. See CWCT Technical Note 41 and 102 for guidance. Where testing fails, the cause and remedial action should be implemented and advised to the Warranty Surveyor and additional checks to be carried out to determine whether the failure is local or a system issue in accordance with CWCT TN 101. If it is a system issue, remedial work to the façade must be carried out prior to further testing is carried out, to demonstrate the remedial solution is effective.

Additional testing may be required for developments over 6 storeys. For further information, our Major Projects Team should be consulted.

Rainscreen cladding systems

A rainscreen cladding system consists of a multi-layer construction of materials which is designed to provide a barrier to the weather on new or existing buildings. The typical build-up would consist of a supporting airtight and water tight backing wall and rainscreen system.

The rainscreen should comprise of supporting brackets fixed to the backing wall, thermal breaks to the brackets, insulation between the brackets, a breather membrane, carrier support rails fixed to the brackets, a ventilated and drained cavity and the rainscreen panels.

Rainscreen systems should have third-party certification confirming satisfactory assessment and comply with the requirements of the CWCT Standard for Systemised Building Envelopes. The collation of individual testing of components does not provide an overall performance of the rainscreen system or backing wall.

Dead and live loads should be transferred safely to the building structure without undue permanent deformation or deflection of any component. Imposed loads (live and dead load) of the backing wall and rainscreen including the external sheathing board should be calculated in accordance with BS EN 1991 and movement (structural and thermal) should be accommodated without any reduction in performance to satisfy the project requirements. Fixings and supports should be designed to accommodate specified loads and take account of the product manufacturer's recommendations.

Where insulation is fixed to a backing wall, a minimum of one non-combustible fixing per 1m^2 or per insulation batt (whichever is the lesser) should be provided in addition to the other fixings.

Rainscreen systems require adequate drainage and ventilation in accordance with CWCT standards for systemised building envelopes. At the head and base of a rainscreen cavity a minimum of 5000mm^2 of ventilation must be provided per linear meter run. Ventilation gap must not be less than 10mm high (a continuous 10mm gap will provide 10,000mm² ventilation). Drainage must be provided at the base of the rainscreen system. The functional drainage gap must not be less than 10mm.

Pressure Moderation – Cavities should be closed within 300mm of corners to reduce the effect of wind pressure in line with clause 2.2.6.1 of the CWCT Standard for Systemised Building Envelopes.

Rainscreen panels are generally lightweight and vulnerable to impact damage. The rainscreen must be able to resist impacts without causing safety hazards. Testing and classification to CWCT Technical Note 75 and 76 may be required to demonstrate the rainscreen's material impact performance.

Design should allow for the line, level, plumb and plane of the completed rainscreen cladding to be within the acceptable tolerances of:

- Line: +/-2mm in any one storey height or structural bay width, and +/-5mm overall.
- Level: +/-2mm of horizontal in any one structural bay width, and +/-5mm overall.
- Plumb: +/-2mm of vertical in any one structural bay width, and +/-5mm overall.
- Plane: +/-2mm of the principle plane in any one storey height or structural bay width, and +/-5mm overall.

Cavity barriers within a ventilated rainscreen system must be appropriately selected, suitable for use and be aligned with the compartment wall and floor and be provided around openings. The cavity behind a rainscreen is deemed to be a moist zone and materials selected must not corrode, deteriorate or affect the performance of the cavity barrier during its design life. The minimum design width of the cavity wall will be determined by the panel joint type, i.e. whether it is sealed, closed, labyrinth, baffled or open. Horizontal cavity barriers must allow for drainage and ventilation in the rainscreen cavity and a gap of 50% of the cavity width must be retained in front of the open state cavity barrier.

Minimum cavity widths
Cavity widths are determined by the joint type:

- Sealed / closed = 25mm
- Open = 50mm
- Baffled = 38mm
- Labyrinth = 38mm

Rainscreen systems and their materials must comply with the relevant Building Regulations.

The risk of bimetallic corrosion should be checked and avoided through the isolation of dissimilar metals. Fixings and finishes to curtain walling must consider the location and corrosion category to ensure corrosion is avoided. Aluminium components must be robustly isolated from cementitious products to mitigate corrosion.

Cavity barriers should be mechanically fixed to rigid construction (for both vertical and horizontal positions) in accordance with the manufacturer's recommendations. Open state barriers are not suitable for vertical arrangements.

Cavity trays are required at the base of rainscreen façades to direct water away from the building to prevent the risk of water ingress.

Sheathing boards
External Sheathing boards being fixed to Light Gauge Steel Frame Systems (LGSF) must hold suitable third party accreditation and be assessed by calculation to withstand the design wind loads. This is to ensure the LGSF stud spacings and board fixing centres satisfy the project wind load requirements.

Joints between the boards must be sealed and interfaces between the external sheathing board and the structure must have adequate sealing to ensure the wall is weathertight.

For Warranty purposes, a breather membrane must always be installed irrespective of the external sheathing board product. Movement must be accommodated in the sheathing board and breather membrane at floor level.

Seals
All penetrations in the façade including windows, doors, ductwork etc. must be sealed to the structure and external sheathing board with EPDM or suitable alternative. The sealing membrane must have adequate test data suitable for the project specific wind load and proposed substrate compatibility.

Tolerances

Design should allow for the line, level, plumb and plane of the completed curtain wall to be within the acceptable tolerances of:

- Line: +/-2mm in any one storey height or structural bay width, and +/-5mm overall.
- Level: +/-2mm of horizontal in any one structural bay width, and +/-5mm overall.
- Plumb: +/-2mm of vertical in any one structural bay width, and +/-5mm overall.
- Plane: +/-2mm of the principle plane in any one storey height or structural bay width, and +/-5mm overall.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full set of drawings including locations of timber and tile cladding applications for each elevation and section details showing the external wall makeup.
2. Fixing specification for the cladding system including the fixing type, size, spacing and method of fixing to the substrate.
3. Where timber cladding/boarding is proposed, a specification of the timber to be used should be provided to confirm it has a minimum service life of at least 15 years. Details of preservative treatment used (if any) to BS8417 should also be provided.
4. Details of proposed cavity barriers to be used including materials, period of fire resistance (in compliance with the project fire strategy), locations and vertical and horizontal design details at all interfaces.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Timber cladding

Timber and boards for exterior use should be of a durable species, with sapwood excluded, or preservative treated by pressure impregnation using preservatives suitable for use in hazard Class 3 in compliance with BS 8417, or equivalent. Further guidance on the durability of timber is provided in ‘Appendix C - Materials, Products, and Building Systems’.

Where timber boarding or plywood spans across an intermediate floor zone in a timber frame construction, allow for differential movement caused through timber shrinkage by incorporating a movement joint.

Where cavity barriers are required, they shall be appropriately tested and approved for their intended purpose, this should include all fixings. Cavity barriers are also required behind decorative cladding such as timber boarding which is constructed on the outside of an external cavity masonry wall.

Abutments between cladding and other weather-resisting elements should be neatly made, weather tight and allow for differential movement. Workmanship should comply with BS 8000:5.

Timber boarding

Timber boarding should be at least 16mm thick, and allowance for moisture movement in boarding should be achieved by making tongues, joints or overlaps at 10% of the board width or 20mm, whichever is greater.

Timber boarding should be battened off the supporting background to provide a minimum 19mm cavity for draining and venting board.

Battens should be a minimum of 38mm wide, preservative treated and at maximum 600mm centres. Battens on timber frame should be fixed to each stud (and not to the sheathing) with annular ring nails of length at least twice the batten thickness plus the sheathing thickness (or plain shank nails of length 2.5 times the batten thickness plus the sheathing thickness).

Boards should be fixed to battens by face or secret nailing with annular ring nails at least 2.5 times the board thickness. In addition, all of the following conditions should be satisfied:

- Use double battens to support abutting boards. Batten should extend the full width of the boards either side.
- Pre-drill fixing points at board ends to prevent splitting.
- For boards 100mm and wider, use two fixings per board at every batten.
- On boards under 100mm in width, use one centrally placed fixing.
- Use two fixing points per board where they cross a support batten.
- Position fixing 25% in from each side and a minimum of 20mm in at board ends and pre-drill to avoid splitting where necessary.
- All fixings should finish flush with the surface and should not be punched or countersunk.

All metal fixings must be from corrosion resistant materials such as stainless steel (austenitic grade), hot dipped galvanised (BS7371:6 min) copper, silicon bronze or high performance coated steel. The following should not be used for any metal fixings: aluminium, electro plated steel or brass. Galvanised nails should not be used with Western Red Cedar.

The use of dissimilar materials in the same fixing point should be avoided to minimise the risk of galvanic corrosion.

When using timber species with high tannin or corrosive oil content such as Western Red Cedar, Douglas Fir and some hardwoods, stainless steel fixings should be used.

Where finishes are applied to timber boarding, they should be a translucent or opaque penetrating vapour permeable stain or paint, rather than a film coating type e.g., oil-based paint or varnish.

Mock Tudor cladding

Where mock Tudor cladding is proposed over a rendered substrate, the wall should be rendered in its entirety and the timber planted onto the render.

Render between mock Tudor cladding panels will not be acceptable for Warranty purposes.

Where mock Tudor cladding is proposed the following recommendations should be followed:

- To minimise movement all timber, used for mock Tudor cladding, regardless of species should be kiln dried.
- It is recommended that the timber is not sealed against the render, as the likely hood is that this can lead to moisture being trapped behind the structure, e.g. where horizontal timbers are against the wall the top more exposed mastic seal may fail first allowing moisture in, whilst the bottom mastic seal remains intact trapping the moisture behind.
- To reduce the effects of warping it is better to fix the timber ‘Pith out’ which means any warping across the width of the timber the edges will be in the direction of the backing wall. Using only Quarter sawn timber will also help reduce this.
- Depending on the desired visual effect, timber thickness can range from 19-40mm max. 40mm is generally the maximum, as thicker timbers can exert higher forces when warping which can pull the fixings out.
- Due to the limited access, the back of the timber should be decorated/stained before it is fixed to the wall.
- The timber species selected should have a minimum natural durability of 15 years unless treated.
- When jointing mock Tudor cladding a butt joint is sufficient. Halved joints should be avoided, due to the potential to trap moisture and biscuit joints also avoided, as often the biscuit is also not durable enough.

Specific to Oak
Where oak is specified, the fixings should not react with the timber or timber treatment, therefore stainless steel fixings are recommended.

Please note: With oak, there is a risk of extractive staining, where moisture will remove tannings from the oak and stain the render (particularly where light renders are used).

Please refer to ‘Appendix C’ for further guidance on the use of oak.

Vertical tiling and slating

Vertical natural slate or fibre cement slates

- Natural and fibre cement slates should satisfy the material specifications outlined in ‘Roofs – Pitched roof coverings (tiles and slates)’.
- Use counter battens over masonry construction (38mm x 25mm minimum) to allow moisture to drain away and not rot the horizontal battens. Special masonry fixings may be required.
- Slate-and-a-half should be used in alternate courses at internal and external corners and adjacent to openings.
- Use Code 3 lead soakers to weather internal and external corners.
- Fix slates by two nails and one rivet, and slate-and-a-half by three nails and two rivets.
- Code 4 lead cover flashings should be used above and below openings, in accordance with Lead Sheet Training Academy recommendations.

Vertical tiling with plain tiles

- Plain tiles should satisfy the material specifications outlined in ‘Roofs – Pitched roof coverings (tiles and slates)’.
- Use counter battens over masonry construction (38mm x 25mm minimum) to allow moisture to drain away and not rot the horizontal battens.. Special masonry fixings may be required.
- Ensure tiling details do not interfere with the opening of windows and doors.
- Lead flashings and soakers should be used around openings, in accordance with Lead Sheet Association details.
- Use double course of tiles at eaves, by laying first course of eaves/tops tiles with course of full tiles laid over.
- At the top of a wall or under a sill, use a course of eaves/tops tile laid over a course of full tiles. Dress a Code 4 lead cover flashing over by 100mm.
- Use internal and external angle tiles at all 90° corners. Purpose-made 135° angle tiles are also available. For other angles, close mitre tiles and use Code 3 lead soakers.
- All tiles should be twice nailed.

Please note: Cavity barriers are required behind decorative cladding such as vertical tiling and slating which is constructed on the outside of an external cavity masonry wall and where counter battens are used. Cavity barriers should not impeded on the ability of the cavity to be drained.

Further guidance on tiles and slates can be found in the ‘Roofs’ section.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full set of drawings including locations of where brickslips and brickslip systems are to be used for each elevation and section details showing the external wall makeup.
2. Detailed specification of all materials to be used within the brickslip system build-up.
3. Details of material specification for the brick slips with evidence the brick slips satisfy the requirements of BS EN 771.
4. Third party product conformity certificates for brickslip systems.
5. Details of proposed cavity barriers to be used including materials, period of fire resistance (in compliance with the project fire strategy), locations and vertical and horizontal design details at all interfaces.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Material specification

Brickslips facings can be adhered to a variety of materials and substrates, where they are specified, the brick slips should meet the following requirements:
- Clay masonry units must conform to BS EN 771-1 and have UKCA Marking.
- Calcium silicate masonry units must conform to BS EN 771-2 and have UKCA Marking.
- Concrete brick slips (Aggregate concrete masonry units) must have UKCA Marking and conform to BS EN 771-3.
- Agglomerated stone - slabs and tiles for wall finishes to BS EN 15286 and have UKCA Marking (Artificial stone).
- Natural stone masonry units must conform to BS EN 771-6 and have UKCA Marking.
- Accelerated weathering test data for the specific brick proposed must be provided. The full brick (prior to cutting to 25-28mm) must be tested by UKAS test laboratory for Hygrothermal testing, conditioning to ETAG 034, Freeze/thaw to EN 772-22 and tensile testing to BS EN 1015-12.

In all circumstances, we can only accept F2/S2 bricks complying with EN 771.

Installation on different substrates

Masonry cavity walls
Where slips are to be bonded onto masonry walls, the following must be met:
- The cladding system i.e. slip, adhesive and associated ancillary products such as clips, strapping etc. must hold a valid third party product conformity certificate.
- The design and fixing of the slip system must be in strict accordance with the third party product conformity certificate with any adhesion tests, pull out tests and saturation/freeze/thaw testing completed satisfactorily as per the requirements of the certificate.
- The substrate which the slip is to be attached to must achieve the desired weather resistance from the wind driven rain exposure map as if the slip was not to be installed and in strict accordance with the weather resistance requirements of the Building Regulations.
- The backing wall to which the slips are to be adhered is typically blockwork and therefore the blockwork is considered to be ‘C2 - High risk of saturation’ and must be of the correct classification i.e. classified as MX3.2, MX4 or MX5 built in M4 mortar. Please refer to ‘Appendix C’ for further guidance. Please also see PD6697 for further information.
- Where adhesive is used, the brickslip must have a full bond that covers the entire surface area of the brickslip. Spot bonding must be avoided.
- The substrate must be appropriately prepared as per the brickslip manufacturer’s instructions.
- The cavity width must be correct and comply with Building Standards for a ‘facing masonry’ wall type not ‘rendered finish’ or ‘impervious cladding’ finish.
- Slips should not be applied to render, unless covered by a valid third party product conformity certificate which is deemed acceptable as meeting our requirements. Any third party product conformity certificate for such construction must confirm the permitted maximum exposure zone the system can be used, if reliance is to be placed on the system to provide weather resistance.
- Slips must not bridge the damp proof course. The damp proof course must extend through the slip to the outside face of the slip cladding.
- Movement joints in the substrate must be installed in strict accordance with the Technical Manual and extend through the decorative slip cladding.
- Cavity trays must be present, as per the requirements of the Technical Manual.
- Weep holes must be installed, as per the requirements of the Technical Manual and extend through the decorative slip cladding.
- Where checked reveals are required (very severe exposure zone), the design must be assessed and deemed compliant. The check must be formed by the masonry substrate not slips or render. Windows must be sealed prior to the slip installation.
- Any mortar pointing of the slips, must be full depth, with the mortar suitable for the environment. Please refer to ‘Appendix C’ for further guidance.
- Any systems utilising clips, strapping, screws, etc. must used in a coastal location within 500m of the shoreline must be Grade A4 stainless steel.
- Any fixings of ancillary rainwater goods, satellite dishes, clothes lines, hanging baskets and similar items must go through the slips and into the substrate to ensure adequate fixing.

Brickslip cladding on framed construction with a backing board or as a rainscreen cladding system
- Where slip’s are to be used in conjunction with a framed structure and bonded onto a board, the ‘cladding system’ i.e. slip, adhesive, board and associated ancillary products such as clips, must all be covered by a valid third party product conformity certificate for the system as a whole.
- The design and fixing of the slip system must be in strict accordance with the third-party product conformity certificate with any adhesion tests, pull out tests and saturation/ freeze/thaw testing completed satisfactorily as per the requirements of the certificate.
- Where adhesive is used, the brickslip must have a full bond that covers the entire surface area of the brickslip. Spot bonding must be avoided.
- The substrate must be appropriately prepared as per the brickslip manufacturer’s instructions.
- The framed structure (backing wall) must be water tight and protected with a suitable breather membrane.
- A drained cavity, ventilated where required, must be provided in accordance with the Technical Manual.
- Cavity barriers behind the brick slips or rainscreen system must be appropriately selected, suitable for use and be aligned with the compartment wall and floor and be provided around openings.
- MgO boards are not acceptable for Warranty use.

Insulated Concrete Formwork
Where brick slips are specified for ICF, they must be a part of a system which has an appropriate third party product approval certificate (for the entire system). The following must also be satisfied:
- The third party product conformity certificate must confirm the cladding system can provide the necessary weather resistance.
- There must be a drained and vented cavity between the ICF and cladding system.
- The design and fixing of the slip system must be in strict accordance with the third-party product conformity certificate with any adhesion tests, pull out tests and saturation/ freeze/thaw testing completed satisfactorily as per the requirements of the certificate.
- The brick slip system must be secured back to the concrete core of the ICF.
- Where adhesive is used, the brickslip must have a full bond that covers the entire surface area of the brickslip. Spot bonding must be avoided.
- The substrate must be appropriately prepared as per the brickslip manufacturer’s instructions.
- Cavity barriers behind the brick slip system must be appropriately selected, suitable for use and be aligned with the compartment wall and floor and be provided around openings.

** Note: If the project location is situated in a wind driven rain exposure zone exceeding that stated in the third party accreditation, the certificate holder must seek agreement with the Warranty provider prior to any installation.

Brickslips external wall insulation (EWI) on a masonry substrate
Please refer to the ‘External Walls – Cladding’ section for further guidance on EWI systems:
- The EWI system, must hold a valid third party product conformity certificate, which is deemed acceptable as meeting our insurance requirements. The third party accreditation approval must be for the substrate construction proposed.
- The backing wall behind the EWI system must be watertight, protected with a breather membrane which has appropriate third party product conformity certificate.
- A drained cavity must be provided.

Brickslips on lintels
- Slips used in conjunction with either concrete, steel or lightweight (SIP) lintels, must hold a valid third party product conformity certificate covering the lintels, adhesive and slip system as a whole.

Brickslips on chimneys
All GRP chimneys must either:

- Hold a valid third party product conformity certificate confirming a minimum service life of 25 years and be deemed acceptable to the Warranty provider, **or**,
- The GRP chimney manufacturer must be a current ‘Accredited Member for the Production of GRP Brick Slip Chimneys’ from the ‘Construction Glass fibre Manufacturers Association’. Please refer to the ‘Chimneys and Flues’ section for further guidance.

Brickslips on soffits
- Where slips are used in conjunction with horizontal soffits, the product must hold a valid third party product conformity certificate for use in this situation.

Please note the following in all circumstances:
- Where adhesive is used the brickslip must have a full bond that covers the entire surface area of the brickslip. Spot bonding should be avoided.
- The design and fixing of the slip system must be in strict accordance with the third party product conformity certificate with any adhesion tests, pull out tests and saturation/freeze/thaw testing completed satisfactorily as per the requirements of the certificate.
- The substrate must be appropriately prepared as per the system manufacturer’s instructions.
- Pointing mortars should be chosen and installed as per the system manufacturer’s instructions. Traditional sand and cement mortar should be avoided. Lime based mortars should be used instead to aid in thermal expansion and settlement.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of any technical assessment (third party product conformity certificate) for the entire EWI system including the cladding or render to be used on the external face. The certificate must clarify which type of wall substrate the EWI system has been assessed.
2. Note: For coastal environments and areas of severe and very severe wind driven rain exposures, the technical assessment for the EWI system must explicitly confirm the system is suitable for use in a coastal environment or severe/very severe wind driven rain exposure.
3. A full manufacturer's specification for the installation of the system to the substrate must be provided.
4. The manufacturer or Engineer should provide a fixing specification for the insulation boards. This should be site specific and must detail type, spacing and method of fixing to the substrate. On-site pull out testing and a report confirming fixing type and length to satisfy the design loads including safety will be required in accordance with the Construction Fixings Association.
5. Where adhesive is used to fix insulation boards back to the substrate, a technical assessment (third party product conformity certificate) must be provided for the adhesive.
   a) Specification and detailing of:
   b) How external fixtures (such as downpipes, satellite dishes and other ancillary fittings) are to be fixed back to the substrate (not just the EWI system).
   c) Details of materials to be used for sleeving of service penetrations where required.
   d) Interface detailing for window and door reveals to avoid interstitial condensation.
   e) Detailing around DPC's, cavity trays, flashings etc.
6. Details of proposed cavity barriers including location, materials and technical assessments (third party product conformity certificate).
7. A condensation risk analysis should be provided for the external wall makeup.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General conditions

These are systems applied to the exterior walls of existing or new buildings, comprising of an insulant and a protective cladding or render finish. The Insulation type can vary from Expanded Polystyrene Insulation (EPS), Extruded Polystyrene Insulation (XPS), Phenolic insulation or mineral wool insulation.

A third party product approval certificate is required for the entire EWI build up including the cladding or render on the external face. Components outlined within the third party product approval should not be replaced on site.

For further guidance for rendering on EWI systems, see the 'External Walls – Render' section.

Please Note: ETA documents do not state the maximum exposure zone the system is tested for. The ETA documents usually only say the system (including the render) improves the thermal performance of the wall and contributes towards weather resistance.

Therefore for Warranty purposes:

For installing on a masonry substrate:
- The masonry wall should be thick enough to meet PD6697.

For installing on a framed structure:
- A drained (and vented) cavity will be required AND a breather membrane installed to protect the framed structure.

It should be noted that most third party product approvals will state the EWI system will only 'contribute towards' the weather resistance of the wall i.e. not give full weather resistance. Therefore the substrate must also be constructed to provide adequate resistance to water penetration. This can be identified by reference to either BS 5628-3:2005 Table 11 or PPD 6697, depending on the wall thickness and site exposure.

Also, the certificate will say the EWI provides a means to 'improve' the thermal performance of the external wall construction. Therefore any proposed installation must account for the overall thermal performance of the wall construction and the provision of a cavity to meet our Warranty requirements.

Please note: EWI / EWCS: May not be acceptable for use in external walls in buildings over 11m / 18m high (Scotland / England-Wales).

The design and installation of EWI systems should ensure all building functions are maintained, e.g. vented cavities should not be blocked. Ensure all fixtures and fittings which penetrate the insulation system e.g. flues, ventilation pipes, water pipes etc. are appropriately sleeved and fully weather sealed in accordance with the system manufacturer's recommendations.

The insulation type for the structure and application should be suitable for the intended purpose and, when required, should be keyed to receive the desired base coat and reinforcement. The insulated render system should be designed to minimise the risk of interstitial condensation and the effects of thermal bridging. A condensation risk analysis should be carried out in accordance with BS 5250 to ensure the building fabric meets the required performance standard. If a vapour control layer is required then this must be installed to the warm side of the insulation and the type must be approved and suitable for the application.

The dead and live loads should be transferred safely to the buildings structure without deformation or deflection of any component. Ensure the insulation continues around openings and other penetrations to maintain the thermal benefits.

Movement within the EWI system should be accommodated without any reduction in performance and should be constructed in accordance with the manufacturer's details. Movement joints in the backing substrate should be mirrored through the insulated render system and formed in accordance with the manufacturer's recommendations.

Fixing requirements

Insulation boards should be fixed in accordance with the manufacturers requirements. The density of proprietary fixings should designed on a site specific basis by an Engineer.

This generally consists of a minimum of 5 fixings per full insulation board / 8/m² with additional fixings to corners and reveals. On-site pull out testing and a report confirming fixing type and length will be required in accordance with the Construction Fixings Association and made available to the Warranty surveyor. Where the support of the system is via a horizontal rail system, calculations to demonstrate the system can withstand the design load are required. If the fixing for the insulation boards are to pierce a breather membrane, a site specific installation guide must be provided from either the EWI manufacturer, breather membrane manufacturer or frame manufacturer (timber or light gauge steel frame) detailing how this should be completed without comprising the effectiveness of the breather membrane.

A minimum of one non-combustible fixing per $1m^2$ or per insulation batt, whichever provides the greater number should be provided in addition to the other fixings.

For Warranty purposes; Dot and dab method of fixing using adhesives is not acceptable on masonry substrates. A full coat of approved adhesive (often the manufacturer's adhesive base coat) must be applied across the full face of the substrate with a tooted finish as per the manufacturer's specifications.

For coastal environments and areas of severe and very severe wind driven rain exposures the third party product approval for the EWI system must explicitly confirm the complete the system is suitable for use in a coastal environment or severe/very severe wind driven rain exposure. Furthermore, all external metals must have suitable corrosion protection for the intended environment. Further guidance can be found in 'Appendix C - Materials, Products, and Building Systems'. For further information please see 'Appendix B' of our Technical Manual which provides further guidance on additional requirements for developments within coastal locations.

Window and door reveals

Insulation is used in all construction projects to ensure buildings are kept warm and in turn reduce energy loss, however any break in the insulation line can often lead to interstitial condensation; with EWI systems, insulation is often missed around window and door reveals leading to condensation issues around the reveals.

The design for the EWI system should be carefully reviewed to ensure the insulation boards are present around the window and door reveals and there are no breaks in the insulation line. The design review should be aided by regular checks by the site management team to ensure the workmanship for the EWI system meets the requirements of the Warranty provider, EWI manufacturer and third party product approval certificate.

A continuation of the breather membrane and Vapour Control Layer (VCL) must be catered for around the window and door reveals where the EWI is applied to a framed substrate.

Allowance must also be made to ensure window cills adequately project beyond the finished surface of the EWI system to ensure any throating is correctly positioned clear of the finish, and that opening lights / ventilators are correctly installed to allow correct opening without being restricted by the EWI system and to prevent staining from water run-off.

Drainage deflection beads should be incorporated into the system to deflect water present in the drainage cavity around openings, other penetrations or items that block the drainage cavity.

Condensation risk analysis

EWI systems have an inherent risk interstitial condensation, therefore a condensation risk analysis should be carried out in accordance with BS 5250 to ensure the building fabric meets the required performance standard. If a vapour control layer is required then this must be installed to the warm side of the insulation and the type must be approved and suitable for the application.

Please note, providing a condensation risk analysis doesn't negate the need for thorough and robust checks on the design, workmanship and materials by the site management team and installers.

Particular attention should also be given to detailing around DPC level to ensure that there are no thermal breaks between the wall and floor construction and that any products used below DPC are suitable and accredited for use in that location.

Movement joints

Movement joints in the backing substrate should be mirrored through the insulated render system and formed in accordance with the EWI and timber frame/LGSF manufacturer's recommendations.

DPCs, cavity trays, flashings and weep holes

- The EWI system must not bridge any horizontal damp proof course.
- Where cavity trays are installed e.g. over openings or roof abutments, provision for draining the cavity tray will be required through the system as well as the correct construction of any flashing.
- Weep holes should be clear and functioning correctly (i.e. not blocked by the EWI system).

External fixtures

All fixings, down pipes, rainwater pipes, cables, fence posts, external light fittings, satellite dishes and other ancillary fittings and fixtures should be temporarily removed to enable the easy application of the insulated render system. Once the EWI system has been installed, the external fixtures can installed into the substrate construction (not solely fixed to the EWI).

In addition the following should be observed:

- Temporary downpipes should be provided. Avoid allowing the temporary downpipes to spill water over the render system.
- If required reset all drainage gulley's to accommodate the insulation system thickness.
- If required ensure that any gap around the window and door frames is correctly sealed against rain penetration before application of the insulated render system.

Risks associated with framed structures

Where an insulated render system is used as a cladding to a timber framed structure a drained and vented cavity will be required. A suitable breather membrane must also be provided to protect the sheathing board and framing system from water penetration reaching the internal finishes. The EWI system must have a third party product approval certificate confirming it can be used on the outside of a timber frame or light gauged steel framed structure.

EWI systems applied to Light Gauge Steel Frame should have a drained cavity only with limited ventilation. Cavity ventilation might decrease U-Value and introduce additional condensation/corrosion risk – please make sure installation is carried out in accordance with the design and condensation risk analysis provided.

Key points during Installation of the EWI system

The EWI system must be installed by an approved installer from the EWI manufacturer. Evidence of the installer being approved should be provided to the Warranty Surveyor before works start on site. When installing the EWI system, the following should be observed:

- On-site fixing pull-out / proof testing to be carried out prior to works commencing on site to verify the fixing can withstand the design loads (including safety) and is suitable for the project.
- Protection must be provided when applying the insulation boards in rain or other inclement weather; to avoid trapping moisture in the system.
- Vented cavities should not be blocked, nor should any 'weep holes'.
- The use of timber supports and blocks within the EWI system should not be used.
- Ensure all fixtures and fittings which penetrate the insulation system e.g. flues, ventilation pipes, water pipes etc. are appropriately sleeved and fully sealed in accordance with the system manufacturer's recommendations.
- The installation of EWI's at window / door reveals often fail due to poor detailing or support (often by wooden boards).
- The manufacturer's details must be followed and appropriate trims should be provided at openings, corners, angles and interfaces etc.
- Ensure the cavity barriers at compartment wall, floor locations and around openings are correctly installed and effective in a fire situation.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full set of drawings including locations of stone cladding applications for each elevation and section details showing the external wall makeup.
2. Details of material specification for the stone cladding with evidence the stone cladding satisfy the requirements of BS EN 771-6 (e.g. Declaration of Performance document).
3. A statement from the supplier confirming the selected stone units are freeze/thaw resistant. Please note, the units must be selected based on the performance of the actual sourced product and not a generic one.
4. Details of proposed cavity barriers to be used including materials, period of fire resistance (in compliance with the project fire strategy), locations and vertical and horizontal design details at all interfaces.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General

The following additional guidance for natural stone shall be used in conjunction with any other information in the Technical Manual. When selecting stone for cavity wall house building, it is important to consider the exposure rating for the area.

Natural stone masonry should comply with the following:

- BS EN 771-6
- BS EN 1996
- PD 6697

Natural stone masonry must be selected by the designer, to be based on its suitability for:

- The specific cladding proposal design requirements.
- For the specific site exposure and orientation that the building / plot will be located – using that stone.

The Architect must ensure the units are selected based on the performance of the actual sourced product and not a generic one. BS EN 771-6 specifies the characteristics and performance requirements of masonry units manufactured from natural stone.

The selected stone performance information may be found in a Declaration of Performance document issued by the quarry supplier.

The document providing the performance information, must include, a statement from that supplier, that the selected stone units are freeze / thaw resistant. A copy of this document must be given to the Warranty Surveyor, if this information is not available, we may not be able to accept the proposed stone cladding.

It is advisable to use a stone that has been quarried within a reasonable vicinity of the development, ensuring both weathering qualities and visual blending with existing buildings. Natural stone has a grain or natural bed that is determined during its formation in the strata of the quarry.

It is not recommended to use a soft, porous-type stone in a severe or very severe exposure zone. Consideration should be given to the compatibility of different stone to prevent staining and premature decay. Limestone and sandstone should not be mixed together.

Natural stone masonry should comply with BS EN 12370 (Natural stone test methods. Determination of resistance to salt crystallisation) or have evidence it is not susceptible to salt crystallisation when used below DPC level.

It is important that the stone is laid with the grain running horizontal to the bed. In the case of jambs and mullions, the grain should be vertical.

Sawn bed stonework and random rubble stonework

Sawn bed stonework in the outer leaf of a cavity wall must be at least 100mm thick, although 150mm is recommended. Where dressed stone is used and the sawn bed width falls below 100mm due to the irregularities of the stone, the stone should be backed with a standard brick or block wall to maintain structural stability. It is not acceptable for the stone to be packed or wedged to maintain line and level without the backing wall being in place.

In the case of random rubble stonework used as a facing in a cavity wall, the rubble should have a minimum thickness of 150 mm, which may be increased depending on the type of stone supplied by the quarry. The rubble facing may be built in two ways:

- As a facing to a standard two-leaf cavity wall that will be typically post-fixed to the outer leaf; or,
- Forming the outer leaf itself – in this case the rubble stonework will normally be built up at the same time as the inner leaf, steps to the rear of this rain-screen must be avoided to prevent water running down the inner face and ‘splashing’ the insulation and inner leaf.

Mortar

The mortar for use with stone should comply with the relevant British Standards for sand, lime and cement, as set out in BS EN 1996 or PD 6697.

This can vary in strength from 1:1:6 to 1:3:12 depending on the softness of the stone. It is important to use the correct mortar to allow for movement and associated shrinkage. Ensure that wall ties are stainless steel and of sufficient length to maintain a 50mm embedment. It may be necessary to double up the wall ties where the coursing is out of line due to the varying thickness of natural stone at the reveals, i.e. every other course, and to ensure that wall ties do not slope inwards.

Insulation (applicable to masonry cavity walls only)

Full fill cavity insulation should only be considered where the outer leaf is backed by brick/blockwork, although this is still dependent on exposure, i.e. either partial fill, leaving a residual cavity of 50mm, or a clear cavity should always be the preferred options. Full third party accreditation, BS8104 analysis, site specific designs, information on porosity of stone and strict acceptance from the manufacturer for any wall build-up will be required.

For guidance on insulation for framed structures, please see either the ‘External Walls - Timber Frame’ or ‘External Walls - Light Gauge Steel Frame’ sections.

Movement joints

In movement control where sealants are used, it is important to select a non-oil-based sealant to help prevent any staining to the stone.

Cavity trays

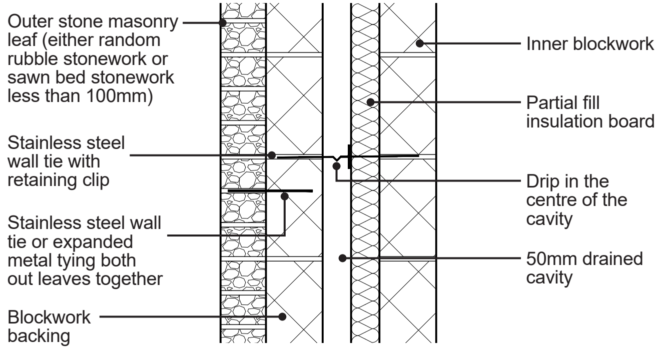
In addition to our guidance on cavity trays in this section, the following shall apply:

When stone heads are being used, it is advisable to double up the cavity trays, one below and one above the stone head, and to provide stop-ends and weep-holes. Please see ‘External Walls - Traditional Masonry Cavity Wall: Feature stone surrounds to openings’ for further information.

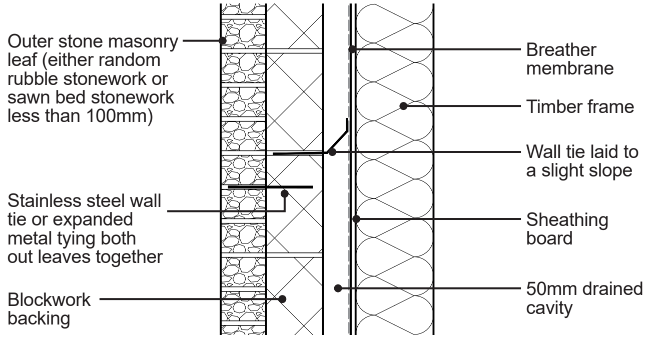
Jambs and mullions

Stone jambs and mullions should be fixed at the top and bottom with stainless steel pins. Stainless steel frame-type cramps can also be used to give extra stability at jambs.

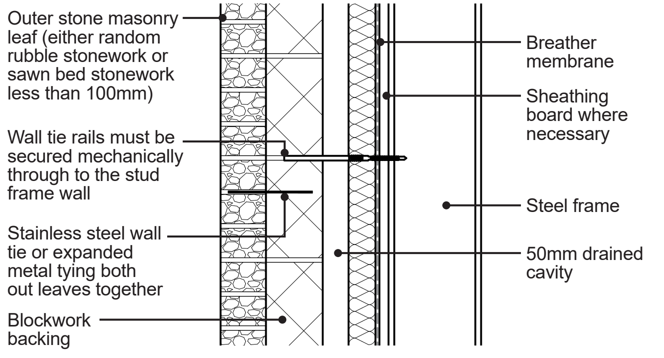
Masonry cavity wall with stone outer leaf



Timber frame with blockwork backing wall and stone outer leaf



Light Gauge Steel Frame with blockwork backing wall and stone outer leaf

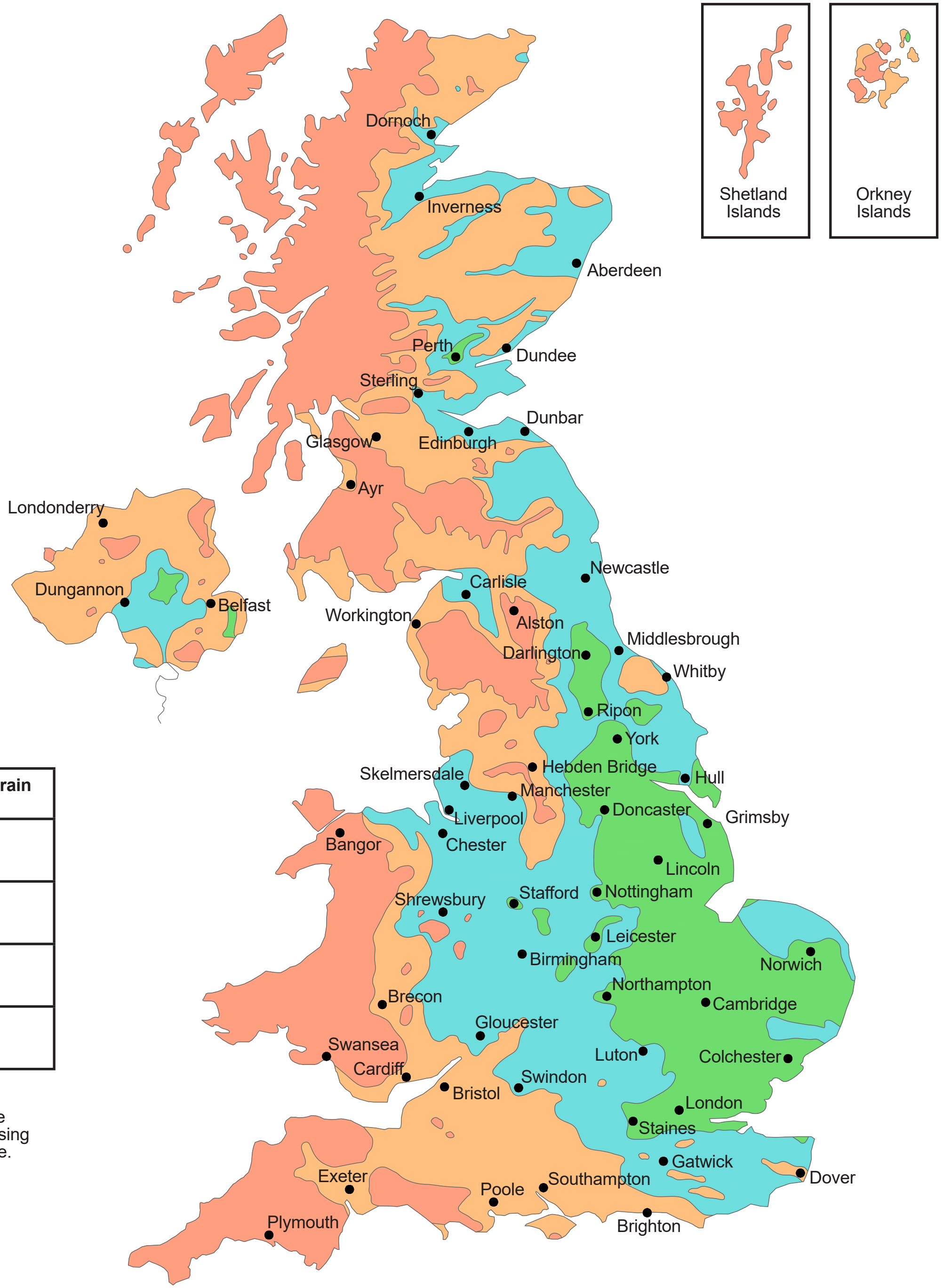


Wind-driven rain

In all situations, external walls and cladding systems must be suitable for the wind driven rain rating specific to the project.

To ascertain the risk relating to wind-driven rain, the following should be determined:

- The exposure to wind-driven rain, using the wind driven rain exposure map.
- The correct type of construction, including the correct application of insulation.
- The correct level of workmanship and design detailing, particularly around window and door openings.



Exposure zones	Exposure to wind driven rain (litres/m² per spell)
Very severe	100 or more
Severe	56.5 to less than 100
Moderate	33 to less than 56.5
Sheltered	less than 33

Note:
Variations to the exposure shown on the map can only be made by site-specific calculations using BS 8104 "Assessing exposure of walls to wind driven rain" and the table above.

6. External Walls

6.6 Parapets

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

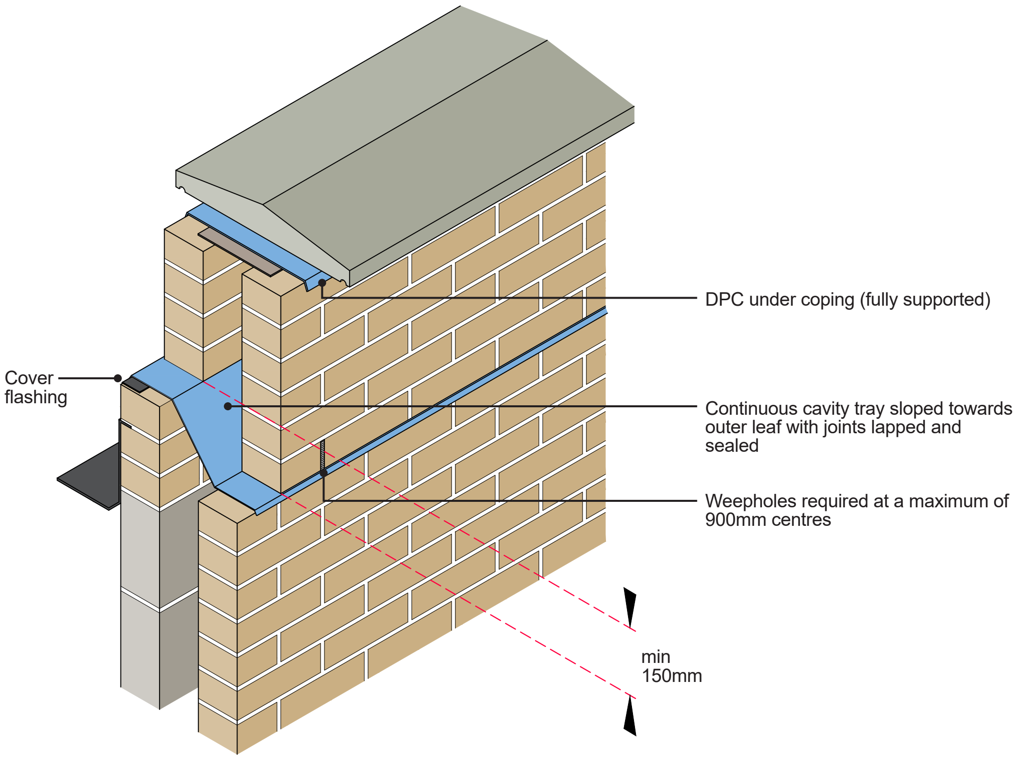
1. Details of all proposed materials to be used in the construction of the parapet wall, including but not limited to:
    a) Details of proposed coping or capping.
    b) Details of DPC material to be used under coping or capping.
    c) Details of material to be used for supporting the DPC under the coping or capping.
    d) Details of cavity tray to be used.
2. A full set of detailed drawings including section details and the dimensions of the parapet wall.
3. Manufacturer or Engineer should provide a site specific fixing specification for the coping or capping. This should detail type, size, spacing and method of fixing to the substrate. Details of corrosion protection should also be provided where applicable.
4. Details of any technical assessment (third party product conformity certificates) for any components used for the construction of the parapet wall.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

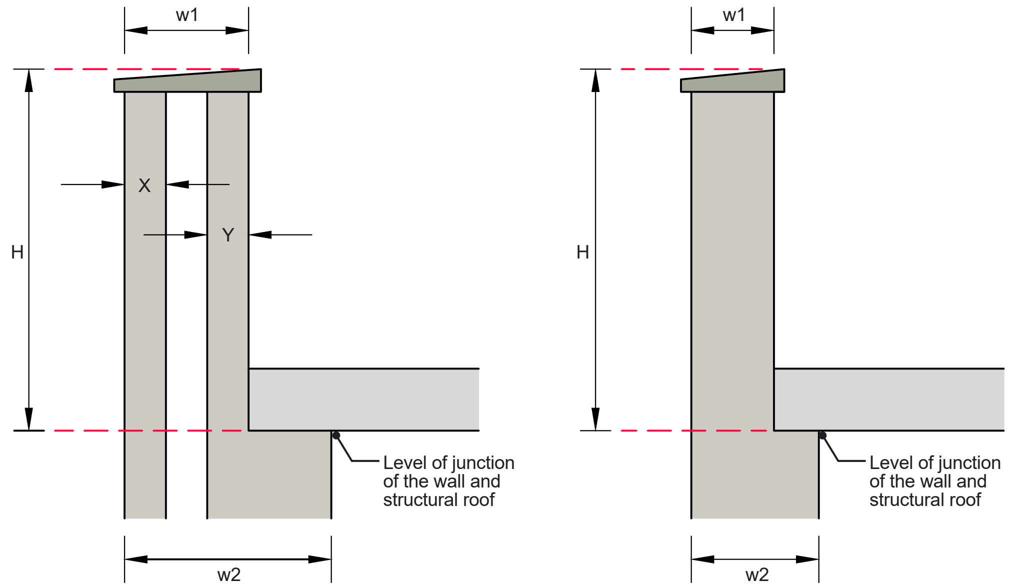
Parapet wall detail

The materials used in construction of the parapets details should be suitable for the location and exposure.

In very severe exposure zones, it is recommended that parapet construction is avoided altogether.



Maximum height of parapet walls (to be read in conjunction with the table below)

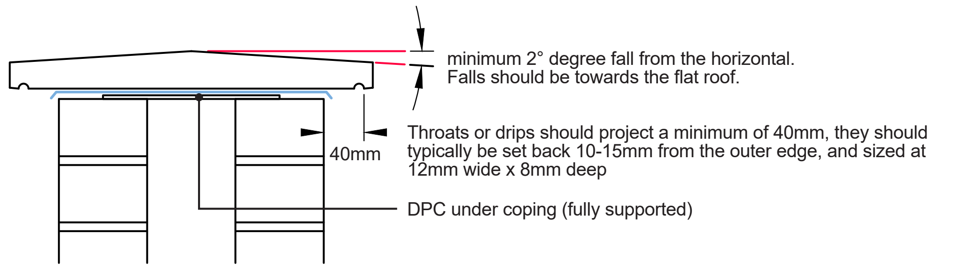


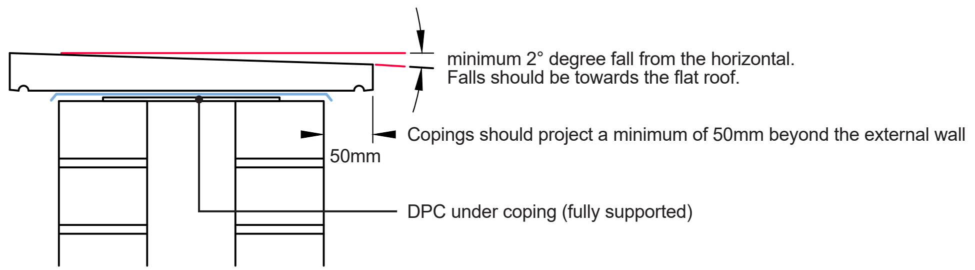
Wall type	Thickness (mm)	Parapet height to be no more than (mm)
Cavity wall	x + y equal or less than 200 x + y greater than 200 equal or less than 250	600 860
Solid wall	w1 = 150 w1 = 190 w1 = 215	600 760 860
Note: w1 should be less than w2, as shown above		

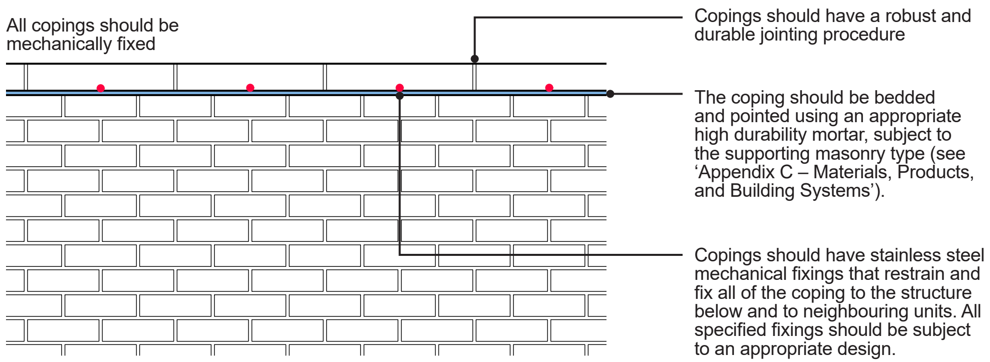
Copings

Copings can be defined as construction that protects the top of a wall, balustrade, or parapet and sheds rainwater clear of the surfaces beneath (BS 5642).

For Warranty purposes:
- The coping should be frost resistant.
- All copings should be mechanically fixed.
- The coping should incorporate weather tight detailing to junctions with other elements of structure e.g. coping terminations abutting perpendicular walls.
- Vertical movement joints in the supporting structure below should be carried through the parapet and copings. DPC's and cavity trays must be continuous at the movement joint. In addition there should be consideration for the coping manufacturer's requirements for the provision of movement of the coping itself (e.g. thermal expansion).
- Masonry copings are not permitted for use in conjunction with timber frame/SIP construction.



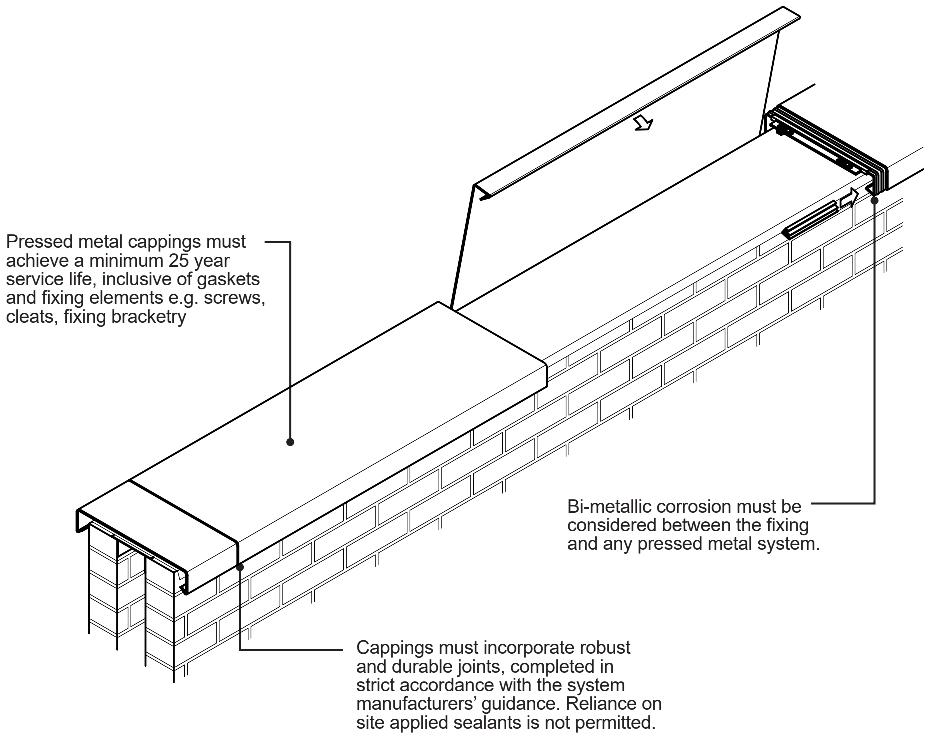




Pressed metal cappings

Can be defined as construction that protects the top of a wall, but does not shed rainwater clear of the surfaces of the wall beneath.

For Warranty purposes, pressed metal cappings should:
- Be suitably durable for the exposure conditions and any potentially aggressive environments (coastal locations, industrial zones, etc.) Pressed metal cappings must achieve a minimum 25 year service life, inclusive of gaskets and fixing elements e.g. screws, cleats, fixing bracketry.
- Bi-metallic corrosion must be considered between the fixing and any pressed metal system.
- Aluminium capping systems must not be installed in contact with copper or its alloys, or the runoff from them.
- Aluminium cappings should not be bedded into mortar or concrete.
- Be 'once weathered' and incorporate pre-formed drip provision within their profile. Typically, the coping will discharge water to the inside e.g. towards the balcony, terrace or flat roof.
- Incorporate robust and durable joints, completed in strict accordance with the system manufacturers' guidance. Reliance on site applied sealants is not permitted.
- Where the specified system relies on overlapping sections or joints that utilise an anti-capillary methodology e.g. drainage gaps at joints, through testing that sufficient weather tightness can be achieved must be proven and demonstrated.
- Be secured to the wall - the preferred method is the use of concealed bracketry, fixings and gaskets which avoids the need for penetrations through the capping.
- The pull-out resistance of the fixings must be checked for wind uplift by an Engineer. Adhesive bonding of pressed metal copings alone is not considered acceptable for Warranty purposes.
- Be designed to accommodate movement e.g. thermal expansion and contraction – notably at external and internal corners. Typically aluminium requires an allowance of approximately 1mm per linear meter for movement.
- Achieve a minimum overlap of 75mm at any lead soaker, lead upstand or secret gutter location. Consideration must be given to bi-metallic corrosion occurring between the pressed metal work, lead work and associated fixings.

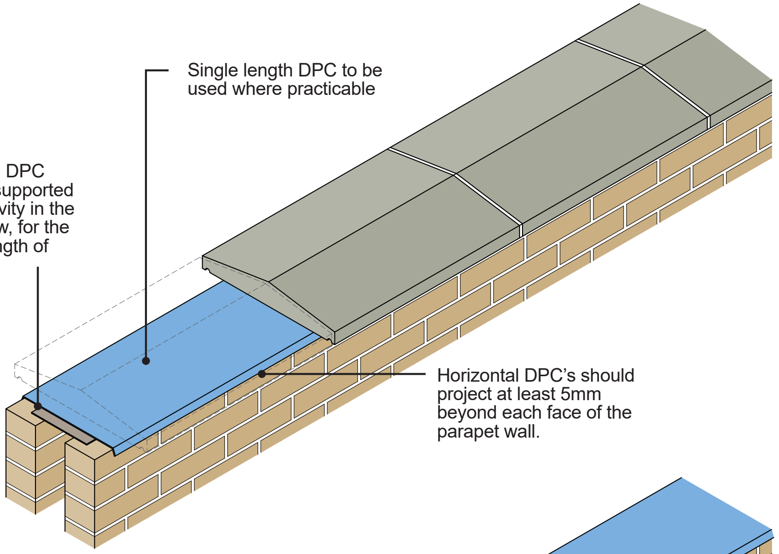


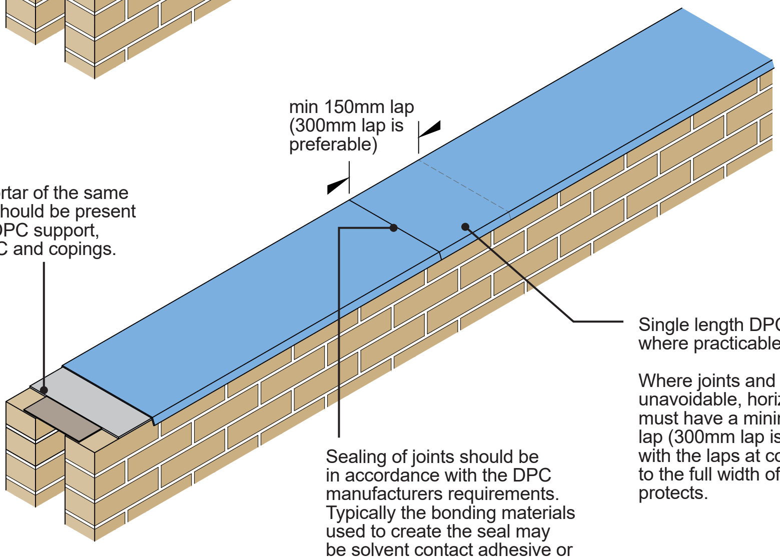
Fully supported horizontal DPCs

The fully supported horizontal DPCs should:

- Be of suitable material specification with particular attention to mortar bond. This should form part of the structural engineers design.
- For pressed metal cappings, the horizontal DPC should be laid and secured in line with the guidance issued by the pressed metal coping system manufacturer.
- Any penetrations through the horizontal DPC e.g. from coping stone fixings, balustrades, balcony guarding, etc., must be fully sealed to prevent penetrating moisture, using working practices and suitably durable sealant material recognized by the manufacturer of the DPC system as acceptable and compatible.

Note: Manufactured DPC pre-formed cloaks are preferred where complex shapes are created by penetrations such as wind post penetrations, etc.

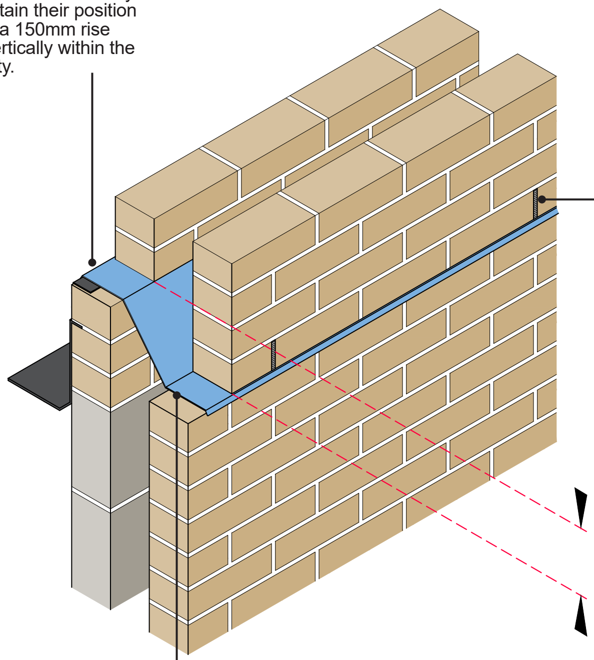




Cavity trays

The cavity tray must:

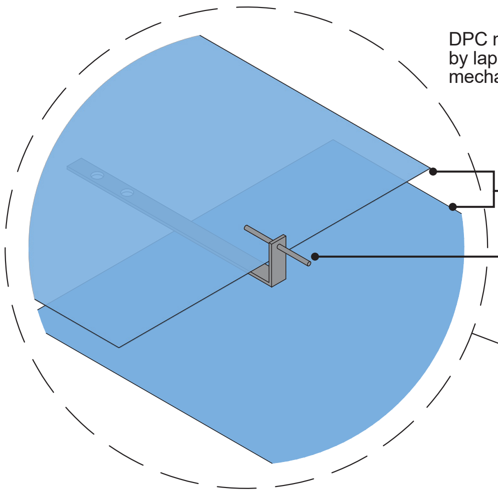
- Be of suitable material specification. Materials attaining the correct bond performance should be specified and this should be checked against 3rd party accreditation as suitable in situations of minimal load.
- Proprietary self-supporting cavity trays should be used; flexible cavity trays should be avoided.
- Where flexible cavity trays are used, evidence of how they are to be continuously supported should be provided.
- When securing to framed construction e.g. timber frame, surface fixing must be done in strict accordance with manufacturers guidance and materials e.g. bonding materials, fixing strips.
- Fixing to insulation boards alone must be avoided and the cavity tray will require to lap with any breather membrane on the frame construction.
- Cavity trays must be formed with minimal joints, as far as practicable. Where joints and laps are unavoidable, laps should be formed and fully sealed in accordance with the manufacturers' guidance. Preformed cloaks should be used for complex geometry and obstructions.

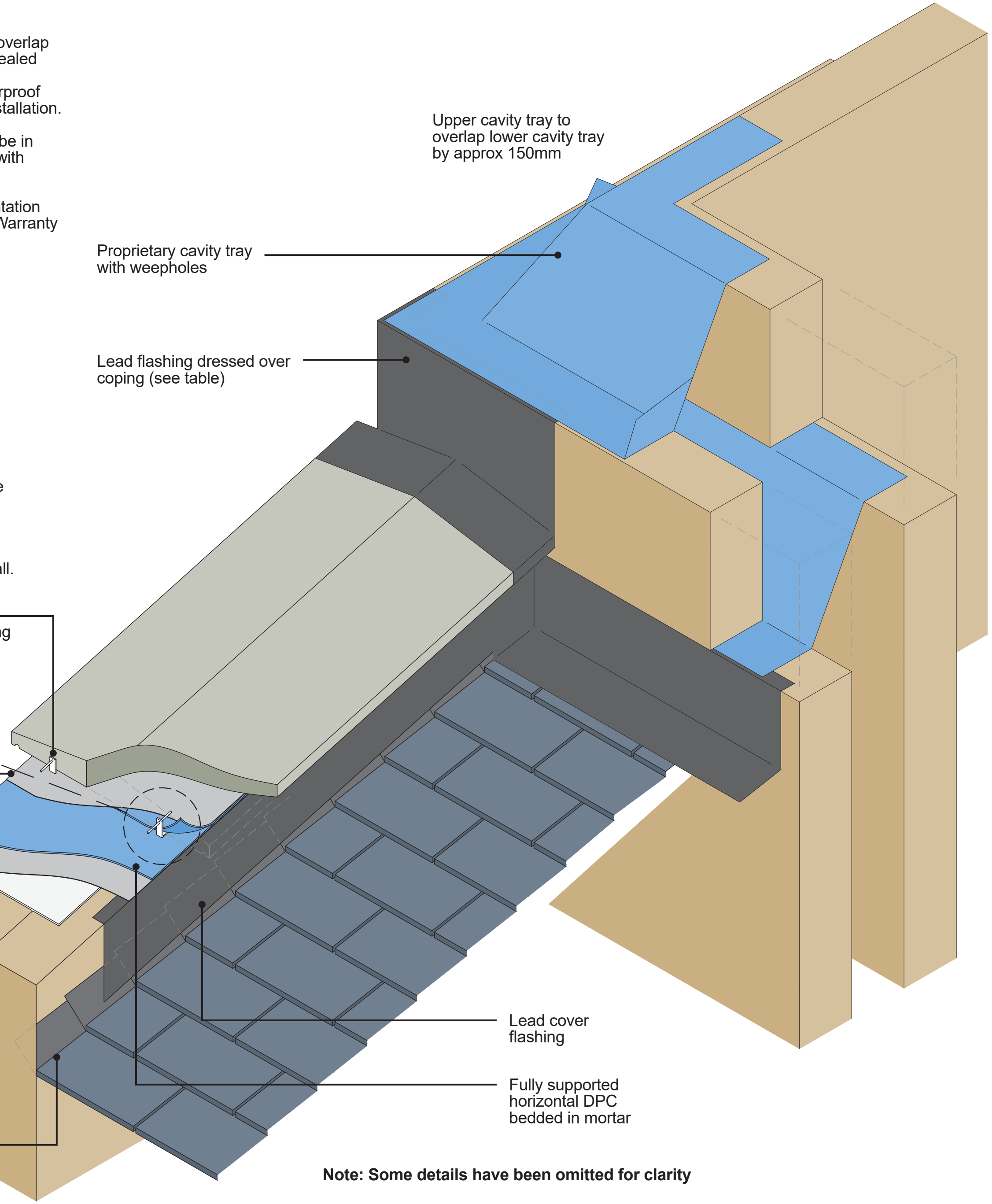


PARAPETS: Raking parapets

In addition to the other guidance in this section, the following should be considered for raking parapets:

- Joints in the DPC are not permitted on raking parapets. Where dual pitched roofs are encountered, an allowable overlap will occur at the transfer from one plane to another e.g. the ridge. This exception must have a minimum 150mm sealed overlap (300mm lap is preferable).
- Where the wall upstand above the roof line is relatively short e.g. 150-300mm, any lead flashings used to weatherproof the junction must dress underneath the DPC arrangement and be secured in place prior to the horizontal DPC installation. The lead flashing must sit on the horizontal portion of the wall by 25-30mm.
- As an alternative to a DPC material being used, a lead detail could be adopted. In such a cases installation must be in accordance with the Lead Sheet Training Academy (LSTA) guidance and the guidance within the 'Roofs' section with regards the execution of flashing details.
- Where pressed metal capping sections are being used, the DPC must:
  - Hold a valid 3rd Party Accreditation where horizontal DPCs do not form part of the installation. This documentation must prove and demonstrate weather tightness of the installed system to a point deemed acceptable to the Warranty provider.



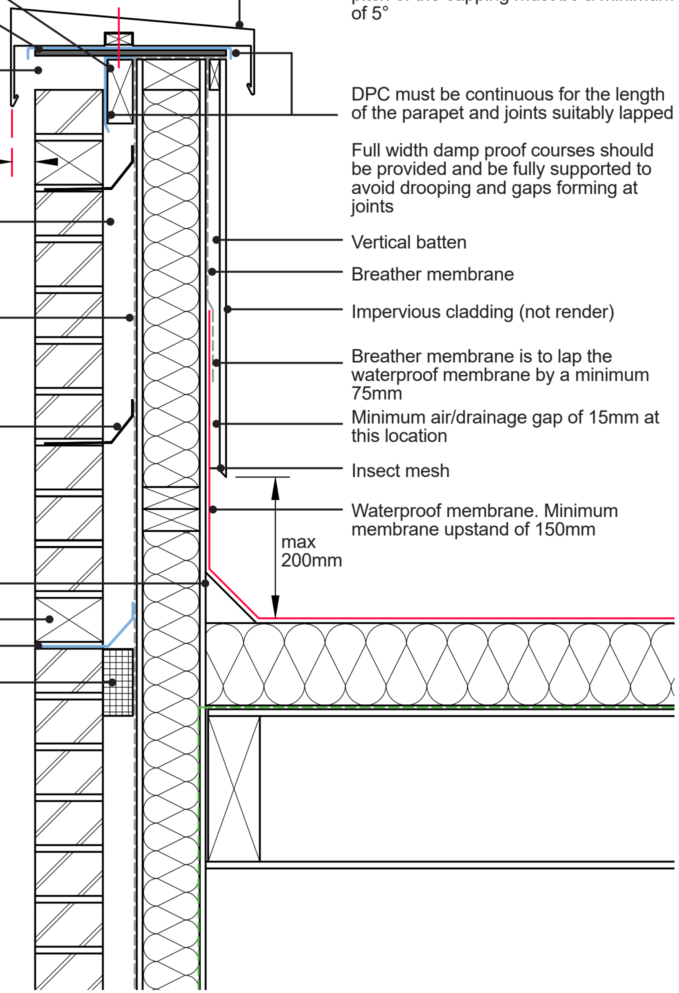


The amount of lead lapping on to the coping should be in accordance with the table shown below.

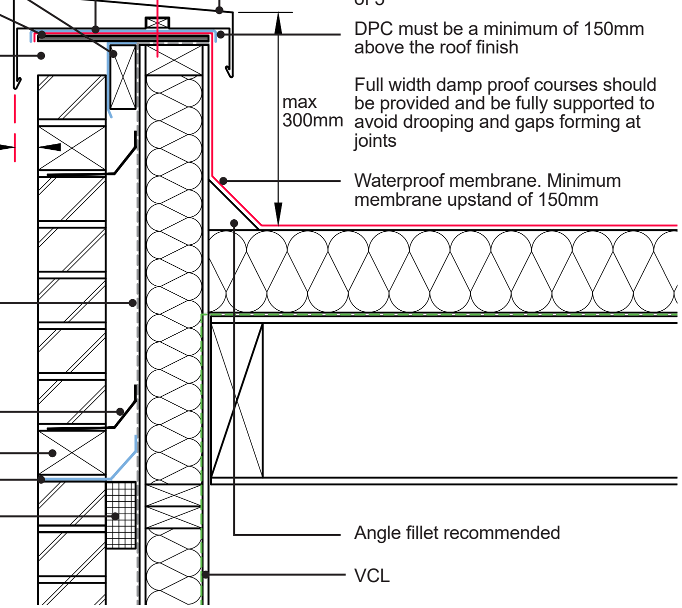
Minimum lap of the flashing with the coping/roof covering	
Pitch of rood (degrees)	**Cover of lead flashing on coping/roof (mm)**
30	150
20	220
15	290

Note:
- For pitches over 30°, a min lap of 150mm should be provided.
- In areas of severe/very severe exposure the vertical upstand should increase to 100mm

Capping detail for up to 1100mm from roof



Capping detail for up to 300mm from roof



Parapets

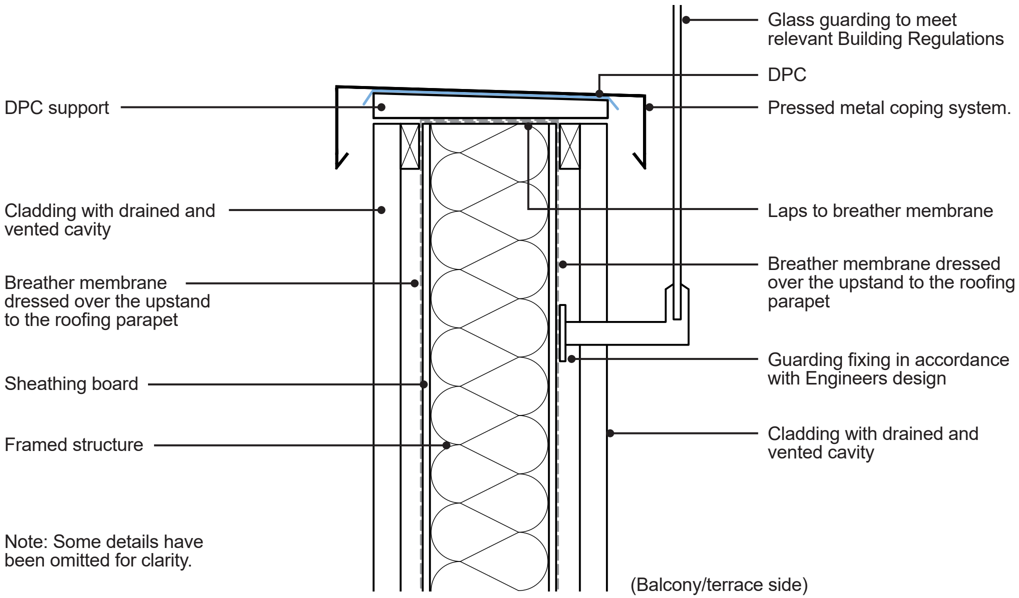
- The parapet should be designed to accommodate differential movement, remain structurally stable, and allow suitable structural support of the lightweight coping.
- The coping should be mechanically fixed to the timber frame and the fixings should be suitable for the exposure and anticipated wind loadings.
- If the capping is secret fixed, each capping piece should be provided with at least 2 security fixings.

General guidance

Where terrace guarding or balustrade systems are specified, the following should be taken into account:

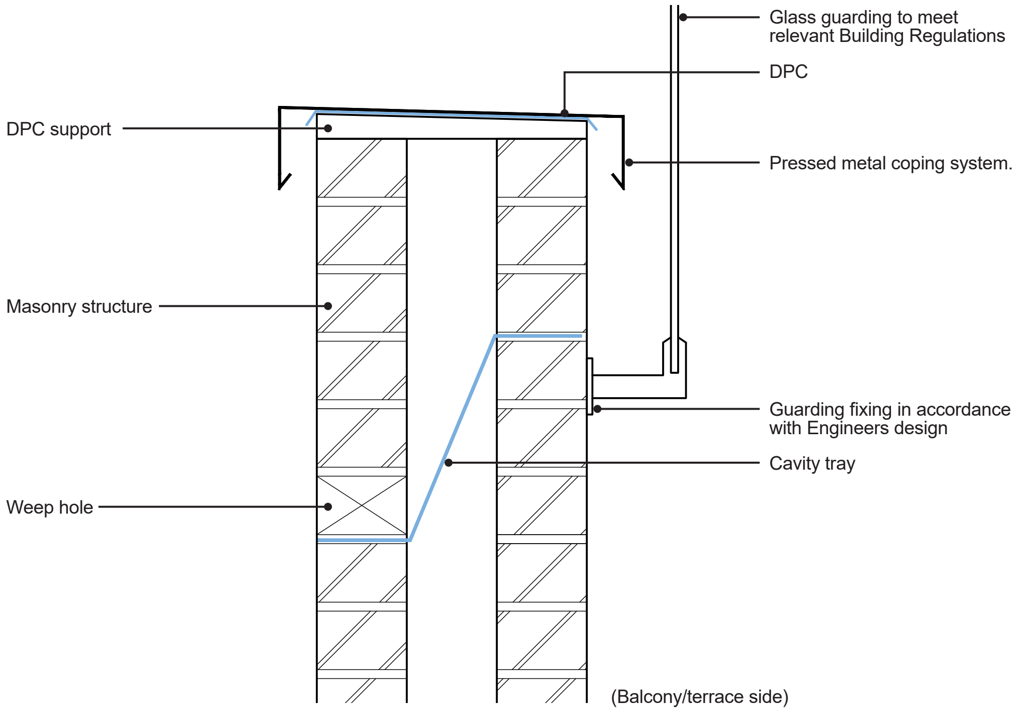
- Any guarding should ideally be mounted to the sides of the parapets, either internally or externally via face fixings into the parapet wall and not through the coping. This should be the preferred method as it prevents creating weak spots for water ingress.
- The copings weathered upper surface, projection and drainage function must be uninterrupted and unhindered by guarding provisions e.g. glazing channels which are recessed into and divide coping provisions should be avoided.
- Where this cannot be avoided, and any guarding over a coping arrangement is in continuous contact, the free drainage of the coping should not be impeded. In such instances, coping arrangements must incorporate a fall away from the obstruction to any outside edge.
- Where the guarding incorporates proprietary glazing and framing profiles, drainage provisions from glazing channels must be provided and kept free from obstruction. Particular attention should be paid to sealant pointing used where such profiles are in continuous contact with the upper surface of a coping system, as this area can often restrict drainage when incorrectly executed.
- Where the guarding, over a coping arrangement, is in continuous contact with the coping fixings which penetrate the coping arrangement, the fixings must only pass through a self-sealing butyl tape. Reliance on silicone is not acceptable.
- Guarding incorporating elements of glazing may need to be heat soak tested to BS EN 14179-1.

Framed structure



Note: Some details have been omitted for clarity.

Masonry structure



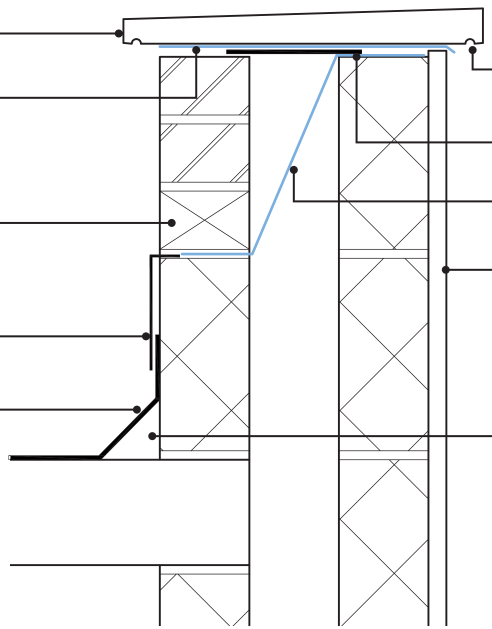
PARAPETS: Render in highly exposed areas of construction and chute detailing

General guidance

A specialist render system and mortar should be employed for parapets with this masonry background type. It is recommended that:

- The backs and exposed horizontal surfaces of parapets are not rendered using a standard render system. Use a specialist render system designed to combat movement and provide robust weatherproofing.
- Throats or drips to copings of parapets and chimneys should project beyond the finished faces by a minimum of 40mm distance to throw water clear.

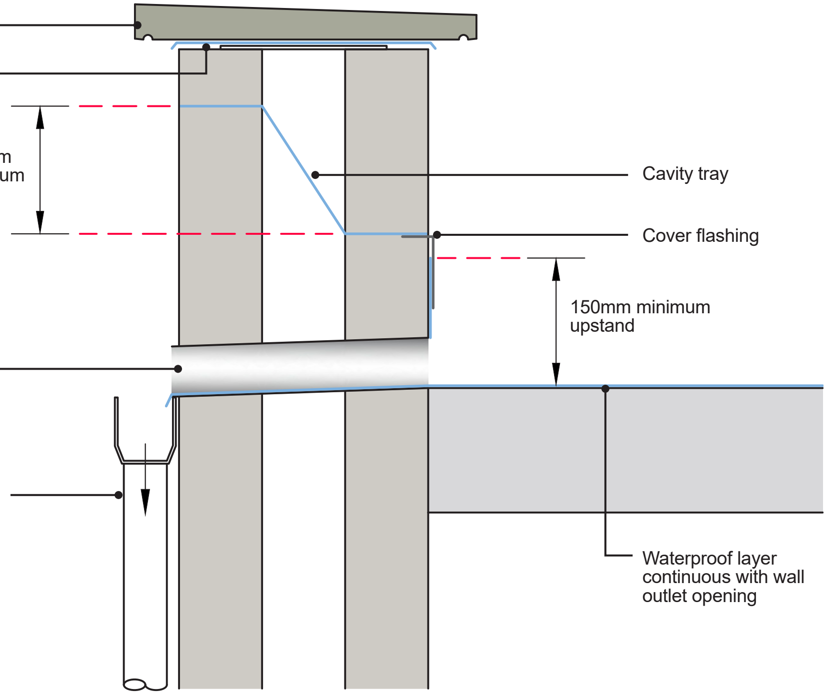
Parapet wall detail (render clad)



Chute detailing

Where a chute penetrates a parapet:

- It must not impede the effectiveness of the cavity tray, flashing or any other waterproofing elements of the parapet.
- The number, size and positioning of the chutes must be designed to BS EN 12056-3 taking local rainfall intensities into account.
- Differential movement should be taken into account for both the chute and the hopper where the chute passes through timber frame construction. Please refer to the 'External Walls – Timber Frame' section for further guidance on differential movement.



Notes:

- Cavity tray requires a 150mm rise, weep holes and stop ends.
- 150mm upstand also required for upstand.
- Drawing shows a generic wall build up.

7. Internal Walls

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. Any multiple occupancy building (which includes flats /apartment accommodation) must have fire stopping and cavity barriers completed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.
2. All workmanship must be within the tolerance requirements set out in this Technical Manual.
3. All work is to be carried out by a technically competent person in a workmanlike manner.
4. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
5. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
7. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. Internal walls shall be designed and constructed so that they:
    a. Are structurally sound;
    b. Have adequate resistance to the effects of fire and surface spread of flame;
    c. Are durable and resistant to moisture;
    d. Provide suitable surfaces to receive a range of finishes.
2. Separating and compartment walls shall be designed and constructed so that they:
    a. Have adequate resistance to the spread of fire between buildings;
    b. Have adequate resistance to the passage of sound between buildings.
3. Separating walls between the dwelling area and garage within a Housing Unit shall be designed and constructed so that they:
    a. Have adequate resistance to the spread of fire between garage, and dwelling area;
    b. Have an adequate thermal performance.
4. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
5. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
6. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
7. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

7.
Internal Walls

7.1
Masonry

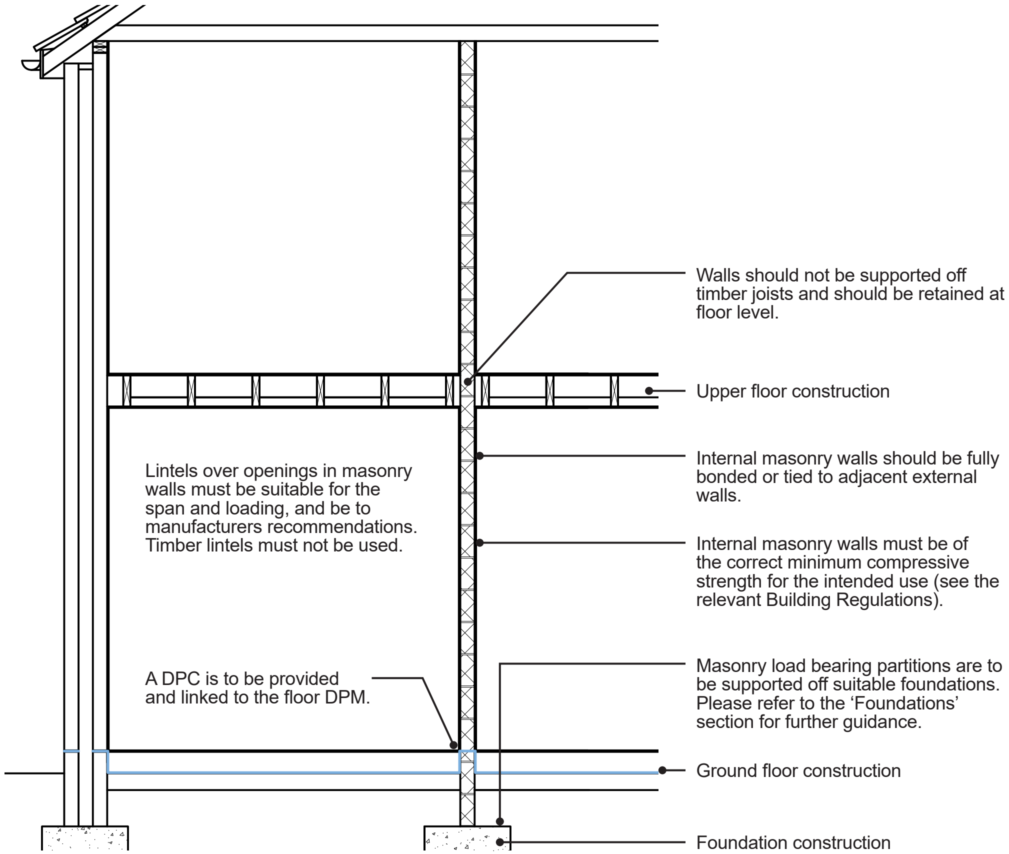
Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

- Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
- Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
- Site specific supporting calculations confirming design loading where required.
- Details of proposed fire stopping and cavity barriers.
- Details relating to service penetrations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

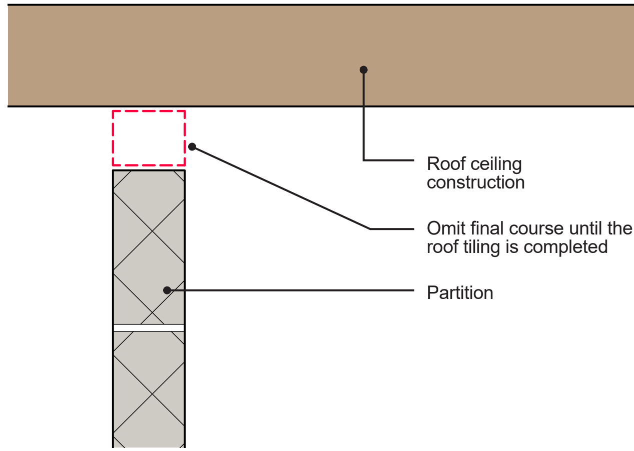
Internal loading bearing walls



Note:
- Internal partitions should not be supported by compressible layers forming part of a floating floor unless suitable for that purpose.
- Internal partitions between bedrooms or rooms containing WC's and other rooms, must achieve adequate sound resistance.
- Internal masonry partitions should have a minimum density of 600kg/m³ and finished both sides with 13mm of plaster.

Additional requirements may apply for Building Regulations compliance. Please refer to the relevant Building Regulations.

Internal non-loadbearing walls



It is advisable to erect non-load bearing walls after the roof tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until roof tiling has been completed.

Damp proof course (DPC) and damp proof membrane (DPM)

Where an internal wall is built off a foundation continuity of the DPM must be achieved.

The internal wall should have a DPC, which is at least the width of the internal wall and linked with the DPM by a minimum of 100mm.

Foundations

Below ground, load-bearing walls must be supported using a suitable foundation. Where the upper floors are supported by a suitable beam or lintel, the load should be adequately transferable to the foundations. All structural masonry walls should be provided with foundations.

Compressive strength

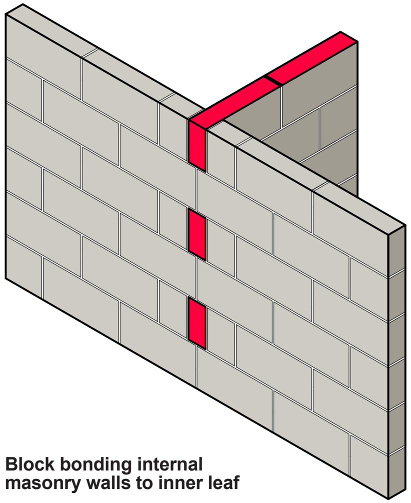
The varying strengths of bricks and blocks mean that they have to be chosen in accordance with the proposed use of the building. The recommended strengths of bricks and blocks to be used in buildings up to three storeys high are found in 'Appendix C - Materials, Products, and Building Systems' and the relevant Building Regulations.

Lateral restraint

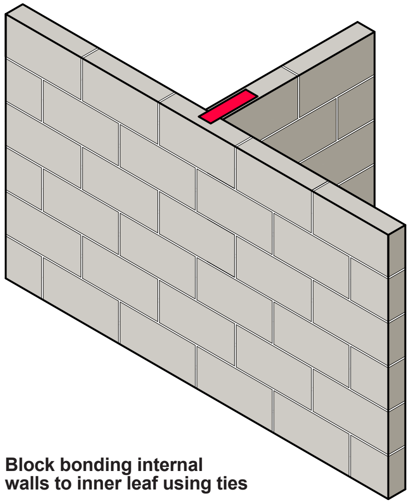
Lateral restraint is to be provided for load-bearing walls and separating walls at each floor level and the ceiling level below a roof.

Bonding and tying

Where a separating wall abuts an external wall, they may be tied or bonded together. Tied joints should be formed using expanded metal strip, wall ties or equivalent fixings, at maximum 300mm vertical centres.



Block bonding internal masonry walls to inner leaf



Block bonding internal walls to inner leaf using ties

Where the external wall cavity needs to be closed at the junction with the separating wall with a flexible cavity stop, but not if the cavity is fully filled with built-in insulation (where permitted).

Beams and lintels

Beams and lintels shall be satisfactory for their purpose. Concrete and steel lintels should be appropriate for use in masonry walls. Support for masonry should not be provided by timber lintels.

Items to be taken into account include:

- Loads and spans are in accordance with the manufacturer's recommendations.
- Wall and cavity thicknesses.
- Bearing capacity of the masonry supporting the lintel or beam.

Steel beams should be designed by an Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used on a project in a coastal location, please follow the requirements for additional corrosion protection 'Appendix B - Coastal Locations'.

Minimum bearing lengths of lintels

Lintels should extend beyond each end of openings in masonry as follows:

Span (m)	Minimum length of bearing (mm)
Up to 1.2	100
Over 1.2	150

- Steel lintels should comply with the manufacturers installation guidance.
- Where structurally necessary, provide padstones under the bearings of lintels and beams.
- Beams and lintels should bear on a full masonry unit.
- Non-load bearing partitions shall have acceptable strength and be adequately supported.

Method of supporting partitions

Masonry partitions should be supported on one of the following:

- A suitable foundation.
- Other masonry partitions or walls (wherever conceivable, the design of buildings should be such that the first floor masonry partitions are an extension of those on the ground floor).
- Structural concrete floors.
- Steel or concrete beams.

It may be necessary to use padstones at bearings where steel or concrete beams are to be used.

Masonry partitions should not be supported by timber joists or beams.

Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing. Allowance should be given in the design for the relatively flexible nature of the timber and the rigid nature of masonry.

Walls and partitions that are supported off structural floors, should not be built directly off a compressible layer forming part of a floating floor system.

Minimum masonry thickness to achieve fire resistance

Material	1/2 hour FR	1 hour FR
Brick	90mm thickness	90mm thickness
Block	90mm thickness	90mm thickness

All internal, separating and compartment walls should have the fire resistance required by the Building Regulations.

Penetrations in fire resisting masonry construction must be designed to meet the requirements of the Building Regulations.

Fire stopping in apartments and flats with a floor over 4.5m will have additional requirements. Please see 'Internal Walls - General Requirements - Cavity Barrier and Fire Stopping' for further guidance.

Fire doorset

Where an internal wall is required to fulfil a fire resisting function, any fire doorset installed in it must maintain the period of fire resistance of the internal wall and the following must be satisfied:

- The fire door and frame must be installed as a combined tested fire doorset and not made from either different untested components or components from different products which were not tested together.
- Proof of fire test performance to be available to demonstrate meeting the requirements of the relevant Building Regulations.
- Suitable approved linear gap sealing systems must be utilised to protect the frame and supporting construction gap. These should be applied subject to the conditions contained in the relevant fire test certification.
- The fire doorset must be installed as per manufacturer's instructions.

Fire doorsets between a dwelling and attached/integral garage must be half-hour fire resisting, be fitted with a self-closer and also meet the above requirements.

It is recommended that third party accredited installers are used as this provides a means of ensuring that installations have been conducted by knowledgeable contractors and are to appropriate standards.

Openings for pipes and ducts in fire resisting walls

Pipes and ducts which pass internally through fire resisting walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

For pipes and ducts passing through compartment walls, guidance supporting the relevant Building Regulations will need to be consulted for additional provisions.

Sound insulation

Internal separating walls shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

Wall ties for cavity separating walls

To provide structural stability, the two leaves of a masonry cavity separating wall should normally be tied together.

Sound transmission across the cavity should be limited by the type of tie and spacing.

Ties should be specified in accordance with the System Designer's recommendations for separating walls. The type of tie and spacing should limit sound transmission across the cavity.

To limit sound transmission, metal tie straps should be:

- No more than 3mm thick.
- Fixed below ceiling level.
- Spaced at least 1.2m apart horizontally.

Thicker ties, fixed at ceiling level or more closely spaced, will increase sound transmission through the cavity.

Chases in party walls

Chases in masonry walls for service pipes and cables should be avoided. Where unavoidable, chases should:

- Only be made in solid masonry (not hollow blocks).
- A horizontal chase must not exceed 1/6 the thickness of the single leaf.
- A vertical chase must not exceed 1/3 the thickness of the wall.
- Electric sockets should be staggered either side of a party wall.

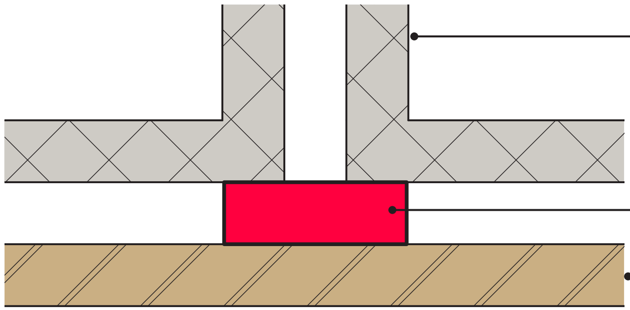
Fire resistance

Typically, in buildings, a half-hour or one-hour fire-resistance from both sides is required to satisfy the relevant Building Regulations with regard to fire separation between buildings and/or compartments within buildings.

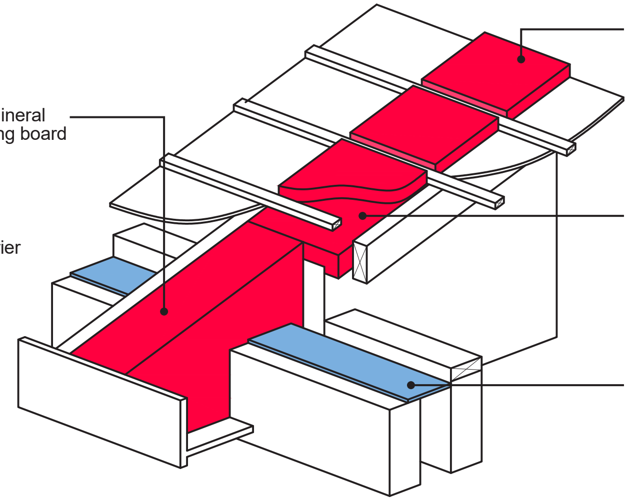
Compartment walls that are common to two or more buildings should run the full height of the building in a continuous vertical plane and should be continued through the roof space.

Where a compartment wall meets another external wall or floor junction fire resistance should be maintained.

Fire stopping within the cavity on the party wall line



Fire stopping at roof level between party walls



Fire stopping should be provided in accordance with the relevant Building Regulations.

- Party/separating walls should be finished 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed.

Spandrel panel construction

Spandrel panels are generally a softwood structural frame with head and soleplates with vertical studs at 600 centres. The typical section sizes are 47mm x 72mm where joints are plated and 38mm x 89mm where joints are nailed. The designer should provide supporting calculations for the design of the spandrel panel upon request.

Fire resistance

Fire resistance should be provided on a site-by-site basis; however generally for party walls a minimum of 60 minutes' fire resistance from both sides is required. Plasterboard should be fixed at a minimum of 300 centres with plasterboard screws, the screws should penetrate a minimum of 25mm into the timber studs, and joints of the plasterboard should be over timber studs or noggins and staggered.

Fire stopping should be provided above the panel between the roofing membrane and in between the battens, the fire stopping should continue into the boxed soffits. Where the spandrel panel is sat on a masonry wall fire stopping is required between the panel and the wall.

In the case of a fire the party wall the spandrel panels should be designed to remain in place should one side of the roof structure be burnt away, as a result party wall spandrel panels should be restrained from both sides.

Party wall spandrel panels for ease of handling may consist of a number of panels, it is important that these panels are suitably jointed as not to impair the required fire resistance of the panel.

Acoustic requirements

Spandrel panels should meet the relevant Building Regulations. If robust details are being used it is important that the construction of the party wall is in conjunction with the robust details.

In a cold roof where masonry party walls are used in conjunction with a single piece panel, the masonry walls should extend a minimum of 300mm above the ceiling line and incorporate a suitable cavity closer to close the cavity.

Weather protection

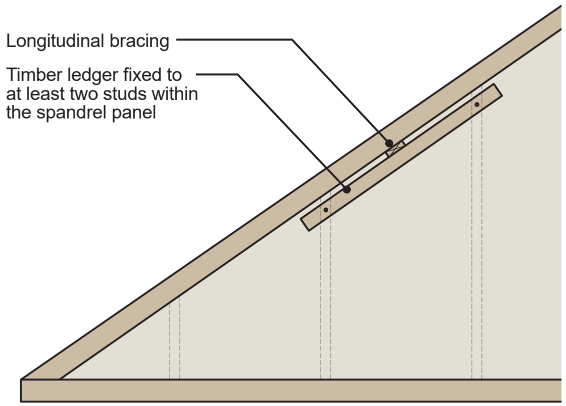
Any impervious weather protection should be removed sufficiently to allow the panels to breathe.

Lateral restraint of the spandrel panel at roof level

The spandrel panel should be restrained at roof level this should be on both sides of the panel and should be in accordance with the design typically at 2m centres. Common methods of achieving this are:

- Fixing a timber ledger to the face of the spandrel panel to at least 2 vertical studs and fixing a timber to the top of the timber ledger, which extends back over a minimum of three trusses at 2m centres, **or**
- Using restraint straps at 2m centres (this may commonly need to be increased to 1.8m centres to coincide with the vertical studs) fixed to vertical studs within the panel and extending back over three trusses, these straps should be supported by noggins in between the truss. The restraint should not impair the fire resistance of the panel.

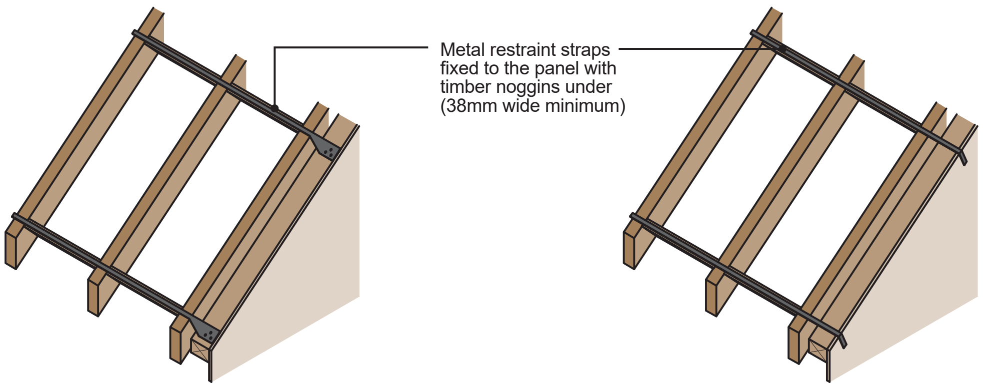
Lateral restraint of the spandrel with the use a timber ledger and lateral bracing



Head restraint may be achieved through timber bracing. Requirements for the spandrel panel head restraint are as follows:

- Lateral bracing at a maximum 2m centres.
- Minimum bracing section 25mm x 100mm, fixed using 2mm x 3.35mm x 65mm galvanised wire nails to top edge of the timber ledger.
- Timber ledger minimum section 45mm x 72mm and minimum length 900mm.
- Timber ledger screw-fixed with minimum 100mm long screws to at least two vertical studs within the panel.
- Lateral bracing should be fixed to a minimum of three trusses (note: 3.1mm machine nails may be used in lieu of 3.35mm standard wire nails).

Lateral restraint of the spandrel with the use a restraint strap



Head restraint may be achieved through metal restraint straps. Requirements for the spandrel panel head restraint are as follows:

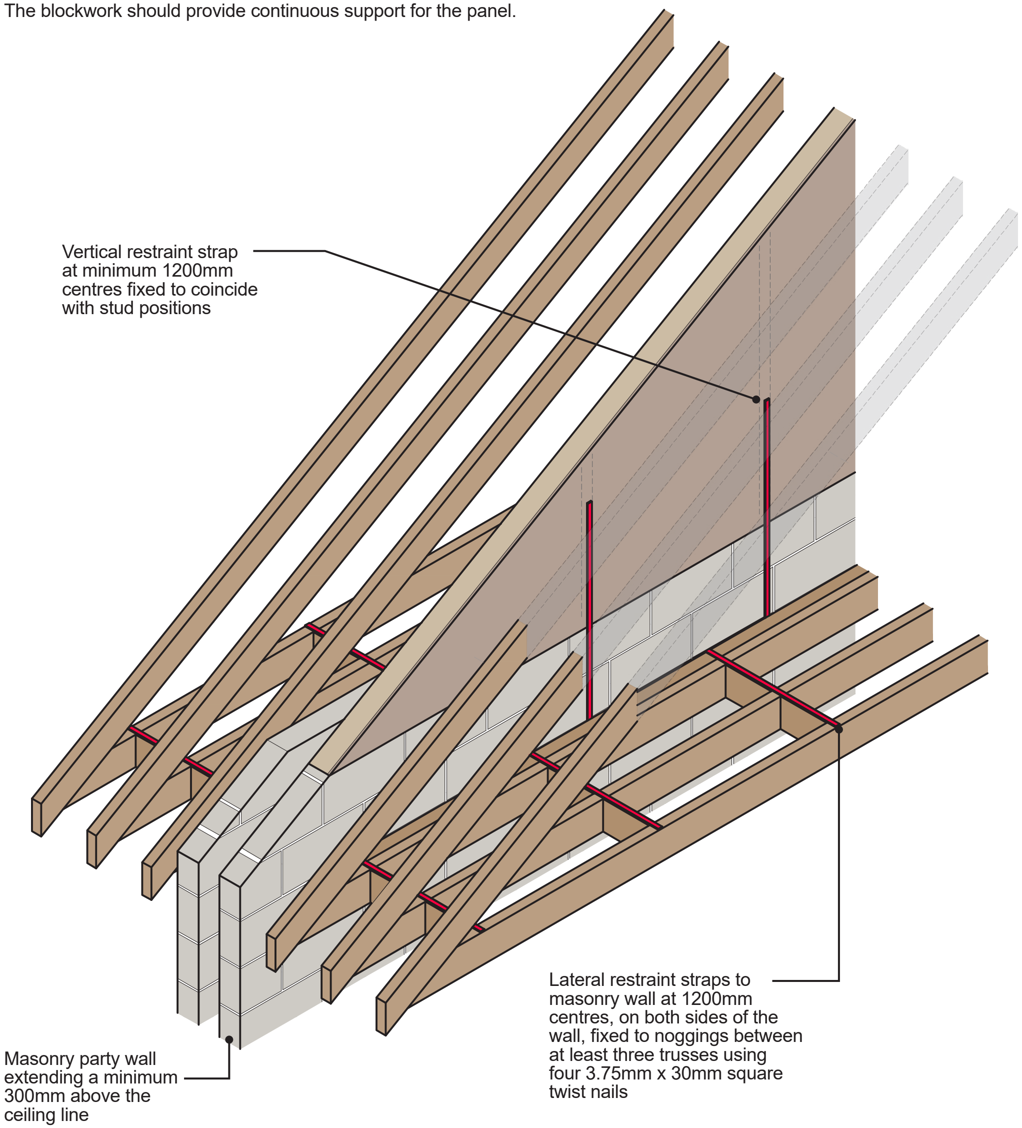
- Lateral bracing to be fitted at apex and along rafters and ceiling joists maximum two-metre centres (no more than 1.25m centres for dwellings over three storeys or over two storeys in Scotland).
- Minimum 38mm x 63mm noggings fixed between at least three trusses.
- Metal restraint strap fixed to noggings with eight 3.75mm x 30mm square twisted nails evenly spaced.
- End of metal restraint strap to be screw-fixed to studwork within spandrel with minimum 50mm-long screws.

Restraint requirements for party wall spandrel panels at low level

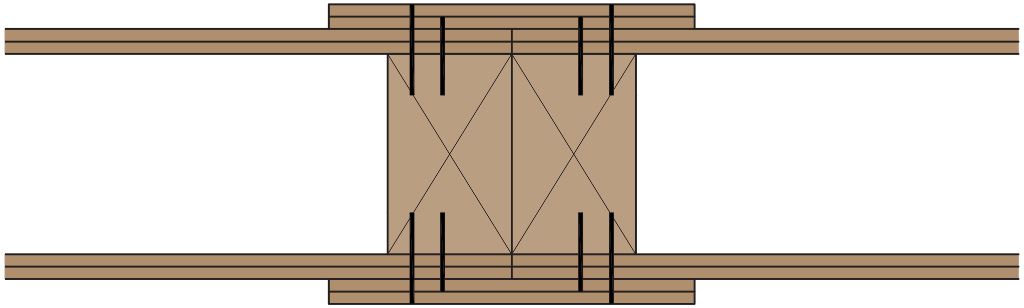
Vertical restraint strap requirements
Party wall spandrel panels should be fixed to the head of the masonry wall, this can be achieved with the use of vertical restraint straps at centres specified by the designer. These are typically placed at a minimum of 1200mm centres and face fixed to coincide with stud positions. The strap length should ensure a minimum of two fixings into the panel framework and three fixings into the blockwork, into a minimum of 2 blocks.

Lateral restraint of the masonry wall
In addition, lateral restraint straps are required to the masonry wall at 1200mm centres on both sides of the wall. The lateral restraint straps should be fixed to noggins between at least 3 trusses using four 3.75mm x 30mm square twist nails.

The blockwork should provide continuous support for the panel.



Spandrel panel connections



- Joints should be backed by timber.
- Where panels are butt jointed cover strip should be fitted. The correct lapping must be to the manufactures requirements to achieve adequate fire resistance, generally the cover strip should be a minimum of 150mm wide.
- The cover strips should provide the same fire resistance as the rest of the wall. Each cover strip should be independently fixed and the joints of the cover strip should be staggered.
- Fixings should penetrate the timber by a minimum of 25mm.

7.
Internal Walls

7.2
Timber Stud

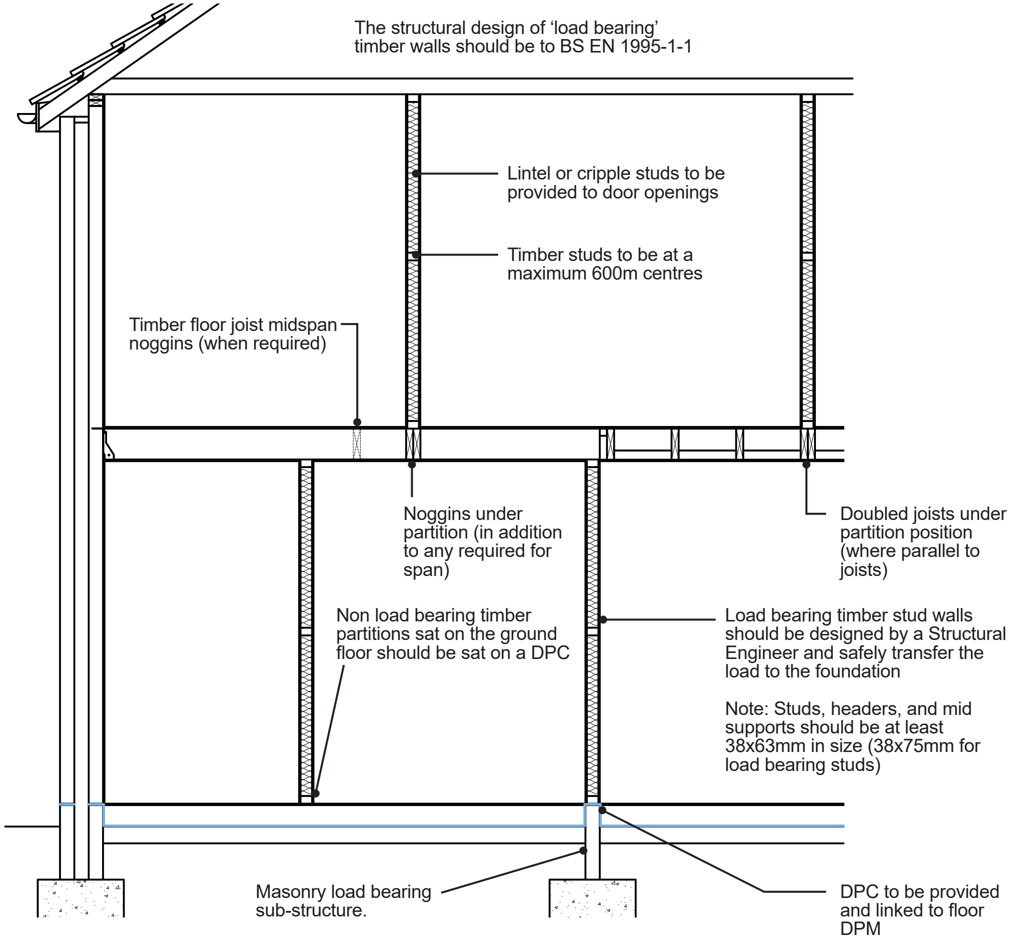
Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

- Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
- Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
- Site specific supporting calculations confirming design loading where required.
- Details of proposed fire stopping and cavity barriers.
- Details relating to service penetrations.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Internal timber partitions (load bearing and non load bearing)



Damp proof course (DPC) and damp proof membrane (DPM)

Where partitions are placed onto concrete round floors a DPC should be provided directly below regardless of if there is a DPM beneath the slab.

Note:

1. Internal partitions should not be supported by compressible layers forming part of a floating floor unless suitable for that purpose.
2. Internal framed partitions between bedrooms or rooms containing WC’s and other rooms, must achieve adequate sound resistance.

Load-bearing timber walls and partitions

Load-bearing timber internal walls are to be designed to provide support and transfer loads to foundations safely and without undue movement.

The structural design of load-bearing timber walls should be in accordance with BS EN 1995-1-1.

Structural timber should be specified according to the strength classes, e.g. C16 or C24.

Load-bearing partitions should be designed by an Engineer.

Structural elements of load bearing partitions

Typically, individual studs, sills and head plates are to be 38mm x 75mm. Larger timber section sizes are required to achieve satisfactory levels of fire resistance. 38mm x 89mm are common for low rise housing in the UK. Studs should be spaced at maximum 600mm centres.

Lintels and studs

A lintel and cripple studs are to be provided to any opening other than where the stud spacing is not affected. Traditionally, multiple studs will be used to support multiple joists.

Where internal walls are made-up of panels, structural continuity is to be maintained, for example through the use of a continuous top binder.

Framing joints need to be secured with a minimum of two nails per joint.

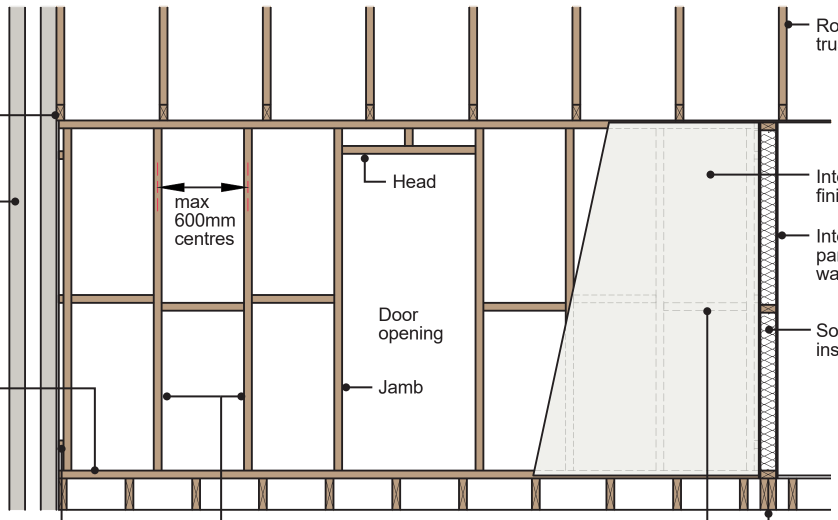
Beams and lintels

Beams and lintels shall be satisfactory for their purpose.

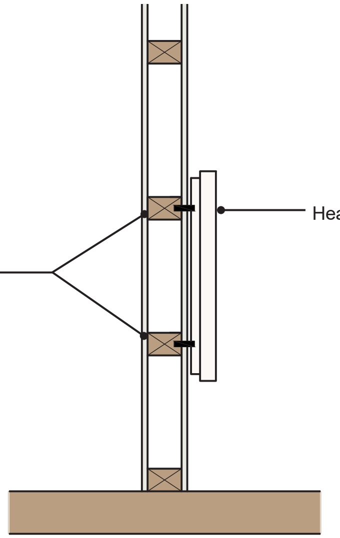
Items to be taken into account include:

- Loads and spans are in accordance with the manufacturer’s recommendations.
- Wall thicknesses.
- Bearing capacity of the wall construction supporting the lintel or beam.

Timber stud partitions



Support of heavy timber fixtures



Where partitions are to support heavy items such as radiators or kitchen cupboards, additional noggins or plywood sheathing should be provided within the stud partition to accommodate fixings.

Partition construction

The following partition constructions are satisfactory:

- Loading bearing timber stud partitions using studs, sills and head plates nominally 75mm x 38mm.
- Non load bearing timber stud partitions using studs, sills and plates nominally 63mm x 38mm.*
- Maximum 450mm spacing for 9.5mm boards.
- Maximum 600mm spacing for 12.5mm-20mm boards.

Partitions should be robust and form a smooth, stable, plane surface to receive decoration:

- Supporting members should be accurately spaced, aligned and levelled.
- The tolerance of horizontal straightness of a partition should be +/-10mm over a 5m length.
- The deviation in vertical alignment of a partition in any storey height should be +/-10mm.
- Timbers supporting plasterboard should be regularised and have a moisture content not greater than 20% at the time of erection (lower moisture contents can reduce incidents of nail popping and other effects of shrinkage).

* Note: Stud partitions should be no less than 38mm wide and no less than 63mm thick (up to a maximum partition height of 2.4m), and 89mm thick up to a maximum partition height of 3m. However, in order to accommodate tolerances for plasterboard fixing, a minimum width of 44mm is recommended.

The use of oak in the external wall construction

Green oak, air dried (seasoned)/kin dried oak is not acceptable in the external wall construction, frame, window/door construction, internal wall or roof constructions, regardless of whether it forms part of the weather proof envelope or not. Projects incorporating such oak will not be acceptable for Warranty cover except where described in ‘Appendix C - Materials, Products, and Building Systems’ of this Manual.

Method of supporting partitions

Walls and partitions are to be supported by the structural floor, only if the material is specifically manufactured for that purpose; it is not to be supported by a floating floor that incorporates a compressible layer.

Extra noggins or joists should be specified where stud partitions or proprietary plasterboard partitions are supported by a timber floor, unless it can be shown that the deck can transfer the load without undue movement. Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing.

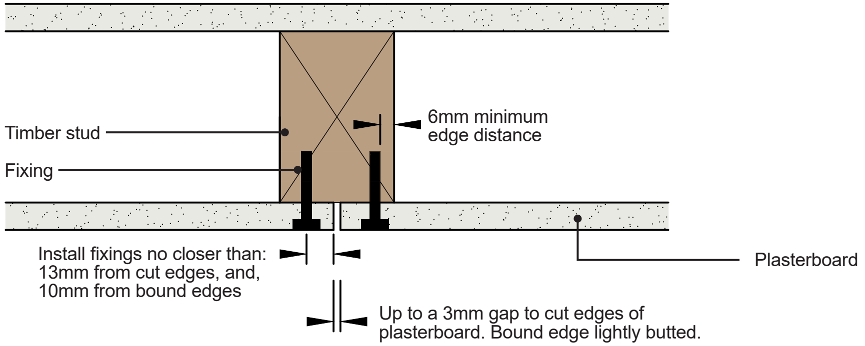
Head and sole plates should consist of single length members fixed to the building structure at no less than 600mm centres.

Partitions should be located on double joists when parallel to floor joist span and nailed to 50mm x 50mm noggins fixed between ceiling joists at 600mm centres when parallel to ceiling joist span. For short lengths of partitions (1.2m maximum), blocking between joists at 600mm centres may be used. Intersecting head and sole plates should be skew nailed together.

Timber members should be fixed together with a minimum of 2 No. 75mm long x 2.65mm diameter nails. Proprietary partitions of plasterboard, strawboard or other material must be detailed and constructed in accordance with the manufacturer’s recommendations.

Walls and partitions that are supported off structural floors, should not be built directly off a compressible layer forming part of a floating floor system.

Fixing of plasterboard to studs at joint positions



Plasterboard joints and fixings

Supports for plasterboard should be designed so that the following span limits are not exceeded.

Board thickness	Timber support centres (mm)	Intermediate noggins required
9.5mm	400mm	No
	450mm	Yes
12.5mm	400mm	No
	450mm	No
	600mm	Yes
15mm	600mm	No

When fixing plaster boarding:
- Fix with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends. Fix to timber studs using dry-wall screws.
- When dry lining, plasterboard can be fixed to walls using adhesive dabs or by screwing to timber battens.

Note: Where adhesive dabs are used, the plasterboard manufacturers recommendations must be followed.

Alternatively, a proprietary wall system can be used, providing it has full third-party accreditation. Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

Minimum periods of fire resistance

Material	½ hour FR	1 hour FR
Plasterboard on timber	12.5mm board on both sides of framing	Two layers of 12.5mm board on both sides of framing or proprietary fire boards (typically 12.5mm-15mm) on both sides of framing
Plasterboard on laminated wall	12.5mm laminated on both sides of 19mm board	Refer to manufacturers recommendations

All internal, separating and compartment walls should have the fire resistance required by the relevant Building Regulations.

Fire doorsets

Where an internal wall is required to fulfil a fire resisting function, any fire doorset installed in it must maintain the period of fire resistance of the internal wall and the following must be satisfied:
- The fire door and frame must be installed as a combined tested fire doorset and not made from either different untested components or components from different products which were not tested together.
- Proof of fire test performance to be available to demonstrate meeting the requirements of the relevant Building Regulations.
- Whilst some gaps between the fire door frame and opening may be present, they should be kept to a minimum and be no greater than the gaps stipulated in the fire test certification. Expanding fire foam which has relevant testing and certification may be used to seal gaps up to 10mm.
- The fire doorset must be installed as per manufacturer’s instructions.

Fire doorsets between a dwelling and attached/integral garage must be half-hour fire resisting, be fitted with a self-closer and also meet the above requirements.

Openings for pipes and ducts in fire resisting walls

Pipes and ducts which pass internally through fire resisting walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

For pipes and ducts passing through compartment walls, guidance supporting the relevant Building Regulations will need to be consulted for additional provisions.

Internal plastering

Internal plastering should comply with BS EN 3914-2.

Plasterboard should be to BS EN 520: Gypsum plasterboards - Definitions, requirements and test methods.

Plasterboard thickness should be:

- 9.5mm for stud spacing up to 450mm.
- 12.5mm for stud spacing up to 600mm.

This guidance covers all plastered finishes to walls and ceilings. The workmanship of plastered finishes should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

Plaster mixes

Plaster mix ratios should be in accordance with manufacturer’s recommendations and be appropriate for the intended use.

Minimum plaster thickness

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified, and be of a suitable quality so that a decorative finish can be applied. Please refer to the ‘Tolerances’ section for further guidance.

Plastering of plasterboard walls

Plasterboard walls should be skimmed to provide a suitable and durable finish. A minimum of one coat is required.

Sound insulation

Internal separating walls shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

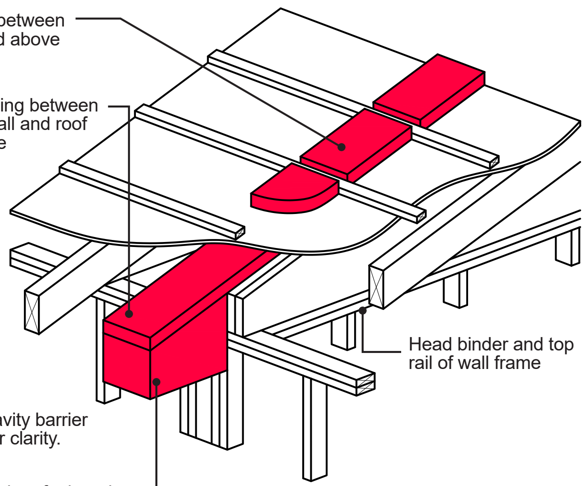
Method of supporting partitions

Walls and partitions are to be supported by the structural floor only if the material is specifically manufactured for that purpose; it is not to be supported by a floating floor that incorporates a compressible layer.

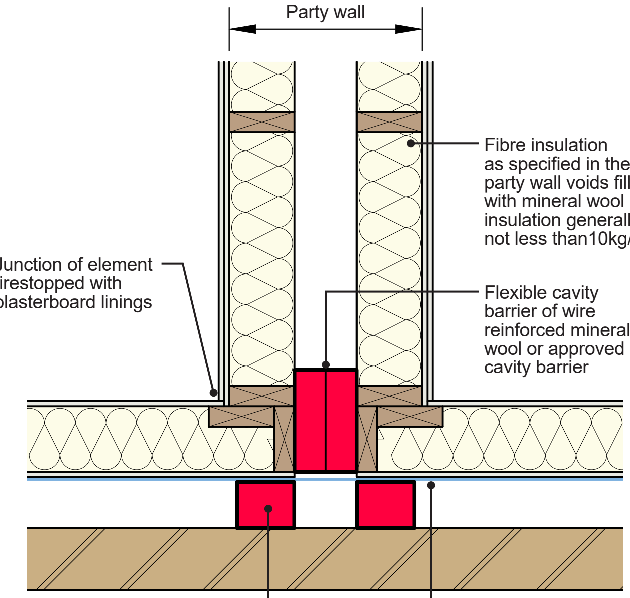
Extra noggins or joists should be specified where stud partitions or proprietary plasterboard partitions are supported by a timber floor, unless it can be shown that the deck can transfer the load without undue movement.

Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing.

Fire stopping at roof level between party walls



Fire stopping within the cavity on the party wall line



Fire stopping

Where separating walls and compartment walls meet a roof, further guidance can be found in the 'Roofs' section.

Penetrations in walls that are required to have fire resistance must be designed to meet the requirements of the Building Regulations. Fire stopping in apartments and flats with a floor over 4.5m will have additional requirements. Please see 'Internal Walls - General Requirements - Cavity Barriers and Fire Stopping' for further guidance.

Fire stopping should be provided in accordance with the relevant Building Regulations.

- Party/separating walls should be finished 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed.

Fire resistance

Typically, in dwellings, a half-hour or one-hour fire-resistance is required to satisfy the relevant Building Regulations with regard to fire separation between dwellings and/or compartments within dwellings.

Compartment walls that are common to two or more buildings should run the full height of the building in a continuous vertical plane and should be continued through the roof space.

Where a compartment wall meets another external wall or floor junction fire resistance should be maintained.

All internal, separating and compartment walls should have the fire resistance required by the relevant Building Regulations.

Penetrations in walls that are required to have fire resistance must be designed to meet the requirements of the relevant Building Regulations.

Electrical sockets in party walls

Electrical sockets within the party walls should be avoided where possible, where this is not possible the fire and sound resistance of the walls should be maintained.

Sockets should not be installed back to back in party walls. Please refer to the 'Electrical Services' section for further guidance.

7.
Internal Walls

7.3
Metal Stud

METAL STUD: Non load bearing internal metal partitions

Provision of Information

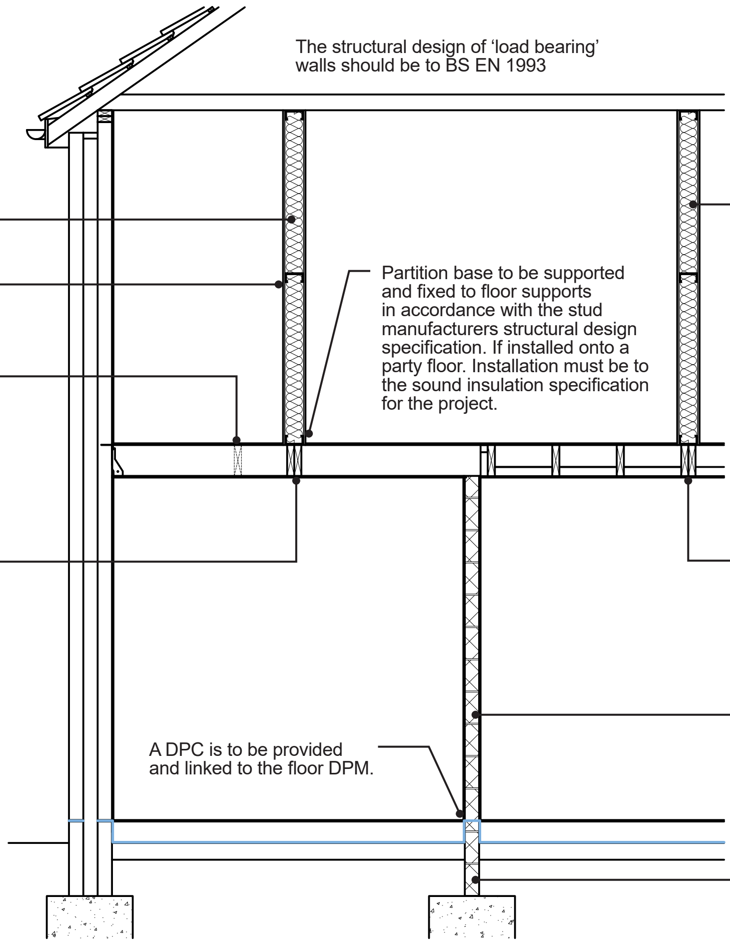
A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

- Floor plans indicating the positions of internal walls - load-bearing and non-load-bearing.
- Specifications relating to the proposed construction of internal walls and formation of openings including lintels.
- Site specific supporting calculations confirming design loading where required.
- Details of proposed fire stopping and cavity barriers.
- Details relating to service penetrations.

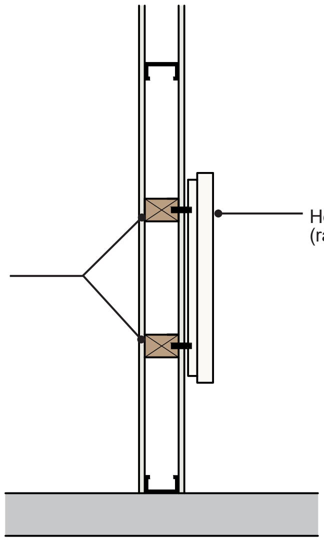
The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Metal stud system

There are a number of proprietary systems on the market. This traditionally consists of U-shaped channels that act as ceiling (head), base plates (tracks) and the vertical studs. The advantage of this system is that it is lightweight, versatile and quick to erect. Installation should always be carried out in accordance with the manufacturer's instructions. Plasterboard coverings are screw-fixed to the metal studs, with the perimeter studs/tracks generally being mechanically fixed to the surrounding walls, ceilings and floors. It may be necessary to provide earth-bonding to the metal stud system.



Support of heavy timber fixtures



Where additional loads will be applied to the walls e.g. radiators or kitchen cabinets, these may require additional strengthening support as per the manufacturers guidance

Proprietary systems

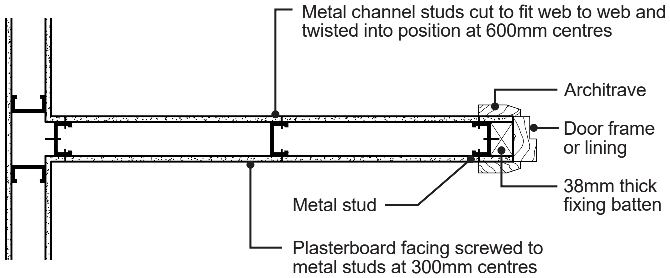
Proprietary systems are to be specified in accordance with the manufacturer's recommendations.

Metal stud system

There are a number of proprietary systems on the market.

This traditionally consists of U-shaped channels that act as ceiling (head), base plates (tracks) and the vertical studs. The advantage of this system is that it is lightweight, versatile and quick to erect. Installation should always be carried out in accordance with the manufacturer's instructions. Plasterboard coverings are screw-fixed to the metal studs, with the perimeter studs/tracks generally being mechanically fixed to the surrounding walls, ceilings and floors.

Metal stud partition (plan)



Method of supporting partitions

Walls and partitions are to be supported by the structural floor only if the material is specifically manufactured for that purpose; it is not to be supported by a floating floor that incorporates a compressible layer.

Extra noggins or joists should be specified where stud partitions or proprietary plasterboard partitions are supported by a timber floor, unless it can be shown that the deck can transfer the load without undue movement.

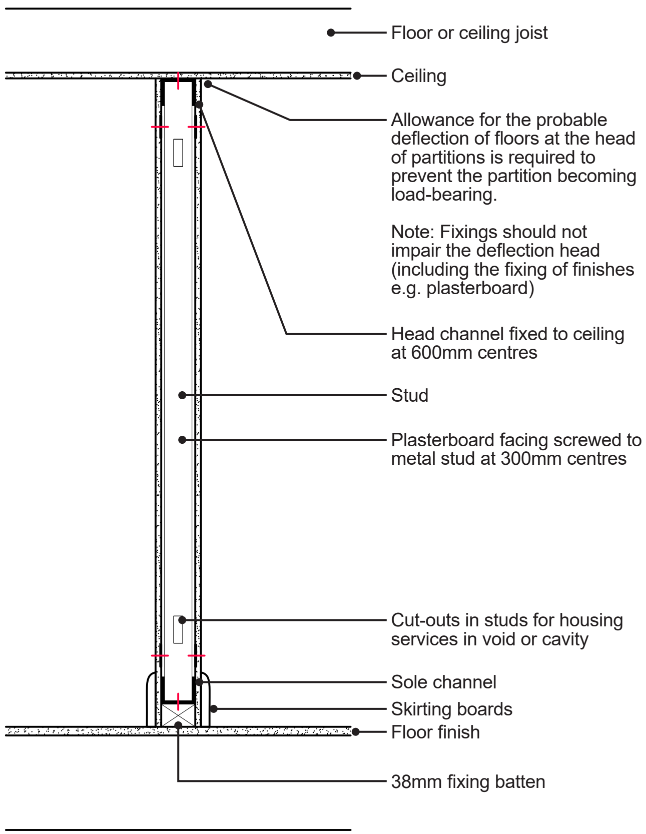
Allowance for the probable deflection of floors at the head of partitions is required to prevent the partition becoming load-bearing.

Head and sole plates should consist of single length members fixed to the building structure at no less than 600mm centres.

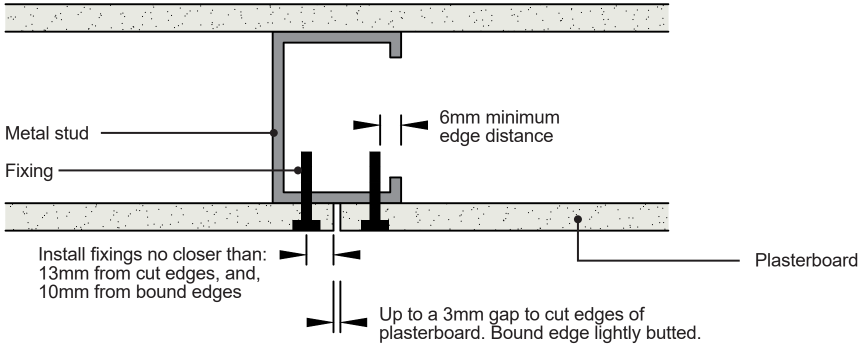
Partitions should be located on double joists when parallel to floor joist span and nailed to 50mm x 50mm noggins fixed between ceiling joists at 600mm centres when parallel to ceiling joist span. For short lengths of partitions (1.2m maximum), blocking between joists at 600mm centres may be used. Intersecting head and sole plates should be fixed in accordance with the manufacturers recommendations.

Proprietary partitions of plasterboard, strawboard or other material must be detailed and constructed in accordance with the manufacturer's recommendations.

Metal stud partition



Fixing of plasterboard to studs at joint positions



Plasterboard joints and fixings

Supports for plasterboard should be designed so that the following span limits are not exceeded.

Board thickness	Timber support centres (mm)	Intermediate noggins required
9.5mm	400mm	No
	450mm	Yes
12.5mm	400mm	No
	450mm	No
	600mm	Yes
15mm	600mm	No

When fixing plaster boarding:

- Fix with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.
- Fix metal studs using dry-wall screws.
- When dry lining, plasterboard can be fixed to walls using adhesive dabs or by screwing to metal battens.

Note: Where adhesive dabs are used, the plasterboard manufacturers recommendations must be followed.

Alternatively, a proprietary wall system can be used, providing it has full third-party accreditation. Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

Minimum periods of fire resistance

All internal, separating and compartment walls should have the fire resistance required by the relevant Building Regulations.

Fire doorsets

Where an internal wall is required to fulfil a fire resisting function, any fire doorset installed in it must maintain the period of fire resistance of the internal wall and the following must be satisfied:

- The fire door and frame must be installed as a combined tested fire doorset and not made from either different untested components or components from different products which were not tested together.
- Proof of fire test performance to be available to demonstrate meeting the requirements of the relevant Building Regulations.
- Whilst some gaps between the fire door frame and opening may be present, they should be kept to a minimum and be no greater than the gaps stipulated in the fire test certification. Expanding fire foam which has relevant testing and certification may be used to seal gaps up to 10mm.
- The fire doorset must be installed as per manufacturer’s instructions.

Fire doorsets between a dwelling and attached/integral garage must be half-hour fire resisting, be fitted with a self-closer and also meet the above requirements.

Openings for pipes and ducts in fire resisting walls

Pipes and ducts which pass internally through fire resisting walls (unless in a protected shaft) must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through walls should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction.

For pipes and ducts passing through compartment walls, guidance supporting the relevant Building Regulations will need to be consulted for additional provisions.

Internal plastering

Internal plastering should comply with BS EN 3914-2.

Plasterboard should be to BS EN 520: Gypsum plasterboards - Definitions, requirements and test methods.

Plasterboard thickness should be:

- 9.5mm for stud spacing up to 450mm.
- 12.5mm for stud spacing up to 600mm.

This guidance covers all plastered finishes to walls and ceilings. The workmanship of plastered finishes should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

Plaster mixes

Plaster mix ratios should be in accordance with manufacturer’s recommendations and be appropriate for the intended use.

Minimum plaster thickness

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified, and be of a suitable quality so that a decorative finish can be applied. Please refer to the ‘Tolerances’ section for further guidance.

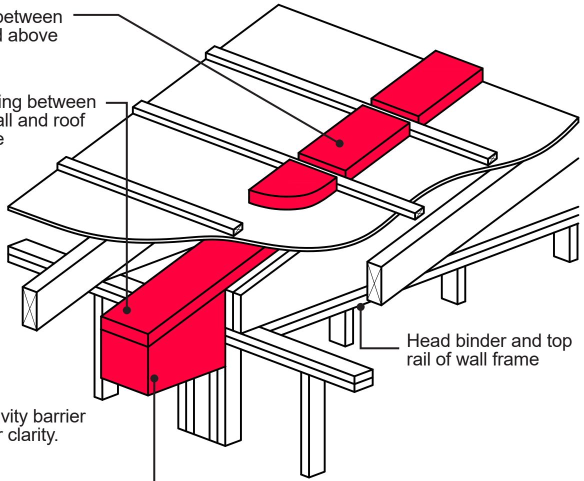
Plastering of plasterboard walls

Plasterboard walls should be skimmed to provide a suitable and durable finish. A minimum of one coat is required.

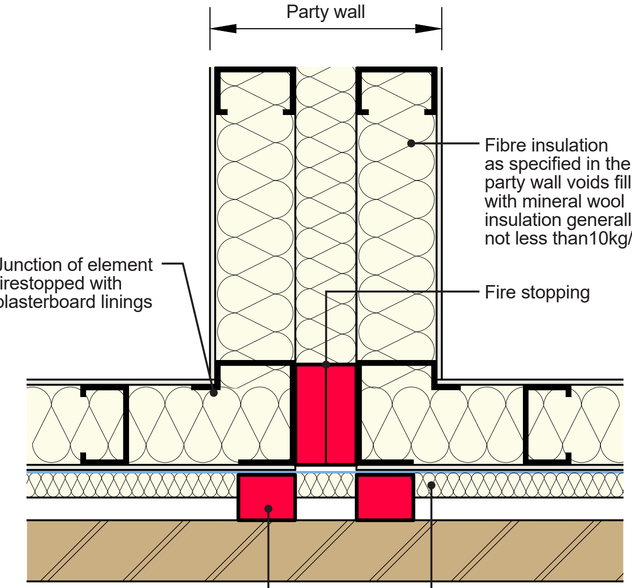
Sound insulation

Internal separating walls shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

Fire stopping at roof level between party walls



Fire stopping within the cavity on the party wall line



Fire stopping

Where separating walls and compartment walls meet a roof, further guidance can be found in the 'Roofs' section.

Penetrations in walls that are required to have fire resistance must be designed to meet the requirements of the relevant Building Regulations. Fire stopping in apartments and flats with a floor over 4.5m will have additional requirements. Please see 'Internal Walls - Cavity Barriers and Fire Stopping' for further guidance.

Fire stopping should be provided in accordance with the relevant Building Regulations.

- Party/separating walls should be finished 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed.

Fire resistance

Typically, in dwellings, a half-hour or one-hour fire-resistance is required to satisfy the relevant Building Regulations with regard to fire separation between dwellings and/or compartments within dwellings.

Compartment walls that are common to two or more buildings should run the full height of the building in a continuous vertical plane and should be continued through the roof space.

Where a compartment wall meets another external wall or floor junction fire resistance should be maintained.

All internal, separating and compartment walls should have the fire resistance required by the relevant Building Regulations.

Penetrations in walls that are required to have fire resistance must be designed to meet the requirements of the relevant Building Regulations.

Electrical sockets in party walls

Electrical sockets within the party walls should be avoided where possible, where this is not possible the fire and sound resistance of the walls should be maintained.

Sockets should not be installed back to back in party walls. Please refer to the 'Electrical Services' section for further guidance.

7.
Internal Walls

7.4
Cavity Barriers and Fire Stopping

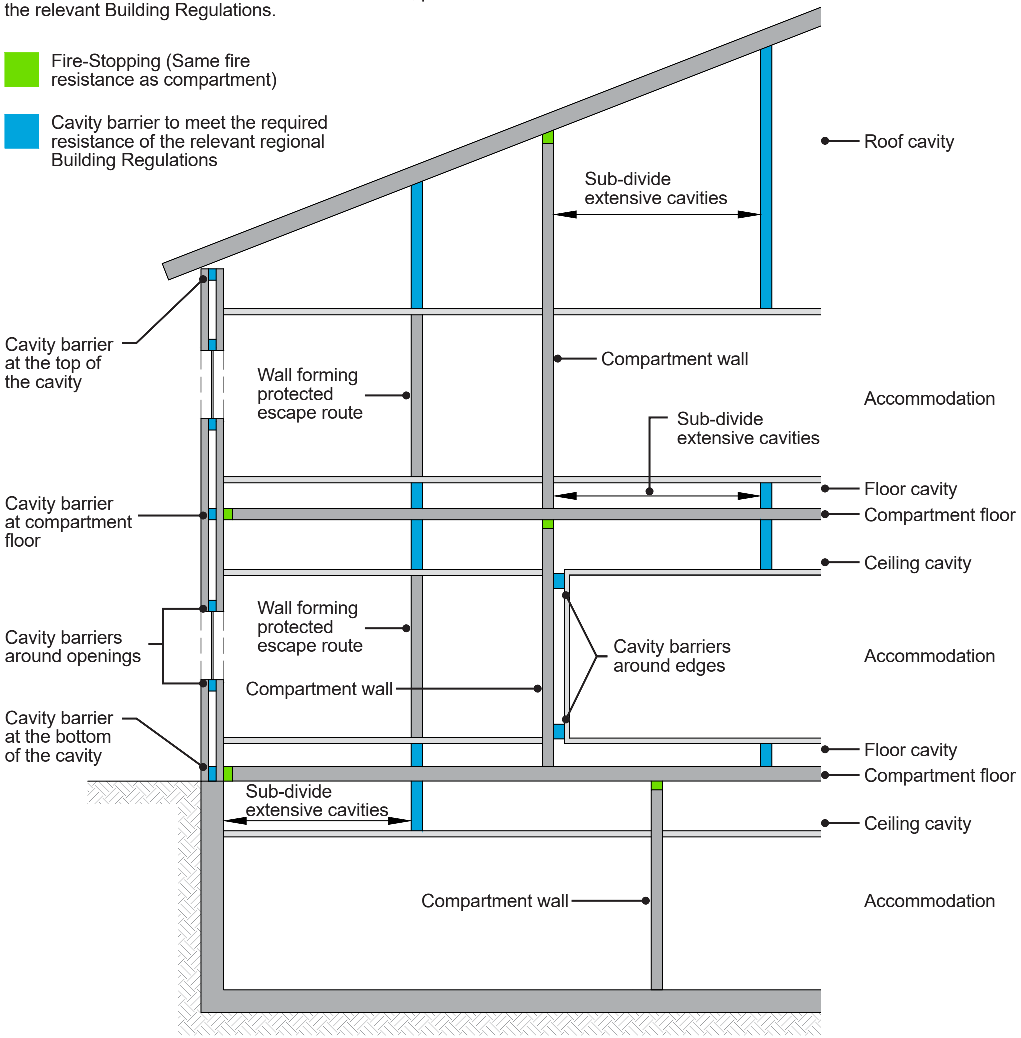
Openings for pipes in separating elements

Pipes which pass through fire separating elements (unless in a protected shaft) shall:

- Have an approved proprietary sealing system that has a UKAS accredited test to prove it will maintain the fire resistance of the wall. Note: It should only be installed as per the test requirements, or,
- Where an approved proprietary sealing system is not used; the pipes penetrating the fire separating element should be restricted in diameter to a maximum size shown in the relevant Building Regulations and fire stopping used around the pipe, or,
- A sleeving system with a maximum 160mm internal diameter is used as specified in the relevant Building Regulations.

Provisions for cavity barriers and fire stopping

For more information on the subdivision of cavities, please see the relevant Building Regulations.



Note: Diagrams courtesy of the approved documents for England

Fire resistance general

All walls should have the fire resistance required by the relevant Building Regulations.

Fire stopping

Penetrations in walls between buildings shall be fire stopped, there are to be no holes or gaps for smoke to pass through once the fire stopping has been fitted.

Further additional requirements for internal fire stopping and fire protection for compartment floors, walls, and roof junctions to flats and apartments with a floor 4.5m or more above the ground

The following additional guidance applies to internal fire stopping and fire protection only to buildings with a floor 4.5m or more above the ground that contain flats or apartments.

Although building legislation is robust in applying provisions for fire protection and fire stopping, it can often be difficult to implement high standards of fire stopping in complex buildings. This can lead to significant safety risks if the building does not have the correct levels of fire protection and if holes in compartment walls are not sealed correctly. This guidance assists Developers in providing good standards of fire stopping and fire protection.

It is not the intention to enhance the requirements of the Building Regulations, but more to ensure that the statutory requirements are applied correctly to the construction. It is therefore deemed that the requirements of Part B of the Building Regulations in England and Wales, or Section 2 of the Scottish Building Standards (whichever is appropriate depending on region), that apply to fire stopping, separating walls, service penetrations, minimum periods of fire resistance and concealed spaces will also meet the requirements of this guidance.

1. Fire stopping

Design information
Drawings showing the lines of compartmentation and the lines of fire-resisting construction should be provided to the Surveyor and the Builder. The drawings should also give the required level of fire resistance for each element. Drawings to show the position of cavity barriers should be provided, and the specification of cavity barriers included.

Materials for fire stopping and cavity barriers
All materials used to form a fire barrier must have relevant third-party certification or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products. A competent person is deemed to be a third-party approved contractor specialising in fire stopping and passive fire protection.

2. Fire protection in buildings

Design information
The design details must show the correct level of fire resistance for the building, in accordance with Part B of the Building Regulations or Section 2 of the Scottish Building Standards, depending on region.

Materials for fire protection
All materials used to form a fire barrier must have relevant third-party certification, or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products.

Where intumescent paints are used to provide the required level of fire protection, certification confirming that the paint applied will achieve the correct level of fire protection is required.

8. External Windows and Doors

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.
4. Indoor air quality is concerned with pollutants or moisture that may affect the health and safety of occupants by humidity, dust, odours or a reduction in oxygen. The occurrence of high indoor temperatures, and the measures to mitigate or control, are a health and welfare matter that is outside the scope of our Warranty that will need agreement with your Building Control provider.

Workmanship

1. Adequate testing and certification is required for any curtain wall and rain screen construction systems.
2. All workmanship must be within the tolerance requirements set out in this Technical Manual.
3. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/ door or ‘decorative external cladding’ (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
7. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
8. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. External window and doors frames, and roof lights shall be designed and constructed so that they:
    a. Meet the requirements of BS 6375-1 are durable and resistant to weather;
    b. Have adequate thermal performance and air tightness;
    c. Have sufficient strength to withstand operational and wind loads;
    d. Offer reasonable resistance to unauthorized entry;
    e. Can be operated readily and safely by the user.
2. Windows and roof lights shall be designed and constructed so that they offer, where necessary, sufficient natural ventilation.
3. External principal entrance doors and frames shall be designed and constructed so that they permit convenient access for users.
4. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
5. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
6. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

8. External Windows and Doors

8.1
General Requirements

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that the external windows and doors are suitable for the site exposure. e.g. A manufacturers declaration of performance for the site.
2. Evidence of certification confirming weather-tightness rating as detailed within BS 6375.
3. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
4. Details of external window and door fixing will be required.
5. Details of sealing around the frame will need to be confirmed.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

Workmanship should follow the recommendations of BS 8213-4.

Factory made and bespoke external windows and doors should be selected to withstand the design weather conditions and be classified and tested in accordance with the following weather performance standards:

- BS 6375-1 Weather tightness.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.

For developments that are 6 storeys and above, the test pressure should be at least 25% of the design wind load for weathertightness. For further information, advise should be sought from our Major Projects Team.

Additional requirements of CWCT Technical Note 95 also apply for developments that are 6 storeys and above.

External bay, oriel and dormer windows require particular care in detailing and fitting so that they are stable, weather tight and reasonably air tight.

Roof lights should be proprietary components, fixed within prepared openings in accordance with the manufacturer's instructions and have effective weather sealing.

Non-timber components should comply with the following British Standards (as appropriate), and be installed and fixed in accordance with the manufacturer's recommendations:

- BS EN 514 Plastics. Poly(vinyl chloride) (PVC) based profiles. Determination of the strength of welded corners and T-joints.
- BS 7412 Specification for windows and doorsets made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles.

External UPVC windows and doorsets should be designed and constructed in accordance with the requirements of the following British Standards:

- BS 6262 Code of Practice for glazing for building.
- BS 6375: 1 Performance of windows.
- BS 7412 Specification for windows and doorsets made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles.
- BS 8213 Windows, doors and roof lights.

External windows and doors should comply with the current Building Regulations taking into consideration:

- Thermal insulation.
- Ventilation.
- Safety.
- Security.

Draught Seals

External doors and opening lights to windows should be reasonably air tight by ensuring that effective draught seals are fitted.

Control of Condensation

External window and door installations must be constructed to ensure resistance to the effects of condensation forming on the surface of the frames, the glazing and at junctions with the surrounding building fabric.

To ensure that condensation does not occur and give rise to mould growth in these areas, external windows and doors must be:

- Thermally efficient to the level identified within the guidance of the relevant Building Regulations.
- Detailed and constructed to ensure continuity of insulation and avoidance of thermal bridges at lintels, sills and jambs.
- Detailed to be contributing to the requirements of airtightness, providing appropriate seals between frame sections, opening lights and at junctions with surrounding fabric e.g. housing window boards into frames to prevent the opportunity for air leakage.

Security

The design and specification of external doors and windows which provide access into a dwelling or into a building containing a dwelling should take into account the requirements of current relevant Building Regulations to ensure the system is classified and tested to the appropriate burglar resistance class.

In addition:

- The frames of secure external doorsets and windows should be mechanically fixed to the building structure in accordance with the manufacturer's tested specifications.
- Where an external doorset is installed in a lightweight framed wall, a resilient layer should be incorporated to reduce the risk of anyone breaking through the wall to access the locking systems. The resilient layer should be for the full height of the door and 600mm either side of the doorset, 9mm timber sheathing or expanded metal may be used.
- Any glazing which if broken in an attempt to gain access to the locking device on a door must be a minimum class of P1A in accordance with BS EN 356:2000.
- A means of caller identification should be provided at the main door to the dwelling to allow means of seeing callers. The same external doorsets should also have a securely fixed door chain or door limiter fitted.
- The external doors and windows should be manufactured to a design that has been shown by tests to meet the security requirements of PAS 24.

External windows and doors installation

External windows and door frames should be installed so that:

- They do not carry loads unless designed to do so.
- They are plumb and square and they satisfy the 'Tolerances' section of this Technical Manual.
- External doors and opening lights to windows should be reasonably air tight by ensuring that effective draught seals are fitted.
- The masonry on the external side of vertical DPC should not be in contact with internal finishes.
- The window head is set back behind the edge of the cavity tray.
- The frame to wall junction is weather tight and reasonably air tight.
- Where checked rebated reveals are provided, the frame should be set back behind the outer leaf and should overlap it. In other areas of exposure, the frame should be set back at least 38mm and overlap the DPC.
- Distortions of doors should be minimized by not locating radiators or other heaters close to doors.
- The reveal should be protected throughout its width by a continuous DPC. The width of the DPC should be sufficient to overlap/be fixed to the frame and fully protect the reveal. Alternatively, an insulated finned cavity closer with third-party certification may be used.
- Proprietary materials with third party certification should be used to close cavities at window and door openings. They should also be installed in accordance with the manufacturer's recommendations.

Check (rebated) reveals

Check (rebated) reveals will be required in the following locations:

- Scotland
- Northern Ireland
- Areas of very severe exposure in England & Wales

Installations into check reveal apertures need to consider the following:

- Frame to be positioned centrally behind the external skin with a minimum overlap of frame behind the external skin of 12mm on both sides.
- Where applicable the frame should be positioned vertically with the head of the frame positioned behind the external wall at the head.
- Vertical DPC within the check should be positioned as far forward as possible, with the vertical DPC between the rear of the external skin and the external face of the frame.

Additional requirements for coastal locations

Where developments are within a coastal location additional Warranty requirements should be met.

For the purpose of this Technical Manual we are considering sites within 5km inland from the shore line or sites located in 'tidal' estuarine areas where they are within 5km of the general shoreline.

Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.

Protection for falling

For houses and flats the guidance in Approved Document K2 (Building Regulations England and Wales) specifies a minimum guard height of 800mm to external window openings in the external wall. This would normally be achieved by forming external window openings of at least 800mm above the finished floor level. The wall beneath the opening is therefore considered to be the barrier to falling.

Where external window openings are formed less than 800mm from the finished floor level, permanent guarding should be provided to the opening in accordance with the design requirements specified in the relevant Building Regulations.

If external window openings are formed less than 800mm from the finished floor level, and there is no permanent guarding provided, and the glass is required to act as the barrier and provide containment to persons falling against it; the glass needs to be designed in accordance with the requirements of BS 6180. The designer shall determine the potential impact energy by establishing the perpendicular unhindered distance that could be travelled prior to impact.

In the absence of an assessment by a suitably qualified person, any glass which is required to provide containment must meet with BS EN 12600 Class 1(C)1.

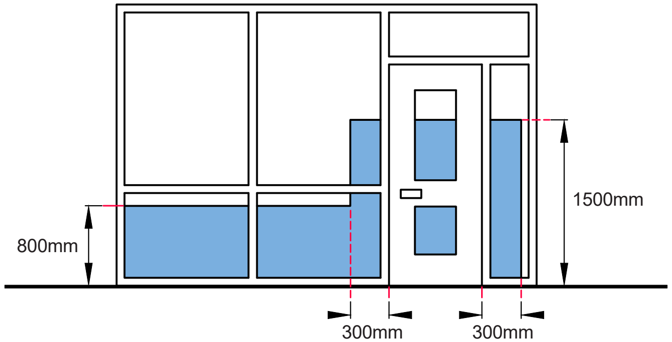
Critical locations

Glazing in doors and windows in areas known as ‘critical locations’ needs to be given special consideration in order to prevent potential injury to people within or around the building.

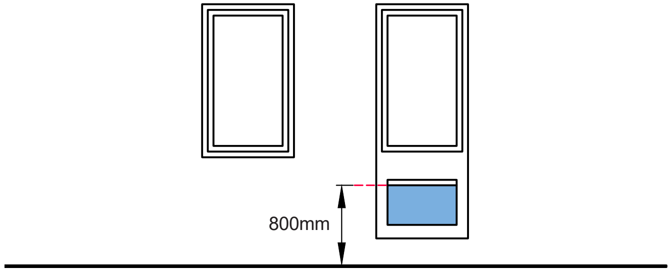
These ‘critical locations’ are:
- In a door or in a side panel adjacent to a door where the glazing is within 300mm of the door and the glazing is situated between floor level and a height of 1500mm.
- In an internal or external wall or partition between floor level and a height of 800mm.

It is important that any glazing within these ‘critical locations’ should be either:
- Provided with permanent protection.
- Small panes.
- Robust.
- Break safely.

Glazing to critical locations - doors and side panels



Glazing to critical locations - windows



If permanent protection is provided in the form of fixed guarding, there is no requirement for the glazing itself to be of a special type. Permanent protection may take the form of railing or barriers and should:
- Be designed to be robust.
- Have a maximum opening or gap in any railing of 75mm or less.
- Be a minimum of 800mm high.
- Be non-climbable (especially where floor is acting as a balcony).

Small panes, either an isolated pane within glazing bars or copper or lead lights should be restricted in size so that any breakage would be strictly limited.

Small panes should be:
- No more than 0.5m² in area.
- No wider than 250mm.

Where annealed glass is used a minimum of 6mm thickness is recommended (4mm for copper or lead lights). Some materials are inherently strong such as glass blocks or polycarbonate, whereas annealed glass will need to be of an increased thickness as the area of the panel increases to be considered ‘safe’. As an alternative to any of the above solutions it is possible for the material to break ‘safely’ when tested to BS EN 12600 which would mean that:

- Only a small opening was created with a limited size of detached particles.
- The balance would create only small pieces that are not sharp or pointed.
- The pane disintegrates with only small detached particles.

A glazing material would be suitable for a critical location if it meets the requirements of BS 6262 - 4 Table 1 when tested in accordance with BS EN 12600. Glass installed in a door or in a side panel to a door that exceeds 900mm wide must meet the relevant requirements of BS EN 12600 and BS 6262 - 4.

Glazing to critical locations

Glazing should be in accordance with BS 6262. Insulated glass units (IGU) should meet requirements of BS EN 1279 - Glass in building - insulating glass units, be CE marked and carry third-party accreditation.
- They should have continuous dual seals; single seal units are not acceptable.
- Desiccant should be provided to spacer bars.
- Any glazing on-site must have a drained and ventilated bottom bead with a minimum gap of 5mm between the edge seal of the insulated glass unit and the bottom channel of the frames glazing rebate.
- Any glazing with an area greater than 1m² must have a drained and ventilated bottom bead with a minimum gap of 5mm between the edge seal of the insulated glass unit and the bottom channel of the frames glazing rebate.
- Glazing with an area less than 1m² may be solid bedded.
- UPVC frames and spacer bars should be stamped with BS 7412, 7413 and 7414.

Linseed oil glazing putty should not be used when the joinery is finished with vapour permeable paint or stain. Glazing putty should also not be used with organic solvent-based stains, the putty should be neatly finished to receive a protective paint coat.

Putty is not suitable for laminated glass and double-glazed units, the workmanship should be in accordance with BS 8000: 7. To ensure the compatibility of the whole glazing system is to a high level of workmanship and control, it is recommended that factory pre-glazed systems be installed in all external openings.

The window beads should suitably lap the external windows and doors to prevent premature degradation of the glazing unit.

External glazing beads should be pinned at a maximum of 150mm centres (a maximum of 50mm from corners) or screwed at 200mm centres (maximum 50mm from corners).

The preferred method of installation for double-glazed units is either:
- Drained and ventilated frames, as recommended by the Glass and Glazing Federation (GGF), where possible this method should be adopted for external glazing.
- Solid bedding of units in 16mm-18mm deep frame rebates; 18mm rebates are recommended by the GGF to allow for tolerances. In all cases, sealants should not be sensitive to ultraviolet light. External glazing beads should be fixed at a maximum of 150mm centres, and the glazing bedded in non-setting putty. Louvre windows should not be used and double-glazing should be fixed and bedded as recommended by the GGF.

Appearance of glazing

Glass must meet the visual assessment criteria of the Glass and Glazing Federation and CWCT Technical Note 35 (TN 35). The total number of faults permitted in a glass unit shall be the sum total of those permitted by the relevant BS EN Standard for each pane of glass incorporated into the unit concerned.

Acceptable faults include:
- Inclusions, bubbles, spots and stains.
- Residues within the insulated glass unit cavity.
- Fine scratches not more than 25mm long.
- Minute particles.

When assessing the appearance of glass:
- The viewing distance used shall be the furthest stated in any of the BS EN Standards for the glass types incorporated in the glazed unit. In the event of doubt the viewing distance shall be three metres.
- The viewing shall commence at the viewing distance and shall not be preceded by viewing at a closer distance.
- The viewing shall be undertaken in normal daylight conditions without use of magnification.

The above does not apply within 6mm of the edge of the pane, where minor scratching is acceptable. Scratches on external doors, windows and frames and factory finished door and window components should not have conspicuous abrasions, or scratches when viewed from a distance of 0.5m.
- Surface abrasions caused during the building-in process should be removed in accordance with the manufacturer’s instructions, which may include polishing out, re-spraying or painting.
- In rooms where there is no daylight, scratches should be viewed in artificial diffused light from fixed wall or ceiling outlets and not from portable equipment.

Nickel sulphide inclusions in glazing

In low-rise buildings which exceed three storeys in height, 100% of the toughened glazing used from the third storey upwards must be heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.

Alternatively where toughened glazing does not exceed 50kg in weight and where there is safe and easy access to remove and replace the glazing without the need for access scaffolding or fall arrest equipment, a methodology statement of how this will be undertaken should be provided.

Please note: A storey is defined as the space between two consecutive floors or a floor and a roof. The number of storeys should be counted from the lowest external ground level.

Gaps around external windows and doors

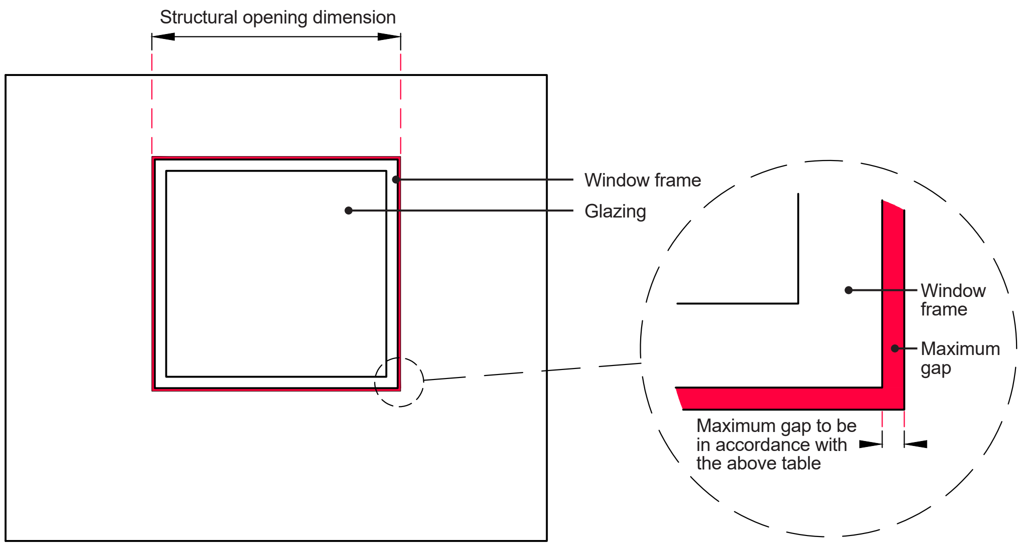
Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	1.5m – 3.0m*	3.0 – 4.5m**
Upvc-white	5	5	7.5
Upvc-non-white	7.5	7.5	11
Timber	5	5	5
Steel	4	5	6
Aluminium	5	5	7.5

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

External window and door frames should be installed in accordance with the manufacturer's instructions.



Sealants

Thermally insulating filling materials should be applied to the perimeter gap around the frames (such as PU foam, or impregnated tapes). Perimeter joints needs to be continuously sealed on both the outside and the inside of the frames. Sealants should be appropriate to:

- The frame surface.
- The substrate material.
- Joint size and configuration.
- Anticipated joint movement.
- Anticipated weather exposure conditions.

Wet sealants (e.g. silicones) should be tested and classified in accordance with BS EN ISO 11600.

When using impregnated tapes, over-capping with a wet sealant is generally not required – manufacturer's instructions should be followed.

In situations where the sealant will rely on atmospheric moisture to begin curing then deep filling should be avoided.

When applying sealant:

- Apply against a firm backing, forcing it against the sides of the joint.
- It should not be applied to the backing as this restricts lateral movement of the joint.
- Any gaps greater than 6mm require a closed-cell oversized polyethylene (PE) foam backing rod be included.
- A width to depth ratio of between 1:1 and 2:1 should be observed.
- When applying a fillet joint a minimum 6mm contact to non-porous, and 10mm to porous substrates should be achieved.
- Seal should be provided between any sill and frame.

For further guidance on the application on sealants around external windows and doors, please see BS 8213-4 Code of practice for the survey and installation of windows and external doorsets.

Finishing trims

The use of proprietary surface fixed finishing trims e.g. D-moulds, should be undertaken only as part of a designed junction between window and door framing and the surrounding opening.

For this purpose, surface finishing trims:

- Must be compatible with the materials used within the frame.
- Must be robust in their attachment.
- Must not be detrimental to the performance of the junction e.g. create thermal bridging.
- Must not impede the function or operation of the window or any attached fitments e.g. obstructing trickle vents, framing drainage outlet.

The inclusion of finishing trims should not be considered as a means to:

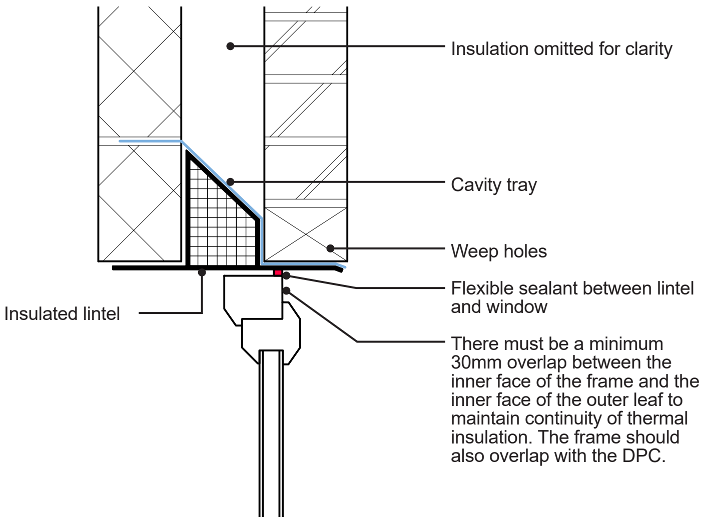
- Achieve weather tightness, unless they are included within appropriate weather and water tightness testing conducted on the window and door system.

Extend frame dimensions where windows are undersized for the opening. Only recognised sections that form part of the window system can be used for this purpose e.g. proprietary or manufactured interlocking sections ('knockons'), or manufacturer led alterations using fixed sections (adhesively bonded planted sections).

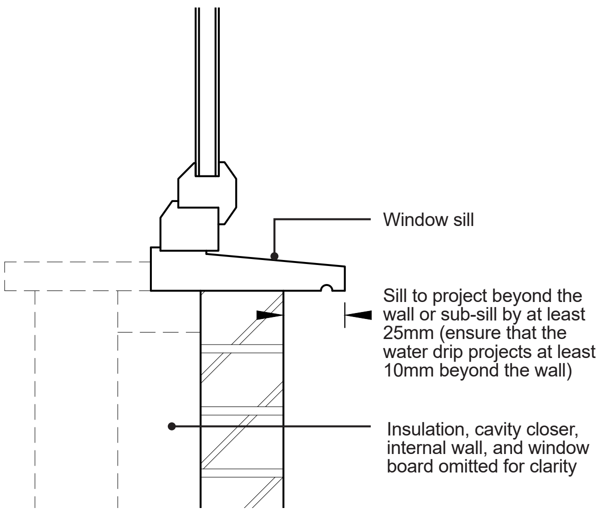
8.1.4 GENERAL REQUIREMENTS: Reveal closing details

These illustrations show accepted practice for forming weather resistant openings and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

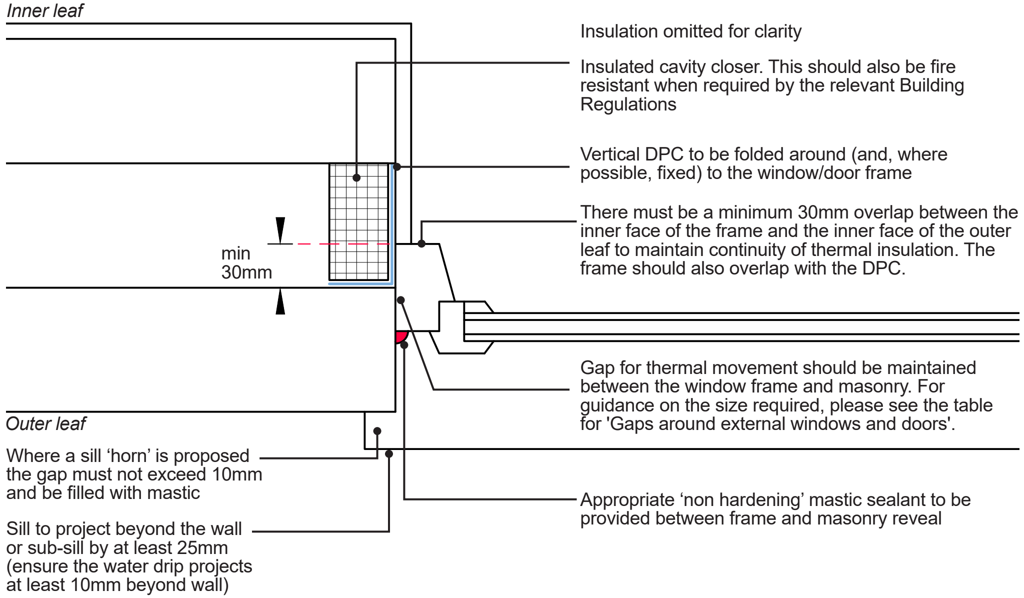
Typical vertical section through an external window head



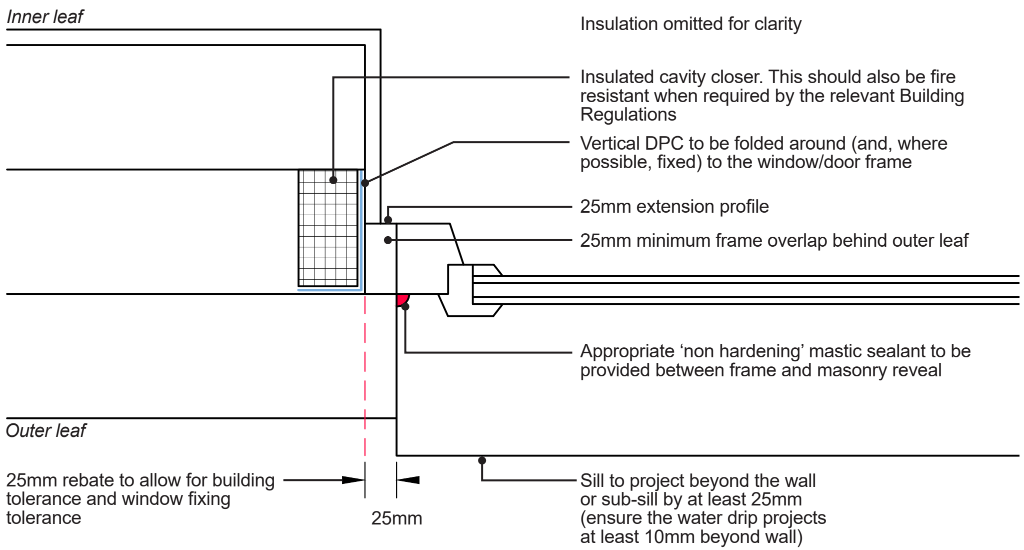
Typical vertical section through an external window sill



Typical external window reveal (normal exposure)



Checked rebate window frame detail



When installing window/door frames in a checked rebate, allow for the frame to be deeper:

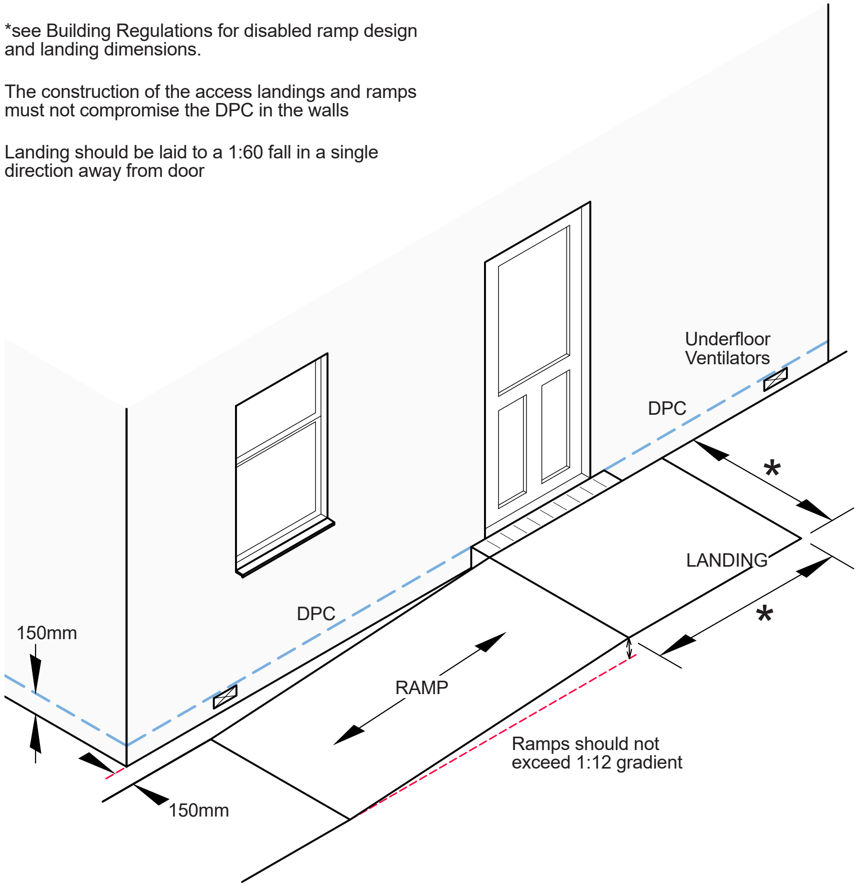
- To accommodate the 25mm rebate, and,
- To allow for opening lights to open clear of the masonry/render.

Level access

*see Building Regulations for disabled ramp design and landing dimensions.

The construction of the access landings and ramps must not compromise the DPC in the walls

Landing should be laid to a 1:60 fall in a single direction away from door



Level thresholds

Thresholds and sills should be at least 150mm above finished ground level. However, where a level (threshold) access is required, the general guidance in this section should be followed - ensuring a high level of supervision and workmanship together with the correct specification of materials and consideration to design, location, and exposure.

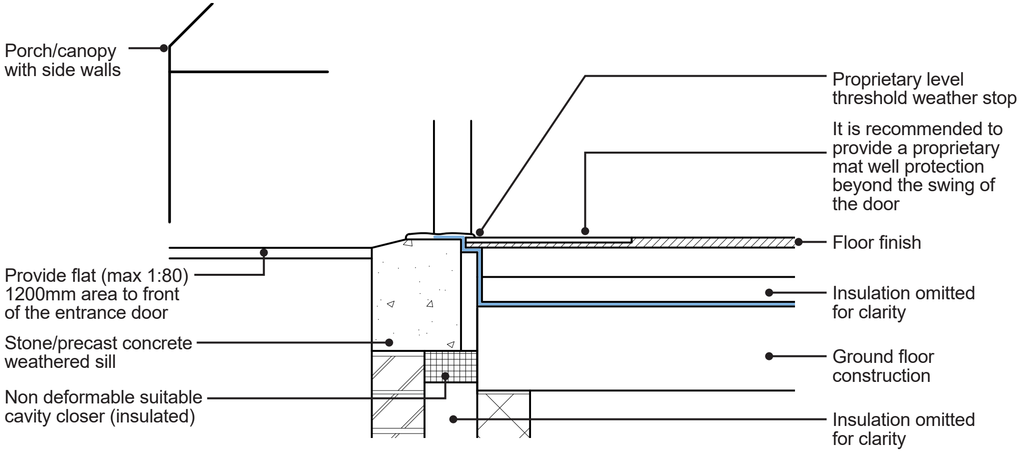
Wherever possible, locate the entrance door away from the prevailing weather and provide a storm porch. Where a drainage channel is provided, this must be connected to the storm drainage system to prevent flooding occurring and water ingress into the building.

It is recommended that a mat well be constructed within the entrance hall to accommodate the swing of the door without fouling the carpet and/or the proprietary door seal.

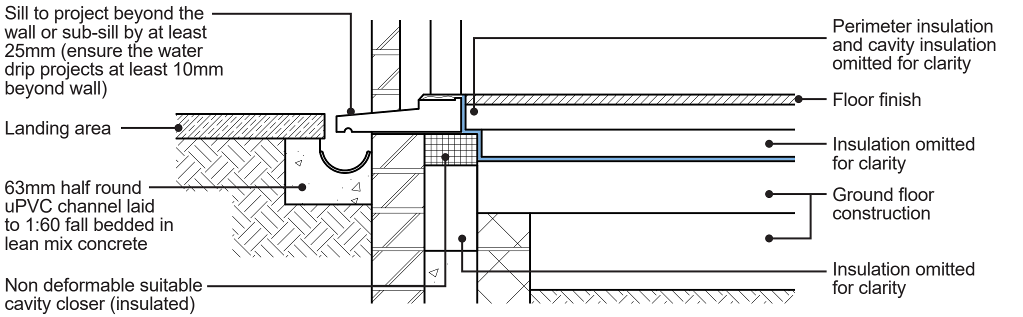
Level thresholds in timber frame superstructure

At the level threshold open perpends should be provided in close proximity to the timbers on each side of the door opening one brick course below the lowest timber. The open perpends must provide adequate ventilation of the external wall cavity, and drainage to disperse water that may penetrate the cladding.

Typical level threshold where a porch/canopy is provided

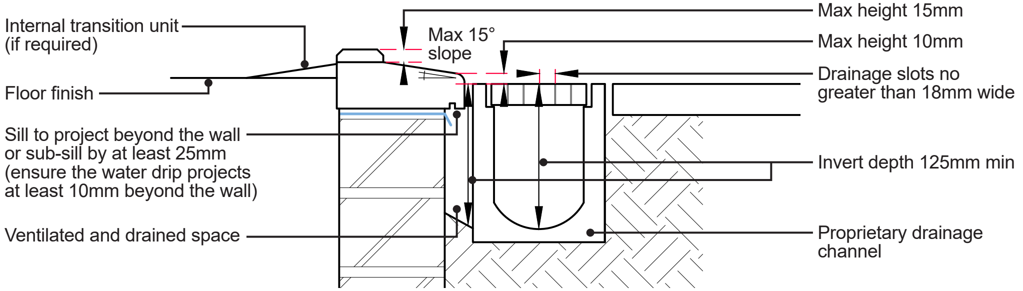


Typical level threshold without canopy protection



Timber sill

Where timber sills are installed, to prevent deterioration of the timber due to the risk of moisture ingress, a drained and vented void must be provided immediately in front of the sill (at least 125mm invert).



These illustrations show accepted practice for forming a weather resistant threshold detail and may not indicate the full extent of insulation requirements to meet relevant Building Regulations.

8.

External Windows and Doors

8.2

Additional Requirements for External UPVC Window and Door Frames

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that the external windows and doors are suitable for the site exposure. e.g. A manufacturers declaration of performance for the site.
2. Evidence of certification confirming weather-tightness rating as detailed within BS 6375.
3. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
4. Details of external window and door fixings will be required.
5. Details of sealing around the frame will need to be confirmed.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Certification

External uPVC windows and doors shall have evidence of certification confirming weather-tightness rating as detailed within BS 6375.

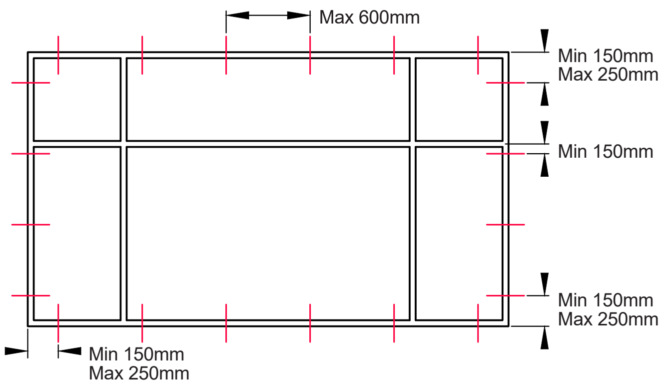
The design and construction of factory assembled external windows must meet BS 7412.

Non factory assembled units and ‘bespoke’ units are also expected to meet the same standard.

Fixings for external uPVC windows and doorsets

Frames should be fixed in accordance with the manufacturers recommendations or, if no instructions are given, with the following guidance:

Fixing locations for external uPVC windows and doors
Wherever practicable, all four sides of the frame should be secured as follows:



- Corner fixings should be between 150mm and 250mm from the external corner.
- No fixings should be less than 150mm from the centre line of a mullion or transom.
- There should be a minimum of two fixings on each jamb and sill, with intermediate fixings at centres no greater than 600mm.
- If the head is fixed with polyurethane foam, then the fixings at the head may be as follows:
  a) Frame width up to 1200mm - no fixings;
  b) Frame width 1201mm to 2400mm - one central fixing;
  c) Frame width 2401mm to 3600mm - two equally spaced fixings.

Note: These fixings do not apply to French doors, patio doors, or bi-fold doors. Manufacturers recommended fixing details should be followed.

Fixing type
- Two methods of fixing are lug fixing, or through frame fixing. These can be used separately or as a combination.
- Should be galvanised steel cramps or by non-corrodible screw fixings appropriate to the surrounding wall.

Fixing substrate penetration
Fixings should penetrate surrounding structure as per the following:

Into masonry, by at least:
- 40mm for external windows.
- 50mm for external doors.

Into structural timber framing, by at least:
- 25mm for all situations.

For fixings into surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with:
- Power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

For fixings into surrounding structure formed by steelwork which is greater than 2mm thick should be made:
- Either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Notes:
- Please refer to the lintel manufacturers’ recommendations for making mechanical fixings to the underside of the lintel.
- Fixings should not be made into the insulated cavity closer.

Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	**1.5m – 3.0m***	**3.0 – 4.5m****
Upvc-white	5	5	7.5
Upvc-non-white	7.5	7.5	11

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

External window and door frames should be installed in accordance with the manufacturer’s instructions.

Glazing

The glazing installation should follow manufacturer’s guidance.

In order to achieve acceptable performance, any glazing on-site must:

- Have a drained and ventilated bottom bead, with a minimum gap of 5mm between the edge seal of the insulated glass unit and the bottom channel frames glazing rebate.
- Have window beads that suitably lap the external windows and doors to prevent premature degradation of the glazing unit.

Standards

Design, Specification, and Manufacturing

- BS EN 514 Plastics. Polyvinyl chloride (PVC) based profiles. Determination of the strength of welded corners and T-joints.
- BS 7412 Specification for windows and doorsets made from unplasticized polyvinyl chloride (PVC-U) extruded hollow profiles.
- BS 6262 Glazing for buildings - Code of practice for safety related to human impact.
- BS 6375 Performance of windows and doors - Classification for weathertightness and guidance on selection and specification.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.
- BS EN 1670 Building hardware. Corrosion resistance. Requirements and test methods.

Installation

- BS 8213 Windows and doors - Code of practice for the survey and installation of windows and external doorset.
- BS 8000: 7 Workmanship on building sites. Code of Practice for glazing.

8.
External Windows and Doors

8.3
Additional Requirements for External Timber Window and Door Frames

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Timber and other wood based materials need to comply with the relevant requirements of BS EN 942. Evidence of this needs to be provided to the Warranty Surveyor.
2. Evidence that the external windows and doors are suitable for the site exposure. e.g. A manufacturers declaration of performance for the site.
3. Evidence of certification confirming weather-tightness rating as detailed within BS 6375. External bespoke timber windows and doors that cannot provide a BS 6375 rating will need to be water tested as per CWCT Note 41.
4. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
5. Details of external window and door fixing will be required.
6. Details of sealing around the frame will need to be confirmed.
7. External bespoke timber windows and doors must provide a detailed specification of the design, construction, and durability of the proposed units. Bespoke timber windows will not be acceptable for use without prior approval from the Warranty Surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Timber frame quality

Workmanship should follow the recommendations of BS 1186: 2. The design and construction of factory assembled external windows must meet BS 644:2009.

Non factory assembled units and ‘bespoke’ units are also expected to meet the same standard.

Timber used for external joinery should be a species classified as suitable in BS EN 942 and preservative treated; if not, use a moderately durable species or better (sapwood excluded). Guidance on selection is provided in TRADA Wood Information Sheets 3.10 and 4.16.

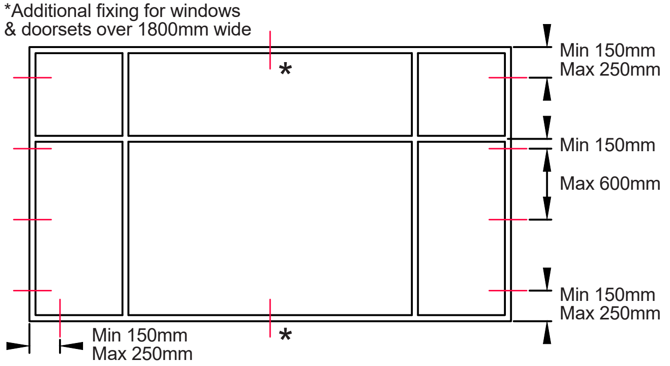
External joinery should be designed and constructed in accordance with the requirements of the following British Standards:

- BS 4787: 1 Internal and external wood door sets, door leaves and frames.
- BS 6262 Code of Practice for glazing for buildings.
- BS 6375: 1 Performance of windows.
- BS 644: 1 Wood windows.
- BS 8213: 1 Windows, doors and roof lights.

Fixings for external timber windows and doorsets

Frames should be fixed in accordance with the manufacturer’s recommendations, or if no instructions are given, with the following guidance.

Fixing locations for external timber windows and doorsets
Wherever practicable, all four sides of the frame should be secured as follows:



- Corner jamb fixings should be between 150mm and 250mm from the external corner.
- Intermediate fixings should be at centres no greater than 600mm.
- There should be a minimum of two fixings on each jamb.
- On external windows and doorsets over 1800mm wide, central head and sub-sill fixings should be provided.

Fixing type

- Two methods of fixing are lug fixing, or through frame fixing. These can be used separately or as a combination.
- Should be galvanised steel cramps or by non-corrodible screw fixings appropriate to the surrounding wall.

Fixing substrate penetration
Fixings should penetrate surrounding structure in line with the relevant section below.

Into masonry, by at least:

- 40mm for external windows.
- 50mm for external doors.

Into structural timber framing, by at least:

- 25mm for all situations.

For fixings into surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with:

- Power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

For fixings into surrounding structure formed by steelwork which is greater than 2mm thick should be made:

- Either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Note: Fixings should not be made into the insulated cavity closer.

Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	**1.5m – 3.0m***	**3.0 – 4.5m****
Timber	5	5	5

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

External window and door frames should be installed in accordance with the manufacturer’s instructions.

Glazing

Glazing should be installed as per the manufacturer’s guidance and any relevant standards.

In order to achieve acceptable performance, any glazing on-site must:

- Have a drained and ventilated bottom bead, with a minimum gap of 5mm between the edge seal of the insulated glass unit and the bottom glazing rebate.
- Have window beads that suitably lap the external windows and doors to prevent premature degradation of the glazing unit. Glazing spacer bars must not project above the top of glazing beads and rebate where they can be affected by UV.
- Have the insulated glass unit set into position using location and setting blocks set at intervals around the perimeter of the insulated glass unit. The spaces in between allow for any penetrating moisture to run to the bottom rebate and out.

Where internally glazed windows are proposed, the design must facilitate drainage to the same levels as that of externally beaded windows.

Drained and ventilated systems are the preferred method for installation of insulated glass units. Various systems can be used to seal contact points between glazed unit faces and timber e.g. self-adhesive dry glazing tapes, extruded gaskets, butyl tapes/gaskets with sealant capping.

Importantly however mixing and matching approaches should be avoided.

Fully bedded insulated glass units installations should only be accepted where glazing operations are carried out within a factory controlled environment with appropriate QA procedures as the extensive monitoring of sealant use on site is very difficult to execute.

Glazing beads

Glazing should be installed as per the manufacturer’s guidance and any relevant standards.

Glazing beads should:

- Not be mitred but scribed to bead profiles at junctions.
- Have a wider bottom bead running the full width of the opening and projecting beyond the face of the frame to conceal the drainage provision. The bottom bead should have a 1:6 (11° angle) weathering slope on its top surface.
- Have an uppermost horizontal glazing bead that runs the full width of the opening to protect the top of the jamb beads on either side.
- Have side (jamb) beads that stop short of the bottom bead by 3mm – where the bottom bead has a 1:6 (11° angle) weathering slope on its top surface, the gap can be reduced at the glass face by cutting the ends of the side beads to a shallower pitch.
- Be securely fixed with pins or screws at a 200mm maximum spacing, starting at 50mm from corners to create compression of seal provided between the timber sections and the glass surfaces.

On site operations that incorporate site applied capping sealant on drained and vented glazing systems should be executed in strict accordance with the design and specification.

Decoration, treatment and protection of external timber windows and doors

It is recommended that all external windows pre-finished to ensure all parts of external timber windows and doors, including joints, are fully protected during the build process. Where this is not the case, the external windows should be protected using appropriate weather resistant sheeting until paint finishes are applied.

Preservative-treated joinery cut or adjusted on-site should be brushed liberally with an appropriate and coloured preservative. Where the colour of the preservative will adversely affect the final appearance of the joinery, an appropriate clear preservative should be used.

Where a painted finish is proposed to the external window/door frame and opening units; the primer coat should be applied to all final exposed parts, including rebates prior to glazing installed or bottoms of external doors, or external windows.

The use of oak in external windows and doors

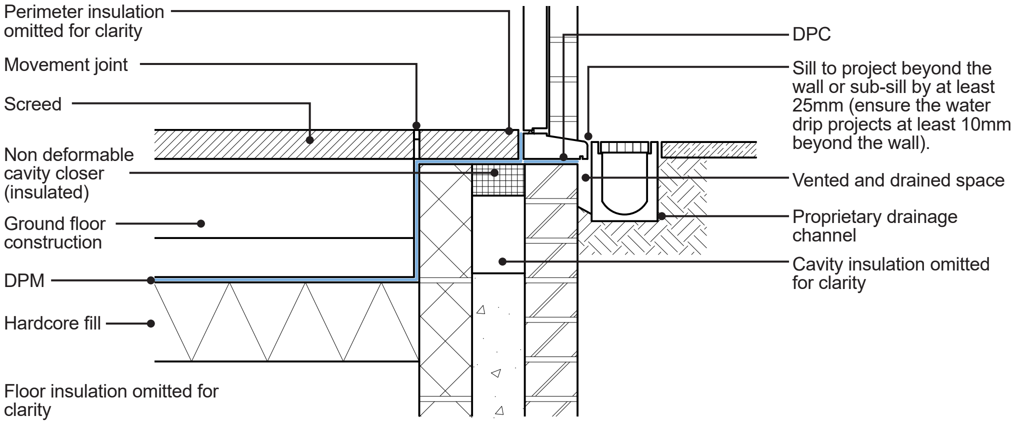
For the purpose of this section there are three types of oak considered;

- Green Oak - recently felled Oak with a moisture content typically between 60%-80%.
- Air Dried (seasoned) Oak - naturally stored Oak with a natural seasoning process moisture content up to 30%
- Certified kiln dried oak - processed seasoned timber with a moisture content of 12% or less.

Green or air dried Oak is not acceptable for use when manufacturing external windows and doors.

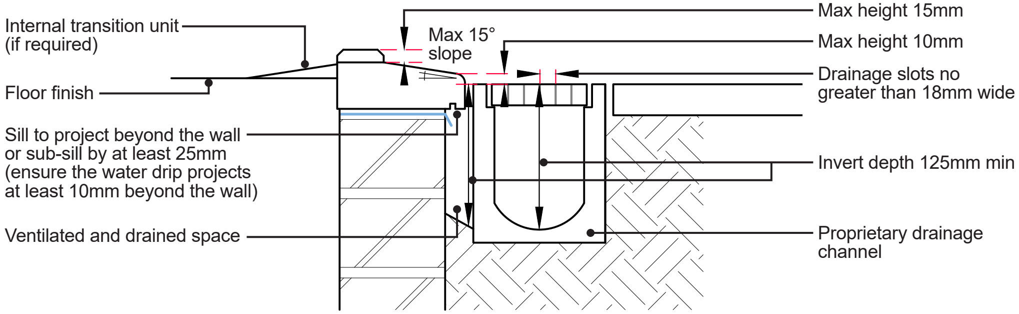
Certified kiln dried Oak with a certified moisture content of 12%, is acceptable for the manufacturing of windows and doors, subject to the external joinery meeting the relevant British Standards for manufacturing/testing, as outlined in this section.

Ground floor and timber sill typical detail



Timber sill

Where timber sills are installed, to prevent deterioration of the timber due to the risk of moisture ingress, a drained and vented void must be provided immediately in front of the sill (at least 125mm invert).



Standards

Design, Specification and Manufacturing

- BS 1186: 2 Timber for and workmanship in joinery - Specification for workmanship.
- BS 644 Timber windows and doorsets. Fully finished factory-assembled windows and doorsets of various types.
- BS 6375-1 Weather tightness.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.
- BS 4787: 1 Internal and external wood door sets, door leaves and frames.
- BS 6262 Code of Practice for glazing for buildings.
- BS 8213: 1 Windows, doors and roof lights.
- BS 942 Timber in joinery. General requirements.

8.
External Windows and Doors

8.4
Additional Requirements for External Aluminium and Steel Window and Door Frames

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that the external windows and doors are suitable for the site exposure. e.g. A manufacturers declaration of performance for the site.
2. Evidence of certification confirming weather-tightness rating as detailed within BS 6375.
3. Evidence of UKCA marking in accordance with UK Construction Production Regulation.
4. Details of external window and door fixing will be required.
5. Details of sealing around the frame will need to be confirmed.
6. Details relating to the quality control processes for the procurement of metals, and the quality control processes of the factory where they are assembled.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Certification

External aluminium/steel windows and doors shall have evidence of certification confirming weather-tightness rating as detailed within BS 6375.

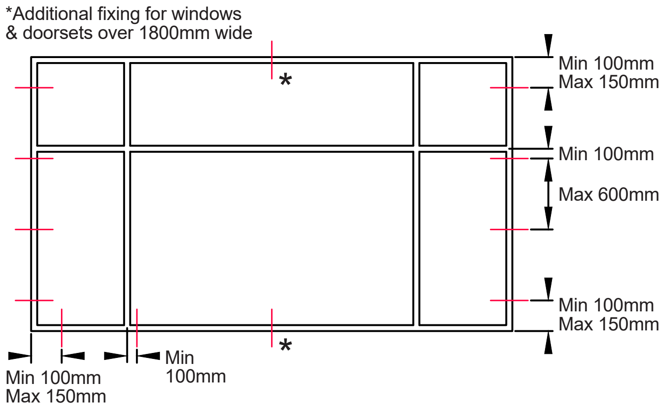
The design and construction of factory assembled external windows and doors must meet BS 4873 for aluminium windows and door frames and BS 6510 for steel window and door frames.

Non factory assembled units and 'bespoke' units are also expected to meet the same standards.

Fixings of external aluminium & steel window & doorsets

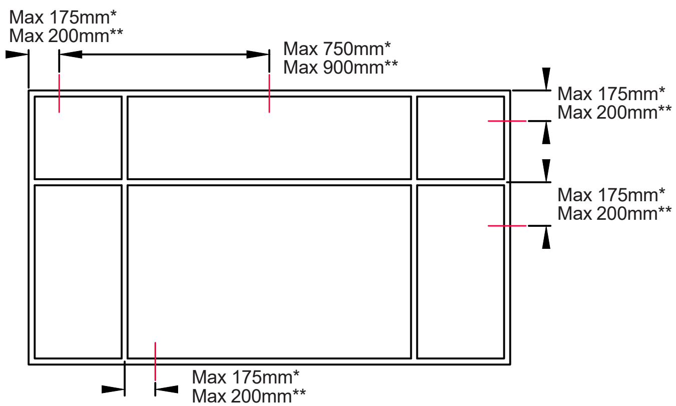
Frames should be fixed in accordance with the manufacturers recommendations or, if no instructions are given, in line with the following guidance.

Fixing locations for external aluminium windows and doorsets
All sides of the frame should be secured as follows:



- Corner jamb fixings should be between 100 mm and 150 mm from the external corner.
- Fixings should be a minimum of 100mm from the centre line of a mullion or transom.
- Intermediate fixings should be at centres no greater than 600 mm.
- There should be a minimum of two fixings on each jamb.
- On windows and doorsets over 1800 mm wide, central head and sill fixings should be provided 100mm or more distant from any mullion that might coincide.

Fixing locations for external steel windows and doorsets
All sides of the frame should be secured as follows:



* Dimension for hot rolled sections
** Dimension for cold rolled sections

For steel frames of hot rolled solid section
- Fixings should be a maximum of 175 mm from corners.
- Intermediate fixings should be at centres no greater than 750 mm.
- For steel frames of cold formed hollow section:
- Fixings should be a maximum of 200 mm from corners;
- Intermediate fixings should be at centres no greater than 900 mm.
- Either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Fixing type

- Two methods of fixing are lug fixing, or through frame fixing. These can be used separately or as a combination.
- Should be galvanised steel cramps or by non-corrodible screw fixings appropriate to the surrounding wall.

Fixing substrate penetration

Fixings should penetrate surrounding structure in line with the relevant section below.

Into masonry, by at least:

- 40mm for external windows.
- 50mm for external doors.

Into structural timber framing, by at least:

- 25mm for all situations.

For fixings into surrounding structure formed by steelwork which is a maximum of 2mm thick should be made with:

- Power driven hardened self-drilling screws or self-tapping screws (with pilot hole).

For fixings into surrounding structure formed by steelwork which is greater than 2mm thick should be made:

- Either into pre-tapped holes with machine screws a minimum of 5mm diameter or with power driven hardened self-drilling screws.

Note: Fixings should not be made into the insulated cavity closer.

Gaps around external windows and doors

Gaps around external windows and doors should be sized to allow for thermal movement and this will vary depending on the material of the frame.

Material	Recommended gap per side for width of structural openings (mm)		
	Less than 1.5m*	**1.5m – 3.0m***	**3.0 – 4.5m****
Steel	4	5	6
Aluminium	5	5	7.5

Notes:
* The maximum gap permitted for openings less than 3m should be 10mm.
** For openings more than 3m, the maximum gap permitted should be 15mm.

For gaps greater than 5mm, a backing strip should be provided behind the sealant and the sealant should have a minimum depth of 6mm.

External window and door frames should be installed in accordance with the manufacturer's instructions.

Additional provisions of information for powder coated aluminium:

- Present details of quality management system from recognised source (such as ISO 9001).
- Provide details confirming that the operations will be completed in line with BS EN 12206-1.
- Provide details of pre-treatment to frames.
- Provide details of the powder coating manufacturer and confirmation that the applicator is an approved installer with regular, up-to-date audit records.
- Provide details of third party guarantees (e.g. adhesion, colour, etc).
- Provide details of third party accreditations (such as QUALICOAT, etc.).
- Provide full specification details for the application, outlining why the proposed product is best suited for use.
- Provide details of necessary future maintenance.

Aluminium frames to receive powder coating must be pre-treated to ensure good adhesion of the coating to the surface. Pre-treatment seals the surface of the aluminium and helps form a "key" for the powder coating to adhere to. It is necessary to remove all forms of contamination, the naturally forming oxide layer, and any deformation layer prior to applying the powder coating.

Pre-treatment of aluminium frames should not include the use of hexavalent chromium. The pre-treatment of components to be powder coated is covered within BS EN 12206-1.

Durability
For external window and door frames in coastal locations the durability of the coating must take into account of aggressive environment conditions. Please refer to 'Appendix B' for further guidance.

Standards

Design, specification, and manufacturing

- BS 4873 Aluminium alloy windows and door sets.
- BS 6510 Steel windows and doors.
- BS 6375 Performance of windows and doors - Classification for weathertightness and guidance on selection and specification.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.
- BS EN 1670 Building hardware. Corrosion resistance. Requirements and test methods.

Installation

- BS 8213 Windows and doors - Code of practice for the survey and installation of windows and external doorsets.

8.
External Windows and Doors

8.5
Additional Requirements for Vertically Stacked Coupled Window Assemblies

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A fully specified system for the coupled window assembly and this must include details of dual sealed coupling joints, seals, fixings and other ancillary components.
2. Evidence of CE/UKCA marking in accordance with UK Construction Production Regulation.
3. Details of proposed testing strategy as outlined within CWCT Note 41 and 102 are to be provided along with test report.
4. Evidence of certification confirming weather-tightness rating as detailed within BS 6375-1.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

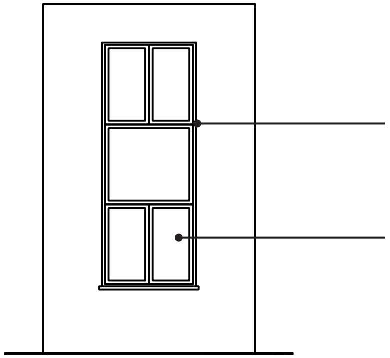
Vertically stacked coupled window assemblies for the purposes of Warranty, are more than one separate glazed panel and frame unit coupled together vertically in an external wall elevation.

The guidance within this section is limited to where coupled window assemblies are:

- Specified in low rise construction (Buildings of 5 storey or lower – including the ground floor level); and,
- Coupled in a vertical position.

The guidance within this section should be read in conjunction with the rest of the applicable guidance in the ‘External Windows and Doors' section.

Typical detail



Fixing should allow for differential movement if in a timber framed building as well as suitability to join one frame to the other. Fixings must also meet the requirements of BS8213: 4 for spacing requirements with particular emphasis on the side and tops.

General requirements

Vertically stacked coupled window assemblies must be part of a fully specified system and this must include details of dual sealed coupling joints, seals, fixings and other ancillary components.

Vertically stacked coupled window assemblies must be manufactured to BS 7412, BS 4873 or BS 6510. Timber coupled window and door assemblies are not acceptable for Warranty purposes.

Where vertically stacked coupled window assemblies are proposed, thermal breaks should be incorporated into the dual sealed coupling joints.

Vertically stacked coupled window assemblies need to be sealed at the edges and drained at the front to prevent water ingress at the edges.

Testing

Where vertically stacked coupled window assemblies are proposed, they will require both off-site and on-site testing as detailed below.

Off-site testing
Vertically stacked coupled window assemblies require off-site testing to BS EN 14351-1 and this must be for the complete coupled window assembly (with the dual sealed coupling joint in place), not just individual units.

Vertically stacked coupled window assemblies with higher levels of performance will be required for locations exposed to high levels of driving rain and this should be detailed by the system manufacturer.

Please note: individual units with third party certification may not cover a coupled window assembly scenario.

On-site testing
Where vertically stacked coupled window assemblies are proposed, on-site testing of water penetrations to critical joints (such as dual sealed coupling joints) in accordance with CWCT test methods is required to check to site workmanship of the building envelope as constructed. Areas and method of testing is to be agreed with the Warranty Surveyor prior to construction commencing. See CWCT Technical Note 41 and 102 for guidance.

Minimum requirements for on-site testing may be increased for areas subject to extreme weather conditions, exposed locations or coastal locations. The testing may also be increased where bespoke jointing systems are proposed as part of the construction.

Dual sealed coupling joints

Where vertically stacked coupled window assemblies are specified, pre-fabricated dual sealed coupling joints should be used for creating a weathertight joint. A dual sealed coupling joints should include:

- Outer seals as the primary water barrier.
- Inner seals providing an air barrier and secondary water barriers. The air barrier must be fully continuous around the full perimeter of the window.
- A drained cavity to remove any water that by passes the outer seal. This should be detailed to prevent water entering parts of the structure which are not intended to becoming wet.

Inner seals within the coupling joint must be placed within the joint during the assembly operation and be suitable for the proposed detailing. Suitable inner seals include impregnated foam tapes or flexible polymer gaskets. Wet sealants should not be solely relied upon.

If sealants (internal or external) are inaccessible or not easy to replace, their service life should match the service life of the window system as a minimum.

All seals must be permanently flexible and resistant to weathering.

All external sealants must be easy to replace.

Structural integrity

Vertically stacked coupled window assemblies must be designed to be able to appropriately transfer its self-weight and imposed loads to the supporting structure.

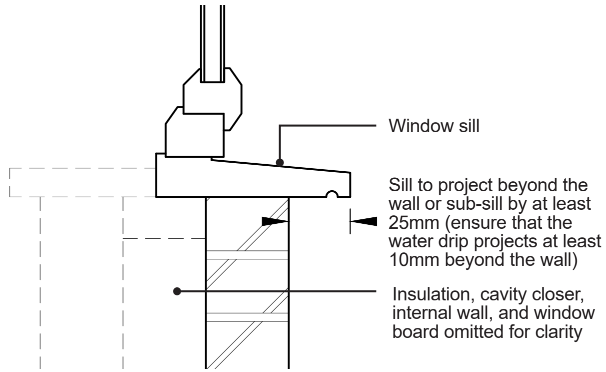
The frame of the window needs to be able to resist the wind load in deflection, alternatively, the joining component needs to provide support and contribute to the overall stiffness of the system in resisting deflection.

Where the vertically stacked coupled window assembly extends to more than one window in both directions, the joining component in one direction must span the full width or height of the assembly and will have to carry all the load at the junction(s) between the window frames. It will also have to support the ends of the joining components running in the transverse direction.

Window sill

Vertically stacked coupled window assemblies must incorporate a sill which projects from the wall by at least 25mm. The water drip must project the wall by at least 10mm.

Vertically stacked coupled window assemblies may encounter an extra volume of rainfall due to the increase in the amount of glazing used in the window system. This should be taken into account with the window system to ensure rainfall is discharged away from the building and does not impact on the weatherproof envelope.



Accommodating movement

Gaps are required around external windows and doors to accommodate differences in movement between the window and the surrounding wall construction as specified in our ‘External Windows and Doors – General requirements’ section.

Where vertically stacked coupled window assemblies are specified however, the gap sizes between the frame and wall construction may need to be greater and this should be specified by the system manufacturer.

Where a vertically stacked coupled window assembly extends across a horizontal movement joint (in a timber framed building with lightweight cladding for example), the design should allow for suitable jointing of the window assembly that will accommodate predicted structural movement whilst remaining weathertight and transferring loads to the building structure.

Vertically stacked coupled window assembly over 5 storeys

While the guidance within this section is predominantly for low rise developments, it should be noted for developments of 5 storeys or over, developers and designers should consult with our Major Projects team for further advice. For testing the following will be required:

- A minimum performance of 600 pascals water tightness will need to be achieved for vertically stacked coupled window and door assemblies
- Vertically stacked coupled window assemblies will need to comply with CWCT Technical Note 95.

8.
External Windows and Doors

8.6
External Bi-fold Doors

EXTERNAL BI-FOLD DOORS: General requirements for external bi-fold doors

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full specification of the external bi-fold door must be provided to the Warranty Surveyor.
2. The designer must take thermal bridging into account. Details of how thermal bridging is to be mitigated must be provided to the Warranty Surveyor
3. Where external top hung bi-fold doors are specified, the Engineer must design and specify the lintel provision above the bi-fold doors.
4. The provision of information in the other sub-sections within the ‘External Windows and Doors’ section must also be satisfied.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General

Where external bi-fold doors are specified, the guidance within this sub-section must be read in conjunction with the guidance within the rest of the 'External Windows and Doors' section.

The designer must take thermal bridging into account. Details of how thermal bridging is to be mitigated must be provided to the Warranty Surveyor.

Installation

Where external bi-fold doors are specified, the manufacturer’s guidance must be followed to ensure structural stability, weather resistance and desired service life is achieved.

Where external top hung bi-fold doors are specified, an Engineer must design and specify the lintel provision above the external bi-fold doors.

Level access thresholds

Care must be taken for level access threshold detailing to ensure weather resistance is maintained. Falls in the external ground levels must be away from the building.

The sill must project a minimum 25mm (ensure the water drip projects at least 10mm beyond wall) into a channel drain which is laid to a 1/60 fall. Please refer to the 'External Windows and Doors – General Requirements' section for further guidance.

9. Stairs

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. All work is to be carried out by a technically competent person in a workmanlike manner.
2. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
5. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
7. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. Staircases, ramps and guards shall be designed and constructed so that they adequately protect the user from the risk of falling.
2. Access staircases in flats which form part of the separation between flats and between other parts of the same building shall:
    a. Have adequate resistance to the spread of fire;
    b. Have adequate resistance to the passage of sound.
3. Staircases must be adequately fixed in place to maintain stability.
4. The design and specifications of stairs and landings, shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
5. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
6. Damp proofing works should prevent any external moisture passing into the internal environment of the building.

9.
Stairs

9.1
General Requirements for all Stairs

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

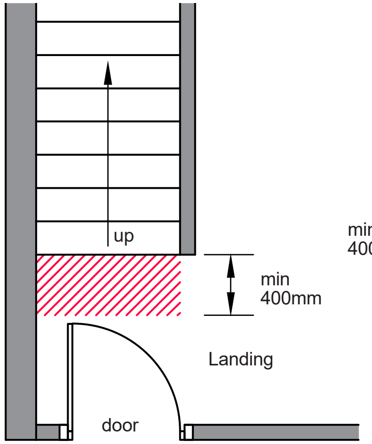
1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, headroom, etc).
3. Proposed fixing details of stairs at strings, top and bottom of flights.
4. Structural calculations for concrete and/or steel stairs.

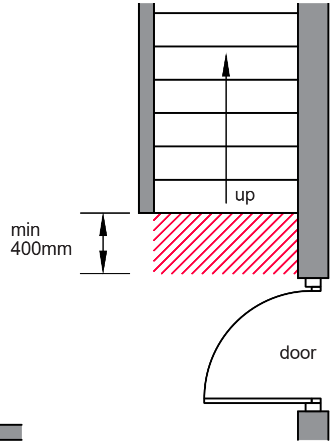
The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Landings

Landings must be provided at the top and bottom of every flight and should be:

- The width and length at least as great as the smallest width of the flight. For Scotland, landings should have an effective width of not less than the effective width of the stair flight it serves. The minimum length of a stair landing, measured on the centreline of travel, should be either 1.2m or the effective width of the stair, whichever is less.
- Be kept clear of permanent obstructions including opening doors, except in a building where a door may swing across the landing at the bottom of a flight providing there is a clear unobstructed landing of at least 400mm deep maintained between the flight and the opening swing of the door.
- Inside the building, landings must be level.
- Landings are to be designed and constructed robustly and they are to provide full support, and secure fixings, for flights, nosing's, newels, apron linings etc.

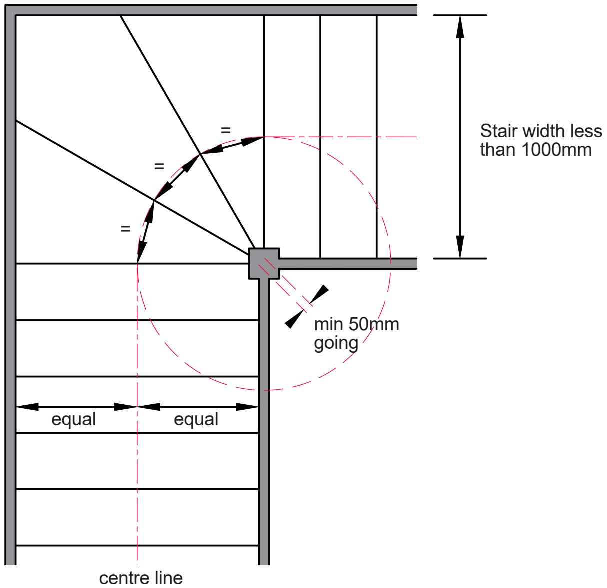




Tapered treads and winders

This Technical Manual does not consider flights over 1000mm in width; please see BS 5395-2 directly for guidance on turning of flights for stairs 1000mm or greater.

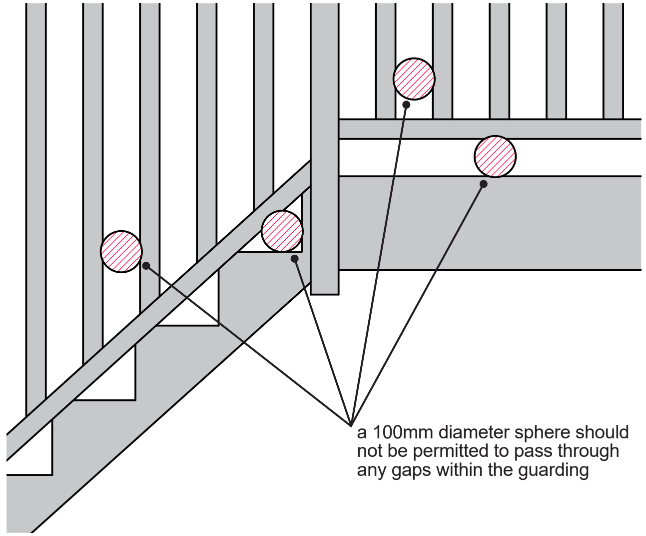
- The centre line arc from the newel around the winder must consist of consistent going dimensions.
- Goings to winders around the newel must be a minimum of 50mm.



Guarding

The following applies to dwellings only:

- Guarding to stairs, landings, ramps, and the edges of internal floors must be at least 900mm high (note, considerations for guarding heights at other locations, such as balconies will be covered within the appropriate sections).
- Guarding should be provided so as to prevent children climbing or being held fast; a 100mm diameter sphere should not be permitted to pass through any gaps within the guarding, including between the bottom of the guarding and the string of the stairs.
- Guarding will be required where there are changes in level greater than 600mm.



Glazed guarding

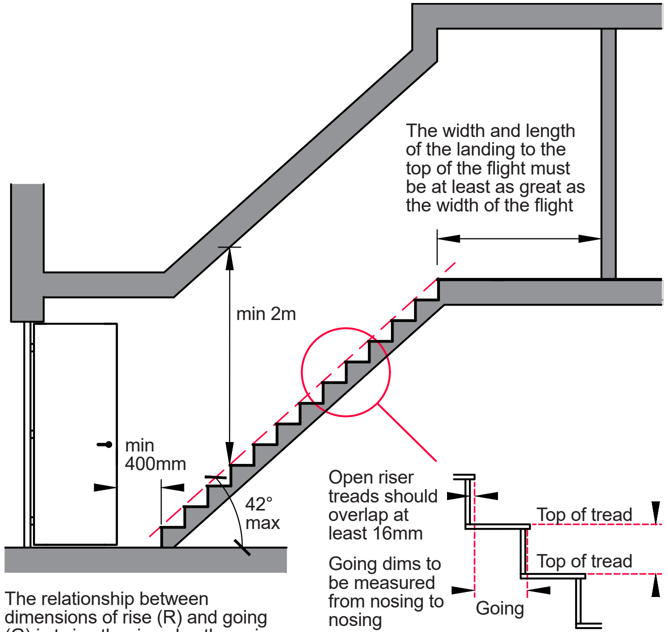
Where glazing is specified in and around a staircase, the glazing should either:

- If broken on impact, break in a way which is unlikely to cause injury; or,
- Resist impact without injury; or,
- Be shielded or protected from impact.

Where toughened glazing is specified, 100% of toughened glazing should be formed and then heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.

Rise and going

- Must be consistent throughout the flight of the stairs.
- Each tread is to be provided level.
- Open risers permissible in dwellings if the treads overlap by a minimum of 16mm and the steps are constructed in a manner so as to prevent a 100mm diameter sphere passing through them.
- Common stairs must have a visually contrasting material at nosings, and the tread profile must be appropriate (see diagram). Open risers are not permissible on common stairs.



The relationship between dimensions of rise (R) and going (G) is twice the rise plus the going (2R + G). The result must be between 550mm and 700mm

England

	Rise	Going
Private Stair **	150mm to 220mm	220mm to 300mm
Utility Stair	150mm to 190mm	250mm to 400mm
General Access Stair	150mm to 170mm	250mm to 400mm

** For dwellings for external tapered steps and stairs that are part of the building the going for each step should be a minimum of 280mm.

Scotland

	Rise	Going
Private Stair	100mm to 220mm	225mm (minimum)
Other	100mm to 250mm	250mm (minimum)

Wales

	Rise	Going
Private Stair	155mm to 220mm	245mm to 260mm
	165mm to 200mm	223mm to 300mm
Institutional/Assembly **	135mm to 180mm	280mm to 340mm
Other **	100mm to 250mm	250mm (minimum)

** Maximum rise for stairs providing access for disabled people should give reference to Approved Document M (Wales)

Pitch

Staircases should be accurately located and fixed with the string at the correct angle, so that all treads are horizontal. The pitch should be suitable for the intended use in accordance with the relevant Building Regulations.

The maximum angle of pitch of a stairway should not exceed 42° for private stairs.

Headroom

The overall floor opening is to be checked for the size required to accept the stairs and allow for sufficient headroom.

- The minimum headroom above the stairs is to be measured vertically from the pitch line.
- The clear headroom should be 2m over the entire length and width of a stairway, including landings.

Handrails

Dwellings

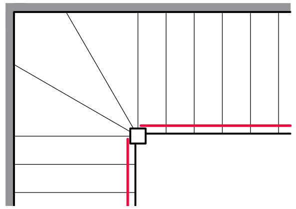
- Handrails should be provided at a height of between 900mm to 1000mm (or 840mm to 1000mm in Scotland), measured above the pitch line of the stairs.
- Handrails will need to be continuous across intermediate landings and around winders.
- They must be firmly secured and comfortable to grip, allowing the entire hand to grasp the rail.
- Where the staircase is greater than or equal to 1000mm width, then additional handrails will need to be provided on both sides.
- Handrails should be provided in a manner that reduces the risk of clothing being caught.

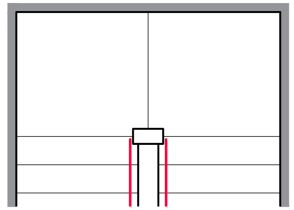
Common Stairs to Flats

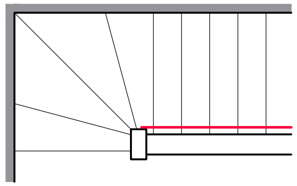
In addition to the above requirements, handrails in common stairs:

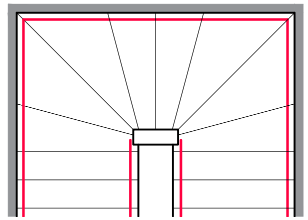
- Will need to be provided on each side of the flight, and continued a minimum of 300mm passed the top and bottom nosings of the flight with ends returned into the wall or down to prevent “catching”.
- Handrails must be continuously graspable along their length; the handrails must be 50mm to 75mm clearance from any outside walls, yet be no further than 50mm from the face of the inside string.
- The handrail must have at least 50mm clearance under the bottom of the rail.
- Circular handrails are to achieve a diameter of between 32mm and 50mm, whereas non-circular handrails must be 50mm wide and 39mm deep.
- Should bee provided in a manner that reduces the risk of clothing being caught.

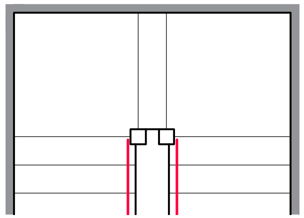
Please note, for the purposes of Warranty, common stairs are defined as a staircase serving more than one property.

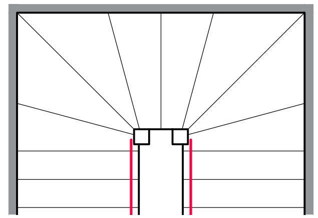

Additional handrail not needed


Additional handrail not needed


Additional handrail not needed


Additional handrail needed


Additional handrail not needed


Additional handrail not needed

Lighting

Artificial light sources should be provided to all internal staircases and landings. Within a building, lighting to stairs should be controlled by two-way switching.

Automatic light-sensitive controls may be used in common areas, provided lights can also be two-way switched manually.

Where staircases are lit by glazing, any glass immediately adjacent to the stair should be:

- Protected by a balustrade or railing, or,
- Toughened or laminated glass, non-openable, or,
- Constructed of glass blocks.

Acoustics sound resistance

- Stairs should have the appropriate sound resistance to meet the relevant Building Regulations.
- Stairs should be designed and constructed so far as possible to ensure that they do not vibrate and cause excessive noise. They should be fixed accordingly to minimise creaking or squeaking within the joints.

External stairs

In addition to the guidance covering internal stairs:

- All external stairs must be constructed from masonry, concrete or metal.
- All external stairs must have suitable tread nosings to meet the requirements of relevant Building Regulations.
- External lighting requirements must meet relevant Building Regulations.

Standards

- BS 5395-1: Code of practice for the design of stairs with straight flights and winders.
- BS 585-1: Specification for stairs with closed risers for domestic use, including straight and winder flights and quarter or half landings.
- BS 8000-5:1990 Workmanship on building sites – Code of practice for carpentry, joinery and general fixings.

9.
Stairs

9.2
Timber

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, headroom, etc). The rise of the steps must be equal throughout the flight.
3. Proposed fixing details of stairs at strings, top and bottom of flights. See guidance within this section.
4. Details of balustrades and handrails to be used which must be securely fixed and robust.
5. Drawings to show headroom and depth of landings meet Building Regulation requirements.

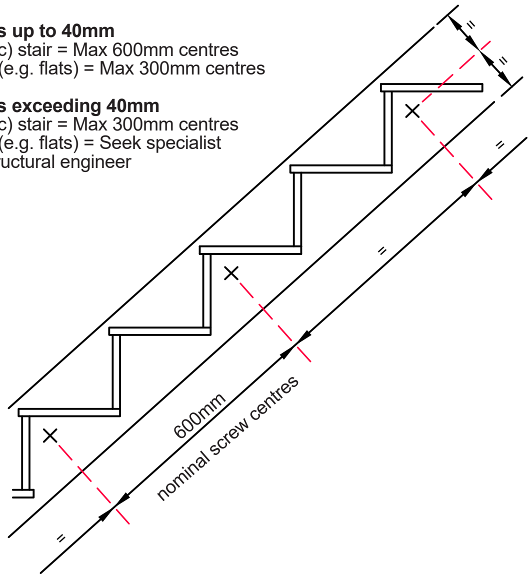
The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Wall string fixings

- Structural screws, UKCA/CE marked to EN 14592 should be used to secure wall strings to both timber stud and masonry walls. The screws should be nominal diameter of 5mm and should be either self-drilling or into pre-drilled holes. Each screw should achieve a minimum bearing of 50mm into the timber stud/noggin, or the masonry wall.
- Wall plugs used in masonry walls should also be at least 50mm long. Timber packing of adequate width to prevent the possibility of splitting should be fixed the full length of the string.
- Stair string fixing should begin with screws being provided beneath the top and bottom treads.
- Working from these top and bottom fixings, additional screws should be inserted at centres no greater than those noted below, working toward the centre of the string. Note: this will often result in two fixings being closer than the given centres toward the centre of the string.

String-wall gaps up to 40mm
Private (domestic) stair = Max 600mm centres
General access (e.g. flats) = Max 300mm centres

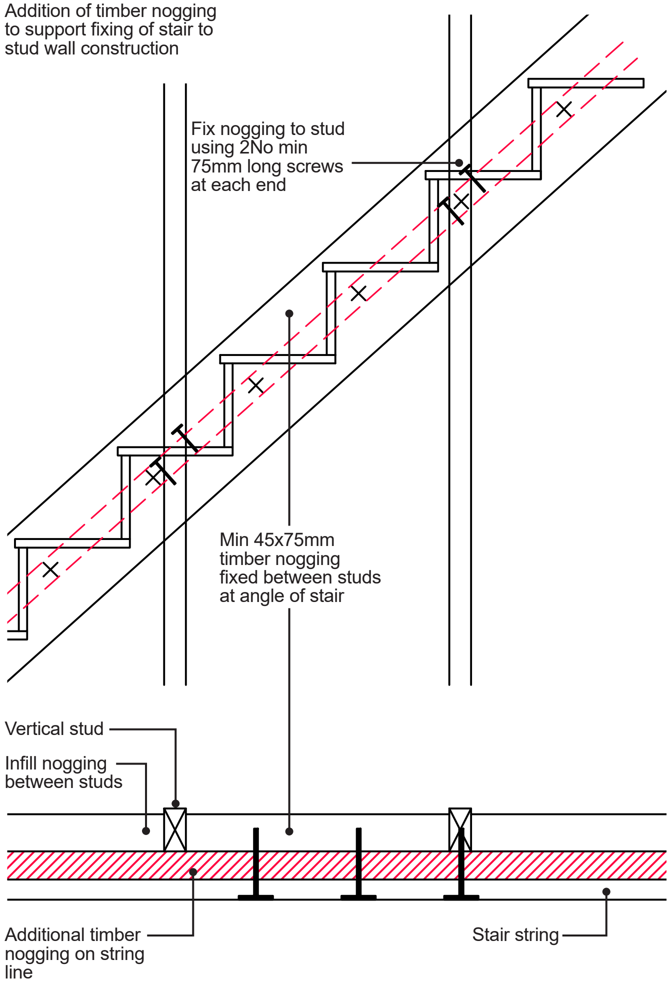
String-wall gaps exceeding 40mm
Private (domestic) stair = Max 300mm centres
General access (e.g. flats) = Seek specialist advice from a structural engineer



Additional requirements for fixing to timber studs

When fixing timber stairs to timber studs, either:

- Provide timber infill pieces between the studs following the intended line of fixings (noggins should be at least 45x75mm and double fixed at each end using 75mm long screws); or,
- Alternatively, provide additional vertical studs at 300mm centres to enable direct fixing of strings into the studs.

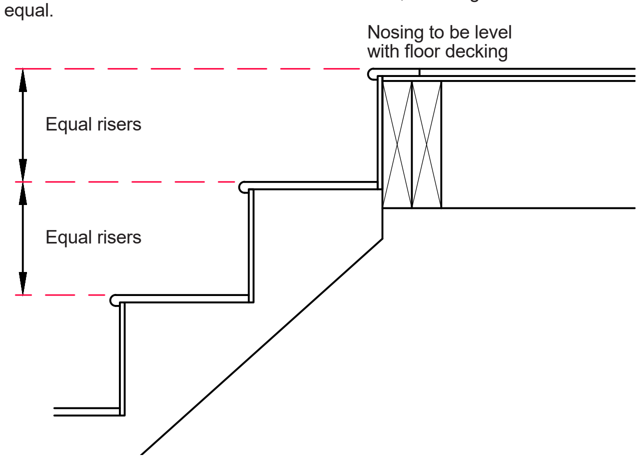


Additional requirements for fixing to steel stud partitions

Fixing of stairs into steel partitions is not generally permissible unless confirmed by the steelwork designer – please refer to the ‘External Walls - Light Gauge Steel Frame’ section for further guidance.

Floor finishes

Allowance should be made for stair and floor finishes, ensuring that all risers are equal.



Construction of stairs

- If stairs are supplied in kit form for construction on site then fixing instructions will need to be provided.
- The top nosing of the flight should finish flush with the surface of the flooring and adequately secured into place.
- The underside of the string can be cut so that the measurement from the top of the tread to the underside of the string is equal to the overall rise.
- Consideration should be given to differential movement within the setting-out, levels, and finishes (e.g. in timber framed buildings).
- The first rise of the staircase must be positioned so as to allow for any floor screed or other hard finish to ensure the rise is equal throughout the flight.

Protection

- Staircases should be protected during the construction phase to prevent damage and marking.
- When storing staircases they must be stacked on bearers and suitably protected from the weather.
- Timber stairs should only be incorporated into the build once the unit is suitably weather-tight.

9.
Stairs

9.3
Concrete and Steel

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Detailed specification relating to the construction of the stairs.
2. Planned details indicating proposed dimensions of stairs (such as dimensions of rise, goings, pitch, headroom, etc). The rise of the steps must be equal throughout the flight.
3. Structural calculations for concrete and/or steel stairs.
4. Details of balustrades and handrails to be used which must be securely fixed and robust.
5. Drawings to show headroom and depth of landings meet Building Regulation requirements.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Additional requirements for precast concrete staircases

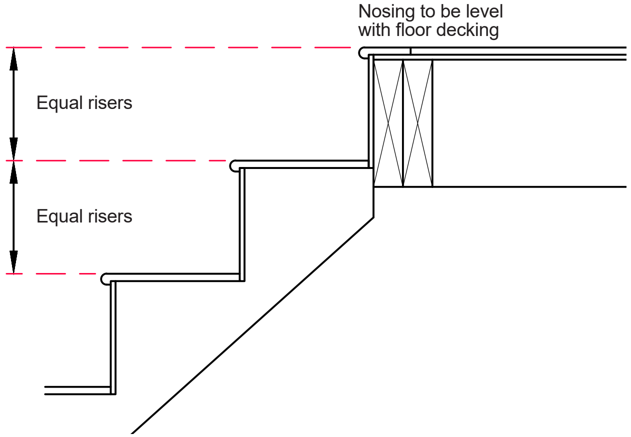
- Manufacturer's design and calculations will be required for pre-cast concrete stairs taking consideration of the relevant standards listed within this section.
- Engineers design and calculations will be required prior to construction.
- Design should include depth of cover to proposed steelwork within the stair.
- Design should include proposed concrete mix design outlining strength and slump.
- In-situ concrete must be allowed to cure appropriately prior to shuttering being struck.
- Weather and working conditions must be consistent with guidance for working with in-situ concrete provided in the 'Appendix C' section.
- Balustrading and guarding associated with the stair must either be grouted into preformed holes, or bolted to brackets cast into the stair.

Additional requirements for steel staircases

Engineers design and calculation will be required for the proposed element.

Floor finishes

Allowance should be made for stair and floor finishes, ensuring that all risers are equal.



Construction of stairs

- If stairs are supplied for construction on site then fixing instructions will need to be provided.
- The top nosing of the flight should finish flush with the surface of the flooring and adequately secured into place.
- The underside of the string can be cut so that the measurement from the top of the tread to the underside of the string is equal to the overall rise.
- Consideration should be given to differential movement within the setting-out, levels, and finishes.
- The first rise of the staircase must be positioned so as to allow for any floor screed or other hard finish to ensure the rise is equal throughout the flight.

Protection

- Staircases should be protected during the construction phase to prevent damage and marking.
- When storing staircases they must be stacked on bearers and suitably protected from the weather.

Standards

- BS EN 1992-1-1 Design of Concrete Structures
- BS EN 14843 Precast Concrete Products. Stairs

10.
Upper Floors

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. Any multiple occupancy building (which includes flats /apartment accommodation) must have fire stopping and cavity barriers completed by a third party approved Contractor, or have a suitable quality assurance process provided to evidence the installation of the fire stopping and cavity barriers. This is applicable to all floor levels of a building that has a floor 4.5m above the lowest external ground level.
2. All workmanship must be within the tolerance requirements set out in this Technical Manual.
3. All work is to be carried out by a technically competent person in a workmanlike manner.
4. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
5. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. Evidence must be provided to demonstrate the party floors between buildings achieve satisfactory levels of sound insulation to meet the relevant requirements of the Building Regulations.
2. Upper floors (including separating floors) shall be designed and constructed so that they:
   a. Are structurally sound;
   b. Are durable and resistant to moisture;
   c. Have adequate resistance to the effects of fire and surface spread of flame.
3. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
4. The following additional elements shall be supported by structural calculations designed by an Engineer:
   a. Structural elements outside the parameters of Building Regulations.
   b. Specialist structural works.
   c. Reinforced concrete elements.
   d. Precast structural elements.
   e. Any engineered beams/posts manufactured off-site.
5. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
6. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

10.
Upper Floors

10.1
Suspended Timber

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor joists to be used including floor joist layouts.
2. Details of proposed services to be constructed within the floor void.
3. Details of any proposed underfloor heating systems to be incorporated.
4. Details of insulation be used within the floor construction.
5. An Engineer’s full set of structural calculations for the floor construction.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Sizing of timber floor joists

For advice on sizing of certain timber members of floors, the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by BM TRADA. Note: Reference should be made to the version of the BM TRADA document current at the time of construction of the floor/ceiling or roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

Installation of timber floor joists

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by an Engineer.

The floor joists must be laid reasonably level and onto suitable solid and level bearings.

Please refer to the ‘Tolerances’ section for guidance on levelness and deflection limits of floor joists. There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

Joists should be restrained at supports using tightly fitted strutting.

Joists should have a minimum end bearing of 90mm, unless joist hangers are used, where a 35mm bearing is acceptable (subject to the manufacturer’s details).

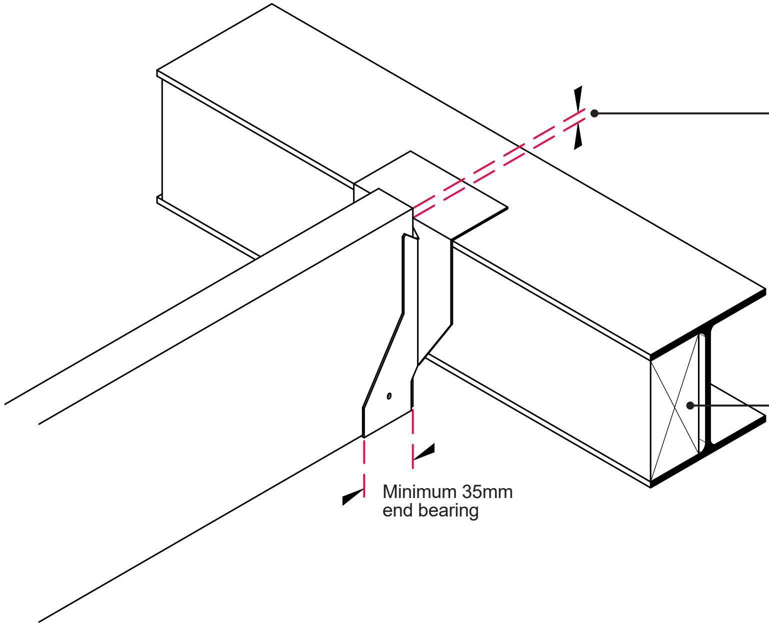
Steel beams

Steel beams should be designed by the Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. under croft) please follow the requirements for additional corrosion protection in the ‘Appendix B - Coastal Locations’ and ‘Appendix C - Materials, Products, and Building Systems’ section.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

Steel beam bearing



Lateral restraint of walls

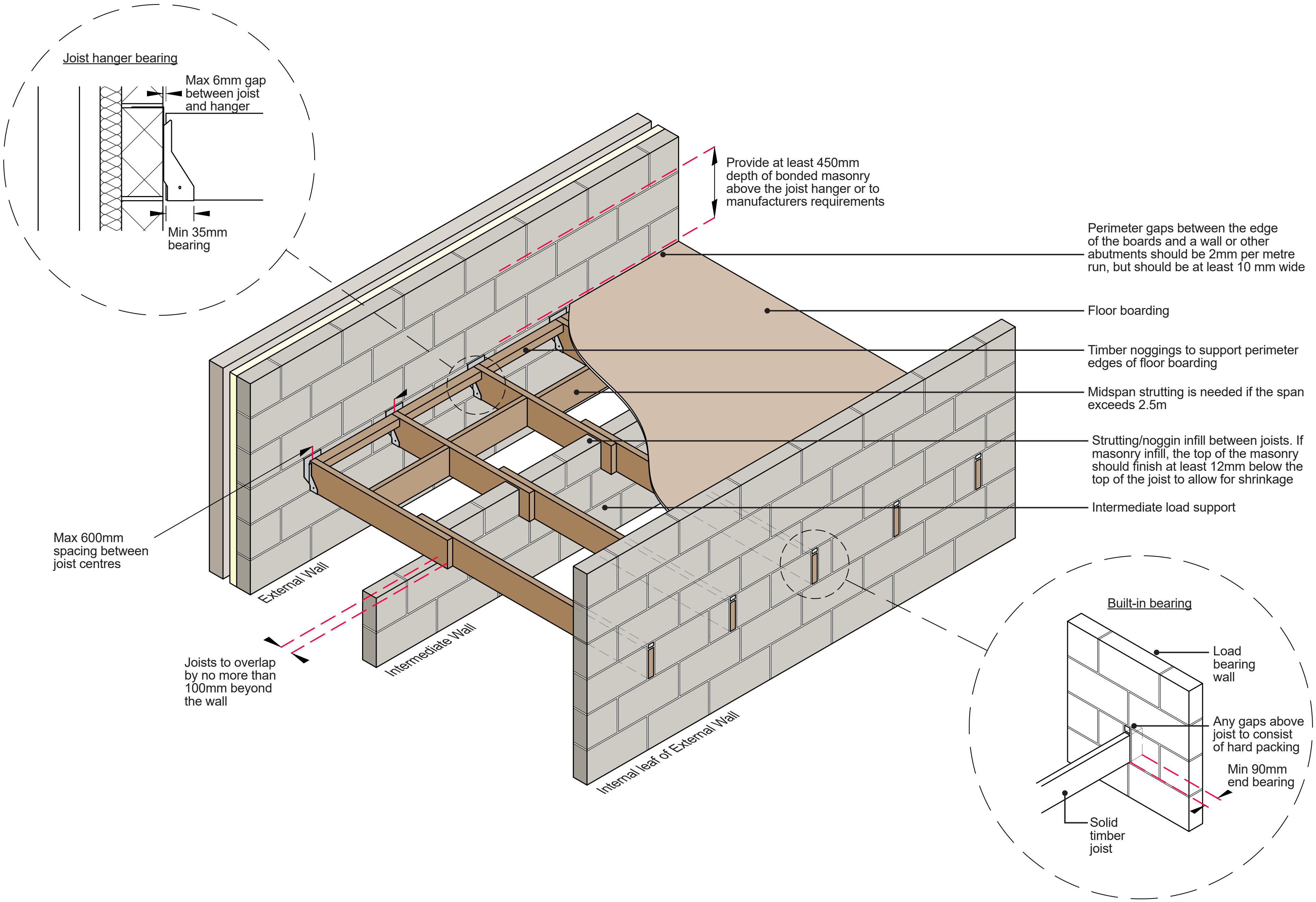
Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

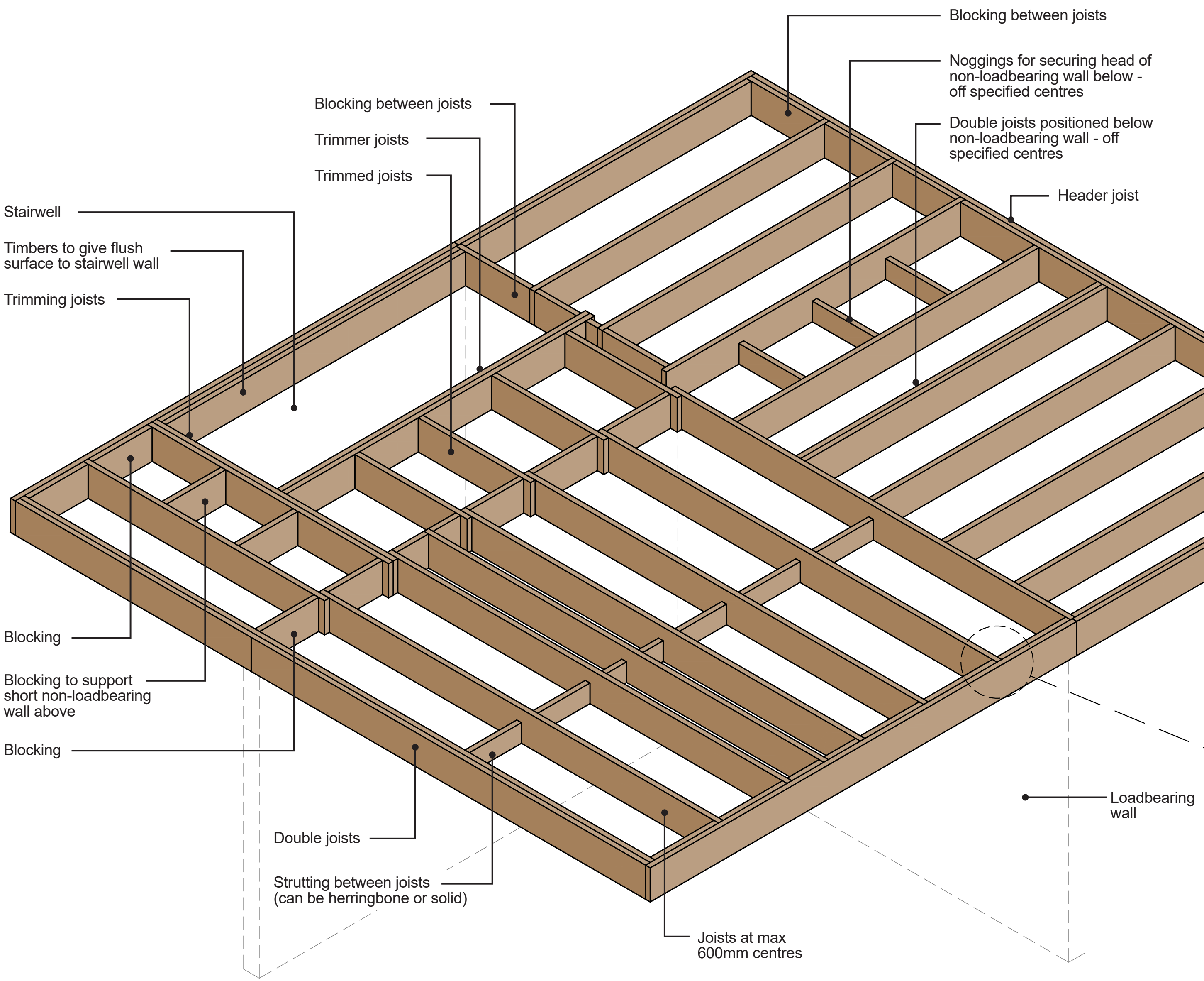
- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

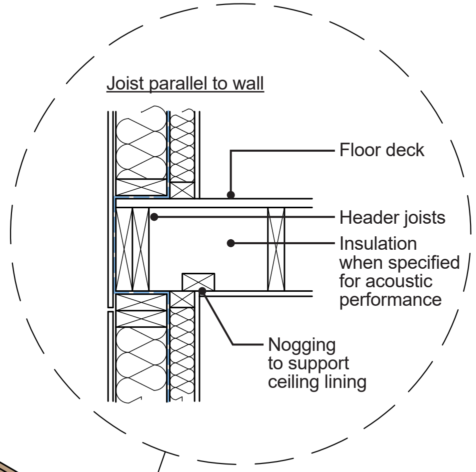
Please refer to the ‘External Walls’ section for further guidance.

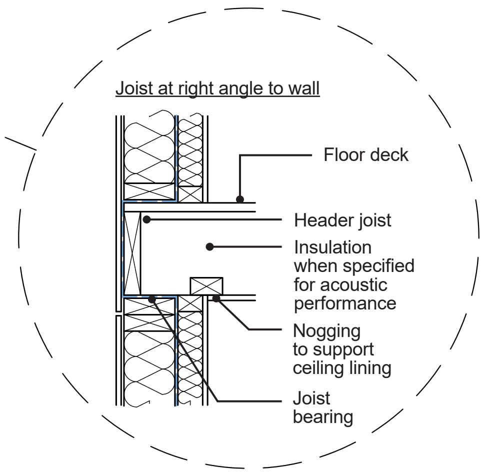
SUSPENDED TIMBER: Floor joists bearing on to masonry walls



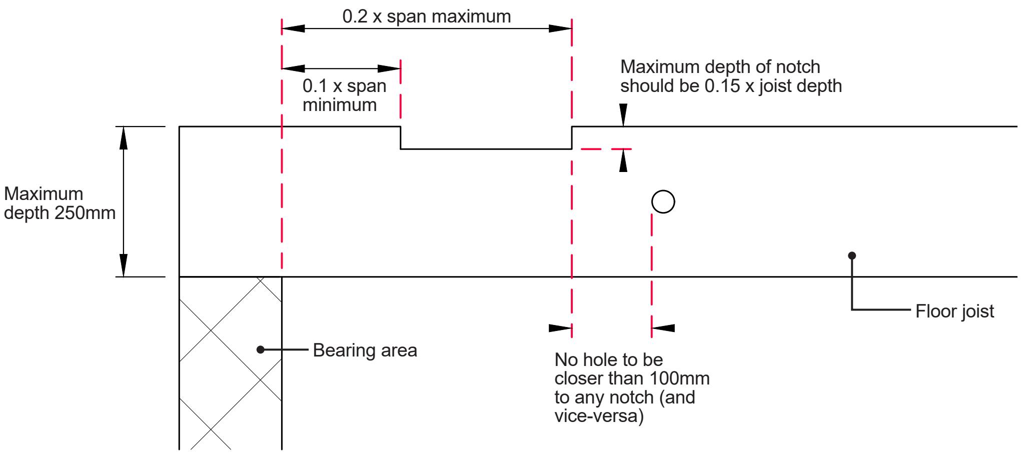
SUSPENDED TIMBER: Floor joists bearing on to a timber frame



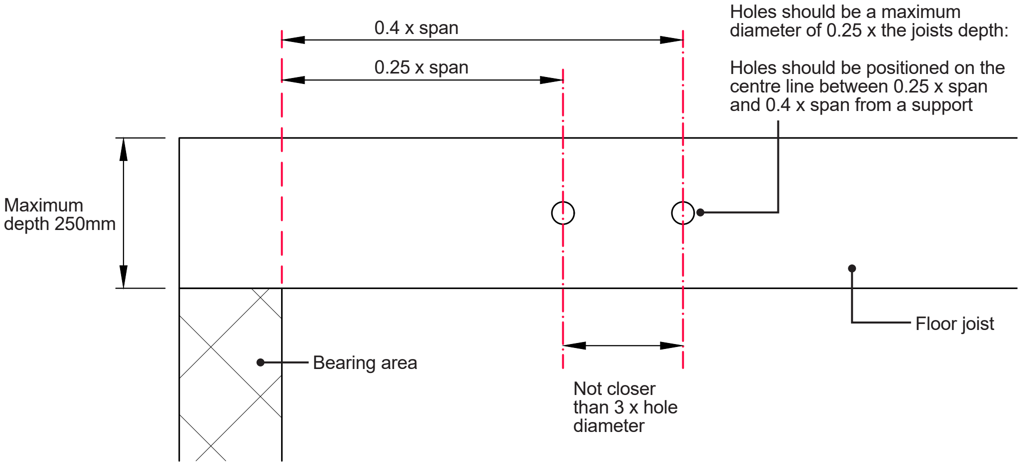




Permissible areas for the notching of joists



Permissible areas for the drilling of joists



Notching and drilling in solid timber joists

Requirements for notching and drilling of solid timber joists (further guidance can be found in BS 8103, TRADA span tables, BS EN 1996 and PD 6693 - 1).

This guidance is for joists up to 250mm deep, notching and drilling for joists exceeding this depth should be designed by the Engineer.

Notches: Notches should be made in between 0.1 and 0.2 x span. Notches should be no deeper than 0.15 x depth of the joists in this area e.g. for a 250mm deep joist, the maximum notch depth should not exceed 35mm.

Holes: Holes should be drilled on the centre line of the joist. Holes should be between 0.25 and 0.4 x the span. Holes should be a maximum diameter of 0.25 x the joists depth and kept apart by at least 3x the diameter. The maximum hole diameter should not exceed 65mm.

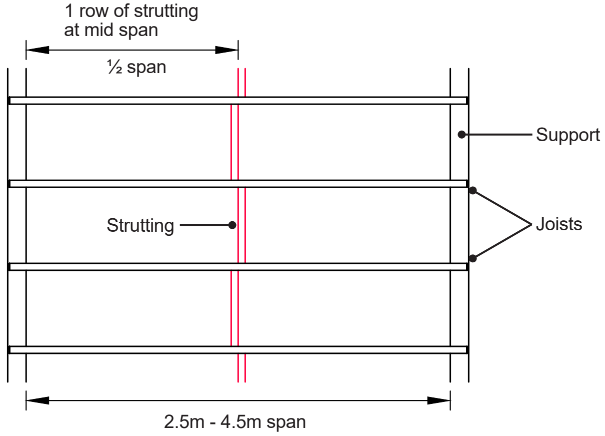
Note: Notches and holes should be a minimum of 100mm apart.

The table below gives an indication of the areas in a joist which are suitable for notching and drilling.

Typical permissible zones for notching and drilling of solid timber joists

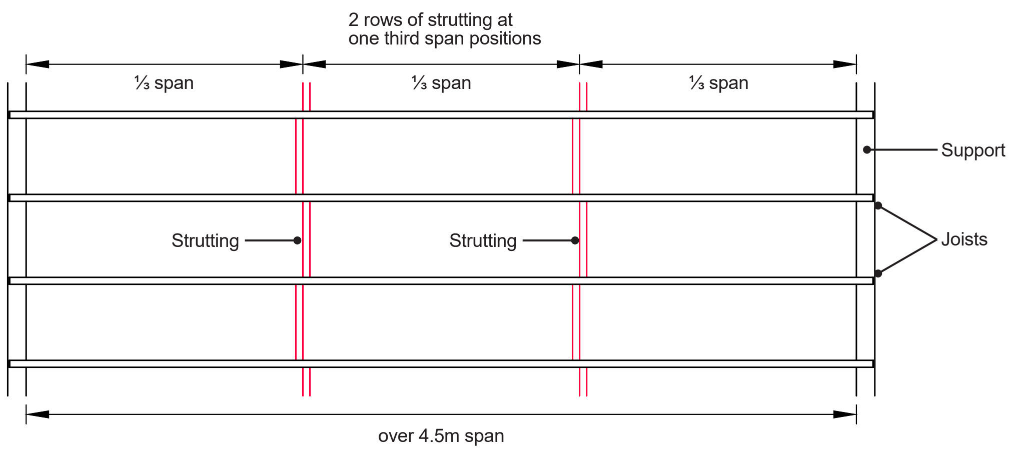
Span (m)	Notches to be taken out only within these zones (m)		Holes only to be drilled within these zones (m)	
1.5	0.15	0.30	0.375	0.6
2	0.2	0.4	0.5	0.8
2.5	0.25	0.5	0.625	1
3.0	0.3	0.6	0.75	1.2
3.5	0.35	0.7	0.875	1.4
4	0.4	0.8	1	1.6
4.5	0.45	0.9	1.125	1.8
5	0.5	1	1.25	2

Strutting of joists with a span between 2.5m and 4.5m



Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3:2009 or by a proprietary system.

Strutting of joists with a span over 4.5m



Where the span of a floor joist or flat roof joist is more than 4.5m, two rows of strutting at ⅓ the span position will be necessary.

Strutting or bridging of solid timber floor joists

Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3: 2009 or by a proprietary system.

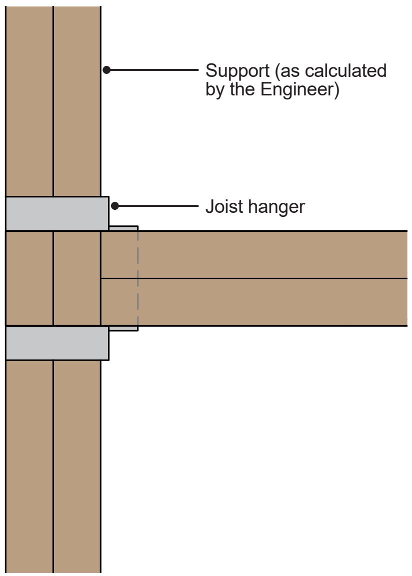
Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists; or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

Deflection of floors

For upper floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections with a relevant British Standard; however, our tolerance requirements will take precedence.

Typical trimming detail (plan)



Double joists should be bolted together at 600mm centres using minimum 10mm diameter bolts with large washers that will prevent the bolt head and nut from penetrating the joist. It is recommended that the bolting of double joists is along the centre line of joists. Suitably sized trimmer joists shall be provided around floor openings.

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection; timber trimmers around openings should consist of at least two members and be designed by the Engineer.

10.

Upper Floors

10.2
I-joists

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Manufacturer's joist layout drawings and calculations.
2. Details of the manufacturer relevant accreditation (TRADA, STA, etc.). The accreditation must confirm the manufacturers has been assessed for the design of joists.
3. Details of proposed services to be constructed within the floor void.
4. Details of any proposed underfloor heating systems to be incorporated.
5. Details of insulation be used within the floor construction.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

I-joists and their design

Engineered timber I-joists include a timber flange (usually solid timber or laminated veneer lumber (LVL)) and a panel product web (usually OSB). They are manufactured in an assortment of depths and flange widths under controlled factory conditions to low and uniform moisture contents.

I-joists should be designed in accordance with BS EN 1995, Eurocode 5 design of Timber Structures. General: Common rules and rules for buildings. I-joists should be appropriately UKCA / CE marked and comply with ETAG 011 or hold independent third party certification.

Installation of I-joists

The installation of I-joists must follow the manufacturer's guidance and specification for the project.

I-joists must be laid reasonably level and onto suitable solid and level bearings.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by the Engineer.

Joists should be restrained at supports using tightly fitted strutting.

Joists should have a minimum end bearing of 90mm, unless joist hangers are used, where the minimum bearing should be not less than 45mm.

Joist hangers should be detailed in the design, including confirmation that the joist hangers have the equivalent to restraint straps at 2m centres where required to provide restraint.

Deflection

For upper floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

Storage of i-joists

I-joists should be protected from the elements and supported on suitable bearers over a free draining surface. Levels of exposure, which are more severe than those encountered during a normal uninterrupted build programme should be addressed by the provision of suitable protection.

Bracing

Large areas of floor joists can be assembled with these products due to their lightweight and availability in long lengths. It is of great importance that adequate safety bracing is provided to ensure that the joists remain stable through the construction phase. Joist manufacturers provide simple guide recommendations that allow an installer to facilitate this process with ease and speed.

- Unbraced joist layouts are not to be walked on by workers.
- Floors should not become overloaded during construction.
- Under no circumstances should the flanges of the I-joist be cut, notched or drilled.

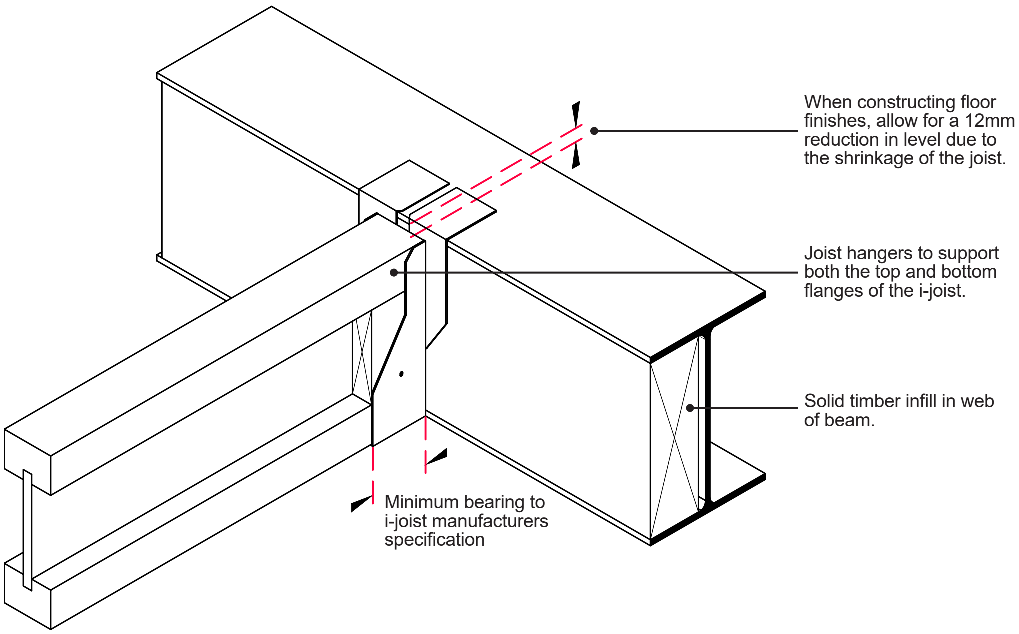
Steel beams

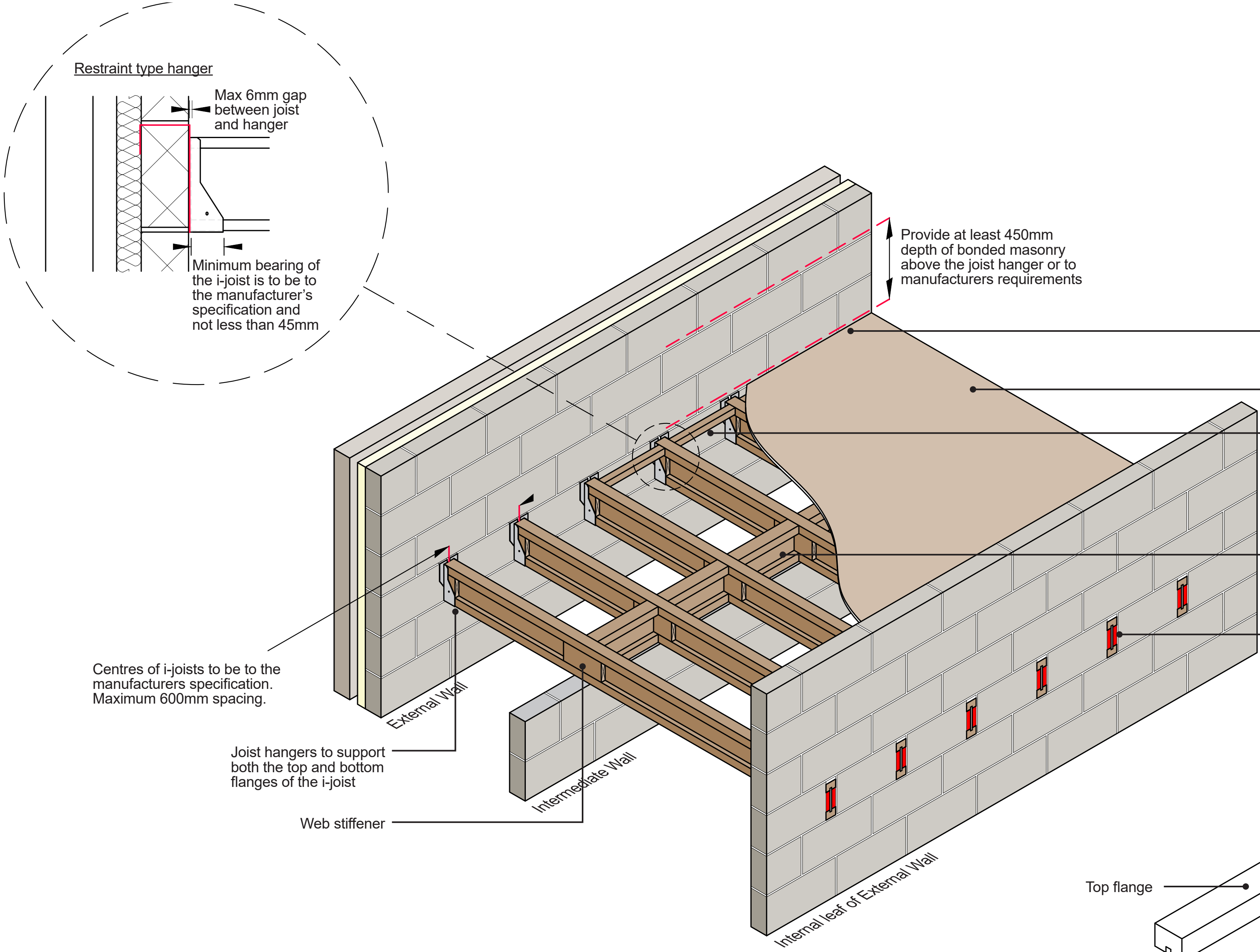
Steel beams should be designed by the Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

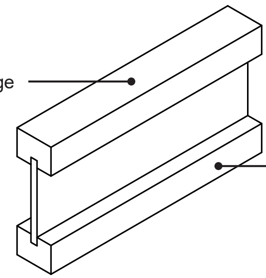
Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. under croft) please follow the requirements for additional corrosion protection in 'Appendix B - Coastal Locations' and ' Appendix C - Materials, Products, and Building Systems'.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

Steel beam bearing

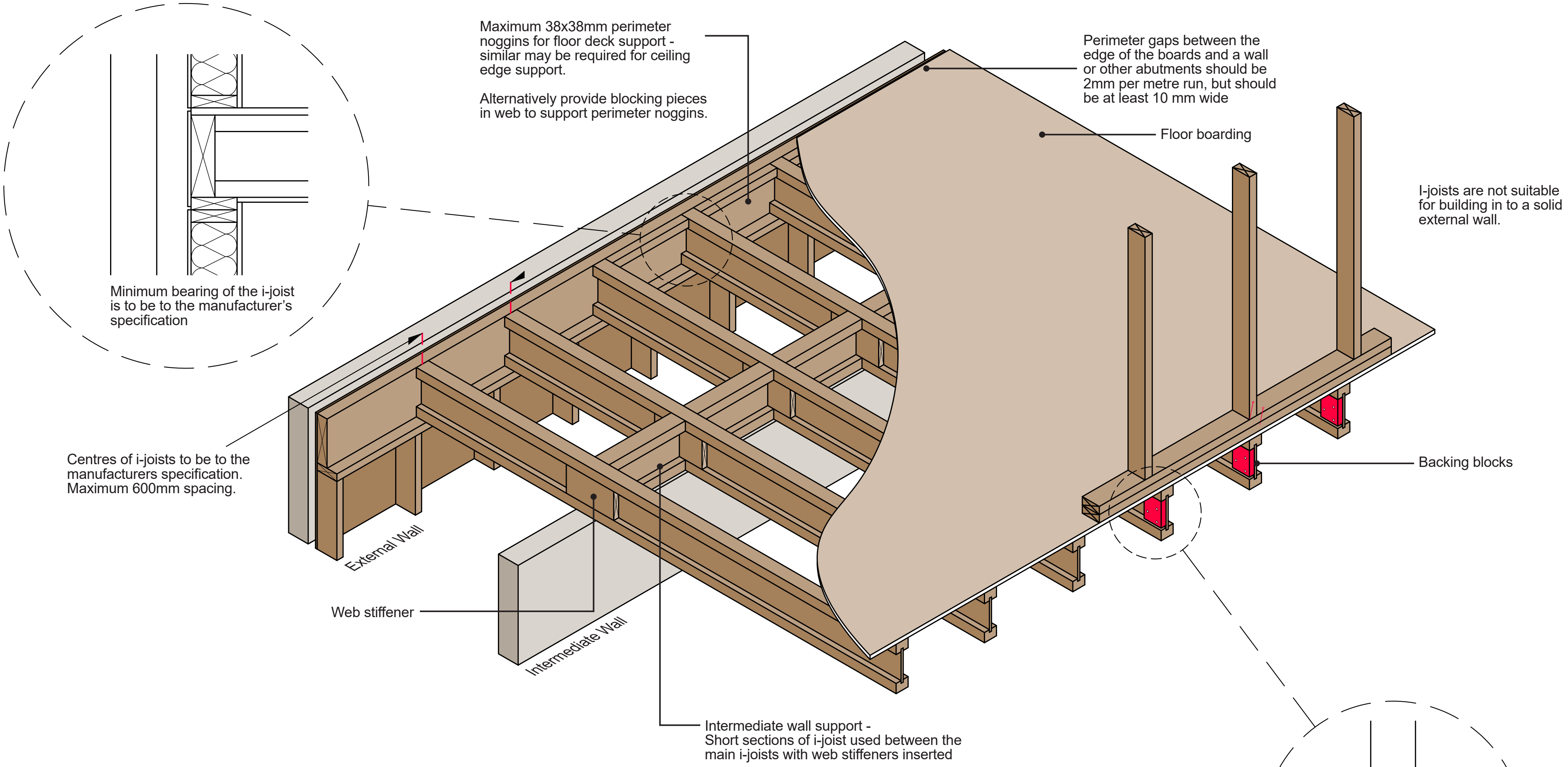


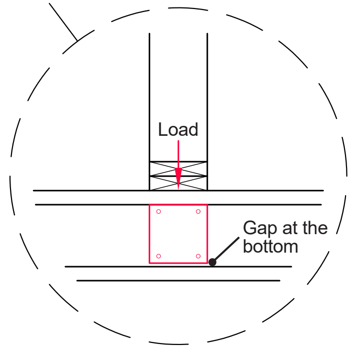


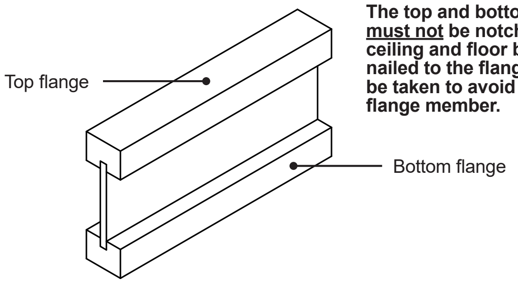


The top and bottom flanges must not be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting of the flange member.

I-JOISTS: I-joists bearing on to a timber frame







The top and bottom flanges <u>must not</u> be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting of the flange member.

Lateral restraint of walls

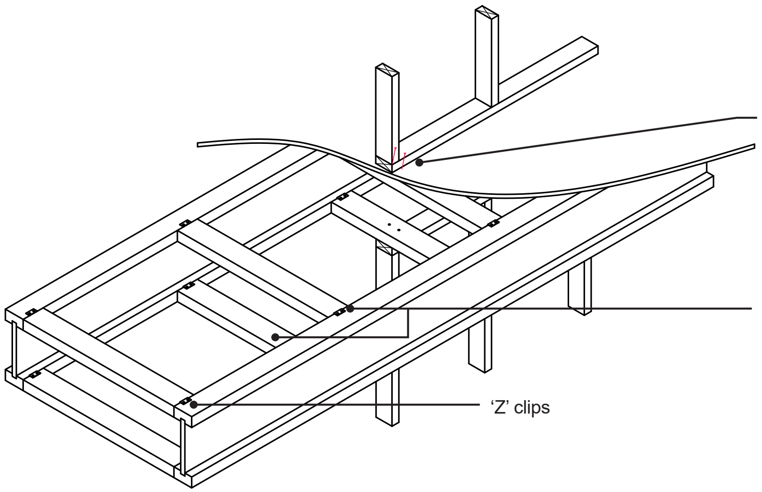
Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

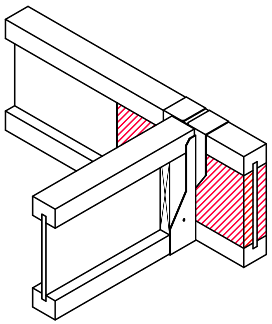
- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Support of light-weight non load bearing partitions

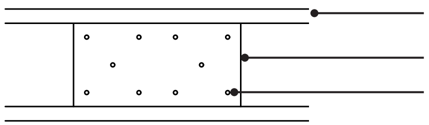


Backer blocks



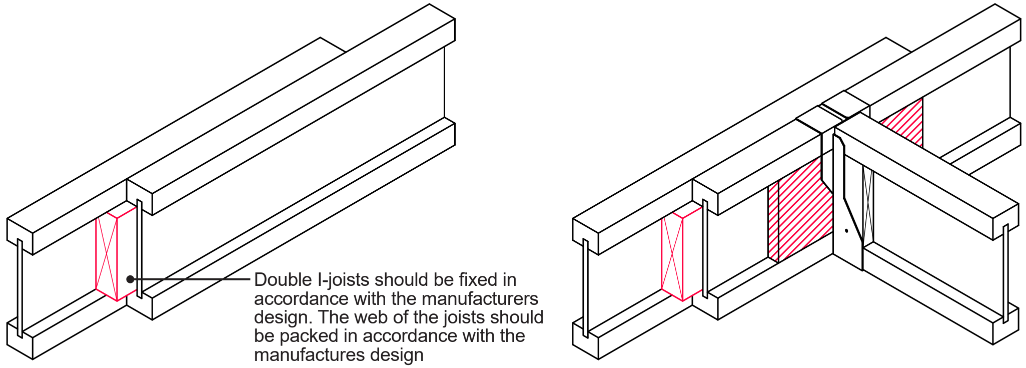
Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using joist hangers. Timber trimmers around openings should consist of at least two members and be designed and installed in accordance with the manufacturers instructions. Where an I-joist is faced fixed to another I-joists backer blocks should be provided on both sides of the web of the trimmer.

Fixing of I-joists should be in accordance with the engineers design and specification. A timber filler block should be installed between I-joists.

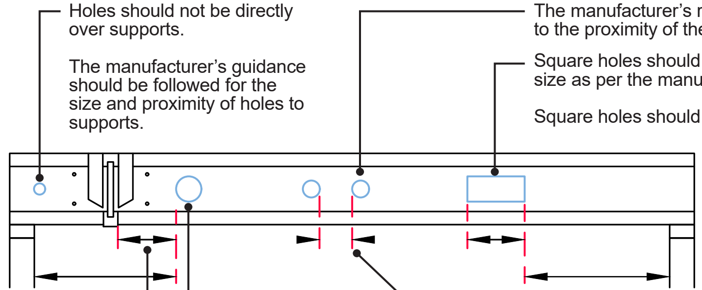


Backer blocks should be fixed in accordance with the manufacturer's design.

Fixing of multiple i-joists

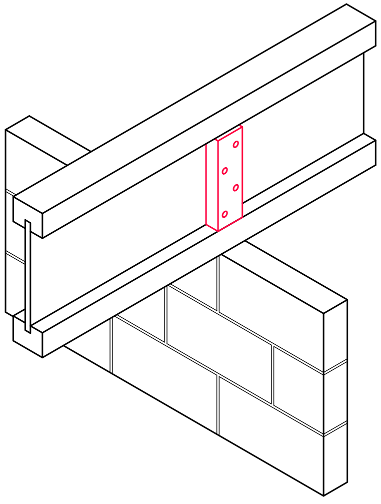


Notching and drilling of i-joists



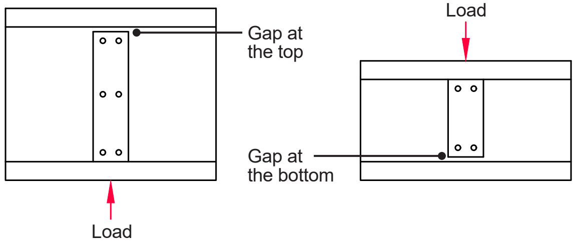
Building in of I-joists over internal walls

To reduce shrinkage, all mortar should be adequately dry and solidly packed in, but it should not be packed up tight to the underside of the top flange. Before the floor decking is fixed, all continuous joists must be packed down to the intermediate bearing wall.



Additional blocking should be installed in accordance with the manufacturer's instructions.

Generally a gap is required at the top or bottom of the packing, dependent on the direction of the load. Generally if the load comes from the bottom e.g. bearing on an internal wall the gap should be at the top. If the load is from the top the gap should be provided at the bottom.

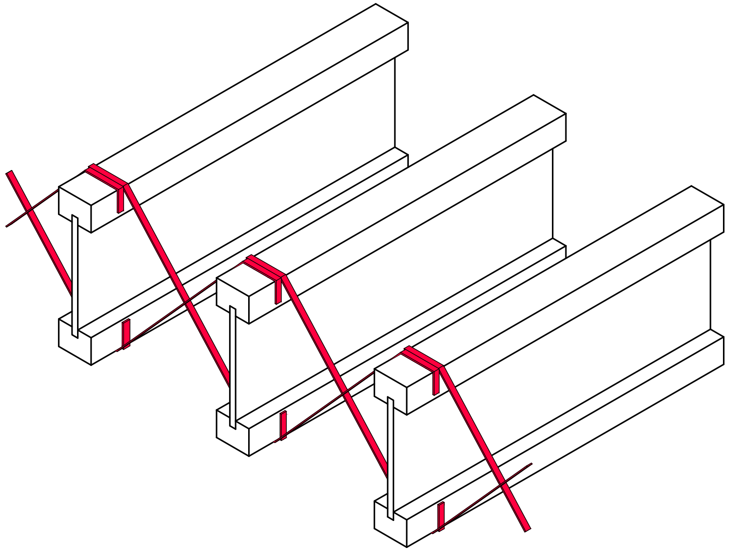


The backing blocks should be fixed in accordance with the manufacturers design. Generally, backing blocks on deeper joists require a higher number of fixings.

Proprietary strutting devices

Solid strutting is difficult to install between I-joists and propriety strutting maybe used as an alternative.

An alternative to solid strutting is Steel herringbone strutting systems, which are generally pressed lengths of galvanized mild steel, usually 1mm thickness and are produced in a variety of lengths to suit differing joist depths and spacing's.



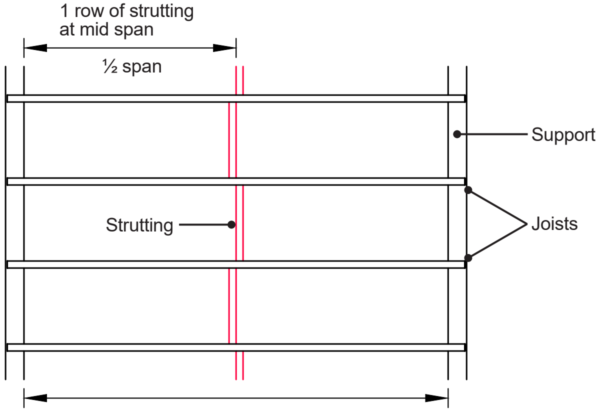
Strutting or bridging

Strutting or bridging of I-joists should be installed as per the below table.

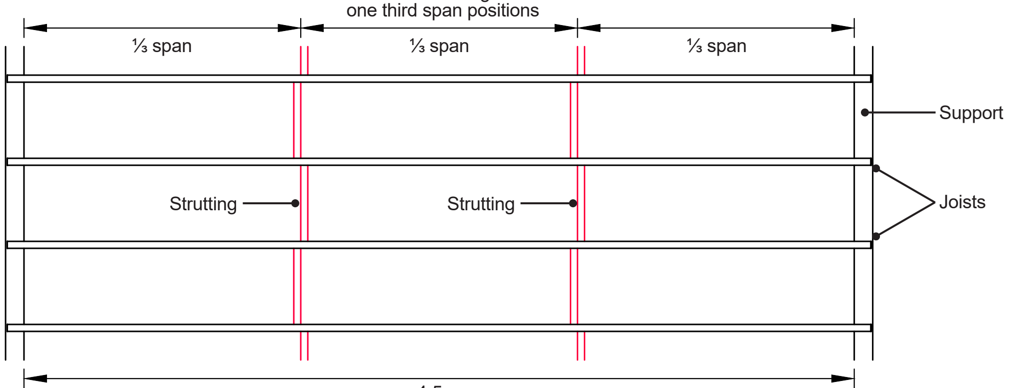
Joist span (m)	Rows of strutting
up to 2.5	None
2.5 - 4.5	1 at mid-span
over 4.5	2 at 1/3 points

Strutting of joists with a span between 2.5m and 4.5m

Strutting or bridging of I-joists should be installed as per the below table.



Strutting of joists with a span over 4.5m



Where the span of a floor joist or flat roof joist is more than 4.5m, two rows of strutting at ⅓ the span position will be necessary.

10.
Upper Floors

10.3
Metal Web

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Manufacturer's joist layout drawings and calculations.
2. Details of the manufacturer relevant accreditation (TRADA, STA, etc.). The accreditation must confirm the manufacturers has been assessed for the design of joists.
3. Details of proposed services to be constructed within the floor void.
4. Details of any proposed underfloor heating systems to be incorporated.
5. Details of insulation be used within the floor construction.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Metal web joists and their design

Metal web joists consists of parallel stress graded timber flanges joined together with V-shaped galvanised steel webs. The webs are fixed to the flanges via nail plates. The open web design gives great flexibility in running through services.

Metal web joists should be designed in accordance with BS EN 1995, Eurocode 5 design of Timber Structures. General: Common rules and rules for buildings.

Metal web joists should be appropriately UKCA / CE marked and comply with ETAG 011 or hold independent third party certification.

Installation of metal web joists

The installation of metal web joists must follow the manufacturer's guidance and specification for the project.

Metal web joists must be laid reasonably level and onto suitable solid and level bearings.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or be designed by the Engineer.

Joists should be restrained at supports using tightly fitted strutting.

The minimum end bearing of the joists should be in accordance with the manufacturer's instruction and the site specific design. Generally the minimum end bearing should be no less than 90mm, unless joist hangers are used, where the minimum bearing should be to the manufacturer's specifications.

Deflection

For upper floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections with a relevant British Standard; however, our tolerance requirements will take precedence.

Storage of metal web joists

Metal web joists should be protected from the elements and supported on suitable bearers over a free draining surface. Levels of exposure which are more severe than those encountered during a normal uninterrupted build programme should be addressed by the provision of suitable protection.

Bracing

Large areas of floor joists can be assembled with these products due to their light weight and availability in long lengths. It is of great importance that adequate safety bracing is provided to ensure that the joists remain stable through the construction phase. Joist manufacturers provide simple guide recommendations that allow an installer to facilitate this process with ease and speed.

- Unbraced joist layouts are not to be walked on by workers.
- Floors should not become overloaded during construction.
- Under no circumstances should the metal web joist be cut, notched or drilled.

Steel beams

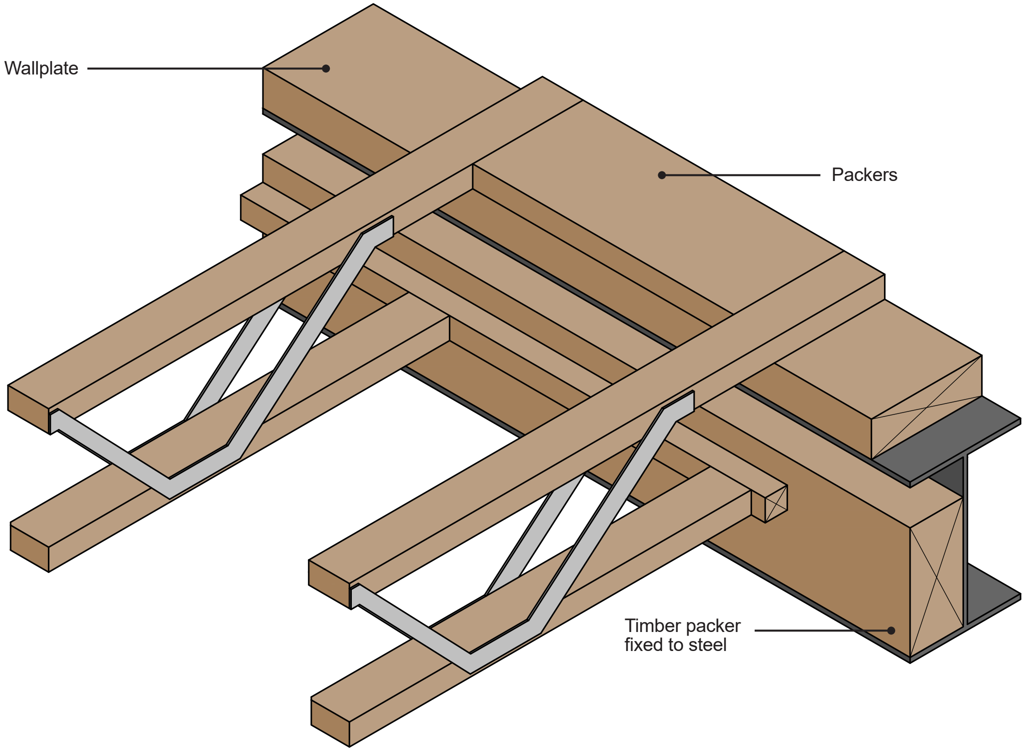
Steel beams should be designed by a suitably qualified Structural Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. under croft) please follow the requirements for additional corrosion protection in 'Appendix B - Coastal Locations' and ' Appendix C - Materials, Products, and Building Systems'.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

Steel beam bearing

Metal web joists may be top hung subject to the manufacturer's site specific design.



Lateral restraint of walls

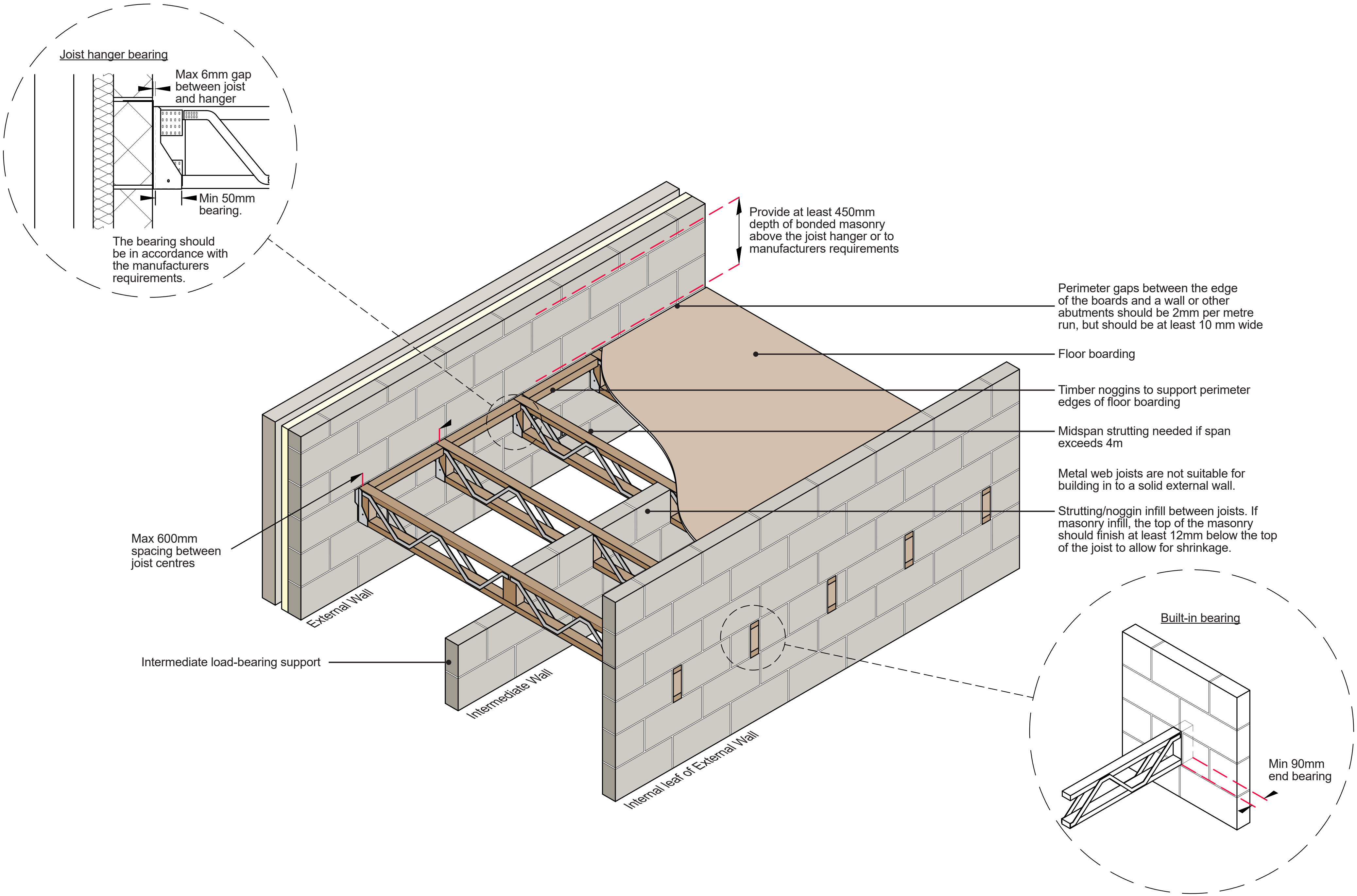
Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

METAL WEB: Metal web bearing on to masonry walls

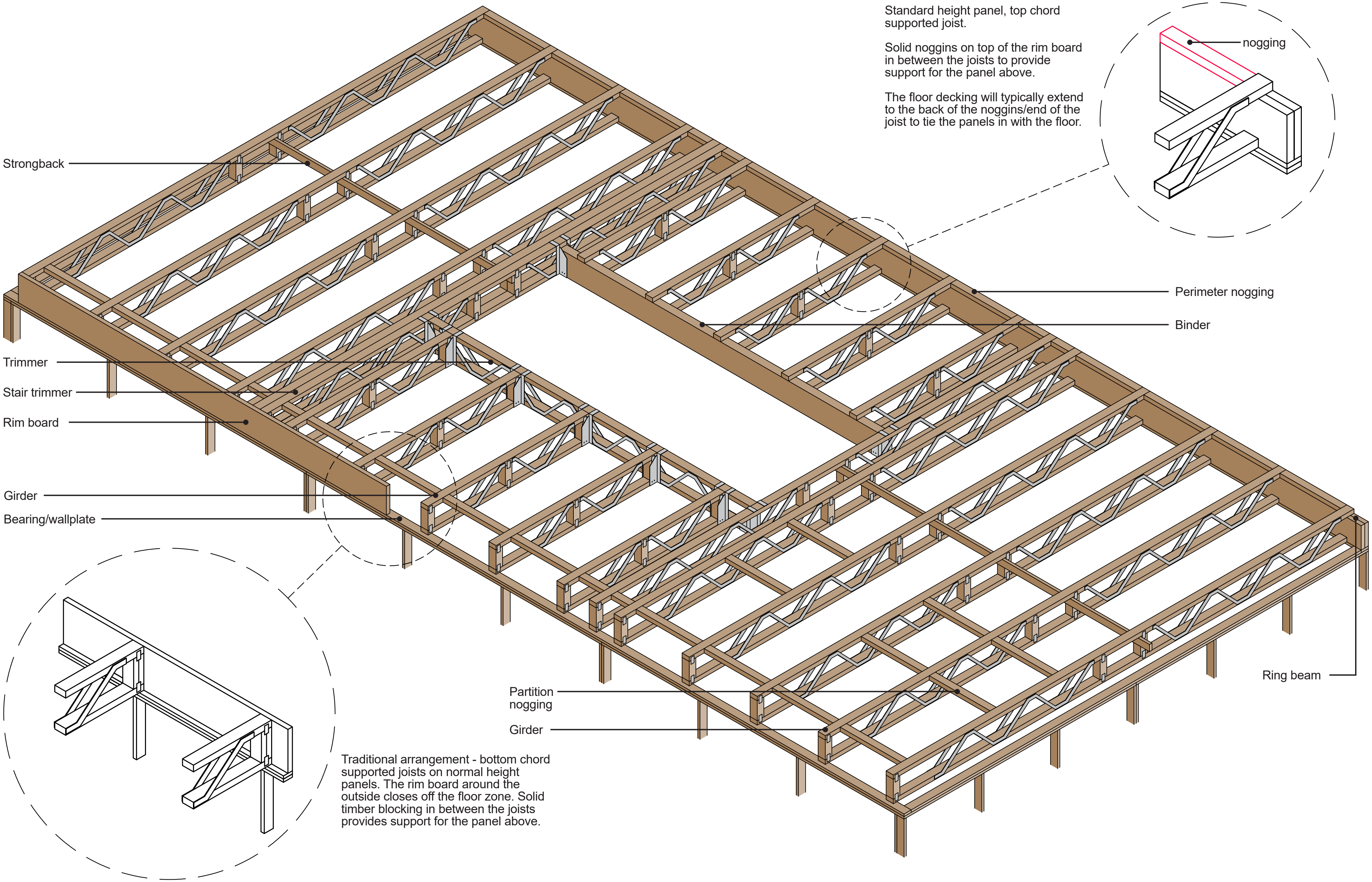


METAL WEB: Metal web bearing on to a timber frame

Standard height panel, top chord supported joist.

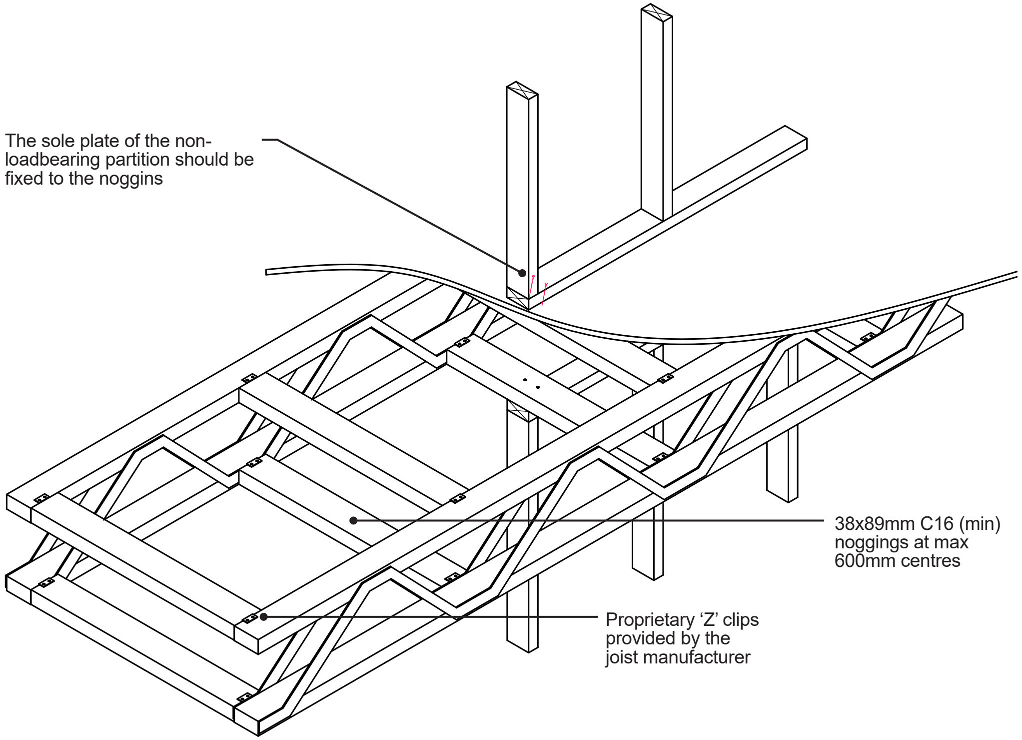
Solid noggins on top of the rim board in between the joists to provide support for the panel above.

The floor decking will typically extend to the back of the noggins/end of the joist to tie the panels in with the floor.



Traditional arrangement - bottom chord supported joists on normal height panels. The rim board around the outside closes off the floor zone. Solid timber blocking in between the joists provides support for the panel above.

Support of light-weight non load bearing partitions



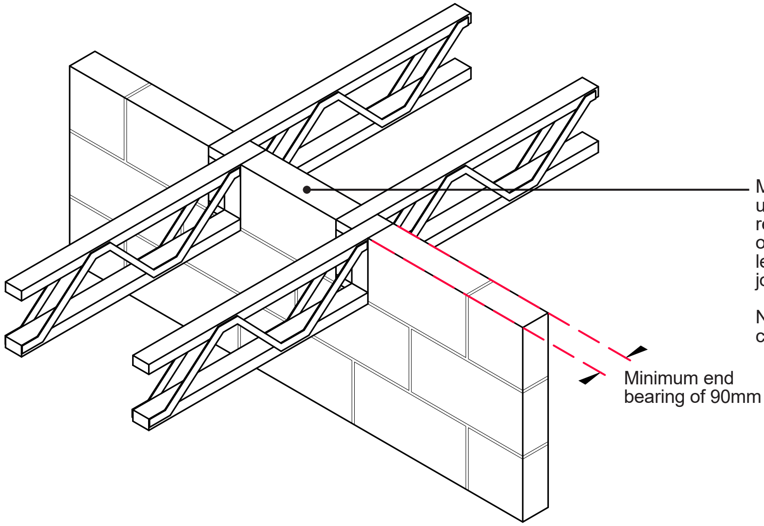
Where light weight non load bearing partition are parallel to the joists, they should be suitably supported in accordance with the manufacturers design.

Where metal web joists are used they should be:

- Positioned centrally below a non load bearing partition. Double or triple joists should be provided in accordance with the manufacturers details and fixed with propitiatory fixings in accordance with the manufactures design.
- Or the weight of the partition should be supported by noggins or bearers fixed to joists with the floor systems propitiatory fixings on either side. The noggins should be at a maximum of 600mm centres and should be 38mm x 90mm unless designed otherwise.

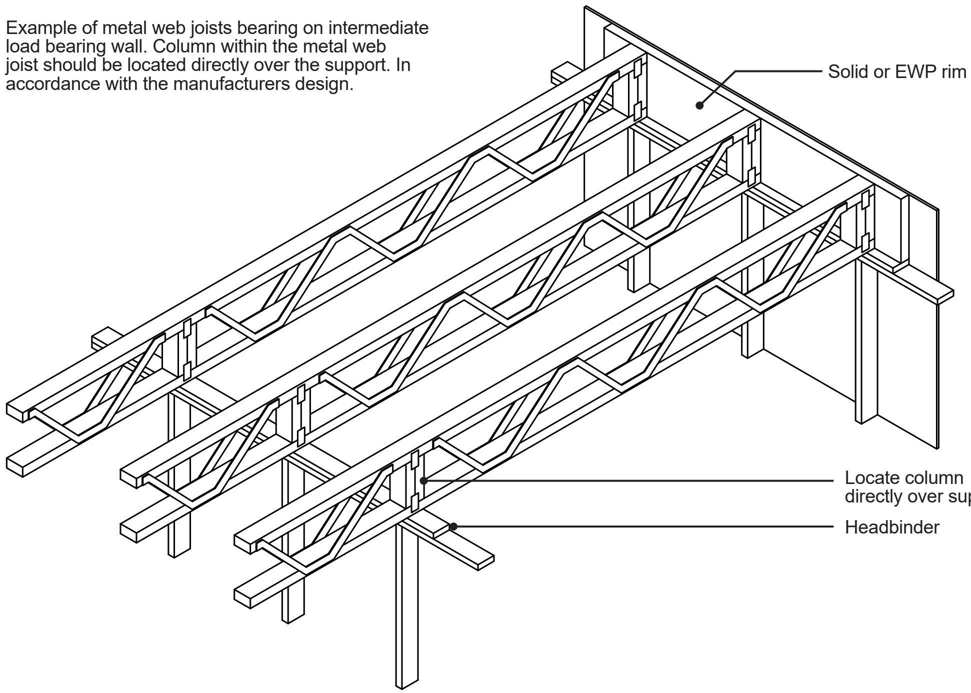
Sole plates should be fixed to the noggins or joists.

Metal web joists supported on load bearing masonry internal wall

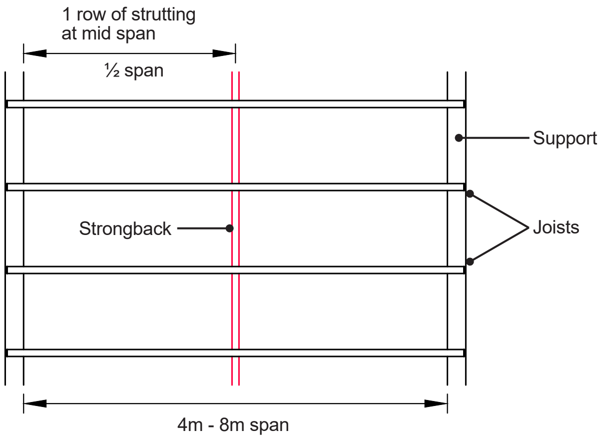


Metal web joists supported on load bearing timber internal wall

Example of metal web joists bearing on intermediate load bearing wall. Column within the metal web joist should be located directly over the support. In accordance with the manufacturers design.

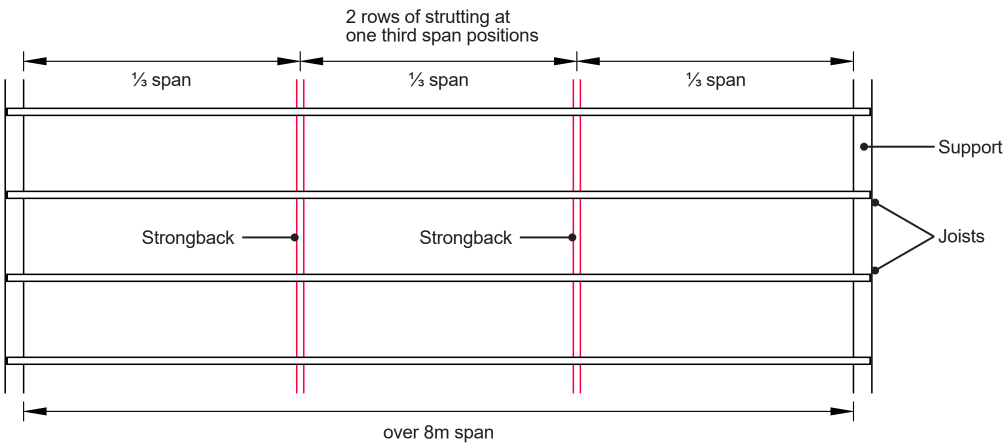


Strutting of joists with a span between 4m and 8m



Where the span of a floor joist or flat roof joist is more than 4m, strutting is necessary. This should be provided by timber strong backs in accordance with the manufacturers design

Strutting of joists with a span over 8m



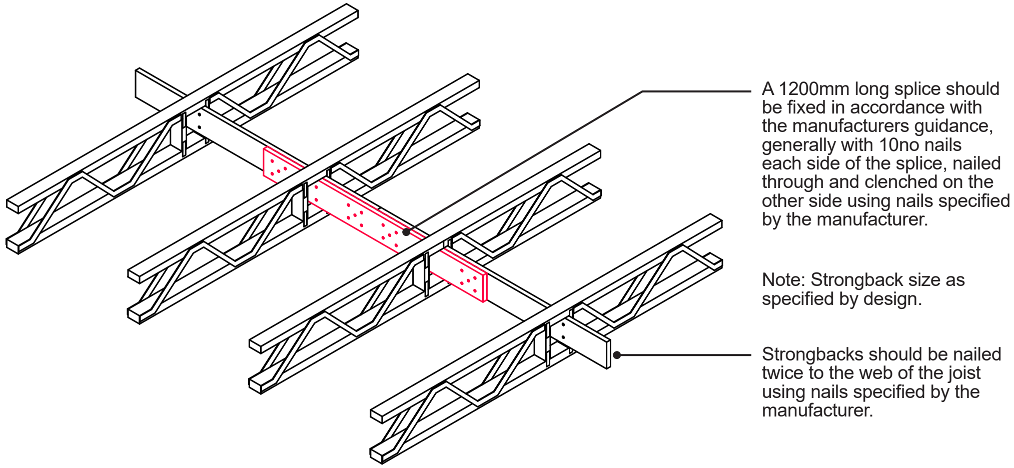
A minimum of two rows of strutting are required for spans over 8m. This should be provided by strongbacks in accordance with the manufacturers design.

Strutting of joists

Strutting to metal web joists should be provided in accordance with the manufacturers guidance and the table below.

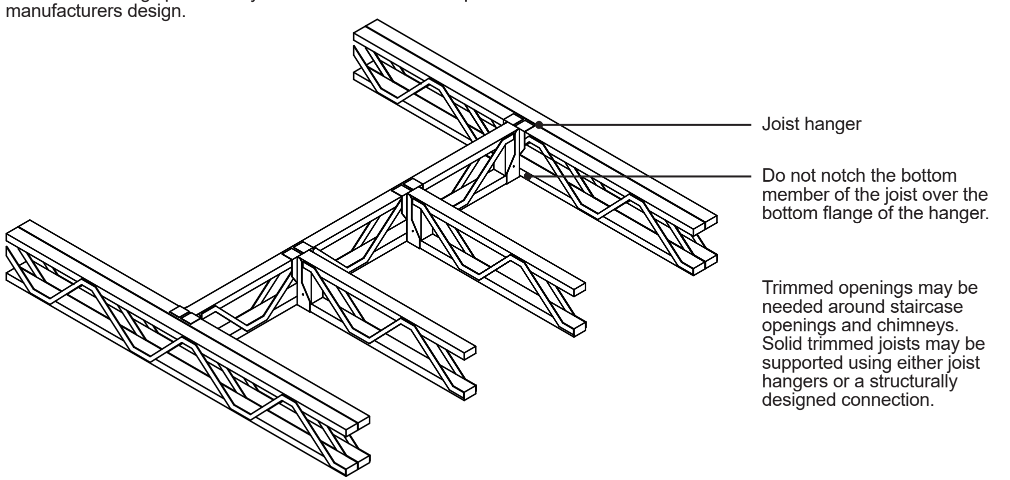
Joist span (m)	Rows of strutting
4 - 8	1 at centre of span
over 8	2 at equal spacing

Strongback splice



Typical trimming detail

Double joists should be fixed as per the manufactures design, this can be with a propriety clip or fixed at specified centres with fixings provided by the manufacturer. It is important to ensure that the work on site is in accordance with the manufacturers design.



10.
Upper Floors

10.4
General Requirements for Timber Upper Floors

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed decking boards to be used.
2. Details of type, size, spacing and method of fixing.

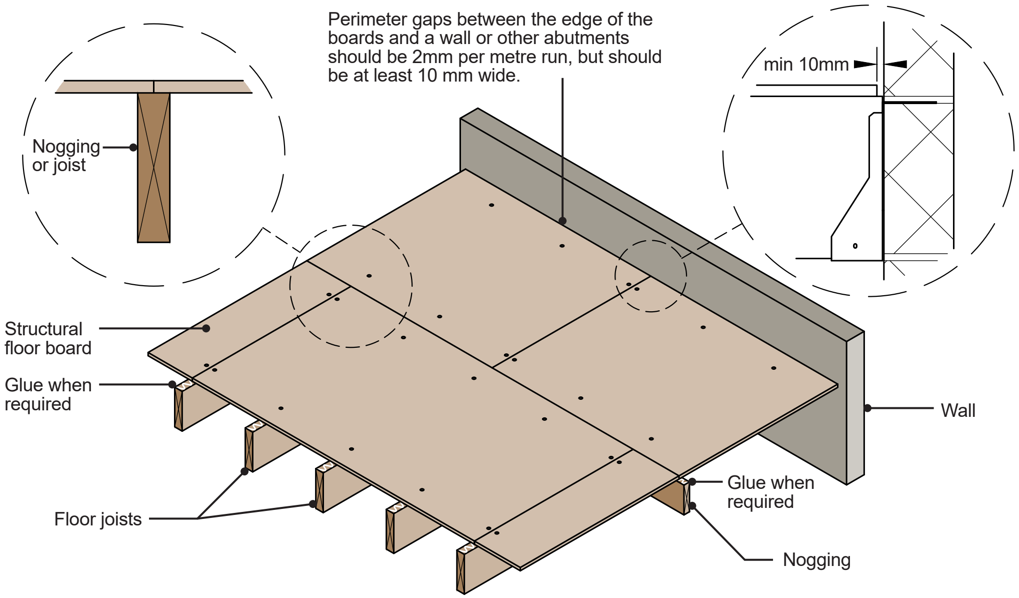
The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Where structural floor boards are specified, the following should be taken into account:

- They should be specified in accordance with the ‘Minimum thickness for structural floor boards’ table, guidance within this section and relevant British Standards.
- Fixings should be in accordance with the manufacturer’s recommendations, where this is not provided, the guidance within this section or BS 8103-3 should be used.
- Where gluing is required, boards should be glued to the joists and between board joints, using a suitable polyvinyl acetate (PVAc) adhesive.
- Square edged boards should be supported on all edges by joists or noggings.
- Tongue and groove boards should be laid:
    - With long edges at right angles to joists.
    - So that short edges are supported on joists or noggings or they should be cut back to form a butt joint over a joist.
    - So that long edges at room perimeters are supported on a joist or noggings.
- Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10 mm wide.

Typical floor board arrangement



Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

Protection against weather

Structural floor boards that are built in as the work proceeds and left exposed to the elements will be subjected to various issues, especially during prolonged periods of precipitation. As such, we require these floor boards for timber joists (both engineered and traditional) to have a third party approval certificate from a UKAS accredited body which covers weather resistance for the period of time the boards are to be left exposed on site.

Any boards that are left exposed beyond the period stated in the third party approval certificate should be replaced.

Minimum thickness for structural floor boards

Structural floor boards should be specified in accordance with the below table[1].

Structural floor board type	400mm joist centres	450mm joist centres	600mm joist centres
Softwood floor boarding	16mm	16mm	19mm
Particle board (chipboard)	18mm	18mm	22mm
Oriented strand board (OSB)	15mm	15mm	18mm/19mm
Plywood boarding	15mm	15mm	18mm/19mm
1. This table applies to normal domestic loads (imposed loads of 1.5 kN/m²).			

Softwood floor boarding

- Softwood floor boarding should be specified in accordance with BS EN 13353 and BS 1297
- Maximum moisture content at the time of fixing should be between 15%-19% (this may be reduced when installing in heated spaces, see BS 8103-3 for further details).
- All boards must be double nailed or secret nailed to each joist using nails that are at least three times the board depth.

Particle board (chipboard) and oriented strand board (OSB)

- Particle board should be type P5 to BS EN 312 or OSB boards should be type 3 or 4 to BS EN 300.
- Maximum moisture content at the time of fixing should be 12%.
- Flat headed annular-ringed shank nails or screws should be used.
- All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater.
- The diameter of the fixing should be a minimum of 0.16 times the thickness of the board.
- Fastenings should be spaced at centres not more than 150 mm along both continuously supported edges and 300 mm along the intermediate supports.
- Fastenings should be at least 8 mm from the edge of the board.
- Nail heads should be punched 2-3mm below the surface of the board and screws should pre-drilled and countersunk.
- Fixings in service class 2 fixings should be corrosion resistant.
- A 3 mm gap should be left between each square edge boards.

Plywood boarding

- Plywood boarding should be specified in accordance with BS EN 636.
- Maximum moisture content at the time of fixing should be 12%.
- Plywood boarding should be laid so that the grain within the face is at right angles to the supporting elements.
- Fixings should be spaced at a maximum of 150mm around the outer perimeter of the boards, with fixings a maximum of 300mm apart at intermediate supports.
- An expansion gap of a minimum of 2mm should be allowed between each panel.

Plywood boarding: Minimum fixing nails

	Plain wire nails	Annular ring shank nails
Minimum diameter	3.35mm	3mm
Minimum length	65mm	50mm
Minimum penetration	40mm	32mm

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed plasterboards to be used; type of board, thickness, number of boards to create the layer.
2. Details of mechanical fixings of plasterboards.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Plastered finishes

Workmanship of plastered finishes to ceilings should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

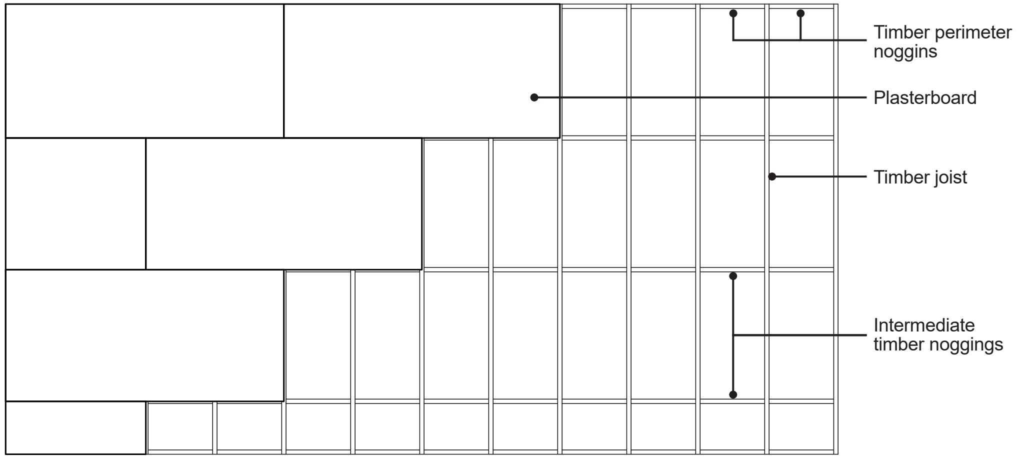
Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

Ceiling plan - plasterboard fixed to timber joists



Minimum plaster thicknesses

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in this Technical Manual, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the table below.

Element	Minimum number of coats	Typical thickness
Ceiling - plasterboard	1	Skim to provide suitable and durable finish

Support of plasterboard

Supports for plasterboard should be designed so that the following span limits are not exceeded:

Board thickness (mm)	Timber support centres (mm)	Intermediate noggings required	Perimeter noggings required*
9.5	400	No	Yes
	450	Yes	Yes
12.5	400	No	Yes
	450	No	Yes
	600	Yes	Yes
15	600	No	Yes

* Fire resisting plasterboard should be fully supported at edges by noggins if the floor joist are not against the wall.

When fixing plaster boarding:

- Fix boards with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.
- Fix to timber joists using dry-wall screws.

Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

10.
Upper Floors

10.5
Suspended Beam and Block

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Manufacturer's floor layout drawings and calculations.
2. Plan details showing dimensions, levels and locations of incoming service penetrations.
3. Details indicating the locations of all load and non-load bearing walls.
4. Manufacturer's third party certification for the proposed insulation to be used within the floor.
5. Details of underfloor heating systems where being used.
6. Third party certification for non-standard beam & block flooring.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Precast beams are proprietary products, which the design and construction are specific to the manufacturer of the product. Projects incorporating precast beams must be provided with full manufacturers design, structural calculations and specifications including fixings specific for the project.

Precast beams and infill blocks are to be carefully stored and handled on-site, preventing damage occurring before, during and after incorporation into the structure. Precast beams should be lifted as near as possible to their ends.

Installation

The installation of precast beams and blocks must follow the manufacturer's guidance and specification for the project.

Ensure that precast concrete beam and block floors are fully supported by load-bearing walls.

The bearing surface of walls, beams and other supports to receive precast units are to be smooth and level.

Infill blocks and slabs should fully bear onto supporting beams and walls.

Similar beams of the same size may have differing strength properties because of their varying reinforcement size, so it is important to check beam reference numbers and their layout. It is also essential sometimes to provide two or more beams adjacent to each other where spans are excessive or in heavily loaded areas. Suitable infill bricks or blocks are to be properly bedded on mortar and provided between pre cast (PC) beams where bearing onto supporting walls.

Beams and blocks are to be grouted together with a 1:6 cement to sand mix in accordance with the manufacturer's instructions.

Load-bearing walls are to continue through the beam and block floor.

Holes for service pipes are properly filled by laying non-timber formwork between PC joists and filling with good quality concrete (ST2 mix) prior to screeding.

Beams should bear onto masonry with a minimum 90mm bearing, and steelwork with a minimum 70mm bearing.

Ensure that the blockwork carrying the beam and block flooring has sufficient compressive strength.

Levels

Precast beams or beam and block floor constructions must be laid reasonably level and onto suitable solid and level bearings.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Deflection of floors

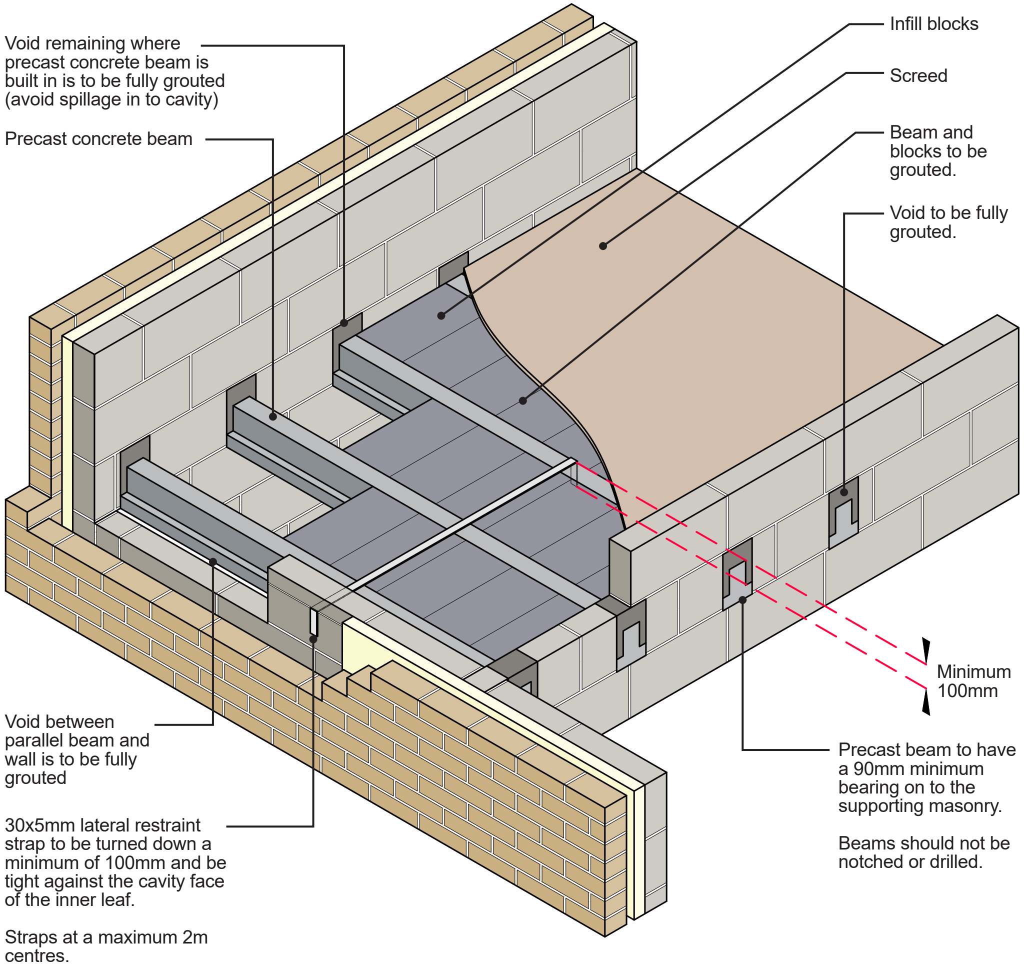
For upper floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections with a relevant British Standard; however, our Tolerances requirements will take precedence.

Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

Typical suspended beam and block construction



10.
Upper Floors

10.6
Concrete Plank

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Manufacturer's floor layout drawings and calculations.
2. Plan details showing dimensions, levels and locations of incoming service penetrations.
3. Details indicating the locations of all load and non-load bearing walls.
4. Manufacturer's third party certification for the proposed insulation to be used within the floor.
5. Details of underfloor heating systems where being used.
6. Third party certification for non-standard beam & block flooring.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

General requirements

Precast concrete planks are proprietary products, which the design and construction are specific to the manufacturer of the product. Projects incorporating precast concrete planks must be provided with full manufacturers design, structural calculations and specifications including fixings specific for the project.

Precast concrete planks are to be carefully stored and handled on-site, preventing damage occurring before, during and after incorporation into the structure. Units should be lifted as near as possible to their ends.

Installation

The installation of precast concrete planks must follow the manufacturer's guidance and specification for the project.

The bearing surface of walls, beams and other supports to receive precast units should be smooth and level.

Infill blocks and slabs should fully bear onto supporting beams and walls.

Ensure that precast suspended concrete plank floors are fully supported by load-bearing walls.

It is important to check the plank reference numbers and their layout. Similar units of the same size may have differing strength properties because of their varying reinforcement size, so it is important to check unit reference numbers and their layout. Suspended concrete planks should be grouted in accordance with the manufacturer's instructions ensuring the correct strength and aggregate size is used.

Holes for service pipes are to be properly filled by laying non-timber formwork between PC joists and filling with good quality concrete (ST2 mix) prior to screeding.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Deflection of floors

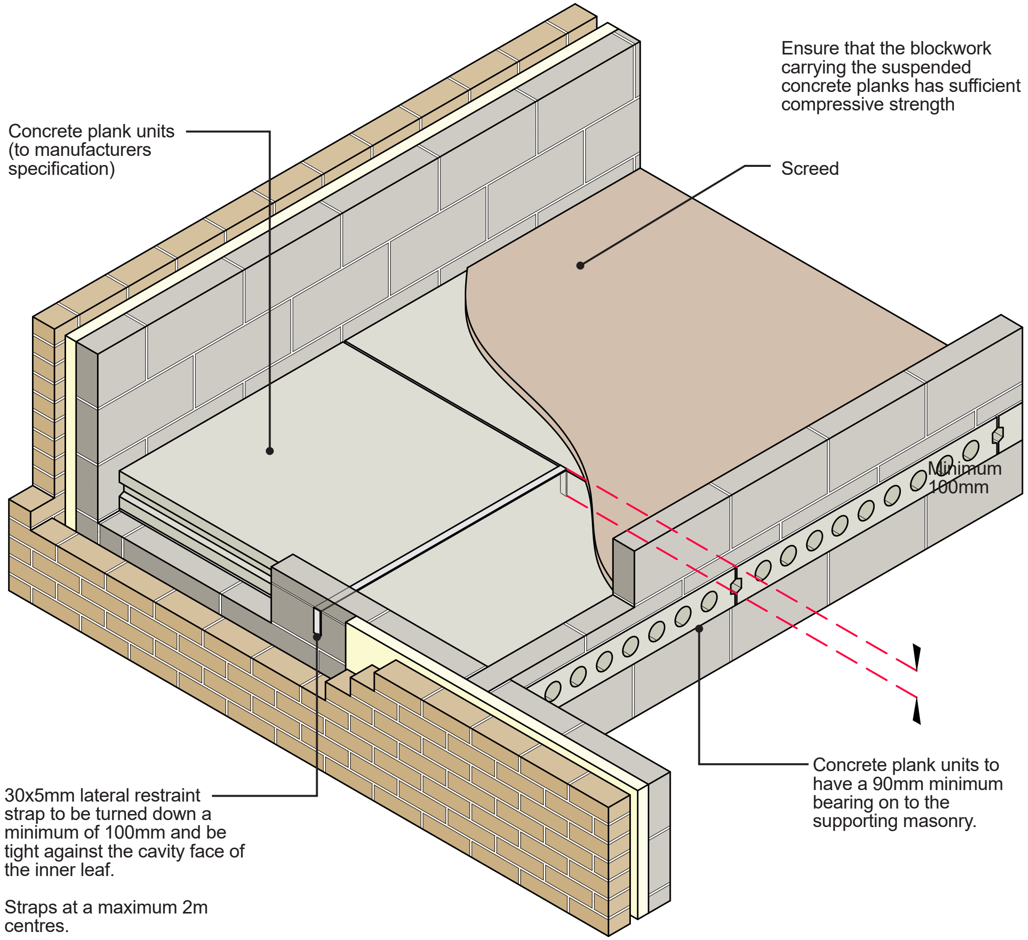
For upper floors (intermediate floors), designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections with a relevant British Standard; however, our Tolerances requirements will take precedence.

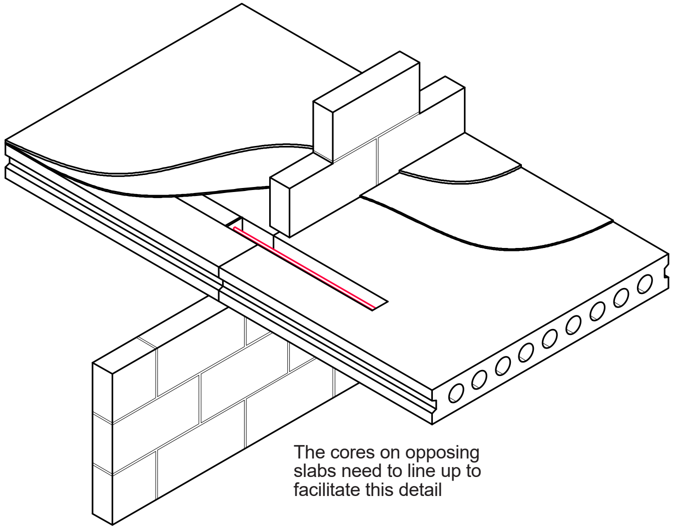
Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations. Compliance with the relevant Building Regulations can be demonstrated by either carrying out pre-completion testing or Robust details. For further information, advice should be sought from your Building Control Body.

Typical concrete plank construction



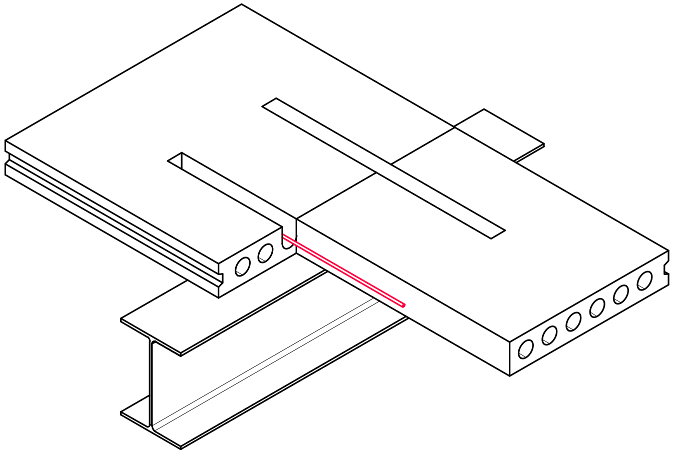
Narrow wall bearing



Generally for walls narrower than 190mm the slabs should be tied together in accordance with the manufacturer's instructions.

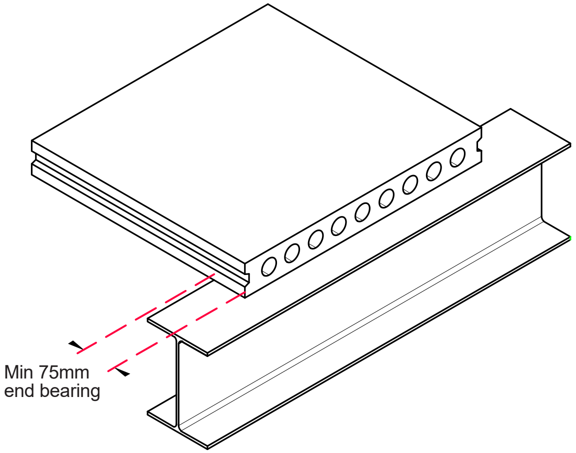
Typically this is achieved by two cores per 1200mm wide slab are formed open so that a reinforcement bar can be inserted across to form the tie detail, however this should be constructed in accordance with the manufacturer's site specific design.

Continuity over steelwork



When continuing over steel work the slabs may also require tying together in accordance with the manufacturers recommendations.

Bearing on top of steelwork

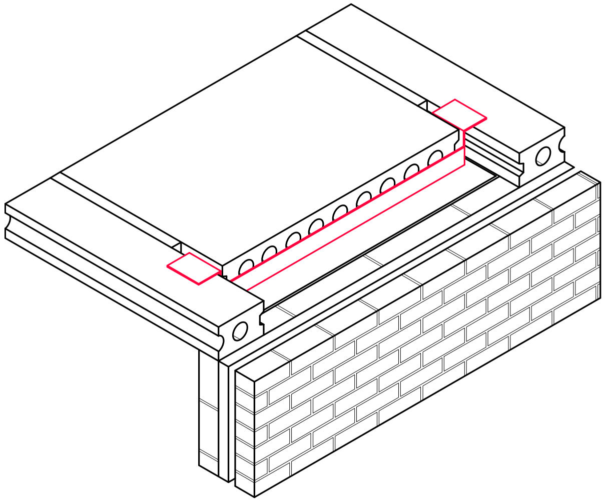


A minimum of 75mm bearing should be provided on steel beams. Planks may require mechanical restraint to the steel beam in accordance with the manufactures specification.

Steel beams should be designed by a suitably qualified structural engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. under croft), please follow the requirements for additional corrosion protection in 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems'.

Holes and notches



Openings to accommodate service voids and column notches should be preformed. Large openings may require steel trimming supports. Holes of less than 100mm can be formed on site in accordance with the manufactures design.

All holes/openings should be in accordance with the manufacturers design.

10.
Upper Floors

10.7
General Requirements for Concrete Upper Floors

Provision of Information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor screeds including thickness and mix.
2. Details of substrates to which the screeds will be laid upon.
3. Details of proposed curing times and environmental constraints.
4. Details of services within the floor, including underfloor-heating.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Floor screeds

Traditional floor screeds consist of sand and cement. If the ratios and properties of these screeds are not correctly controlled; cracking, peeling or collapse of the screed will occur (due to being too strong/weak).

Proprietary screeds typically are pre-blended to achieve greater consistency and strength and more suitable over larger areas. As such where the floor area exceeds 50m² only a proprietary screed installed by the screed manufacturers trained installers will be accepted.

Screeds should be fit for purpose, have a suitable finish and be of an appropriate thickness.

Curing

Screeds should be cured naturally and should not be covered for at least three weeks.

Background surfaces

Background surfaces where screeds are being supported should meet the following requirements:

- **Bond**
  Background surfaces for bonded screeds should provide an adequate mechanical key. If necessary, cement grouting or a bonding agent should be specified to provide adequate adhesion. Where bonded screeds are used, mechanical means of preparing the concrete should be used to create an adequate bond between the substrate and the screed.

- **Moisture protection**
  The floor design should ensure that moisture from the ground does not enter the dwelling.

- **Adequate support**
  Substrate structures must be adequately constructed to provide adequate support to the screed. (Note: Timber floor constructions are not suitable to support screeded finishes.)

- **Screed mix**
  Cement and sand screeds should have a mix ratio of between 1:3 and 1:4½.

Proprietary additives should have been assessed and have third-party certification.

Screed thickness requirements

The minimum thicknesses of screeds are as follows:

Surface	Minimum thickness at any point (mm)
Laid monolithically with base	12
Laid and bonded to a set and hardened base	20
Laid on a separating membrane (e.g. 1000g polyethylene)	50
Laid on resilient slabs or quilts (screed reinforced with galvanised wire mesh)	65

Where service pipes are bedded in the screed, the screed should be deep enough to provide at least 25mm of screed cover over service pipes, insulation and reinforcing.

Maximum areas of screed

Screeds should be laid room by room. Unreinforced screeds should have a maximum area of 40m². Expansion joints should be provided and consistent with joints in the floor slab below.

Finishing of screeds

Screed should provide an even surface as appropriate, as defined in the ‘Tolerances’ section. Concrete floor slabs may be suitably finished to serve directly as a wearing surface without the need for an additional topping, in accordance with the recommendations of BS 8204. If required, surface sealers or hardeners should only be used in accordance with the manufacturer’s instructions.

Anhydrite screeds

If an anhydrite screed is used, it must be sealed before the application of any cement based floor finish adhesive is proposed. Anhydrite screeds can be difficult to identify once laid, if the screed type cannot be identified the screed should be fully sealed as a precaution to prevent the possibility of the floor finish adhesive de-bonding from the screed.

The floor screed should be fully dry before the sealant is applied. The screed drying time will depend on the thickness and type of screed.

A decoupling membrane is also recommended as this can reduce the stress on the fixed floor finish layer.

Insulation

Insulation below screeds should have enough compressive strength to support the screed. DPM’s should be installed in the correct positions, as indicated by the insulation manufacturer’s instructions. Sound insulation should be installed in accordance with the manufacturer’s instructions.

Constructing screeds over all substrates:
- Substrates must be level with no pockets or high spots to ensure the thickness of the screed remains even.
- Where screeds are laid over insulation; the insulation must be tightly butted together and level.
- Screeds must be correctly mixed.
- Screeds must not be walked on during the drying period.
- Screeds must not be constructed during cold periods (below 5°C).
- Movement joints will be required across door thresholds.
- Movement joints are required if bay sizes exceed 40m² with a maximum of 8m on any one side.
- Movement joints are also required where joints exist or a change of span occurs e.g. beam and block floors.
- The screed must be ready to accept any floor finishes (see guidance below for over insulated substrates).

Drying times

- With cementitious levelling screeds, one day should be allowed for each millimetre of thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness (BS 8204).
- Polymer modified screeds: strictly follow the manufacturer’s specifications and recommendations.
- The developer should keep an accurate record of the screed drying times elapsed before any fixed floor finish is constructed on top is laid and the Warranty Surveyor may ask for this information.

Note: The moisture contents of levelling screeds onto which particular floorings are to be laid and methods for measuring moisture content are given in BS 5325, BS 8201, BS 8203 and BS 8425.

Building services

Where building services pass through the screed e.g. underfloor heating, allowance should be made for thermal movement between the screed and the service (so that service pipes can resist chemical attack from the screed).

Additional steps where constructing screeds over concrete substrates

Where a concrete slab is insulated from below and a finishing screed is required to the top surface:
- The concrete substrate slab must be of the correct thickness and not less than 100mm thick.
- Concrete substrate must be adequately dried out and not wet. See drying time guidance.
- Surfaces of hardened in situ concrete bases for bonded screeds should be roughened (Scrabbled) and cleaned to remove laitance and to expose cleanly, but not loosen, the coarse aggregate particles.
- Brushing to remove laitance from a fresh concrete base is inadequate preparation before laying a bonded screed and is not recommended.
- Remove all loose debris, dirt and dust by appropriate means, preferably with vacuum equipment.
- Carry out the preparation of the surface with as little delay as is practicable before the screed is laid so as to reduce the risk of contamination.
- The surface of the prepared slab must be reasonably level to avoid deviations in thickness’s of the screed.

Constructing screeds over insulated substrates with under floor heating (UFH) system

1. Provision and construction of movement joints

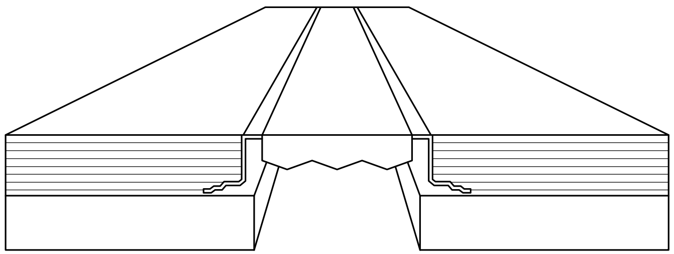
Movement joints should be provided in the floor screed / fixed floor finish where floor heating is provided in the following places:

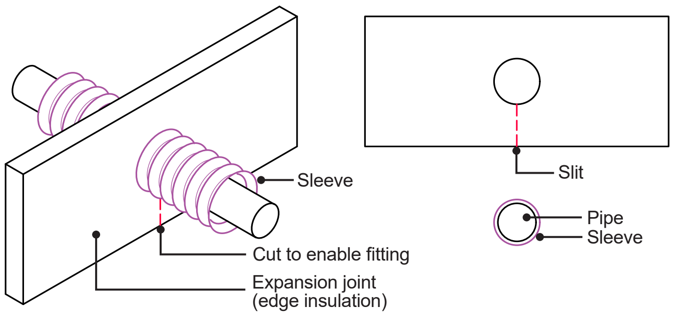
- Between independently controlled heating zones.
- Between heated and unheated areas of screed.
- Additional joints should be considered in areas of high thermal gain e.g. large conservatories or glass atria.

Bay joints should be formed using rigid joint formers where possible, which can be placed during the preparation phase and will remain in place during operation. The joint former should be 5mm lower than the finished screed depth to allow a smooth transition in height between bays.

- All joints in the screed should extend through to any subsequent bonded floor covering.
- Joint positions should be specified prior to the installation of the screed and full consultation between all parties including the main contractor, underfloor heating installer, finished flooring installer and the screed installer should take place to determine appropriate locations.
- Movement joints should be carried through the subfloor to the floor finish and all applied layers terminated either side of the joint.
- The joint should be filled with a suitable flexible filler and a proprietary cover strip applied to cover the joint. Grout must not be used.
- Movement joints should not be bridged by any resilient, textile or other adhered floor finish.
- Movement joint covers may be flush, surface mounted or bedded in mortar and metal, metal with a rubber insert or PVC (see typical detail below).

Typical movement joint covers





2. Provision of edge strip perimeter expansion joint

When incorporating under floor heating (UFH):

- Screeds should be isolated at all edges, abutments and columns to allow for movement due to thermal loadings.
- The floor screed and finished floor manufacturers guidance to be followed particularly when incorporating under-floor heating to determine the minimum thickness of edge strip required to allow for expansion. Typically, between 6-15mm may be required.
- The joint can be concealed by the skirting.
- These joints must be left empty, or else filled with a compressible material.
- Movement joints must not be filled with grout.

3. Screed drying time

- The drying time allowed must be calculated for the proposed depth of screed, taking account of the environmental conditions present e.g. temperature and humidity. Where polymer modified type screeds are being used the manufacturer's requirements must be strictly followed for the actual depth of screed. Surface finishes placed on a screed too early will fail.
- Drying times for polymer modified screeds could potentially be different to cementitious screeds.
- All subcontractors involved with the screed and floor finishes (including installation of underfloor heating systems) must follow the installation requirements and not deviate or change materials.
- The screed should not be walked on until fully cured.

4. UFH testing and commissioning

- Ensure there are no joints in the heating system loops.
- UFH systems should be commissioned before floor finishes are applied. This will add to the total time before any floor finish can be applied.
  Note: If floor finishes are installed prior to the UFH being turned on and commissioned, any residual moisture in the floor is driven to the surface of the screed and can potentially cause delamination of the floor finish.
- Pressure testing of the system does not constitute commissioning of the system. The heat source has to be in place and operating in order to deliver the correct temperatures.
- The UFH system must be commissioned in accordance with the manufacturer's recommendations by their approved installers. A commissioning certificate will be required.

5. Moisture testing of the screed where floor finishes are proposed

- Moisture testing should be carried out after the commissioning of the UFH system but before any floor finishes are laid.
- Where UFH is not installed, moisture testing of the screed should still be carried out before floor finishes are installed.
- Moisture testing is carried out using a suitable approved method such as a flooring hygrometer or carbide bomb test. Due to the potential inaccuracies of using hygrometers at high humidity levels, a direct measurement should be used such as Carbide Bomb or oven dried sample.
- The base is deemed to be sufficiently dry when the relative humidity, as measured by a surface mounted flooring hygrometer/probe is 75% RH or less. For the use of a flooring hygrometer, reference should be made to Dampness testing in BS 5325, BS 8203, BS 8425 and BS 8201.
- If underfloor heating is present in the base, the heating must be switched off 96 hours prior to any hygrometer test being carried out.
- The hygrometer must be allowed to remain in position until full equilibrium has been established. This is generally considered to be 72 hours but could be longer over thick sections and considerably longer on power floated concrete.

6. Screed preparation for finishes

- The top surface of screeds may require to be scored, sanded or keyed in preparation to accept the primer and floor finish.
- Sanding, keying etc. of the screed surface allows the penetration of primers. It also provides a "key" for the adhesive to grip onto.
- The surface must then be cleared of dirt and debris prior to primers being applied.
- Any primers and adhesives must not be applied until the screed has fully hardened and dried out. Drying times vary depending on the type of screed.
- Surfaces to receive fixed floor finishes should be rigid, dimensionally stable, flat with no dips and rises, sound, clean and free from laitance, paints, salts, grease, dust and any contamination which may prevent adhesion.

7. Adhering to the manufacturers' process during the installation of the flooring finish.

All the relevant manufacturers recommendations should be followed which will identify timelines to adhere i.e:

- Removing the laitance by sanding to provide a key for the primer and/or adhesive.
- Commissioning the underfloor heating before installing the fixed floor finish.
- Allowing the UFH system to cool down for at least 48 hours before installing the fixed floor finish.
- Moisture testing to confirm the dryness of the screed before installing the fixed floor finish.
- Ensuring the time from screed completion to installing the fixed floor finish commencement is calculated and adhered to.
- Ensure the fixing of the finished floor finish has stabilized before walking on. Some finishes require typically 12 -24 hours dependent on environmental conditions.
- Ensure the UFH system is not turned on for at least 48 hours after any adhered floor finish is completed.
- If an anhydrite screed is used, it must be sealed before the application of a cement based floor finish adhesive if proposed in conjunction with a finished floor surface covering.

8. Exceeding the Maximum 27°C floor temperature

The underfloor heating system must be correctly commissioned to ensure temperature fluctuations are avoided and potential damage to the floor finishes.

BS 8203 Code of Practice for the Installation of Resilient Floor Coverings states: When used with many flooring materials underfloor heating can cause problems if the temperature at the interface between the subfloor and flooring exceeds 27°C, or is subject to rapid fluctuations in temperature.

Where a resilient floor covering is proposed: 'the temperature should never exceed the agreed maximum of 27°C at the underside of the floor covering (the adhesive line).

Note: UFH designers may refer to this as the 'interface' temperature.

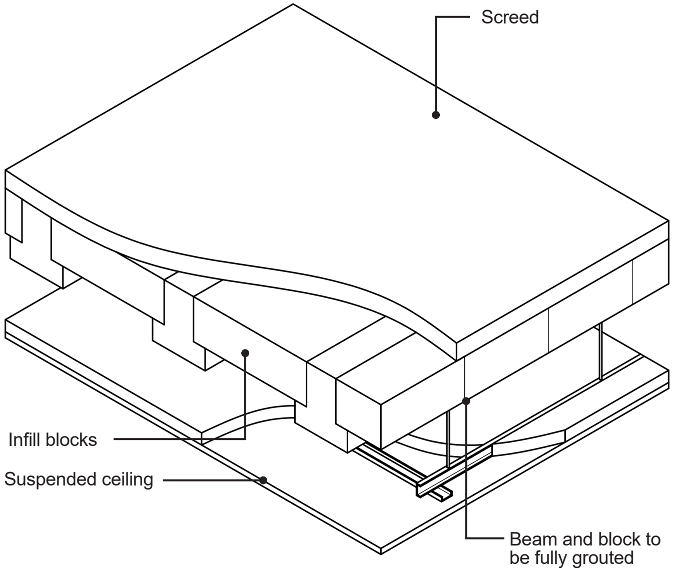
Please Note: BS EN 1264 - 2 refers to a max 29°C however for Warranty purposes a maximum 27°C is to be followed.

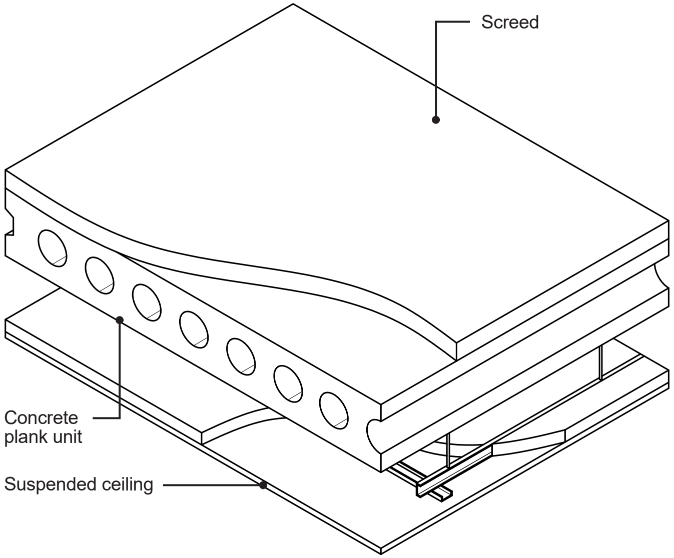
9. End user information

End users must be aware of how to use an UFH system, as these need to be operated differently than other heating systems both for in use and to avoid damage to screeds and finishes.

Typical detail for suspended ceilings

Suspended ceilings should be designed and constructed in accordance with BS EN 13964.





Fixing requirements

Fixings should be appropriate for the site conditions and the loads to be supported. They must also be installed in accordance with the manufacturer's specifications. Fixings to the floor construction should be at the correct designated centres using the correct wires/brackets that are compatible with the suspended ceiling (and the intended environmental conditions - see below). Pull tests should be carried out on ceilings with an area exceeding 100m² and a factor of safety of 2 is applicable.

Ceiling grid layouts and fixing schedule and method of fixing to soffit, should be provided.

Confirmation that the weight of the ceiling construction and any additional fire/sound insulation loads has been taken account of in the supporting structure design calculations.

Where there is any doubt regarding the adequacy or installation or variation from the initial design a manufacturer's inspection and certification will be required.

High humidity or external environment

Where the ceiling is above a high humidity area or is an external suspended ceiling; third party certification should be provided to demonstrate the product is suitable for the specified environment.

Fire resistance

Where suspended ceilings are designed to give a minimum period of fire resistance, fire test certification will be required to confirm the periods of fire resistance given. This should also take into account any recessed light fittings which may bypass the fire resistant layer. Consideration should also be given to the quality of workmanship in these installations, and a manufacturer approved installer be used.

The additional weight of materials used to achieve fire resistant specifications or where sound insulation requirements occur must also be taken account of in the structural design of the supporting structure and the fixings of the ceiling construction.

Minimum plaster thicknesses

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in this Technical Manual, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the table below.

Element	Minimum number of coats	Typical thickness
Ceiling - plasterboard	1	Skim to provide suitable and durable finish

Support of plasterboard

Supports for plasterboard should be designed so that the following span limits are not exceeded:

Board thickness (mm)	Support centres (mm)	Intermediate support required	Perimeter support required
9.5	400	No	Yes
	450	Yes	Yes
12.5	400	No	Yes
	450	No	Yes
	600	Yes	Yes
15	600	No	No

When fixing plaster boarding:

- Fix boards with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.

Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

Plastered finishes

Workmanship of plastered finishes to ceilings should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Plaster mixes

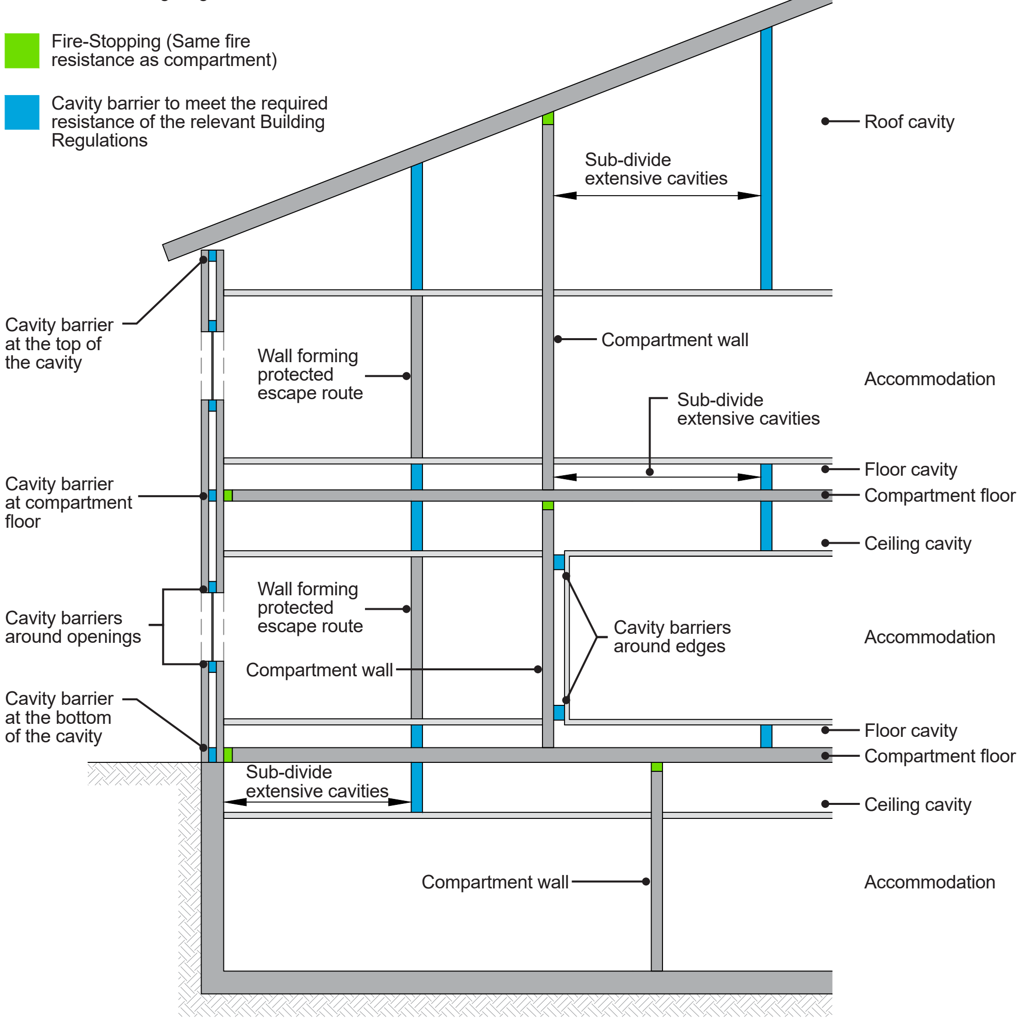
Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

10.
Upper Floors

10.8
Cavity Barriers and Fire Stopping

Provisions for cavity barriers and fire stopping

For more information on the subdivision of cavities, please see the relevant Building Regulations.



Note: Diagrams courtesy of the approved documents for England

Fire resistance general

All floors should have the fire resistance required by the relevant Building Regulations. To achieve the same fire resistance, I-joists and metal web joists may require a different specification for the ceiling than that for solid timber joists. Holes should not be made in the ceilings, e.g. for down lighters, unless it can be proven that the floor construction achieves the required fire resistance.

Fire stopping

Penetrations in floors between buildings shall be fire stopped, there are to be no holes or gaps for smoke to pass through once the fire stopping has been fitted. Where down lighters are incorporated in a ceiling they should be fitted in accordance with the manufacturer's instructions.

Further additional requirements for internal fire stopping and fire protection for compartment floors, walls, and roof junctions to flats and apartments with a floor 4.5m or more above the ground

The following additional guidance applies to internal fire stopping and fire protection only to buildings with a floor 4.5m or more above the ground that contain flats or apartments.

Although building legislation is robust in applying provisions for fire protection and fire stopping, it can often be difficult to implement high standards of fire stopping in complex buildings. This can lead to significant safety risks if the building does not have the correct levels of fire protection and if holes in compartment walls are not sealed correctly. This guidance assists Developers in providing good standards of fire stopping and fire protection.

It is not the intention to enhance the requirements of the Building Regulations, but more to ensure that the statutory requirements are applied correctly to the construction. It is therefore deemed that the requirements of Part B of the Building Regulations in England and Wales, or Section 2 of the Scottish Building Standards (whichever is appropriate depending on region), that apply to fire stopping, separating walls, service penetrations, minimum periods of fire resistance and concealed spaces will also meet the requirements of this guidance.

Openings for pipes in fire resisting floors
Pipes which pass internally through fire resisting floors must not compromise the required fire resistance of the element through which they pass. As a minimum, openings through floors should be as few as possible in number, as small as practicable in size and fire-stopped to the surrounding construction. For pipes passing through compartment floors, guidance supporting the Building Regulations in the relevant UK nation will need to be consulted for additional provisions.

1. Fire stopping

Design information
Drawings showing the lines of compartmentation and the lines of fire-resisting construction should be provided to the Surveyor and the Builder. The drawings should also give the required level of fire resistance for each element. Drawings to show the position of cavity barriers should be provided, and the specification of cavity barriers included.

Materials for fire stopping and cavity barriers
All materials used to form a fire barrier must have relevant third-party certification or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products. A competent person is deemed to be a third-party approved contractor specialising in fire stopping and passive fire protection.

2. Fire protection in buildings

Design information
The design details must show the correct level of fire resistance for the building, in accordance with Part B of the Building Regulations or Section 2 of the Scottish Building Standards, depending on region.

Materials for fire protection
All materials used to form a fire barrier must have relevant third-party certification, or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products.

Where intumescent paints are used to provide the required level of fire protection, certification confirming that the paint applied will achieve the correct level of fire protection is required.

11. Roofs

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. For Warranty purposes, flat cold deck roofs over $3m^2$ in area are not acceptable.
4. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. A flat roof membrane manufacturer's approved installer must be used for all flat roof coverings where the third party accreditation requires this to be in place.
2. Flat roof membranes will be required to be weather and waterproof and tested at completion where stipulated in the guidance.
3. All workmanship must be within the tolerance requirements set out in this Technical Manual.
4. All work is to be carried out by a technically competent person in a workmanlike manner.
5. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/door or 'decorative external cladding' (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
7. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
8. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. Roof structures and coverings shall be designed and constructed so that they:
    a. Are structurally sound;
    b. Satisfactorily resist the passage of moisture due to rain and snow to the inside of the building, and to materials which might be adversely affected by such moisture;
    c. Have an adequate thermal performance;
    d. Have adequate resistance to fire penetration and the spread of flame across their external surfaces;
    e. Do not allow fire spread across the tops of separating walls;
    f. Adequately discharge rainwater from the roof area to a suitable drainage system;
    g. Have adequate provision for ventilation in pitched roofs.
2. In addition to point 1f: Flat roof design shall, unless specifically agreed otherwise with the Warranty provider, comply with the requirements of BS 6229 and be designed to have a minimum finished fall of 1 in 80.
3. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
4. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
5. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

11. Roofs

11.1 Pitched Roof Structures

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Full details of the roof layout inclusive of the layout of trusses, any intersecting roof construction such as hips and valleys, details of girder trusses, multiple trusses and diminishing trusses, including how they are to be fixed together and supported on truss shoes, lay boards or all associated bracing requirements, details of restraint/holding-down strapping and fixings.
2. An Engineer's full set of structural calculations for the roof construction.
3. Details for any required trimming work around chimneys, formation of access hatches, details for the formation of supportive structure for equipment and access to equipment requiring periodic maintenance and inspection contained within the roof space, etc.
4. Waterproofing and flashing details around abutments, chimneys, service penetrations etc.
5. Third party product approval certificate for the roof underlay.
6. Detailed sections and material specification for all components to be used in the construction of the pitched roof including but not limited to, vapour control layers, breather membranes, insulation etc.
7. Details of the ventilation strategy for the pitched roof in line with the guidance provided in this section and/or BS 55250.
8. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Statutory requirements

Roof framing and rafter design must be in accordance with current relevant Building Regulations.

The roof of the building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground safely, and without causing such deflection or deformation of any part of the building, or such movement of the ground, as to impair the stability of any part of another building.

The roof structure should be of such construction that it has adequate interconnection with the walls, allowing it to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building.

The need for diagonal rafter bracing equivalent to that recommended in BS EN 1995- 1, or Annex H of BS 8103-3 for trussed rafter roofs, should be provided, especially for single-hipped and non-hipped roofs of more than 40° for detached houses.

For advice on 'sizing of certain timber members in floors and roofs for dwellings', the Designer should refer to the following sources:

- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

Treatment of timber
Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice, and in the following circumstances:

- Roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch.
- Trussed rafter construction which is cut back at eaves or where the rafter 'feet' is trimmed to sit into the external walls. Preservative treatment will be required to the cut ends.
- The Approved Document of Regulation 7 of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

The treatment should be impregnated with a preservative suitable for use in 'Use Class 1' in pitched roofs and 'Use Class 2 flat roofs', in accordance with BS 8417, for a 60 year anticipated service life. Cut ends must be liberally brushed or dipped with an end-grain preservative.

It is strongly recommended that, where punched, metal fasteners are proposed to roof trusses. Only micro-emulsion or organic solvent preservatives should be used for timber treatment, to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

Further information can be found in 'Appendix C- Materials, Products, and Building Systems'.

Design criteria

The Building Designer is responsible for the 'framing' of any given roof as a whole. This means that they must take responsibility for the bracing together (framing) of the trussed rafter configuration, which then supports the roof covering and the tying together of the supporting walls.

Whilst it is the supplier of the rafters who generally has the knowledge and expertise required to achieve the best engineering solutions, the designer must be certain that the loading calculations and resultant configuration is fit for purpose.

The roof structure should be designed in accordance with:

- BS 8103-3, structure design of low rise buildings, code of practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules for buildings.

All structural timber should be stress graded. All such timber must be stamped as either 'DRY' or 'KD' (Kiln Dry). The use of ungraded, or 'green', timber is not acceptable.

Loadings

The design criteria set out is intended to be adequate for imposed roof loads of 1.00kN/m² for spans not exceeding 12m, and 1.50kN/m² for spans not exceeding 6m.

Trussed rafters and the framed roof must have dead and imposed loads calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4 and be in accordance with PD 6693-1.

Loads acting on rafters are dead loads (tiles/slates, battens, underlay and rafter self-weight), imposed loads (snow load and maintenance) and the wind uplift load. Other dead loads that act on the ceiling ties (ceiling, insulation, water tanks and the tie self-weight) and imposed loads (loft access and weight of storage) will also have to be taken into account by the Designer.

The following limits for imposed loads on the rafters uniformly distributed over the whole roof, measured on plan:

- Roofs pitched 10° to 30°: 0.75kN/m².
- Roofs pitched 31° to 75°: 0.75kN/m² - 0kN/m² (reduced linearly), or,
- A concentrated load of 0.9kN, whichever produces the greater stress or deflection.

Experience shows that for most common tiled and slated roofs, the uniformly distributed load is more severe.

Allowances for wind loading
The need for a roof to withstand wind pressure and suction will be met if the proposed roof is braced effectively, as discussed elsewhere in this section, and secured to the structure, as detailed below, with walls adequately restrained.

The securing of roofs to the supporting structure normally involves a timber wall plate or similar, which should be levelled using a spirit level so that loadings from the roof are directed perpendicularly down the supporting wall.

The wall plate should be fixed to ensure correct positioning when roof timbers or trusses are being installed by means of galvanised mild steel holding down straps (30mm x 5mm x 1000mm long at maximum 2m centres) nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.

There is a need to ensure that holding down straps are provided in areas of severe wind exposure where required by the roof design.

Spans

Maximum permissible spans for the most common building types and rafter configurations are given in BS EN 1995-1: Section 9.

For designs that fall outside BS EN 1995-1 conditions, the trussed rafter must demonstrate adequate jointing and structural integrity by calculation.

Modifications to trussed rafters

Trussed rafters should never be cut, altered or repaired for use without the full agreement of the Trussed Rafter Designer. Remedies for defects to erected trusses can be found in BS 5268: 3, but the Roof Designer's advice should be sought prior to repairs being carried out.

Combined trussed rafter and traditionally framed roofs

Extra care is necessary where the two principal timber pitched roof types are used in conjunction. The trussed rafters should be specifically designed to accept any additional loadings imposed by an adjacent traditional roof. Similarly, account should be taken of any loadings imposed by trusses on traditional roofs where only nominal loadings have been allowed for. If in doubt, consult the Roof Designer.

Gable spandrel panels

The gable spandrel panel should be suitably designed to transmit loads to the roof structure and down through the supporting walls.

It is important that gable spandrel panels should be designed to transmit these loads to the roof structure via lateral restraints and vertically down to the supporting walls. Full design with structural calculations should be provided.

The truss designer or the Engineer should provide details of the lateral resistant to the gable spandrel panel, including details of the restraint used and the fixings to be provided.

Please refer to the 'External Walls' section for further guidance.

Restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Additional requirements in a coastal location

Where developments are within a coastal location additional Warranty requirements should be met.

For the purpose of this Technical Manual we are considering sites within 5km inland from the shore line or sites located in 'tidal' estuarine areas where they are within 5km of the general shoreline. Further information on Warranty requirements within a coastal location can be found in 'Appendix B - Coastal Locations'.

Erection

It is essential when erecting a trussed rafter roof to ensure that the first trussed rafter is erected and braced rigidly in the correct vertical position so that it provides a base model against which all the other trusses can be set out.

Any temporary bracing should not be removed until permanent bracing has been installed. Immediately prior to the fixing of permanent bracing, the trussed rafters should be checked again for alignment and verticality.

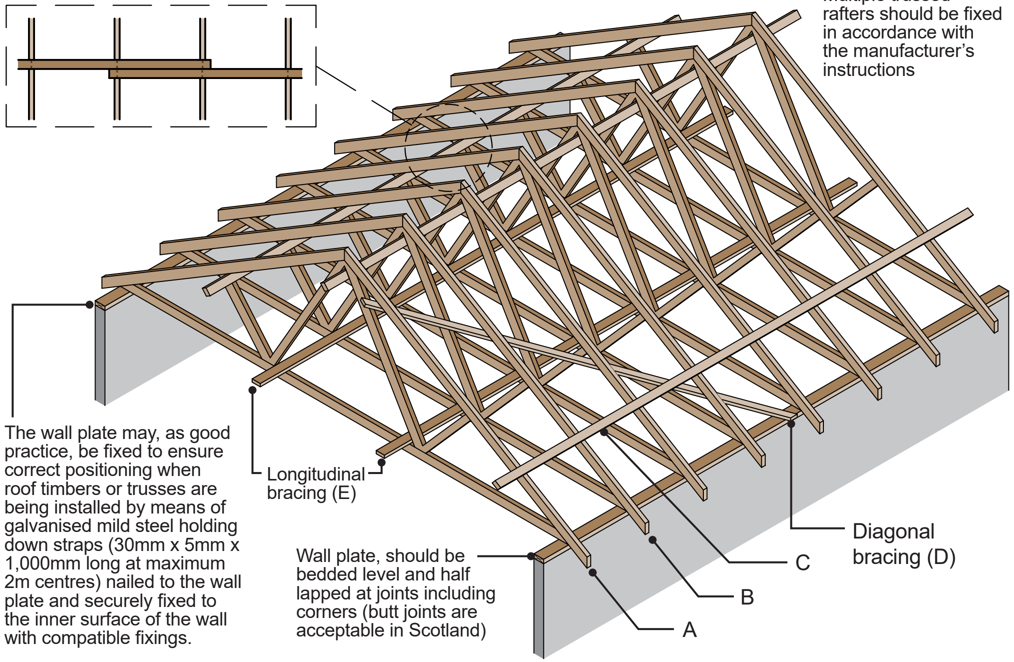
Trussed roof installation

The roof structure should be fully braced by 100mm x 25mm timber, twice nailed to roof timbers using 65mm long x 3.35mm diameter galvanised wire nails. Where nail guns are used, 75mm long x 3.1mm diameter annular ring-shank nails are allowed.

Procedure for erection

- Before placing first truss, mark required position of trussed rafters on opposing wall plates.
- Erect and brace first trussed rafter (A) (only one shown but fix others as necessary).
- Erect next adjacent trussed rafter (B) and brace back to (A) using brace (C).
- Erect other trussed rafters as with (B).
- When the final accurate positioning of the trussed rafters has been confirmed, the rafter feet can be fixed into position.
- Fix permanent diagonal bracing (D) (only one brace shown for clarity).
- Fix longitudinal bracing (E) (only three shown for clarity).
- Fix all remaining bracing.
- Remove all temporary bracing.

The International Truss Plate Association Technical Handbook, available from trussed rafter suppliers, provides additional advice on trussed rafter erection.



Trussed rafters, including attic trusses, should never be cut, altered, notched, or repaired for use without the full agreement of the Trussed Rafter Designer.

Bracing requirements

The correct bracing configuration locks all timber supporting roof elements into a single structural, load-bearing unit. Standard bracing details are given in BS 5268-3.

Fixing
To achieve a stable and wind-resistant roof and gable wall structure, the roof must be secured to the gable wall, if applicable, and fully braced by 100mm x 25mm timber, twice nailed to roof timbers using 65mm long x 3.35mm diameter galvanised wire nails. Where nail guns are used, 75mm long x 3.1mm diameter annular ring-shank nails are allowed. They do not need to be galvanised.

Types of bracing
There are three main types of wind bracing, which should be fixed:

- Diagonal rafter bracing.
- Longitudinal bracing.
- Chevron bracing (only necessary on trussed rafter spans over 8m and mono-pitched roofs exceeding a 5m span).

Diagonal and longitudinal bracing are required in all trussed rafter roofs. Bracing for wind loads can also be enhanced by adequately fixed tiling battens and/or sarking boards. The ceiling plasterboard (12.5mm thickness) or a similar rigid material will also contribute to the bracing process. Sarking boards, such as moisture-resistant plywood (minimum thickness 9mm) and moisture-resistant chipboard (minimum thickness 12mm), may provide adequate bracing without the need for additional wind bracing to the roof. Sarking boards should be laid with staggered joints and nailed at 200mm centres on every truss with 50mm long x 3mm diameter galvanised round wire nails.

Longitudinal bracing
Longitudinal bracing should be positioned tightly to abut separating and gable walls. In timber frame construction, you should ensure that longitudinal braces are fixed to timber frame gables/separating walls to provide additional lateral restraint.

Chevron bracing for duo-pitched roofs
Chevron bracing is only required for roof spans exceeding 8m, and it can be identified as diagonal bracing to the web members of the roof truss.

For spans of between 8m and 11m, such bracing may only be required to a single web member on either side of the roof. For spans exceeding 11m, more extensive chevron bracing may be necessary. 100mm x 25mm chevron bracing should be installed continuously along the lines of webs so that there are no more than two consecutive trusses between braces. Each brace must be at 45° and fixed to at least 3 trusses.

Bracing to mono-pitched roofs
In mono-pitched trussed rafter roofs, the diagonal bracing pattern for narrow-fronted houses should be adopted. The requirement for longitudinal bracing is the same as for duo-pitched trussed rafter roofs.

Chevron bracing is required to the webs in roofs exceeding a 5m span and also to upright members where inadequate lateral restraint is provided at the apex of the roof.

Coastal Locations and sites of severe or very severe exposure ratings (BS 8104)

Roof bracing for sites in these locations should be designed by an Engineer.

Diminishing trusses

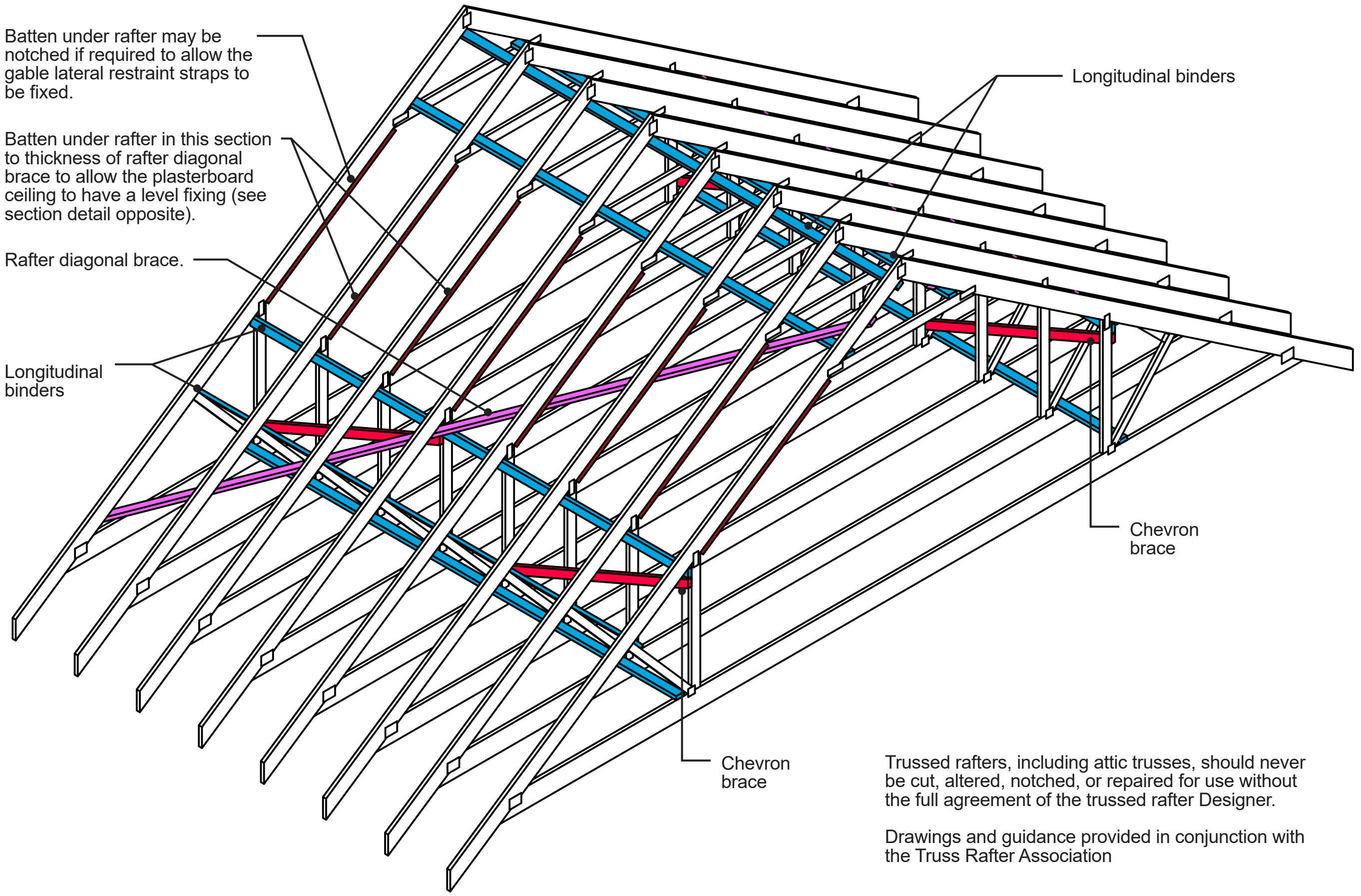
The Truss Roof Designer should provide details of fixings for the diminishing truss to the main roof truss:

- Where the diminishing truss has a splayed bottom chord that matches the pitch of the main truss (usually where the roof pitch is less than 30º), the truss can be skew-nailed to the main truss with two no 3.35mm diameter x 75mm galvanised wire nails.
- Where the diminishing truss has a square bottom chord, the truss can be skew-nailed to the main truss and supported on a continuous binder also fixed to the main truss. The top of the binder should be splayed to suit the bottom chord and; 2 no. 3.35mm diameter x 75mm galvanised wire nails should be used for the fixing.

Attic truss

Where attic trusses are used, bracing should also be provided in accordance with the design, the diagonal bracing for attic trusses can be placed internally and the inside of the rafters battened out to take the plasterboard. Alternatively, plywood diaphragms can be placed between the rafters within the sloping ceiling area.

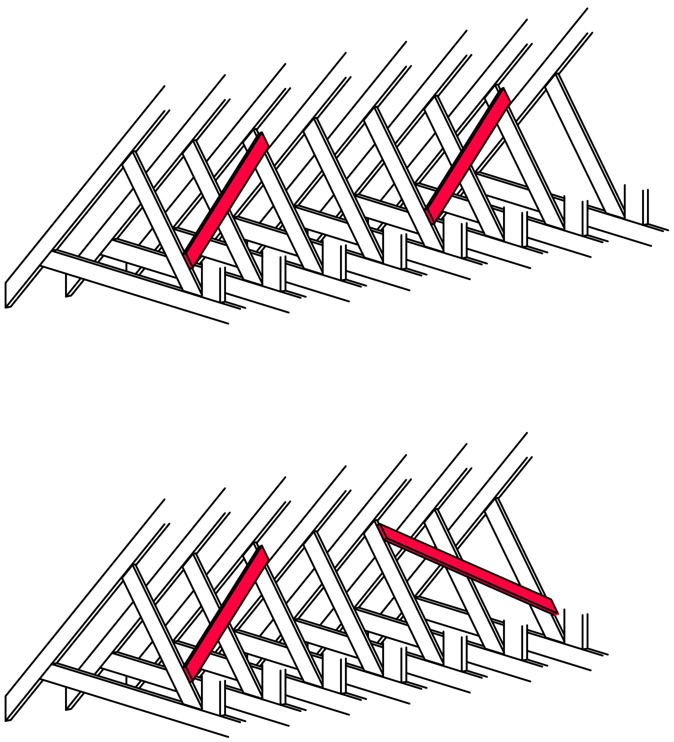
Attic truss bracing



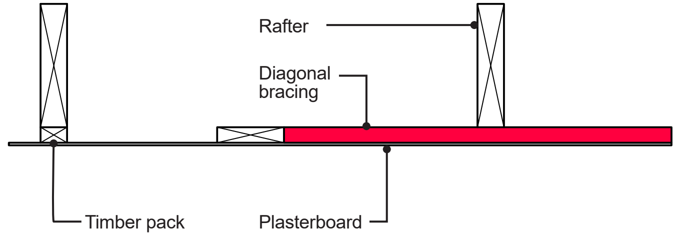
Trussed rafters, including attic trusses, should never be cut, altered, notched, or repaired for use without the full agreement of the trussed rafter Designer.

Drawings and guidance provided in conjunction with the Truss Rafter Association

Chevron bracing



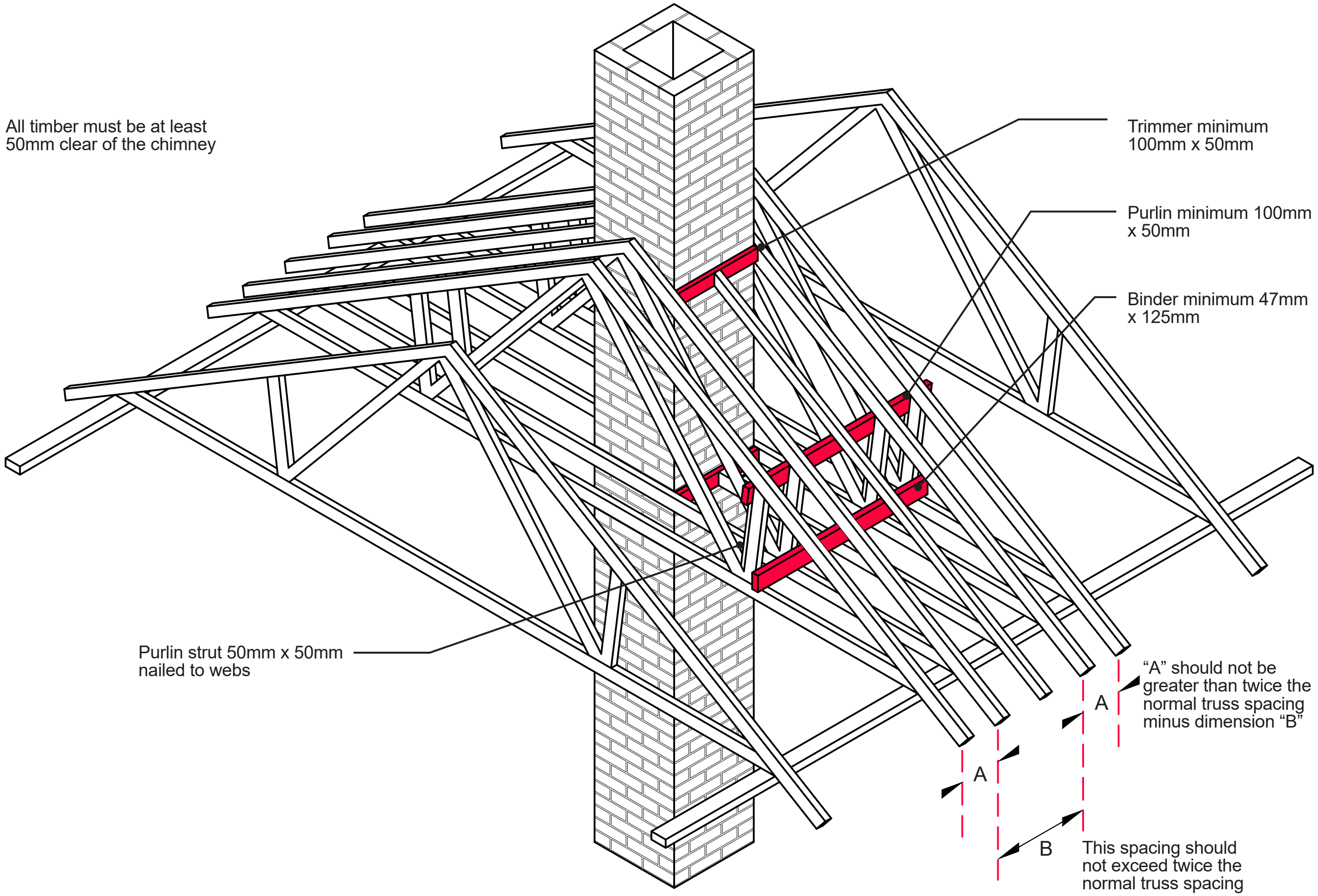
Section of diagonal bracing battened out for plasterboard



Mono-pitch and girder trusses on trussed rafter hipped-end roofs

Mono-pitch trussed rafters can be used in conjunction with girder trusses on trussed rafter hipped roofs. Mono-pitched trusses are fixed to girder trusses using metal shoes. The bearing of mono-pitched trusses onto the mild steel proprietary girder shoe should be confirmed with the Roof Designer before site installation is attempted. Girder trusses are strengthened trusses designed to support loads in another plane (such as mono-pitched trusses).

Roof trusses trimming around a chimney



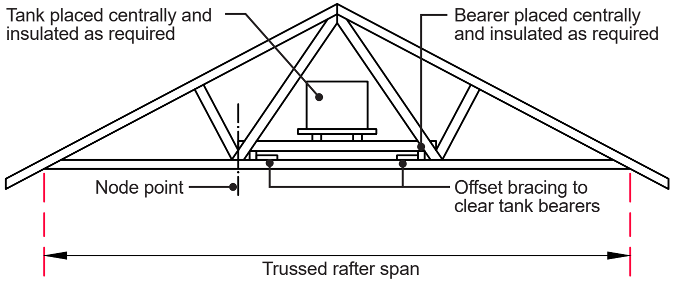
Provision for openings, i.e. loft hatches, chimneys, etc.

Wherever possible, a trussed rafter roof should be designed to accommodate necessary openings within the trussed rafter spacing, e.g. a loft hatch. Trusses must never be cut or trimmed except according to details supplied by the truss manufacturer. The Roof Designer should provide all necessary details. This is applicable particularly for where roof lights and dormers are formed. Detailed specifications of the trimming joists at the side, head and base of the opening must be provided to ensure the roof is safely supported.

Multiple-trussed rafters

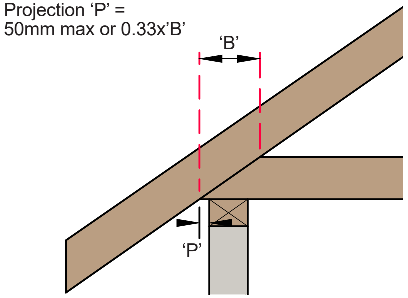
Multiple-trussed rafters may be specified for a particular purpose, and may be delivered to site already fastened together. Alternatively, fixing together on-site of multiple trusses may be necessary, in which case it will be necessary to get full details of the fixing specification from the Roof Designer.

Tank stand configuration



Confirmation should be obtained from the Roof Designer that a trussed rafter roof design is capable of supporting water storage tanks. Tanks should be supported by bearer beams, on the ceiling ties portion of the truss. Bearers should be skew-nailed to supports as appropriate. Alternatively, proprietary joist hangers can be used. Tank bearers should be situated as close as possible to the node or intersection points of the trussed rafter. The dimensions of the bearers depend upon the size of the supported tank and the span of the trussed rafters. Tanks with a capacity up to 230 litres should be supported by a minimum of 3 rafters. Tanks up to 330 litres should be supported by a minimum of 4 rafters. The tank platform should not be constructed from chipboard as it may become wetted by condensation, plumbing leaks, or rainwater ingress and lose its strength.

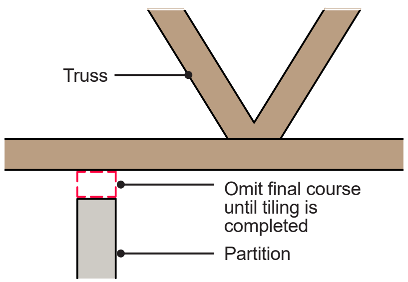
Correct positioning of roof trusses



Trussed roofs should be supported on timber wall plates. Wall plates should be bedded to line and level, joined using a half lapped joints at all joints including corners.

The truss roof structure and the wall plate should be bedded and fixed to transmit and distribute loads and prevent uplift.

Internal non-load-bearing walls



It is advisable to erect non-load bearing walls after the tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until tiling has been completed.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of Engineers drawings and calculations for the roof. This should also include fixing methodology and specification, full details of all associated bracing requirements, restraint/holding-down strapping and associated fixings.
2. Full details of the roof layout inclusive of the layout of cut roof members, any intersecting or supportive roof structure such as hips, ridges, purlins, valleys and associated timbers e.g. lay boards, trimming members.
3. Details for any required trimming work around chimneys, formation of access hatches, details for the formation of supportive structure for equipment and access to equipment requiring periodic maintenance and inspection contained within the roof space, etc.
4. Waterproofing and flashing details around abutments, chimneys, service penetrations etc.
5. Third party product approval certificate for the roof underlay.
6. Detailed sections and material specification for all components to be used in the construction of the pitched roof including but not limited to, vapour control layers, breather membranes, insulation etc.
7. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
8. Details of the ventilation strategy for the pitched roof in line with the guidance provided in this section and/or BS 55250.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Statutory requirements

Roof framing and rafter design must be in accordance with current relevant Building Regulations and British Standards.

The roof of the building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground safely, and without causing such deflection or deformation of any part of the building, or such movement of the ground, as to impair the stability of any part of another building.

The roof structure should be of such construction that it has adequate interconnection with the walls, allowing it to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building. The potential for roof spread should be considered by the Engineer and incorporated within the design calculations for the roof.

In this respect, it is acknowledged that a traditional cut roof i.e. using rafters, purlins and ceiling joists, generally has sufficient built-in resistance to instability and wind forces, e.g. from either hipped ends, tiling battens, rigid sarking or the like. However, the need for diagonal rafter bracing equivalent to that recommended in BS EN 1995-1: 2004+A1, or Annex H of BS 8103-3 for trussed rafter roofs, should be considered, for all cut roofs especially for single-hipped and non-hipped roofs of more than 40° for detached houses.

For advice on ‘sizing of certain timber members in floors and roofs for dwellings’, the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by TRADA. Note: Reference should be made to the version of the TRADA document current at the time of construction of the roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

Treatment of timber
Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice, and in the following circumstances:

- Roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch.
- Rafter construction which is cut back at eaves or where the rafter ‘feet’ is trimmed to sit into the external walls. Preservative treatment will be required to the cut ends.
- The Approved Document of Regulation 7 of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

The treatment should be impregnated with a preservative suitable for use in ‘Use Class 1’ in pitched roofs. Cut ends must be liberally brushed or dipped with an end-grain preservative.

It is strongly recommended that, where punched, metal fasteners are proposed to roof trusses. Only micro-emulsion or organic solvent preservatives should be used for timber treatment, to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

Further information can be found in ‘Appendix C- Materials, Products, and Building Systems’.

Design criteria

The design of pitched roofs should:

- Have dead and imposed loads calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4.
- Be in accordance with PD 6693-1.

All structural timber used in a conventional cut roof, i.e. rafters, purlins, ceiling joists, binders and other timber elements, should be stress graded. All such timber must be stamped as either ‘DRY’ or ‘KD’ (Kiln Dry). The use of ungraded, or ‘green’, timber is not acceptable.

The purlins/binders should be adequately supported to contribute fully to the roof structure. For example, they could be built into the inner leaf of a gable end wall and supported by struts onto the load-bearing structure at centres specified in the design.

Always ensure that the correct strength class of timber is both ordered and used. Structural timbers are allocated a strength class by BS 5268-2. The most common strength classes used are C16 and C24.

The timber supplier will require the following information before supplying timber:

- Type and strength class of timber required.
- Required sizes of timber.
- Any treatment required.

Moisture content

The moisture content of structural timber should not exceed 20% at the time of stress grading and at the time of erection. All structural timber for use within the building fabric should be stress graded and marked ‘KD’ (Kiln Dry) or ‘DRY’.

Additional requirements in a coastal locations

Where developments are within a coastal location additional Warranty requirements should be met.

For the purpose of this Technical Manual we are considering sites within 5km inland from the shore line or sites located in ‘tidal’ estuarine areas where they are within 5km of the general shoreline. Further information on Warranty requirements within a coastal location can be found in ‘Appendix B - Coastal Locations’.

Design responsibility

The Building Designer is responsible for the 'framing' of any given roof as a whole. This means that he or she must take responsibility for the bracing together (framing) of the roof configuration, which then supports the roof covering and the tying together of the supporting walls.

The Designer must be certain that the loading calculations and resultant configuration is fit for purpose.

All cut roofs that are beyond the limitations of the 'Eurocode 5 Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings' published by TRADA should be designed by an Engineer and calculations and structural drawings should be submitted for assessment when requested.

The design of the cut roof should demonstrate:

- Finished sizes, species, stress grades or strength classes of timber members.
- The type, sizes and positions of all jointing devices with tolerances, or the number of effective teeth or nails required in each member at each joint.
- The positions and sizes of all bearings.
- Loadings and other conditions for which the cut roof is designed.
- The spacing of rafters, joists, binders and purlins.
- The positions, fixings and sizes of any lateral supports necessary to prevent buckling of compression members, such as rafters and struts. Details of the permanent bracing necessary to ensure the overall stability of the complete roof structure and supporting walls should be provided by the Building Designer.
- The method of support for water tanks and ancillary equipment, together with the capacity or magnitude of additional load assumed.
- The range of reactions to be accommodated at the support positions, including those required to resist wind uplift forces.
- The basis of the design.
- Details of any changes in spacing to accommodate chimneys or openings.
- Any special precautions for handling and erection, in addition to those covered by BS EN 1995-1
- The span of the rafters, joists, binders, purlins etc.
- The pitch or pitches of the roof.
- The method of support and position of supports.
- The type or weights of roof tiles or covering, including sarking, insulation and ceiling materials.
- The size and approximate position of any water tanks or other equipment to be supported on the trussed rafters.
- The overhang of the rafters at eaves, and other eaves details.
- The positions and dimensions of hatches, chimneys and other openings.
- The size of any structural members and supporting calculations.
- Due to the site locality, any particular preservative treatment necessary for the timber, e.g. to protect against House Longhorn Beetle.

Loads

Traditional cut roofs must have dead and imposed loads calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4 and be in accordance with PD 6693-1.

Loads acting on rafters include dead loads (for example tiles/slates, battens, underlay and rafter self-weight), imposed loads (snow load and maintenance) and the wind load. Other dead loads that act on the ceiling ties (ceiling, insulation, water tanks and the tie self-weight) and imposed loads (loft access and weight of storage) will also have to be taken into account by the Designer.

Experience shows that for most common tiled and slated roofs, the uniformly distributed load is more severe.

Allowances for wind loading
The need for a roof to withstand wind pressure and suction will be met if the proposed roof is braced effectively, as discussed elsewhere in this section, and secured to the structure, as detailed below with walls adequately restrained. The securing of roofs to the supporting structure normally involves a timber wall plate or similar, which should be levelled using a spirit level so that loadings from the roof are directed perpendicularly down the supporting wall.

The wall plate should be fixed to ensure correct positioning when roof timbers are being installed by means of galvanised mild steel holding down straps (30mm x 5mm x 1000mm long at maximum 2m centres) nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.

There is a need to ensure that holding down straps are provided in areas of severe wind exposure where required by the roof design.

Additional holding down fixings may be required dependent on the roof structure and wind loading, this should be considered by the Engineer and be incorporated within the structural calculations.

Approved Document A of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

Combined trussed rafter and traditionally framed roofs

Extra care is necessary where the two principal timber pitched roof types are used in conjunction. The trussed rafters should be specifically designed to accept any additional loadings imposed by an adjacent traditional roof. Similarly, account should be taken of any loadings imposed by trusses on traditional roofs where only nominal loadings have been allowed for. If in doubt, consult the roof designer.

Gable spandrel panels

The gable spandrel panel should be suitably designed to transmit loads to the roof structure and down through the supporting walls.

It is important that gable spandrel panels should be designed to transmit these loads to the roof structure via lateral restraints and vertically down to the supporting walls. Full design with structural calculations should be provided.

The truss designer or Engineer should provide details of the lateral resistant to the gable spandrel panel, including details of the restraint used and the fixings to be provided.

Please refer to the 'External Walls' section for further guidance.

The use of oak

Green oak, air dried (seasoned)/kin dried oak is not acceptable in the external wall construction, frame, window/door construction, internal wall or roof constructions, regardless of whether it forms part of the weather proof envelope or not. Projects incorporating such oak will not be acceptable for Warranty cover except where described in 'Appendix C - Materials, Products, and Building Systems' of this Manual.

Restraint of walls

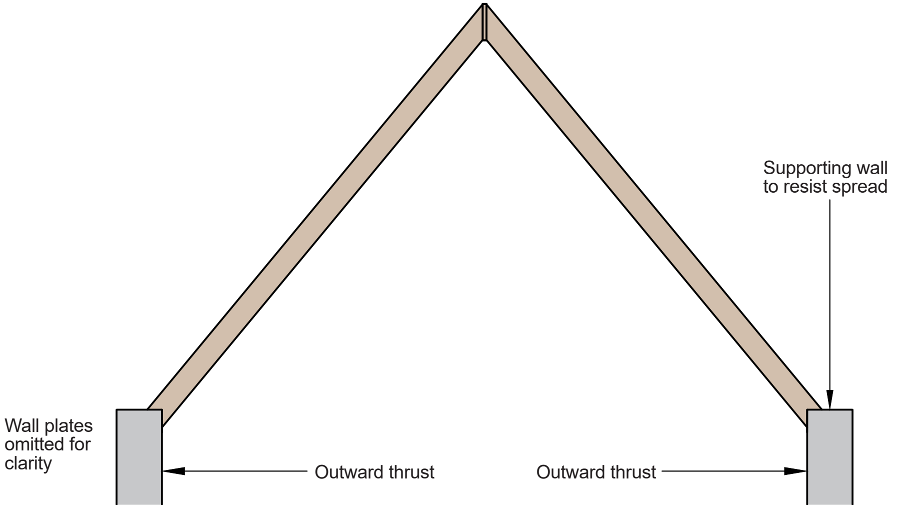
Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

- Restraint can be provided by:
- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

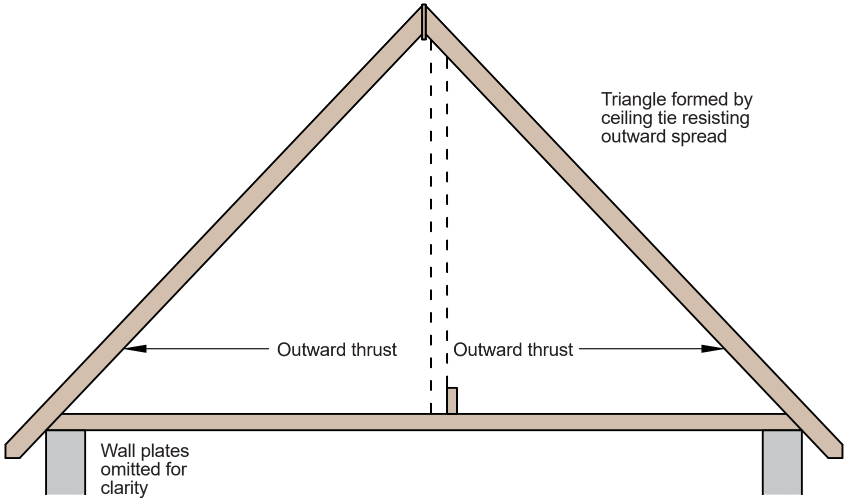
Couple roof

This is the simplest method of producing a pitched roof, consisting of pairs, or couples, of rafters pitched against each other at their heads, with feet bearing on opposite walls. It is economical, but structurally limited, as heavy supporting walls are required to resist outward spread. When a steep pitch is combined with low eaves, the resulting clear roof space can be used to advantage. Where such roofs are designed, full structural calculations prepared by an Engineer should be provided to demonstrate how eaves spread will be prevented.



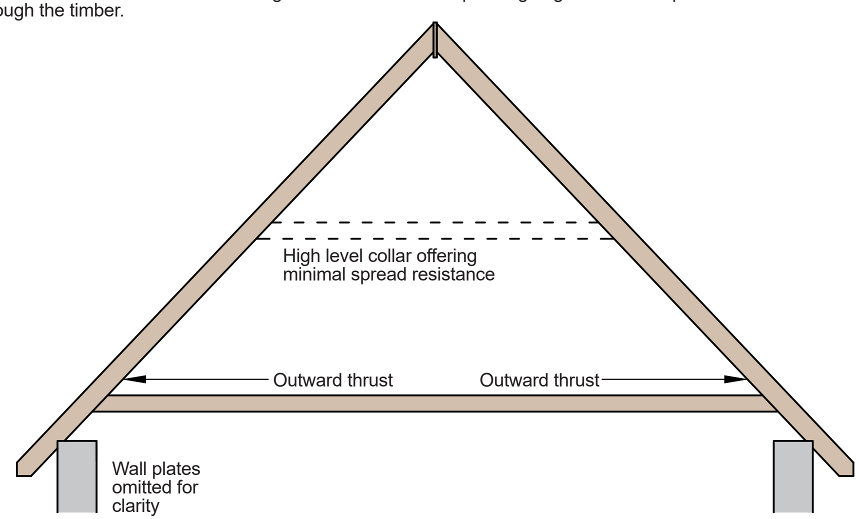
Close couple

Pairs of rafter feet are joined together with ties, often doubling up as ceiling joists, to form triangulation. The tie resists the outward thrust, and load is transferred vertically to supporting walls. The connection of ceiling joists or ties with a binder, supported from the ridge by hangers, allows a smaller timber section to be used. Rafter and ceiling joist dimensions for typical spans are given in the TRADA document, Span Tables for Solid Timber Members in Floors, Ceilings and Roofs for Dwellings.

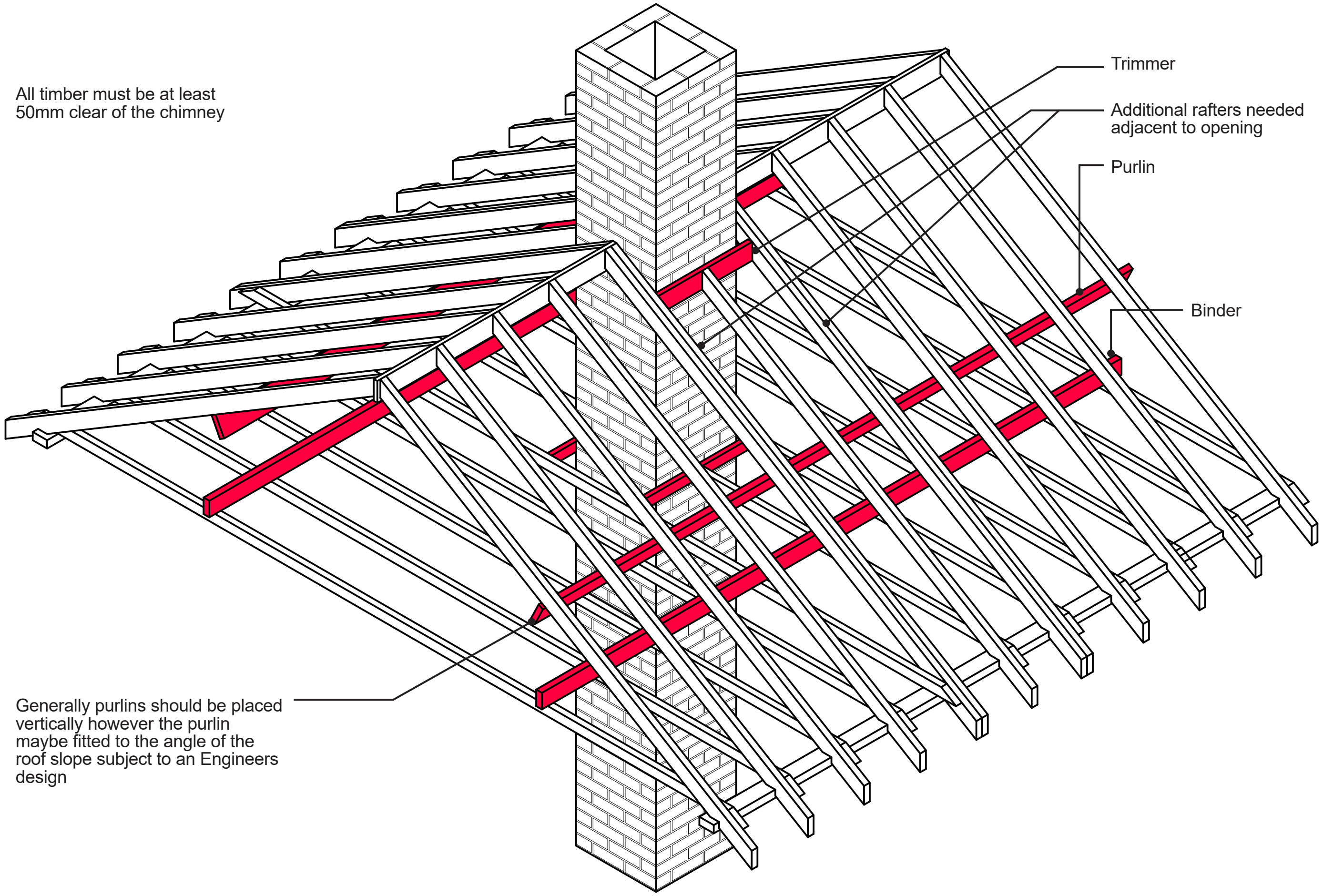


Raised collar roof

When ties are introduced at a higher level than the rafter feet, they are termed ‘collars’. The higher the collar, the less influence on rafter spread and the larger the rafter section required to resist the bending moment. The height of supporting walls may be reduced, as the roof is effectively lowered so that the rafters and collars support the ceiling. To resist eaves spread, the height of the collar should be no higher than a third of the vertical height between the wall plate and ridge. Rafters supporting collar ties should be designed by an Engineer, taking into account the additional point load imposed by the collar. The collar should be fixed to the rafters using 10mm bolts and incorporating large washers to prevent the bolt from being pulled through the timber.

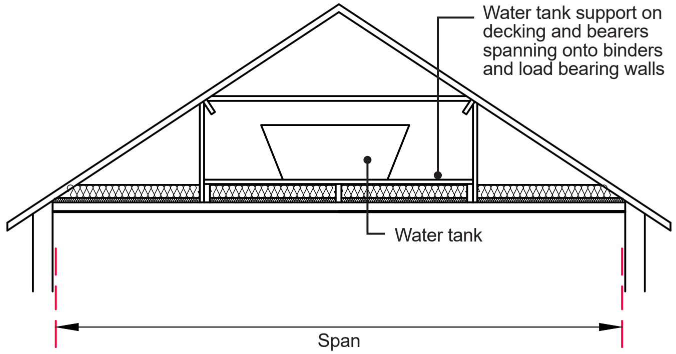


Roof trimming around a chimney



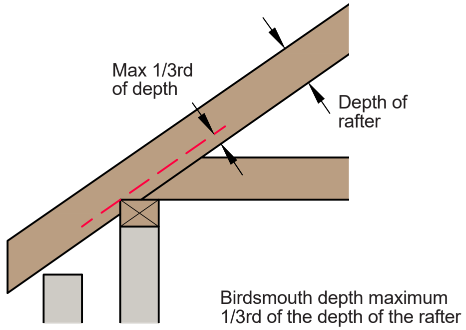
Tank stand configuration

The design of tank stands should be provided as part of the Engineers roof design.

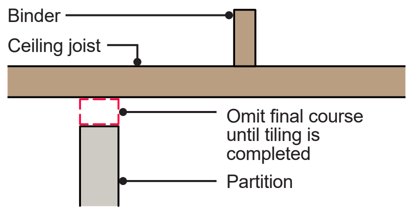


The tank platform should not be constructed from chipboard as it may become wetted by condensation, plumbing leaks, or rainwater ingress and lose its strength.

Maximum depth of birds mouth



Internal non-loadbearing walls



It is advisable to erect non-load bearing walls after the tiling has been completed thus allowing deflection to take place under dead load, thereby reducing the risk of cracking appearing in the ceiling finishes. If partitions are of brick or block, then alternatively the final course can be omitted until tiling has been completed.

Provision for openings

All openings formed in the roof structure for dormers, rooflights etc. must be carefully designed to ensure the roof remains safely supported and weather tight.

Roof lights formed in traditional cut roofs

The roof should have doubled up rafters either side of the opening to support the trimming joists at the head and base of the unit. The head and base trimming joists should be fixed to the doubled rafters according to the structural design requirements.

Condensation and ventilation

Statutory requirements

The roof should be designed and constructed in accordance BS 5250 and BS EN ISO 13788. Detailed information on methods to control harmful condensation is provided in BS 5250.

Prevention of condensation in roof voids is best achieved through the provision of natural air ventilation. BS 5250 states that the Designer should take account of the following moisture sources in buildings:

- Water incorporated during the construction process (including precipitation).
- Precipitation after construction.
- Water vapour arising from the occupants and their activities.
- Atmospheric moisture drawn into the roof during warm humid weather conditions.

Well sealed ceilings/air tightness of ceilings

BS 5250 emphasises the importance of a well-sealed ceiling as a means of curbing the transfer of moisture into a roof space by means of moisture-laden air. This means:

- The avoidance of gaps and holes in a ceiling.
- Loft access doors and hatches should not be located in rooms with high rates of moisture generation such as kitchens and bathrooms.
- That hatch covers must be effectively sealed.
- High levels of workmanship.

Air leakage through gaps in a ceiling transfer more heat and moisture into the roof by convection than passes through the ceiling materials by diffusion. Sealing the ceiling is therefore an essential requirement when considering the design of the roof envelope.

Key design issues to consider are as follows:

- Avoid construction gaps.
- Avoid roof access doors or hatches in rooms that produce excessive moisture.
- Use a proprietary sealed loft hatch and frame, and seal correctly in accordance with the manufacturer's recommendations.

There is advice found in BS EN 13141-1 Ventilation for buildings. Performance testing of components/products for residential ventilation.

- Seal all services and roof lights.
- Use recessed light fittings rated IP60 to IP65 to BS EN 60529.
- Seal the head of cavity walls to prevent the transfer of warm moist air into the loft.

Air and vapour control layer (AVCL)

If an AVCL is installed it should be placed on the warm side of the insulation. Installation of an AVCL at ceiling level will increase the need for sufficient ventilation below it during the drying out of wet trade construction phases. The performance of an AVCL depends not only on the material selected, but also on the workmanship and the ability of the construction to be assembled on-site (see BS 5250). It is essential that an AVCL be adequately lapped and all joints sealed, and that its integrity is maintained. Particular attention should be paid to detail design and installation around penetrations through the AVCL e.g. services, compartment walls and to the sealing of punctures caused by fixings.

Cold roof

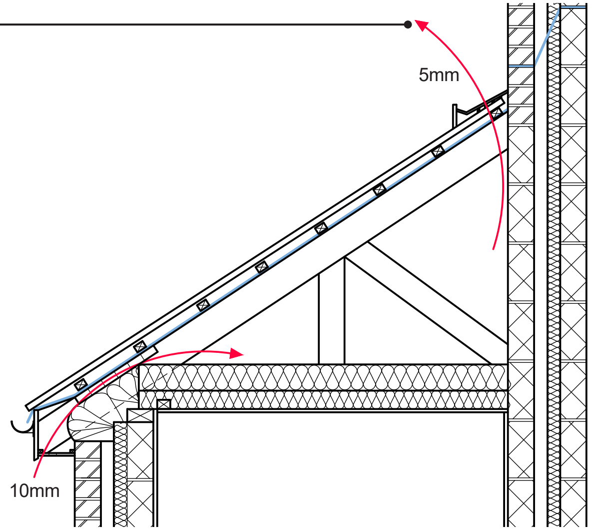
The following suggest the correct positioning of vents and the precise amount of free airspace required for 'cold roof' construction, in accordance with current Building Regulations and BS 5250.

These recommendations apply if a high water vapour resistance (type HR) underlay is used.

Mono pitched/lean to roof

A free airspace of 5,000mm²/m should also be provided at high level (equivalent to a continuous 5mm opening)

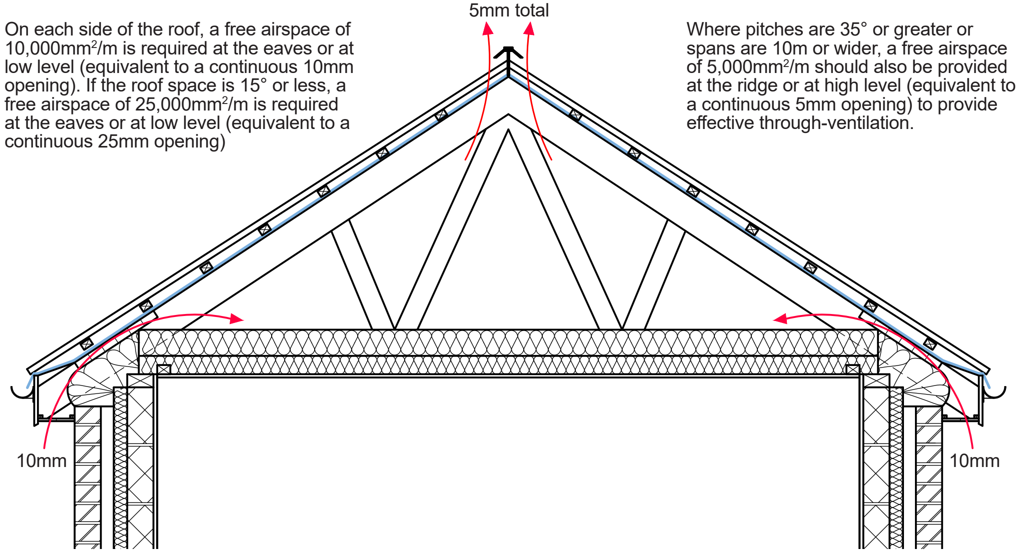
If the roof space is 15° or less, a free airspace of 25,000mm²/m is required at the eaves or at low level (equivalent to a continuous 25mm opening). If the roof pitch is more than 15°, a free airspace of 10,000mm²/m is required at the eaves or at low level (equivalent to a continuous 10mm opening)



Duo pitched roof

On each side of the roof, a free airspace of 10,000mm²/m is required at the eaves or at low level (equivalent to a continuous 10mm opening). If the roof space is 15° or less, a free airspace of 25,000mm²/m is required at the eaves or at low level (equivalent to a continuous 25mm opening)

Where pitches are 35° or greater or spans are 10m or wider, a free airspace of 5,000mm²/m should also be provided at the ridge or at high level (equivalent to a continuous 5mm opening) to provide effective through-ventilation.

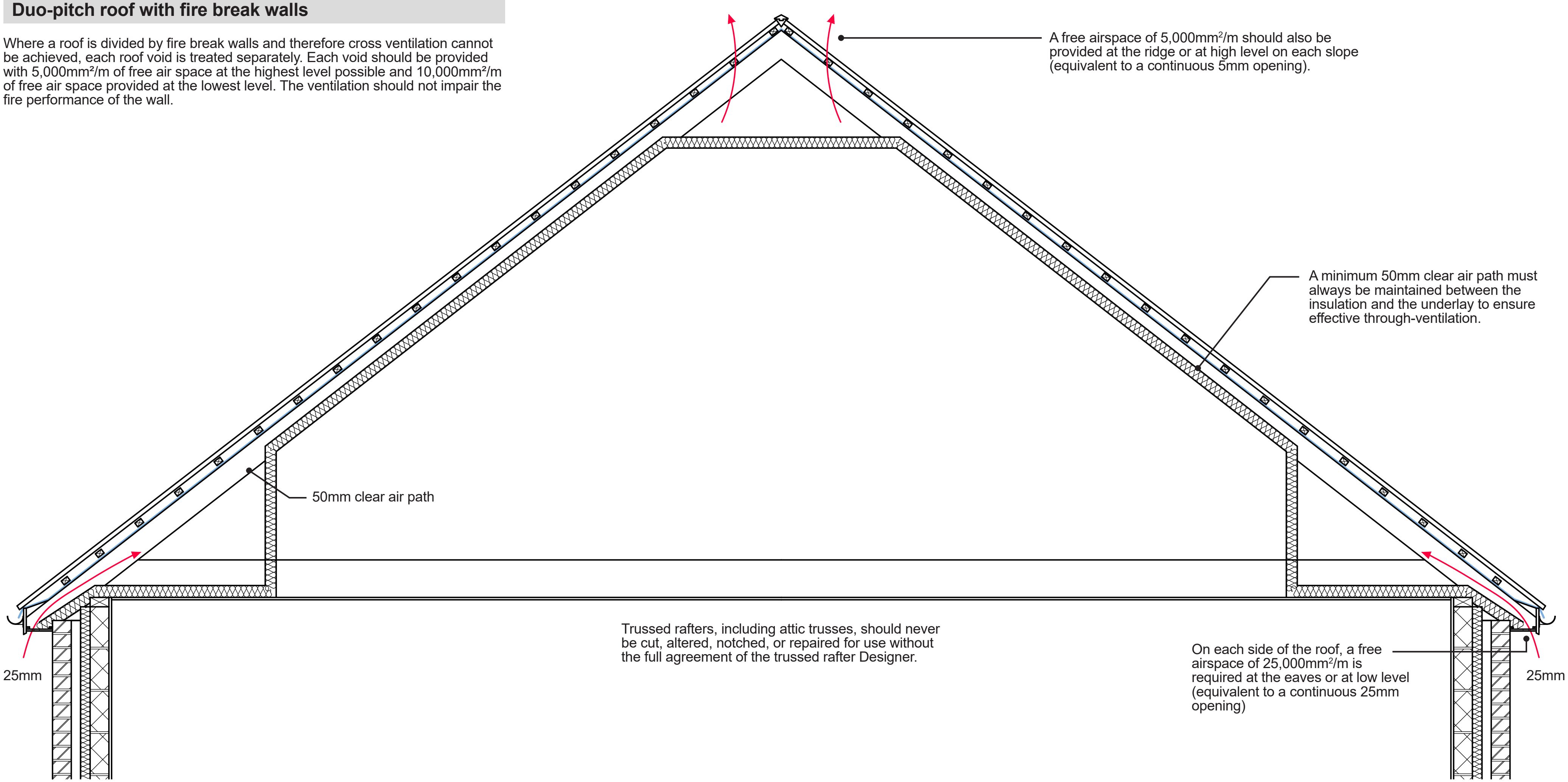


Duo pitched roof with sloping insulated ceilings

Roofs should be designed and constructed in accordance with BS 5250 and BS EN ISO 13788. Detailed information on methods to control harmful condensation is provided in BS 5250.

Duo-pitch roof with fire break walls

Where a roof is divided by fire break walls and therefore cross ventilation cannot be achieved, each roof void is treated separately. Each void should be provided with 5,000mm²/m of free air space at the highest level possible and 10,000mm²/m of free air space provided at the lowest level. The ventilation should not impair the fire performance of the wall.



Vapour permeable (type LR) underlays

If an LR underlay is used, interstitial condensation is unlikely to occur, provided the ceiling is well sealed and the eaves have a minimum continuous ventilation opening of 3mm. If the ceiling is not well sealed, openings equivalent to 7mm should be used; 10mm eaves vent systems will satisfy both requirements.

BS 5250 does not consider the situation where it is proposed to provide no ventilation to the roof void, or ventilation more limited than described above. Should Designers wish to adopt this principle, they should refer to the conditions attached to Technical Approvals given by UKAS (or European equivalent) accredited technical approval bodies.

A third party product conformity certificate should be obtained to prove and demonstrate any performance for the low resistance underlays used.

Where a LR underlay is used over a fully supported material (plywood, OSB or chipboard for example) which provides a high resistance to the passage of air and water vapour, the LR underlay should be treated, for design purposes, as a HR underlay. Where open jointed square edged sarking boards are used, typically 150mm wide with a minimum of 2mm gaps between each board, they can for design purposes be treated as unsupported LR underlays.

Close fitting roof coverings

When specifying a close fitting roof covering which is relatively airtight, such as fibre cement slates, there is a risk of interstitial condensation forming on the underside of the underlay and external covering. To avoid this risk, the batten space should be ventilated in accordance with BS 5250 using counter battens for both warm and cold roof constructions. This is due to problems that may arise where an underlay which offers low resistance to the passage of water vapour will tend to lower the risk of condensation in the loft, but might increase the risk of condensation in the batten space.

Where underlays are used which allow the transfer of moisture vapour into the batten space by diffusion or convection, potentially damaging condensation can occur if the batten space is not adequately ventilated either by purpose introduced ventilation or by natural ventilation through a suitably permeable roof covering.

Written confirmation and evidence must be sought from the manufacturer confirming the tiles/slates are considered air permeable or air impermeable as stipulated in BS 5250.

Cold pitched roof with an LR underlay with a close fitting roof covering

If an LR underlay is used, the designer may provide less ventilation to the loft than is recommended for a roof with a HR underlay in BS 5250 providing that it is installed in accordance with the manufacturers 3rd party accreditation.

Note: BS 5250 does not cover situations where limited or no ventilation is proposed to the loft space.

With some LR (breathable) underlays, moisture can move by both diffusion and convection from the loft into the batten space.

To reduce the risk of potentially damaging condensation, the batten space should be ventilated. This should be achieved by means of counter battens and vents at both low and high level:

- Low-level vents should be equivalent in free area to a slot 25 mm deep running the whole length of the eaves.
- High-level vents should be equivalent in area to a slot 5 mm deep running the whole length of the ridge in accordance with BS 5250.

Note: Alternative methods of ventilating the batten void should provide an equivalent level of ventilation.

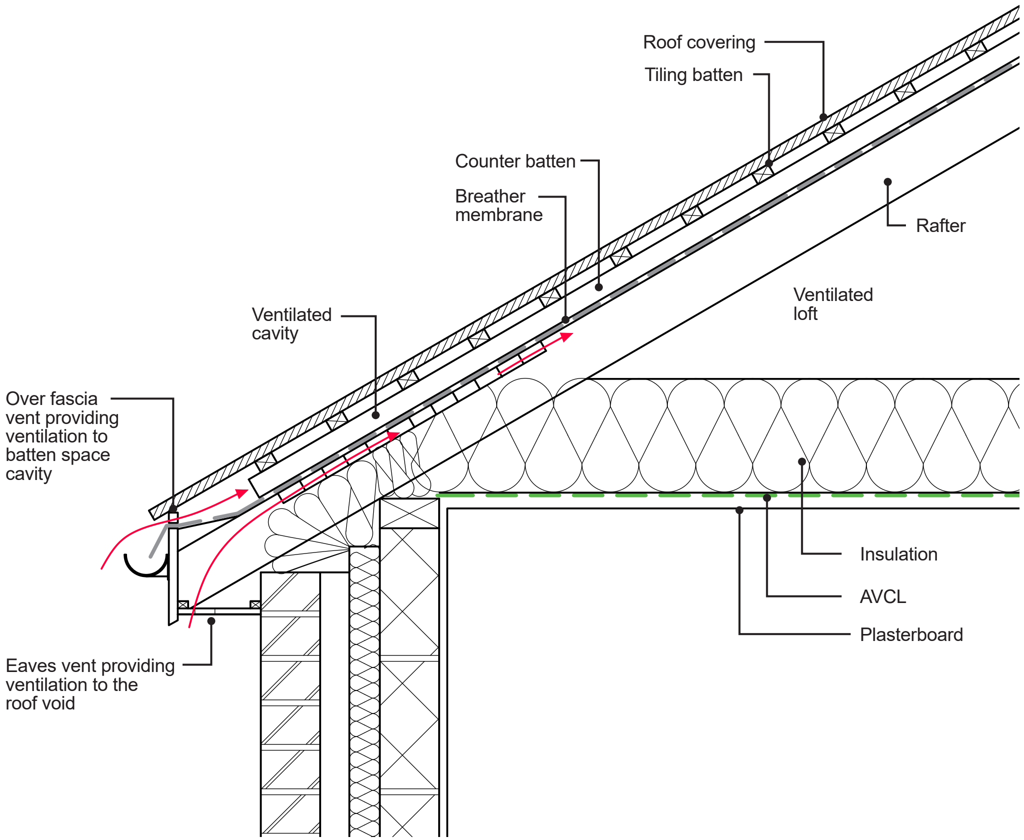
If ventilation is not provided to the batten space there needs to be an increased level of ventilation to the roof space and that should be in accordance with BS 5250. The underlay manufacturer's 3rd party accreditation also needs to be followed.

It is very difficult to determine a HR or LR underlay by sight alone and the manufacturers third party accreditation should be referred too if ventilation requirements are in doubt.

Cold pitched roof with HR underlay with a close fitting roof covering

A HR underlay provides high vapour resistance on the cold side of the thermal insulation, preventing the diffusion of water vapour from the loft in to the batten space; it is therefore essential that the loft space be ventilated in accordance with BS 5250 and this Technical Manual.

Cold pitched roof - LR underlay - Impermeable external covering



Warm roof construction

Insulation may be provided above the rafter and between rafters to form a warm roof construction. The position of insulation and vapour control layers (AVCL) must strictly adhere to the insulation manufacturer's recommendations. All warm roof construction products must have appropriate third party certification.

Ventilation to counter batten void will be required where vapour permeable (type LR) underlays are not used.

Warm pitched roof with an LR underlay and tight fitting roof covering

In warm pitched roofs with an LR underlay, an AVCL (air and vapour control layer) should be provided at ceiling line. Where an external covering (such as fibre cement slates) is relatively airtight there is also a risk of interstitial condensation forming on the underside of the underlay and the external covering; to avoid that risk the batten space should be ventilated as described.

Warm roof construction (vented battens)

In roofs with an HR underlay, whatever form of external covering or ceiling is provided, there is a risk of interstitial condensation forming on the underside of the HR underlay; to avoid that risk, an AVCL should be provided on the warm side of the insulation, and ventilated voids should be formed between the underside of the underlay and the insulation.

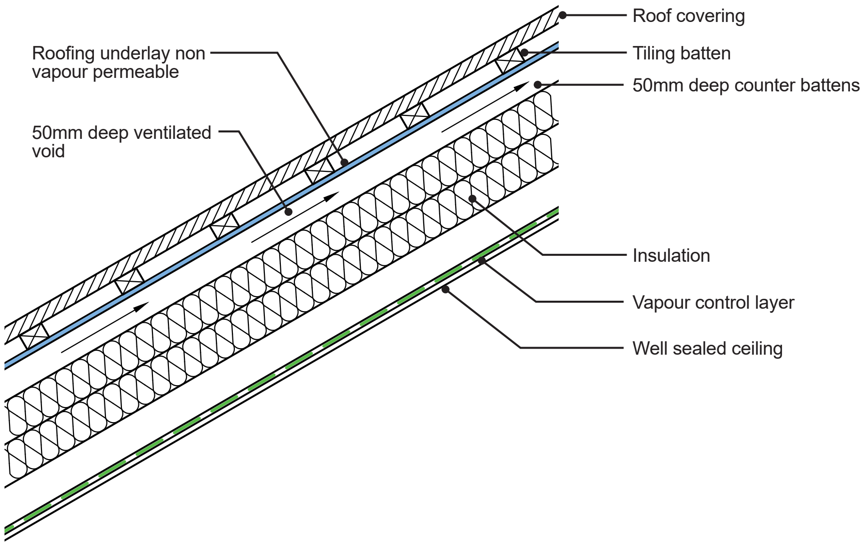
Thermal insulation provisions for the compliance with the Building Regulations

Thermal insulation must be installed to meet current Building Regulations, to an acceptable level of workmanship, to avoid cold bridges and to meet the following provisions:

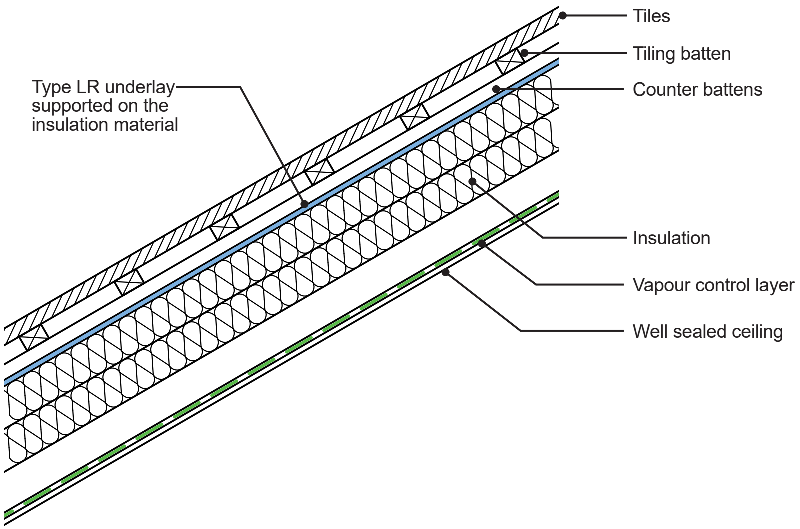
- The use of over joist and under rafter insulation is considered best practice, as it eliminates the cold bridge caused by the joist/rafter.
- If required by BS 5250, use a vapour control plasterboard or a separate VCL behind the plasterboard.
- Use a proprietary eaves ventilator to ensure ventilation is in accordance with BS 5250.
- The installation of the eaves ventilator must not prevent free water drainage below the tiling battens.

The requirements of the regulations are designed to reduce carbon emissions from new buildings and improve the performance of existing buildings where new work is carried out.

Warm roof construction (vented battens)



Warm roof construction (vapour breathable underlay)



11.
Roofs

11.2
Panelised Roof Cassettes

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A complete site specific design package satisfying all of the guidance within this section.
2. Evidence the installers have been trained and approved by the manufacturer to install the specified panelised roof cassette system.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Definition

For the purposes of our Warranty, roof cassette systems are prefabricated pitched roof panels (open or closed) which may also be supplied with wall and floor panels, beams and other supporting elements of structure. The systems may be constructed from timber, metal or structural insulated panels (SIP) or a combination of these. They can provide a completely clear roof space free from struts ties or bracing.

Please note for Warranty purposes, cross laminated timber is not an acceptable material for panelised roof cassettes.

Third party product conformity certification

The roof cassette system must hold a full third party product conformity certificate from an independent approval body which is accepted by us. This could either be a UKAS, European equivalent product conformity accredited organisation or other body accepted by us, which looks at the system as a whole and reports on its suitability and scope of accepted use. Please refer to ‘Appendix C – Suitability of Products and Systems’ section for further guidance on third party product conformity certification.

Transitional arrangements
For roof cassette systems that do not yet hold a full third party product conformity certificate, a satisfactory third party product conformity certificate must be in place from an appropriate independent UKAS approved product conformity body by **31st of December 2024**.

Design

All panelised roof cassettes must be supported with a site specific design package. An Engineer must take overall design responsibility of the roof cassette systems and take account of interactions between the roof cassettes and the main house structure. The site specific design package must include:

1. A full description and specification of the system and how this system complies with all current regulations and design codes, along with copies of calculations, drawings, reports, testing, etc.
2. Structural calculations and drawings should be carried out in accordance with the current European/British Standards and refer to the worst case scenario where the system could be used.
3. The Engineer must take account in the design of all structural components of the building, and elements that interact with the roof cassette to ensure they are all compatible. The calculation package must fully reflect the construction type and build-ups of the final structure of the house and roof including roof covering and any additional attachments (such as PV panels).
4. Principle connection details (drawing and calculations) must be provided for the floor and roof panel at the external wall, ridge connections, ceiling strut connections, and floor and roof connections. The calculations must cover all connection details and details of the roof load transfer.
5. There must also be a house type specific fixing schedule document available to allow the Warranty surveyor to check that the fixing specification has been followed on site. A generic fixing specification is not acceptable. It should also not be left to a third party to provide a fixing specification, this should be part of the holistic structural package from the Engineer.
6. The structural calculation package will need to include wind uplift calculations to ensure that the roof will be connected by restraint straps to the wall plates and gable/hipped ends accordingly. A gable restraint system will need to part of the design calculation package to consider the continuous or raised gable wall plate depending on the gable panel (i.e. masonry or timber frame or panels).
7. The whole design package must consider how all other elements will interact with the roofing cassette, such as insertion of false prefabricated chimneys, roof light penetrations or dormers, roof covering, Solar photovoltaic installations and ventilation systems.
8. The design package will also need to consider the prevention of fire spread, thermal insulation requirements, durability, weatherproofing, vapour permeability and sound insulation requirements (where applicable). The designer must consider critical elements especially at party walls and gable ends for fire resistance where Building Regulations may have different requirements than a traditional roof due to the differing loadbearing elements.
9. As part of the design there must be details on how the roofing cassettes will be finished at eaves and verge. Due to the varying nature of the roofing cassettes this could be done in different ways. Such as site attached constructed gable ladder or pre-installed gable ladder to roofing cassettes. Some have extended rafters to be cut on site and some have additional add on sections to extend the eaves. This must be in the design and not left as an ad-hoc solution to be constructed on site.
10. Roof cassette manufacturers must have a system operating procedure manual covering repairability and installation and sign off processes. All installers of the roof cassette system should receive suitable training from the manufacturer evidence of which must be provided to the Warranty Surveyor upon request.

Site storage and temporary protection

Due to the closed panel nature of the roofing cassettes, storage on site should be minimised and delivery of roof cassettes and lifting equipment/installation should be co-ordinated to prevent prolonged storage periods on site.

Where delays are anticipated there should be a site storage plan in line with the manufacturer’s recommendations to ensure roof cassettes do not get damaged and moisture content of the timber does not exceed 20%. As panels are closed, storage on site with no protection is NOT acceptable.

Where a breather membrane is proposed as a temporary weather protection details of maximum exposure of the membrane should be provided.

Installation

All installers of the roof cassette system should receive suitable training from the manufacturer, evidence of which should be provided to the Warranty Surveyor upon request.

Fillet pieces
Where additional fillet pieces are required at junctions (at wall plate and ridge level for example), they should be design and specified by the manufacturer prior to the roof cassettes being installed. Ad-hoc on site installations not designed or specified by the manufacturer will not be acceptable for Warranty purposes.

Service penetrations
Service penetrations through the roof cassette should not be through structural members. Where large service penetrations are required, they must be accommodated for in the design.

11.

Roofs

11.3
Pitched Roof Coverings (Tiles and Slates)

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Evidence that all roof tiles and/or slates satisfy the relevant British Standards as outlined within this section.
2. A site specific fixing specification for the roof tiles and/or slates.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Specification and classification of underlays

Underlays for use beneath tiles and slates are either fully supported over boarding, sheathing or sarking, or unsupported and draped over rafters/counter battens. Underlays may be of the following specification:

- BS 8747 Class 1F reinforced bitumen or Class 5U polyester reinforced bitumen.
- 2HR* underlay to BS EN 13859-1 Class W1 water penetration classification with third party certification for the use intended.
- 3LR† underlay to BS EN 13859-1 Class W1 water penetration classification with third party certification for the use intended.

* HR (high water vapour resistance) underlay - >0.25MNs/g.
† LR (low water vapour resistance) underlay - <0.25MNs/g.
(LR underlays are sometimes referred to as ‘vapour permeable’ or ‘vapour open’).

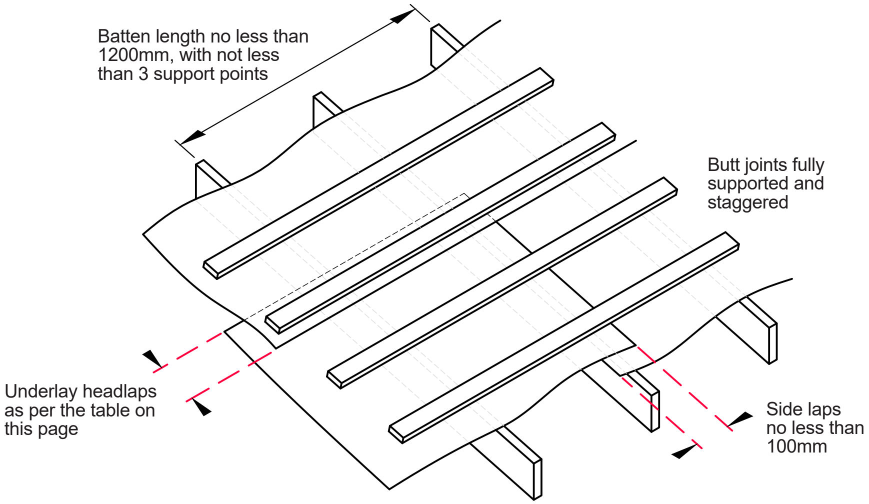
There are two categories of underlay: HR, non-vapour permeable and LR, vapour permeable. These types of underlay should comply with BS EN 13859-1 and have third-party accreditation, i.e. a BBA certificate. They should also have sufficient tensile and nail-tear strength, and low extensibility, to produce the required resistance to wind uplift.

Classification of underlays
Underlays should be classified in accordance with their geographic location and wind zone. Underlays should only be used in those wind zones for which the design wind pressure is not greater than the declared wind uplift resistance. Refer to BS 5534 A8. Figure A.4 for design wind pressures for geographical wind zones location map. It is important to ensure the underlay is suitable for the geographical wind zone and that laps in the underlay are secured in accordance with the manufacturer’s 3rd party accreditation for the geographical wind zone and batten spacing. This lap can be secured either with a batten or a manufacturer’s 3rd party approved product.

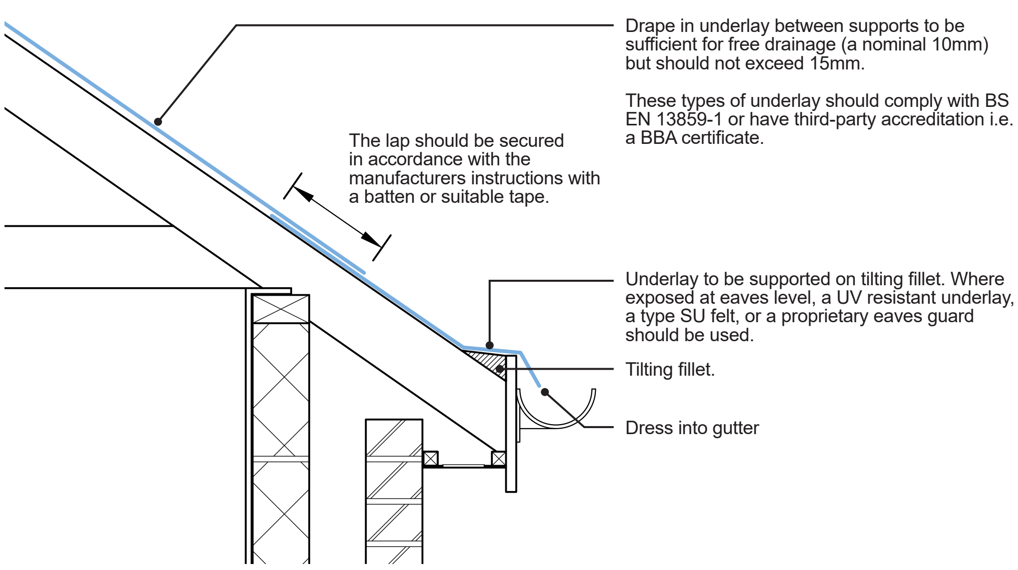
Underlay nails
Nails for use with roofing underlays should be clout head nails of no less than 3mm shank diameter and 20mm length made of copper, aluminium alloy or steel coated by any of the zinc or zinc alloy coating methods specified in BS EN 10230-1.

Roof underlay provision

Lap of underlay should be secured in accordance with the manufacturers 3rd party certification.



Roof covering (underlay)



Installation of underlays

Lay the specified roofing underlay parallel to eaves or ridge with horizontal overlaps, as specified in the table below. Vertical side laps should be a minimum of 100mm. Minimise the gap at laps resulting from different tautness between underlay courses. Drape in underlay between supports is to be sufficient for free drainage (a nominal 10mm) but should not exceed 15mm in accordance with BS 5534. Fix underlay with the fixings specified, keeping the number of perforations to a minimum. Handle and fix underlay with care to ensure there are no tears or punctures, and repair any tears or punctures prior to tiling. Ensure that the underlay does not obstruct the flow of air through ventilators located at eaves, ridge or in the main roof, and appropriately weather all holes formed in underlays for soil vent pipes, etc. Avoid contact between the underlay and the underside of tiles. To prevent wind uplift, fix additional battens or timber strips where laps occur between tiling battens (refer to BS 5534 6.2 Underlays).

Minimum horizontal laps for underlays

Rafter pitch	Not fully supported (mm)	Fully supported (mm)
12.5° to 15°	225	150
15° to 35°	150	100
35° and above	100	75

Timber battens

Timber species

Tiling battens and counter battens should be selected from the timber species set out in BS 5534, and their characteristics and defects should not exceed the permissible limits given in Annex D to G of BS 5534.

Grading

Battens should be suitably graded to meet the requirements in BS 5534. Only battens that have been graded and bear the BS 5534 marking will be acceptable for use.

Sizing

Timber batten sizes should be not less than the minimum values recommended in BS 5534 and as per the table on this page.

Battens for large spans or special loading conditions should be designed by structural calculation for strength and stiffness, in accordance with Annex F of BS 5534.

Batten marking

Each batten should be permanently marked with the following information:

- Supplier.
- Origin (imported or British grown and/or species code).
- Graded BS5534.
- Size.

Preservatives

BS 8417 provides recommendations for preservatives for timber. Indicative preservative treatment schedules are given in Annex E of BS 5534. Battens treated with preservatives can contain toxic substances that could introduce an environmental hazard, and should be disposed of safely.

Fixing timber battens

Battens should be at least 1200mm in length and supported at each end and intermediately by at least three rafters or walls. Stagger butt joints over intermediate supports, splay nail each batten end and nail battens to each rafter.

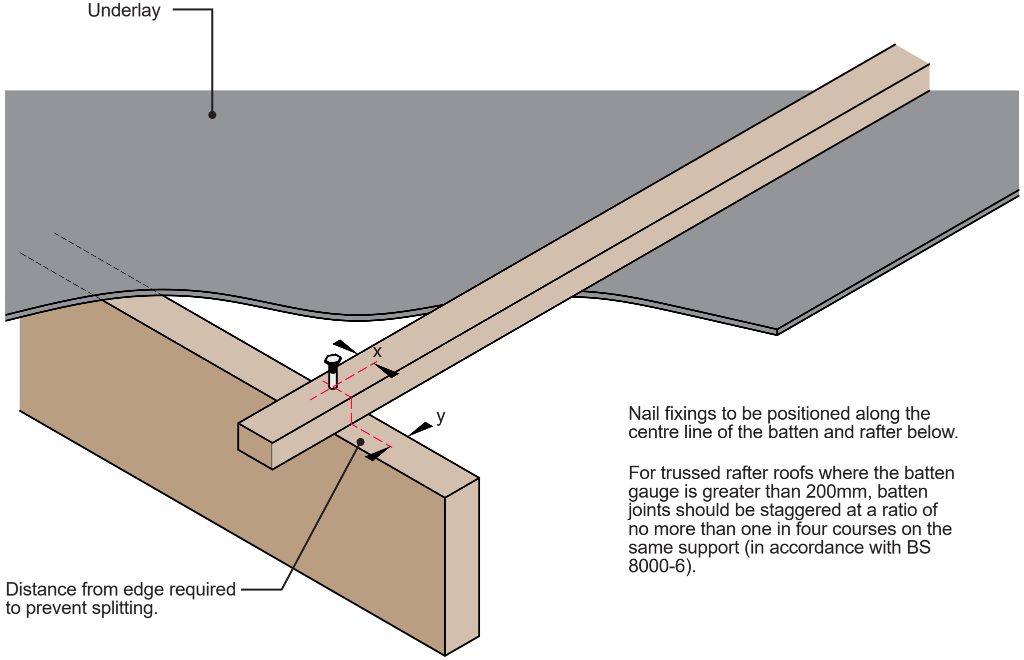
For trussed rafter roofs where the batten gauge is greater than 200mm, do not have more than one joint in any four consecutive battens on the same support.

For trussed rafter roofs where the batten gauge is less than 200mm do not have more than three joints together in any 12 consecutive battens on the same support.

The batten sizes given in the table should be taken as minimum dimensional requirements. Take care that nails used to secure tiles do not penetrate the underside of battens or the underlay.

For guidance on fixing roof coverings to battens, please prefer to our ‘Roofs – Pitched Roof Coverings (Tiles and Slates) - Fixing requirements’ section.

Fixing battens to rafters



Nail fixings to be positioned along the centre line of the batten and rafter below.

For trussed rafter roofs where the batten gauge is greater than 200mm, batten joints should be staggered at a ratio of no more than one in four courses on the same support (in accordance with BS 8000-6).

Recommended batten sizes for pitched roofs and vertical work (BS 5534 in accordance with clause 4.11.4.1 Table 3)

Tile type	Basic minimum sizes*			
Rafter/supports	**450mm span**		**600mm span**	
	width	**depth**	**width**	**depth**
Plain pitched/vertical	38	25	38	25
Single lap interlocking tiles/slate	38	25	50	25
Fibre cement slates	38	25	50	25
Natural slates	50	25	50	25
*All dimensions subject to re-sawing allowance: width +3mm, depth 0 or +3mm based on measurement reference moisture content of 20%				

Fixing roof battens

Fix the specified battens up the roof slope on top of the rafters, ensuring a minimum 40mm nail penetration into rafters (smooth shank). Nail counter battens at maximum 300mm centres vertically up the roof slope. Where boarding is used the fixing should coincide with the line of rafters.

Roof coverings

Legislation and planning
Tiled and pitched roof coverings should be in accordance with the relevant Building Regulations.

The principal British Standards relevant to this section are:

- BS 5534 Code of Practice for slating and tiling (including shingles). This gives recommendations for the design, materials, application, installation and performance of slates and tiles (BS 5534 should be read in conjunction with BS 8000-6).
- BS 8000-6 Workmanship on building sites. Code of Practice for slating and tiling of roofs and claddings. This applies to the laying and fixing of clay and concrete tiles, natural and fibre cement slates and their associated fixings and accessories.
- BS 5250 Management of moisture in Buildings: Code of Practice. This describes the causes and effects of surface and interstitial condensation in buildings, and gives recommendations for control of condensation in roofs.

To ensure safe working practices during construction, the Designer should consider relevant safety regulations. These include the Construction (Design and Management) Regulations and the Health and Safety Executive's Approved Code of Practice for Management of Health and Safety at Work.

Certain advisory bodies, such as the Loss Prevention Council, Building Research Establishment Ltd (BRE) and Timber Research and Development Association (TRADA), also produce recommendations and guidance on roof construction.

Material specification

Tiles and slates should meet the requirements of the following standards:

- BS EN 1304 – Clay roofing tiles and fittings
- BS EN 490 and BS EN 491 – Concrete tiles and fittings
- BS EN 12326 – Natural slates
- BS EN 492 - Fibre cement slates and fittings

Natural slates

Natural slates must meet the following level of performance and durability as detailed in BS EN 12326:

- Achieve a A1 code rating for water absorption less then 0.6%
- Achieve a T1 code rating for 'Thermal cycle' test.
- Achieve a S1 code rating for 'Sulphur dioxide exposure' test.
- A copy of the consignment documentation or "accompanying commercial document" (ACD) from the supplier/producer should be provided to confirm these test performances.

It is important that slates are graded on site to ensure an even finish.

Weather exposure

Rain penetration of the roof covering is dependent on a combination of the rainfall rate, wind speed and the ability of the roof tile to resist the ingress of snow and rain water. The Designer should therefore be aware of the various means by which rain and snow can, under certain conditions, penetrate the roof covering.

These include:

- Capillary action and rain water creep.
- Raindrop bounce and negative pressure rain suction.
- Driving rain, deluge rain and flooding.
- Surcharging of rain water over laps on long-rafter roofs.
- Wind-driven snow.

Rain and snow
The roof of the building shall adequately protect the building and people who use the building from harmful effects caused by precipitation and wind-driven spray. Roofs are required to resist the penetration of precipitation (rainfall) to the inside of the building, thereby preventing damage to any part of the building where it might be carried.

Most pitched roofs keep the rain and snow out of the building and give a satisfactory performance. However, it is acknowledged that similar roofs built to the same design and using identical roof materials, but in different locations, may not necessarily provide the same level of assurance since they will be subject to different weather conditions and exposure.

Exposure to driving rain
The UK has a high risk of severe driving rain, and even in some sheltered locations may be subject to high levels of deluge rainfall. BS 5534 defines four categories of exposure, based on the driving rain data given in BS 8104 and BR 262, and should be used for buildings up to 12m in height. For buildings over 12m in height, the influence of increased wind speeds should be taken into account using BS EN 1991-1-4.

Design for wind loading
When considering the wind loading on the roof covering, designers should consult BS 5534. This provides calculation methods to assess the wind load on each tile as a uniformly distributed load, and also takes into account the porosity of the tiles and the effectiveness of the substrate (boarding or sarking), and/or underlay shielding, when calculating wind uplift loads. The standard method in BS EN 1991-1-4 Eurocode 1. Actions on structures. General actions. Wind actions should be used to determine the basic wind speed of the site, which is then used to calculate the effective wind speed and dynamic wind pressure on the roof by applying a series of factors to account for terrain, topography, building height and length etc.

Control of internal pressure
The total wind force on a roof is dependent on the pressure differential between the inner and outer faces of the roof covering. Such pressures are significantly reduced by the use of underlay or boarding beneath tiling or slating. Its contribution towards shielding the underside of the tiles or slates from the full transmission of internal pressures means the underlay is required to have an adequate tensile strength for the specific application. The tensile strength of the underlay, its air permeability factor and the withdrawal resistance of batten nail fixings are therefore important when determining the overall resistance to wind uplift of the roof system.

Aircraft vortices
Roofs near airports can experience high local wind load forces due to air vortices created by certain aircraft when taking off and landing, which may be greater than the wind loads calculated to BS 5534. Designers should seek advice from the Airport Authority Planning Department when designing roof fixings in these locations, and refer to the guidance contained in BRE Digest 467 Slate and tile roofs: avoiding damage from aircraft wake vortices.

Calculating the fixing specification

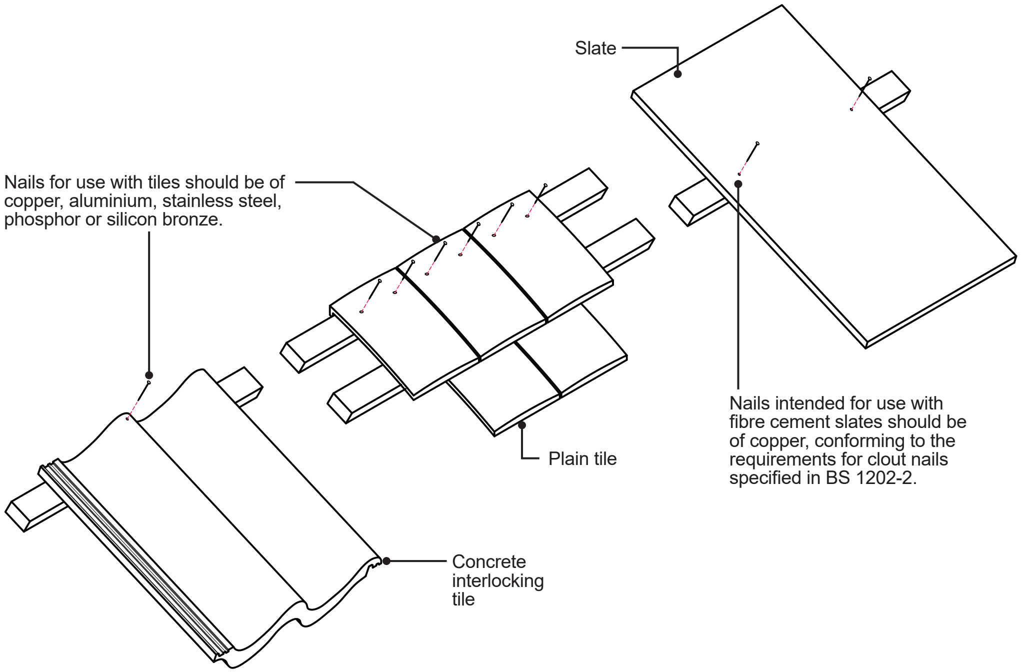
The procedures for calculating the wind loads and determining the fixing specification for tiles and slates in accordance with BS EN 1991-1-4 and BS 5534 are complex to undertake. Designers are advised to obtain a full roofing fixing specification from the slate or tile manufacturer.

Alternative proprietary mortar mixes may be accepted if they are shown to have similar durability and workability.

Nailing tiles and slates to battens

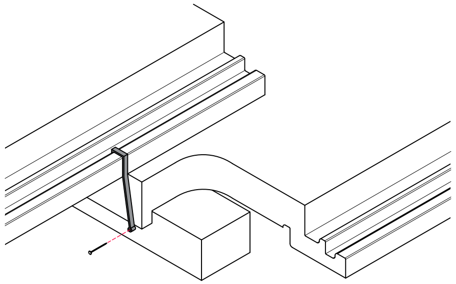
Concrete interlocking, plain tiles and natural slate
Nails for use with tiles should be of copper, aluminium, stainless steel, phosphor or silicon bronze. Aluminium nails intended for use with tiles should conform to BS 1202-3 and should be clout head nails of 3.35mm or 2.65mm diameter. The length of nail will be determined by the required wind uplift and the design of the tile. Stainless steel nails for use with tiles should conform to BS EN 10088-3 and BS 5534 grade 304, 316, 321 or 347, and should be specified for coastal areas, areas of high exposure or where there is a risk from chemical reaction.

Fibre cement slates
Nails intended for use with fibre cement slates should be of copper, conforming to the requirements for clout nails specified in BS 1202-2. The shank diameter and length should be determined by the exposure of the site and the nail's withdrawal resistance. Normally, 30mm x 2.65mm copper nails are adequate for most applications. For exposed sites, or where aggressive environments are encountered, contact the slate manufacturer. Copper disc 'tail' rivets are used to further secure the tail of fibre cement slates against wind chatter.



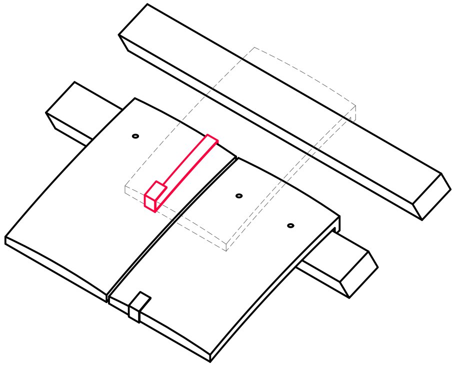
Tile clips

Interlocking tiles



Tile clips should be located over the side interlock of the tile immediately behind the overlapped tile, and nailed to the tiling batten. Tile clips provide resistance to the applied overturning moment more successfully than a nail fixing. The latter is closer to the pivot line, where the nib touches the batten and cannot resist the uplift force at the tail. The phenomenon is also related to roof pitch and the step height of the roof covering, and BS 5534 acknowledges that, at roof pitches of 45° - 55°, all tiles should be at least nailed to battens to prevent displacement. At pitches exceeding 55° all tiles must be both head nailed and tile clipped to reduce 'chatter' in high winds.

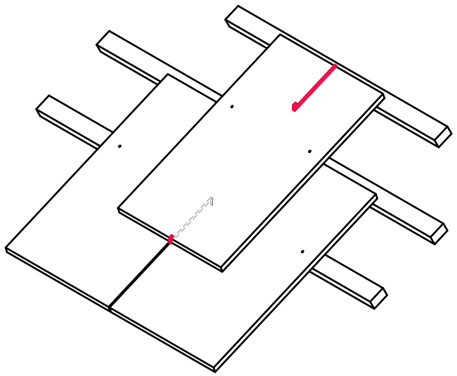
Plain tiles



Tile clips may need to be utilized to achieve a subtitle number of fixings to comply with BS 5534 especially on hips or valleys. Tile clips provide resistance to the applied overturning moment more successfully than a nail fixing. The latter is closer to the pivot line, where the nib touches the batten and cannot resist the uplift force at the tail.

BS 5534 acknowledges that for nibbed tiles, where the rafter pitch is below 60°, two nails should be used in each tile in at least every fifth course. For rafter pitches of 60° and above, including vertical, two nails should be used in every tile.

Slate hooks



Hooks are formed from stainless steel wire conforming to BS 1554 grade 316 S11 or 316 S19. For further advice on the use of slate hooks, refer to BS 5534 section 4.12.3 and 5.3.6.4 Hooks and rivets for slates. Slates should not be nailed to accommodate hooks.

Hooks with crimped shanks reduce the capillary rise of water at the perpendicular joints between slates and are suitable for all roof pitches between 25° and 90°. Straight shank hooks should not be used at roof pitches below 30°. Hooks should not be used at roof pitches below 25°.

Workmanship
Tile fixing should be in accordance with BS 8000-6 and the manufacturer's recommendations.

Roof pitch and lap requirements

When determining the pitch, head-lap and/or side-lap of a tile, the roof pitch is taken to be equal to the rafter pitch. Hence, all references to pitch refer to the rafter pitch, with the laid angle of the roof tile or slate always being less than roof pitch.

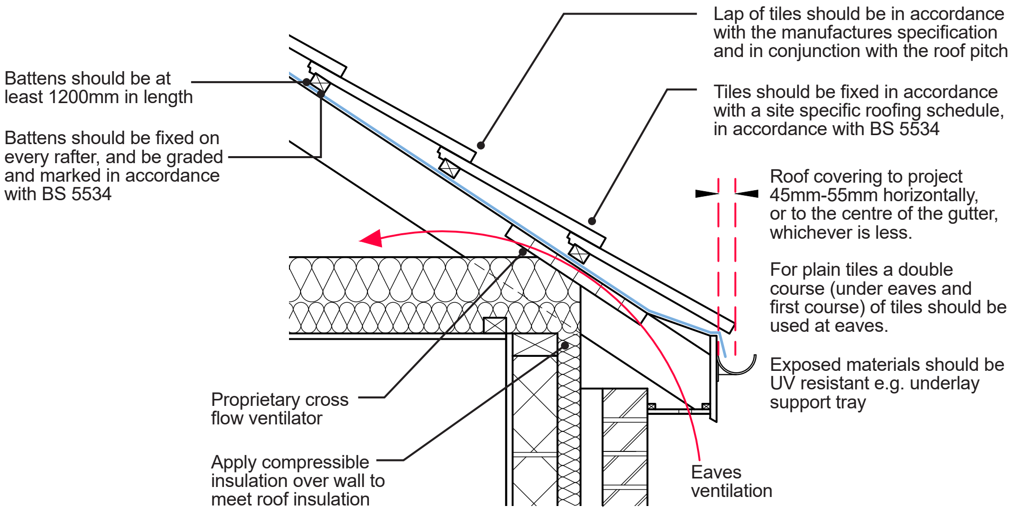
The actual pitch of a tile should be determined in accordance with the following guidelines:

- Tile to rafter pitch angles.
- Interlocking single-lap tiles: 5° less than rafter pitch.
- Plain tiles: 7° less than rafter pitch.
- Double-lap fibre cement slates: 1.25° less than rafter pitch.

If the design rafter pitch is less than the minimum recommended rafter pitch for the particular tile, then they can be considered as having an aesthetic function only. In such cases, the true weatherproofing of the roof system must rely on a fully supported waterproof membrane with an uninterrupted drainage path between counter battens to the eaves gutter.

Type of tile or slate	Gauge	Minimum headlap	Minimum permissible pitch
Concrete interlocking (single lap)	As per manufacturers recommendations	75mm or to the manufacturer's recommendations	30° (2)
Plain (double lap)	Plain (double lap)	65mm generally for clay tiles 75mm in severe exposure conditions	35°
Slates (double lap)	Maximum 1/3 length lap	54mm (1) minimum, increased with lower pitch and severe exposure conditions	20° subject to headlap
Notes: 1. For pitches greater than 45° in sheltered and moderate exposure zones only. 2. For pitches below 30°, evidence shall be provided as to suitable performance. The roof pitch should not be less than 20°.			

General detailing at eaves



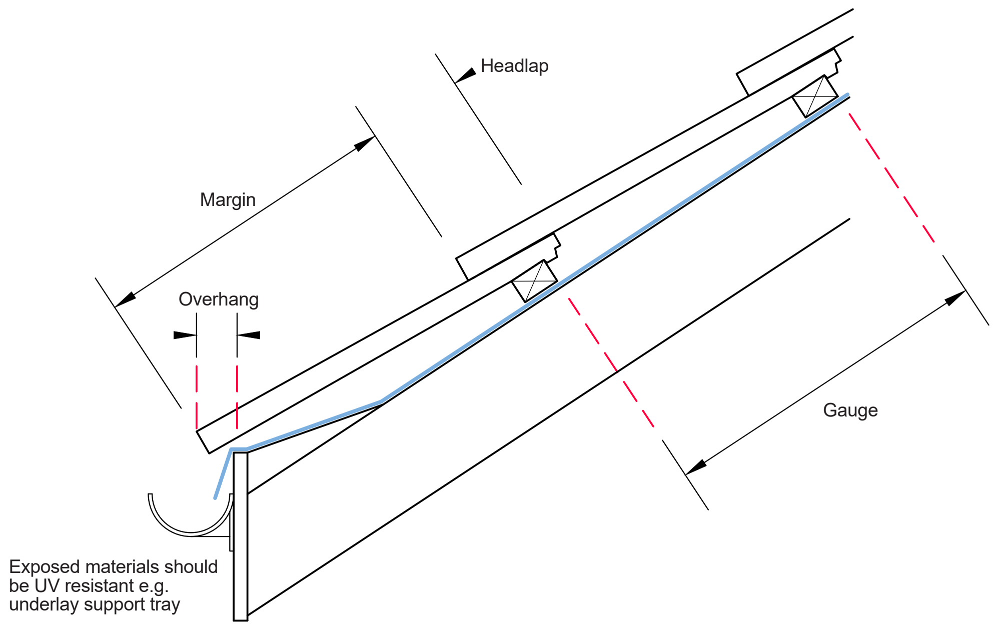
BS 5534 recommends the use of aluminium or stainless steel nails under normal conditions of exposure. Plain or galvanised nails may be used for fixing battens to rafters, but care must be exercised when there is high humidity as certain timber preservative treatments may corrode steel, zinc or aluminium. For all roof areas and rafter pitches, every tile should be mechanically fixed.

Key check points at the eaves

At the eaves (bottom edge), the batten should be set to provide the required overhang of the tiles into the gutters. The recommended overhang is 45mm-55mm horizontally or to the centre of the gutter, whichever is less.

- Ensure fascia board is to correct height so as to prevent tiles kicking up or drooping.
- Fit duct trays to retain insulation.
- Fix underlay protector trays, fascia vents and comb fillers (profiled tiles).
- Clip eaves course where required.
- Ensure vent path to roof space is achieved.
- Ensure exposed materials are UV resistant.

Eaves and bottom edge detail



Relevant British standards

- BS EN 490
- BS 5250
- BS EN 1990
- BS 5534
- BS EN 1991-1-4
- BS 8000-6
- EN 13859-1
- BS 6399

Ridges, hips, verges and valleys

The use of mortar for the bedding of ridge tiles, hip tiles, or lay tiles does not provide sufficient tensile bond strength to resist wind uplift, as it can be affected by a number of factors, such as wind loadings, mix of mortar, design and movement of the roof structure. The tensile strength of mortar should not be taken into account as the mechanical fixings should provide the resistance. Tiles only bedded on mortar are not acceptable.

Note: Dry fix ridge and hip systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 recommendations.

Verge (in accordance with BS 5534, BS 8612 and BS 8000-6)

Battens should overlap onto the outer skin of the brickwork or the undercloak material; the projection for plain tiles and slates should be 38-50mm beyond the gable wall. For concrete interlocking tiles, the projection should be 30-60mm beyond the gable wall. Where the distance of the nearest batten fixing to the rafter is greater than 300mm, an additional mechanical fixing is recommended.

Note: Where proprietary verge tiles or systems are specified, the detailing should be in accordance with manufacturers' recommendations that are relevant to UK conditions of use.

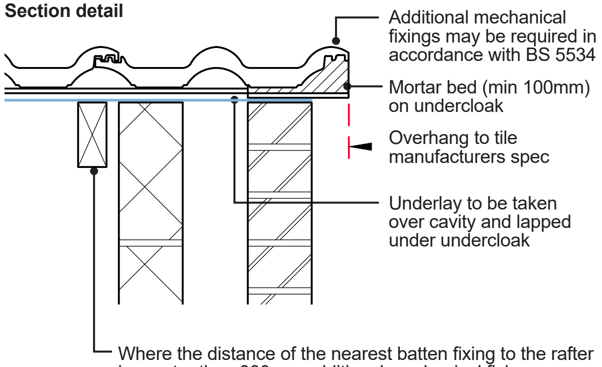
- Use recommended undercloak for mortar.
- Level off irregularities in brickwork.
- Carry underlay over gable wall or bargeboard, and fit undercloak.
- Use the correct mortar mix.
- Bed and point tiles in one operation.
- Keep mortar clear from the ends of tiling battens.
- Fix all perimeter tiles (clip and/or nail).
- Cut plain tiles are not acceptable, and purpose-made plain tile-and-a-half tiles should be used.
- Natural slate verges should be formed with full slates and either slate-and-a-half or half slates that are a minimum of 150mm wide.

Undercloak

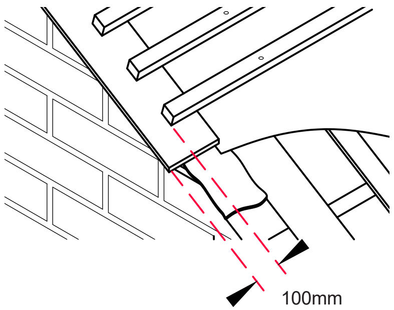
Where an undercloak is used it should comprise plain tiles, slates or fibre cement sheet strip. It is usually fixed at verges beneath the battens and on top of the underlay to support the mortar onto which the verge tiles are bedded. If batten ends are cut, treat with a suitable preservative. A 100mm wide bed of mortar should be neatly laid on the undercloak, this should be bedded solidly and finished neatly.

Verge detail

Section detail



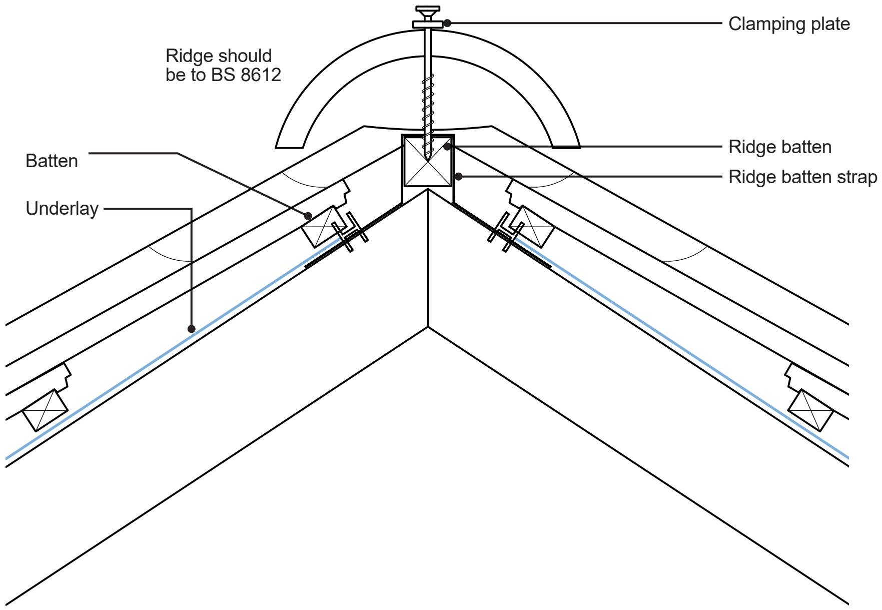
The projection for plain tiles and slates should be 38-50mm beyond the gable wall. For concrete interlocking tiles, the projection should be 30-60mm beyond the gable wall



Where proprietary verge tiles or systems are specified the detailing should be in accordance with the manufacturer's recommendations that are relevant to UK conditions of use.

Mortar must not be the sole means of fixing and should only be used for decorative purposes. Suitable mechanical fixings are required. Mortar should be to the recommendations in BS 5534 and typically consist of a cement and sand mix based on sharp sand, with soft sand added to achieve workability. The proportion of sharp sand should not be less than a third of the total sand content to ensure the durability of the feature. The mortar should be 1:3 cement: sand with plasticiser.

Typical dry ridge detail



Ridge (in accordance with BS 5534, BS 8612: Dry-fixed ridge, hip and verge systems for slating and tiling and BS 8000-6)

Proprietary dry roofing products and systems should be used as an alternative to just mortar bedding at verges, ridges, hips and valleys to provide weathering and mechanical resistance properties. Dry roofing products as fitted should not adversely affect the performance of the roof as laid.

Dry ridge systems should be manufactured and tested to meet BS 8612. The dry ridge system should be specified in accordance with BS8612 and be suitable for the location and the wind loading (see 'Note 1' below).

Specifiers should seek evidence that this will not be the case, and should use dry roofing products only if such evidence is available.

Note 1: Users should pay particular attention to the resistance to wind load and durability performance of dry roofing products.

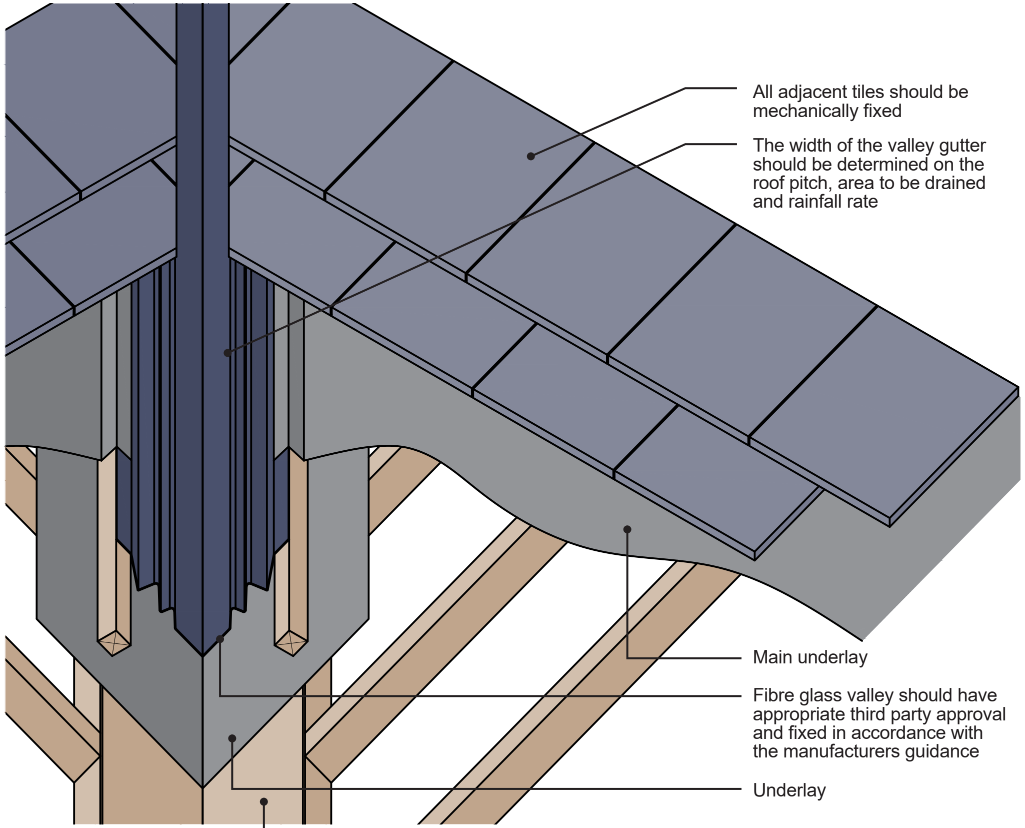
The ridge or top course batten should be set to allow the ridge tiles, ridge units or metal ridge to overlap the top course of tiles by the overlap necessary for the main tiles. For interlocking tiles, this should be not less than 75mm. For double-lap products, the top batten should be set to allow the ridge to overlap the penultimate course by the required head-lap.

For ridge tiles:

- Check ridge tile is suitable for pitch of roof.
- Edge bed components onto tiles.
- Ensure top course tiles or slates are mechanically fixed.
- Mitre tiles neatly at hip ridge junctions, and use a lead saddle underneath for protection.
- Use the correct mortar mix.
- Use dentil slips in deep profiled tiles in all joints more than 25mm thick to reduce mortar and risk of shrinkage.
- **All** mortar bedded ridge tiles must also be mechanically fixed by proprietary fixings in accordance with the roof covering manufacturer's recommendations.

Note: Dry fix ridge systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 recommendations.

GRP dry valley detail



Valley (in accordance with BS 5534 and BS 8000-6)

The design of pitched valley gutters is just one roof detail where the latest guidance is much improved over previous Codes of Practice. The valley is the most vulnerable area of a pitched roof in respect to potential water ingress, as it drains all of the water from adjacent roof slopes.

Consequently, the design data is related to the pitch of the roof, the rainfall rate, the length of the valley and the catchment area or area of the roof to be drained. Designers are able to determine the width of the valley trough so that it is appropriate for discharging the rain water from the adjacent roof covering to the eaves gutter.

For valley gutters:

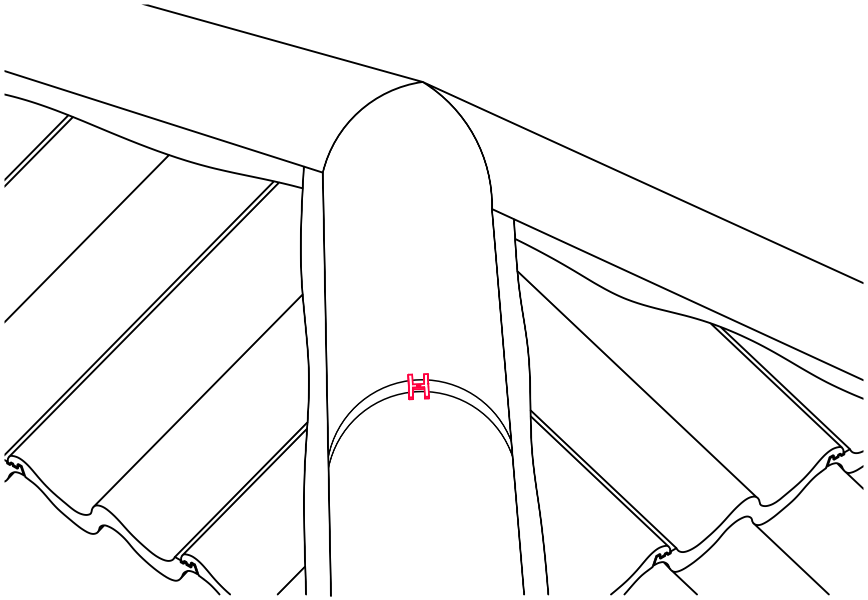
- Check roof pitch, area to be drained and rainfall rate to determine width of valley gutter.
- Consider length of valley when choosing proprietary valley troughs (over 8m).
- Ensure roof structure provides adequate support for valley lining; make flush with top of rafter.
- Do not place bitumen underlay beneath a lead sheet valley.
- Keep open gutter width 100mm-250mm (correct width to be determined by reference to Table 11 and 12 in BS 5534).
- Keep roof design as simple as possible.
- Avoid discharge of valleys onto roofing wherever possible, but where inevitable use a lead saddle.
- Avoid direct contact with lead when using mortar; provide a fibre cement undercloak or tile slips.
- Do not block tile laps with mortar to avoid water damming.
- Where fibre glass valleys are used only products supported by a third party product approval will be acceptable and the installation and support of the fibre glass valley unit must follow the manufacturer's guidance.
- Mechanically fix all tiles adjacent to valleys.

Hip (in accordance with BS 5534, BS 8512 and BS 8000-6)

For hip roof construction:

- Check hip tile is suitable for pitch of roof.
- Mitre tiles neatly at hip ridge junctions and use a lead saddle underneath for protection.
- Use the correct hip iron at base of hip.
- Use the correct mortar mix.
- For concrete interlocking tiles, use dentil slips in deep profiled tiles in all joints more than 25mm thick to reduce mortar and risk of shrinkage.
- All mortar bedded hip tiles must also be mechanically fixed (screws, nails, clips, etc.).

Note: Dry fix ridge systems are available to provide full mechanical fixing of all ridge and hip tiles to meet BS 5534 and BS 8512 recommendations.



Materials for flashings and weatherings

Lead is generally ideal for roofing purposes; it is easily dressed over complicated shapes using simple hand tools, and can be joined by soldering or lead burning. For most roofing purposes, Codes 3, 4 and 5 will be adequate, but for extreme conditions of exposure, thicker codes may be necessary.

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability to meet the Warranty requirements, be in accordance with BS EN 12588 or hold a valid UKAS (or European equivalent) third-party accreditation (e.g. British Board of Agrément, BRE, etc.) that demonstrates adequacy and durability for use.

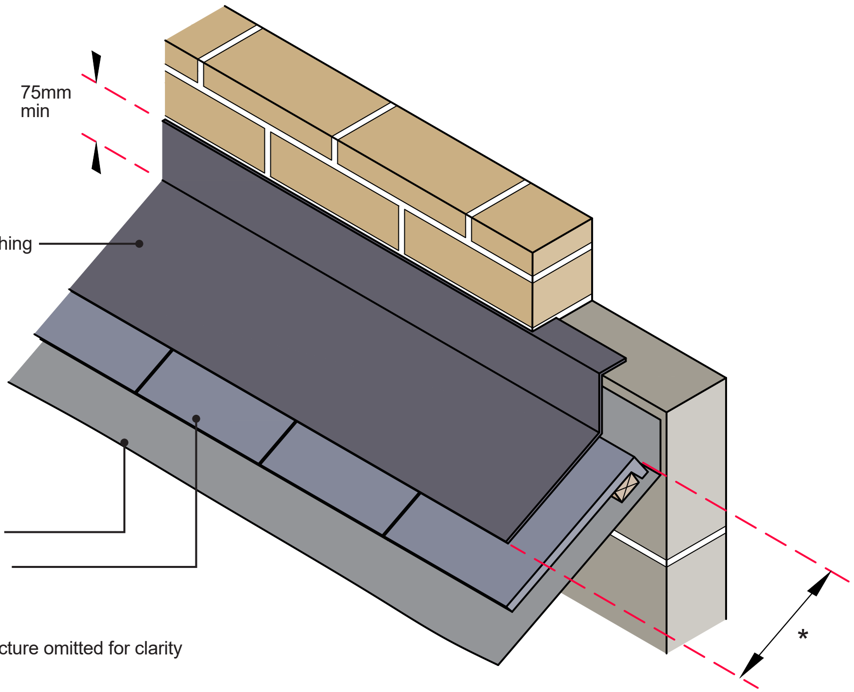
Lead flashing, patination and compatibility with other metals

A coat of patination oil should be applied to lead flashings after fixing. Lead can be used in contact with other metals, such as copper and stainless steel, without risk of bimetallic corrosion, but should not be used with aluminium in a marine or coastal environment.

Top edge abutment

- Turn roofing underlay a minimum of 50mm up at the abutment.
- Fix the top tiling batten as close as possible to the abutment.
- Complete tiling in the usual way.
- Chase abutment and insert lengths of code 4 lead, no more than 1.5m long; wedge in with small pieces of lead or stainless steel lead flashing clips, no less than 450mm apart.
- Lead should be wide enough to give at least 150mm cover to top course of tiles, below 30°. Increase cover to 290mm at 15° rafter pitch.
- Vertical upstand should be 75mm-100mm.
- Lap each length of lead by no less than 100mm.
- Dress lead to the profile of the tiles.
- Secure lead flashings with copper or stainless steel clips, with frequency dependent on exposure.

*The lap should be measured from the lowest fixing of underlying material and be no less than 150mm or the 'Minimum lap of the flashing with the roof covering' table, whichever is the greater.



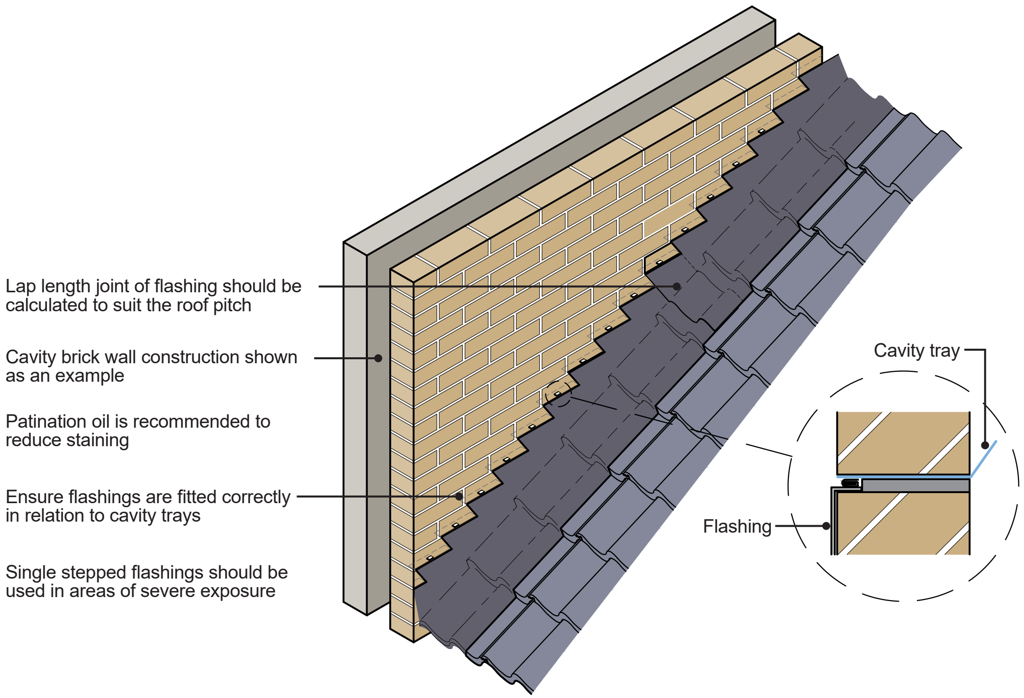
Minimum lap of the flashing with the roof covering

Pitch of roof	Cover of lead flashing on roof (mm)
30º	150mm
20º	220mm
15º	290mm

Note:
1. For pitches over 30°, a minimum lap of 150mm should be provided
2. In areas of severe/very severe exposure the vertical upstand should increase to 100mm

Side abutment (stepped cover flashing) with concrete interlocking tiles

- Turn roofing underlay a minimum of 50mm up at the abutment.
- Finish the tiling battens as close to the abutment as possible.
- Lay the tiles to butt as close as possible to the wall.
- Cut a piece of Code 4 lead to form a combined step and cover flashing.
- Flashing should not exceed 1.5m in length, and should be 150mm-200mm in width or wide enough to cover the first roll, whichever gives the greater cover.
- Chase out brickwork mortar joints and push folds of flashing into chases; wedge in with small pieces of lead.
- Dress cover flashing as tightly as possible to tile profile.
- Re-point brickwork.
- In areas of high exposure, or when dressing lead over flat tiles, use clips to hold cover flashing in place. When using this type of flashing with flat tiles below 25°, increase cover of flashing over tile to 200mm.
- All free edges of flashings should be clipped to suit the exposure. Lead clips are only for use in very sheltered locations whereas all other clips should be of copper or stainless steel.



Side abutment (soakers and step flashings) with plain tiles

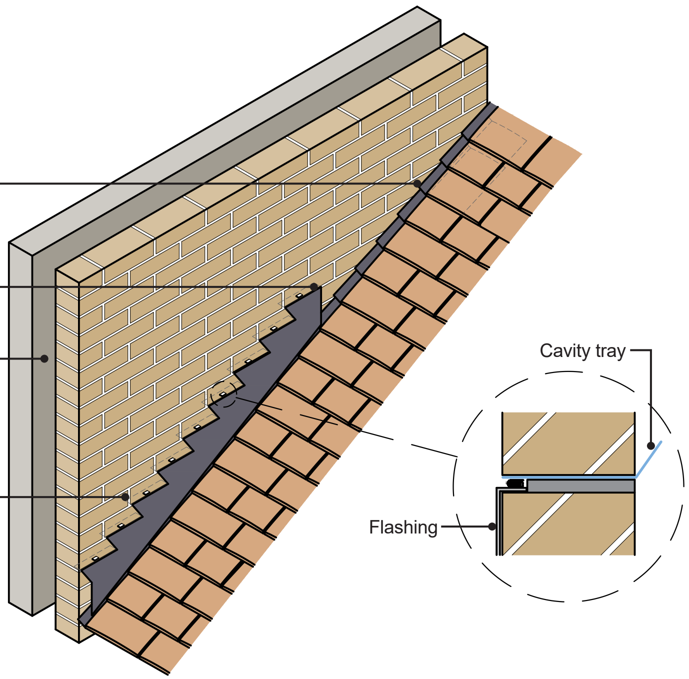
Soakers are used where double-lap plain tiles abut a wall.

- Turn underlay 50mm up the abutment and cut tiling battens 10mm-25mm short of the wall and fix securely.
- Lay tiles close to the abutment with a soaker fitted between each tile.
- Form Code 3 lead soakers with an upstand of 75mm to place against the abutment. They should be 175mm wide and 190mm long, allowing a 25mm downturn over the back of the tile. After all tiles and soakers have been fixed, insert a stepped flashing into the abutment wall and dress down over the upturned edges of the soakers.

Side abutment (step and cover flashing with soakers) with fibre cement/natural slates

- Continue the underlay across the roof and turn up the wall by a minimum of 50mm. Cut the battens 10mm-25mm short of the wall, and fix securely.
- Finish the slating with alternate courses of slates and slate-and-a-half slates, cut as necessary to maintain the bond.
- Code 3 lead soakers, with a minimum width of 175mm and length equal to gauge + lap +20mm, are to be interleaved with the slates and turned 75mm up the wall.
- The Code 4 stepped lead flashing should be secured in the brickwork bed joints with lead wedges and dressed neatly over the soakers.

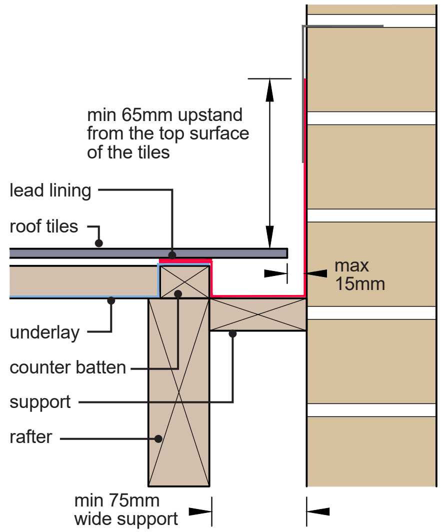
Side abutment detail with plain tiles or fibre cement/natural slates



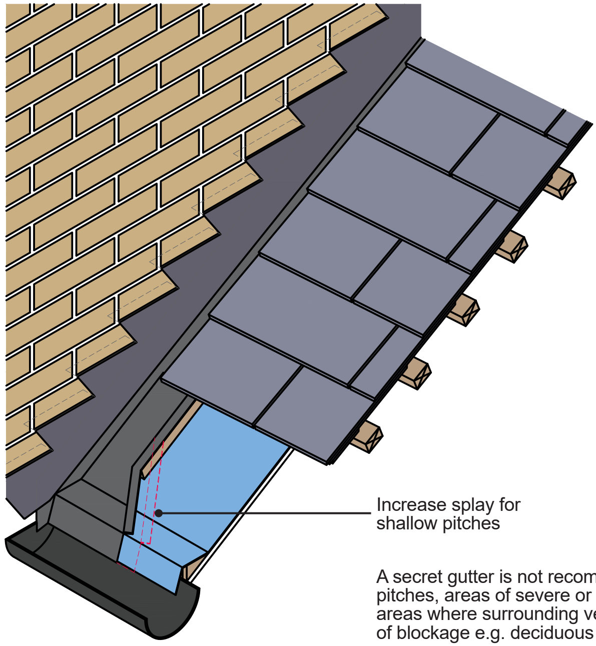
Side abutment secret gutter arrangement

A secret gutter may be formed as an alternative to a step and cover flashing when using single-lap flat interlocking tiles. Profiled tiles are not suitable for use in conjunction with a secret gutter.

- Form secret gutters before starting tiling.
- Fix a support between the last rafter and the abutment; this should be a minimum of 75mm wide and run the full length of the abutment.
- Fix a splayed timber fillet at the discharge point to raise lead lining to the right height; avoid backward falls.
- Fix a counter batten along the outer edge of rafter.
- Line gutter with Code 4 or 5 lead, in lengths of no more than 1.5m.
- Lap each strip offered over the lower one by a minimum of 150mm, and fix with copper nails at head.
- Turn up lead welts to provide a weather check and exclude birds and vermin from entering tile batten space.
- Gutter should be a minimum of 25mm deep and have a vertical upstand of no less than 65mm above the top surface of the tiles.
- Fit a stepped flashing, chased into brickwork and dressed over vertical upstand.
- Turn the roofing underlay up the side of the counter battens and butt the tiling battens up to the counter batten.
- Lay tiles to leave a gap of 15mm by the side of the abutment.
- All free edges of flashings should be clipped to suit the exposure. Lead clips are only for use in very sheltered locations whereas all other clips should be of copper or stainless steel.

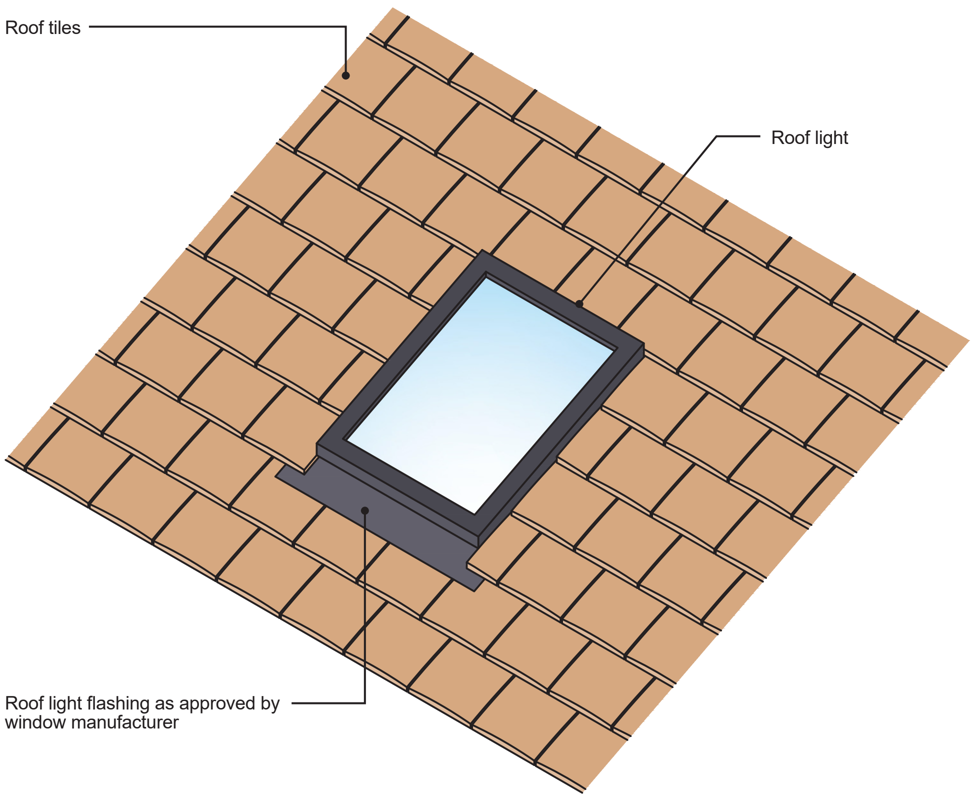


Secret gutter construction for concrete interlocking tiles and slates



A secret gutter is not recommended for shallow pitches, areas of severe or very severe exposure, or areas where surrounding vegetation may cause risk of blockage e.g. deciduous trees

Flashings to roof lights



Roof lights

Most roof lights are of the 'factory manufactured' variety which should have appropriate third party approval. Most of these come with 'flashing kits' which should be installed in accordance with the manufacturer's instructions. If a flashing kit is not provided, the flashing should be installed following the Lead Sheet Association good practice guide.

Box/Back gutters

Back gutters may be lead welded off-site and positioned when tiling is undertaken. A gutter should be formed where the bottom edge of tiling meets an abutment. Form the gutter before tiling, but after felting and battening is complete.

- Fix a lay board to support lead lining, with a tilting fillet, close to the abutment to flatten the pitch of the lead.
- Dress a sheet of Code 5 lead (width of abutment plus 450mm) into position with a vertical upstand of at least 100mm up the abutment.
- Dress the extra width of lead around the corner of the abutment after any side abutment weathering has been fitted.
- Dress the upper edge of lead over the tilting fillet and turn it back to form a welt.
- Chase abutment, insert a cover flashing of Code 4 lead and dress it over the vertical upstand of the gutter.

Roof protrusions

The flashings against chimney stacks, skylights and other similar projections through the roof surface should be similar to that described for abutments where appropriate.

- Make perforations for pipes, chimney stays, supports for ladders etc. weather tight by dressing over and under tiling with a lead or copper slate to which a sleeve is burned or soldered.
- Boss sleeve around pipe or stay, and seal at top with a collar.

Saddles

The following details can apply to any type of valley or hip /ridge intersection:

- Use Code 4 lead no less than 450mm square and large enough to give a lap of at least 150mm over the gutter lining on each side.
- Saddles should be capable of being readily dressed down when in position.

Clips

Clips for flashings are important in all roofing applications and where used should be fixed at 300mm-500mm centres, depending on the exposure of the building.

Clips may be formed from the following materials:

- Lead: Only suitable for sheltered locations with a thickness the same as that of the flashing it is fixing.
- Copper: Should be a minimum of 0.6mm thick, and may be thicker for very exposed locations.
- Stainless steel: Should be 22swg or 28swg thick, and is used for very exposed locations or where the fixing point is more than 75mm from the free edge of the flashing.
- Nails and screws: Copper wire nails (with jagged shanks) should be a minimum 25mm long x 10 gauge. Stainless steel annular ring shank wire nails should be a minimum 25mm long x 12 gauge. Screws should be brass or stainless steel, minimum 25mm long x 10 gauge.

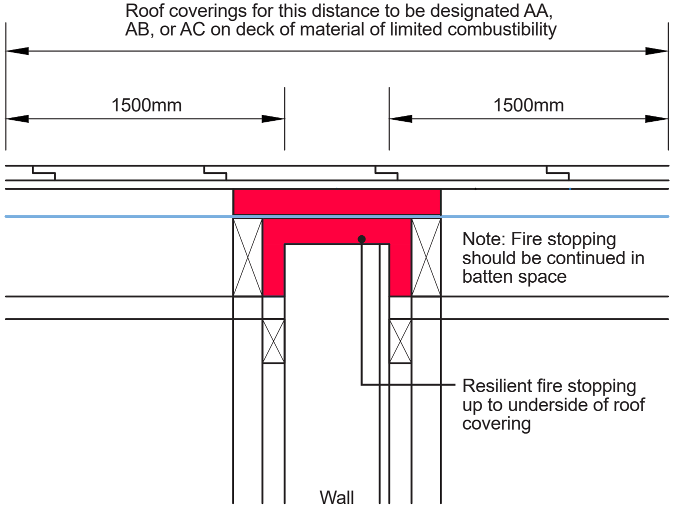
Compartmentation

The spread of fire within a building can be restricted by sub-dividing it into compartments separated from one another by walls and/or floors of fire-resisting construction. The roof void, like most spaces within a building, can provide a route for the spread of fire and smoke. As an often-concealed space, it is particularly vital that fire-resistant cavity barriers are provided at the following points:

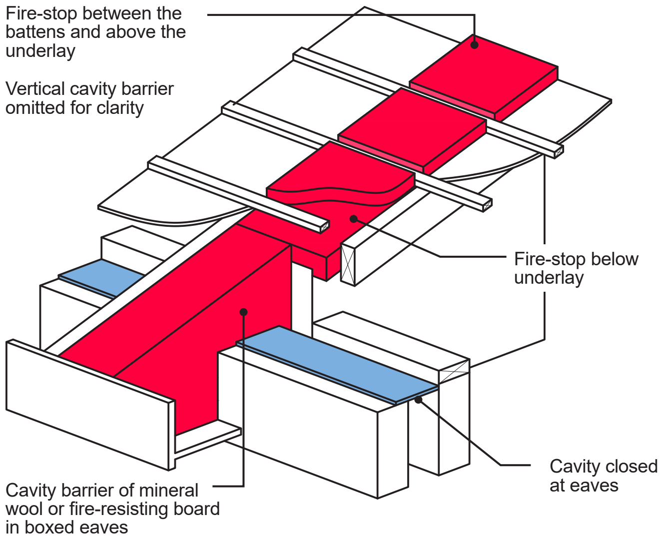
- At junctions of separating wall and external cavity wall.
- At junctions of compartment wall and compartment floor (not illustrated).
- At junctions of separating wall with roof, under roof tiles.
- Within boxed eaves at separating wall position.

Junctions of compartment walls with roof
A compartment wall should be taken up to meet the underside of the roof covering or deck, with fire stopping, where necessary, at the wall/roof junction to maintain the continuity of fire resistance. The compartment wall should also be continued across any eaves cavity. If a fire penetrates a roof near a compartment wall, there is a risk that it will spread over the roof to the adjoining compartment. To reduce this risk, a roof zone 1500mm wide on either side of the wall should have a covering of designation BROOF (t4) to BS EN 13501-5 classification.

Note: AA, AB or AC to BS 476-3 classification on a substrate or deck of a material of limited combustibility can still be used as an alternative in Wales, Scotland and for some products on older projects in England.

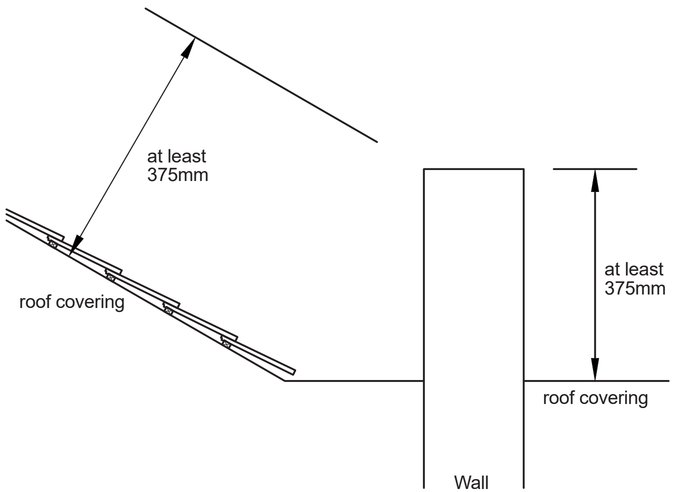


Fire stopping at roof level between party walls



Fire stopping should be provided in accordance with the relevant Building Regulations

- Party/separating walls 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed.



Further additional requirements for internal fire stopping and fire protection for compartment floors, walls, and roof junctions to flats and apartments with a floor 4.5m or more above the ground

The following additional guidance applies to internal fire stopping and fire protection only to buildings with a floor 4.5m or more above the ground that contain flats or apartments.

Although building legislation is robust in applying provisions for fire protection and fire stopping, it can often be difficult to implement high standards of fire stopping in complex buildings. This can lead to significant safety risks if the building does not have the correct levels of fire protection and if holes in compartment walls are not sealed correctly. This guidance assists Developers in providing good standards of fire stopping and fire protection.

It is not the intention to enhance the requirements of the Building Regulations in this section, but more to ensure that the statutory requirements are applied correctly to the construction. It is therefore deemed that the requirements of Part B of the Building Regulations in England and Wales, or Section 2 of the Scottish Building Standards (whichever is appropriate depending on region), that apply to fire stopping, separating walls, service penetrations, minimum periods of fire resistance and concealed spaces will also meet the requirements of this guidance.

Fire stopping

Design information
Drawings showing the lines of compartmentation and the lines of fire-resisting construction should be provided to the Surveyor and the Builder. The drawings should also give the required level of fire resistance for each element. Drawings to show the position of cavity barriers should be provided, and the specification of cavity barriers included.

Materials for fire stopping and cavity barriers
All materials used to form a fire barrier must have relevant third-party certification or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products. A competent person is deemed to be a third-party approved contractor specialising in fire stopping and passive fire protection.

Fire protection in buildings

Design information
The design details must show the correct level of fire resistance for the building, in accordance with the Part B of the Building Regulations or Section 2 of the Scottish Building Standards, depending on region.

Materials for fire protection
All materials used to form a fire barrier must have relevant third-party certification, or be CE marked in accordance with the Construction Products Regulations. The materials must be installed in accordance with the manufacturer's instructions and recommendations.

Installation
The fire stopping material or cavity barriers should be installed by a person who is deemed competent to install such products.

Where intumescent paints are used to provide the required level of fire protection, certification confirming that the paint applied will achieve the correct level of fire protection is required.

11.
Roofs

11.4
Flat Roofs

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
   a) Roof plan showing direction of falls and position of outlets and overflows.
   b) Sections showing roof build up and how falls are to be created. Sectional details should show all components to be used in flat roof build up (insulation type and thickness, vapour control layer, waterproofing membrane/layers etc.).
   c) Site specific detailing for all junctions, outlets and penetrations.
2. Details of all components to be used in the construction of the flat roof should be provided.
3. Engineers drawings and calculations for the roof structure.
4. Third party accreditation for the waterproofing membrane/layer.
5. Details of all fixings, their frequency and fixing method, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
6. Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
7. Outline of method and plan for testing the integrity of the waterproofing layer.
8. A flat roof membrane manufacturer's approved installer must be used for all flat roof coverings. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty Surveyor.
9. A roof deflection analysis should be provided for medium to large roofs, those with complex roof layouts and for any roof areas that carry items of plant or are subject to access provisions beyond periodic maintenance of the roof area.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Definitions

For the purposes of this Technical Guidance, the following definitions shall apply:

Condensation: process whereby water is deposited from air containing water vapour when its temperature drops to or below dew point.

Filter layer: construction material (usually a geotextile) that substantially reduces the transfer of mineral and organic material to the insulation in an inverted warm deck roof.

Flat roof: a roof having a pitch no greater than 10º to the horizontal.

Insulation cricket: wedge of shallow-fall insulation material, designed to divert the flow of rainwater on a roof.

Interstitial condensation: condensation occurring within or between the layers of the building envelope.

Protection layer: construction material (usually a geotextile all rigid board) that isolates another construction material from mechanical damage.

Separation layer: construction material (usually a geotextile) that separates two construction materials that are not chemically compatible.

Structural deck: continuous layer of the construction (comprising concrete, profiled metal or timber panel) supported by the building structure and which supports the roof system.

Thermal bridge: part of a roof of lower thermal resistance than its surrounding elements, which may result in localised cold surfaces on which condensation, mould growth or staining may occur.

Air vapour control layer (AVCL): construction material (usually a membrane) that substantially reduces the movement of water vapour through the roof system.

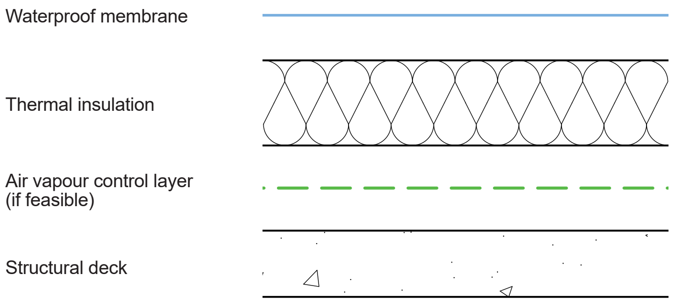
Water flow reducing layer (WFRL): construction material (usually a sheet membrane) that substantially reduces the transfer of rain water to the insulation in an inverted warm deck roof.

Warm deck roof

The principal thermal insulation is placed immediately below the roof covering, resulting in the structural deck and support being at a temperature close to that of the interior of the building.

The design should ensure that:

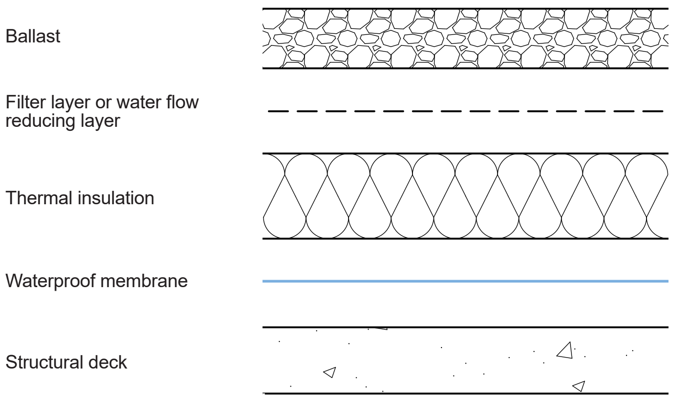
- The waterproof membrane has sufficient resistance to temperature to suit the conditions created by a substrate of insulation.
- The insulation has sufficient mechanical characteristics to resist loading.
- The AVCL is provided by the deck or by a membrane placed above the deck.
- The structural deck is maintained at a temperature above that which could cause condensation to occur at this level during service.



Inverted warm deck roof

A variant of the warm deck roof in which the principal thermal insulation is placed above the waterproof membrane, resulting in the waterproof membrane, structural deck and structural support being at a temperature close to that of the interior of the building. Generally, the principal insulation is secured by separate ballast (paving, gravel, or blue/green roof - minimum 80 kg/m^2).

A filter membrane or WFRL should be provided to control mineral and organic material passing into and below the insulation joints. A WFRL is recommended because it will provide improved rain water run-off, which may allow for a reduced thickness of insulation and reduced loading of ballast. Where a WFRL is included, it is essential that the drainage design facilitates the rapid transfer of rain water across the product and to rain water outlets.



Hybrid roof

Many roofs combine the features of two or more of the roof types previously described. Examples include structural decks of high thermal resistance combined with additional insulation, and existing roofs to which thermal insulation is added. Once assessed in terms of their thermal and water vapour transmission characteristics, such roofs will generally fall into one of the categories described.

In some constructions the waterproof membrane is placed between two layers of insulation, combining the properties of warm roof and inverted warm roof construction. This form of construction is generally known as a 'duo roof '.

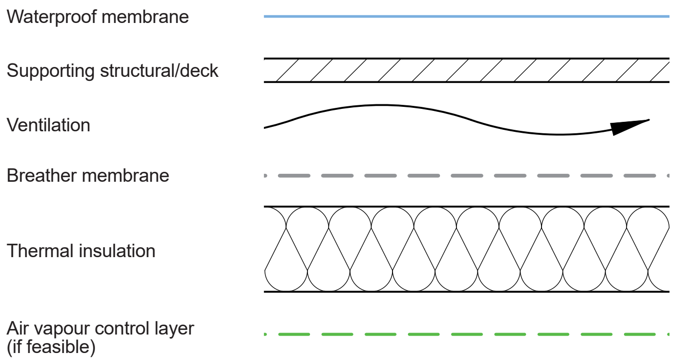
There is an increased risk of interstitial condensation with a hybrid roofs and therefore where these types of roof systems are used a full condensation risk analysis should be carried out.

Cold deck roof

For Warranty purposes, cold deck roofs are not recommended and an alternative form of flat roof should be adopted.

Where allowed under the Functional Requirements (roof areas less than 3m^2), the following approach to cold deck roofs should be adopted.

The principal thermal insulation is placed at or immediately above the ceiling i.e. below the structural deck, resulting in the waterproof membrane and structural deck being substantially colder in winter than the interior of the building. The structural support will typically form a thermal bridge between the high and low temperature zones of the construction. It is very difficult to insulate a cold roof system to current mandatory levels without introducing thermal bridges and/or increasing the risk of interstitial condensation in the system. In addition, the mandatory requirement for uninterrupted external air circulation limits the application of the system where abutting elevations or changes in building geometry occur. Mushroom intermittent vents have proved not to be effective. Therefore, it is not recommended.



Cold roof section 'under ventilation' (to/from external air. Minimum height of void 50mm)

Refurbishments involving cold deck constructions

If an existing cold deck roof is refurbished, it is important to ensure that the ventilation requirement is achieved, whether or not the level of insulation is to be increased. It is also not feasible to introduce vapour control and insulation below an existing structural deck of concrete, e.g. if during refurbishment, a cold deck roof is converted to a warm deck roof by placing insulation above the deck and closing off the ventilation. It is necessary to provide at least as much thermal resistance above the deck as was previously provided below the deck. A condensation risk calculation should always be carried out in such circumstances to ensure that the deck is above dew point during service.

Limitations of this guidance

The guidance on timber structures is limited to buildings of not more than three storeys above ground.

Loading

Roof structure and loading
The design of the roof structure must be in accordance with current relevant Building Regulations.

The roof of the building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground safely, and without causing such deflection or deformation of any part of the building, or such movement of the ground, as to impair the stability of any part of another building.

The roof structure should be of such construction that it has adequate interconnection with the walls, allowing it to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building.

If joists are spanning intermediate beams it is important that the joists are fixed to these beams and it is important that this is carried out in accordance with the Engineers specification.

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and any penetration through waterproof roof coverings are sealed correctly in accordance with the waterproof covering manufacturer's recommendations. Such fixings should not be made through to a wood substrate but to the masonry structure e.g. timber plates or packing pieces must not be used under the waterproof membrane to secure the balustrade too.

For advice on 'sizing of certain timber members in floors and roofs for dwellings', the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by BM TRADA.
  Note: Reference should be made to the version of the BM TRADA document current at the time of construction of the roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995-1: Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

It is important that the deck have adequate provision to resist wind uplift, and that the deck is adequately anchored to the main structure.

Resistance to wind load
In all situations, including ballasted, green and inverted roofs, a calculation of wind load at each zone of the roof to BS EN 1991-1-4 should be undertaken by a suitably competent person.

Allowances for wind loading
The need for a roof to withstand wind pressure and suction will be met if the proposed roof is braced effectively and secured to the structure, as detailed below, with walls adequately restrained.

The securing of roofs to the supporting structure normally involves a timber wall plate or similar, which should be levelled using a spirit level so that loadings from the roof are directed perpendicularly down the supporting wall.

The roof structure should be fixed in accordance with the design to resist the site specific wind loads.

As a minimum, when roof timbers are being installed, the wall plate should be fixed to ensure correct positioning by means of galvanised mild steel holding down straps (30mm x 5mm x 1000mm long at maximum 2m centres) nailed to the wall plate and securely fixed to the inner surface of the wall with compatible fixings.

Resistance to imposed loads
At the earliest possible stage, the employer should define the range of potential functions of the roof with regards loading with equipment, e.g. air handling, renewable energy capture and the intensity and frequency of foot traffic. This should inform the selection of the deck, insulation, safety guarding and protection.

Structural timber

All structural timber used should be stress graded. All such timber must be stamped as either 'DRY' or 'KD' (Kiln Dry). The use of ungraded or 'green' timber is not acceptable.

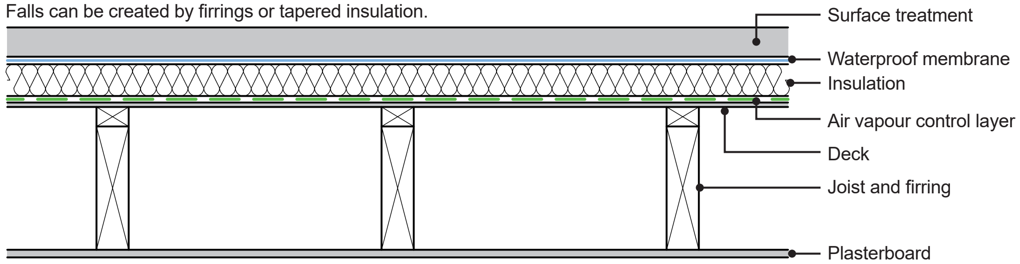
Treatment of timber

Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice further information can be found in 'Appendix C - Materials, Products, and Building Systems'.

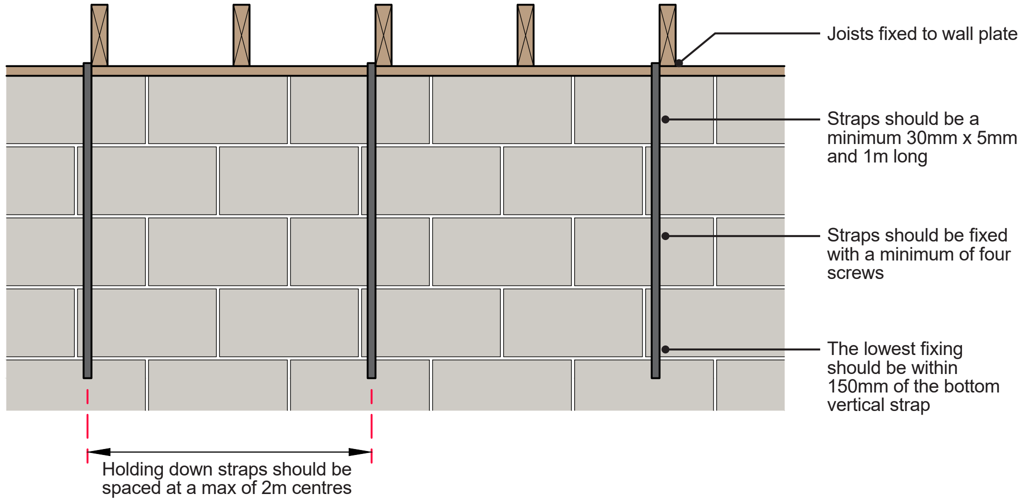
Insulation of warm decks

The insulation should be suitably specified taking into account the roof type, having regard to its load-bearing capacity and, where relevant, its water absorption characteristics. Compressible materials cannot support imposed loads and their use in flat roofs is limited to cold flat roofs - which are not recommended for Warranty projects. Warm roofs require the use of rigid insulation, and should be suitably specified to support the any anticipated loads from trafficking across the roof. Insulation in an inverted roof should also have high resistance to water absorption, freeze/thaw cycling and be shielded from UV light.

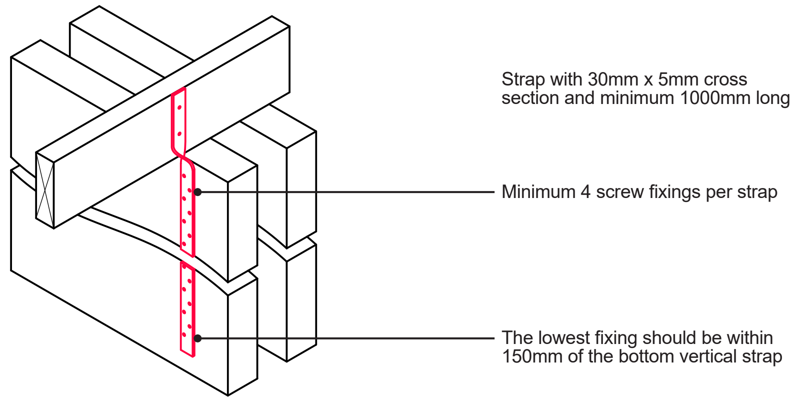
Typical warm deck construction



Holding down straps



Alternative strap detail



FLAT ROOFS: Timber decks, firrings, joist hanger bearing and allowance for expansion at abutments

Structural deck

At the earliest practical stage, the likely deflection of the deck should be confirmed, to ensure a minimum 1:80 as built fall is maintained. If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

Timber deck materials

Roofing grade OSB should be manufactured to BS EN 300 grade OSB/3 and be certificated by the British Board of Agrément. The minimum recommended thickness is 18mm.

Plywood should be minimum 18mm thickness and certificated to conform to BS EN 1995-1-1 Eurocode 5. Design of timber structures, and to BS EN 636 Plywood, specifications minimum service class 2 - humid conditions, or, where required, service class 3 - exterior conditions.

Pre-treated timber planking, tongue and groove (close boarded timber) should have a minimum thickness of 19mm. Suitable floor boards and decking include:

- Pre-treated tongue and grooved softwood boarding should have a minimum moisture content at the time of fixing of between 16%-20% and in accordance with BS 8103.
- For boards of no more than 175 mm basic width, two nails should be used at each intersection.
- For wider boards, a minimum of three nails should be used at each intersection.

Fixing of timber decks

Fixing nails should be at centres not exceeding 150 mm along any end or edge, and not exceeding 300 mm along any intermediate support.

Plywood
Fixing Plywood should be laid with the face grain perpendicular to the supports.

All end joints should occur over joists of at least 38 mm basic thickness or be supported by noggings. Fixing nails should be either:

- Plain wire nails at least 3.35 mm in diameter and at least 65 mm long, which penetrate at least 40 mm into the support; or,
- Annular-ringed shank nails at least 3.35 mm in diameter and at least 50 mm long, which penetrate at least 32 mm into the support.

OSB
All boards should be fastened firmly to the supporting timber. Flat headed annular-ringed shank nails and screws have superior holding power and should be used in preference to plain shank nails.

All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater; and the diameter of the fixing should be a minimum of 0.16 times the thickness of the board.

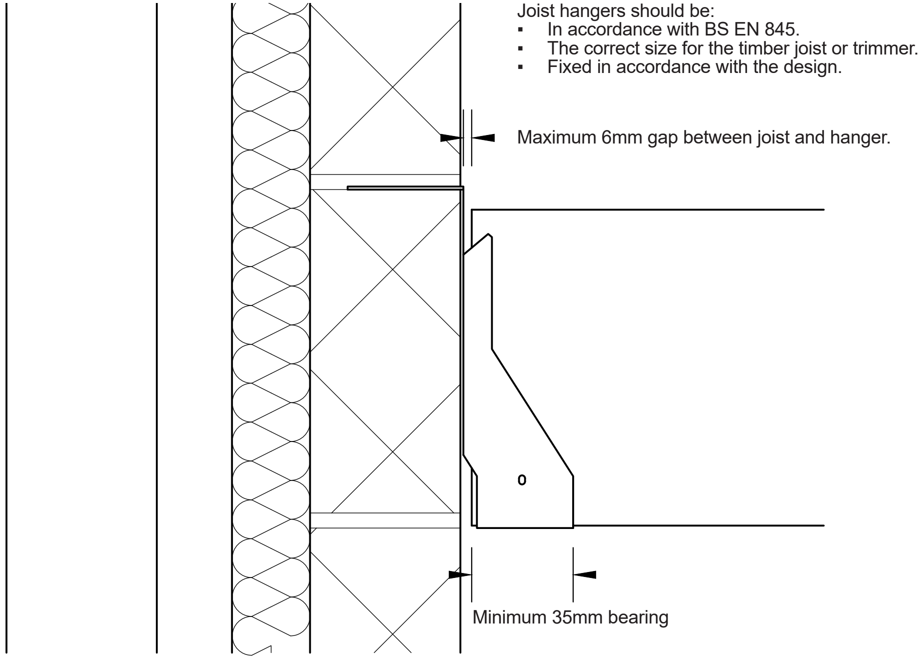
Fastenings should be at least 8 mm from the edge of the board. Nail heads should be punched 2 mm to 3 mm below the surface of the board and screws should be pre-drilled and countersunk. In service class 2 fixings should be corrosion resistant. Corrosion resistant materials include galvanized or sherardized steel, austenitic stainless steel, phosphor bronze and silicon bronze.

Timber firrings

The firrings should be fixed prevent wind uplift. Firrings should be fixed in accordance with the following:

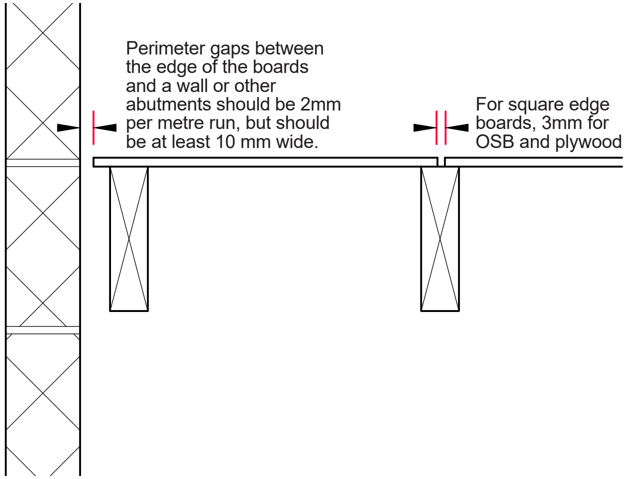
- Where the firrings run at 90° to the flat roof joists, the firrings (min. 50mm deep) are deeper in section as they must span between the joists, therefore due to their size they may be too deep to ensure a nail has adequate purchase. Therefore all firring pieces should be held in place by proprietary frame anchors, secured to the joists/firring pieces, positioned at each intersection of a firring with a joist with each frame anchor being fully nailed up.
- Where firrings sit directly on top of the joists, these should be secured at 300mm centres, by 3.1mm x 90mm ring shank nails, with a minimum purchase of 40mm. Where firrings become too deep and the minimum purchase cannot be achieved, skew nailing should be adopted using two 3.1mm x 90mm ring shank nails at 300mm centres.

Joist hanger bearing

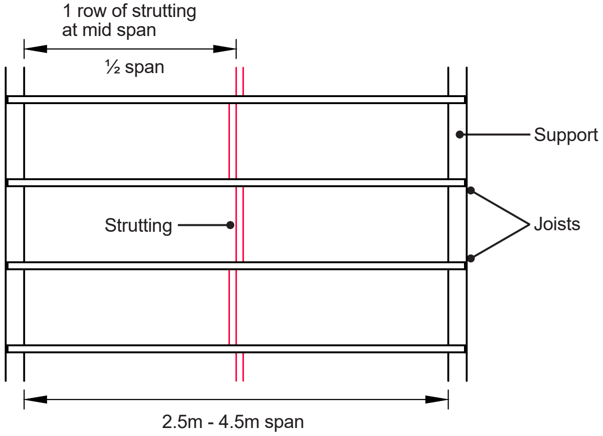


Allowance for expansion at abutments

- OSB should be installed at the direction indicated on the boards with the strongest direction perpendicular to the joists.
- OSB and Plywood tongue and grooved boards should be installed with the longest edge at right angles to the joists and short edges supported on a joist or nogging.
- A maximum movement gap of 3mm should be provided for square edge boards.
- Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10 mm wide.
- Boards should be supported by noggins at the perimeter where they run at right angles to roof joists.

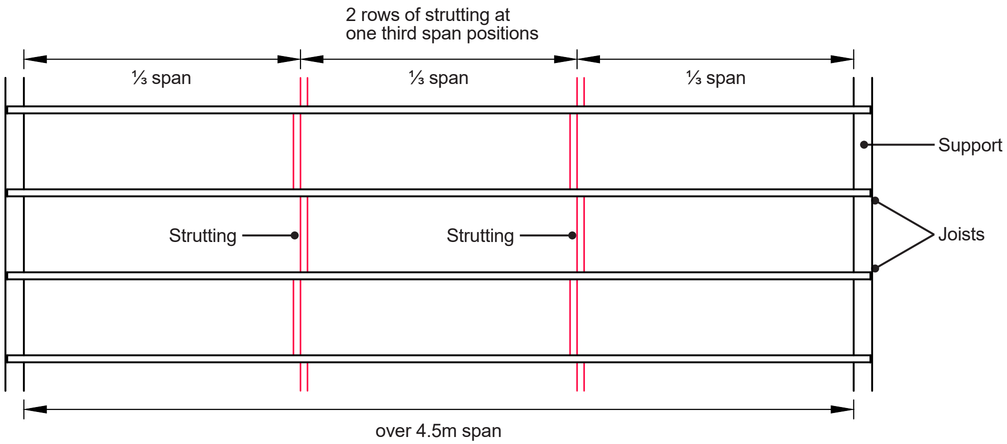


Strutting of joists with a span between 2.5m and 4.5m



Where the span of a roof joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3: 2009 or by a proprietary system.

Strutting of joists with a span over 4.5m



Where the span of a floor joist or flat roof joist is more than 4.5m, two rows of strutting at ⅓ the span position will be necessary.

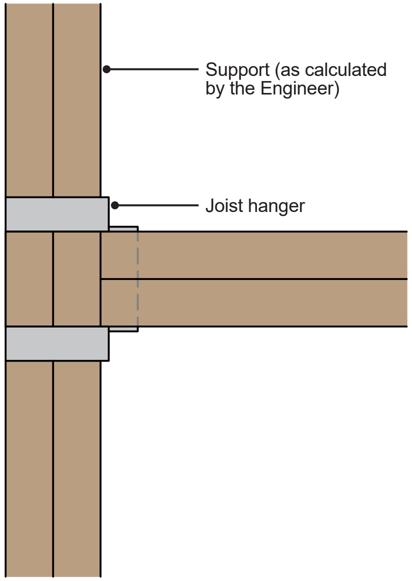
Strutting or bridging of solid timber roof joists

Where the span of a flat roof joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance with Figure 3 of BS 8103-3 or by a proprietary system.

Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists; or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

Strutting should not prevent cross ventilation in cold deck roofs.

Typical trimming detail (plan)



Double joists should be bolted together at 600mm centres using minimum 10mm diameter bolts with large washers that will prevent the bolt head and nut from penetrating the joist. It is recommended that the bolting of double joists is along the centre line of joists. Suitably sized trimmer joists shall be provided around floor openings.

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection; timber trimmers around openings should consist of at least two members and be designed by the Engineer.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

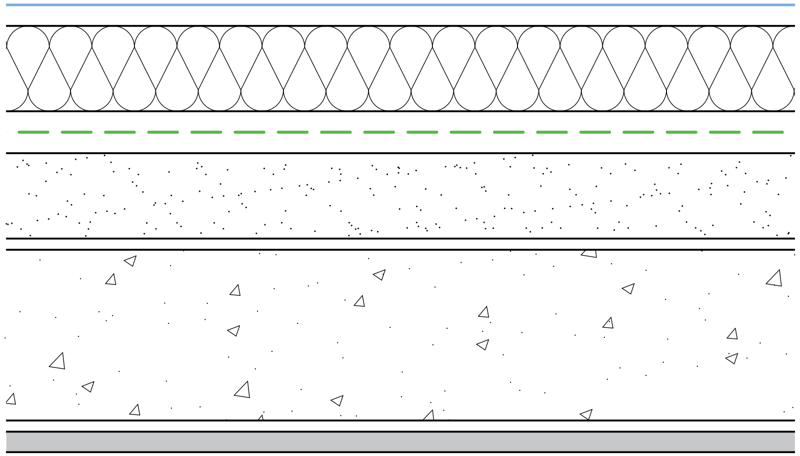
Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Typical deck construction (warm roof)

Permanent waterproofing should not be installed until the moisture content of the deck is as per the membrane manufacturer's recommendations. Preparation of the receiving substrates should also be as per the membrane manufacturer's guidance.



For in situ concrete decks it is important that:

- The form work is adequately and accurately constructed.
- The mix should be one that has relatively low shrinkage characteristics.
- The slab should be adequately protected until cured.

Pre cast concrete decks should:

- Have a minimum of 90mm bearing unless justified by the design.
- Be grouted in accordance with the design, and,
- Allowance for movement should be provided at abutments.

Loading

Statutory requirement
The design for loading should comply with the current Building Regulations.

Resistance to wind load
In all situations, including ballasted and inverted roofs, a calculation of wind load at each zone of the roof to BS EN 1991-1-4 should be undertaken by a suitably competent person.

It is important that the deck have adequate provisions to resist wind uplift by either being of sufficient self-weight or adequately anchored to the main structure.

Resistance to imposed loads
At the earliest possible stage, the designer should define the range of potential functions of the roof with regards loading with equipment e.g. air handling, renewable energy capture and the intensity and frequency of foot traffic. This should inform the selection of the deck, insulation, safety guarding and protection.

Structural deck

General
At the earliest practical stage, the likely deflection in the deck, and the tolerance in the level of its finish, should be confirmed, because this informs the design for drainage. If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

Concrete
Precast concrete construction should be designed in accordance with BS 8110. Information on span capability and the installation requirements of precast panels can be obtained from manufacturers. Information on the location of required movement joints should be obtained early in the design process as they have implications for drainage layout and detailing. Precast panels installed to a fall can provide a simple layout but without cross falls.

In-situ concrete construction should be designed in accordance with BS 8110.Concrete decks should be laid to falls wherever possible, concrete maybe more difficult to lay to a fall, and it is common to create falls in the insulation (warm roofs only) or by using an additional screed. Information on compressive strength, resistance to point load and drying periods of wet screeds can be obtained from suppliers and relevant trade associations.

Where structural movement joints are required in large concrete decks, a clearly defined movement joint detail should be constructed to a design and with the materials that afford durability equivalent to that of the roof system.

In precast panel decks the locations of any anticipated differential movement (e.g. at perimeter or abutment interfaces or between adjacent panels that are subject to differential loading) must be identified in order that stress is not transferred to the waterproof membrane.

Screeds

Screeds should be suitably specified for the anticipated loadings, further information can be found in 'Appendix C - Materials, Products, and Building Systems'. Moisture from the construction can become trapped in a roof if the waterproof layer is applied before a concrete slab or screed has had sufficient time to dry out. In situ concrete slabs and cementitious screeds contain large volumes of water which, if not allowed to dry out, can prevent adhesion of the waterproof layer. If bonding to the slab, it is advised that an adhesion test be carried out.

Insulation of warm decks

The insulation should be suitably specified taking into account the roof type, having regard to its load-bearing capacity and, where relevant, its water absorption characteristics. Warm roofs require the use of rigid insulation, and should be suitably specified to support the any anticipated loads from trafficking across the roof. Insulation in an inverted roof should also have high resistance to water absorption, freeze/thaw cycling and be shielded from UV light.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

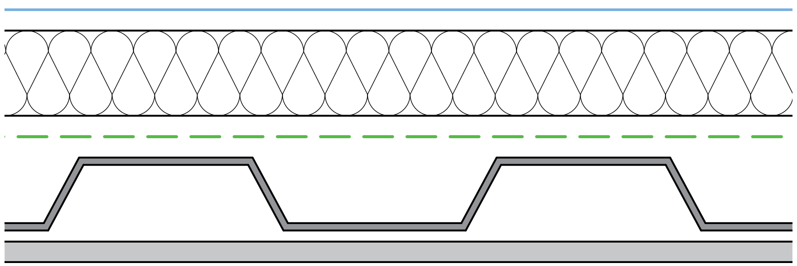
Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Typical deck construction (warm roof)

Note: Permanent waterproofing should not be installed until the deck has fully dried.



Loading

Statutory requirement
The design for loading should comply with the current Building Regulations.

Resistance to wind load
In all situations, including ballasted and inverted roofs, a calculation of wind load at each zone of the roof to BS EN 1991-1-4 should be undertaken by a suitably competent person.

Resistance to imposed loads
At the earliest possible stage, the designer should define the range of potential functions of the roof with regards loading with equipment e.g. air handling, renewable energy capture and the intensity and frequency of foot traffic. This should inform the selection of the deck, insulation, safety guarding and protection.

Insulation of warm decks

The insulation should be suitably specified taking into account the roof type, having regard to its load-bearing capacity and, where relevant, its water absorption characteristics. Warm roofs require the use of rigid insulation, and should be suitably specified to support the any anticipated loads from trafficking across the roof. Insulation in an inverted roof should also have high resistance to water absorption, freeze/thaw cycling and be shielded from UV light.

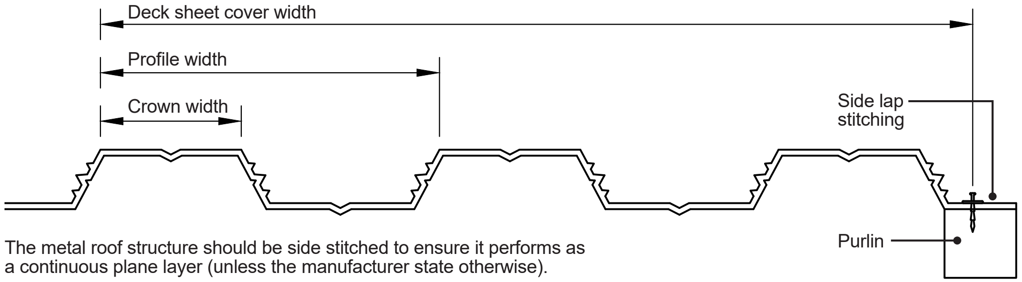
Structural deck

General
At the earliest practical stage, the likely deflection in the deck, and the tolerance in the level of its finish, should be confirmed, because this informs the design for drainage. If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

Profiled metal (steel or aluminium)

Profiled metal decks should have a crown width at least 50% of the profile width. To provide a sound base for the insulation and waterproofing system, and to avoid reduced drainage performance, the mid-span deflection of the metal deck should not exceed 1/200 of the span under uniformly distributed design loads. When considering the deck profile and the necessity for side lap stitching and metal deck closures, reference should be made to the manufacturers of the deck, insulation and waterproof membrane.

Profiled metal decks: critical dimensions



The metal roof structure should be side stitched to ensure it performs as a continuous plane layer (unless the manufacturer state otherwise).

Profiled metal decks should conform to the following standards:

- Galvanised steel: minimum recommended thickness 0.7mm to BS EN 10346 Fe E280G Z275. Typical gauge range 0.7mm-1.2mm.
- Plain aluminium: minimum recommended thickness 0.9mm to BS EN 485-2 AA3004 H34. Reference should also be made to BS EN 1396 as appropriate.

It is important that the deck have adequate provisions to resist wind uplift by being adequately anchored to the main structure.

Thermal performance

Design for thermal performance must comply with current relevant Building Regulations, as appropriate.

Thermal insulation

The thermal insulation should be selected with regard to the following minimum criteria:

- Thermal insulation must have a relevant third party product approval confirming suitable for use in proposed situation.
- Thermal resistance (and therefore thickness) to suit minimum clearances at details.
- Resistance to compression.
- Compatibility with the AVCL and waterproof membrane.
- Compatibility with adhesives (if insulation or the waterproof covering is adhered).
- Contribution to the external fire performance of the system.
- Acoustic properties: resistance to external sound is not currently regulated. However, there may be a need to consider attenuation from balconies (See the 'Roof Terraces and Balconies' section for further information).

Note: The alternative of a separate acoustic attenuation layer should be considered where appropriate.

Thermal transmittance

Design for thermal transmittance should take account of the effect of thermal bridging within the roof field and at interfaces between the roof system and adjoining elements, such as parapet walls or abutments.

In particular, allowance should be made for the effect of:

- Thermal bridging by metal fasteners used to secure insulation and/or membrane. Thermal break telescopic tube fasteners are recommended to avoid this.
- Thermal bridging due to drainage of rain water or snow-melt through insulation in inverted roofs. The use of WFRLs beneath ballast to reduce thermal bridging is recommended.
- The locations of above average thermal transmittance at sumps, gutters or areas of minimum thickness of tapered insulation.

Manufacturers of thermal insulation and WFRLs provide certification and calculations of the effects of thermal bridging by fasteners and drainage respectively. Further advice is available in Building Research Establishment BR 262 Thermal insulation: avoiding risks.

Air permeability

Relevant contract drawings should define the position of the component - the air barrier - that determines resistance to air permeability. This may be achieved by an additional, purpose designed membrane or by an additional function of another component, such as the deck or waterproof membrane.

Control of condensation

Any provision required to control interstitial condensation within the roof should be determined to the calculation method defined by BS 5250, but with ambient conditions set in BS 6229. The calculated maximum accumulation of moisture within thermal insulation should not exceed 350g/m² and there shall be no net accumulation in any annual cycle.

Installation of thermal insulation

The attachment of the thermal insulation should be designed to resist calculated wind load by a declared margin of safety. This includes consideration of dead loads required in all roof zones in ballasted warm roofs and inverted warm roofs.

Except in tapered insulation schemes, thermal insulation should always be laid in a broken bond pattern. Where two or more layers are laid, the joints in each layer should be offset. On substrates of profiled metal, the short dimension should be parallel to the deck crowns and supported across half the crown width.

Insulation should be tightly butted so as to avoid thermal bridging caused by gaps. If large gaps are created by damaged or undersized boards, any infill sections should be attached in accordance with the manufacturer's instructions.

Air vapour control layer (AVCL)

The AVCL should be selected with regard to the following minimum criteria:

- Ease with which it can be sealed at laps and at abutments to other elements.
- The method of attachment.
- Condensation risk, expressed as calculated vapour pressure based on notional conditions pertaining to the project building.
- Compatibility with the waterproof membrane and thermal insulation.

The following is a minimum recommended specification. The actual specification will depend on the level of vapour resistance required, based on calculation, and the type of deck.

The attachment of the AVCL should be designed to resist calculated wind load by a declared margin of safety. All laps should be sealed and the AVCL should be sealed to the adjoining element, which forms the continuation of the resistance to air permeability. The AVCL should be extended behind all thermal insulation, including insulation placed on vertical surfaces such as parapet walls. Where the roof system is penetrated by a detail such as a pipe or duct, a suitable method for providing continuous vapour control should be provided, and this method should be followed in practice.

Where a reinforced bitumen membrane AVCL is used, its installation should be in accordance with BS 8217.

Minimum recommended specification for AVCL for warm deck roofs

Roof system type	Deck type	AVCL	Attachment
Reinforced bitumen membrane	Profiled metal	S2P3[2]	Partial bond by 3G or approved proprietary alternative
	Concrete	S2P3	Fully bonded
	Timber panel[1]	S2P3	Partial bond by 3G or approved proprietary alternative
High density polyethylene	All	200µ	Loose laid beneath mechanically fixed insulation
High density polyethylene and metal foil laminate	As per certification	Proprietary	Fully bonded to prepared substrate all as per manufacturer's instructions
Coated metal foil laminate - self-adhesive	As per certification	Proprietary	Fully bonded to prepared substrate all as per manufacturer's instructions

Notes:
1. Reinforced bitumen membranes: minimum recommended specification based on classification in BS 8747.
2. S and P are classifications 1-5 of Strength (tensile strength and elongation) and resistance to puncture (static and dynamic); the higher the rating, the higher the performance.

Falls and drainage - Statutory requirements

Design for drainage of the flat roof covering should comply with the current relevant Building Regulations.

British and industry standards
BS 6229 states that a minimum finished fall at any point of 1:80 (1.25%) should be achieved inclusive of gutter beds and cross falls.

Where two roof planes intersect at a cross fall, the line of the cross fall junction that is formed must achieve a minimum 1:80 fall along its length. In order to achieve this, the adjoining roof planes should be designed to achieve a minimum installed finished fall of 1:60 or 1:40.

Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).

Cut-to-falls systems are often produced to a 1:60 (1.7%) fall or 1:40 (2.5%) fall. However the use of these systems does not remove the need to check that deck deflection and tolerance is overcome and that a resulting fall in the waterproof membrane of a minimum of 1:80 is achieved. Allowance for deflection is particularly important in designing inverted roofs where calculation of dead loading should be based upon the ballast type and depth to be used.

The manufacturers of certain waterproofing products have certification for their use in ‘completely flat’ or ‘zero falls’ applications. However, for the purposes of this standard, the design conditions of BS 6229 shall be assumed to prevail in all warm, inverted, and cold deck roof systems, and a designed fall will be required including allowance for deflection of the deck from all anticipated loads.

Consideration should also be given to:
- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the roof area to be drained. If necessary additional rainwater outlets should be provided.
- Avoidance of ponding behind wide obstructions to the drained slope such as plant plinths or roof lights. Additional rainwater outlets and/or insulation crickets should be provided.
- Avoidance of gutters by designing with intersecting roof planes.
- Falls between rain water outlets along a perimeter.

Since the primary function of the roof is to exclude water, it is important to consider how best to direct this into the drainage system.

Ponding on membrane roofs must be avoided because:
- It encourages the deposit of dirt and leaves, which can be unsightly, may obstruct outlets and/or become a slip hazard.
- In the event of damage, the interior will suffer increased water ingress.
- The load may cause progressive deflection of the deck.
- Ice or algae may create a slip or wind hazard, particularly on walkways.

Independent research has shown that roofs with extensive ponding require increased maintenance input.

Waterproof coverings of all types are tested for water absorption and water tightness as part of third-party certification. However, the construction process, including the installation of components and the forming of seams, is clearly facilitated in dry, well-drained conditions.

Note: Rainwater outlets and downpipes can constitute thermal bridges which may increase the risk of localized condensation; an assessment might be required to determine whether insulated outlets are to be used.

Creation of falls

Roof falls may either be created during the construction of the deck or alternatively by using tapered insulation systems.

The creation of falls in the deck should always be attempted because it has the following advantages:
- There will be a consistent thermal environment across the roof.
- The AVCL will also be to a fall.
- If mechanical fasteners are to be used for the waterproof membrane, their length will be constant, which facilitates planning and installation.

Cementitious screeds provide a stable substrate to mitred and general falls of 1:80 and are recommended. Screeds should be in accordance with BS 8204. Lightweight screeds should be overlaid with a 1:6 (cement to sand) screed topping of a minimum 10mm thickness.

Tapered insulation schemes, suitable for warm deck roofs only, have the following advantages:
- It is possible to create effective drainage layouts to complex plan areas.
- Mitred falls can be created easily to direct rain water to single points where outlets are to be located.

Where falls are created by tapered insulation, the design should ensure that the average U-value and maximum U-value at any point, required by SBEM or SAP calculation, is achieved.

Where the roof finish is to include paving on access routes, consideration should be given to the height difference created by the falls and spacing of rain water outlets in order that the maximum height of paving supports is not exceeded or trip hazards created.

Drainage

Drainage design should be based upon calculations in accordance with BS EN 12056 Part 3 given a design head of water (typically 30-35mm). Rainwater outlet capacity should be taken from properly certificated information provided by manufacturers, and the resulting number and layout of outlets should allow for obstruction and drag due to any additional surface finishes, such as walkways.
- For flat roofs with parapets where internal drainage is provided, at least two outlets (or one outlet plus an emergency overflow) shall be provided for each roof area.
- Overflows or emergency outlets should be provided on flat roofs with parapets and in non-eaves gutters in order to reduce the risk of over spilling of rainwater into a building or structural overloading.
- Outlets should be positioned so that the direction of flow is not changed sharply (e.g. through 90° just before reaching it).
- Where rainwater downpipes from other higher roof areas, balconies or terraces discharge via a lower roof, an open downpipe shoe is not permitted. The downpipe should be connected directly to the downpipe serving the lower roof.

Rainwater outlets

The following should be confirmed by reference to the manufacturer’s information or independent certification, as appropriate:
- Capacity in litres per second at a range of typical water heads.
- Compatibility with the waterproof membrane.
- Integral insulation to avoid condensation.
- Method of attachment.
- Rainwater outlets for inverted roofs should be of the dual height type, designed to maximise removal of rainwater at WFRL level.

Overflows

Roofs which drain to a single internal outlet or combined outlets connected into a single downpipe, should be provided with an overflow to drain and warn of outlet/ downpipe blockage and so avoid the risk of flooding or structural overloading. The capacity of the overflow should be not less than that of the outlet or combined outlets, and its discharge should be visible but directed away from the building.

Overflows should be conspicuously positioned for inspection and as close to the outlets as practicable to avoid rainwater build up on roofs.

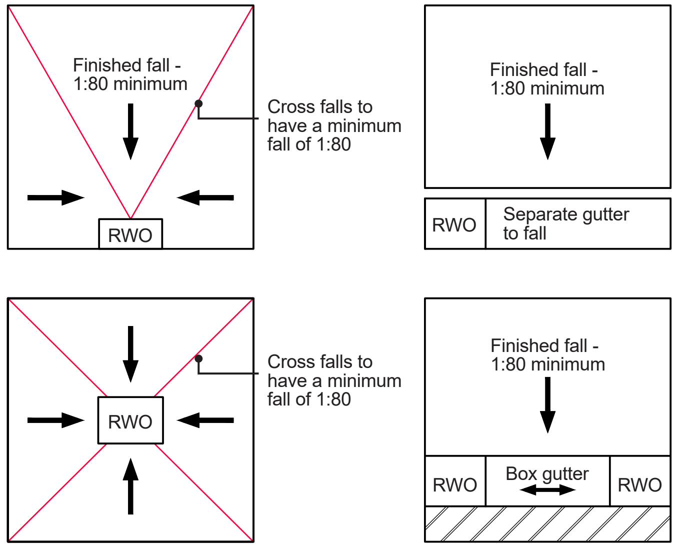
The overflow level should be set at the design water level for the rainwater outlets, which in most instances is typically 30-35 mm above the outlet. Where there is a sump included at the rainwater outlet position, the overflow should be set at the level of the lip into that sump.

The level of overflows should be 25 mm below the underside of the any sill positions e.g. thresholds.

Box gutters

It is not generally necessary to provide separate box gutters where two planes of roofing intersect, or where a single plane falls to an abutment. In the latter case, there will be no fall between outlets, so consideration should be given to creating these in the structure or insulation. Box gutters are slow, difficult to construct and introduce unnecessary complexity. The need to maintain a fall in gutters and comply with the energy requirements of the Building Regulations may be difficult to achieve.

Drainage layout options



Note: Gutters must also have a minimum 1:80 fall towards the RWO.

Drainage layout options are for illustrative purposes only and should be further developed by a suitably experience drainage designer prior to roofing work commencing.

Where RWO’s are shown, they may or may not be sumped and will be dependent on the drainage design.

Siphonic drainage

All waterproof membranes are compatible with siphonic roof drainage systems, which for larger roofs offer many advantages:
- Very high capacity, enabling fewer outlets and therefore less detailing work on-site.
- Smaller bore horizontal collector pipe work, enabling reduced roof void depth.
- Self-cleaning in many situations.

Note: Siphonic drainage is generally not appropriate for inverted roofs.

For further information see www.siphonic-roof-drainage.co.uk

These roof proposal are to be considered on a case by case basis and full design and calculations should be submitted for Warranty approval before construction begins on site.

Rainwater discharge
The management and disposal of rainwater discharge from the roof drainage system should be in accordance with the ‘Drainage – Above Ground - Storm Drainage’ section.”

Materials

Compatibility of components
The selection of components within the roofing system should be discussed in detail with the membrane manufacturer or appropriate trade association to ensure chemical and mechanical compatibility between components, since the incorrect specification may lead to reduced performance or premature failure of the roofing system. The correct choice of insulation is also important when it is to be adhered to the substrate. In case of doubt, the insulation manufacturer or relevant trade association should be consulted.

General
Materials for use in flat roofing systems are suitable only if the manufacturer has declared compliance with the relevant harmonised European Assessment Document EAD, (previously a European Technical Assessment Guideline, ETAG) and has an affixed CE Mark to the product. All waterproof membrane products shall also have a certificate of fitness for purpose issued by a member of the European Union of Agrément (UEAtc). This may comprise a British Board of Agrément certificate or an equivalent certificate of another UEAtc member.

Requirement
The waterproof membrane should be selected with regard to the following minimum criteria:

- Anticipated service life based on independent certification.
- Minimum maintenance.
- Ease of adaptation and repair.

External fire performance

All roof coverings within close proximity of buildings must achieve the fire designation required by the relevant Building Regulations.

Statutory requirement
Design for external fire performance must comply with current Building Regulations.

Certification of system
The manufacturer of the waterproof membrane must demonstrate by reference to independent test certification that the system of waterproofing and insulation (type and thickness) for a particular project meets or exceeds the minimum level of fire performance defined by the Building Regulations.

Polymeric single ply membranes

The manufacturer should declare compliance with the harmonised European Product Specification for single ply membranes, BS EN 13956, which defines requirements for testing and declaration of characteristic values.

There is no relevant British Standard. Products suitable for roofing should have current certification as detailed in ‘Appendix C’.

Such certification should be accompanied by full instructions for installation.

There is no British Standard for the installation of single ply membranes. Installation should be in accordance with the Single Ply Roofing Association’s Design Guide to Single Ply Roofing and with the specific instructions of the membrane manufacturer.

The attachment of the single ply membrane should be designed to resist calculated wind load by a declared safety factor of two times (200%). This design will normally be provided by the membrane manufacturer.

Whatever the means of attachment, specific restraint is always required at the roof perimeter, at changes of slope and around details. This ensures that any tension in the membrane in the roof field or upstand is not transferred to the other as a peeling action.

Perimeter restraint is achieved by several methods, depending upon the manufacturer:

- Individual fasteners, protected by a flashing.
- A linear bar, protected by a flashing.
- Clamping underneath a mechanically fastened, membrane-laminated trim, with the line of fixings waterproofed by a cover strip.
- Welding the field sheet to a membrane-coated metal trim secured to the deck (with thermal break fasteners where appropriate).This is not recommended for fully adhered membranes.

If the remainder of the roof system is to be bonded, it is essential that the design resistance to wind load is also achieved for the attachment of these components.

Irrespective of the wind uplift considerations or distribution requirements for securing the membrane, the fixing of the insulation boards should always be considered separately, unless specifically sanctioned by the membrane manufacturer. The number and distribution of mechanical fasteners required to fix the insulation boards may vary with the insulation type, geographical location of the building, topographical data and the height of the roof concerned.

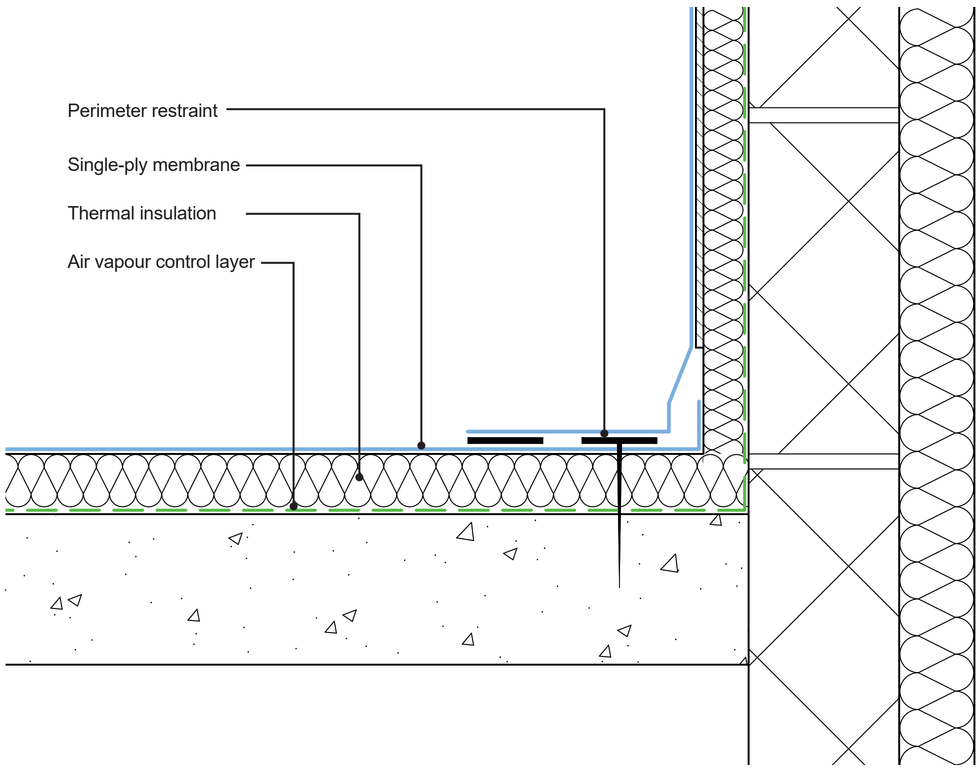
The upper termination of the single ply membrane at linear details such as plinths, parapets, abutments and door openings should be secured by one of the following mechanical means:

- Clamping beneath a metal rail, e.g. a parapet capping or roof light frame.
- Welding to a membrane-metal laminate trim (itself mechanically fixed).
- Mechanical fixing using individual fasteners or a mechanically fixed termination bar.

The welding of single ply membranes is a critical process. The following should be considered:

- Supply of certification for each installer indicating successful completion of the manufacturer’s product specific training.
- Provision of consistent electrical power supply.
- Production and retention of test weld samples at the start of each day.
- Declared procedures for repair of weak welds or damage.

Methods of restraint of a single-ply membrane at perimeters



Warm roof systems with polymeric single ply membranes

Where the insulation is mechanically fixed, the number and arrangement of fasteners required to resist wind load will be prescribed by the manufacturer, applying a safety factor of two to the design load on each fastener. This arrangement may vary across the roof according to wind load, but should be followed in all areas. Thermal break fasteners shall be used wherever feasible.

Where the insulation is adhered, the adhesive should be approved by the insulation manufacturer and should be laid at the coverage rate and pattern designed to achieve calculated wind load with a safety of factor of two times (200%). The contractor should allow for temporary loading as required to achieve a suitable adhesion and to achieve the best possible level in the upper surface of the insulation.

Liquid applied membranes

Liquid applied membranes consist of a material or combination of materials where at least the main component is a liquid form.

There is no harmonised European Product Specification for liquid applied membranes for roofing. There are many types of liquid applied membranes and many may be covered by European Assessment Document (EAD) 030350-00-0402 ‘Liquid Applied Roof Waterproofing Kits’ (EADs are the basis for issuing European technical assessment (ETA’s) certificates).

Evidence of appropriate certification should be provided to demonstrate its suitability for its proposed use.

European Assessment Document (EAD) 030350-00-0402 should be used for systems that are:

- Polymer modified bitumen emulsions and solutions.
- Glass reinforced resilient unsaturated polyester resins.
- Flexible unsaturated polyesters or Reactive poly(methyl) methacrylate (PMMA)
- Hot applied polymer modified bitumen.
- Polyurethane, Polyurea or Polyaspartic.
- Silane modified polymers (SMP)/Silane Terminated Polymers (STP)
- Water dispersible polymers.
- Thermoplastic block copolymer.

European Assessment Document (EAD) 030019-00-0402 should be used for systems that are:

- Polysiloxane (waterproofing on the basis of a silicone).

The manufacturer of a product for use in flat roofing should declare compliance with the relevant parts of the relevant European Assessment Document (EAD). In the absence of this declaration, the product should have a current certificate of fitness for purpose issued by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

Such certification should be accompanied by full instructions for installation.

Further information on these generic types of liquid applied membranes can be found on the Liquid Roofing and Waterproofing Association (LRWA) website www.lrwa.org.uk.

Installation of liquid applied membranes

There is no British Standard for the installation of liquid-applied membranes. Installation should be in accordance with the Liquid Roofing and Waterproofing Association guidance, as follows:

- Guidance Note No. 2 - Substrates for liquid applied waterproofing.
- Guidance Note No. 4 - Roof, Balcony and Walkway Refurbishment Using Liquid applied Waterproofing Systems.
- Guidance Note No. 5 - Health and Safety Provision for LAWS on Roofs, Balconies and Walkways.
- Guidance Note No. 6 - Safe Use of Liquid applied Waterproofing Systems.
- Guidance Note No 11 – Use of Adhesives for Liquid Flat Roof Systems.
- Guidance Note No 12 – Termination of Waterproofing at Cills and Thresholds.
- Guidance Note No 13 – Drying of Existing Roof Substrates Prior to Installation of Liquid Waterproofing Systems.
- Guidance Note No 16 – Walls Built onto Waterproofing Systems.
- Guidance Note No 17 – Best Practice for the Installation of a Flues Passing Through a Flat Roof.

A consistent film thickness is essential for reliable and durable liquid-applied membranes.

The following should be considered:

- Supply of a card for each installer indicating successful completion of the manufacturer’s product-specific training.
- The coverage rate in kg/m² or l/m² must be declared before work starts.
- During installation assessment of wet film thickness by one of the following methods as appropriate:
  - Gauge pin.
  - ‘Comb’ type measurer.
  - Visual inspection.

In all cases, where a liquid applied membrane is proposed, the designer will be required to distribute the following information to all appropriate contractors, site supervisors and suppliers, in a clearly understandable format to demonstrate the installed system provides an adequate level of performance:

- A full third party product conformity approval certificate for the system.
- A full specification for the proposed works prior to works starting on site – this must be accompanied by a full set of drawings covering aspects of detailing.
- The installing contractor must provide evidence of inclusion into an Approved Installer scheme, which is controlled and verified by the system manufacturer.

Insulation for use with liquid applied membranes

Any proposal that requires on site installation of an OSB or plywood sheet over a proprietary rigid insulation board **should only be accepted** when supported by a site specific Condensation Risk Analysis calculation.

The type of insulation used for liquid applied membranes must be confirmed by the manufacturer of both the liquid applied membrane and insulation board manufacturer as being compatible. The insulation core must also be capable of giving support to the completed liquid applied membranes system in order to ensure that applied loads do not give rise to cracking or indentation of the finished waterproofing system.

It should be noted that some liquid applied membranes use an adhered carrier or preparation membrane prior to application of the liquid applied membrane. Where this is the case, confirmation should be sought from the manufacturer of the insulation board regarding the compatibility of any roofing system primers or adhesives used for the attachment of the carrier material.

In both instances, the manufacturers of the insulation board should provide any performance data for inclusion into the specification which has been produced for the roofing system.

Insulation products must be manufactured in controlled factory conditions, with manufacturing facilities holding evidence of appropriate Factory Control Certification from a UKAS accredited 3rd Party which confirms they are manufactured to the relevant industry standard. The product itself must be covered by a full third party product conformity approval certificate.

Typically acceptable build-ups

Cold flat roof build ups are only acceptable with a roof area up to 3m² with cross flow ventilation maintained.

For the purposes of Warranty, a warm flat roof build up is recommended for site applied liquid applied membrane roof coverings. The insulation should be compatible with the chosen liquid applied membrane and method of application.

Detailing

The Warranty Surveyor must receive a full set of sectional drawings, which should be accompanied by the specification. These sectional details should be produced by the system manufacturer for all aspects of detailing specific to the project.

Compatibility with other materials – penetration detailing

For instances where the liquid applied membranes system is required to bond onto lead pipe sleeves, flashings, steel balusters, anchoring system, etc., the liquid applied membrane manufacturer’s guidance should always be sought prior to works taking place. Incompatible material will often need special preparation and need to be primed with a system specific primer to facilitate a good adhesion of the liquid applied membrane to the material in question.

Mastic asphalt

There is no harmonised European Product Specification for mastic asphalt for roofing. Products used for flat roofing should comply with BS 6925: 1988 Specification for mastic asphalt for buildings and civil engineering (limestone aggregate).

Proprietary grades of polymer modified mastic asphalt are produced for roofing and paving applications. There is no British Standard or European Standard for these products.

Products suitable for roofing should have current certification as detailed in ‘Appendix C’.

The separating membrane should be one of the following, and should be laid directly under the mastic asphalt:

The separating membrane should be one of the following, and should be laid directly under the mastic asphalt:

- Sheathing felt, comprising a base of flax or jute, or other suitable fibres, impregnated with bitumen.
- Glass fibre tissue.

Bitumen-coated plain expanded metal lathing should be in accordance with BS EN 13658-2.

Stone chippings (bedded) for use as a protective topping should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution over the mastic asphalt membrane.

Generally, mastic asphalt on sheathing felt provides sufficient dead load to resist wind load, but this should be demonstrated by calculations in all situations.

Installation of mastic asphalt

The number of coats should be appropriate to the waterproofing requirements and traffic conditions of the roof. When laid to falls of 1:80 or more, mastic asphalt roofing is laid in two coats to a thickness of 20mm, on a separating membrane of sheathing felt, all in accordance with BS 8218.

On sloping and vertical surfaces over 10° pitch, the mastic asphalt should be laid in three coats to a thickness of 20mm without a separating membrane.

On sloping and vertical surfaces of timber or lightweight concrete, the mastic asphalt should be laid in three coats to a thickness of 20mm on expanded metal lathing over a separating membrane of sheathing felt.

Reinforced bitumen membranes

The manufacturer should declare compliance with the harmonised European Product Specification for reinforced bitumen membranes, BS EN 13707, which defines requirements for testing and declaration of characteristic values. There is no relevant British Standard.

Products suitable for roofing should have current certification by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

In addition, specifications for systems of multi-layer reinforced bitumen membranes for flat roofing should comply with BS 8747.

Minimum recommended specification for reinforced bitumen membranes

Roof system type	Deck type	Insulation type[1]	Venting layer[2]	Underlayer[3]	Cap sheet[4]
Warm deck	Profiled metal	Thermoplastic foam	3G	S2P3[5]	S4P4[5]
		Mineral fibre	-	S2P3	S4P5
	Concrete	Thermoplastic foam	-	S2P3	S4P4
		Mineral fibre	-	S2P3	S4P4
	Timber panel	Thermoplastic foam	3G	S2P3	S4P5
		Mineral fibre	-	S2P3	S4P4
Inverted warm deck	Profiled metal	Extruded Polystyrene (XPS)	3G	S2P3	S4P5
	Concrete		-	S2P3	S4P5
	Timber panel	Deck type not suitable for inverted roofs			

Notes:
(1) Insulation type: Thermoplastic foam: PIR, EPS, PF. Mineral fibre: MW.
(2) Venting layer: BS 8747 3G or proprietary equivalent with suitable certification.
(3) Under layer: as defined in BS 8747. SBS-modified products are recommended.
(4) Cap sheet: as defined in BS 8747. SBS-modified products are recommended.
(5) S and P are classifications 1-5 of Strength (tensile strength and elongation) and resistance to puncture (static and dynamic); the higher the rating, the higher the performance.

Bitumen membranes should be protected from solar radiation. This should be by integral protection provided in the product in the form of:

- Mineral granules.
- Metal foil.

The use of solar reflective paint is not permitted. The use of stone chippings is not recommended unless required to achieve enhanced external fire performance. If used, chippings should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution.

Warm roof systems with reinforced bitumen membrane waterproofing

The limiting wind load for the different methods of attachment of insulation is prescribed by BS 8217 as follows:

- Partial bitumen bond: up to $2.4kN/m^2$.
- Full bitumen bond: up to $3.6kN/m^2$.

Where the method of attachment is outside the scope of BS 8217, the manufacturer should demonstrate that the method provides sufficient resistance to wind load.

Reinforced bitumen membranes installation

Installation should be in accordance with BS 8217. In case of doubt, or where the waterproof membrane is beyond the scope of the Standard, the advice of the Flat Roofing Alliance (National Federation of Roofing Contractors) should prevail.

The safe use of gas torches, and the positioning, monitoring and transferring hot bitumen to the work face, should be adopted, all in accordance with the Health and Safety Executive/Flat Roofing Alliance Code of Practice for Safe Handling of Bitumen.

The practice of applying reinforced bitumen membranes by torching onto thermoplastic foam insulation is not permitted, unless the boards are manufactured with a covering of reinforced bitumen membrane.

Site-applied hot melt coverings

There is no harmonised European Product Specification for site-applied hot-melt waterproofing systems. Hot applied polymer modified bitumen (hot melt) is covered by European Assessment Document (EAD) 030065-00-0402 ‘Composite Roof Waterproofing Kits’. EADs are the basis for issuing European technical assessment (ETA’s) certificates.

The manufacturer of a product for use in flat roofing should declare compliance with the relevant parts of the relevant European Assessment Document (EAD). In the absence of this declaration, the product should have a current certificate of fitness for purpose issued by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

Evidence of appropriate certification should be provided to demonstrate its suitability for its proposed use.

As these systems comprise a multi-layer application (usually a base coat, reinforcement and top coat), a detailed specification for the system should be available prior to commencement of the works to enable its suitability for the project to be confirmed. There is no British Standard for the application of proprietary hot melt waterproof membrane systems. Reference should be made to independent certification and the manufacturer’s detailed instructions.

EPDM roof coverings

EPDM products are only acceptable for Warranty purposes where the roof does not exceed a $100m^2$ maximum roof area (Gross flat roof area of the project – not individual plots).

The EPDM water proofing membrane product should be CE marked in accordance with harmonised Standard BS EN 13956, AND must hold a current third party product conformity certificate.

The membrane must only be installed:

- As a fully adhered bonded only membrane to the roof deck (not mechanically fixed with ballast covering) and,
- Installed only by the EPDM membrane manufacturers approved installer.

EPDM roofs should only be proposed where a simple open plan laid to fall roof is proposed (i.e. no parapets, changes of levels or plant installations).

EPDM membranes are not acceptable where any pedestrian access is proposed (other than occasional maintenance) and are not acceptable for use in the following constructions:

- Balcony / Terrace deck
- Blue roof
- Green roof
- Podium deck

Fixing of guarding/balustrades

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and any penetration through waterproof roof coverings is sealed correctly in accordance with the waterproof covering manufacturer’s recommendations.

Detailing

At an early stage in the design process, an audit of roof geometry should be carried out to establish what types of details will be required and whether they are to be weather proof (incorporating an upstand/cover flashing arrangement) or waterproof (providing continuous waterproofing across the detail).

The following key principles should be followed in design of all details:

- Upstands to extend 150mm above the finished roof level.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- Construction should achieve independence between different elements and trades.
- Thermal and fire performance should be maintained across the detail.
- A continuous barrier to air leakage should be maintained.
- Reliance on sealant as the sole means of protection should be avoided.

The total roof zone depth should be assessed at critical points, such as the top of drainage slopes, to ensure that there is enough free upstand available to create the minimum required 150mm of waterproofing protection above finished roof level.

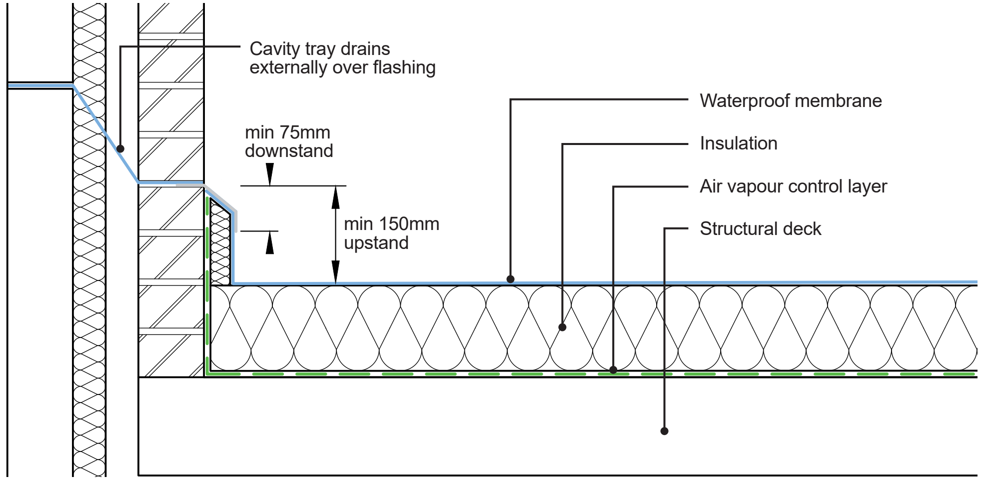
It is important that this minimum 150mm upstand is maintained at all points around the waterproofed area, except at continuous water checks and verges.

Designers should carefully consider the risks of any departure from this criterion. In the event of this being unavoidable, a written justification should be provided.

Special design features are essential, depending upon the generic type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Penetrations.
- Supports.

Example of warm deck roof at an abutment

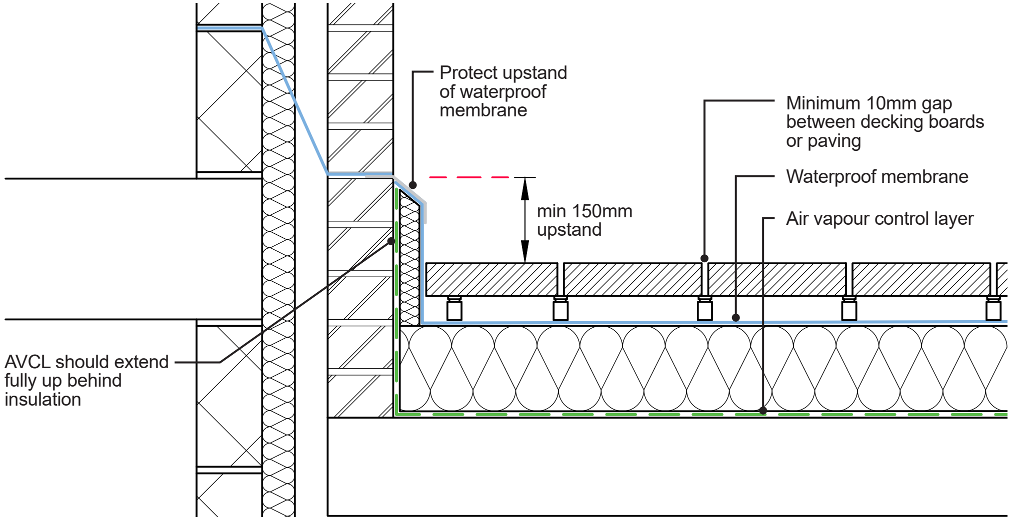


Insulation fully wrapped around by air vapour control layer and waterproof membrane.

Notes:

- A fillet is required at the base of the upstand for certain types of waterproof membrane.
- Vertical insulation may not be required.
- AVCL, waterproof membrane, or both may form the air seal to the abutting wall.
- The principles for a parapet wall are similar but the cavity tray may be detailed differently.
- Discharging the cavity tray in the course above the corner flashing (a) avoids it being damaged during the roofing works and (b) allows for increase in insulation depth at refurbishment.

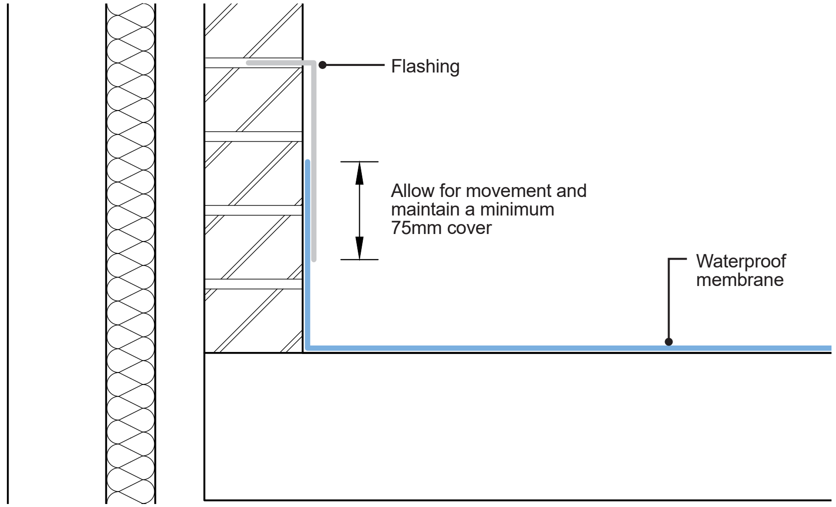
Upstand to decking and paving finishes - e.g. where access is required



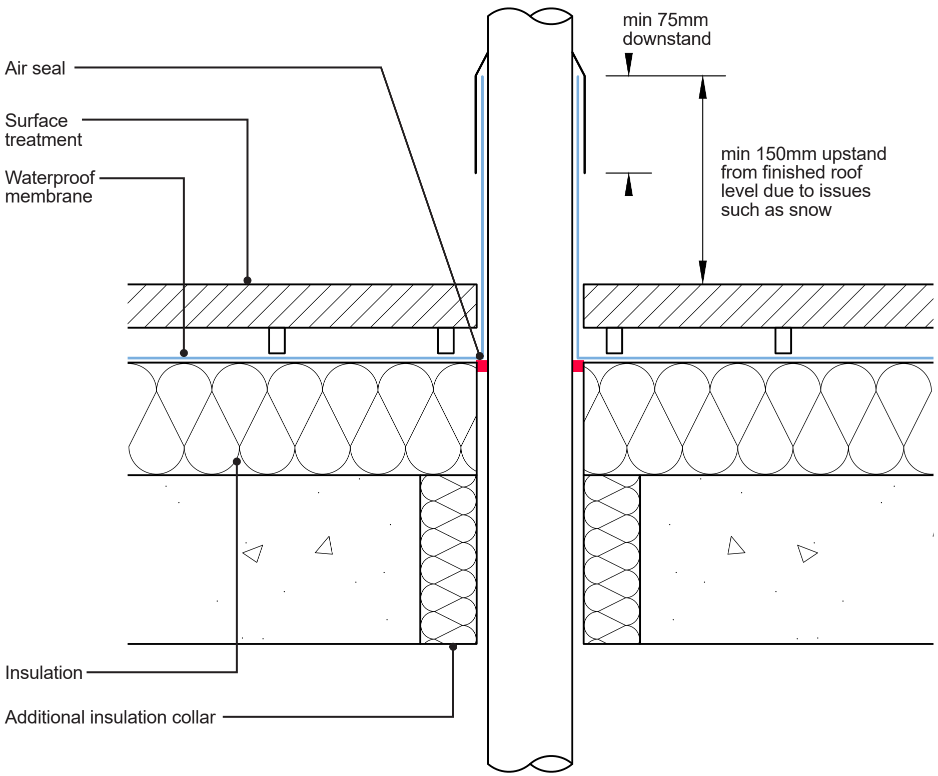
Allowance for movement where a timber frame with masonry cladding abuts a flat roof

Where a timber frame structure abuts a masonry structure, allowance should be made to accommodate movement in the timber frame and ensure the appropriate cover is maintained.

For detailing with parapet wall construction, see the 'External Walls' section.



Penetration through roof system



Notes:

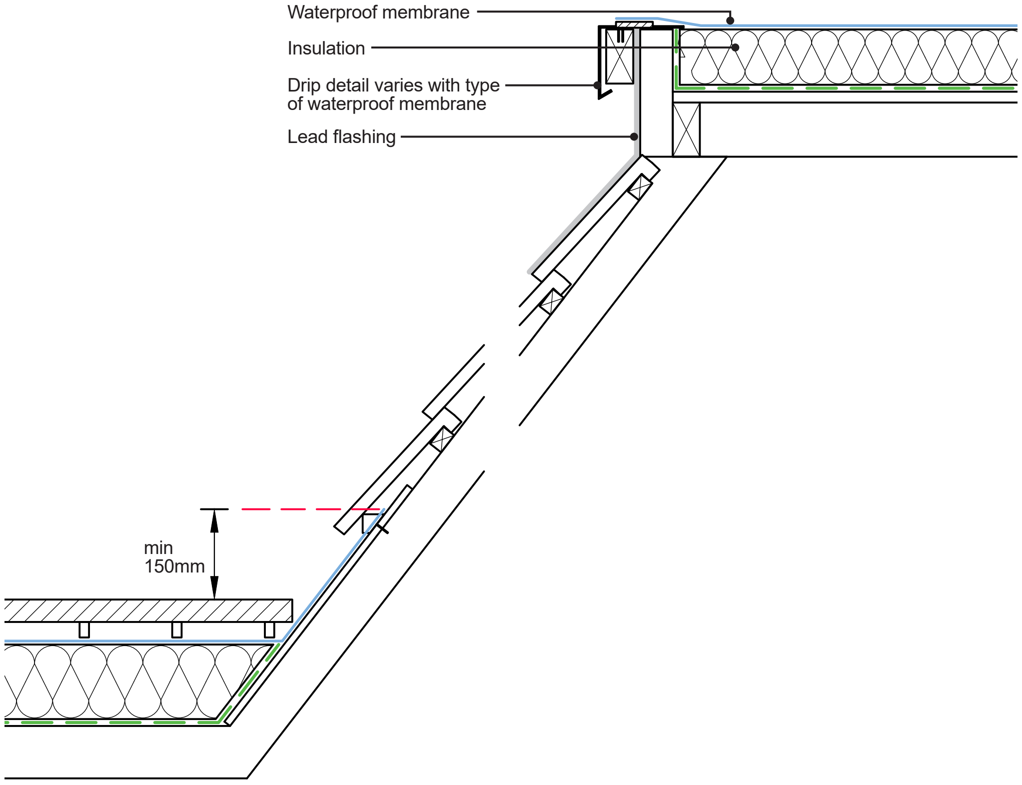
- Upstands to extend 150mm above the finished roof level.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- A fillet is required at the base of the upstand for certain types of waterproof membrane. Roof membrane manufacturer specification should be followed.
- An effective seal is required between the air vapour control layer and pipe. Clearly it is difficult to dress a sheet material around a pipe. The method for doing so should be stated in the contract drawings and/or specification.

Special design features

Special design features are essential, depending upon the generic type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Penetrations.
- Supports.

Principles: Flat roof interface to pitched roof



Testing

Final inspection
At practical completion of the flat roof, all areas should be clear of stored material, other site operations and all protection. A thorough, recorded, visual inspection of all areas, including details, should be carried out with representation from the General Contractor and Roofing Contractor in attendance.

Parameters for testing
Upon completion testing of the flat roof covering will be required to be carried out as per the following criteria.

Testing of flat roofs (all types of waterproofing systems)
Testing is required in the following situations:

1. On low rise housing: Detached/semi-detached/terraced housing 3 stories or less in height (including the ground storey) when:
   - The roof areas exceed 50m², or;
   - Where the project consists of 10 or more properties: one test per ten houses (with a minimum of two tests per site) are required.
2. On large developments: Apartments etc. over 3 stories in height (including the ground storey), where the total combined roof areas exceed 50m². In this case, a minimum of 20% of the roof areas must be tested.
3. On developments involving our Major Projects Team, all flat roofs will require low voltage testing.
4. Where, after completion of the site risk assessment, the Warranty Surveyor has identified areas of complexity in relation to the roof and its ancillary components that present a higher risk to Warranty (e.g. service penetrations, abutments with claddings, and penetrations from fixed items such as man safe systems).

These areas of complexity may be resultant of elements of:

Design, where:

1. The roof includes features beyond a typical wall abutment e.g. (but not limited to); variations of upstand constructions/penetrations/fixings/external permanent machinery/balustrading fittings etc.
2. The waterproof membrane is to be covered over (by pedestrian finishes or solar panels). Note: Inverted roofs of straightforward design and with continuous hot-applied waterproof membrane could be exempted.

Construction, where:

1. There are to be/have been, follow on trades on the roof after completion of the roof covering.
2. Secondary items such as fall protection devices, PV supports, balustrades etc. are to be attached.

In all circumstances, testing should be carried out when the first flat roofs are completed in order to determine if there are any inherent issues with the design or workmanship. Where there is a failure the root cause should be determined and appropriate remedial actions should be taken. The Warranty Surveyor may request an increase in the amount of testing required.

Testing of EPDM roof coverings

Where EPDM roof coverings are installed and require testing, they must be tested at completion to demonstrate waterproofing integrity. The testing provider will need to demonstrate their chosen technique is suitable for testing EPDM roof coverings as electronic leak detection techniques are not suitable.

Procurement of testing services

If testing to demonstrate waterproofing integrity is required it should be undertaken by a suitably qualified and experienced third-party who is independent of the roofing contractor.

The testing service provider should provide evidence of the following:

- Efficacy of the method proposed in the circumstances of the project.
- A detailed testing regime that includes integrity testing of detailing, specifically where the Warranty Surveyor has raised these as elements of particular complexity within the site risk assessment.
- Experience and training of operator.
- Membership of an appropriate trade association that sets a Code of Conduct for the service.

Methods of test

Low voltage earth leakage
Low voltage earth leakage is a safe and effective method for the testing of waterproofing integrity in roofs where the waterproof membrane is an electrical insulator and the deck provides an electrical earth. It is not suitable for testing flat roofs where the waterproof membrane has been overlaid with insulation and ballast (inverted roofs) or ballast only (ballasted warm roofs); therefore, testing should be carried out prior to completion of the roofing system.

Voltage field mapping
Voltage field mapping uses a generator, trace wire and field electrodes on a roof with a thin layer of water spread across the selected test area. The trained operator uses electrodes and generated voltage flow to determine the presence and precise location of defects in the area being tested.

High voltage electrical discharge
High voltage electrical discharge method is a versatile and effective method of testing. It can be used on steep slopes or inverted surfaces, provided the underlying structure will provide the necessary ground. Can be used for single ply (check with the relevant manufacturer before testing), reinforced bitumen membranes and liquid applied coatings.

Vacuum
Vacuum testing of seams of membranes manufactured off-site is an effective means of quality assessment, but is not recommended as a method of demonstrating the integrity of flat roofs.

Flood testing
Flood testing is not recommended as a method of demonstrating the integrity of flat roofs. It may be used to test balconies.

Approved installers

A flat roof membrane manufacturer’s approved installer must be used for all flat roof coverings.

Evidence of the manufacturer’s approval of the contractor to install their products should be provided to the Warranty Surveyor. Typically, this is in the form of an identity card, which features the installer’s name; a passport-style photograph; a unique card number; an expiry date; the manufacturer’s name and logo; and lists the products and/or systems for which the installer has been trained.

Periodic inspections and maintenance

Periodic inspections and maintenance should be completed in line with the advice provided within the Operation and Maintenance Manual for the project, by an appropriately skilled or trained party. The Operations and Maintenance Manual should be provided to the home owner upon completion.

As a minimum it is advisable that a flat roof is inspected at least twice yearly. Typically in the autumnal period of the year to ensure outlets are operational and the roof is free draining to deal with any subsequent inclement weather conditions in coming winter months. A further inspection is then carried out in spring to discover and rectify any damage due to weather. Extra inspections are advisable following any extreme weather events or where it is suspected that vandalism, and/or theft may have occurred on the roof.

As a minimum, it is advisable that any inspections should include the following elements:

- An examination of ceilings for signs of water damage;
- An examination of external walls, eaves and soffits for signs of movement;
- Signs of damage to the roof surface and subsequent layers of construction along with associated flashings;
- Mounted or ballasted roof top installations e.g. safety equipment, communications and renewable energy installations should be examined to ensure their attachment and associated work remains waterproof.
- Extensive build-up of leaves, moss, plants or debris should be recorded along with any influencing factors such as the effect of overhanging trees, mounted plant items, etc.

It is advisable that when additional construction work is planned on or near to the roof, an appropriate and specific inspection regime is established to cover the aspects of risk associated with the work at hand.

Where provision for access is required to flat roofs

Protection of roof system
At the earliest possible stage, the anticipated loading of the roof by plant and access during service use should be assessed in terms of:

- Load e.g. foot traffic, equipment.
- Frequency.
- Risk of impact.

The design should include protection to suit the anticipated conditions as appropriate:

- Slip-resistant walkway material.
- Polymeric single ply membranes; compatible sheets or tiles welded to the membrane.
- Load-spreading materials.
- All waterproof membrane types; paving on paving supports or protection layer.
- Polymeric single ply and reinforced bitumen membranes: galvanised steel sheet with additional covering with slip-resistant finish.

Installation

Protection of the roof

Temporary protection (during construction)
Responsibility for temporary protection and a method statement for its use should be agreed prior to commencement of works. Suitable materials should be selected in consultation with membrane manufacturers as appropriate, for example:

- Linked recycled thermoplastic sheets.
- Rolled recycled thermoplastic or elastomeric sheets.

Particular consideration should be given to locations of concentrated access, such as step-out areas onto the roof or where wheeled equipment may be used.

Permanent protection (during service)
Permanent protection should not be laid on routes where access is most likely, and should not be laid on routes where temporary ponding is likely e.g. near parapet walls in the absence of cross falls between rain water outlets.

It is recommended that concrete paving is laid on support pads, as this allows adjustment, thus reducing the risk of a trip hazard:

- The height of support pads should not exceed the maximum recommended by the manufacturer.
- Paving should not be cut. If cutting (part-slabs) is unavoidable to match plan geometry then an alternative means of support may be required.
- Paving should be firmly butted up against support pad separating pegs.

Further guidance on the suitability of finishes for temporary access can be found in the ‘Roof Terraces and Balconies’ section.

Ancillary components installed on top of waterproof layer

Non-access areas: stone ballast
Stone ballast for inverted warm deck roofs and ballasted warm deck roofs should be clean, rounded aggregate graded 20mm-40mm and as free from fines as practicable. Ballast should be applied over a protection layer on warm ballasted systems and over a filter layer or WFRL on inverted warm roofs.

Access areas: concrete paving slabs
Concrete paving slabs for use as walkways or as paving on terrace decks should conform to BS EN 1340, and be laid in accordance with the manufacturer’s instructions.

Access areas: flexible walkway tiles
Evidence of the compatibility of the tile with the waterproof membrane is required.

Lightning protection
The installation of any lightning protection measures must not compromise the water proof membrane of the roof.

The following should be confirmed by reference to the manufacturer’s information or independent certification, as appropriate:

- Method of attachment to the waterproof membrane, including arrangements for self-ballasting of conductors and finials (centres, compressive loads).
- Recommended detailing at penetration of roof system.

Mechanical and electrical services

Detailed design should take account of the installation of such equipment by other (usually following) trades, as follows:

- Service entry/exit points should be suitably weathered to enable connection without loss of integrity of the waterproof membrane and without the involvement of the roofing specialist.
- The upstand of the waterproof membrane at risers should be arranged to enable a separate downstand or weathering flashing to be formed in ductwork.
- Sufficient clearance should be provided to horizontal ductwork to ensure it does not rest upon the waterproof membrane or roof finish.

Support for renewable energy capture equipment

Renewable energy capture equipment includes photovoltaic panels and multi-panel arrays, solar thermal panels and multi-panel arrays and wind turbines. All such equipment should be secured to a frame and/or posts that transfer their load directly to the structure. The roof system and waterproof membrane should be designed to enable equipment to be de-mounted without loss of the roof’s waterproofing integrity and without the involvement of the roofing specialist. Support systems based on ‘top-fixed’ plate and post components should be accompanied by documentation to demonstrate their compatibility with the waterproof membrane.

Edge protection

If guarding to the perimeter of flat roofs should be designed to provide the simplest means of achieving waterproofing integrity, given that installation of balustrade or stanchions may occur after the installation of the roof system.

If the design requires a collar of waterproof membrane at the stanchion, the stanchion should be of circular section at this point and should incorporate a weathering apron.

Fall-arrest and edge protection equipment

The following should be confirmed by reference to the manufacturer’s information or independent certification, as appropriate:

- Compliance with BS EN 795.
- Method of attachment.
- Compatibility with the waterproof membrane.
- Means of forming a water tight seal to the waterproof membrane.

11.
Roofs

11.5
Green Roofs

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
   a) Roof plan showing direction of falls and position of outlets and overflows.
   b) Sections showing roof build up and how falls are to be created. Sectional details should show all components to be used in the green roof build up (insulation type and thickness, vapour control layer, waterproofing membrane/layers etc.).
   c) Site specific detailing for all junctions, outlets and penetrations.
2. Details of all components to be used in the construction of the green roof.
3. Engineers drawings and calculations for the roof structure.
4. Third party accreditation for the waterproofing membrane/layer. This must confirm the membrane can be used in a green roof build up.
5. Details of all fixings, their frequency and fixing method, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
6. Details of all fire stopping within structure and fire mitigation measures made within the green roof elements e.g. vegetation free zones. This should include specification and a detailed location layout drawings showing positioning.
7. Outline of method and plan for testing the integrity of the waterproofing layer.
8. A flat roof membrane manufacturer's approved installer must be used for all flat roof coverings. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty Surveyor.
9. A roof deflection analysis should be provided for medium to large roofs, those with complex roof layouts and for any roof areas that carry items of plant or are subject to access provisions beyond periodic maintenance of the roof area.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Scope

This guidance should be read in conjunction with the 'Roofs - Flat Roofs' section of this Technical Manual.

This guidance provides specific advice and requirements in respect of membrane roof systems over which a finish of living vegetation or materials that will support vegetation is to be applied.

The membrane roof systems may comprise one of the following;

Warm deck comprising of:

- Waterproof membrane.
- Principal thermal insulation.
- Vapour control layer.
- Continuously supporting deck (structural deck).

Inverted warm deck roof systems:

- Ballast.
- Water control membrane.
- Principal thermal insulation.
- Waterproof membrane.
- Continuously supporting deck (structural deck).

Cold deck roof systems are not acceptable for Warranty where green roofs are proposed.

Definitions

For the purposes of this Technical Guidance, the following definitions shall apply:

Condensation: process whereby water is deposited from air containing water vapour when its temperature drops to or below dew point.

Filter layer: construction material (usually a geotextile) that substantially reduces the transfer of mineral and organic material to the insulation in an inverted warm deck roof.

Flat roof: a roof having a pitch no greater than 10º to the horizontal.

Insulation cricket: wedge of shallow-fall insulation material, designed to divert the flow of rainwater on a roof.

Interstitial condensation: condensation occurring within or between the layers of the building envelope.

Protection layer: construction material (usually a geotextile all rigid board) that isolates another construction material from mechanical damage.

Separation layer: construction material (usually a geotextile) that separates two construction materials that are not chemically compatible.

Structural deck: continuous layer of the construction (comprising concrete, profiled metal or timber panel) supported by the building structure and which supports the roof system.

Thermal bridge: part of a roof of lower thermal resistance than its surrounding elements, which may result in localised cold surfaces on which condensation, mould growth or staining may occur.

Water flow reducing layer (WFRL): construction material (usually a sheet membrane) that substantially reduces the transfer of rain water to the insulation in an inverted warm deck roof.

Biodiverse green roof: a roof that is designed to create a desired habitat that will attract a particular flora and fauna, whether replicating the original footprint of the building or enhancing the previous habitat.

Biodiverse brown roof: a biodiverse roof where the growing medium is purposely selected to allow local plant species to inhabit the roof over time.

BioSolar roof: A system of using green roof materials to hold solar photovoltaic panels in place.

Blue roof: a roof level rainwater attenuation system forming part of a SuDS strategy to mitigate flood risk. Typically installed beneath a green roof. Please refer to the 'Roofs – Blue Roofs' section for further guidance on blue roofs.

Drainage layer/reservoir board: available in a variety of materials, including hard plastic, polystyrene, foam, coarse gravel and crushed recycled brick, depending on the design Functional Requirements. This allows excess water to drain away, thereby preventing the water-logging of the substrate. Some drainage layers also incorporate water storage cells to retain additional water that can be diffused to the plant support layer during prolonged dry periods.

Extensive green roof: a lightweight, low maintenance roof system, typically with succulents or other hardy plant species (often sedum) planted into a shallow substrate (typically less than 100 mm) that is low in nutrients. Irrigation is not normally required. A variant using wildflower species will require a deeper substrate (typically 100mm to 150mm depending on species mix). Permanent irrigation is not required but it is advisable to include an option to irrigate in times of drought.

Filter fleece/fines layer: geotextile of low resistance to water penetration, which prevents fines and sediments from being washed out of the green roof into the drainage system.

FFL: Forschungsgesellschaft Landschaftsentwicklung Landschaftbau (German Landscape Research, Development and Construction Society).

Green roof: a roof or deck onto which vegetation is intentionally grown or habitats for wildlife are established, including extensive, intensive and semi-intensive roofs, roof gardens, biodiverse roofs, brown roofs and public and private amenity spaces.

Green roof system: the component layers of a green roof build-up.

Growing medium/substrate: an engineered soil replacement that contains a specified ratio of organic and inorganic material, specifically designed to provide green roof plants with the air, water and nutrient levels they need to survive, whilst facilitating the release of excess water.

GRO: Green Roof Organisation, the industry forum for green roof development and promotion in the UK. GRO publish the Green Roof Code of Best Practice amongst other technical guidance.

Hydro seeding: spraying a specially designed blend of seeds.

Inspection chamber: a chamber situated over an internal rain water outlet designed to constrain the surrounding landscaping but allowing easy access for maintenance. Allows water entry but helps prevent unwanted silt, debris or vegetation from entering and obstructing free drainage.

Intensive green roof: a version of a green roof often referred to as a roof garden that provides benefits akin to a small urban park or domestic garden. Designed primarily for recreational use, intensive roofs are typically configured with 200mm+ of substrate, and often require regular maintenance and irrigation.

Moisture/protection layer: geotextile blanket, available in varying thicknesses (typically between 2mm-12mm), which performs a dual function. Firstly, protecting the waterproof membrane during the installation of the green roof system, and secondly, increasing the water holding capacity of the green roof system.

Root barrier: a waterproof membrane designed to prevent roots from penetrating the waterproofing layer and building fabric. This function may be incorporated in a single membrane waterproofing product.

Sedum: genus of about 400 species of low-growing, leafy succulents that are wind, frost and drought tolerant and found throughout the northern hemisphere. Not all species are suitable for roofs.

Semi-intensive green roof: intermediate green roof type with characteristics of both extensive and intensive green roofs. Typically with a 100mm-200mm substrate depth, sometimes irrigated, occasionally managed and usually planted with a range of species.

SuDS: Sustainable (Urban) Drainage Systems.

Air Vapour control layer (AVCL): construction material (usually a membrane) that substantially reduces the transfer of water vapour through the roof.

Wildlife roof: a version of a biodiverse roof designed to provide a specific habitat to attract a wildlife species.

Design and system types

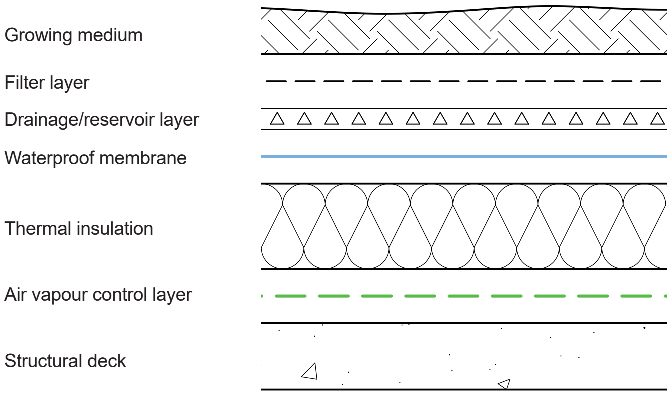
A green roof essentially comprises an organic vegetation layer and those components necessary to support its growth, which is placed over a membrane roof system. For convenience, green roofs are divided into the following types:

- Biodiverse green roof.
- Biodiverse Brown roof.
- Extensive green roof.
- Semi-intensive green roof.
- Intensive green roof.
- BioSolar roof.

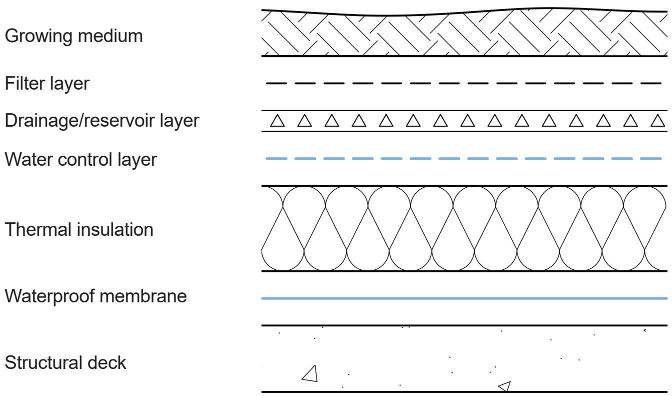
The roof system may be of warm deck or inverted warm deck configuration. The approach taken will be dependent on a number of variables which should be considered by the designer. The chosen approach should be discussed with the Risk Management Surveyor as early as possible to ensure all Warranty risks are mitigated.

For Warranty purposes, cold deck roofs are not suitable for green roof applications.

Extensive green roof - warm roof system (section)



Intensive green roof - inverted warm roof system (section)



Loading

Statutory requirement
Design for loading should comply with current relevant Building Regulations. Further information can be found in the 'Roofs - Flat Roof' section of this Technical Manual.

Resistance to wind load
In all situations, including ballasted and inverted roofs, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Wind load acting on a green roof will be affected significantly by the design of the perimeter and by the geometry and finishes on the elevations of the building. Any changes to these elements will necessitate a review of the calculation output.

In biodiverse, brown and extensive green roof systems, the dead load contribution from the growing medium should be calculated on an assumption of dry substrate conditions. Such loadings may be insufficient to restrain the green roof and certain types of waterproof membrane and insulation, necessitating the provision of supplementary ballast or netting restraint. Information on loading is available from horticultural suppliers.

Resistance to imposed loads
At the earliest possible stage, the employer should define the range of potential imposed loads for which the green roof is to be designed, such as seats, stand-alone planters, storage and public access. In the absence of such a performance requirement, the loading limits of the roof should be defined.

Materials

Please refer to the 'Roofs - Flat Roofs' section of this Technical Manual.

Note: If the waterproof membrane is also intended to provide root resistance, suitable certification of testing in accordance with BS EN 13948 should be available.

Air vapour control layer (AVCL)

Please refer to the 'Roofs - Flat Roofs' section of this Technical Manual.

Thermal insulation

Please refer to the 'Roofs - Flat Roofs' section of this Technical Manual.

Protection of the roof

Temporary protection (during construction and in service)
Responsibility for temporary protection and a method statement for its use should be agreed prior to commencement of works. Suitable materials should be selected in consultation with membrane manufacturers as appropriate, for example:

- Linked recycled thermoplastic sheets.
- Rolled recycled thermoplastic or elastomeric sheets.

Particular consideration should be given to locations of concentrated access, such as step-out areas onto the roof or where wheeled equipment may be used.

Thermal performance

Statutory requirement
Design for thermal performance must comply with current relevant Building Regulations, as appropriate.

Provision for access

Statutory requirement
Design should comply with the current relevant Building Regulations.

Temporary provision during construction

At the earliest possible stage, the anticipated loading of the roof system (prior to application of the green roof components) should be assessed in terms of:

- Load e.g. foot traffic, equipment.
- Frequency.
- Risk of impact.

If such usage is intense or long-lasting during the construction phase, consideration should be given to temporary works only, with completion occurring after all non-roofing usage has ceased as follows:

- Warm deck roof system: following the installation of vapour control layer, temporary protection is required to be overlaid until the remainder of the system is installed.
- Inverted warm deck roof system: overlay completed waterproof membrane with a geotextile and continuous temporary decking, such as plywood, Oriented Strand Board or compatible recycled thermoplastic board.

Permanent pedestrian access finishes

Pedestrian finishes should be designed to suit the purpose and frequency of access in the context of the intended planned maintenance regime. For example, paving on paving supports may be desirable to allow drainage and to level up the finish, but may be unsuitable if plants could spread beneath the paving. Generally, for amenity access, a finish of porous or hard concrete paving laid directly on a suitable protection fleece may be most suitable.

For service and maintenance access only, a flexible walkway tile may be sufficient (depending on the waterproof membrane and roof system type).

For further information regarding permanent protection during service, see the 'Roofs - Flat Roofs' section of this Technical Manual.

External fire performance

Statutory requirement
Design for external fire performance must comply with current Building Regulations.

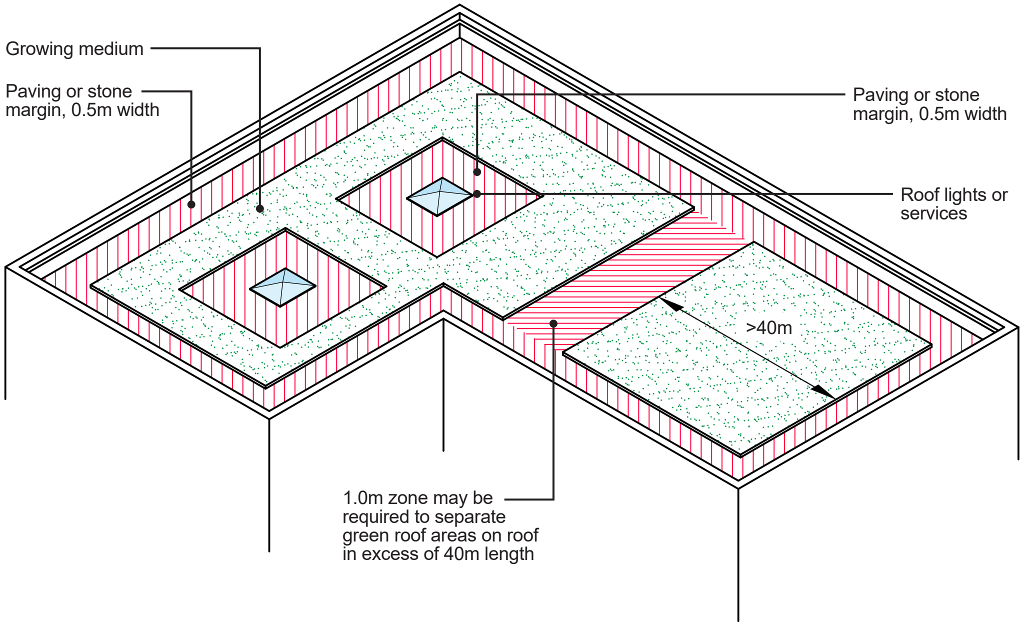
Design for resistance to external fire
The design of green roof systems can influence the fire performance of the overall roof system. The rate of growth and moisture content of natural vegetation is unpredictable and determined by irregular weather conditions. The substitution of planted species with others is also unpredictable. Design to minimise fire risk cannot be based on an assumption of regular maintenance or of irrigation during drought. The latter is not relevant with sedum species, which die back, but is important for intensive roof gardens or extensive systems planted with wildflowers and grasses.

The design should not allow the vegetation to grow or propagate towards adjoining elements, such as abutments, eaves or pitched roofs. It should also be kept away from openings, such as roof lights and smoke vents.

This is achieved in two ways:

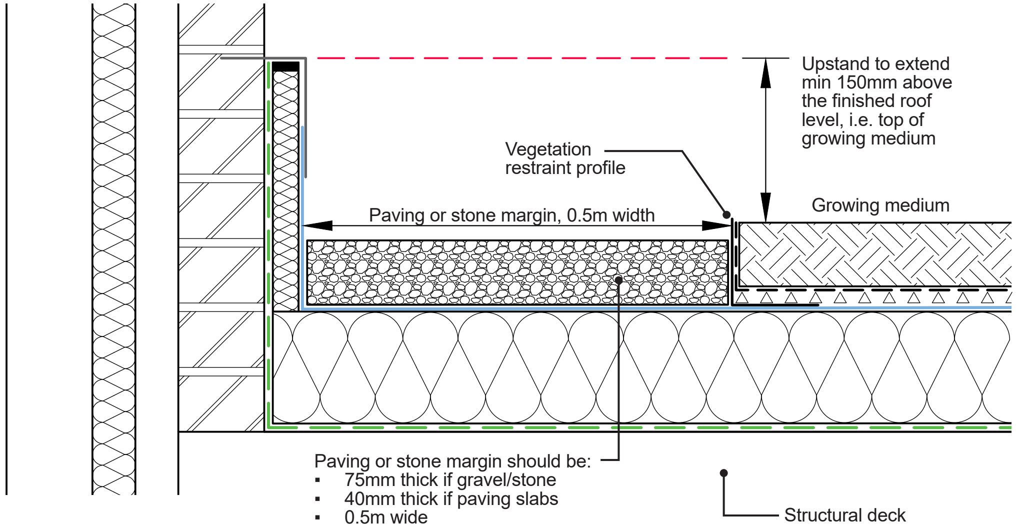
- A vegetation-free zone of minimum 0.5m width consisting of either 20 – 50mm rounded gravel at 75mm depth or 40mm thick paving slabs at all vertical perimeters, vertical abutments and vertical openings. This zone should be extended to 1m to separate large roof zones in excess of 40m in length.
- Design of flexible walkways, hard paving and ballasted areas so as to minimise root and plant spread.

Green roofs: Vegetation-free zones (Plan, zone width: not to scale of building)



Notes:
1. 0.5m zone around openings, along abutments, and at perimeters.
2. 1.0m zone may be required to separate green roof areas on roof in excess of 40m length.
3. Vegetation-free zone to comprise non-combustible stone or paving on suitable protection.

Green roofs: Vegetation-free zones: Warm roof (section)



Notes:

1. Vegetation restraint profile should be secured with ballast as necessary. Additional restraint will be required on sloping roofs to stop creep of the vegetation zone.
2. Protection of waterproof membrane should be extended under ballast zone.
3. Paving or stone should not simply be added to the growing medium at the perimeter as this (a) may reduce the available height of upstands, and (b) will not stop plants growing in the zone.

Detailing

General principles
At an early stage in the design process, an audit of roof geometry should be carried out to establish what types of details will be required and whether they are to be weatherproof (incorporating an upstand/cover flashing arrangement) or waterproof (providing continuous waterproofing across the detail).

The following key principles should be followed in design of all details:

- Upstands to extend 150mm above the finished roof level i.e. top of growing medium.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum of 75mm.
- Reliance on sealant as the sole means of protection should be avoided.
- Consideration of the effect of vegetation growth on the integrity of the weatherproofing.

The total roof zone depth should be measured from the surface of the growing medium and assessed at critical points, such as the top of drainage slopes, to ensure that there is enough free upstand available to create the minimum required 150mm of waterproofing protection above finished roof level. It is important that this minimum 150mm upstand is maintained at all points around the area of the green roof, except at continuous water checks and at verges.

Waterproof membranes

For further information on waterproof membranes please refer to the ‘Roofs - Flat Roof’ section of this Technical Manual.

Please note: Warm roof systems - restraint against wind load. It is unusual for the installation of ballast and green roof components to follow immediately after installation of the roof system. This may be because the roof system and green roof overlay are to be installed by different contractors, or because of site factors, such as limited storage. Unless it is sequenced to do so, the roof system should be installed with restraint against wind load based on an assumption of an exposed waterproof membrane.

If the waterproof membrane is also intended to provide root resistance, suitable certification of testing in accordance with BS EN13948 should be available.

Falls and drainage - Statutory requirements

Design for drainage of the flat roof covering should comply with the current relevant Building Regulations.

British and industry standards
BS 6229 states that a minimum finished fall at any point of 1:80 (1.25%) should be achieved. Since adjoining roof planes at 1:80 will meet at a mitre of less than 1:80, the intended finished fall at such intersections should be considered at an early stage.

The relevant requirements of BS 6229 should prevail in respect of green roofs, irrespective of the type of vegetative covering.

Falls are required for green roofs because:
- Standing water will inevitably result from design without falls, due to tolerances and deflection. Standing water, which may become stagnant, is not conducive to plant growth and should not be confused with the temporary retention of water in drainage/reservoir layers.
- Absence of falls will result in ponding, a potential slip hazard and the retention of mineral fines in vegetation-free zones, which in turn may encourage the growth of weeds.

Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).

Cut-to-falls systems are often produced to a 1:60 (1.7%) fall or 1:40 (2.5%) fall. However the use of these systems does not remove the need to check that deck deflection and tolerance is overcome and that a resulting fall in the waterproof membrane of a minimum of 1:80 is achieved. Allowance for deflection is particularly important in designing inverted roofs where calculation of dead loading should be based upon the ballast type and depth to be used.

The manufacturers of certain waterproofing products have certification for their use in ‘completely flat’ or ‘zero falls’ applications. However, for the purposes of this standard, the design conditions of BS 6229 shall be assumed to prevail in all warm, inverted, and cold deck roof systems, and a designed fall will be required including allowance for deflection of the deck from all anticipated loads.

Consideration should also be given to:
- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the roof area to be drained. If necessary additional rainwater outlets should be provided.
- Avoidance of ponding behind wide obstructions to the drained slope such as plant plinths or roof lights. Additional rainwater outlets and/or insulation crickets should be provided.
- Avoidance of gutters by designing with intersecting roof planes.
- Falls between rain water outlets along a perimeter.

Since the primary function of the roof is to exclude water, it is important to consider how best to direct this into the drainage system.

Ponding on membrane roofs must be avoided because:
- It encourages the deposition of dirt and leaves, which can be unsightly, may obstruct outlets and/or become a slip hazard.
- In the event of damage, the interior will suffer increased water ingress.
- The load may cause progressive deflection of the deck.
- Ice or algae may create a slip or wind hazard, particularly on walkways.

Independent research has shown that roofs with extensive ponding require increased maintenance input.

Waterproof coverings of all types are tested for water absorption and water tightness as part of third-party certification. However, the construction process, including the installation of components and the forming of seams, is clearly facilitated in dry, well-drained conditions.

Please note: Rainwater outlets and downpipes can constitute thermal bridges which may increase the risk of localized condensation; an assessment might be required to determine whether insulated outlets are to be used.

Creation of falls

Roof falls may either be created during the construction of the deck or alternatively by using tapered insulation systems.

Where the roof finish is to include paving with or without paving supports, consideration should be given to the height difference created by the falls and spacing of rain water outlets in order that the maximum height of paving supports is not exceeded, the minimum height of upstands is not affected or trip hazards created.

The creation of falls in the deck should always be attempted because it has the following advantages:
- There will be a consistent thermal environment across the roof.
- The AVCL will also be to a fall.
- If mechanical fasteners are to be used for the waterproof membrane, their length will be constant, which facilitates planning and installation.

Cementitious screeds provide a stable substrate to mitred falls with minimal tolerances, and are recommended. Screeds should be in accordance with BS 8204. Lightweight screeds should be overlaid with a 1:6 (cement to sand) screed topping of a minimum 10mm thickness.

Tapered insulation schemes, suitable for warm deck roofs only, have the following advantages:
- It is possible to create effective drainage layouts to complex plan areas.
- Mitred falls can be created easily to direct rain water to single points where outlets are to be located.

Where falls are created by tapered insulation, the design should ensure that the average U-value and maximum U-value at any point, required by SBEM or SAP calculation, is achieved.

Where the roof finish is to include paving on access routes, consideration should be given to the height difference created by the falls and spacing of rain water outlets in order that the maximum height of paving supports is not exceeded or trip hazards created.

Drainage

Drainage design should be based upon calculations in accordance with BS EN 12056 Part 3 given a design head of water. Rain water outlet capacity should be taken from properly certificated information provided by manufacturers, and the resulting number and layout of outlets should allow for obstruction and drag due to any additional surface finishes, such as walkways.

Green roofs are proven to reduce the volume and rate of transfer of rain water-to-rain water goods. This effect is clearly dependent upon many factors, including depth and type of growing medium, type of drainage/reservoir layer, weather conditions prevailing prior to the rainfall event and fall in the waterproof membrane. Due to these variables, it is recommended that the design for rain water drainage in accordance with BS EN 12056 is as follows:
- Brown, biodiverse and extensive green roof systems: no allowance for rain water attenuation.
- Intensive green roof systems: attenuation as advised by the horticultural supplier. If no data is supplied, no allowance should be made.

The UK’s National Annex to BS EN 12056 does permit the use of a coefficient to factor down the drainage infrastructure to account for factors such as the additional retention performance of green roofs. However the coefficient that is used to reflect this reduction should be based on average annual retention and not on responses to dynamic storm events.

Any drainage infrastructure designed to accommodate this reduced flow rate may not accurately account for seasonal differences or individual storm events. Any reductions in drainage capacity should be countered by alternative measures, e.g. appropriate detailing to ensure that any attenuation of water at the roof level will not be detrimental to the building structure or fabric.

Rain water outlets should be readily accessible without disruption to the green roof or pedestrian finish. On finishes raised above the waterproof membrane (warm deck roofs) or Water Control Membrane (inverted roofs), this may be achieved by a suitably marked paving slab or demountable section of decking. Within the area of the green roof, a specific vegetation-free inspection chamber and cover should be provided in order to avoid plant growth obstructing the outlet. Purpose made products are available from suppliers of green roof components and waterproof membranes, and it is recommended that they be used wherever possible.

Rain water goods from higher roof areas or adjacent roof areas should not be designed to discharge onto the green roof. The downpipe should be connected directly to the downpipe serving the green roof.

Rainwater outlets

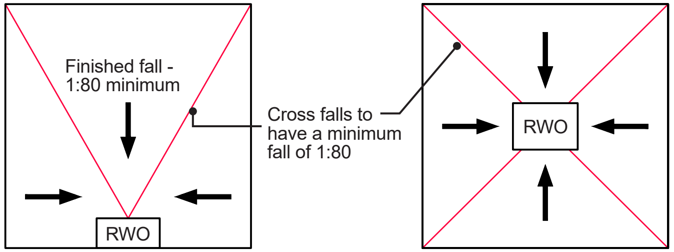
The following should be confirmed by reference to the manufacturer’s information or independent certification, as appropriate:
- Capacity in litres per second at a range of typical water heads.
- Compatibility with the waterproof membrane.
- Integral insulation to avoid condensation.
- Method of attachment.
- Rainwater outlets for inverted roofs should be of the dual height type, designed to maximise removal of rainwater at WFRL level.

Design for irrigation

Rainfall is the typical source of water. However, complementary irrigation options may be required for semi-intensive and intensive systems or those where, for example, the appearance of a grass finish may be important.

Provision may include hoses, sprinklers, overhead irrigation and automated systems that pump from some reservoir storage. The establishment of a need for an irrigation system, and the design of an irrigation scheme, should be in accordance with the principles of BS 7562-3. Where irrigation is required, a frost-protected water supply, rain water or grey water storage facility should be provided at roof level.

Drainage layout options



Drainage layout options are for illustrative purposes only and should be further developed by a suitably experience drainage designer prior to roofing work commencing’.

Where RWOs are shown, they may or may not be sumped based on the drainage design.

Siphonic drainage

Green roofs are compatible with siphonic roof drainage systems. In the right circumstances, these can offer the advantages of:
- Very high capacity, enabling fewer outlets and therefore less detailing work on site.
- Smaller bore horizontal collector pipework, enabling reduced roof void depth.
- Self-cleaning in many situations.

However, siphonic drainage should be designed specifically for the green roof system because it must operate siphonically with sufficient regularity to avoid silting-up small-bore pipework.

For further information, see www.siphonic-roof-drainage.co.uk

These roof proposal are to be considered on a case by case basis and full design and calculations should be submitted for Warranty approval before construction begins on site.

Testing

Testing of the green roof system
No reliable method is available for testing the integrity of a green roof following application of the green roof components. Therefore the roof covering should be tested at completion to demonstrate waterproofing integrity before application of the green roof components, and care should be taken to ensure that damage to the waterproof membrane does not occur during installation. With extensive greening on certain warm roof systems, it may be feasible to use low voltage earth leakage, but any defects recorded will in any case involve removal of the green roof components. Therefore, it is strongly recommended to ensure the very highest possible standards of protection of the water proof membrane during the application of the green roof components.

Procurement of testing services

The water proof membrane should be tested for integrity before the application of any other components above it. Testing should be undertaken by a third-party that is independent of the roofing contract.

The testing service provider should provide evidence of the following:

- Efficacy of the method proposed in the circumstances of the project and a detailed testing regime that includes integrity testing of all detailing, specifically where the Warranty Surveyor has raised these as elements of particular complexity within the initial site risk assessment.
- Experience and training of operator.
- Membership of an appropriate trade association that sets a Code of Conduct for the service.

Final inspection

At practical completion of the flat roof, all areas should be clear of stored material, other site operations and all protection. A thorough, recorded, visual inspection of all areas, including details, should be carried out with representation from the General Contractor and Roofing Contractor in attendance.

Methods of test

Low voltage earth leakage
Low voltage earth leakage is a safe and effective method for the testing of waterproofing integrity in roofs where the waterproof membrane is an electrical insulator and the deck provides an electrical earth. It is not suitable for testing flat roofs where the waterproof membrane has been overlaid with insulation and ballast (inverted roofs) or ballast only (ballasted warm roofs); therefore, testing should be carried out prior to completion of the roofing system.

Voltage field mapping
Voltage field mapping uses a generator, trace wire and field electrodes on a roof with a thin layer of water spread across the selected test area. The trained operator uses electrodes and generated voltage flow to determine the presence and precise location of defects in the area being tested.

High voltage electrical discharge
High voltage electrical discharge method is a versatile and effective method of testing. It can be used on steep slopes or inverted surfaces, provided the underlying structure will provide the necessary ground. Can be used for single ply (check with the relevant manufacturer before testing), reinforced bitumen membranes and liquid applied coatings.

Vacuum
Vacuum testing of seams of membranes manufactured off-site is an effective means of quality assessment, but is not recommended as a method of demonstrating the integrity of flat roofs.

Flood testing
Flood testing is a suitable method of demonstrating the integrity of small areas of roof to which a green roof system is to be applied. However, consideration should be given to the effect of ingress on programme and the risk of entrapped water in insulation (warm deck roofs) and decks (all types). The area under any one test should not exceed 50m².

Approved installers

An approved contractor who is recognised by the manufacture as competent to install the manufacturer’s roof membrane system will need to be used. Evidence of the manufacturer’s approval of the contractor to install their products should be provided to the Warranty Surveyor.

Typically, this is in the form of an identity card, which features the installer’s name; a passport-style photograph; a unique card number; an expiry date; the manufacturer’s name and logo; and lists the products and/or systems for which the installer has been trained.

Periodic inspection and maintenance

Periodic inspections and maintenance should be completed in line with the advice provided within the Operation and Maintenance Manual for the project, by an appropriately skilled or trained party. The operations and maintenance manual should be provided to the home owner upon completion.

As a minimum it is advisable that a flat roof is inspected at least twice yearly. Typically in the autumnal period of the year to ensure outlets are operational and the roof is free draining to deal with any subsequent inclement weather conditions in coming winter months. A further inspection is then carried out in spring to discover and rectify any damage due to weather.

Extra inspections are advisable following any extreme weather events or where it is suspected that vandalism, and/or theft may have occurred on the roof. As a minimum, it is advisable that any inspections should include the following elements:

- An examination of ceilings for signs of water damage.
- An examination of external walls, eaves and soffits for signs of movement.
- Signs of damage to the roof surface and subsequent layers of construction along with associated flashings.
- Mounted or ballasted roof top installations e.g. safety equipment, communications and renewable energy installations should be examined to ensure their attachment and associated work remains waterproof.
- Extensive build-up of leaves, moss, plants or debris should be recorded along with any influencing factors such as the effect of overhanging trees, mounted plant items, etc.

It is advisable that when additional construction work is planned on or near to the roof, an appropriate and specific inspection regime is established to cover the aspects of risk associated with the work at hand.

11.
Roofs

11.6
Metal Deck Roofing

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full structural design for the roof, including (but not limited to) sizing of timber members for spans and loads, fixing methodology/specification, bracing and restraint requirements.
2. A full set of detailed drawings including:
   a) Manufacturer's pre-formed truss layout drawings or full details of the roof layout inclusive of any intersecting or supportive roof structure such as hips, ridges, purlins, valleys and associated timbers e.g. lay boards, trimming members.
   b) Sectional details showing roof build-up with all materials to be used in the construction of the single skin metal roof.
   c) Details of the ventilation strategy where applicable.
   d) Details for any required trimming work around chimneys, formation of access hatches, details for the formation of supportive structure for equipment and access to equipment requiring periodic maintenance and inspection contained within the roof space.
   e) Waterproofing and flashing details around abutments, chimneys, service penetrations etc.
   f) Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
3. A detailed site specific design from either the manufacturer or the designer (see checklist within this section).
4. Third party accreditation for the single skin metal roofing system where applicable.
5. Details of all materials to be used in the construction of a fully supported single skin metal roof including (but not limited to, the metal sheet, insulation, separation layers/membranes, vapour control layers, structural deck, ancillary components etc.)
6. In all circumstances, the fully supported single skin metal roof will need to be installed by an approved contractor who is recognized by the manufacturer as competent. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty Surveyor.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Approved installers

Due to the complex nature of external metal sheet roofing, we require the installer to be approved by the manufacturer.

Where the manufacturer doesn't retain a list of approved installers, evidence should be provided showing the installer is competent and trained with external metal sheet roofing.

Single skin metal roofing

This section covers single skin metal roof covering, which are not self-supporting in nature.

Fully supported single skin metal roofing materials include zinc, copper, lead, and powder coated aluminium. They are used as the weatherproofing element of build-ups consisting of a structural deck (usually metal or timber), fully supported vapour control layer, insulation such as mineral board or PIR, separation membrane and an external metal sheet.

Product conformity

For fully supported zinc warm roof systems, the product must have a third party product conformity certificate from a UKAS accredited body which covers the complete build-up and clearly details all of the components used.

The certificate should carefully be reviewed by all interested parties to ensure all of the conditions within the certificate are satisfied. Where materials or components have been substituted with alternatives not covered within the certificate, the build-up should not be accepted.

Cold pitched roof build ups do not require a third party product conformity certificate, however the building designer should carefully consider all of the information contained within this section e.g. incompatible materials, separation layers, underside coating to the external metal sheet and ventilation to the cold roof space.

All products and components should have UKCA marking in accordance with UK Construction Product Regulations.

Design

Permitted Build-ups
For the purpose of Warranty, the use of fully supported single skin metal roof covering are not permitted in a cold flat roof build up.

In all other instances, a site specific design should be provided as early as possible so it can be reviewed by the Warranty Surveyor before any works to the roof covering is started. A checklist is present within this section highlighting the areas the site specific design must cover as a minimum for our Warranty purposes.

All designs should follow best practice as per the guidance available within the UK Guide to Good Practice in Fully Supported Metal Roofing and Cladding, published by the Federation of Traditional Metal Roofing Contractors (FTMRC).

Avoidance of underside corrosion
All metal roofs are prone to underside corrosion (to varying degrees) by various means:

- Moisture becomes trapped between the metal and the supporting material.
- An inability for the product to develop a protective layer to the underside (Patina).
- The use of incompatible materials.

The following sections are offered as guidance on how to mitigate the risk of underside corrosion occurring.

Determination of internal humidity classes
The influence of the type of building occupation cannot be underestimated when considering condensation risks. Occupants and their many activities create a moisture load for the structural elements to deal with, and unsurprisingly as occupants increase in number, the moisture load on the building increases.

For the purpose of Warranty, 'Humidity Class 3' should be adopted as the internal humidity class for a residential property. In all other instances, the guidance of the Humidity Class table should be used to determine an appropriate humidity classification.

Humidity class	Building type
1	Storage areas.
2	Offices, shops, dwellings with low occupancy.
3	Dwellings with high or unknown occupancy.
4	Sports halls, kitchens, canteens, school classrooms, hospitals, buildings heated with flue less gas heaters.
5	Special buildings (laundry, brewery, swimming pools).

Deck selection
Equally, the structural deck material should be considered with great care. The use of fully supported metal roofing systems on large span commercial buildings was routinely coupled with metal deck materials, which have an inherent resistance to moisture and vapour.

The adoption of fully supported metal roof coverings into the residential sector has resulted in wood based panels being used as a structural deck instead of metal (e.g. plywood, OSB, square edged timber boards). This switch to the use of timber decks plus the increased levels of humidity can result in moisture reaching the underside of the metal sheet roof covering.

For the purpose of Warranty, the use of timber as a structural deck should be restricted and only considered when a condensation risk analysis has been carried out.

Air and vapour control layer
As moisture can accelerate the onset of corrosion to unprotected metal sheets, this creates an increasing importance on the arrangement of vapour control layers within the built element in controlling this risk. Many fully supported metal roofing systems use a product specific air and vapour control layer (AVCL) to reduce this risk so particular attention should be paid to the correct and system specific requirements in this area.

AVCL's should always be on the warm side of the insulation. For continuity of detailing, typically the use of self-adhesive aluminium foil backed modified bitumen membranes is predominant within manufacturer's guidance literature with specific termination detailing for penetrations, etc.

For the purpose of Warranty, the Air and Vapour Control Layer (AVCL) should be strictly in accordance with the third party product conformity certificate and have a minimum vapour resistance between 5000-7000 MN.s.g. All detailing should be strictly in accordance with the manufacturer's guidance literature.

Compatibility of materials
Underside corrosion can also be caused by incompatible materials being specified together. The table below shows which metals should not be used together.

	Al	Pb	Cu	Zn	S.S	G.S
Aluminium (Al)	✓	✓	✗	✓	✓	✓
Lead (Pb)	✓	✓	✓	✓	✓	✓
Copper (Cu)	✗	✓	✓	✗	✓	✗(1)(2)
Titanium Zinc (Zn)	✓	✓	✗	✓	✓	✓
Stainless Steel (S.S)	✓	✓	✓	✓	✓	✓
Galvanised Steel (G.S)	✓	✓	✗(2)	✓	✓	✓

1. Steel hollow rivets are not compatible when used externally.
2. Galvanic copper plating of galvanised components can increase corrosion development; they do not provide corrosion protection.

It's important to consider both direct contact and surface run off from incompatible materials; for example with the use of rain water goods. If the use of incompatible materials cannot be avoided, they should be separated from each other by either non-conducting, non-metallic isolators (e.g. seals and grommets in fixing systems) or coated with compatible or inert materials.

Timber treated with certain types of preservative, particularly of copper-chrome-arsenic formulation, can cause corrosion of zinc, carbon steel and aluminium in contact with the timber. As such, external metal sheets supported on any timber deck such as plywood must have a factory applied coating specified and be separated from the timber deck by a compatible separation membrane as specified by the system manufacturer.

In addition to the incompatibility issues highlighted above, external metal sheets can also be susceptible to incompatibility issues with other common materials. Zinc for example may be incompatible with materials such as, bituminous membranes, mortar and building paper.

In all situations, the metal sheet manufacturer should be consulted with regards to incompatible issues and this should be highlighted in the site specific design.

Separation layers and low resistance membranes
Separation layers are employed to avoid the metal sheet roof covering from sitting directly on the supporting material. Underside corrosion can manifest itself where either incorrect membranes have been specified, or the correct membranes have been specified but they've been substituted for an inferior product post design approval.
Low resistance (Type LR) membranes, also referred to as 'breather membranes' will be employed in between insulation layers and any ventilated void serving the underside of the material supporting the metal roof covering. Due to the opportunity for increased temperatures created within ventilated voids inherent of the metal roof covering, any breather membrane specified must be tested for use within metal roof covering build-ups.

For the purpose of Warranty, separation layers and Type LR membranes specified in the site specific design must align with products that are set out within the third party product conformity approval certificate.

They must not be substituted and they should be subject to strict on-site quality assurance measures, which should include but not limited to, verification of product specification.

For cold pitched roofs without a third party product conformity approval certificate, membrane specification and compatibility should be carefully considered by the designer and consultation with the metal sheet manufacturer is recommended. Once specified, they must not be substituted and should be subject to the same strict on-site quality assurance measures.

Typical build-ups

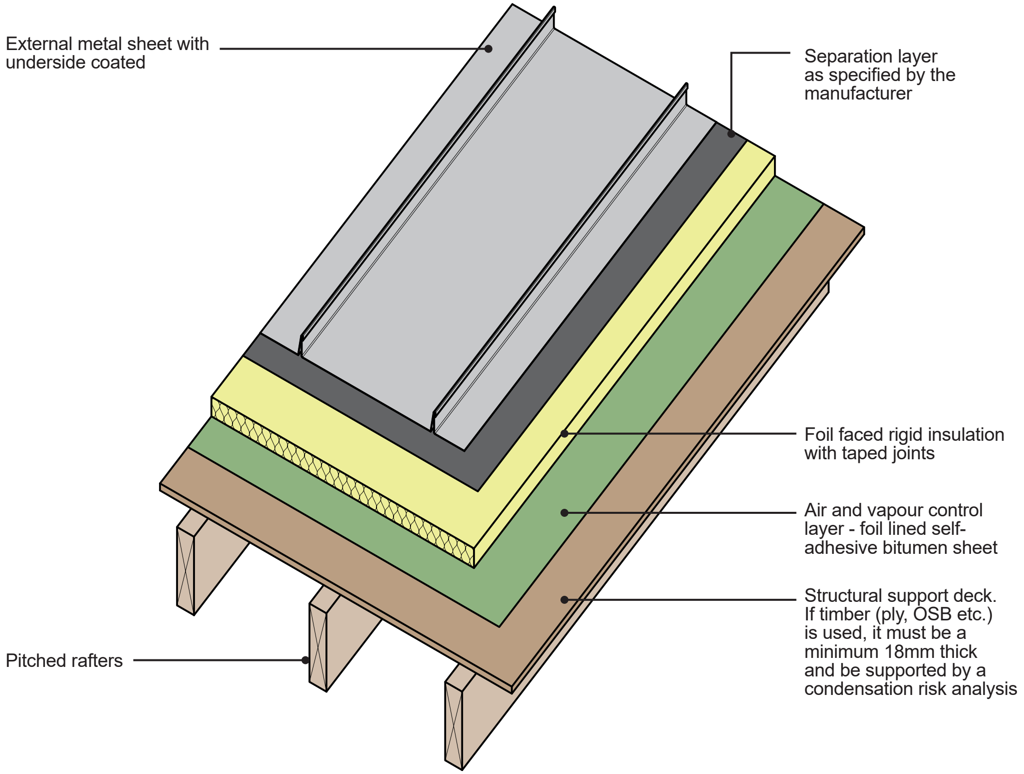
The following illustrations and associated narratives are given only as guidance to typically employed build-ups.

Warm non-ventilated roof – Pitched or flat.

Constructed without ventilation provision, the warm deck roof relies on the moisture resistant properties of the fully sealed AVCL that sits beneath the insulation. It is critical that this layer is as specified in the system manufacturers' guidance, with its integrity remaining undamaged during construction.

Any fixings from layers above must be fully considered in design with provisions for sealing penetrations, as untreated, they may give risk to moisture transfer and increase the risk associated with interstitial condensation and a premature failure of both the external metal sheet and supporting material.

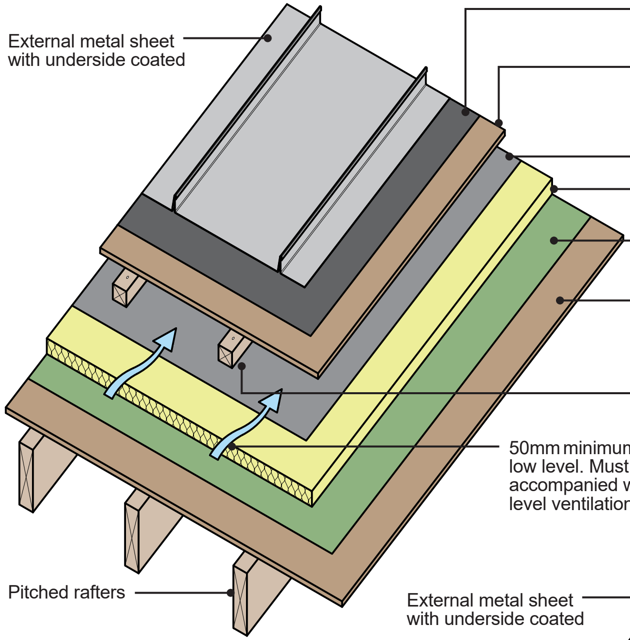
Mechanical fasteners should be avoided above conditioned spaces with high humidity e.g. swimming pools, gymnasiums. This approach, subject to an appropriate supporting site specific design, may be employed on both flat and pitched roofs.

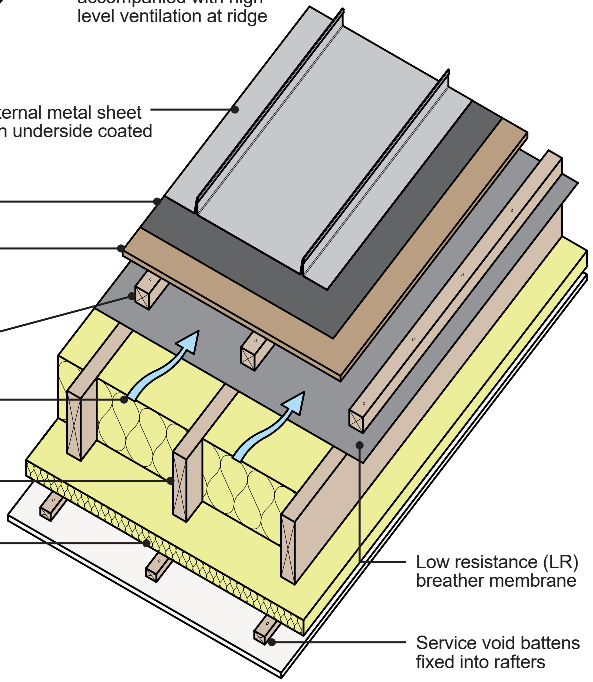


Ventilated warm roof

The ventilated warm roof arrangement incorporates a well-sealed AVCL directly on top of the structural deck and a well ventilated void between the supporting board to the underside of the external metal sheet and the overlying low resistance breather membrane layer.

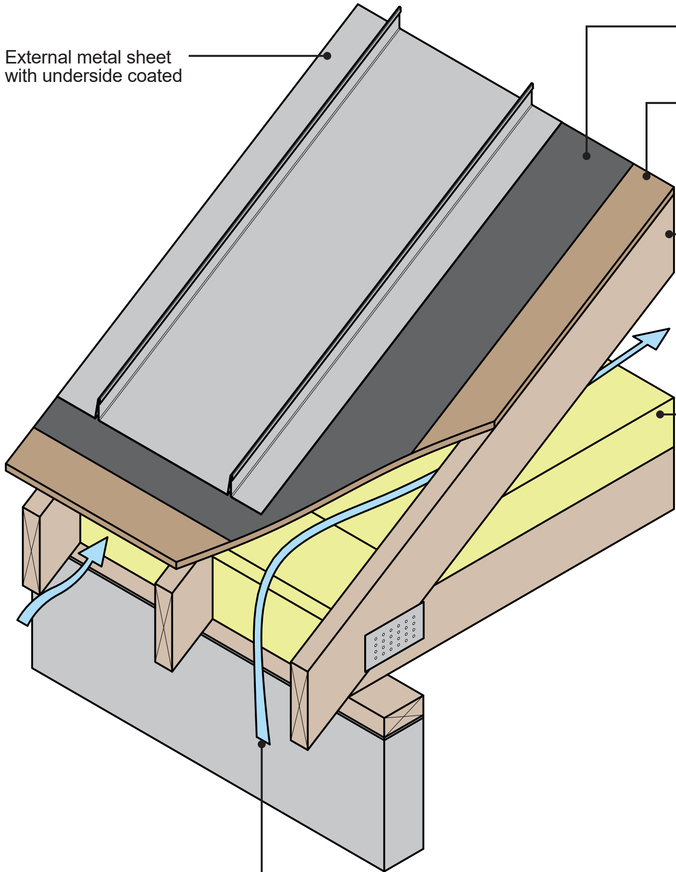
This ventilated roof void allows for any moisture escaping through the fabric to be expelled by a cross flow of air. The span of the roof should be considered when using this approach as larger spans will require an increase to the void depth and eaves ventilation provisions.





Cold ventilated ‘pitched’ roof

The cold pitched roof arrangement requires ventilation at low level and at high level as per guidance in the ‘Roofs’ section, as the timber deck prevents any warm air escaping.



Other considerations

External environments
External metal sheets can degrade at a faster rate in coastal locations. In addition, certain chemically corrosive environments, such as sites in close proximity to manufacturing facilities such as chemical works, cement works, copper foundries or coal mines can also cause external metal sheets to degrade at a faster rate.

Where external metal sheets are used within 5km of the coast or when they're used in chemically corrosive environments as specified above, a third party product conformity certificate must be available for the external metal sheet (for both warm and cold pitched roofs).

For the purpose of Warranty, the third party product conformity certificate must be made available to the Warranty Surveyor prior to the selection of the system and explicitly state the product has been assessed for use in the environment it is intended to be used and it has at least a minimum life expectancy of 25 years.

In instances where the third party product conformity certification does not explicitly state the metal sheets are suitable for use in the above environments, the product should not be specified within 5km of the coast or in chemically corrosive environments as it has not been assessed for use in that location.

Where external metal sheets are specified in the above environments, periodic cleaning may be necessary; and a man safe system should be included as part of the design to aid in the periodic cleaning. Advice should be sought from the external metal sheet manufacturer.

Fire classification
The entire system (not just the external metal sheet) should be assessed to meet the requirements of the Building Regulations, Approved Document B in England and Wales. In particular, the entire system must meet B4 of Approved Document B. For further guidance, advice should be sought from the appointed Building Control Body.

Deck exposure during construction
Any membrane applied during construction that is left open should be capable of resisting moisture penetration. In the event that a LR membrane is used, the deck should be assessed in relation to its moisture content before any further layers of building fabric are applied. Moisture content of timber boarding should not exceed 20% at point of roof covering being applied.

Ply bonded on insulation
Ply or timber topped insulation should not be a site formed configuration. Ply or timber topped insulation boards must be produced in a controlled factory environment which holds all the necessary accreditation for production and has a demonstrable quality control procedures to ensure they are fit for purpose. Such documentation may be requested by the Warranty Surveyor to prove and demonstrate the above is achieved.

The overall performance of such insulation boards, inclusive of structural capabilities, compatibility and durability should be subject to assessment utilising suitable third party product conformity certificate as a minimum.

Expansion
If timber such as plywood is used for the structural support deck, movement gaps should be considered for square edged boards at rigid upstands and between boards. A minimum gap of 3mm needs to be maintained between boards and 10mm with rigid abutments.

Checklist for manufacturer's site specific design

As a minimum, the site specific design should include all of the following points:

- The document must reference the third party product conformity certificate (for the complete system, not only individual components) to confirm this has been reviewed in line with our Warranty requirements (not applicable to cold pitched roofs).
- The location of the development must be reviewed - if the location is a chemically corrosive environment (as described within this section), reference should be made to the third party product conformity certificate confirming it is suitable for use with a minimum life expectancy of 25 years.
- The manufacturer should be consulted with regards to the site specific fixing specification for the external metal sheets.
- Roof build up needs to be detailed to be aligned with the third party product conformity certificate (for the complete system, not only individual components).
- A list of components to be used needs to be provided and any incompatible components should be clearly highlighted. Details for methods of separation between incompatible materials (location, type and method of fixing) must be specified.
- Details of protective coating applied to the underside of the external metal sheeting needs to be highlighted (type and thickness of coating). Protective coatings must be factory applied.
- Air and Vapour control layers (AVCL's) should have a minimum vapour resistance of 5000-7000 MN.s.g. This must be detailed in the site specific design.
- A condensation risk analysis must be provided with reference to the humidity class used.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. As a minimum, we require the following:

1. A full structural design for the roof, including (but not limited to) sizing of timber members for spans and loads, fixing methodology/specification, bracing and restraint requirements.
2. A full set of detailed drawings including:
   a) Manufacturer's pre-formed truss layout drawings or full details of the roof layout inclusive of any intersecting or supportive roof structure such as hips, ridges, purlins, valleys and associated timbers e.g. lay boards, trimming members.
   b) Sectional details showing roof build-up with all materials to be used in the construction of the double skin metal roof.
   c) Details for any required trimming work around chimneys, formation of access hatches, details for the formation of supportive structure for equipment and access to equipment requiring periodic maintenance and inspection contained within the roof space.
   d) Waterproofing and flashing details around abutments, chimneys, service penetrations etc.
   e) Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
3. Details of all materials to be used in the construction of a double skin metal roof including (but not limited to, the metal sheet, insulation, separation layers/ membranes, vapour control layers, support system, ancillary components etc.)

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Approved installers

Due to the complex nature of external metal sheet roofing, we require the installer to be approved by the manufacturer.

Where the manufacturer doesn't retain a list of approved installers, evidence should be provided showing the installer is competent and trained with external metal sheet roofing.

Double skin insulated roof

A double skin insulated roof is constructed on-site from separate components generally comprising: liner sheet, vapour control layer (VCL), spacer system, insulation, breather membrane and finished externally with top weathering sheets.

Top weathering sheets are generally secret fixed onto clips or standing seam sheets onto halters, these being machine seamed once fixed. Pierce fixed sheets are still widely used, which are fixed directly to the spacer system with external visible fixings.

Liner sheets can be solid or perforated to give an acoustic, sound-deadening roof. They are fixed directly to purlins, and can act as a VCL if a separate vapour barrier is not specified. If the liner is not used as a VCL, a reinforced vapour control sheet should be incorporated within the roof.

Insulation must be installed between the VCL and the top weathering sheet; some systems may require ventilation above the insulation and others may not; it varies from manufacturer to manufacturer. Where there is no requirement to ventilate, the insulation should be compressed slightly to ensure that there are no air voids where condensation may occur.

Workmanship

Top weathering sheets
Ensure that the top weathering sheets are installed in accordance with the manufacturer's instructions.

These must be long enough to discharge into the gutter correctly and allow for an eaves angle if required by the system.

Check that end and side lap tape sizes conform to the manufacturer's requirements. For pierce fixed trapezoidal sheets, check for tell tales to end laps and side laps for the correct number of rows of tape.

Liner sheets
Where the liner sheet is solid and used as a vapour check, note the following:

- Frequency of main fixings to purlins and frequency of side lap stitchers.
- End laps to be sealed with mastic tape; check the size and that this is continuous. Side laps have a wider 50mm Polyband tape placed from the inside so this is visible from above.
- Check for cuts or splits in this metal liner.
- Ensure that to eaves and ridge the correct filler blocks have been used, bedded in mastic; if necessary, a closure flashing must be used from the crown of the sheet to the wall junction to maintain a vapour check. Check the use of sealant tapes and fire-retardant foam.

Separate vapour control layer (VCL)
This should be a reinforced sheet, and is used to ensure a more positive air seal around the perimeter of the building. The vapour check should be sealed in the field area with the correct tape, with the number of rows dependent on the application. Check the integrity of these tapes and that they are continuous and correctly joined. Where the vapour check abuts the walls to the verge or eaves, it must be properly sealed in accordance with the Architect's detail. Around penetrations, the vapour check must be cut and sealed to any pipes or upstands.

The spacer system is fixed through the vapour check and liner into the purlins. The spacer system will have a soft sealing pad to ensure the vapour check is maintained around the fixing. Check for punctures of the vapour check by foot traffic or damage, and patch as required.

Insulation
Check the packaging to ensure that the correct thickness is being used if one layer is used, or a combination of thicknesses to give the correct specified thickness. For two thicknesses or more, check that all joints are staggered and check the Lambda value against the specification.

Ensure that no packaging or debris is left in the roof void prior to or during the installation of the insulation. The insulation should fill the void or be compressed into the void; there should be no slumping or gaps and it should be packed into voids at the junctions of the ridge and verge.

With standing seam roofs, a rigid mineral slab insulation should be placed at eaves, ridge and around all penetrations and walkways to support the vulnerable areas of the roof, which will give a solid support to the roof sheet pans. This is easy to see during construction and easily felt on completion. The supported pan of the sheet feels solid to walk on.

Support system
Check the frequency of brackets against the specification and the number of fixings per bracket, and that they are the correct type of fixing. With standing seam roofs, the halter may be fixed with a stainless steel fixing; check the type and frequency of fixing. Check the orientation of the halter in relation to the lay of the sheet, i.e. will they pick up the seam, as there is a right and wrong way round for halters.

Manufacturers provide halter templates to set out halters, and there must be one on-site to obtain the correct gauging of the halters.

Roof penetrations
These must be sealed to maintain the VCL. Where the liner is used as a VCL, the metal-to-metal junction must be sealed with fire-retardant foam. With a separate VCL, this must be sealed to the upstand or pipes with the appropriate tape. Externally with aluminium roof sheets, the junctions with penetrations should be site welded or weathered using glass reinforced plastic (GRP) in-situ weathering.

Roof lights
Standing seam roof sheets are usually on separate insulated upstands. With pierce fixed trapezoidal roof sheets, roof lights are in line, either factory or site assembled. Ensure that the correct size of tape is used, check the number of rows of tape that are required and that side lap tapes are not twisted by fasteners.

General
Check surface finishes for abrasions, dents and cuts, and that the roof has not been used as a cutting surface for flashings or other metal. Hot swarf from angle grinders burns into the plastisol coating of steel sheets, marks aluminium and rapidly turns to rust. Flashings should have sufficient overlap or butt straps, 150mm wide, and be sealed and supported. Check the frequency of fixings and that they are of the correct type.

Composite panel metal roofing

A composite metal panel which is manufactured 'off-site' in a factory controlled environment, and is delivered as a complete material/sheet incorporating the top weathering sheet, insulated core and liner sheet to its underside. With the increase in insulation, thickness panels are being made shorter in length so they can be handled into position. This means that there are more end laps to be checked.

The standard manufacturer's details are to be adhered to, but the following need to be checked.

Workmanship and installation

Fixings
There may be a requirement for stainless steel fixings to be used. Check by inspecting boxes and use a magnet; drill points will be magnetic only. Check fixings are suitable for the purlin type - steel, light gauge cold rolled, heavy gauge or timber - as all fixings are different.

Check the bearing area of the purlin; if the building is not square, the sheets will run out and the end lap detail will not be supported. This can be overcome by using a galvanised support that is fixed to the purlin and which supports the end lap.

Check that the right number of fixings has been used for the panel and the frequency of side lap stitchers; ensure that they are side lap stitchers and not main fixings.

Sealant tapes
Check the number of rows required by the manufacturer of the panel for end laps. Tell tales should be visible at side laps of each sheet. Tell tales are the ends of the mastic tape run that can be seen or must be felt for at the side of each sheet. The same applies to side laps; there should be a tell-tale at the end of the sheet. Use the end of a hacksaw blade to locate the rows of mastic tape.

On roof lights, mastic tape is visible; check its location, that its size complies with the manufacturer's requirements and that there are the correct number of rows. Tape should not be twisted by the fixings.

Air tightness
There must be a supply of gun foam, fire rated, at roof level for filling in voids before flashings are fixed. If there is not one on site, air tightness and maintaining the insulation cannot be fully achieved.

The use of foam needs to be inspected during the course of construction, and internal tapes to eaves and ridge purlins need to be inspected for size and position. At the ridge, the gap between panels needs to be filled with foam to maintain the insulation and prevent condensation forming. There also needs to be a suitably sealed inner ridge.

Verge details are difficult and it may be necessary for an internal verge to be cut and sealed around purlins. Check sealant tapes and the use of gun foam to maintain insulation. The manufacturer's details may not be achievable, but an alternative must be devised to maintain air tightness. A degree of confidence in this requirement should be shown on-site as an indication of the importance of air tightness and how this can be achieved.

Gutter junctions
If parapet or valley gutters are being used, check the air seal at the junction of the two. Gutter joints are not always level, and any gaps have to be filled. This will not only prevent wind-driven rain from entering the building, but will also maintain an air seal.

Check that roof sheets are oversailing into the gutter correctly.

Roof penetrations
Penetrations such as flues, vents, upstand-type roof lights and sun tubes need to be sealed internally, the insulation being maintained with site-applied foam. Externally, upstands must be weathered correctly and, with steel composite sheets, this is best achieved using GRP in-situ weathering.

General
Check surface finish for cuts and abrasions.

Check that the roof has not been used as a cutting surface for flashings or other metal. Hot swarf from angle grinders burns into the plastisol coating and rapidly turns to rust.

Flashings should have a sufficient overlap and be sealed and supported. Check the frequency of fixings and that they are of the right type. Check for closure from gutters and sheet oversails. There should be suitable shrouds to prevent birds or vermin from getting into the building, which can be often overlooked.

Component/Inspection	**Rectification needed**		**Comments**
	Yes	No	
Check bearing width of purlin			
Check minimum overlap of linear decking sheets: 1. Light gauge steel 2. Hot rolled steel 3. Timber - check for minimum penetration			
Check that side laps are stitched at the correct centres			
Vapour control checks using the liner: 1. Check tape to side laps, minimum width 50mm air and moisture barrier tape 2. Check tape to end laps 3. Check inner fillers to ridge, eaves and verge 4. Check for sealing around the perimeter with fire-resisting foam			
Vapour control checks using a separate VCL: 1. Check the minimum overlap is correct 2. Check for the correct sealant tape 3. Check for the correct number of rows of sealant tape 4. Check junctions between VCL and building elements, e.g. upstands, eaves, verge, etc. 5. Check for puncture and repair where necessary			
Spacer systems: 1. Check for correct height of bracket or halter 2. Correct number of fixings per bracket or halter 3. Check for stainless steel if specified 4. Check for gauging of halters for standing seam and secret fix roof sheets			Use a magnet
Insulation: 1. Check that the correct thickness is being used 2. Check that insulation is the correct type and has the same properties as specified 3. Check for compression 4. Check that insulation joints are staggered 5. Ensure that insulation designed to support load has been correctly installed to eaves, ridge, penetrations and walkways 6. Ensure all packaging and debris is removed prior to fitting of the roof sheets			
Breather membranes: 1. Ensure the membrane is laid in the correct direction and in accordance with the manufacturer's instructions			
Roof sheets - standing seam and secret fixed: 1. Check that sheets are long enough so that water effectively drains into the gutter 2. Check the direction of lay of sheets in relation to the direction of the prevailing wind 3. Check eaves detail, including eaves drips and fixing, in accordance with the manufacturer's details 4. Check ridge detail, including turn up fillers and ridge dams, in accordance with the manufacturers details 5. Check verge detail and adequacy of support for cut sheets 6. Check flashing supports, sheet/verge flashing seals and frequency of fixings			
Roof sheets - pierced fixed: 1. Check overlap dimension 2. Check end lap tape and correct number of rows of tape 3. Check for side lap tape 4. Check quantity of fixings per sheet per purlin 5. Check washer size of main fixings and side lap stitchers 6. Check frequency of side lap stitchers 7. Inspect for correct tightening of main fixings and side lap stitchers			
Penetrations for vents, sun pipes etc. **A - Aluminium sheets:** Check sheets are site welded and area post coated where colour sheets are used Check that the VCL and breather membrane are maintained around the welded area Check upstands are at least 150mm **B - Steel sheets:** Ideally use GRP in-situ weathering flashings; however, if folded flashings are used, check: 1. Overlap 2. Sealing and fixing of overlaps 3. If a flat sheet back to the ridge is used, check for insulation under the sheet 4. Check frequency of fixings 5. Check sealing of overlapping sheets			

Component/Inspection	Rectification needed		Comments
	Yes	No	
Flashings: 1. Check end overlap 2. Check frequency of fixings 3. Check correct type of fixing is used			
General: 1. Check roof surface for cuts and abrasions 2. Check for hot swarf damage			
Panel laps to be tight when viewed from inside the building			
Constant straight line on side laps to be achieved			
Fasteners correct for the purlin: 1. Light gauge steel 2. Heavy gauge steel 3. Timber			
Fastener material: 1. Coated carbon steel 2. Stainless steel			Check with a magnet
Fastener frequency main roof: 1. Main fixings 2. Side lap stitchers			
Fastener frequency roof lights: 1. Main fixings 2. Side lap stitchers			
Bearing area of purlin at end lap; is a supporting bearing plate required?			Is the building square?
End laps: 1. Correct number of rows of joining tape 2. Correct size of end lap tape 3. Correct position of end lap tape in relation to fixing			
Roof light tape positions: 1. Correct number of rows of joining tape 2. Correct size of end lap tape 3. Correct position of end lap tape in relation to fixing			
Is the roof adequately air tight (visual inspection and air tightness test where necessary)?			
Provision of fire-retardant gun foam: 1. Eaves level 2. Verges 3. Gutters 4. Internal verge positions 5. Foam insulation at ridge			
Gutter junctions: 1. Adequacy of seals at gutter junctions 2. Correct provision of weir overflows to gutter runs 3. Correct junction detail between gutters and verge flashings 4. Gaps sealed to prevent vermin infestation 5. Correct discharge of water from roof sheets into gutter			
Roof penetrations: 1. Check seals around cut foam insulation internally 2. Check internal flashing closures 3. Check weather penetrations externally			
Flashings: 1. Check end overlaps 2. Check frequency of fixings			
General: 1. Check roof covering for cuts and abrasions 2. Check for hot swarf damage			

11.
Roofs

11.7
Blue Roofs

Limitations of this guidance

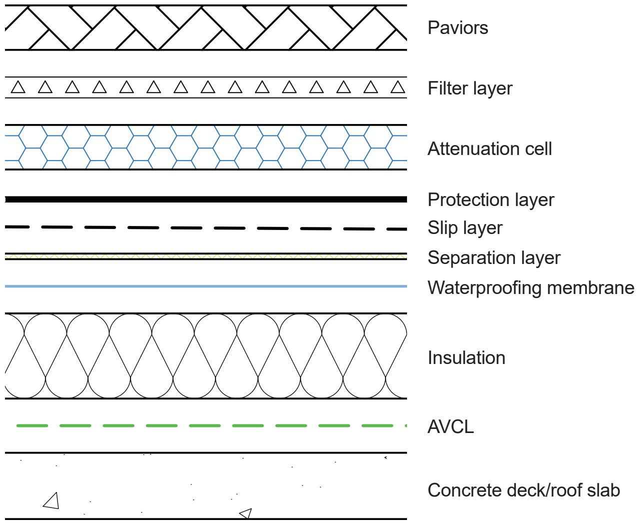
- For Warranty purpose, where insulation is required, ‘cold deck’ applications are not an acceptable approach in any circumstance in the design of above ground attenuation surfaces such as blue roofs.
- Blue roofs used in conjunction with green roof finishes can be effective. In these situations, the green roof build-up may be usable as part of the attenuation storage. However, the attenuated water must not exceed the designed water head.
- Loadings applied must be checked and approved by the Engineer for the design and deflected form of the roof or podium slab.
- Attenuation cells have commonly a water head not exceeding 100mm (1.0kN.m-2) (note: 60mm of water is approximately equivalent to the minimum imposed snow load of 0.6kN.m-2). Total loading for the design of the reinforced concrete roof or deck must be checked and approved by the Engineer.
- Inverted Blue roofs where water storage is layered above the insulation and the waterproofing, will have to withstand potential buoyancy up thrust. This may restrict the depth of insulation which can be used as, a ballast weight of 1.0 kN.m^2 is required for every 100mm thickness of insulation (in addition to the water loading).
- Inverted insulated roofs will require additional insulation to satisfy Building Regulation requirements through reduction of thermal performance of the insulation due to saturation and the cooling effect of water at the waterproofing layer.
- This guidance is not intended as a standalone design guide and does not include full details of what must be considered to comply with other associated design guides.
- All proposals for above ground attenuation surfaces are considered on a case by case basis due to the developing nature of guidance available.

Provision of information

1. Written demonstration that all other retention and within-site attenuation and release strategies have been explored before a blue roof has been proposed.
2. A clear indication of the usage for the roof or deck surface along with its possible future use.
3. A full set of detail drawings, including:
   a) A full set of section details detailing each proposed build up for the above ground attenuation layers and blue roof areas and junctions with adjoining structures.
   b) GA plan details for each above ground attenuation surface areas, noting build up types if these vary.
   c) Waterproof membrane threshold detailing linked back to damp proof course which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
   d) Detail for pipe penetrations through wall and floor and detail showing 150mm waterproofing upstand around penetrations which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
   e) Details of locations of any fixings into slab.
   f) Details showing waterproofing upstand around penetrations which is to be 150mm above the datum of the highest level of attenuated water proposed in all circumstances.
   g) Details of large obstructions such as planters, M&E equipment or similar and method to ensure water is diverted around these obstructions where applicable.
   h) Details showing location of movement joints proposed.
4. Engineers design philosophy statement including but not limited to calculation of substrate deflection, design wind loads, supply of long-term deflection gradient drawings and required installation tolerances. The design team must also collaborate with the drainage consultant to demonstrate clearly that ponding or back falls will not occur.
5. Full details of component products used, including details of third party accreditation certification for all components of the all elements of complete proposed waterproofing and drainage system.
6. Drainage design drawings and peak flow calculations showing position of outlets and provision of overflows. Overflows should be clearly visible to warn of potential blockages in the drainage system.
7. Details of access and repair plan from the building management to address how remedial works could be undertaken in the event of a defect.
8. Details of proposed maintenance strategy, including an undertaking from the building management to ensure that frequent maintenance to the above ground attenuation surfaces are evidenced to be implemented.
9. A condensation risk assessment through the roof, or otherwise demonstrate how the risk of condensation will be limited.
10. All installers must have a demonstrable history of installing blue roof systems. Evidence of this must be provided to the Warranty Surveyor.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Blue roof (warm) – Layering



Filter layer: Protects the attenuation cell - reservoir against clogging by fine particles from the sub-base or layering course. It also ensures effective horizontal drainage. If topsoil is used, special measures should be taken for fine soil particles clogging the filter layer.

Attenuation cell reservoir: Attenuation to be designed to discharge the maximum designed head of water within a 24 hour period.

Protection layer: The layer protects the waterproofing membrane from damage caused by the static and dynamic loads. Protection layers may also fulfil the function of the slip and separation layers.

Slip layer: Horizontal loads occur by temperature change and dynamic forces. Waterproofing materials cannot withstand these loads and therefore care should be given for its specification.

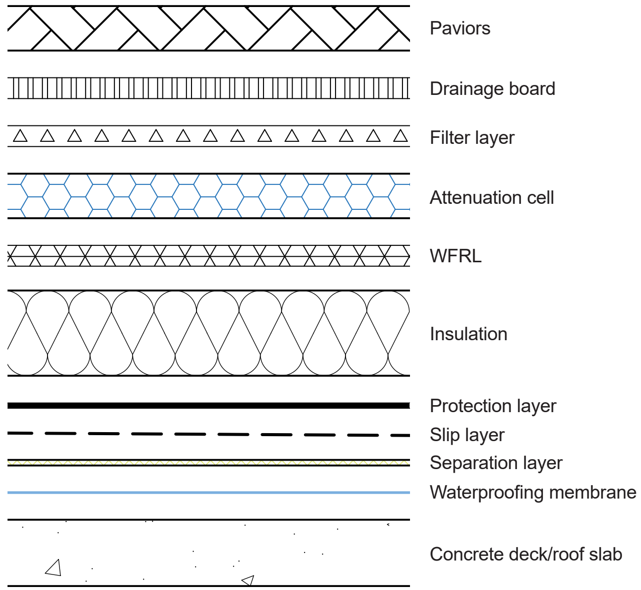
Separation layer: Separates incompatible materials.

Waterproofing membrane: Bonded elastomeric system: Underlay - Self-adhesive; Capping sheet - Torch on.

Insulation: Compressive strength to support increased loadings. Tapered to falls. Thermal requirements to meet Approved Document L.

AVCL: Tear resistant air and vapour control layer.

Blue roof (inverted) – Layering



Drainage board: Allows free multi-directional dispersal of water.

Filter layer: Protects the attenuation cell - reservoir against clogging by fine particles from the sub-base or layering course. It also ensures effective horizontal drainage. If topsoil is used, special measures should be taken for fine soil particles clogging the filter layer.

Attenuation cell reservoir: Attenuation to be designed to discharge the maximum designed head of water within a 24 hour period.

WFRL: Water Flow Reducing Layer. A barrier to rainwater reducing the volume of water that can reach the waterproof roof deck.

Insulation: Compressive strength to support increased loadings. Tapered to falls. Thermal requirements to meet Approved Document L.

Protection layer: The layer protects the waterproofing membrane from damage caused by the static and dynamic loads. Protection layers may also fulfil the function of the slip and separation layers.

Slip layer: Horizontal loads occur by temperature change and dynamic forces. Waterproofing materials cannot withstand these loads and therefore care should be given for its specification.

Separation layer: Separates incompatible materials.

Waterproofing membrane: Bonded bitumen.

Definitions

The requirement of any roof or deck that is to be waterproofed, is to protect the structure and space underneath from the ingress of water.

A Blue Roof is defined as:
A roof design that is explicitly intended to store rainfall temporarily at a level not exceeding the designed hydraulic head, for a defined period of time above a thermally conditioned space.

A Blue Podium deck is defined as:
A deck design that is explicitly intended to store rainfall temporarily at a level not exceeding the designed hydraulic head, for a defined period of time above a thermally unconditioned space.

Therefore, Blue roofs systems manage rainfall by temporarily attenuating rainfall at a controlled predetermined rate and capacity before discharging into the rainwater sewers. Blue roofs may be classified as either ‘Active’ or ‘Passive’ depending on the types of control devices used to regulate drainage of water from the roof and overflows. Active or ‘smart’ approaches are discouraged due to reliance on technological infrastructure and are reviewed on a case by case basis. They should only be proposed where it is not possible to specify a passive approach.

General design principles

- All aspects of the design are to conform to BS 6229 and the ‘Roofs’ section of this Warranty Technical Manual.
- Blue roofs should half empty in no more than a 12-hour period from the end of the specified design storm, AND should manage water for no more than a 24-hour period from the end of a 1:100 year storm profile for the roof (+40% minimum factor for climate change).
- There must be a concealed void to contain the designed attenuation capacity of storm water.
- Rainfall at the exposed surface level must be managed to ensure that it does not accumulate or pond water on the final finishes.
- There must be a multidirectional flow path above the waterproofing membrane, for water to reach the drainage points.
- All component materials and products used for a Blue roof system must include a recognised third party accreditation certification or other harmonised European Standard.
- Flotation risk for inverted roofs should be calculated and addressed by providing loading to the insulation such that it cannot become buoyant. A warm roof to falls is encouraged to avoid the risks associated with flotation in an inverted warm blue roof.

For the design of a Blue Roof, reference to other associated technical standards may be appropriate.
Examples include:
- Continuous Membrane Roofing
- Green Roofs
- Podium Decks
- Drainage

Blue roofs and basements

If the space beneath the Blue Roof is situated below ground level, the design may require to be coordinated alongside a CSSW qualified structural waterproofing specialist. Please refer to the ‘Basements’ section for further guidance.

Associated principles
- The principles of BS6229 Flat roofs with continuously supported flexible waterproof coverings - Code of practice: are to be applied to waterproofing of roof and deck slabs to ensure water ingress does not occur.
- BS 8102 – Code of practice for protection of below ground structures against water ingress Code of Practice to be applied to ensure continuity of waterproofing at junctions with below ground construction.

Substrate – the roof slab or podium deck

The introduction of a Blue Roof system may have loading implications for the structure of the building. It is vital to consult an Engineer at an early stage, especially when designing for a SuDS solution where water will be attenuated within the roof structure. For example: Designing for heads of water and drainage from the roof can result in an uneven distribution load across the substrate and can lead to large horizontal forces on parapet walls and building upstands.

Substrates constructed of reinforced concrete and correctly designed by a competent Engineer have proven to be the most reliable, designed in accordance with BS EN 1992-1- 1 Design of Concrete Structures.

Other substrates will require specialist involvement to demonstrate that the substrate will be dimensionally stable and be suitable for a Blue roof proposal.

For Warranty purposes, roof or deck slabs constructed using pre-cast block and beam systems or pre-cast concrete planks are not acceptable for Blue Roof substrate applications.

Where there is any risk for potential excessive movement as a result of the substrate selection or any subsequent usage of the deck area, the designer must ensure through clear evaluation and demonstration that the system is able to cope with the worst case anticipated movement to avoid inducing tensile and shearing stresses in the water proof membrane.

The hydraulic design must take into account any deflections, and re-evaluate peak water depths and loadings in light of this deflection.

Waterproofing

All aspects of the design of the waterproofing membrane to conform to BS 6229 Flat roofs with continuously supported flexible waterproof coverings – Code of Practice.

Fully bonded or monolithic systems are typically appropriate for ‘above ground attenuation surfaces’ such as those provided for Blue roof waterproofing membranes. Any certified system MUST NOT allow ‘tracking’ of water between the substrate and the waterproof membrane.

Curing agents may, on occasion, be applied to the top surface of the concrete substrate to:
- Enhance the concrete quality and durability.
- Reduce the curing period.

The curing agent essentially forms a membrane across the concrete surface of the laid concrete to increase the density of the cement paste and lower the porosity at the surface. This increases resistance to external influences, surface stresses and attack.

Applied curing compounds are not always compatible with a proposed hot-melt application. Adhesion may be reduced causing delamination from the substrate and potentially cause water to track under the waterproof layer following a membrane failure.

Compounds based on a Sodium Silicate base are generally acceptable for a direct applied hot-melt waterproofing application. Adhesion reduction is likely when the base component of the curing agent is:
- Acrylic and Chlorinated rubber
- Resin
- Wax
- Wax/Resin

All systems provided must have 3rd party product approval accreditation referencing the proposed use.

As soon as is practically possible, the waterproof membrane will require protection against damage from either follow on trades or the deck being used as material storage space.

Prior to applying surface finishes above the waterproof layer, the waterproof membrane must be integrity tested and verified by an independent third party. Additional testing may be required where by inspection there is potential that defects may have occurred as a result of damage from follow on trades or the deck being used as storage.

The waterproofing membrane must be linked to any cavity tray to avoid discontinuity resulting in moisture ingress.

Drainage and falls

Drainage
It is important that the Blue Roof system is effectively designed to adequately deal with the predicted rainwater for the sites geographical location. Analysis calculations to determine the drainage load using a dynamic storage assessment method to find the critical duration can be determined by using data models:
- FEH13 (preferred)
- FSR rainfall data

Analysis is based on 1:100-year risk + 40% climate change allowance. This method examines a series of storm durations from 5 minutes to 48 hours. Each model calculates flow storage and outflow to determine the storm which creates the largest depth becomes the critical duration for Blue Roof system.

A drainage design must be provided for the blue roof element by a suitably qualified and experienced engineer using the methods set out above, with overflow provision being calculated in accordance with BS EN 12056-3

The design is to specify the following:
- A retention of no more than 100mm water head (1.0kN.m^2) should be used. In all cases, the total loading must be checked and approved by the Engineer for the project.
- Drainage flow calculations accompanied with an explanatory statement including assumptions made.
- Multi directional drainage flow above waterproof membrane.

The specified hydraulic head must never be exceeded and therefore drainage outlets must be designed and positioned to remove excess water. Overflows must be conspicuously positioned.

Drainage from Blue Roofs should not discharge onto lower roof or decks.

Please note: the design of site drainage controls may be determined by flood risk strategies in planning consents with run-off rates typically in the range 5-10 l/s/hectare.

Falls
Where positive falls are proposed, the falls should not be less than 1:80. Where zero falls are proposed, the falls must be between 0 and 1:80.

Certain criteria need to be met by an appointed contractor in order to qualify as acceptable to our Warranty, to design and install zero falls. Projects which propose elements of zero fall should be limited to inverted roofs and must be agreed in advance with the Warranty at an early stage in the design and before the offer of Warranty is made.

It should be noted that the degree of fall on a roof is absolutely critical to the functionality of a blue roof and warm blue roofs tapered or laid to fall have several beneficial advantages such as the avoidance of flotation risk and the removal of standing water. However, the designer should note a positive fall will increase water depths on the roof, and lead to an uneven loading on the slab as water is stored in the tapering storage zone a fall creates which must be considered in the structural design approach for the slab.

Great care must be taken on long roofs with a slope to ensure that the fall is adequately designed into the storage, and that water depths at the downstream end are not excessive, either in terms of the vertical or horizontal loading.

Where a ‘Blue roof’ system is proposed above an unheated space these would be considered a podium deck. The designer should ensure that the deck is able to be sufficiently drained to limit ponding and back falls.

Rainwater outlets

The choice of outlet is critical in a Blue Roof construction. Rainwater outlets must be designed so as to allow:

- No significant retention after 24 hours in the water reservoir.
- Retention of water reduced by a minimum 50% after 12 hours.
- Have an overflow facility with a capacity to discharge a peak rainfall discharge rate.(BS EN12056–3 Category 1).
- Certification of rainwater outlet to include water head test of the seal to the waterproof membrane.

Rainwater outlets are also to be:

- Positioned in the locations of maximum deflection.
- Countersunk into the deck surface level under the waterproof layer.
- Waterproofing membrane must be dressed into the outlets.
- Surface water from roof and deck finishes should not discharge directly onto the waterproof membrane.

Particular care and attention is required to demonstrate the fixing method between the outlet and flow rate restrictors are fitted to achieve a homogeneous seal between the waterproofing and the outlet.

Outlets on warm roofs
Insulation should be isolated from the rainwater outlet:

- Air and vapour control layer to be sealed to the waterproof membrane at a square (plan) exclusion zone to all rainwater outlets.
- The exclusion zone is to be not less than 250mm from the rainwater outlet.
- A condensation risk in these locations is to be reviewed and avoided.

Outlets on inverted roofs
Drainage discharge provision should be made to ensure:

- The provision for drainage occurs at waterproof membrane level.
- The provision of clearly marked access to rainwater outlets, which are free of obstruction.
- Sufficient ballast to prevent flotation of insulation.

Insulation, condensation risk and flotation

Insulation specified must be proposed as part of a compatible system from a manufacturer.

The U-value achieved in an inverted roof, greatly depends upon the amount of water that passes through the joints of the insulation and sits on the waterproofing is available in test method Appendix C of ETAG 031-1.

Following BS 6229, it is deemed reasonable to apply an increase 10% correction factor to the thickness of the insulation on what might normally be applied to address the potential reduction in performance of the U-Value of the system.

Condensation risk assessments should be undertaken in the roof build up at an early stage to eliminate the potential risk Interstitial Condensation should calculations show it occur.

Thermal bridge loss factors (for drainage via the water flow reducing layer WRFL and insulation) need to be considered in the U-Value calculation and the designer should demonstrate that the necessary U-Value will be provided.

Measures to achieve this could include applying the following parameters:

a) Insulation boards butted: $0.04 W \cdot day \cdot m^{-2} \cdot K^{-2} \cdot mm^{-1}$ (f=1).
b) Insulation boards twice-rebated: $0.03 W \cdot day \cdot m^{-2} \cdot K^{-2} \cdot mm^{-1}$ (f=0.75).

The warm roof insulation compressive strength must be greater than the proposed loads including additional safety factors for a fully saturated blue roof and allow for the proposed pedestrian surface finish and traffic.

In a warm roof construction, abutting insulation can cause localised depressions in the waterproofing membrane which can promote ponding in these areas which may have a detrimental effect on the lifespan of the waterproofing membrane.

Inverted blue roofs with water storage above the insulation will have to withstand the buoyant up thrust of that insulation. The Water Flow Reducing Layer (WFRL), even where fully taped or glued, properly lapped and with no folds or creases has been shown by testing not to be able to fully resist standing water above it allowing significant rates of water to pass to the waterproofing layer under the insulation. This causes a tendency to produce a buoyant effect and providing uplift and therefore floatation on the system which is not acceptable.

It can take some time for this to occur over the lifespan on the building and so robust measures in inverted roofs are required to ensure the integrity of the WFRL are in place.

The water separation layer is not fully waterproof. Water penetration of that layer should be expected during the longer duration storms which can lead to uplift and so conservative assumptions should be taken on the efficacy of the ability of the WFRL to disperse water for the purposes of avoiding floatation.

Without controls, full floatation of the insulation should be expected, as water level in the insulation will be the same as that at the control. In all cases sufficient loading must be applied to any inverted blue roof, such that uplift of the system due to flotation cannot occur.

This floatation risk may require the designer to consider the depth of insulation that can be used, as every 100mm of insulation thickness will typically require a ballast weight of around 1.0kN.m-2, which will be in addition to the water loading. Thus, an inverted roof with 200mm of insulation and 100mm water storage will have a total loading of nearly 3.0kN.m-2. It should be noted that this will also act as the horizontal loading on all parapets and upstand walls, which must be checked to ensure they can resist the pressure of the water build up against them.

Movement joints

Structural movement joints are required in large areas of reinforced concrete roofs and decks. Detailing of all movement joints must be provided to demonstrate that ingress or accumulation of water adjacent at or local to the joint will be prevented to limit the risk of frost-thaw action.

Materials forming movement joint must be durable and be able to flex with the waterproofing membrane. Joints must be accessible for inspection and maintenance to allow for a repair in the event of a defect.`

Slab penetrations and access provisions

Where possible it is best to avoid penetrations for service provisions and where required, the designer should look to group the services to minimise the necessary number of penetrations. Back falls are not acceptable at service penetrations.

Waterproofing must allow also for potential movement with the service penetration detailing, be fully bonded and compatible with the service pipe material. Waterproofing to extend 150mm above Blue Roof surface finished level.

Access and inspections provisions should be incorporated into the design at surface level to allow for routine maintenance to outlets. Surface Finishes should be demountable to allow for routine maintenance whilst meeting the requirements to resist wind uplift.

Surface finishes

Blue Roofs should have a surface finish above the water attenuation layers, this surface finish can be constructed from any suitable permeable pedestrian surface. An impermeable surface can be used but adequate measures should be taken to ensure the water can filter into the Blue Roof attenuation void. The requirements of the Building Regulations should be considered with regard to The Building Regulations Part B (Fire Safety) part B4.

Research demonstrates that blue roofs with green roof finishes can be effective. In these circumstances, the green roof build up may be usable as part of the attenuation storage, however the reservoir storage must be assumed to be full for blue roof design. Silting and biological growth in the reservoir is to be avoided. A root barrier is to be provided.

Excess water accumulation in a Green or Brown Roof system can have an adverse effect on the imposed dead load and planting. In extreme conditions it could change the whole green roof ecosystem, making the system ineffective. Separate maintenance requirements should be considered in a dual green/blue roof to ensure that both systems achieve the minimum required lifespan.

Building abutment joints and detailing

Abutment joints with isolated vertical construction adjacent to the roof or deck slab, should not permit the ingress of water to the space below.

Allowance therefore in the waterproofing detailing for anticipated movement between the roof slab or deck and the vertical façade must be allowed for to prevent the waterproof layer shearing. Blue Roof to Wall façade abutments are often breached by water between the cavity tray and the waterproofing membrane, therefore continuity is essential.

Additional waterproofing maybe required for any water passing the cavity tray to discharge to the Blue Roof waterproofing membrane. The detailing shall ensure that in the event of a defect in the cavity tray it will not result in moisture ingress into a conditioned space.

Level door access from the Blue Roof level to occupied spaces should provide:

- A drainage channel in front of the door cill.
- A 10mm gap between the drainage channel and the cill.
- The door cill should have a minimum 45mm overhang of the construction below.

The designer should check that in all areas there is an upstand height able to provide a waterproofing upstand at least 150mm in height. At critical points, such as the top of drainage slopes may potentially compromise this upstand height.

Architectural features

At the pre-construction phase, an audit should be established of the surface treatments, architectural features, planters and landscaping that are placed on roof or deck slab. Such detailing will require the necessity for:

- Weatherproofing - incorporating an upstand and cover flashing arrangement for solid features placed on the Blue Roof slab.
- Waterproofing – provide continuous waterproofing under the architectural feature.
- Diversion – measures should be taken to divert water around large structures to ensure that it is directed to outlets provided.

Where structures are built off the Blue Roof slab a suitably designed monolithic upstand or kicker rising above the waterproofing membrane must be provided.

Attenuated water should fall away from any structures built off the roof slab or deck.

Installation and testing requirements

A quality assurance and record keeping system should be provided at pre-construction to ensure that standards of workmanship can be demonstrated throughout installation.

1. Main contractor to provide report of testing for integrity of waterproof membrane, including credentials of test Engineer, method statement, full description of defects found and their location, evidence of repair and re-test.
2. Installer of blue roof system to provide signed certificate of satisfaction with roof finishes over blue roof if these are installed by others.
3. Installer of roof system to provide final inspection report of waterproof membrane manufacturer.
4. Inverted roofs only: Water Flow Reducing Layer (WFRL)
   a) WFRL to be dressed up to finished roof level at all abutments and penetrations noting the requirement for upstands and thresholds to be 150mm above the greatest expected height of the water line datum. Checks to be undertaken to assess the integrity of the WFRL.
   b) WFRL to be dressed down at all Rain Water Outlets.
5. The Engineer is to provide confirmation that the final construction satisfies the design deflection analysis prepared for drainage provisions.

An approved 'installation contractor' recognised by the material manufacturer with installers with a demonstrable history of installing blue roof systems are to be permitted to install the manufacturer's waterproof membrane Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty surveyor at the earliest opportunity.

Testing
Testing is required to demonstrate the integrity of the waterproof membrane undertaken by a suitably qualified and experienced third-party certified test agency independent of the roofing contractor.

Certification should be made available to the Warranty surveyor prior to handover.

The testing service provider should provide in their report:

- Date of test.
- Project name, address and reference number.
- Name, address and contact details of the test provider.
- Experience and training of tester.
- Membership of trade association which sets a code of conduct for the service.
- Description and efficacy of the waterproof installation.
- Details and large, clear photographs of defects identified (where applicable).
- Number of tests undertaken.
- Confirmation of result of testing.

Final inspection
At practical completion of the waterproofing membrane to the Blue Roof. All areas should be cleared of stored material, site operations and all protection. A thorough, visual and photo graphic recorded inspection of all areas, including deck surface architectural and landscaped features, must be carried out with representation from the main and roofing contractors in attendance.

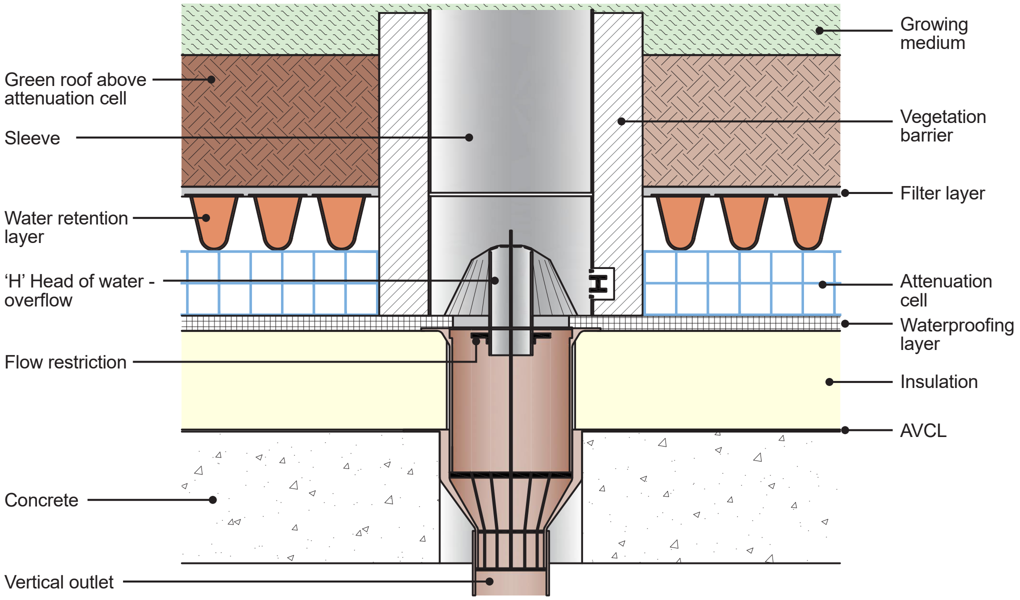
A deflection analysis will be required, 'before' and 'after' completion by the Engineer to confirm the minimum falls are achieved and that no back falls to the waterproofing surface occur.

Operations and maintenance

The Developer should have in place an Operation and maintenance manual (O&M) and should identify areas of risk including:

- Failure of maintenance and cleansing of rainwater outlets.
- Failure of filter membranes leading to obstruction of storage units.
- Flotation of inverted roof insulation.
- Blockage of small diameter control holes to drains.
- Removal of controls, leading to unrestricted discharge (risk to wider community rather than the project building).

Blue roof drainage section (warm) - in conjunction with a green roof



11.
Roofs

11.8
Podium Decks

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full structural design for the podium deck.
2. A plan or plans which detailed drainage provisions showing falls and their direction, and the position of accessible outlets to provide effective drainage with no back falls. Due to complexity and additional loadings, deflection and drainage analysis should also be provided.
3. Sections through the construction, detailing how falls are formed e.g. created by the structural deck, additional bonded screed layers. This should include outline levels survey requirements and preparation treatment of deck before application of waterproofing.
4. Sectional details that show thickness, specification and position of the components inclusive of all materials relating to the podium (see definitions for extensive material listing).
5. Details of all fixings, their frequency and fixing method.
6. Methodology and evidence of pull testing for fixings and pull/peel testing for bonded materials.
7. A suite of site specific details for all junctions, outlets and penetrations.
8. Details of all fire stopping within structure and fire mitigation measures. This should include specification and a detailed location layout drawings showing positioning.
9. Outline of method and plan for testing the integrity of the waterproofing layer.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Introduction

This section provides technical guidance for the design, use of materials and workmanship for podium decks to meet the functional requirements of the Technical Manual.

Examples of podium decks include:

- An open amenity space above a sub-terrain car park.
- A terrace.

Definition

Podium deck
Podium decks are an open spaced amenity structural slab/deck and are defined for Warranty purposes as:
An externally weathered elevated platform over an unconditioned (unheated or soundproofed) space.

The requirement to waterproof is to:

- Protect the deck surface from water accumulation, and,
- Prevent the ingress of water to the space below, and,
- Prevent ingress of water to adjacent buildings.

Where a space below a proposed deck is conditioned (heat and sound), it would no longer be considered as a 'podium' and instead is classified as an insulated flat roof deck.

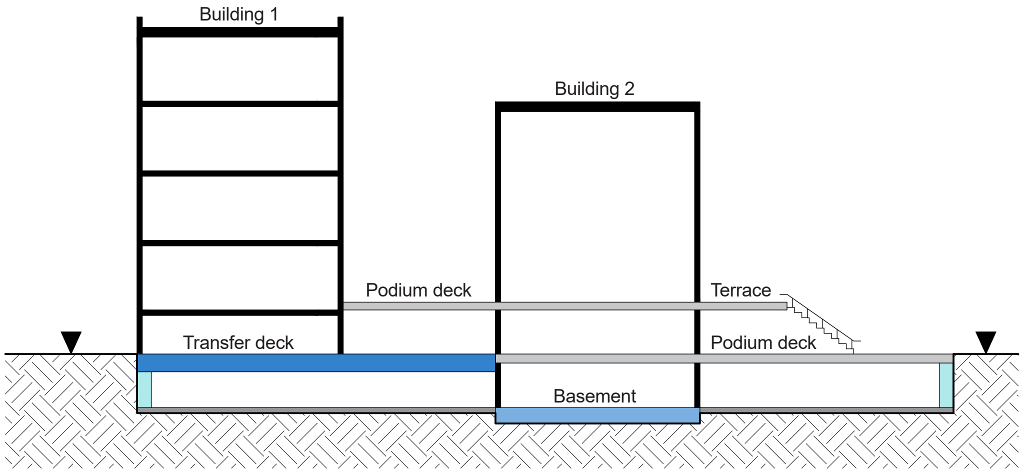
Please refer to BS 6229 – Flat roofs with continuously supported flexible waterproof coverings - Code of practice and the 'Roofs' section of this Technical Manual.

Transfer deck
A transfer deck is a uniquely loaded supporting podium deck. The designed vertical superstructure loads supported from the deck are transferred along a horizontal load path along designed beams integral with the slab to new supports.

The requirement to waterproof is to:

- Protect the deck surface from water accumulation, and,
- Prevent the ingress of water to the space below, and,
- Prevent water ingress into buildings supported on and adjacent to the deck.

Typical podium deck and transfer desk examples



Design considerations

Design intent
For the elemental design of a Podium Deck, the client must provide a clear indication of the surface usage and its possible future use.

The design should demonstrate a satisfactory level of:

- Structural performance of the slab for surface treatment, finishes and drainage.
- Architectural and landscaping placed on the podium deck.
- Management of surface water around landscaped features to drainage points.
- Drainage from the podium deck.

Technical standards
In the design of a podium deck, reference to other associated technical standards may be appropriate. Examples include:

- Continuous Membrane Roofing
- Green Roofs
- Blue Roofs
- Drainage
- Basements

Waterproofing design
If the space beneath the podium deck is below ground, the design of the waterproofing layer must be coordinated alongside a CSSW qualified structural waterproofing specialist.

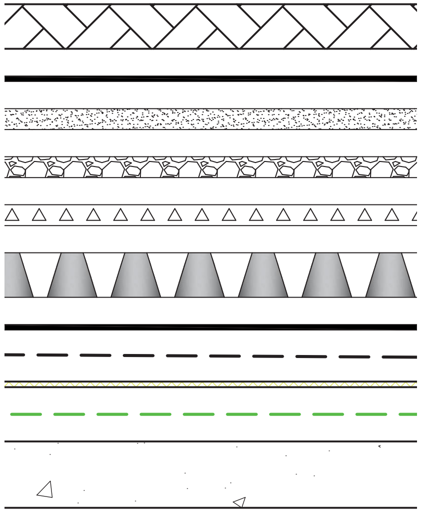
Associated design principles
- The principles of BS 6229 Flat roofs with continuously supported flexible waterproof coverings – Code of Practice, are to be applied to waterproofing of podium decks to ensure water ingress does not occur.
- BS 8102 – Protection of below ground structures against water ingress – Code of practice are to be applied to ensure the continuity of waterproofing of junctions of basements to podium decks is managed to ensure that water ingress does not occur.

Further practical guidance on this and compliance with Warranty requirements for podium decks is included herein.

Guidance limitations
This guidance is not intended as a standalone design guide and does not include full details of what must be considered to comply with other associated design guides.

Typical podium deck layering

The compatibility and co-operation of each individual layer is critical to determining a reasonable life span for a flexibly paved surface. Each layer must have the ability to absorb and constrain potential dynamic and static loading.



Note: Manufacturers will provide systems which are a combination of elemental layers i.e. protection layer + slip layer + separation layer.

Layering course: Accommodates variation in thickness of paviour units.

Levelling layer: To overcome any height differences combination of the laying and sub-base layer.

Sub-base layer: Absorbs and spreads static loads to prevent deformation of the paving.

Filter layer: Protects the drainage layer against clogging by fine particles from the sub-base or layering course. It also ensures effective horizontal drainage. If topsoil is used, special measures should be taken for fine soil particles clogging the filter layer.

Drainage layer: Relieves hydrostatic pressure. Discharges excess water under the sub-base layer, prevents ponding, and risk of frost heave affecting the surface.

Protection layer: The layer protects the waterproofing membrane from damage caused by the static and dynamic loads. Protection layers may also fulfil the function of the slip and separation layers.

Slip layer: Horizontal loads occur by temperature change and dynamic forces. Waterproofing materials cannot withstand these loads and therefore care should be given for its specification.

Separation layer: Incompatible materials need to be isolated.

Design requirements

Information required
To allow a Warranty assessment to be undertaken in a timely manner, developers must provide information at the earliest opportunity. At submission a full design should include:

Drawings
General arrangement plans for each podium deck area showing:

- Deck features and landscaping.
- Directions of falls for surface water management.
- Drainage provisions.
- Deck finishes.
- Below slab space.

General sections and section details for:

- Layering/build up types above the slab showing waterproofing, water flow control and finishes.
- Variance of build-up types.
- Movement joints.
- Entrance thresholds.
- Building abutments and upstands on and adjacent to podium deck.
- Through slab services and pipe penetrations.
- Planters and Green landscaping.
- Slab fixings.
- Other base details for architectural features placed on the slab.

Design and materials

- Slab design and deflection analysis.
- Surface water drainage design philosophy and peak flow calculations for entire podium slab (including countersunk outlets).
- Specification of component materials and products used, including third party accreditation certification.
- Maintenance plan to address how remedial works could be undertaken in the event of a defect.

Podium deck use
At the earliest possible pre-construction stage, the client design should define the range of potential uses of the podium deck with reference to the worst case of dead loads (permanent finishes), live imposed (use types) and rolling (traffic) loads. Detailing should be undertaken to ensure that in the event of a defect, a repair can be feasibly undertaken and should be at the forefront of the design process.

Landscaped areas requiring water irrigation will require additional control of surface water. Please refer to the 'Roofs – Green Roofs' section for further guidance.

Surface water attenuation systems – Blue roofs on the Podium Deck will require additional structural analysis of the deck and drainage control. Please refer to the Warranty 'Roofs – Blue Roofs' section for further guidance.

Substrate - the podium deck slab
Podium Decks constructed from reinforced concrete and correctly designed by an Engineer have proven to be the most reliable when designed in accordance with BS EN 1992-1-1:2004 Eurocode 2 Design of Concrete Structures (+A1:2014). In any event the substrate in all cases must be proven to be dimensionally stable.

For Warranty purposes, Podium Decks constructed of pre-cast block and beam systems or pre-cast concrete planks are not acceptable for any podium deck applications.

Other approaches such as pre-cast concrete hollow core planks with a structural screed and ribbed metal deck formwork require additional specialist involvement to demonstrate that the construction will meet the requirement to show that the substrate will be dimensionally stable.

When there is any risk for excessive movement as a result of the substrate selection or any potential future use of the deck area increasing slab movement, the designer must ensure through clear evaluation and demonstration that the system is able to cope with the worst case anticipated movement.

Deck falls
Drainage falls should be constructed in a manner that they fall away from any structures built off the podium. Water standing on the deck, can exert pressures laterally on the external walls of structures built over the deck, therefore, the waterproofing line from the podium deck surface must be continuous to DPC level.

Cementitious screeds provide a stable substrate to mitred falls and are recommended. Screeds to be in accordance with BS 8204. Surface water should always fall away from any above deck protrusions or abutments.

The finish surface is to have a minimum design fall 1:80 prior to applying the waterproofing layer. This will ensure that adequate flow of surface water is maintained to the drainage system and that no ponding occurs on the deck.

Consideration should be given to height differences between the top and bottom of the falls. Where there are large height differences in the screed forming the falls the height for dressing the waterproof membrane up an abutment wall may be reduced.

On large podium decks it may be necessary to increase the number of drainage outlets to avoid excessive fall heights in the screed.

Waterproofing
Fully bonded or monolithic systems are typically appropriate for Podium Deck waterproofing. Any waterproofing system must not allow the 'tracking' of water under the waterproof membrane.

Curing agents may, on occasion, be applied to the top surface of the concrete substrate to:

a) Enhance the concrete quality and durability.
b) Reduce the curing period.

The curing agent essentially forms a membrane across the concrete surface of the laid concrete to increase the density of the cement paste and lower the porosity at the surface. This increases resistance to external influences, surface stresses and attack.

Applied curing compounds are not always compatible with a proposed hot-melt application. Adhesion may be reduced causing delamination from the substrate and potentially cause water to track under the waterproof layer following a membrane failure.

Compounds based on a Sodium Silicate based are generally acceptable for a direct applied hot-melt waterproofing application. Adhesion reduction is likely when the base component of the curing agent is:

- Acrylic and Chlorinated rubber.
- Resin.
- Wax.
- Wax/Resin.

In all cases a Hot-melt waterproofing membrane must be applied to a primed concrete surface with reference to BS EN 13670 Execution of Concrete Structures (E) - 8.5 Curing and protection states (10) (11)

All 'systems', specified products and materials require a 3rd party product approval certification which references the areas the material can be used. In the selection of a system, it should be considered whether that system is reliant on insulation or a 'Water Flow Reducing Layer' (WFRL) to disperse water to the outlets.

For Podium Deck applications, loose laid or partially bonded waterproofing materials are not acceptable.

The use of a 'waterproof concrete' is not considered to be an acceptable approach for Podium Deck waterproofing.

As soon as is practically possible, the waterproof membrane will require protection against damage from either follow on trades or the deck being used as material storage space.

Prior to applying surface finishes above the waterproof layer, the waterproof membrane must be integrity tested and verified by an independent third party.

The waterproofing layer must be linked to any cavity tray to avoid discontinuity which could result in moisture ingress.

Drainage
A complete drainage design for the Podium Deck must be provided, by an Engineer and in accordance with BS EN 12056-3. Drainage calculations should be accompanied with a short explanatory statement including assumptions made.

It is important that the Podium Deck be designed to adequately deal with the predicted rainwater for its geographical location. Additional consideration should be made for drainage from upper areas such as façade run off or external balconies from the adjacent structure(s).

Surface water from upper podium levels or roofs must not discharge onto lower podium deck levels.

Podium deck surface finishes shall be positively drained to discharge surface water so that it does not accumulate and it does not compromise the use of the space at surface level.

Where a green/blue roof proposal forms part of a podium deck proposal, our Warranty guidance on Green and Blue roofs must be followed as such proposals may impact on the Podium deck performance (loadings and effective drainage).

Rainwater outlets
- Should be positioned in the locations of maximum deflection.
- Outlets within the slab must be designed to be countersunk and discharge at deck level, not at surface finish level.
- The waterproofing layer must be dressed into the outlets.
- Inlet gullies which collect water from the deck and finishes level and then discharge directly onto the waterproof membrane should be avoided.

Where podium decks form part of an enclosed area, an overflow for each outlet required, should be provided to ensure that surface water does not accumulate in the event of a blockage. Surface water should be discharged through the external perimeter in a readily apparent location to allow for maintenance to be undertaken at the earliest opportunity.

Movement joints
Structural movement joints are required in large area reinforced concrete Podium Decks. Detailing of all movement joints are required to demonstrate they will prevent water ingress or accumulation of water adjacent at or local to the joint to limit the risk of frost-thaw action.

Materials forming the movement joint must be durable and be able to flex with the waterproofing membrane. Joints must be accessible for inspection and maintenance to allow for repair in the event of a defect.

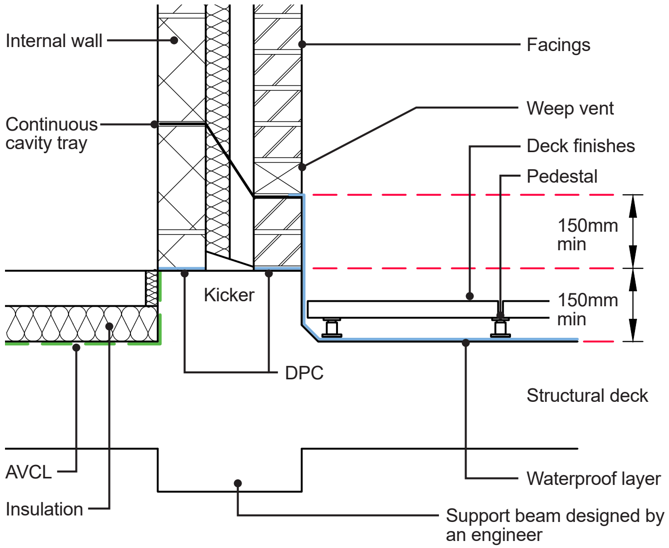
Abutment joints
Abutment joints with isolated vertical construction adjacent to the Podium Deck should not permit the ingress of water to the space below.

Allowance should be made in the detailing for anticipated movement between the Podium Deck and the vertical façade, to prevent the waterproof layer from shearing.

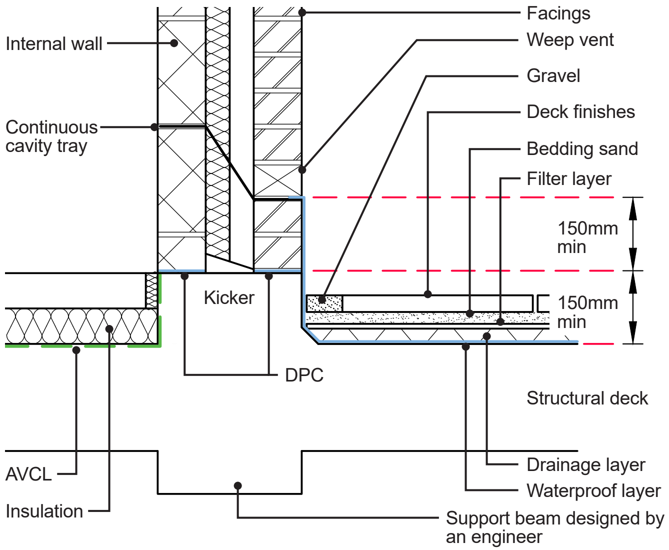
Where structures abut or are built off the podium deck, the waterproofing must be dressed up the vertical surface of the facade to a minimum of 150mm above the finished Podium Deck level.

Cavity trays above abutments (Podium Deck to wall junctions) are often breached at the podium deck level, allowing water to seep into the building. Continuity is therefore essential between these two elements and waterproofing detailing is required to ensure any water passing the cavity tray is discharged to the podium deck adequately. Waterproofing layers must be linked with the DPC which should be at least 150mm above the finished surface level. The masonry should be durable against saturation in accordance with BS EN 771-1.

Wall waterproofing detail (slabs on pedestals)



Wall waterproofing detail (bedded slabs)



Threshold abutments
All level door accesses formed from the podium deck level to occupied spaces should provide:
- A 10mm gap between the drainage channel and the door cill.
- The door cill should have a minimum 45mm overhang of the construction below.
- In order to have a reduced upstand of 75mm max from the underside of the door cill to the top of the structural deck, there must be a fall on the structural deck away from the door opening.
- Waterproofing to be dressed and linked with DPC at reveals.
- Waterproofing may be continuous under door threshold as creep (gradual deformation under stress) is likely to be minimal.

Slab penetrations
Where possible, it is best to avoid Podium Deck penetrations for service provisions. Where required, the designer should look to group the services to minimise the necessary number of penetrations.

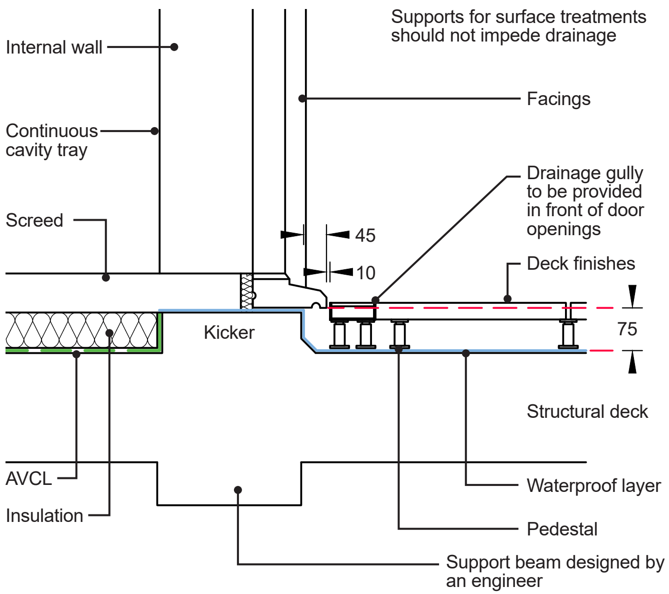
Detailing of the penetration or group to prevent ingress or accumulation of water at the penetration requires consideration and should ensure:
- Back falls are not created at service penetrations.
- Waterproofing must allow for potential movement with the service penetration detailing
- Waterproofing must be fully bonded and compatible with the service pipe material.
- The waterproofing must extend 150mm above Podium Deck surface finished level.

Architectural features
At the pre-construction phase, an audit of the surface treatments, architectural features and planters that are placed on the podium should be established. Such detailing will require the need for:
- Weatherproofing - incorporating an upstand and cover flashing arrangement for solid features placed on the Podium Deck, or
- Waterproofing - providing continuous waterproofing under the architectural feature.
- Diversion – measures should be taken to divert water around large structures to ensure that it is able to reach the outlets provided.

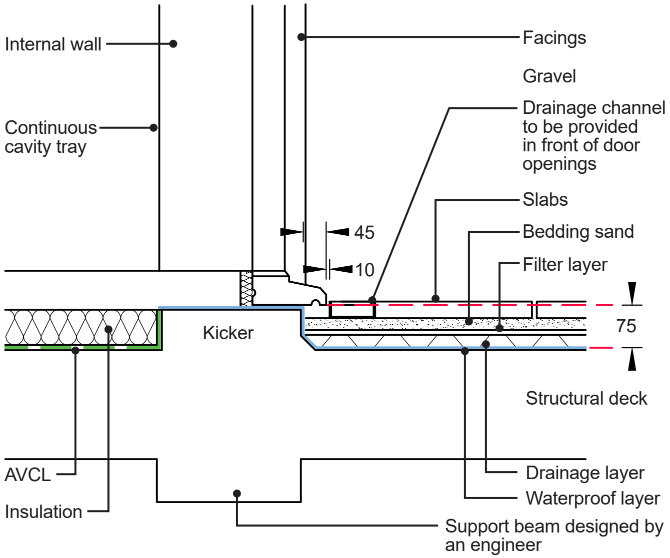
Where structures are built off the Podium Deck, a suitably designed 150mm upstand above the waterproofing layer must be provided. Surface water should be designed to fall away from any structures built off the podium.

Planters should be built off a 150mm monolithic kicker with the Podium Deck slab.

Threshold waterproofing detail (slabs on pedestals)



Threshold waterproofing detail (bedded paviours)



Installation requirements

Construction evidence
A quality assurance and record keeping system should be provided at pre-construction to ensure that standards of workmanship can be demonstrated.

An approved installation contractor recognised by the material manufacture as being competent to install the manufacturer's waterproof membrane should be used. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty Surveyor.

The waterproof layer of the podium deck shall achieve a minimum design fall of 1:80 – 'as built'. A levels survey should be undertaken to demonstrate this is achieved.

Testing
Testing is required to demonstrate the integrity of the waterproof membrane.

It must be undertaken by a suitably qualified and experienced third party certified test agency who is independent of the roofing contractor using either:

- Low Voltage Earth Leakage, or,
- High voltage electrical discharge.

Additional testing may be required where by inspection, there is potential that defects may have occurred as a result of damage from follow on trades, or the deck being used as storage.

Certification should be made available to the Warranty Surveyor prior to handover. The testing service provider should provide in their report:

Date of test
- Project name, address and reference number.
- Name, address and contact of certifier.
- Description and efficacy of the waterproof installation.
- Experience and training of tester.
- Membership of an appropriate trade association, which sets a Code of Conduct for the service.
- Details and provision of large- clear photographs of defects identified (when applicable).
- Number of tests undertaken.
- Confirmation of result of testing.

Final inspection
At practical completion of the waterproofing to the Podium Deck. All areas should be clear of stored material, site operations and all protection. A thorough, visual and recorded inspection, of all areas, including deck surface architectural and landscaped features, to be carried out with representation from the main and roofing contractors in attendance.

References and further guidance

References
- BS EN 1992-1-1 Eurocode 2: Design of concrete structures. General rules and rules for buildings
- BS 6229 - Flat roofs with continuously supported flexible waterproof coverings - Code of practice
- BS 8102 - Code of practice for protection of below ground structures against water ingress
- BS EN 12056-3 - Gravity drainage systems inside buildings - Roof drainage, layout and calculation.
- BS 8204-1 Screeds, bases and in situ floorings. Concrete bases and cementitious levelling screeds to receive floorings – Code of Practice
- BS EN 13670 Execution of Concrete Structures

Guidance notes
- SWG2/12.13 – Property Care Association Podium Decks

12. Roof Terraces and Balconies

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. A flat roof membrane manufacturer's approved installer must be used for all roof terrace coverings.
2. Roof terrace membranes will be required to be weather and waterproof and, tested at completion where stipulated in the guidance.
3. All workmanship must be within the tolerance requirements set out in this Technical Manual.
4. All work is to be carried out by a technically competent person in a workmanlike manner.
5. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/ door or 'decorative external cladding' (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
7. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. For Warranty purposes, cold deck roof terraces are not acceptable.
2. Roof terrace and balcony structures and coverings, shall be designed and constructed so that they:
    a. Are structurally sound;
    b. Satisfactorily resist the passage of moisture due to rain and snow to the inside of the building, and to materials which might be adversely affected by such moisture;
    c. Have an adequate thermal performance where applicable;
    d. Adequately discharge rainwater to a suitable outfall.
3. In addition to point 2d: shall, unless specifically agreed otherwise with the Warranty provider, comply with the requirements of BS 6229 and be designed to have a minimum finished fall of 1 in 80.
4. Roof terraces and balconies must have appropriate guarding meeting the requirements of Building Regulations.
5. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
6. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
7. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

12.

Roof Terraces and Balconies

12.1
Roof Terraces

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
    a) Plan showing direction of falls and position of outlets and overflows.
    b) Sections showing roof terrace build up and how falls are to be created. Sectional details should show all components to be used in roof terrace build up (insulation type and thickness, Vapour control layer, waterproofing membrane/ layers etc.).
    c) Site specific detailing for all junctions, outlets, threshold and upstand interfaces with the façade.
    d) Details of the provision of pedestrian surface support structure (where appropriate).
    e) Details of the provision of guarding including parapet walls and balustrading used as guarding. This should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading and as required by the Building Regulations.
    f) Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
2. Third party accreditation for the waterproofing membrane/layer.
3. Details of all fixings, their frequency and fixing method, including those for insulation and surfacing. Fixing methodology should be supported by appropriate wind uplift calculations.
4. Outline of method and plan for testing the integrity of the waterproofing layer.
5. In all circumstances, the roof terrace membrane system will need to be installed by an approved contractor who is recognized by the manufacturer as competent. Evidence of the manufacturer's approval of the contractor to install their products should be provided to the Warranty Surveyor.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Definitions

For the purposes of this Technical Guidance, the following definitions shall apply:

Roof terraces: an accessible amenity above ground level which is exterior to and with direct access from a building which forms part of a roof or forms the entire roof to other occupied parts of a building. This section provides specific advice and requirements in respect of roof terraces.

Condensation: process whereby water is deposited from air containing water vapour when its temperature drops to or below dew point.

Filter layer: construction material (usually a geotextile) that substantially reduces the transfer of mineral and organic material to the insulation in an inverted warm deck roof.

Flat roof: a roof having a pitch no greater than 10º to the horizontal.

Insulation cricket: wedge of shallow-fall insulation material, designed to divert the flow of rainwater on a roof.

Interstitial condensation: condensation occurring within or between the layers of the building envelope.

Protection layer: construction material (usually a geotextile all rigid board) that isolates another construction material from mechanical damage.

Separation layer: construction material (usually a geotextile) that separates two construction materials that are not chemically compatible.

Structural deck: continuous layer of the construction (comprising concrete, profiled metal or timber panel) supported by the building structure and which supports the roof system.

Thermal bridge: part of a roof of lower thermal resistance than its surrounding elements, which may result in localised cold surfaces on which condensation, mould growth or staining may occur.

Air vapour control layer (AVCL): construction material (usually a membrane) that substantially reduces the movement of water vapour through the roof system.

Water flow reducing layer (WFRL): construction material (usually a sheet membrane) that substantially reduces the transfer of rain water to the insulation in an inverted warm deck roof.

Structure general

The roof terrace structure should be designed for strength and stiffness in accordance with the Code of Practice for the relevant structural material used.

Relevant structural material on roof terrace structure strength and stiffness should be assessed in accordance with BS EN 1992-1-1, BS EN 1993-1-1, BS EN 1994-1-1, BS EN 1995-1-1, BS EN 1999-1-1 and their UK National Annexes.

A roof deck may be classed as air permeable and likely to allow internal air pressures to impinge on the roof system from below. Wind uplift pressure exerted on the underside of any layer of the construction (which is substantially air-impermeable), such as the vapour control layer or the waterproof layer. This should be resisted by adequate mechanical or fully bonded connections between the air impermeable layer and the deck. Particular consideration should be provided at corners of buildings or where funnelling may occur due to adjacent buildings or topography.

The roof terrace design should take account of possible differential movements within the slab/deck and at junctions with supporting structure, parapets, kerbs and upstands.

Note: Such movements might be caused by movement of the structural frame or by changes of temperature and moisture content.

Loading

Statutory requirement
The design for loading should comply with the current Building Regulations.

The terrace shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground safely, and without causing such deflection or deformation of any part of the building, or such movement of the ground, as to impair the stability of any part of another building.

Dead and imposed loads upon a roof terrace should be assessed in accordance with BS EN 1991-1-1 + UK National Annex; taking due consideration of any added surfacing, paving slabs, gravel or other materials contributing to the final loading. Snow loads should be assessed in accordance with BS EN 1991-1-3 + UK National Annex. Wind loads should be assessed in accordance with BS EN 1991-1-4:2005 + A1:2010 + UK National Annex.

The roof terrace structure should be constructed so that it has sufficient structural load transfer to the wall, allowing the roof terrace structure to act as a horizontal diaphragm capable of transferring the wind forces to buttressing elements of the building.

Resistance to imposed loads
At the earliest possible stage, the designer should define the range of potential imposed loads for which the balcony is to be designed such as planters, storage and public access. In the absence of such a performance requirement the loading limits of the balcony should be defined.

Allowances for the prevention of wind uplift
The resistance to wind uplift of the waterproof covering and finishes on a flat roof terrace should be assessed in accordance with BS 8217 and BS EN 16002. The designer must consider the dead weight of materials above the weatherproof surface layer and their method of attachment to the slab or deck and prevent wind uplift in the design.

It is necessary that the design for the roof terrace build up has adequate provision to resist wind uplift by being adequately anchored to the main structure. In all situations a calculation of wind uplift at each zone of the roof terrace to BS EN 1991-1-4 should be undertaken by a suitably competent person. Wind load acting on a terrace will be affected significantly by the design of the perimeter, geometry and finishes on the elevations of the building. Any relevant changes to materials in the build-up of the walls or floors is likely to necessitate a review of the calculated input to ensure that the assumptions initially held remain valid.

Balustrade fixings

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and do not comprise the waterproof membrane. Any penetration through the waterproof membrane are to be sealed correctly in accordance product manufacturer's recommendations.

Insulation

The insulation should be specified taking into account the roof type, having regard to its load-bearing capacity and, where relevant, its water absorption characteristics. Compressible materials cannot support imposed loads and are not suitable in warm deck roofs. Warm roofs require the use of rigid insulation, and should be suitably specified to support the any anticipated loads from trafficking across the roof. Insulation in an inverted roof should also have high resistance to water absorption, freeze/thaw cycling and be shielded from UV light.

Design

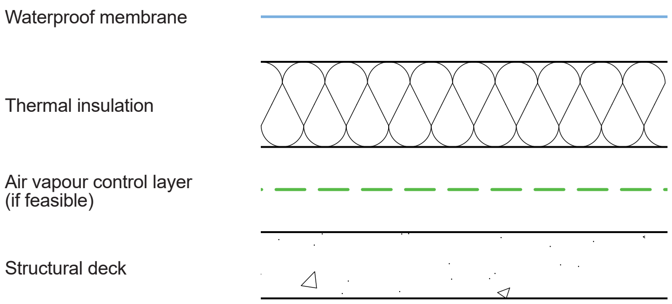
The principal thermal insulation is placed immediately below the roof terrace covering, resulting in the structural deck and support being at a temperature close to that of the interior of the building.

The design should ensure that:

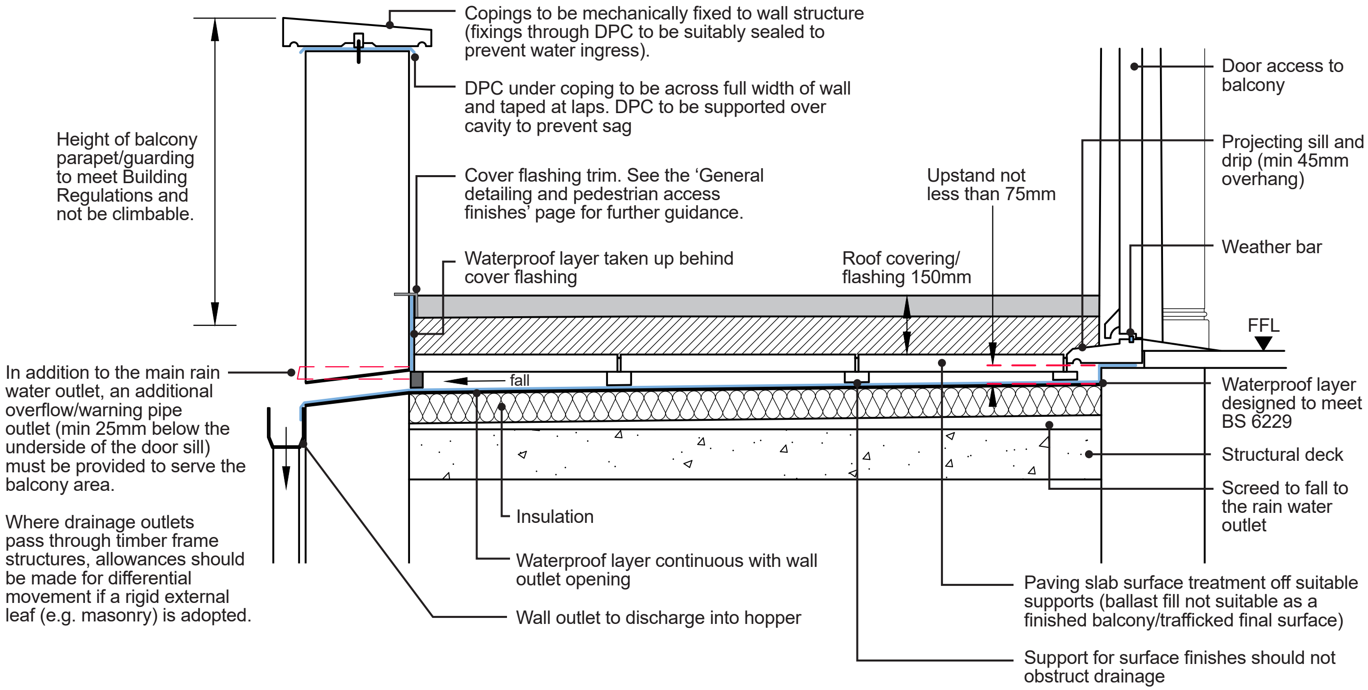
- The waterproof membrane has sufficient resistance to temperature to suit the conditions created by a substrate of insulation.
- The insulation has sufficient mechanical characteristics to resist loading.
- The AVCL is provided by the deck or by a membrane placed above the deck.
- The structural deck is maintained at a temperature above that which could cause condensation to occur at this level during service.

Cold deck roof systems are not permitted on roof terraces that form part of the roof to other occupied parts of the building.

Warm deck



Warm deck roof terrace



Notes

- Insulation above structural deck and waterproof layer to be suitable for exposure to moisture and of sufficient loading to compress the substrate and promote moisture migration to an outlet.
- Waterproof membrane must be laid to a fall - to a suitable outlet. All joints formed must be sealed in accordance with the manufacturer's requirements and not result in water being trapped/ponding.
- Membrane not to be laid in air temperatures less than 5°C. All membranes are to be fully bonded and a sample of peel tests should be undertaken as verification of workmanship.
- Where structural deck is constructed over accommodation below the design, construction should meet sound insulation requirements.
- Structural deck to be an engineered design for the loading/intended use which should be structurally stable over the lifespan of the building.
- A spreader plate or additional protection to any waterproof membrane will be required to protect the insulation under paving supports to spread loads to prevent sag and ponding.
- Where the penetration to form the outlet is made through the wall construction, which is constructed of steel frame care should be taken to prevent thermal bridging.
- Hopper construction should include a flashing apron and the hopper should be accessible for clearing debris on a regular basis.

Design

A variant of the warm deck roof terrace in which the principal thermal insulation is placed above the waterproof membrane, resulting in the waterproof membrane, structural deck and structural support being at a temperature close to that of the interior of the building. Generally, the principal insulation is secured by separate ballast (paving, gravel, or blue/green roof - minimum 80 kg/m^2).

A filter membrane or WCM should be provided to control mineral and organic material passing into and below the insulation joints. A WCM is recommended because it will provide improved rain water run-off, which may allow for a reduced thickness of insulation and reduced loading of ballast. If a WCM is included, it is essential that the drainage design facilitates the rapid transfer of rain water across the product and to rain water outlets.

Cold deck roof systems are not permitted on terraces that form part of the roof to other occupied parts of the building. In these circumstances the selection of system type (warm deck or inverted warm deck) should be based upon the following criteria:

Inverted warm deck

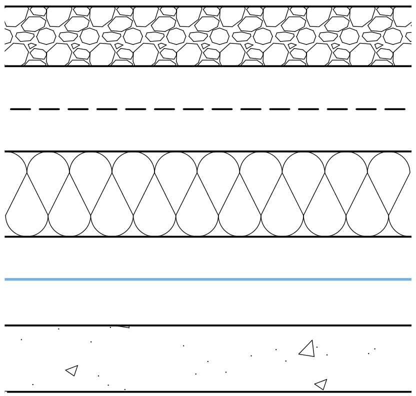
Ballast

Filter layer or water control membrane

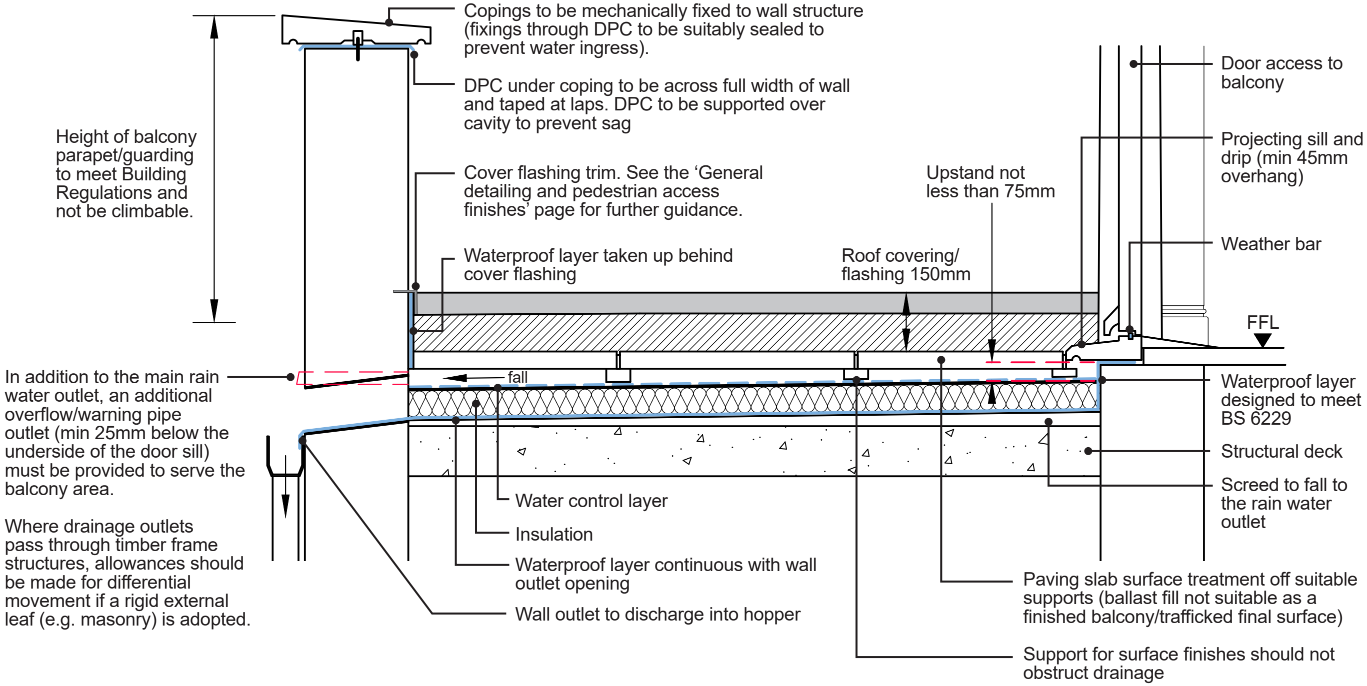
Thermal insulation

Waterproof membrane

Structural deck



Inverted warm deck roof terrace



Notes

- Insulation above structural deck and waterproof layer to be suitable for exposure to moisture and of sufficient loading to compress the substrate and promote moisture migration to an outlet Waterproof membrane must be laid to a fall - to a suitable outlet. All joints formed must be sealed in accordance with the manufacturer's requirements and not result in water being trapped/ponding.
- Membrane not to be laid in air temperatures less than 5°C. All membranes are to be fully bonded and a sample of peel tests should be undertaken as verification of workmanship.
- Where structural deck is constructed over accommodation below the design, construction should meet sound insulation requirements.
- Structural deck to be an engineered design for the loading/intended use which should be structurally stable over the lifespan of the building.
- A spreader plate or additional protection to any waterproof membrane will be required to protect the insulation under paving supports to spread loads to prevent sag and ponding.
- Where the penetration to form the outlet is made through the wall construction, which is constructed of steel frame care should be taken to prevent thermal bridging.
- Hopper construction should include a flashing apron and the hopper should be accessible for clearing debris on a regular basis.

Hybrid roof terraces

Many roofs combine the features of two or more of the roof types previously described. Examples include structural decks of high thermal resistance combined with additional insulation, and existing roofs to which thermal insulation is added. Once assessed in terms of their thermal and water vapour transmission characteristics, such roofs will generally fall into one of the categories described.

In some constructions, the waterproof membrane is placed between two layers of insulation, combining the properties of warm roof terrace and inverted warm roof terrace construction. This form of construction should be avoided wherever possible.

There is an increased risk of interstitial condensation with a hybrid roof and therefore, where these types of roof systems are used, a full condensation risk analysis should be carried out by the methods laid out in BS EN ISO 13788 and BS 5250. No interstitial condensation should occur in the model and where moisture is present and evaporates in the summer months an assessment of the potential degradation of the materials used as part of the build-up should occur so it can be expected that the lifespan and durability of the materials still meets the functional requirements of the Technical Manual.

Limitations of this guidance

The guidance for timber structures forming a roof terrace is limited to any building with a height of no more than three storeys above the lowest adjacent external ground level.

Structure

The design of the terrace should be designed by an Engineer in accordance with BS EN 1995-1: Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

The structural deck should be designed by an Engineer. It is important to ensure that the structural deck is installed and fixed in accordance with the Engineer's design.

If joists are spanning intermediate beams it is important that the joists are fixed to these beams. This must be carried out in accordance with the Engineers specification.

The Designer must establish the intended loadings expected on the roof terrace including loads from finishing surfaces such as paving slabs and/ or ballast as well as any potential planting.

The likely maximum potential deflection of the deck should be confirmed to ensure a minimum 1:80 as built fall is maintained. The designer should consider the impact of long term creep in the design of all joists and the impact on falls this may have in the long term. Secondary joists that span intermediate horizontal primary beams must be mechanically fixed in accordance with the Engineers specification. Fasteners are to be sufficiently protected from corrosion and specified according to the external exposure and environment.

For further guidance on structural design requirements and loadings, please refer to the 'Roof Terraces and Balconies – Roof Terraces: Definitions and general principles' section.

Timber grading and treatment

All structural timber used should be stress graded. All such timber must be stamped as either 'DRY' or 'KD' (Kiln Dried). The use of ungraded, or 'green', timber is not acceptable.

Preservative treatment of roof terrace timbers is normally only required under relevant standards and Codes of Practice, however in some instances may be considered good practice. Further information can be found in 'Appendix C - Materials, Products, and Building Systems'.

Lateral restraint of walls

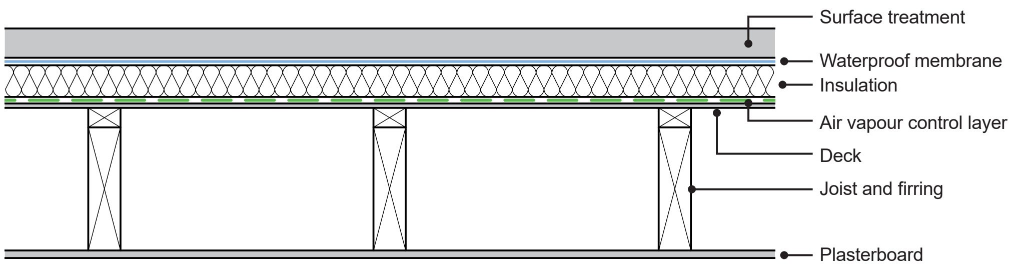
Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

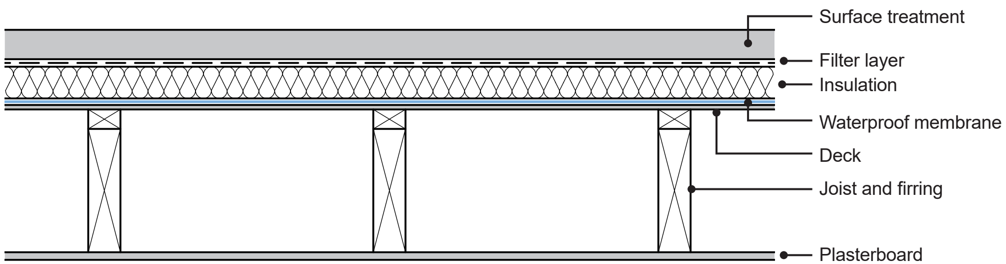
- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Typical warm deck construction

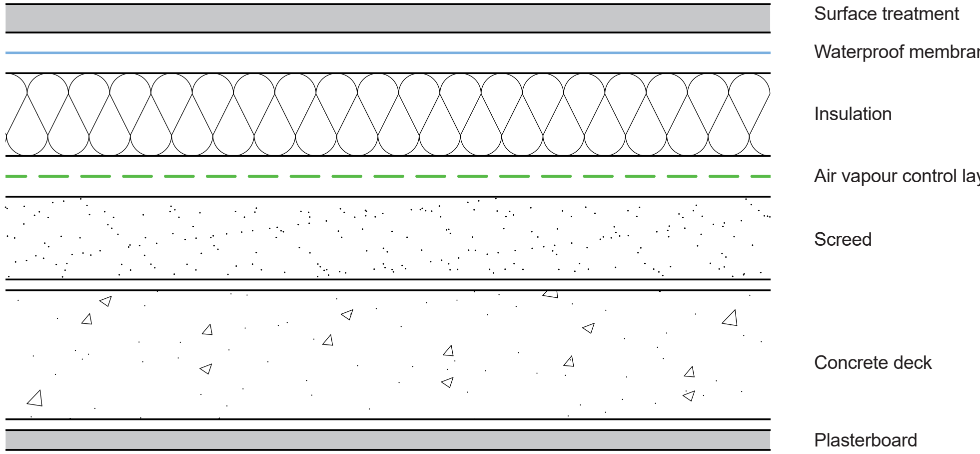


Typical inverted warm deck construction



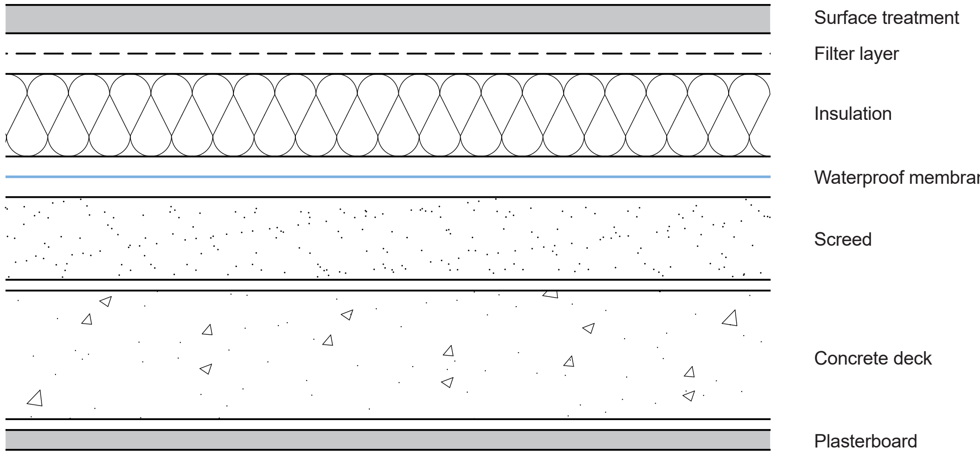
Typical warm deck construction

Note: Permanent waterproofing should not be installed until the moisture content of the deck is as per the membrane manufacturer's recommendations. Preparation of the receiving substrates should also be as per the membrane manufacturer's guidance.



Typical inverted warm deck construction

Note: Permanent waterproofing should not be installed until the moisture content of the deck is as per the membrane manufacturer's recommendations. Preparation of the receiving substrates should also be as per the membrane manufacturer's guidance.



For in situ concrete decks it is important that:

- The form work is adequately and accurately constructed.
- The mix should be one that has relatively low shrinkage characteristics.
- The slab should be adequately protected until cured.

Pre cast concrete decks should:

- Have a minimum of 90mm bearing unless justified by the design.
- Be grouted in accordance with the design, and,
- Allowance for movement should be provided at abutments.

Structural deck

General
At the earliest practical stage, the likely deflection in the deck, and the tolerance in the level of its finish, should be confirmed, because this informs the design for drainage. If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

Concrete
Precast concrete construction should be designed in accordance with BS 8110. Information on span capability and the installation requirements of precast panels can be obtained from manufacturer's. Information on the location of required movement joints should be obtained early in the design process as they have implications for drainage layout and detailing. Precast panels installed to a fall can provide a simple layout but without cross falls.

In-situ concrete construction should be designed in accordance with BS 8110. Concrete decks should be laid to falls wherever possible, concrete maybe more difficult to lay to a fall, and it is common to create falls in the insulation (warm roofs only) or by using an additional screed. Information on compressive strength, resistance to point load and drying periods of wet screeds can be obtained from suppliers and relevant trade associations.

Where structural movement joints are required in large concrete decks, a clearly defined movement joint detail should be constructed to a design and with the materials that afford durability equivalent to that of the roof system.

In precast panel decks the locations of any anticipated differential movement e.g. at perimeter or abutment interfaces or between adjacent panels that are subject to differential loading, must be identified in order that stress is not transferred to the waterproof membrane.

Screeds

Screeds should be suitably specified for the anticipated loadings, further information can be found in 'Appendix C - Materials, Products, and Building Systems'. Moisture from the construction can become trapped in a roof if the waterproof layer is applied before a concrete slab or screed has had sufficient time to dry out. In situ concrete slabs and cementitious screeds contain large volumes of water which, if not allowed to dry out, can prevent adhesion of the waterproof layer. If bonding to the slab, it is advised that an adhesion test be carried out.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

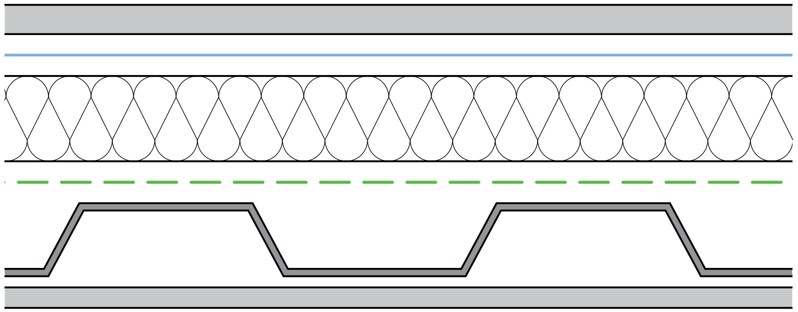
Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

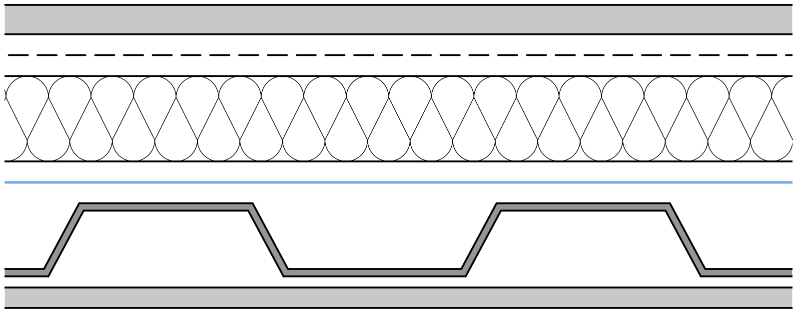
Typical warm deck construction

Falls can be created by firrings or tapered insulation.



Typical inverted warm deck construction

Falls can be created by firrings or tapered insulation.

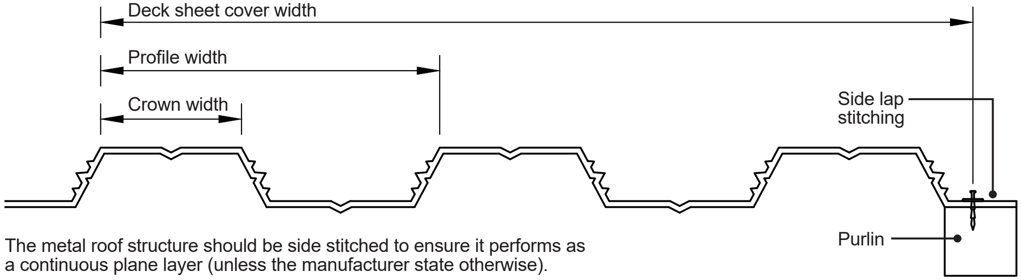


Structural deck

General
At the earliest practical stage, the likely deflection in the deck, and the tolerance in the level of its finish, should be confirmed, because this informs the design for drainage. If the deck is intended to receive mechanical fasteners for the attachment of roof system components such as insulation, or equipment such as fall-arrest line posts, its resistance to pull-out should also be confirmed to enable design for resistance to wind load.

Profiled metal (steel or aluminium)
Profiled metal decks should have a crown width at least 50% of the profile width. To provide a sound base for the insulation and waterproofing system, and to avoid reduced drainage performance, the mid-span deflection of the metal deck should not exceed 1/200 of the span under uniformly distributed design loads. When considering the deck profile and the necessity for side lap stitching and metal deck closures, reference should be made to the manufacturer's of the deck, insulation and waterproof membrane.

Profiled metal decks: critical dimensions



The metal roof structure should be side stitched to ensure it performs as a continuous plane layer (unless the manufacturer state otherwise).

Profiled metal decks should conform to the following standards:

- Galvanised steel: minimum recommended thickness 0.7mm to BS EN 10346 Fe E280G Z275. Typical gauge range 0.7mm-1.2mm.
- Plain aluminium: minimum recommended thickness 0.9mm to BS EN 485-2 AA3004 H34. Reference should also be made to BS EN 1396 as appropriate.

It is important that the deck have adequate provisions to resist wind uplift by being adequately anchored to the main structure.

Lateral restraint of walls

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations.

Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Please refer to the 'External Walls' section for further guidance.

Thermal performance

Design for thermal performance must comply with current relevant Building Regulations, as appropriate.

Thermal insulation

The thermal insulation should be selected with regard to the following minimum criteria:

- Thermal insulation components are to have third party product approval confirming suitability for use in proposed situation.
- Thermal resistance (and therefore thickness) to suit minimum clearances at details.
- Resistance to compression and point loads from surface finishes/supports.
- Compatibility with the AVCL and waterproof membrane.
- Compatibility with adhesives (if insulation or waterproof covering is adhered).
- Contribution to the external fire performance of the system.
- Acoustic properties: resistance to external sound is not currently regulated. However, there may be a need to consider attenuation from balconies.
- A spreader plate will be required to protect the insulation under paving supports to spread loads to prevent sag and ponding.

Note: The alternative of a separate acoustic attenuation layer should be considered where appropriate.

Thermal transmittance

Design for thermal transmittance should take account of the effect of thermal bridging within the roof field and at interfaces between the roof system and adjoining elements, such as parapet walls or abutments.

In particular, allowance should be made for the effect of:

- Thermal bridging by metal fasteners used to secure insulation and/or membrane. Thermal break telescopic tube fasteners are recommended to avoid this.
- Thermal bridging due to drainage of rain water or snow-melt through insulation in inverted roofs. The use of a WFRL beneath ballast to reduce thermal bridging is recommended.
- The locations of above average thermal transmittance at sumps, gutters or areas of minimum thickness of tapered insulation.

Manufacturer's of thermal insulation and WFRLs provide certification and calculations of the effects of thermal bridging by fasteners and drainage respectively. Further advice is available in Building Research Establishment BR 262 Thermal insulation: avoiding risks.

Installation of thermal insulation

The attachment of the thermal insulation should be designed to resist calculated wind load by a declared margin of safety. This includes consideration of dead loads required in all roof zones in ballasted warm roofs and inverted warm roofs.

Air permeability

Relevant contract drawings should define the position of the component - the air barrier - that determines resistance to air permeability. This may be achieved by an additional, purpose designed membrane or by an additional function of another component, such as the deck or waterproof membrane.

Control of condensation

Any provision required to control interstitial condensation within the roof should be determined to the calculation method defined by BS 5250, but with ambient conditions set in BS 6229. The calculated maximum accumulation of moisture within thermal insulation should not exceed 350g/m² and there shall be no net accumulation in any annual cycle.

Air vapour control layer (AVCL)

The AVCL should be selected with regard to the following minimum criteria:

- Ease with which it can be sealed at laps and at abutments to other elements.
- The method of attachment.
- Condensation risk, expressed as calculated vapour pressure based on notional conditions pertaining to the project building.
- Compatibility with the waterproof membrane and thermal insulation.

The following is a minimum recommended specification. The actual specification will depend on the level of vapour resistance required, based on calculation, and the type of deck.

The attachment of the AVCL should be designed to resist calculated wind load by a declared margin of safety. All laps should be sealed and the AVCL should be sealed to the adjoining element, which forms the continuation of the resistance to air permeability. The AVCL should be extended behind all thermal insulation, including insulation placed on vertical surfaces such as parapet walls. Where the roof system is penetrated by a detail such as a pipe or duct, a suitable method for providing continuous vapour control should be provided, and this method should be followed in practice.

Where a reinforced bitumen membrane AVCL is used, its installation should be in accordance with BS 8217.

Minimum recommended specification for AVCL for warm deck roofs

Roof system type	Deck type	AVCL	Attachment
Reinforced bitumen[(1)] membrane	Profiled metal	S2P3[(2)]	Partial bond by 3G or approved proprietary alternative
	Concrete	S2P3	Fully bonded
	Timber panel	S2P3	Partial bond by 3G or approved proprietary alternative
High density polyethylene	All	200µ	Loose laid beneath mechanically fixed insulation
High density polyethylene and metal foil laminate	As per certification	Proprietary	Fully bonded to prepared substrate all as per manufacturer's instructions
Coated metal foil laminate - self-adhesive	As per certification	Proprietary	Fully bonded to prepared substrate all as per manufacturer's instructions

Notes:
(1) Reinforced bitumen membranes: minimum recommended specification based on classification in BS 8747.
(2) S and P are classifications 1-5 of Strength (tensile strength and elongation) and resistance to puncture (static and dynamic); the higher the rating, the higher the performance.

Falls and drainage statutory requirement

Design for drainage of the flat roof covering should comply with the current relevant Building Regulations.

British and industry standards
The requirements of BS 6229 should prevail in respect of balconies and roof terraces, whether or not they form part or the entire roof to occupied parts of a building, and irrespective of the type of waterproof membrane.

Wherever practical, balconies, terraces, and podium decks should be designed to fall away from the building elevation. If this is not practical for reasons of continuity of rainwater services, the falls should be arranged across the balcony, parallel to the elevation.

BS 6229 states that a minimum finished fall at any point of 1:80 (1.25%) should be achieved.

Since adjoining roof planes at 1:80 will meet at a mitre of less than 1:80, the intended finished fall at such intersections should be considered at an early stage.

Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).

Cut-to-falls systems are often produced to a 1:60 (1.7%) fall or 1:40 (2.5%) fall. However the use of these systems does not remove the need to check that deck deflection and tolerance is overcome and that a resulting fall in the waterproof membrane of a minimum of 1:80 is achieved. Allowance for deflection is particularly important in designing inverted roofs where calculation of dead loading should be based upon the ballast type and depth to be used.

The manufacturers of certain waterproofing products have certification for their use in ‘completely flat’ or ‘zero falls’ applications. However, for the purposes of this standard, the design conditions of BS 6229 shall be assumed to prevail in all balcony/terrace situations.

Consideration should also be given to:
- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the balcony/terrace area to be drained. If necessary additional rainwater outlets should be provided.
- Avoidance of ponding behind wide obstructions to the drained slope such as plant plinths or roof lights. Additional rainwater outlets and/or insulation crickets should be provided.
- Avoidance of gutters by designing with intersecting roof planes.
- Falls between rain water outlets along a perimeter.

Since the primary function of the roof is to exclude water, it is important to consider how best to direct this into the drainage system.

Ponding on membrane roofs must be avoided because:
- It encourages the deposit of dirt and leaves, which can be unsightly, may obstruct outlets and/or become a slip hazard.
- In the event of damage, the interior will suffer increased water ingress.
- The load may cause progressive deflection of the deck.
- Ice or algae may create a slip or wind hazard, particularly on walkways.

Independent research has shown that roofs with extensive ponding require increased maintenance input.

Waterproof coverings of all types are tested for water absorption and water tightness as part of third-party certification. However, the construction process, including the installation of components and the forming of seams, is clearly facilitated in dry, well-drained conditions.

Note: Rainwater outlets and downpipes can constitute thermal bridges which may increase the risk of localized condensation; an assessment might be required to determine whether insulated outlets are to be used.

Creation of falls

Roof falls may either be created during the construction of the deck or alternatively by using tapered insulation systems (warm deck systems only).

The creation of falls in the deck should always be attempted because it has the following advantages:
- There will be a consistent thermal environment across the roof.
- The AVCL will also be to a fall.
- If mechanical fasteners are to be used for the waterproof membrane, their length will be constant, which facilitates planning and installation.

Cementitious screeds provide a stable substrate to mitred and general falls of 1:80 and are recommended. Screeds should be in accordance with BS 8204. Lightweight screeds should be overlaid with a 1:6 (cement to sand) screed topping of a minimum 10mm thickness.

Tapered insulation schemes, suitable for warm deck roofs only, have the following advantages:
- It is possible to create effective drainage layouts to complex plan areas.
- Mitred falls can be created easily to direct rain water to single points where outlets are to be located.

Where falls are created by tapered insulation, the design should ensure that the average U-value and maximum U-value at any point, required by SBEM or SAP calculation, is achieved.

Where the roof finish is to include paving on supports, consideration should be given to the height difference created by the falls and spacing of rainwater outlets so that the maximum height of paving supports is not exceeded, the minimum height of upstands is not affected or trip hazards created. On large balconies and roof terraces it may be necessary to increase the number of outlets in order to reduce maximum roof zone depth.

Drainage

Drainage design should be based upon calculations in accordance with BS EN 12056 Part 3 given a design head of water (typically 30-35mm). Rain water outlet capacity should be taken from properly certificated information provided by manufacturer, and the resulting number and layout of outlets should allow for obstruction and drag due to any additional surface finishes, such as walkways.

The drainage above the waterproof covering and below any raised decking finishes must not be restricted or blocked by the decking supports. The decking supports must allow free drainage of all areas of the roof to the designated outlets:
- Rainwater outlets should be readily accessible without disruption to the pedestrian finish. On finishes raised above the waterproof membrane (warm deck roofs) or Water Control Membrane (inverted roofs), this may be achieved by a suitably marked paving slab or demountable section of decking.
- Where rainwater downpipes from other higher roof areas, balconies or terraces discharge via a lower balcony or terrace, an open downpipe shoe is not permitted. The downpipe should be connected directly to the downpipe serving the lower balcony or terrace.

Rainwater outlets

The following should be confirmed by reference to the manufacturer’s information or independent certification, as appropriate:
- Capacity in litres per second at a range of typical water heads.
- Compatibility with the waterproof membrane.
- Integral insulation to avoid condensation.
- Method of attachment.
- Rainwater outlets for inverted roofs should be of the dual height type, designed to maximise removal of rainwater at WFRL level.

Overflows

Roofs which drain to a single internal outlet or combined outlets connected into a single downpipe, should be provided with an overflow to drain and warn of outlet/downpipe blockage and so avoid the risk of flooding or structural overloading. The capacity of the overflow should be not less than that of the outlet or combined outlets, and its discharge should be visible but directed away from the building.

Overflows should be conspicuously positioned for inspection and as close to the outlets as practicable to avoid rainwater build up on roofs.

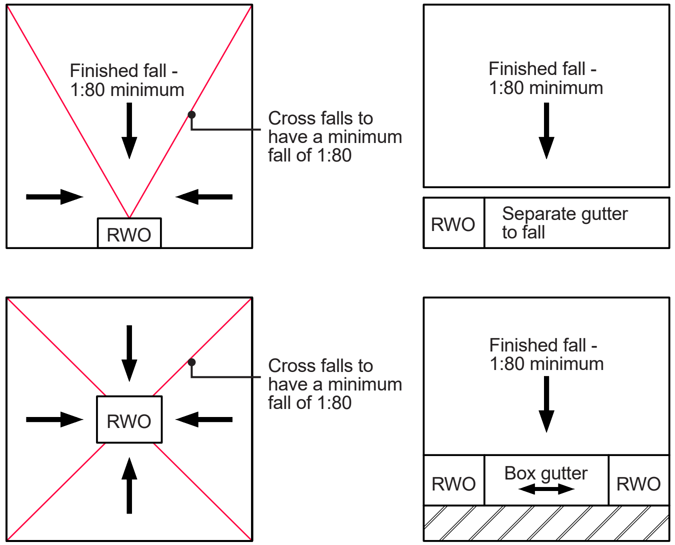
The overflow level should be set at the design water level for the rainwater outlets, which in most instances is 30-35mm above the outlet. Where there is a sump included at the rainwater outlet position, the overflow should be set at the level of the lip into that sump.

The level of overflows should be 25 mm below the underside of the any sill positions e.g. thresholds.

Box gutters

It is not generally necessary to provide separate box gutters where two planes of roofing intersect, or where a single plane falls to an abutment. In the latter case, there will be no fall between outlets, so consideration should be given to creating these in the structure or insulation. Box gutters are slow, difficult to construct and introduce unnecessary complexity. The need to maintain a fall in gutters and comply with the energy requirements of the Building Regulations may be difficult to achieve.

Drainage layout options



Note: Gutters must also have a minimum 1:80 fall towards the RWO.

Drainage layout options are for illustrative purposes only and should be further developed by a suitably experience drainage designer prior to roofing work commencing.

Where RWOs are shown, they may or may not be sumped and will be dependent on the drainage design.

Siphonic drainage

All waterproof membranes are compatible with siphonic roof drainage systems, which for larger roofs offer many advantages:
- Very high capacity, enabling fewer outlets and therefore less detailing work on-site.
- Smaller bore horizontal collector pipe work, enabling reduced roof void depth.
- Self-cleaning in many situations.

Note: Siphonic drainage is generally not appropriate for inverted roofs.

For further information see www.siphonic-roof-drainage.co.uk

These roof proposal are to be considered on a case by case basis and full design and calculations should be submitted for Warranty approval before construction begins on site.

Materials

Compatibility of components
The selection of components within the roofing system should be discussed in detail with the membrane manufacturer or appropriate trade association to ensure chemical and mechanical compatibility between components, since the incorrect specification may lead to reduced performance or premature failure of the roofing system. The correct choice of insulation is also important when it is to be adhered to the substrate. In case of doubt, the insulation manufacturer or relevant trade association should be consulted.

General
Materials for use in flat roofing systems are suitable only if the manufacturer has declared compliance with the relevant harmonised European Assessment Document EAD (previously a European Technical Assessment Guideline, ETAG) and has an affixed CE Mark to the product. All waterproof membrane products shall also have a certificate of fitness for purpose issued by a member of the European Union of Agrément (UEAtc). This may comprise a British Board of Agrément certificate or an equivalent certificate of another UEAtc member.

Requirement
The waterproof membrane should be selected with regard to the following minimum criteria:

- Anticipated service life based on independent certification.
- Minimum maintenance.
- Ease of adaptation and repair.

External fire performance

All roof coverings within close proximity of buildings must achieve the fire designation required by the relevant Building Regulations.

Statutory requirement
Design for external fire performance must comply with current Building Regulations.

Certification of system
The manufacturer of the waterproof membrane must demonstrate by reference to independent test certification that the system of waterproofing and insulation (type and thickness) for a particular project meets or exceeds the minimum level of fire performance defined by the Building Regulations.

Polymeric single ply membranes

The manufacturer should declare compliance with the harmonised European Product Specification for single ply membranes, BS EN 13956, which defines requirements for testing and declaration of characteristic values.

There is no relevant British Standard. Products suitable for roofing should have current certification as detailed in 'Appendix C'.

Such certification should be accompanied by full instructions for installation.

There is no British Standard for the installation of single ply membranes. Installation should be in accordance with the Single Ply Roofing Association's Design Guide to Single Ply Roofing and with the specific instructions of the membrane manufacturer.

The attachment of the single ply membrane should be designed to resist calculated wind load by a declared safety factor of two times (200%). This design will normally be provided by the membrane manufacturer.

Whatever the means of attachment, specific restraint is always required at the roof perimeter, at changes of slope and around details. This ensures that any tension in the membrane in the roof field or upstand is not transferred to the other as a peeling action.

Perimeter restraint is achieved by several methods, depending upon the manufacturer:

- Individual fasteners, protected by a flashing.
- A linear bar, protected by a flashing.
- Clamping underneath a mechanically fastened, membrane-laminated trim, with the line of fixings waterproofed by a cover strip.
- Welding the field sheet to a membrane-coated metal trim secured to the deck (with thermal break fasteners where appropriate).This is not recommended for fully adhered membranes.

If the remainder of the roof system is to be bonded, it is essential that the design resistance to wind load is also achieved for the attachment of these components.

Irrespective of the wind uplift considerations or distribution requirements for securing the membrane, the fixing of the insulation boards should always be considered separately, unless specifically sanctioned by the membrane manufacturer. The number and distribution of mechanical fasteners required to fix the insulation boards may vary with the insulation type, geographical location of the building, topographical data and the height of the roof concerned.

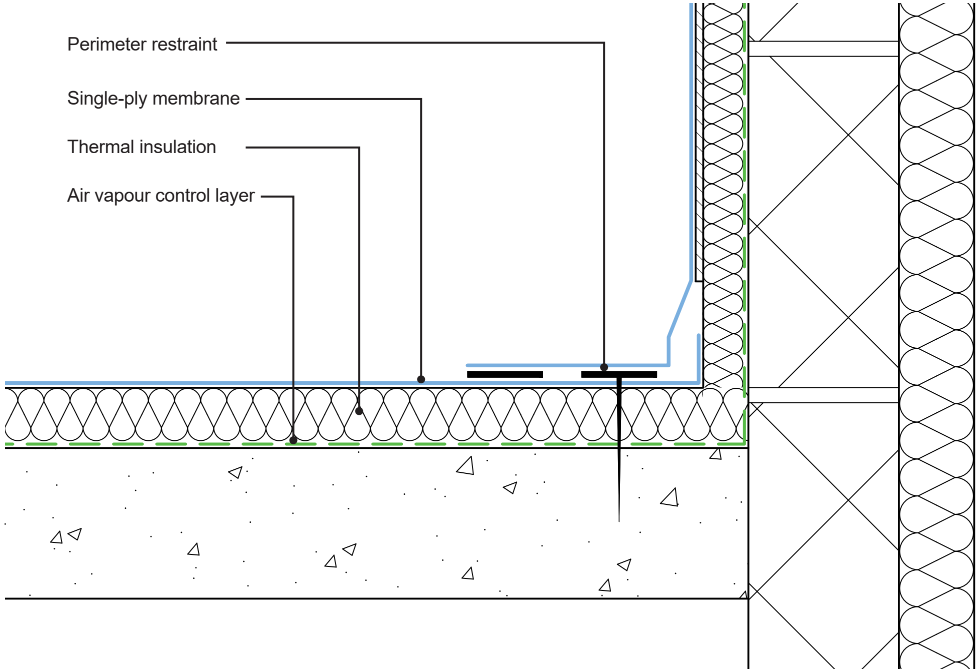
The upper termination of the single ply membrane at linear details such as plinths, parapets, abutments and door openings should be secured by one of the following mechanical means:

- Clamping beneath a metal rail, e.g. a parapet capping or roof light frame.
- Welding to a membrane-metal laminate trim (itself mechanically fixed).
- Mechanical fixing using individual fasteners or a mechanically fixed termination bar.

The welding of single ply membranes is a critical process. The following should be considered:

- Supply of certification for each installer indicating successful completion of the manufacturer's product specific training.
- Provision of consistent electrical power supply.
- Production and retention of test weld samples at the start of each day.
- Declared procedures for repair of weak welds or damage.

Methods of restraint of a single-ply membrane at perimeters



Warm roof systems with polymeric single ply membranes

Where the insulation is mechanically fixed, the number and arrangement of fasteners required to resist wind load will be prescribed by the manufacturer, applying a safety factor of two to the design load on each fastener. This arrangement may vary across the roof according to wind load, but should be followed in all areas. Thermal break fasteners shall be used wherever feasible.

Where the insulation is adhered, the adhesive should be approved by the insulation manufacturer and should be laid at the coverage rate and pattern designed to achieve calculated wind load with a safety of factor of two times (200%). The contractor should allow for temporary loading as required to achieve a suitable adhesion and to achieve the best possible level in the upper surface of the insulation.

Liquid applied membranes

Liquid applied membranes consist of a material or combination of materials where at least the main component is a liquid form. There is no harmonised European Product Specification for liquid applied membranes for roofing. There are many types of liquid applied membranes and many may be covered by European Assessment Document (EAD) 030350-00-0402 ‘Liquid Applied Roof Waterproofing Kits’ (EADs are the basis for issuing European technical assessment (ETA’s) certificates).

European Assessment Document (EAD) 030350-00-0402 should be used for systems that are:

- Polymer modified bitumen emulsions and solutions.
- Glass reinforced resilient unsaturated polyester resins.
- Flexible unsaturated polyesters or Reactive poly(methyl) methacrylate (PMMA)
- Hot applied polymer modified bitumen.
- Polyurethane, Polyurea or Polyaspartic.
- Silane modified polymers (SMP)/Silane Terminated Polymers (STP).
- Water dispersible polymers.
- Thermoplastic block copolymer.

European Assessment Document (EAD) 030019-00-0402 should be used for systems that are:

- Polysiloxane (waterproofing on the basis of a silicone).

The manufacturer of a product for use in flat roofing should declare compliance with the relevant parts of the relevant European Assessment Document (EAD). In the absence of this declaration, the product should have a current certificate of fitness for purpose issued by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

Such certification should be accompanied by full instructions for installation.

Further information on these generic types of liquid applied membranes can be found on the Liquid Roofing and Waterproofing Association (LRWA) website www.lrwa.org.uk.

Installation of liquid applied membranes

There is no British Standard for the installation of liquid-applied membranes. Installation should be in accordance with the Liquid Roofing and Waterproofing Association guidance, as follows:

- Guidance Note No. 2 - Substrates for liquid applied waterproofing.
- Guidance Note No. 4 - Roof, Balcony and Walkway Refurbishment Using Liquid applied Waterproofing Systems.
- Guidance Note No. 5 - Health and Safety Provision for LAWS on Roofs, Balconies and Walkways.
- Guidance Note No. 6 - Safe Use of Liquid applied Waterproofing Systems.
- Guidance Note No 11 – Use of Adhesives for Liquid Flat Roof Systems.
- Guidance Note No 12 – Termination of Waterproofing at Cills and Thresholds.
- Guidance Note No 13 – Drying of Existing Roof Substrates Prior to Installation of Liquid Waterproofing Systems.
- Guidance Note No 16 – Walls Built onto Waterproofing Systems.
- Guidance Note No 17 – Best Practice for the Installation of a Flues Passing Through a Flat Roof.

A consistent film thickness is essential for reliable and durable liquid-applied membranes.

The following should be considered:

- Supply of a card for each installer indicating successful completion of the manufacturer’s product-specific training.
- The coverage rate in kg/m² must be declared before work starts.
- During installation assessment of wet film thickness by one of the following methods as appropriate:
- Gauge pin.
- ‘Comb’ type measurer.
- Visual inspection.

In all cases, where a LARWK roof product/system is proposed, the designer will be required to distribute the following information to all appropriate contractors, site supervisors and suppliers, in a clearly understandable format to demonstrate the installed system provides an adequate level of performance:

- A full third party product conformity approval certificate for the system.
- A full specification for the proposed works prior to works starting on site – this must be accompanied by a full set of drawings covering aspects of detailing.
- The installing contractor must provide evidence of inclusion into an Approved Installer scheme, which is controlled and verified by the system manufacturer.

Insulation for use with liquid applied membranes

Any proposal that requires on site installation of an OSB or plywood sheet over a proprietary rigid insulation board **should only be accepted** when supported by a site specific Condensation Risk Analysis calculation.

The type of insulation used for liquid applied membrane must be confirmed by the manufacturer of both the liquid applied membrane and insulation board manufacturer as being compatible. The insulation core must also be capable of giving support to the completed liquid applied membrane in order to ensure that applied loads do not give rise to cracking or indentation of the finished waterproofing system.

It should be noted that some liquid applied membranes use an adhered carrier or preparation membrane prior to application of the liquid applied membrane. Where this is the case, confirmation should be sought from the manufacturer of the insulation board regarding the compatibility of any roofing system primers or adhesives used for the attachment of the carrier material.

In both instances, the manufacturers of the insulation board should provide any performance data for inclusion into the specification which has been produced for the roofing system.

Insulation products must be manufactured in controlled factory conditions, with manufacturing facilities holding evidence of appropriate Factory Control Certification from a UKAS accredited 3rd Party which confirms they are manufactured to the relevant industry standard. The product itself must be covered by a full third party product conformity approval certificate.

Typically acceptable build-ups

Cold flat roof build ups are not acceptable for roof terraces.

For the purposes of Warranty, a warm flat roof build up is recommended for site applied liquid applied membrane roof coverings. The insulation should be compatible with the liquid applied membrane and method of application.

Detailing

The Warranty Surveyor must receive a full set of sectional drawings, which should be accompanied by the specification. These sectional details should be produced by the system manufacturer for all aspects of detailing specific to the project.

Compatibility with other materials – penetration detailing

For instances where the liquid applied membrane is required to bond onto lead pipe sleeves, flashings, steel balusters, anchoring system, etc., the liquid applied membranes guidance should always be sought prior to works taking place. Incompatible material will often need special preparation and need to be primed with a system specific primer to facilitate a good adhesion of the liquid applied membrane to the material in question.

EPDM roof coverings

EPDM roof coverings are not acceptable where used on a:

- Balcony/terrace decks
- Blue roof
- Green roof
- Podium deck

Site-applied hot-melt coverings

There is no harmonised European Product Specification for site-applied hot-melt waterproofing systems. Hot applied polymer modified bitumen (hot melt) is covered by European Assessment Document (EAD) 030065-00-0402 ‘Composite Roof Waterproofing Kits’. EADs are the basis for issuing European technical assessment (ETA’s) certificates.

The manufacturer of a product for use in flat roofing should declare compliance with the relevant parts of the relevant European Assessment Document (EAD). In the absence of this declaration, the product should have a current certificate of fitness for purpose issued by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

Evidence of appropriate certification should be provided to demonstrate its suitability for its proposed use.

As these systems comprise a multi-layer application (usually a base coat, reinforcement and top coat), a detailed specification for the system should be available prior to commencement of the works to ensure suitability for the project to be confirmed. Reference should be made to independent certification and the manufacturer’s detailed instructions.

Mastic asphalt

There is no harmonised European Product Specification for mastic asphalt for roofing. Products used for flat roofing should comply with BS 6925: 1988 Specification for mastic asphalt for buildings and civil engineering (limestone aggregate).

Proprietary grades of polymer modified mastic asphalt are produced for roofing and paving applications. There is no British Standard or European Standard for these products.

- Products suitable for roofing should have current certification as detailed in 'Appendix C'.

The separating membrane should be one of the following, and should be laid directly under the mastic asphalt:

- Sheathing felt, comprising a base of flax or jute, or other suitable fibres, impregnated with bitumen.
- Glass fibre tissue.

Bitumen-coated plain expanded metal lathing should be in accordance with BS EN 13658-2.

Stone chippings (bedded) for use as a protective topping should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution over the mastic asphalt membrane.

Generally, mastic asphalt on sheathing felt provides sufficient dead load to resist wind load, but this should be demonstrated by calculations in all situations.

Installation of mastic asphalt

The number of coats should be appropriate to the waterproofing requirements and traffic conditions of the roof. When laid to falls of 1:80 or more, mastic asphalt roofing is laid in two coats to a thickness of 20mm, on a separating membrane of sheathing felt, all in accordance with BS 8218.

On sloping and vertical surfaces over 10° pitch, the mastic asphalt should be laid in three coats to a thickness of 20mm without a separating membrane.

On sloping and vertical surfaces of timber or lightweight concrete, the mastic asphalt should be laid in three coats to a thickness of 20mm on expanded metal lathing over a separating membrane of sheathing felt.

Reinforced bitumen membranes

The manufacturer should declare compliance with the harmonised European Product Specification for reinforced bitumen membranes, BS EN 13707, which defines requirements for testing and declaration of characteristic values. There is no relevant British Standard.

Products suitable for roofing should have current certification by one of the following:

- British Board of Agrément.
- Another member of the UEAtc.
- Another notified body.

In addition, specifications for systems of multi-layer reinforced bitumen membranes for flat roofing should comply with BS 8747.

Minimum recommended specification for reinforced bitumen membranes

Roof system type	Deck type	Insulation type(1)	Venting layer(2)	Underlayer (3)	Cap sheet(4)
Warm deck	Profiled metal	Thermoplastic foam	3G	S2P3(5)	S4P4(5)
		Mineral fibre	-	S2P3	S4P5
	Concrete	Thermoplastic foam	-	S2P3	S4P4
		Mineral fibre	-	S2P3	S4P4
	Timber panel	Thermoplastic foam	3G	S2P3	S4P5
		Mineral fibre	-	S2P3	S4P4
Inverted warm deck	Profiled metal	Extruded Polystyrene (XPS)	3G	S2P3	S4P5
	Concrete		-	S2P3	S4P5
	Timber panel	Deck type not suitable for inverted roofs			

Notes:
(1) Insulation type: Thermoplastic foam: PIR, EPS, PF. Mineral fibre: MW.
(2) Venting layer: BS 8747 3G or proprietary equivalent with suitable certification.
(3) Under layer: as defined in BS 8747. SBS-modified products are recommended.
(4) Cap sheet: as defined in BS 8747. SBS-modified products are recommended.
(5) S and P are classifications 1-5 of Strength (tensile strength and elongation) and resistance to puncture (static and dynamic); the higher the rating, the higher the performance.

Bitumen membranes should be protected from solar radiation. This should be by integral protection provided in the product in the form of:

- Mineral granules.
- Metal foil.

The use of solar reflective paint is not permitted. The use of stone chippings is not recommended unless required to achieve enhanced external fire performance. If used, chippings should be washed, crushed rock, normally 10mm-14mm nominal size aggregate, bedded in a proprietary gritting solution.

Warm roof systems with reinforced bitumen membrane waterproofing

The limiting wind load for the different methods of attachment of insulation is prescribed by BS 8217 as follows:

- Partial bitumen bond: up to 2.4kN/m².
- Full bitumen bond: up to 3.6kN/m².

Where the method of attachment is outside the scope of BS 8217, the manufacturer should demonstrate that the method provides sufficient resistance to wind load.

Reinforced bitumen membranes installation

Installation should be in accordance with BS 8217. In case of doubt, or where the waterproof membrane is beyond the scope of the Standard, the advice of the Flat Roofing Alliance (National Federation of Roofing Contractors) should prevail.

The safe use of gas torches, and the positioning, monitoring and transferring hot bitumen to the work face, should be adopted, all in accordance with the Health and Safety Executive/Flat Roofing Alliance Code of Practice for Safe Handling of Bitumen.

The practice of applying reinforced bitumen membranes by torching onto thermoplastic foam insulation is not permitted, unless the boards are manufactured with a covering of reinforced bitumen membrane.

Fixing of guarding/balustrades

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and any penetration through waterproof roof coverings is fully sealed correctly to prevent any risk of moisture penetration. A pinch pocket with an upstand of 150mm is a suitable method of sealing these details.

Protection of waterproof system during construction

At the earliest possible stage, the anticipated loading of the balcony, terrace or podium area by plant and access during service should be assessed in terms of:

- Load, e.g. foot traffic, equipment.
- Frequency.
- Risk of impact.

If such usage is intense or long-lasting during the construction phase, consideration should be given to temporary works only, with completion occurring after all non-roofing usage has ceased as follows:

- Warm deck roof system: installation of temporary vapour control layer (VCL) to be overlaid when remainder of system is installed.
- Inverted warm deck roof system: overlay of completed waterproof membrane with geotextile and continuous temporary decking, such as plywood, oriented strand board or compatible recycled thermoplastic board.

Responsibility for temporary protection and a method statement for its use should be agreed prior to the commencement of works. Suitable materials should be selected in consultation with membrane manufacturer as appropriate, for example:

- Linked recycled thermoplastic sheets.
- Rolled recycled thermoplastic or elastomeric sheets.

Particular consideration should be given to locations of concentrated access, such as step-out areas onto the roof or where wheeled equipment may be used.

Provision for access

Statutory requirement
Roof terraces should have suitable access and drainage meeting the requirements of the current Building Regulations.

Ancillary components

Lightning protection
Where provided, the manufacturer's information or independent certification should be followed. Guidance may be found in BS EN 62305. We would require details of:

- Design in compliance with BS EN 62305.
- Method of attachment to the waterproof membrane, including arrangements for self-ballasting of conductors and finials (centres, compressive loads).
- Recommended detailing at penetration of roof system.

Detailing

The following key principles should be followed in the design of all details:

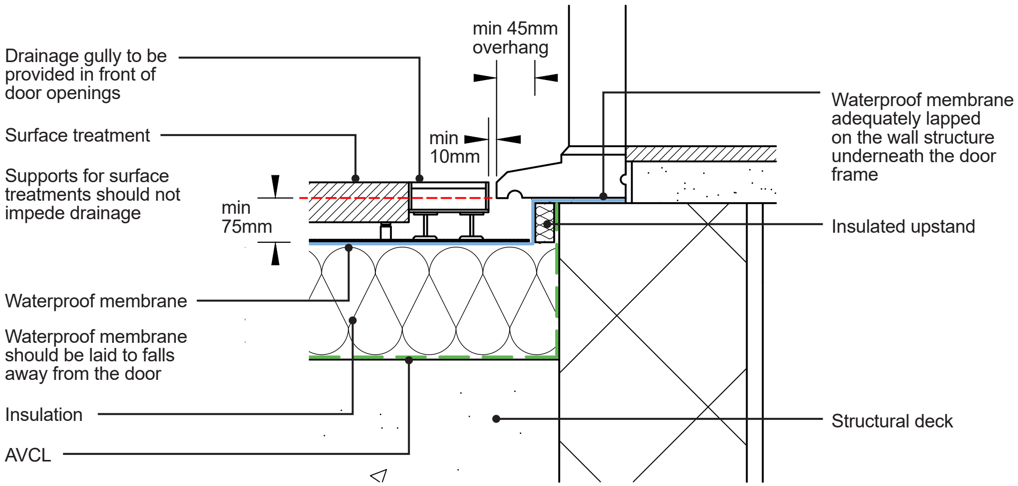
- Upstands to extend 150mm above finished roof level, except at door access to roof terraces.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum of 75mm.
- Where the terrace forms part of the entire roof of an occupied building, a continuous barrier to air leakage should be maintained.
- Reliance on sealants as the sole means of protection from moisture ingress is not an acceptable approach.

The total roof terrace zone depth should be assessed at critical points, to ensure there is enough space to provide a 150mm upstand to provide waterproofing protection above finished roof level. It is important that this minimum 150mm upstand is maintained at all points around the waterproofed area. A 75mm upstand may be permissible at door thresholds subject to review.

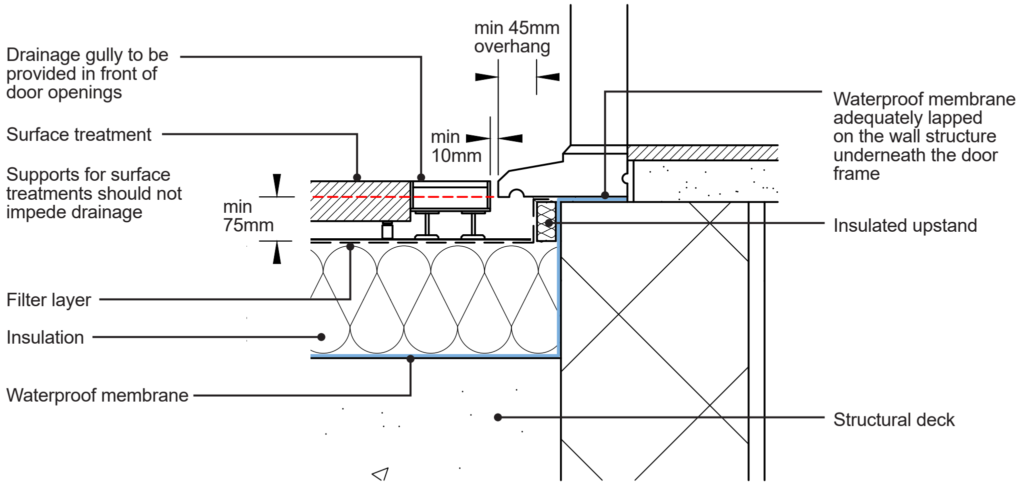
The following design features for a successful design of a level threshold are essential:

- Minimum clearances are maintained to enable the waterproof membrane to be installed.
- Continuity of the membrane across the whole field area of the roof terrace. All Terminations of the waterproof membrane at interfaces to other elements are to consider potential expansion and contraction of the membrane used.
- Sills are adequately supported to ensure no damage to the sill over the long term.
- Thermal bridging is avoided through provision of continuity of the thermal line or thermal breaks as appropriate to minimise heat loss and condensation risk.

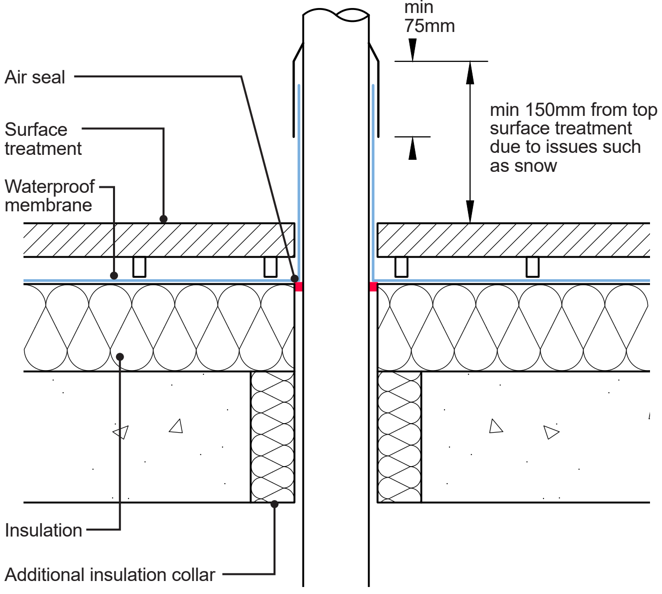
Upstand at door access - Warm deck roof - Level threshold



Upstand at door access - Inverted warm deck roof - Level threshold



Penetration through a roof terrace



Notes:

- Upstands to extend 150mm above the finished roof level.
- Downstands (of separate metal or other flashings) should lap the upstand by a minimum 75mm.
- A fillet is required at the base of the upstand for certain types of waterproof membrane. Roof membrane manufacturer specification should be followed.
- An effective seal is required between the air vapour control layer and pipe. Clearly it is difficult to dress a sheet material around a pipe. The method for doing so should be stated in the contract drawings and/or specification.

Special design features

Special design features are essential, depending upon the generic type of waterproof membrane, including:

- Minimum clearances to enable the waterproof membrane to be installed.
- Termination of the waterproof membrane at interfaces to other elements.
- Penetrations.
- Supports.

Mechanical and electrical services

Detailed design should take account of the installation of such equipment by other (usually following) trades, as follows:

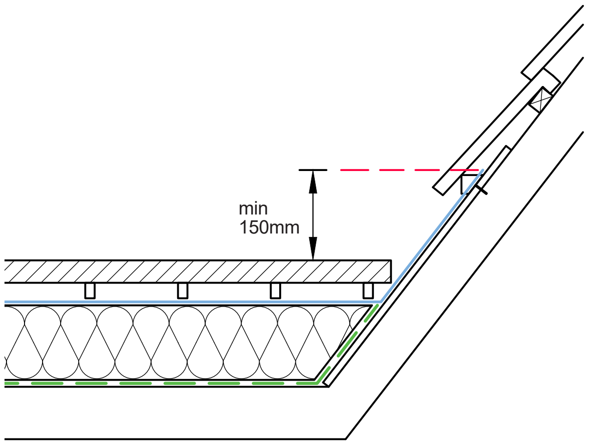
- Service entry/exit points should be suitably weathered to enable connection without loss of integrity of the waterproof membrane and without the involvement of the roofing specialist.
- The upstand of the waterproof membrane at risers should be arranged to enable a separate downstand or weathering flashing to be formed in ductwork.
- Sufficient clearance should be provided to horizontal ductwork to ensure it does not rest upon the waterproof membrane or roof finish.

Support for renewable energy capture equipment

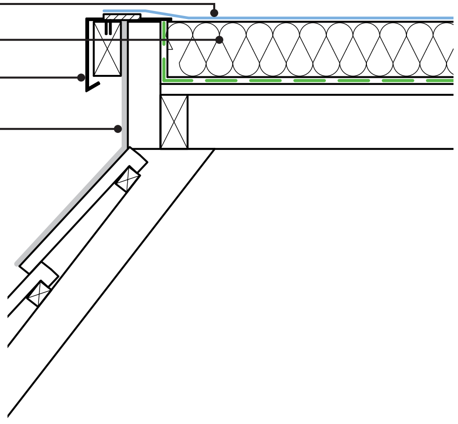
Renewable energy capture equipment includes photovoltaic panels and multi-panel arrays, solar thermal panels and multi-panel arrays and wind turbines. All such equipment should be secured to a frame and/or posts that transfer their load directly to the structure. The roof system and waterproof membrane should be designed to enable equipment to be de-mounted without loss of the roof's waterproofing integrity and without the involvement of the roofing specialist. Support systems based on 'top-fixed' plate and post components should be accompanied by documentation to demonstrate their compatibility with the waterproof membrane.

Principles: Flat roof interface to pitched roof

Flat roof abutting a pitched roof



Pitched roof abutting a flat roof



Edge protection/guarding

The guarding to the perimeter of a roof terrace should be designed to minimise laps and complex junctions to achieve waterproofing integrity. Installation of balustrade or glazing stanchions may occur after the installation of the roof system, this should be avoided where possible.

Acceptable examples include the following, in order of preference:

Full-height parapet walls:
- Stanchions or rails secured to low parapet walls above the level of the waterproof membrane (incorporated in copings or secured to elevation).
- Stanchions secured, clamped and sealed to stainless steel bolts set in raised plinths, which were constructed prior to application of the waterproof membrane (suitable for warm deck and inverted warm deck roof systems).
- Stanchions secured, clamped and sealed to stainless steel bolts set at deck level, which were installed prior to application of the waterproof membrane (suitable for warm deck roof systems only).

If the design requires a collar of waterproof membrane at the stanchion, the stanchion should be of circular section at this point and should incorporate a weathering apron.

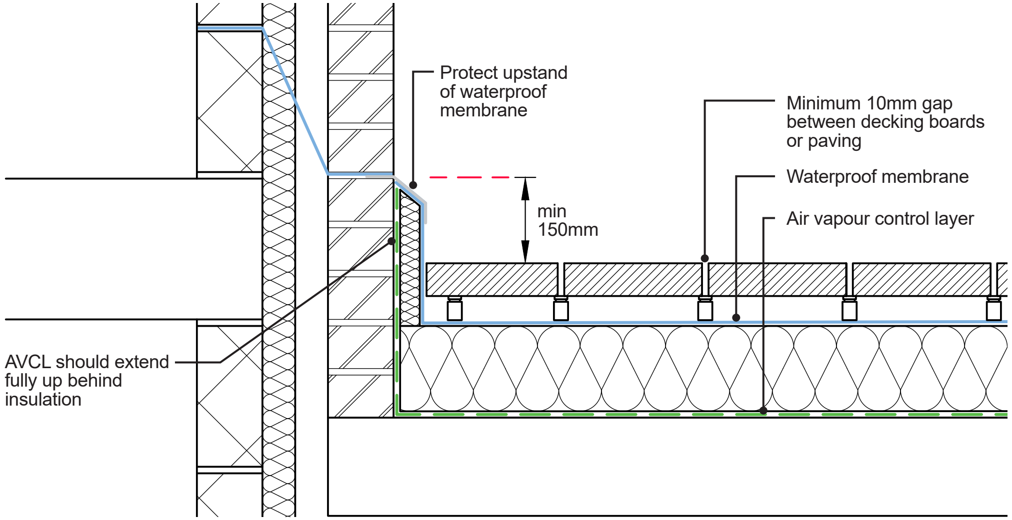
For further guidance, please refer to the 'External Walls – Parapets' section.

Fall-arrest and edge protection equipment

The following should be confirmed by reference to the manufacturer's information or independent certification, as appropriate:

- Compliance with BS EN 795.
- Method of attachment.
- Compatibility with the waterproof membrane.
- Means of forming a water tight seal to the waterproof membrane.

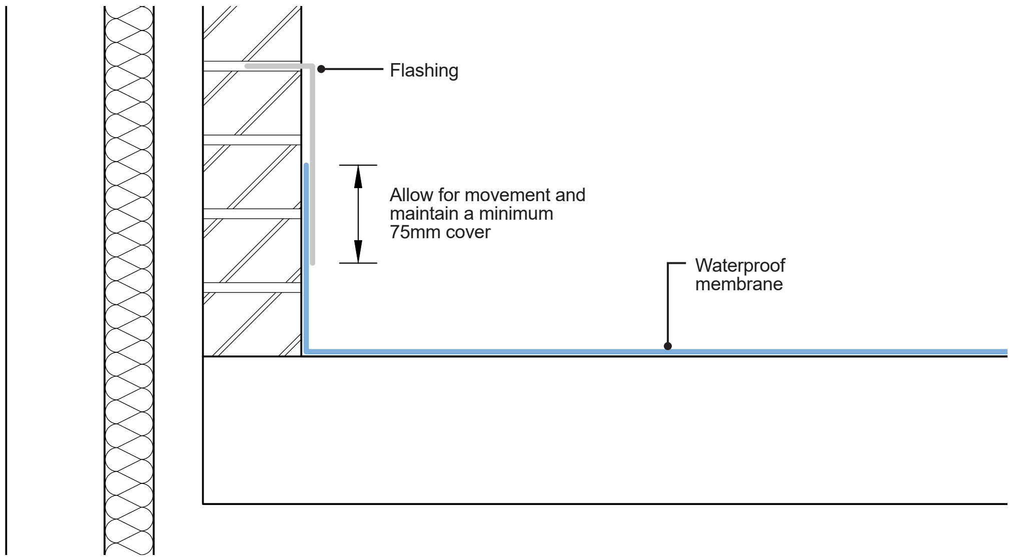
Upstand to decking and paving finishes - e.g. where access is required



Allowance for movement where a timber frame with masonry cladding abuts a flat roof

Where a timber frame structure abuts a masonry structure allowance should be made to accommodate movement in the timber frame and ensure the appropriate cover is maintained.

For detailing with parapet wall construction, see the 'External Wall - Parapets' section.



Pedestrian surface finishes

- The design should include protection to suit the anticipated conditions as appropriate.
- Pedestrian access finish and there supports should not impeded the ability for the terrace to drain to all outlets.
- Supports or pedestals to pedestrian finishes should not be mechanically fixed through the waterproof membrane.
- All pedestrian access finishes should comply with the relevant Building Regulations in regards to combustibility requirements in regards to a relevant boundary.

Pedestrian finishes for roof terraces

	Roof system type		Waterproof membrane type			
Finish	Warm	Inverted	Single ply membrane	Bitumen membrane	Mastic asphalt	Liquid applied
Porous concrete tiles adhered to waterproof membrane (1)	Y	N	N	Y	Y(2)	Y
Fired tiles bedded in screed and grouted (1)	Y	N	Y	Y	Y(2)	Y
Precast concrete paving slabs on adjustable supports (3,4)	Y	Y	Y	Y	Y	Y

Notes:
(1) Product should be certified for use with waterproof membrane.
(2) Consideration should be given to the effects of solar gain on the stability of mastic asphalt under point loading in this situation.
(3) Paving support pad bearing area should be suitable for the compressive strength of the insulation under design loadings.
(4) Bearers should not impede drainage, and should be sized to suit the compressive strength of the insulation under design loadings.

Non-access areas: stone ballast
Stone ballast for inverted warm deck roofs and ballasted warm deck roofs should be clean, rounded aggregate graded 20mm-40mm and as free from fines as practicable. Ballast should be applied over a protection layer on warm ballasted systems and over a filter layer or WCM on inverted warm roofs and suitably provided to prevent wind uplift.

Access areas: concrete paving slabs
Concrete paving slabs for use as walkways or as paving on terrace decks should conform to BS EN 1340, and be laid in accordance with the manufacturer's instructions.

It is recommended that concrete paving is laid on support pads as this allows adjustment, reducing risk of trip hazard. Recommendations are as follows:

- The height of support pads should not exceed the maximum recommended by the manufacturer.
- Paving should not be cut.
- Paving should be firmly butted up against support pad separating pegs.
- Support pad separating pegs should provide clear space for rapid disposal of rain water between paving slabs.
- Provision for movement at perimeters should comprise either a 75mm margin of washed stone or a compressible rubberised fill. In either case drainage should not be obstructed and a suitable restraint trim should be used to ensure stone does not fall beneath the paving adjacent.

Access areas: flexible walkway tiles
Evidence of the compatibility of the tile with the waterproof membrane is required.

Testing

Final inspection
At practical completion of the balcony/terrace, all areas should be clear of stored material, other site operations and all protection. A thorough, recorded, visual inspection of all areas, including details, should be carried out with representation from the General Contractor and Roofing Contractor in attendance.

Parameters for testing
Upon completion testing of the flat roof covering will be required to be carried out as per the following criteria.

Testing of roof terraces (All types of materials)
Testing is required in the following situations:

1. On Low rise housing: Detached/semi-detached/terraced housing 3 stories or less in height (including the ground storey) when:
   - The roof/roof terrace areas exceed 50m² or,
   - Where the project consists of 10 or more properties: one test per ten houses (with a minimum of two tests per site) are required.
2. On large developments: Apartments etc. over 3 stories in height (including the ground storey), where the total combined roof terrace areas exceeds 50m². In this case, a minimum of 20% of the roof areas must be tested.
3. On developments involving our Major Projects team, all roof terraces will require low voltage testing.
4. Where, after the completion of the site risk assessment, the Warranty Surveyor has identified areas of complexity (for example service penetrations, abutments with claddings and/or penetrations from fixed items such as guarding) in relation to the roof and its ancillary components that present a higher risk to Warranty.

These areas of complexity may be resultant of elements of:

Design where:
1. If the roof terrace includes features beyond a typical wall abutment e.g. (but not limited to); variations of upstand constructions/penetrations/fixings/external permanent machinery/balustrading fittings etc.
2. If the waterproof membrane is to be covered over (by pedestrian finishes or solar panels). Note: Inverted roofs of straightforward design and with continuous hot-applied waterproof membrane could be exempted.

Construction where:
1. If there are to be/have been, follow on trades on the roof terrace after completion of the roof terrace covering.
2. If secondary items such as fall protection devices, PV supports, balustrades etc. are to be attached.

In all circumstances, testing should be carried out when the first roof terraces are completed in order to determine if there are any inherent issues with the design or workmanship. Where there is a failure the root cause should be determined and appropriate remedial actions should be taken. The Warranty Surveyor may request an increase in the amount of testing required.

Procurement of testing services

If testing to demonstrate waterproofing integrity is required it should be undertaken by a suitably qualified and experienced third-party who is independent of the installing contractor.

The testing service provider should provide evidence of the following:

- Efficacy of the method proposed in the circumstances of the project.
- Detailed testing regime that includes integrity testing of detailing specifically where the Warranty Surveyor has raised these as elements of particular complexity within the site risk assessment.
- Experience and training of operator.
- Membership of an appropriate trade association that sets a Code of Conduct for the service.

Methods of test

Low voltage earth leakage
Low voltage earth leakage is a safe and effective method for the testing of waterproofing integrity in roofs where the waterproof membrane is an electrical insulator and the deck provides an electrical earth. It is not suitable for testing flat roofs where the waterproof membrane has been overlaid with insulation and ballast (inverted roofs) or ballast only (ballasted warm roofs); therefore, testing should be carried out prior to completion of the roofing system.

Voltage field mapping
Voltage field mapping uses a generator, trace wire and field electrodes on a roof with a thin layer of water spread across the selected test area. The trained operator uses electrodes and generated voltage flow to determine the presence and precise location of defects in the area being tested.

High voltage electrical discharge
High voltage electrical discharge method is a versatile and effective method of testing. It can be used on steep slopes or inverted surfaces, provided the underlying structure will provide the necessary ground. Can be used for single ply (check with the relevant manufacturer before testing), reinforced bitumen membranes and liquid applied coatings.

Vacuum
Vacuum testing of seams of membranes manufactured off-site is an effective means of quality assessment, but is not recommended as a method of demonstrating the integrity of flat roofs.

Flood testing
Flood testing is not recommended as a method of demonstrating the integrity of flat roofs. It may be used to test balconies.

Approved installers

In all circumstances, the roof terrace membrane system will need to be installed by an approved contractor who is recognized by the manufacturer as competent. Evidence of the manufacturer’s approval of the contractor to install their products should be provided to the Warranty Surveyor.

Typically, this is in the form of an identity card, which features the installer’s name; a passport-style photograph; a unique card number; an expiry date; the manufacturer’s name and logo; and lists the products and/or systems for which the installer has been trained.

Periodic inspections

Periodic inspections should be completed in line with the advice provided within the Operation and Maintenance Manual for the project, by an appropriately skilled or trained party. The operations and maintenance manual should be provided to the home owner upon completion.

As a minimum it is advisable that a roof terrace is inspected at least twice yearly. Typically in the autumnal period of the year to ensure outlets are operational and the roof terrace is free draining to deal with any subsequent inclement weather conditions in coming winter months. A further inspection is then carried out in spring to discover and rectify any damage due to weather. Extra inspections are advisable following any extreme weather events or where it is suspected that vandalism, and/or theft may have occurred on the roof terrace.

As a minimum, it is advisable that any inspections should include the following elements:

- An examination of ceilings for signs of water damage;
- An examination of external walls, eaves, critical junctions and soffits for signs of movement;
- Signs of damage to the roof surface and subsequent layers of construction along with associated flashings;
- Mounted or ballasted roof top installations e.g. safety equipment, communications and renewable energy installations should be examined to ensure their attachment and associated work remains waterproof.
- Extensive build-up of leaves, moss, plants or debris should be recorded along with any influencing factors such as the effect of overhanging trees, mounted plant items, etc.

It is advisable that when additional construction work is planned on or near to the roof, an appropriate and specific inspection regime is established to cover the aspects of risk associated with the work at hand.

12.
Roof Terraces and Balconies

12.2
Balconies

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. A full set of detailed drawings including:
   a) Balcony identification plan clearly indicating all balcony types e.g. projecting balconies, inset balconies, access decks/ walkways, Juliet balconies.
   b) Plan showing direction of falls and position of outlets and overflows.
   c) Details of all critical junctions including support of the threshold and any upstand interfacing with the façade.
   d) Details of the provision of pedestrian surface support structure (where appropriate).
   e) Details of the provision of guarding including parapet walls and balustrading used as guarding, should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading and as required by the Building Regulations.
   f) Details of all fire stopping which should include specification and a detailed location layout drawing showing positioning of all fire stopping.
2. A detailed drainage strategy for all balconies.
3. A full structural design by an Engineer.
4. Details of fixings, their frequency and fixing method, including those for surfacing materials.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Definitions

Balcony - A balcony is a building component which is an accessible external amenity platform above ground level which is exterior to and with direct access from a building. A balcony can project beyond the walls of a building; it can be formed within a recess of a building; or it can be a hybrid of both as further explained in this section. A balcony does not form part of the thermal envelope, e.g. not forming a roof.

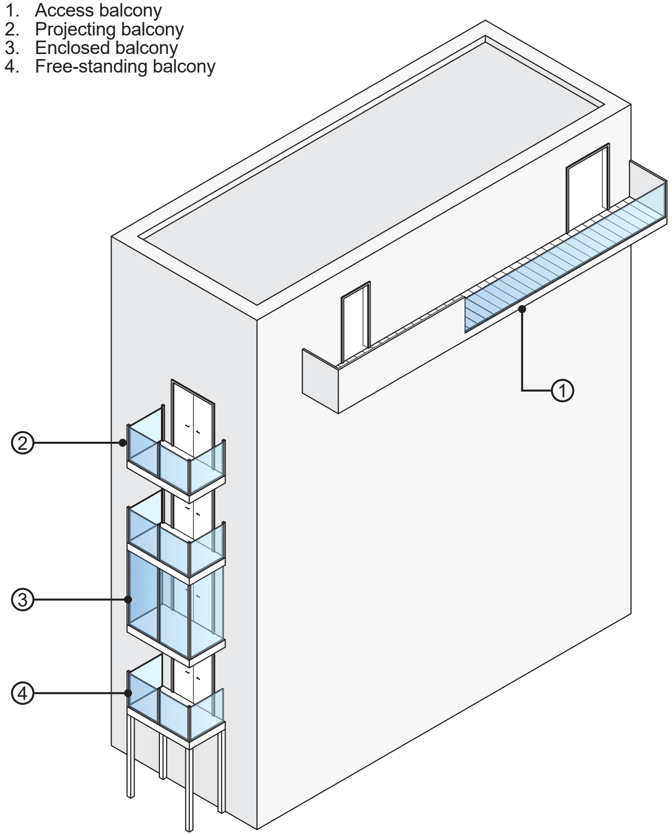
Balconies may take the form of:

- **Access balcony:** providing pedestrian access to two or more dwellings. (Sometimes referred to as a 'walkway' or 'access deck').
- **Projecting balcony:** an accessible external amenity platform affixed to the exterior of a building above ground level exterior to and with direct access from a building.
- **Enclosed balcony:** protected from rain by a roof or balcony above and walls or weather screens to the sides, (sometimes referred to as a 'winter garden').
- **Free-standing:** fully, or partially, supported independent of the building structure.

A 'balcony' formed over an accommodation is a 'Terrace', please see the 'Roof Terraces and Balconies – Roof Terraces' section.

Examples of different balcony types

1. Access balcony
2. Projecting balcony
3. Enclosed balcony
4. Free-standing balcony



General design requirements

Balconies which follow the guidance in this section will be generally acceptable to meet the Functional Requirements of this Technical Manual.

The designer must be aware of the specific scope of the applicable Warranty Policy in context of the limitations of the Technical Manual guidance compared with additional requirements contained within other standards e.g. BS 8579, which may extend beyond the scope of our requirements. The designer may consider their own design aims, beyond the minimum requirements of the Technical Manual in any specification and in this instance BS 8579 may be consulted by the designer.

List of standards
- BS 6229 Flat roofs with continuously supported flexible waterproof coverings. Code of practice.
- BS 8579 Guide to the design of balconies and terraces.

Structural Design Requirements
Balconies should be designed to meet the following requirements:

- Balconies should be designed to meet BS EN 1991-1-1, BS EN 1991-1-3, BS EN 1991-1-4 and BS 8579 for balconies. Due consideration of any added surfacing; paving slabs, decking boards etc. Snow loads should be assessed in accordance with BS EN 1991-1-3 + UK National Annex. Wind loads should be assessed in accordance with BS EN 1991-1-4.
- Balconies should be designed to address both short term and long-term deflection to provide an effective drainage strategy with no back falls or ponding.
- The resistance to wind uplift of the waterproof covering and finishes on a balcony should be assessed having regard to the dead weight of those materials and to the nature, type and disposition of their attachment to the slab or deck, in accordance with BS 8217 and BS EN 16002.
- Balconies should be designed to have adequate crack control/dimensional stability to avoid damage to directly applied AVCL and waterproofing layer, particularly liquid applied waterproofing.
- It is common for several designers to be involved in different elements of the balcony structural design; for example, interfaces with the main structure, guarding and balustrading design etc. There are risks associated with methods of procurement which introduce multiple interfaces. There should always be one party with a responsibility to assure that the final design, as a whole, is acceptable.

Balconies are usually designed to limited load capacities and as such additional excessive loads should be anticipated to avoid any potential structural failures. Examples include planters or using the balcony for storage purposes.

Durability

All structural components must have a service life of at least 60 years unless otherwise stated.

Prefabricated balcony structures should have third party accreditation and have a service life of at least 60 years.

Timber durability
For Warranty purposes, timber should only be considered for projects up to 2.4m from the external ground level. Please note, the use of Timber for non-structural components may be restricted by relevant Building Regulation and other legislative requirements.

Please refer to 'Appendix C' for further guidance on service life requirements for the use of timber in balconies.

All structural timber used should be stress graded. All such timber must be stamped as either 'DRY' or 'KD' (Kiln Dry). The use of ungraded, or 'green', timber is not acceptable.

The design should be in accordance with:

- The Code of Practice 'Balconies on new homes' published by TDCA, or an Engineer's design.

The balcony design should take account of possible differential movements within the slab/deck and at junctions with supporting structure, parapets, kerbs and upstands.

Note: Such movements might be caused by movement of the structural frame or by changes of temperature and moisture content.

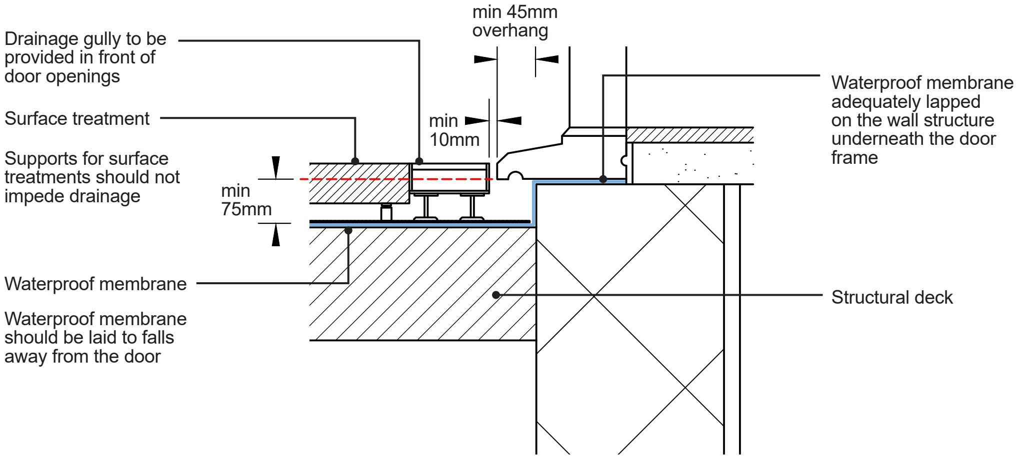
Preventing water ingress

Care should be taken to prevent water ingress from the balcony area to the internal habitable space, structure or building envelope to which the balcony structure is attached. Junctions with the main structure and threshold detailing should be considered during the design stage.

Junctions with main structure and threshold detailing

Where a waterproofing layer is used, a 75mm upstand should be formed with the waterproofing layer. The door threshold sill and drip should form a minimum 45mm overhang. A 10mm gap between the drainage gully and door threshold sill should be provided.

The same principles apply for off-site prefabricated balconies, the manufacturer should be consulted for specific detailing.



British and industry standards
The requirements of BS 6229 should prevail in respect of balconies irrespective of the type of waterproof membrane.

Falls
- Balconies should be designed to fall away from the building elevation.
- A minimum finished fall at any point of 1:80 (1.25%) should be achieved.
- Since adjoining roof planes at 1:80 will meet at a mitre of less than 1:80, the intended finished fall at such intersections should be considered at an early stage.
- Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed a justification, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%).
- The manufacturers' of certain waterproofing products have certification for their use in 'completely flat' or 'zero falls' applications. For Warranty purposes, all balconies must be designed to 1:80 falls to avoid backfalling.

Consideration should also be given to:
- The available upstand height at the high end of the falls. This may be a limiting factor on the length/size of the balcony/ terrace area to be drained. If necessary additional rainwater outlets should be provided.
- Avoidance of ponding behind wide obstructions to the drained slope such as plant plinths. Additional rainwater outlets should be provided.
- Falls between rain water outlets along a perimeter.

Waterproof coverings of all types are tested for water absorption and water tightness as part of third-party certification. However, the construction process, including the installation of components and the forming of seams, is clearly facilitated in dry, well-drained conditions.

Creation of falls
Falls may either be created during the construction of the deck or by applied cementitious screeds. Cementitious screeds provide a stable substrate to mitred falls with minimal tolerances, and are recommended. Screeds should be in accordance with BS 8204.

Paving support systems must be designed so that they take into account the maximum height formed when considering the falls for the balcony.

Drainage design for balconies

The following drainage approaches are suitable for Warranty:
- Positively drained
- Edge drained
- Free drained

Positively drained
All inset or semi inset balconies must be positively drained. Other drainage approaches are not acceptable in this arrangement.

With a positively drained balcony design, water is collected on a waterproof surface and directed to a piped outlet into the wider drainage network. An over flow is used to warn of outlet/downpipe blockage and so avoids the risk of flooding to the balcony area.

A positively drained balcony design should be based upon calculations in accordance with BS EN 12056 Part 3. Rain water outlet capacity should be taken from properly certificated information provided by a manufacturer, the resulting number and layout of outlets should avoid the potential for obstruction, for example by the decking supports. Sub frames or pedestal deck systems must be designed to mitigate the potential risks of point loads on the waterproofing product which could cause localised degradation to the waterproofing system.

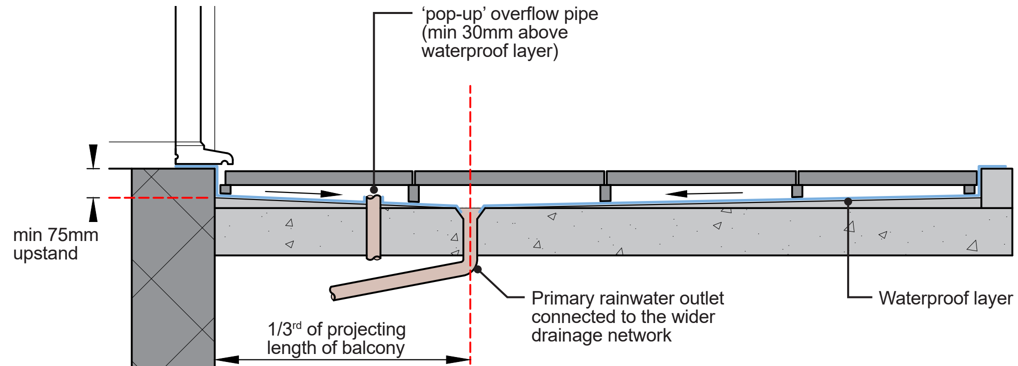
The drainage above the waterproof covering and below any raised decking finishes must not be restricted or blocked by the decking supports. The decking supports must allow free drainage of all areas of the roof to the designated outlets:

- Rainwater outlets should be readily accessible without damage of the pedestrian finish. This may be achieved by a suitably marked paving slab or demountable section of decking.
- Rainwater from higher roof areas and/or higher balcony areas must not discharge directly onto a lower balcony construction unless formally agreed with the Warranty Provider prior to works commencing.

Rainwater outlets
The following should be confirmed by reference to the manufacturer's information or independent certification, as appropriate:

- Capacity in litres per second at a range of typical water heads.
- Material compatibility with the waterproof membrane.
- Method of attachment within the substrate.

The outlet should not be positioned adjacent to the threshold. It is recommended that the outlet is positioned at any point between the leading edge and 1/3 of the length of the balcony from the threshold as per the below detailing.



Red line shows 1/3rd of projecting length of the balcony. Details relating to pedestrian surface and guarding omitted for clarity.

Overflows
A conspicuous overflow should be provided. It is recommended a pop up overflow pipe protruding 30mm above the waterproofing layer is provided. It should be positioned in the zone between the threshold and 1/3 of the projecting length along the balcony. It may be offset along this position but its height must be a minimum of 25mm below any thresholds.

Balconies which drain to a single internal outlet or combined outlets connected into a single downpipe, must be provided with a conspicuous overflow. Its function is to drain and warn of outlet/downpipe blockage and so avoid the risk of surcharging the upstand which can lead to moisture ingress. The capacity of the overflow should be not less than that of the outlet or combined outlets and its discharge should be visible but directed away from the building.

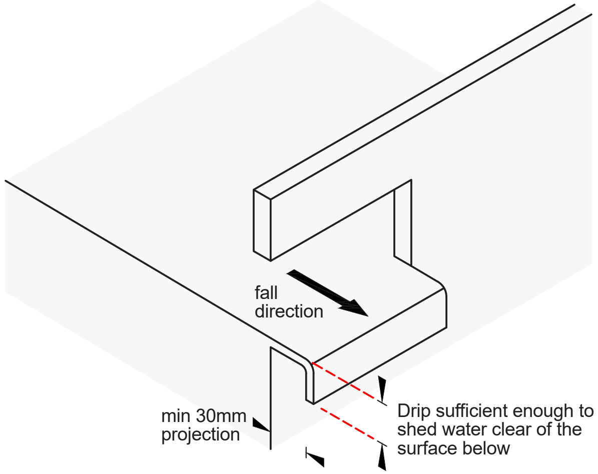
Edge drainage
This is a design approach which allows water to quickly pass through a pedestrian surface through to a soffit collection tray or impervious surface laid to falls. Where it is then momentarily collected and drained away from the weatherproof envelope of the building so that it does not cascade onto another balcony and discharges to a lower level where the water is appropriately managed.

Where edge drainage is proposed, the following should be considered:
- The minimum finished fall should be 1:80. Design falls should take account of any potential deflection and construction tolerances. In the absence of detailed calculations, this may necessitate design falls of twice the minimum finished falls (1:40 or 2.5%). Falls should follow the same direction as the cantilever of the balcony to prevent back falls in drainage or ponding as loads are applied.
- A minimum 30mm projection of the principle water collecting surface should be present beyond the adjacent vertical surface. It should also be turned down to form a drip.
- For effective edge drainage, a linear gap is to be provided and must create at least a permanent 20mm wide opening at the leading edge. It should be continuous across the entirety of the width of the balconies leading edge. Chutes or pipes draining directly to an open area are not acceptable. Any edge draining approaches should ensure as much as practicable that drainage should not be interrupted, for example by any supporting structure or similar.
- Edge drainage should be evenly distributed.
- Balcony projections for edge drainage should be restricted to 2500mm.
- No other roofs or balconies should be designed to deliberately drain onto an edge drained balcony.
- A 6-8mm gap should be provided between each non-combustible decking board. The gaps should not create a health and safety risk to users' e.g. risk of entrapment of walking sticks, stiletto heels, or wheelchairs.
- Where decking boards are used at the pedestrian surface level, grooved decking boards should orientated to promote the shedding of water at the leading edge of the projecting balcony.
- At the base of any stack of balconies, provision for landscaping drainage must be provided as part of the design to ensure that water does not pond at ground or podium level. Paths should be avoided in areas beneath balcony stacks that utilise an edge drained approach. Where paths cannot be avoided, a suitable protection method for pedestrians should be provided.

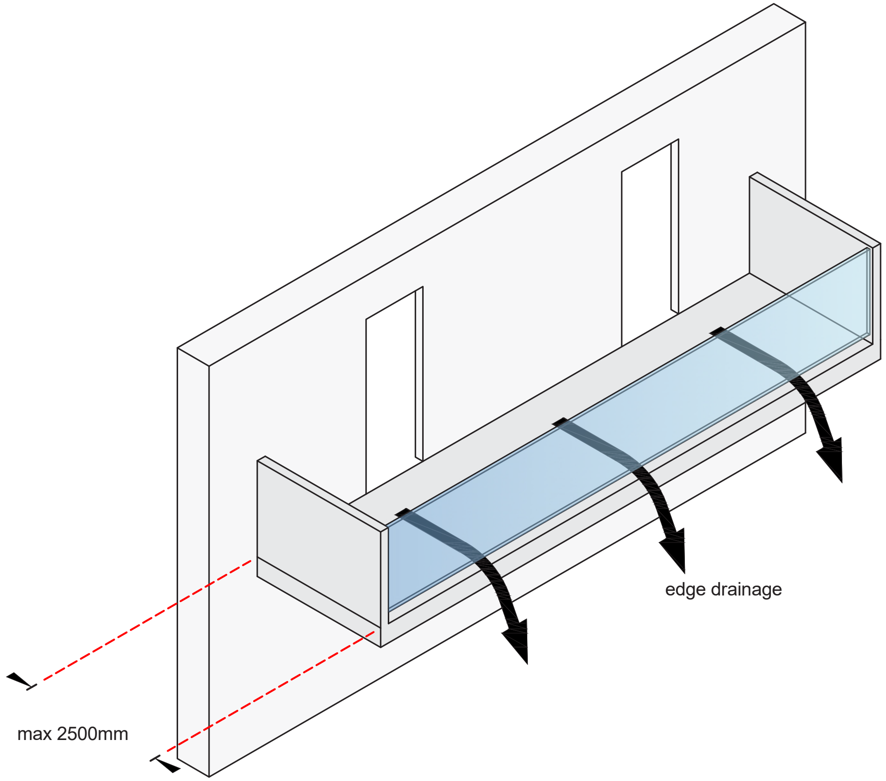
Free drainage
Where a free draining approach is used, water is not collected on a membrane or impervious surface but allowed to dissipate through a number of perforations in the balcony substrate, meaning that any hydraulic head of water is avoided. The pedestrian surface is designed to ensure that water is not collected and stored in any way. The pedestrian surface and the water collecting surface are the same.

Where this approach is proposed:
- Balcony surfaces must be orientated to fall away from the building so that water cannot track back toward the building. Standing water is not acceptable.
- The support arms must be designed to:
  - Prevent water tracking along their underside toward the building. Where this risk is not managed, water may run down the façade, giving a greater likelihood of penetrative damp and staining.
  - Drip edge breaks in the support structure and component design to allow water to track away from the building will mitigate this risk.
- A structural upstand of not less than 75mm consisting of a fully bonded waterproof outer membrane that has 3rd party accreditation for that use is to be provided where level thresholds are required.
- A 10mm gap between the façade and pedestrian surface is be provided to avoid run off water overly wetting the façade. Supporting bracketry connections to the main building are to be sealed so that they are weathertight to any potential moisture ingress entering the building.
- The free draining approach must meet all of the following criteria:
  a) As-built gaps between planks or slabs should be between 6 mm to 8 mm to achieve effective drainage whilst minimizing the risk of discomfort to users with enhanced needs. This spacing must be closely controlled.
  b) As-built gaps of 10 mm to 12 mm should be maintained around the perimeter of the pedestrian surface to facilitate good drainage and the sides of any balcony proposed must not abut the weatherproof envelope.
  c) Where the design is to provide perforated draining, the position and sizing of the perforations or open grid should be consistently and regularly applied across the entire surface of the balcony. Openings, either perforated or linear, should provide a total free draining area of at least 5% of the overall surface area and provide a solution which ensures water is instantly dissipated from the pedestrian surface.
- Where non-combustible decking boards are used at the pedestrian surface level, grooved decking boards should be orientated to promote the shedding of water at the leading edge.
- The design should ensure that the supporting structure does not locally interfere with the drainage path or prevent free draining of the balcony area.

Typical edge drainage detail



Balcony projections for edge drainage should be restricted to 2500mm



Guarding

General
Balconies to which persons have regular access other than for maintenance should be guarded to minimise the risk of falling.

General principles
The following should be considered where any type of guarding is specified:

- The guarding should meet the requirements of the relevant Building Regulations e.g. height requirements, guarding configuration requirements, etc.
- All guarding (including parapet walls and balustrading systems) should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading.
- The guarding should be not prevent the balcony area from draining rainwater or overflows from functioning in the event of an outlet being blocked.

Where guarding is attached to a climbable shelf, plinth or parapet, the guarding height should be taken from the shelf, plinth or parapet.

Glazed barriers
Glazed barriers will require a nominated person to undertake a site specific design to ensure that the design of the guarding for the scheme is suitable and due diligence has been demonstrated. For glazed barriers the criteria should be satisfied by the designer:

- The barrier/glass should have sufficient strength to resist the design loads with an appropriate factor of safety.
- The displacement of the barrier, under load, should be within acceptable limits for human comfort.
- The barrier/glass should have reasonable resistance to accidental impact.
- The post-failure behaviour of the glass in a barrier should be safe and, if necessary, failed glass should retain some residual strength to preserve life safety.
- The designer should clearly demonstrate how containment of the glazing will be achieved.
- Consideration should be made for not solely relying on low level mechanical restraint into a base channel for glass infill panels. A secondary restraint fixing at high level should be considered by the designer.
- In buildings which exceed three storeys in height, 100% of toughened glazing should be formed and then heat soak tested in accordance with BS EN 14179-1. The glass must be permanently marked in accordance with BS EN 14179-1 and substantiated evidence of heat soak testing must be disclosed for all effected panes.
  - Alternatively where toughened glazing does not exceed 50kg in weight and where there is safe and easy access to remove and replace the glazing without the need for access scaffolding or fall arrest equipment, a methodology statement of how this will be undertaken should be provided.

Masonry parapet walls
Please refer to the 'External Walls – Parapets' section for guidance on the construction of masonry parapet walls.

Cavity trays and DPCs can create a slip plain that may limit the ability of the parapet wall to resist horizontal forces. The Engineer should check the structural stability of the parapet wall and appropriate steps should be taken to mitigate this risk.

Balustrading and guard rails
Balustrading and guard rails should be fixed securely to a structure which can safely resist the potential forces acting on the guarding. The durability of balustrading and guard rails should be appropriate with particular attention paid to coastal areas where corrosion resistant materials should be chosen. Please refer to 'Appendix B – Coastal Locations' for further information.

Balustrades should not be fixed through the coping or capping. Balustrades should be fixed to the face of the wall. Please refer to the 'External Walls - Parapets' section for further guidance.

Fixings for balustrades must be carefully designed to ensure appropriate fixings are robust and any penetration through waterproof roof coverings is sealed correctly in accordance with the waterproof covering manufacturer's recommendations.

Slip resistance

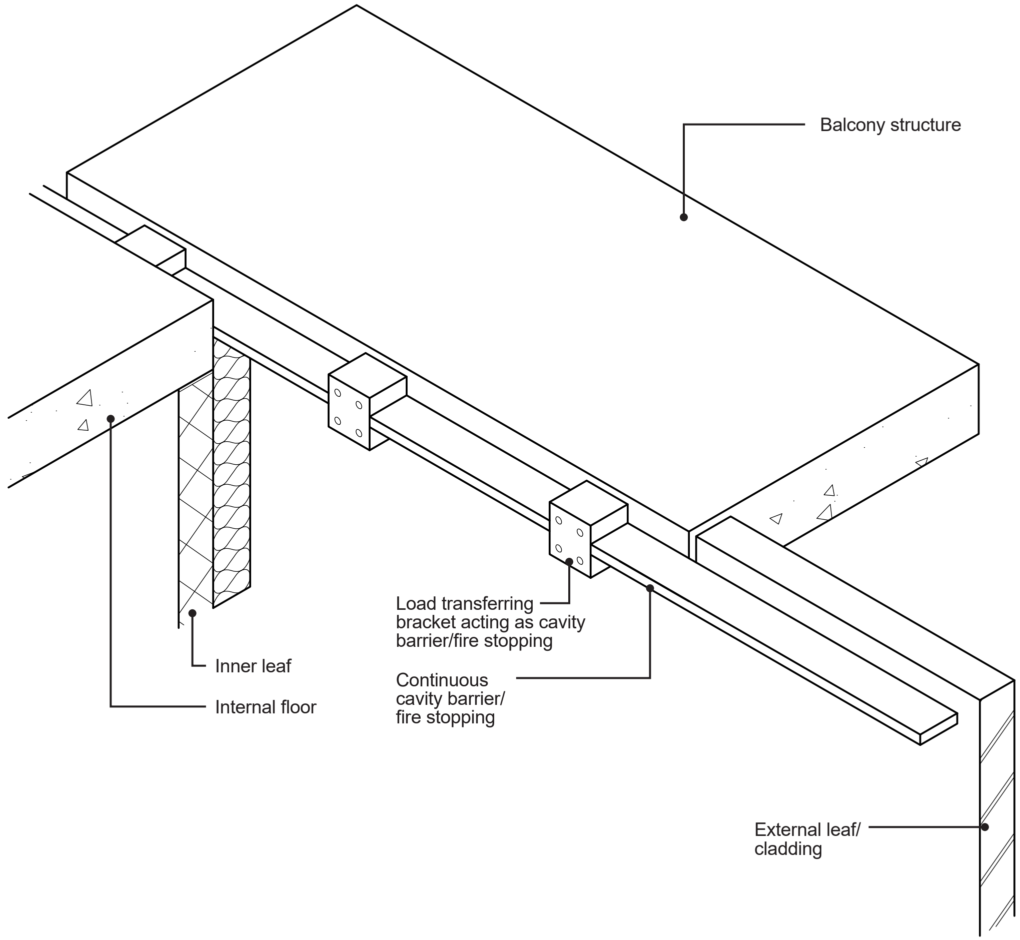
The surface finish of all balcony areas must have a low slip potential (in wet and dry conditions) when tested to BS 7976.

Fire considerations

In all circumstances, balconies must meet the requirements of the relevant Building Regulations. Evidence that the Building Control Body has accepted the balcony construction must be provided to the Warranty Surveyor.

Where enclosed balconies are proposed (either projecting or inset), the horizontal and vertical components separating one compartment from another is classed as a compartment wall or floor and therefore requires fire resistance from both sides (for compartment walls) and from the underside for compartment floors.

Balconies, whatever their type and construction, can have complex detailing around the junction with the external wall. The balcony and any of its components should not compromise the continuity of any cavity barriers or fire stopping. Where possible, balcony brackets that are fixed back to the inner leaf of a cavity wall should be located above or below any horizontal cavity barrier. Where this is not possible, the brackets should incorporate a means to ensure the continuity of fire separation (e.g. thermal wrapping). Any such brackets should only be used where appropriate fire test evidence is available from the manufacturer confirming it is fit for purpose. Evidence of this must be provided to the Warranty Surveyor. Manufacturers' should be consulted for specific detailing and only competent contractors should be used for its installation.



Thermal bridging and cavity trays

Care should be taken to prevent thermal bridging and any breaks in the cavity tray. Thermal breaks and cavity trays should be considered at design stage. It is the responsibility of the designer to ensure condensation risk is sufficiently mitigated.

13. Chimneys and Flues

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. A commissioning certification is required for any work completed by an approved installer.
2. All workmanship must be within the tolerance requirements set out in this Technical Manual.
3. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window / door or ‘decorative external cladding’ (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. Chimneys, flues, flue-pipes, fireplace recesses and hearths shall be designed and constructed so that they:
    a. Ensure efficient operation of the fuel-burning appliance for which they have been designed;
    b. Are provided with sufficient air for proper combustion of the fuel;
    c. Are structurally sound and do not adversely affect the structural stability of the building where they pass through floors, walls or roofs;
    d. Protect the structure and fabric of the building from the effects of fire;
    e. Do not adversely affect the ability of the building to resist the effects of weather and ground moisture;
    f. Discharge the products of combustion safely to the outside air.
2. Structural elements outside the parameters of Building Regulations must be supported by structural calculations provided by a suitably qualified expert.
3. Damp proofing works should prevent any external moisture passing into the internal environment of the building.

13. Chimneys and Flues

13.1
Masonry

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Design details indicating proposed chimney position, layout and height.
2. Details and specification of all materials to be used in the construction of a chimney (e.g. DPC, flashing, soakers, proposed flues, etc.)
3. Details of fire stopping in cavities around flue penetrations.
4. Details of fire places and hearths.
5. A copy of a commissioning certificate will be required at completion to be handed to the Warranty Surveyor.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Construction

Chimneys shall be designed and constructed so as to adequately support the flue liner, resist moisture penetration and be structurally sound.

- Foundations to chimneys must:
  - Be taken to the same depth as adjacent wall foundations.
  - Resist uneven settlement caused by potential loadings.
  - Where the chimney forms part of a wall the foundation should project at least 150mm wider than the chimney base.
- If the chimney is in a severe exposure zone the cavity should extend around the outside of the stack and be continuous up to roof level, as per BS 5628, Part 3.
- A 50mm cavity at the back of the chimney breast is maintained to prevent rainwater penetration. Please refer to the 'External Walls' section of the Technical Manual for further information.
- Where the chimney breast is gathered in, the lower projecting masonry should be protected with a suitable capping and cavity trays.
- Bricks and blocks used in the construction of masonry chimneys must take consideration of weather exposure and resistance to frost. Please refer to 'Appendix C' of the Technical Manual for guidance on appropriate selection of masonry products.
- Mortar used within the chimney must:
  - Take consideration of exposure to elements and frost.
  - Be the strongest appropriate for the type of masonry unit.

Flue liners should be used as specified with sockets uppermost and jointed with fire-resisting mortar. Flue liners should be:

- Non-combustible.
- Reasonably smooth internally.
- Correctly jointed with mortar with the space between the liners and the brickwork filled with weak insulating concrete, unless the manufacturer recommends an alternative specification.
- Properly jointed at the junctions with the starter block or lintel and outlet terminal.

Factory made insulated chimneys should have a operational life of at least 30 years and be designed in accordance with BS 4543 and BS EN 1859, and installed in accordance with BS 7566. Where a chimney is not directly over an appliance or opening, a soot box accessible for emptying should be formed.

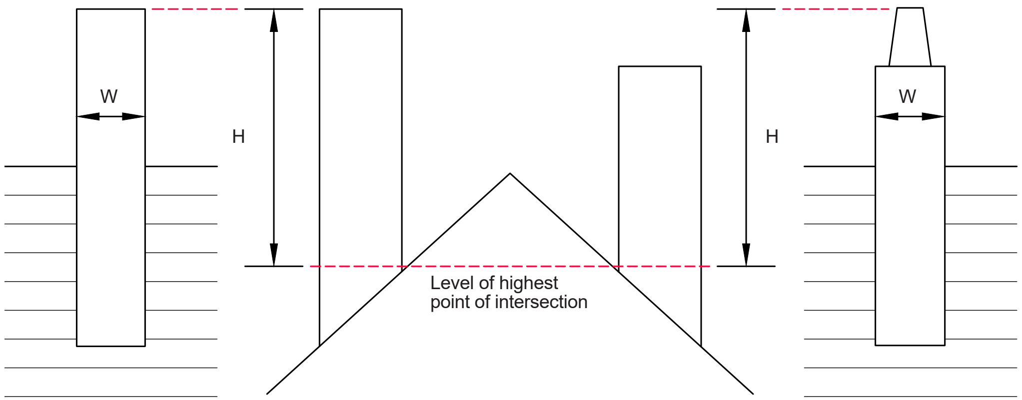
Render directly applied to masonry chimney

- Rendering to chimneys should only be carried out where the masonry contains little or no sulphates. An appropriate specialist sealer/bonding key coat should be applied prior to applying the main coat of render.
- A proprietary alkaline resistant mesh should be embedded throughout the render, the key coat should provide a sound substrate and be compatible with the subsequent render system.
- A specialist render system and mortar should be employed for chimneys with a masonry background.
- Traditional hand mix render using standard sand and cement is not accepted. Only a pre-blended bagged render system will be accepted as a suitable render system that has a third party accreditation and backed up with a manufacturer's specification.
- The chimney which is to be rendered should be examined for excessive moisture content prior to rendering. This is particularly important where the masonry background has no upper limit on its soluble salt content, e.g. 'N' designation clay bricks.
- Ensure that all joints are finished flush with the surface to avoid shade variations.
- To minimise the potential for differential thermal movement and effects that the different suction that each type of background material may create; the section of walling to receive the render should be constructed using the same type and density of material throughout.
- To control suction always apply a specialist sealer key coat or suitable render preparatory coat. Allow a minimum of 48 hours for the key coat to fully dry before applying the next coat.
- It is recommended that throats or drips to chimneys should project beyond the finished faces to throw water clear, a minimum of 40mm to the drip.
- Angles, stop beads and jointing sections should be secured with drilled or shot-fired fixings, and not with gypsum plaster.

Please refer to the 'External Walls' section for further guidance.

Proportions for masonry chimneys

If a chimney is not provided with adequate support using ties or not securely restrained, its height (measured to the top of the chimney) should not exceed 4.5 times its least horizontal dimension when measured from the highest point of intersection with the roof surface (density of masonry must be a minimum of 1500kg/m^3).



Key:
W - is the least horizontal dimension of the chimney measured at the same point of intersection.
H - is measured to the top of any chimney pot or other flue terminal

Masonry chimneys in timber framed buildings

Where masonry chimneys are proposed in timber framed buildings, the following should be considered:

- The effect on the structural stability of the timber frame.
- The effect of differential movement caused by timber shrinkage between the frame and the chimney and/or by thermal movement of the chimney in use. There should also be consideration for the impact of differential movement on flashings and weathering details.
- The integrity of the fire resistance of the timber frame when penetrated by the chimney breast or stack.
- The proximity of combustible materials (timber frames, sheathing and floor decks) to the flue and fire recess.
- The continuation of the sound insulation of compartment and separating walls when chimneys are adjacent or pass through to these walls.

Coastal Locations

For the selection of construction materials and additional design requirements that may apply in coastal locations please refer to 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems'

Lead work

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability, be in accordance with BS EN 12588 or a UKAS (or European equivalent) valid third-party accreditation which demonstrates adequacy and durability for use (see 'Appendix C - Materials, Products, and Building Systems).

Corrosion of lead work

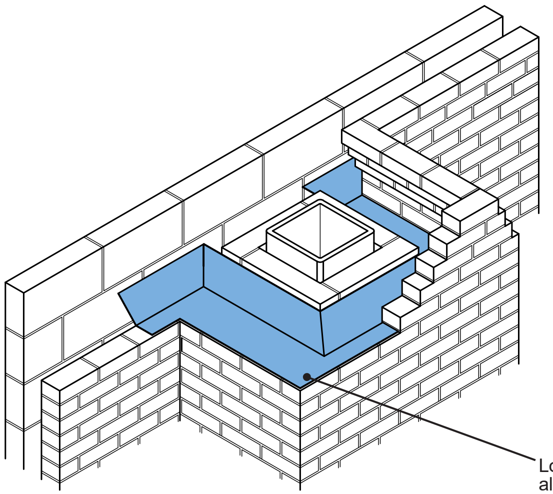
Where free lime from mortar comes into contact with lead trays or flashings (due mainly to the continual saturation of the brickwork) in areas such as chimneys:

- The lead should be protected from corrosion by the use of a thick coat of bitumen paint covering the faces likely to be in contact with the mortar.
- Lead work buried in mortar should be protected as per guidance issued by the Lead Sheet Training Academy. This treatment can also reduce staining of lead and brickwork.
- It is unnecessary to treat flashings buried only 40mm-50mm into mortar joints (cover flashings), as this close to the drying surface, the carbonation of free lime is rapid and there is no risk of corrosion in such circumstances.

Chimney tray - low level

A chimney tray is required at low level where a cavity-walled chimney with brick shoulders is built onto an external wall. The tray prevents water that may enter the shoulders from penetrating to the inner leaf of the wall.

The material used is 1mm aluminium alloy sheet to BS EN 485-2; Aluminium and aluminium alloys. Sheet strip and plate, mechanical properties. This has a higher melting point than lead, so is suitable for installation close to a heat source.

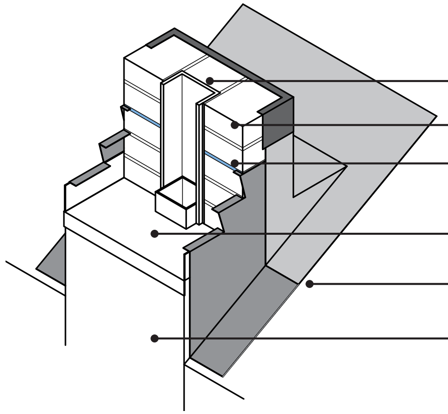


Chimney tray - high level

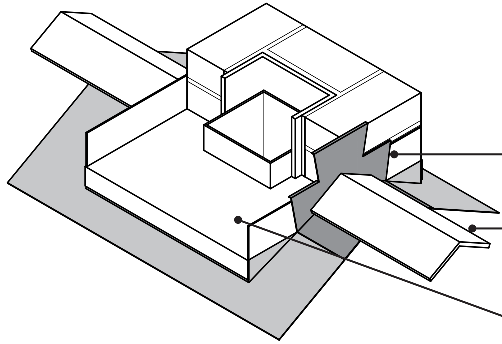
A high level tray may be required to prevent the entry of water at high level where a chimney rises through a pitched roof; suitable for new build or remedial work, this minimises disturbance to surrounding construction in remedial work.

The material used is lead sheet to BS EN 12588 Lead and lead alloys. Rolled lead sheet for building purposes. Code 4 as standard. Standard sizes are 800mm x 800mm, 900mm x 900mm, 950mm x 950mm, to suit either a 195mm square or 195mm diameter circular flue.

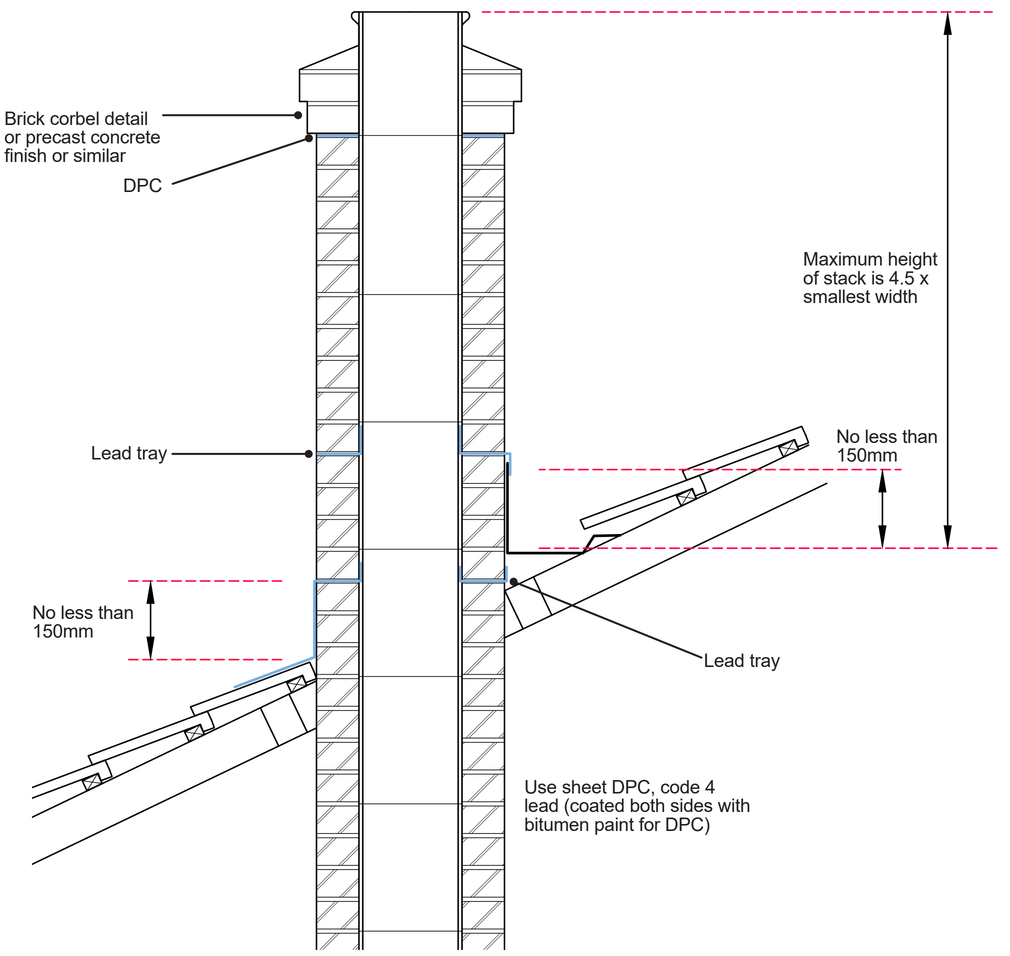
Typical flashings to chimneys

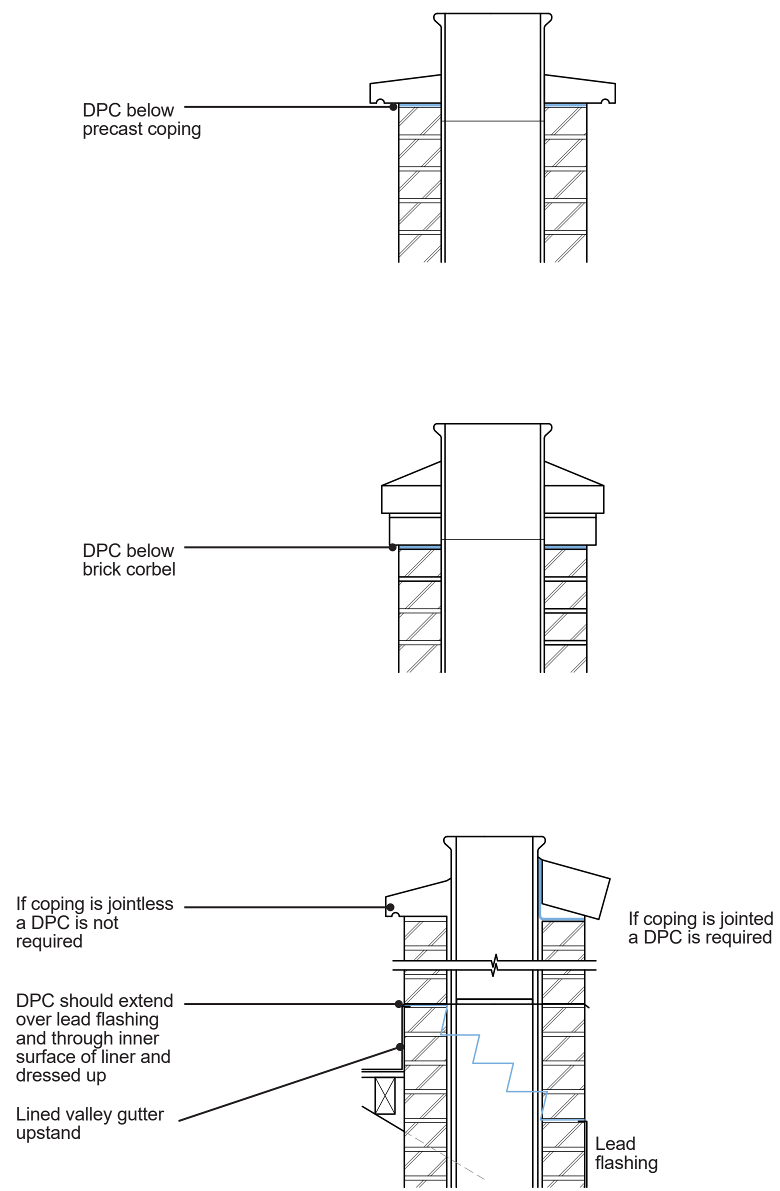


Flashing to chimneys at ridge



Typical chimney details

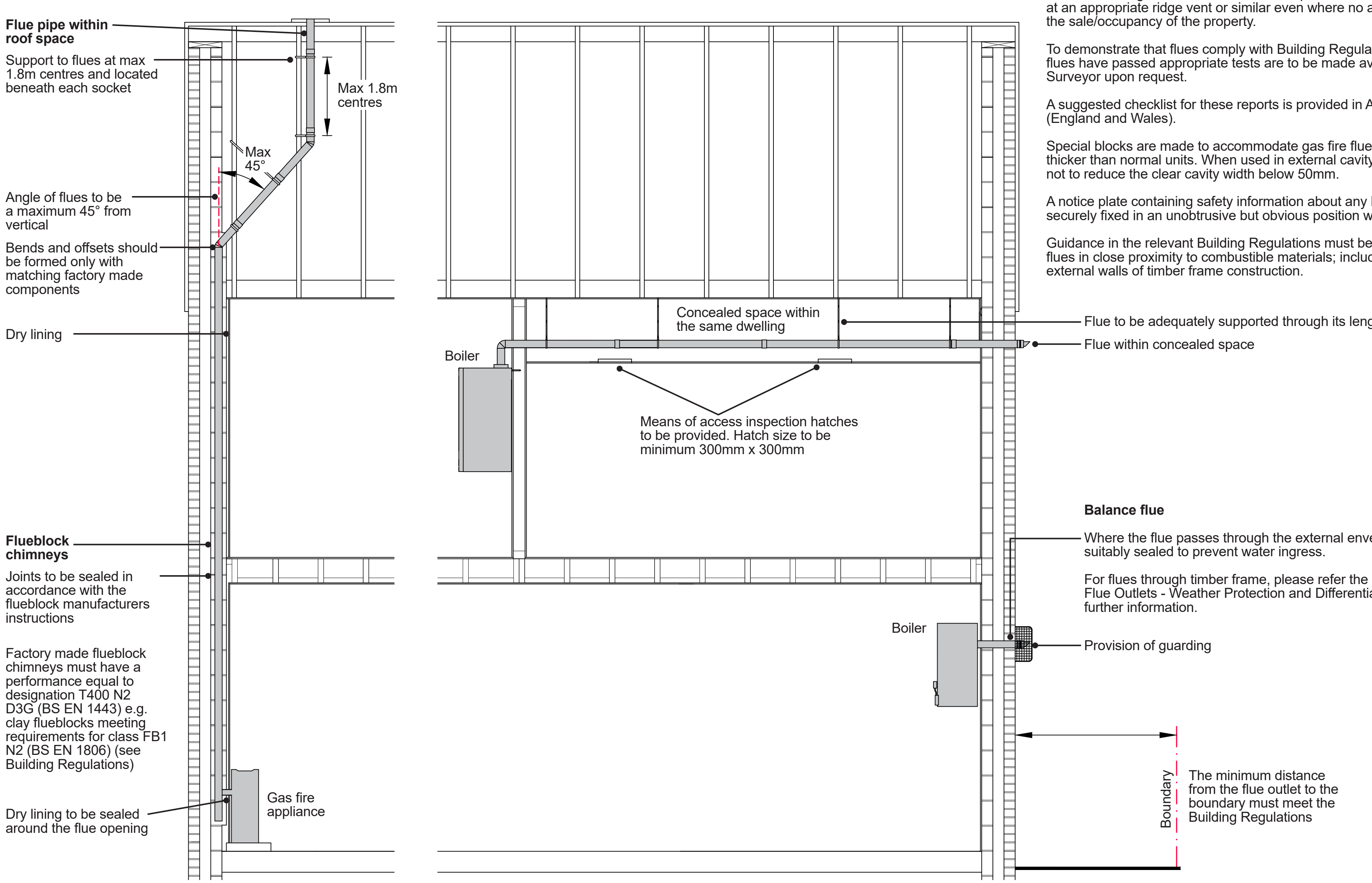




13. Chimneys and Flues

13.2 Gas Flue Outlets

Flue block chimneys in masonry cavity walls and flues for gas appliances



Flue block chimneys in masonry cavity walls

Flues for gas appliances

Flues

Ensure that all gas flues terminate to the open air, i.e. flueblocks must terminate at an appropriate ridge vent or similar even where no appliance is fitted prior to the sale/occupancy of the property.

To demonstrate that flues comply with Building Regulations, reports showing that flues have passed appropriate tests are to be made available to the Warranty Surveyor upon request.

A suggested checklist for these reports is provided in Approved Document J (England and Wales).

Special blocks are made to accommodate gas fire flues, which tend to be slightly thicker than normal units. When used in external cavity walls care should be taken not to reduce the clear cavity width below 50mm.

A notice plate containing safety information about any hearths and flues should be securely fixed in an unobtrusive but obvious position within the home.

Guidance in the relevant Building Regulations must be followed for the siting of flues in close proximity to combustible materials; including floors, roof and also external walls of timber frame construction.

Concealed flues

Where a flue is routed within a void, appropriate means of access should be provided to allow visual inspection of the flue.

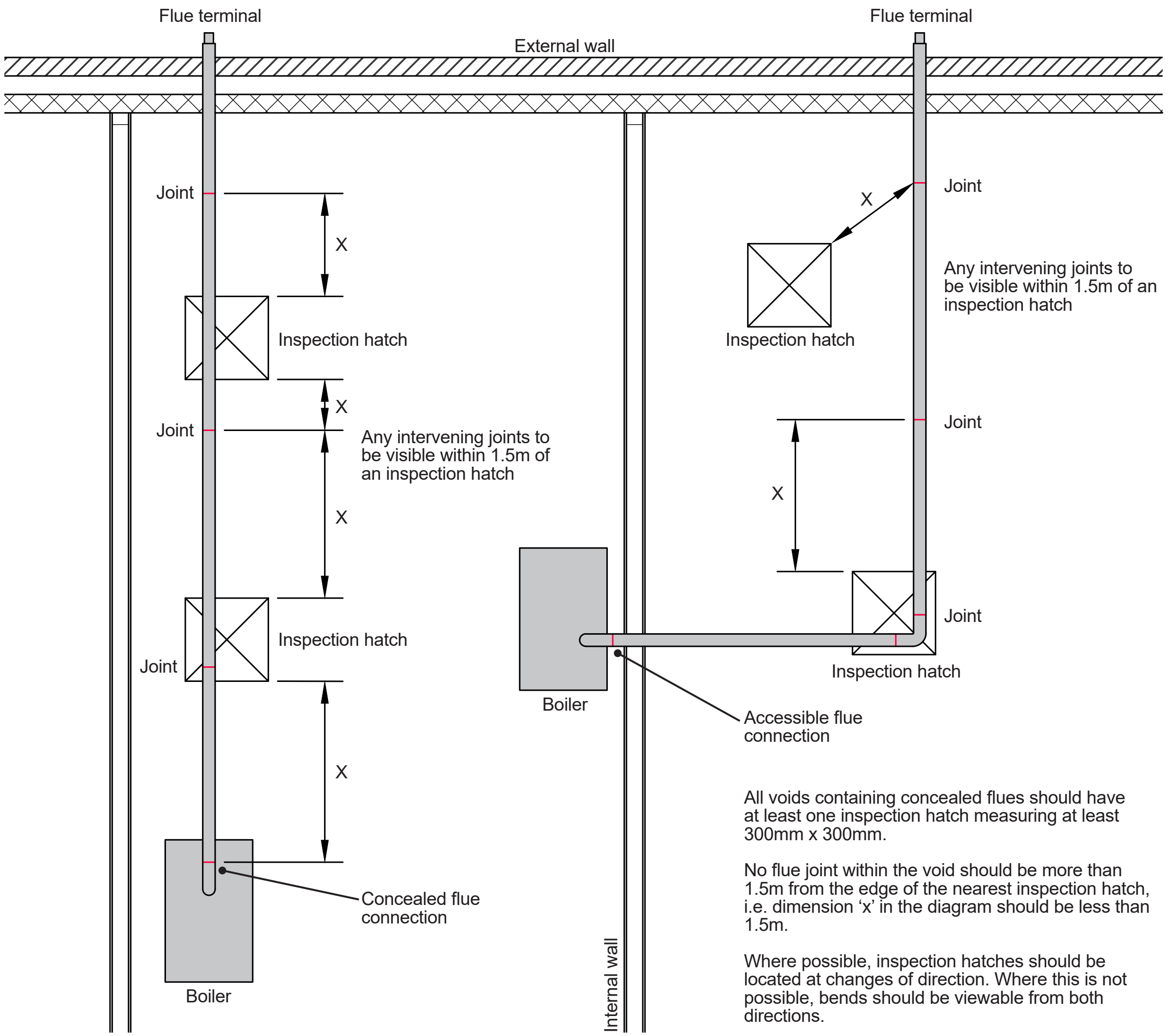
Means of access should be:

- Sufficiently sized and positioned to allow visual inspection to be under taken of the flue.
- The access hatch should be at least 300mm x 300mm or larger where necessary, to allow sufficient access to the void to look along the length of flue.

Means of access should not:

- Pass through another dwelling since access for inspection may not always be available to that dwelling and flue system running through it (flues may pass through communal areas including purpose- designed ducts where inspection access is provided).
- Impair any fire, thermal or acoustic requirements of the relevant Building Regulations.

Example locations of access panels for concealed flues



All voids containing concealed flues should have at least one inspection hatch measuring at least 300mm x 300mm.

No flue joint within the void should be more than 1.5m from the edge of the nearest inspection hatch, i.e. dimension ‘x’ in the diagram should be less than 1.5m.

Where possible, inspection hatches should be located at changes of direction. Where this is not possible, bends should be viewable from both directions.

Minimum separation distances for terminals in mm (England and Wales)

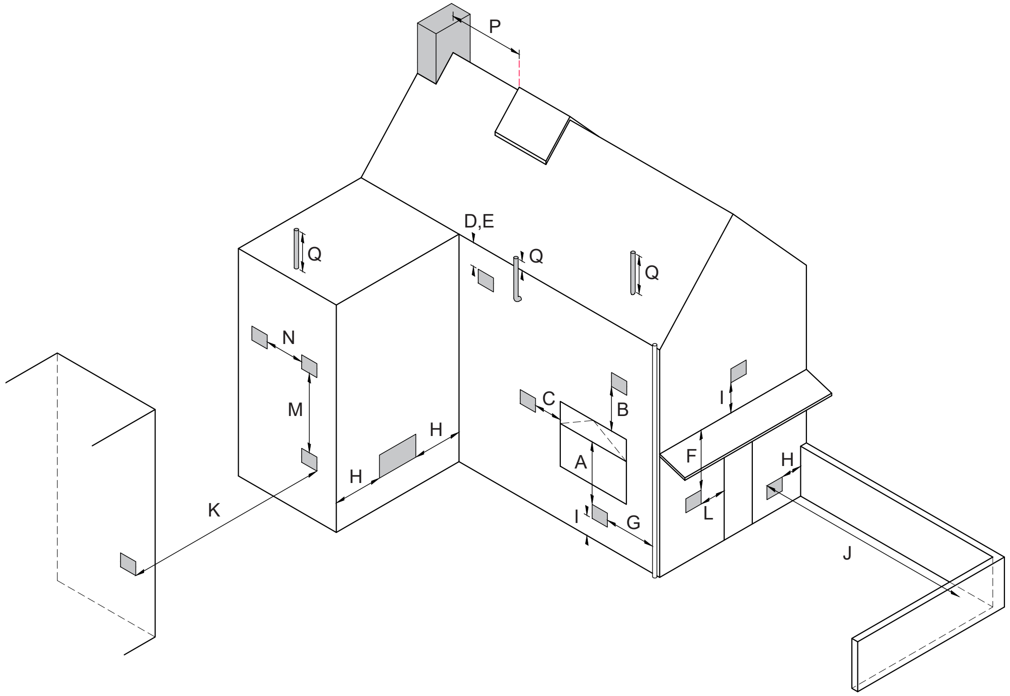
	Location	Balance flue			Open Flue	
		Natural draught		Fanned draught	Natural draught	Fanned draught
A	Below an opening (1)	Appliance rated head input (net) 0-7kW >7-14kW >14-32kW >32kW	 300 600 1500 2000	300	(3)	300
B	Above an opening (1)	0-32kW >32kW	300 600	300	(3)	300
C	Horizontally to an opening (1)	0-7kW >7-14kW >14kW	300 400 600	300	(3)	300
D	Below gutters, soil pipes or drainpipes	300		75	(3)	75
E	Below eaves	300		200	(3)	200
F	Below balcony or car port roof	600		200	(3)	200
G	From a vertical drainpipe or soil pipe	300		150(4)	(3)	150
H	From an internal or external corner or to a boundary alongside the terminal (2)	600		300	(3)	200
I	Above ground, roof or balcony level	300		300	(3)	300
J	From a surface or a boundary facing the terminal (2)	600		600	(3)	600
K	From a terminal facing the terminal	600		1200	(3)	1200
L	From an opening in the car port into the building	1200		1200	(3)	1200
M	Vertically from a terminal on the same wall	1200		1500	(3)	1500
N	Horizontally from a terminal on the same wall	300		300	(3)	300
P	From a structure on the roof	N/A		N/A	1500mm if a ridge terminal. For any other terminal, as given in BS5440-1:2008	N/A
Q	Above the highest point of intersection with the roof	N/A		Site in accordance with manufacturers instructions	Site in accordance with BS 5440-1:2008	150

Notes:
1. An opening here means an openable element, such as an openable window, or a fixed opening such as an air vent. However, in addition, the outlet should not be nearer than 150mm (fanned draught) or 300mm (natural draught) to an opening into the building fabric formed for then purpose of accommodating a built-in element, such as a window frame.
2. Boundary as defined in paragraph 0.4 (4) of Approved document J. Smaller separations to the boundary may be acceptable for appliances that have been shown to operate safely with such separations from surfaces adjacent to or opposite the flue outlet.
3. Should not be used.
4. This dimension may be reduced to 75mm for appliances of up to 5kW input (net).
5. N/A means not applicable.

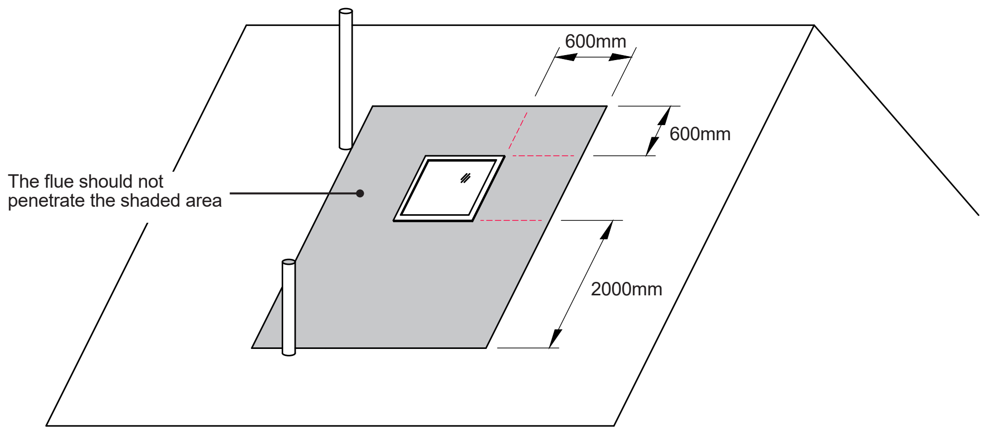
Location of outlets from flues serving gas appliances (reproduced from Approved Document J Building Regulations England and Wales). Requirements may differ in Scotland please refer to the Scottish Building Regulations for further information.

Location of flue outlets

Flues serving gas appliances should be located as shown in the images below, and the table to the left.



Location of outlets near roof windows or opening, on pitched or flat roofs, from flues serving gas appliances



Reproduced from Approved Document J Building Regulations England and Wales

Guarding to flues

A flue outlet should be protected if persons could come into contact with it or if it could be damaged. If a flue outlet is in a vulnerable position, such as where the flue discharges within reach from the ground or a balcony, veranda or window, it should be designed to prevent the entry of any matter that could obstruct the flow of flue gases.

External weather tightness

- Where flues pass through the external wall construction (external weather proof envelope), they must be suitably sealed to protect against water ingress.
- A proprietary cavity tray may be required to be inserted over the flue if the flue opening in the external wall is formed after the external wall is completed.

Lead work

Lead sheet used for roofs, flashings and weatherings should, in terms of suitability, be in accordance with this Technical Manual, or be in accordance with BS EN 12588 or a UKAS (or European equivalent) valid third-party accreditation which demonstrates adequacy and durability for use (see 'Appendix C - Materials, Products, and Building Systems').

External masonry

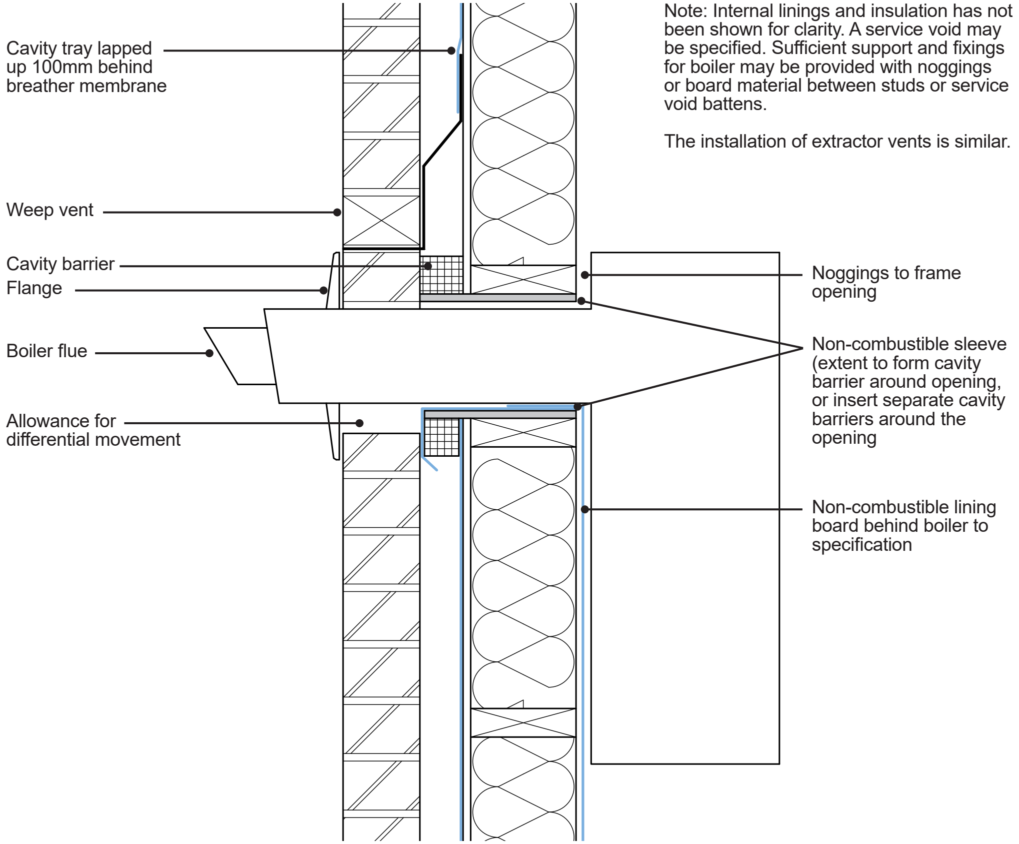
For further guidance on masonry construction refer to the 'External Walls' section.

Differential settlement

Allowance should be made within the structure for differential settlement around flues, as well as ensuring the water tightness of the external envelope is maintained.

- Where core drilling is used to create an opening in the external masonry cladding to timber frame or metal frame buildings; it should be ensured that suitable allowance is made for differential settlement within the external masonry.
- The core drill hole created in masonry cladding, will have to be elongated downwards to allow for the timber frame shrinking and the flue pipe moving with it.
- Care should be taken to ensure that the depth of the external flange is suitable to maintain weather tightness at the time of construction and once differential settlement has occurred.
- Cavity trays should be provided where appropriate.

Differential movement at flue outlets in timber framed walls



Note: Internal linings and insulation has not been shown for clarity. A service void may be specified. Sufficient support and fixings for boiler may be provided with noggings or board material between studs or service void battens.

The installation of extractor vents is similar.

13.

Chimneys and Flues

13.3
False Chimney Stacks

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This must include:

1. Third party certification for the proposed GRP chimney system.
2. Full fixing specification for the proposed GRP chimney system.
3. Design details of supporting roof structure, including but not limited to:
   a) Details of proposed truss layout and design.
   b) Details of proposed bracing.
   c) Details of any cut-roof sections, including specification of materials relating to the structure in accordance with Eurocode 5.
   d) Details of any supporting structural beams or lintels within the roof.
4. Details of proposed roofing felt, including manufacturers third party certificate.
5. Details of proposed roof coverings including manufacturers specified fixing schedule for proposed external environment.
6. Details of proposed flashings, trays, soakers, etc.

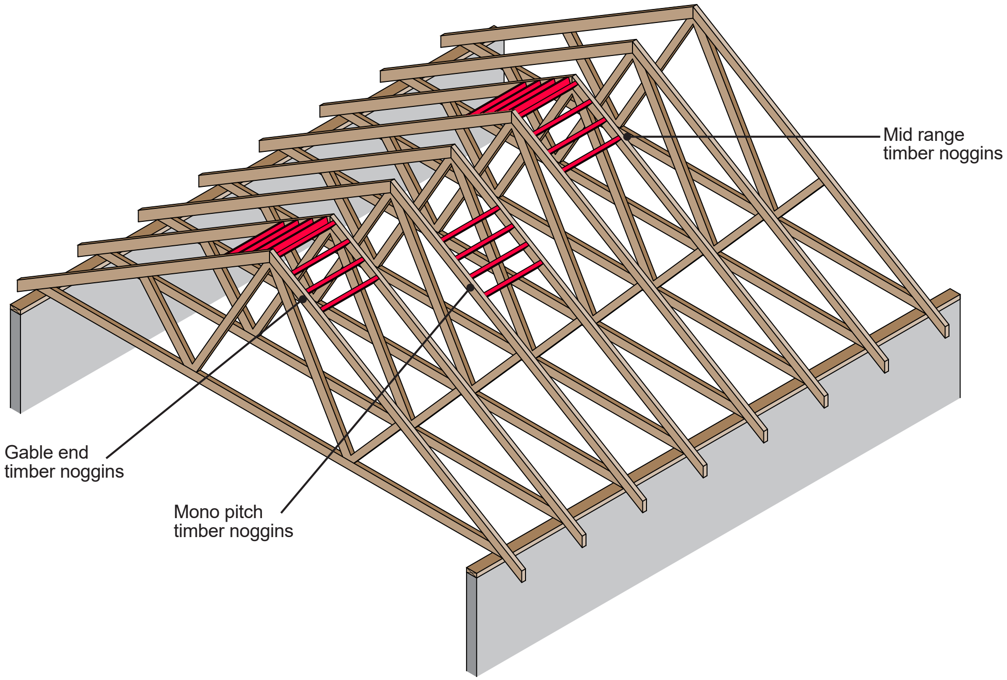
The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Definition and conditions

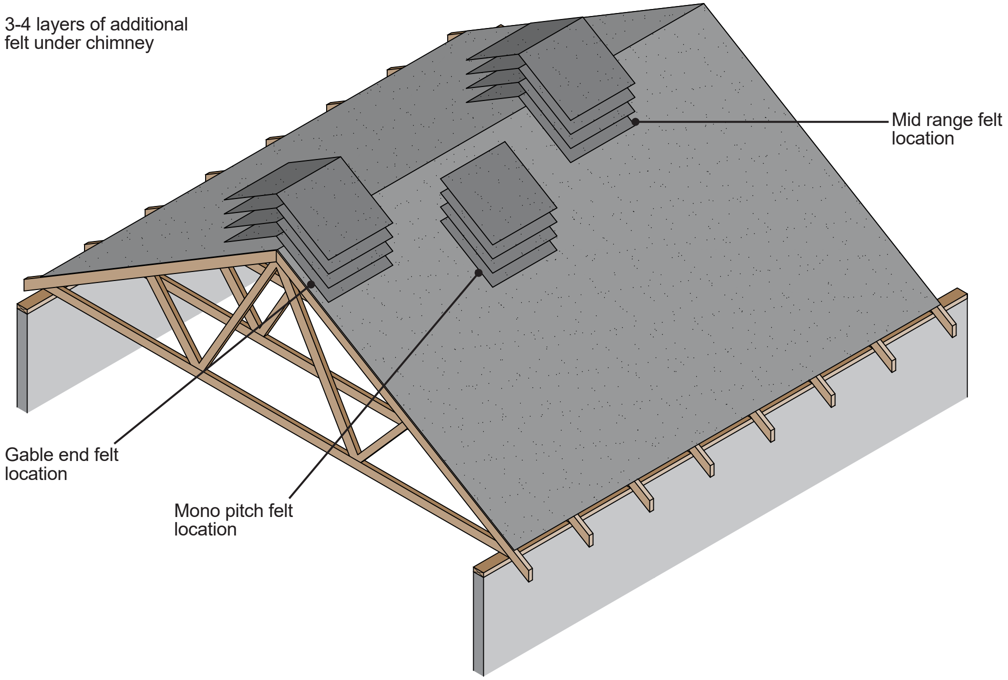
For the purposes of Warranty, a false chimney stack refers to a pre-fabricated chimney stack constructed under factory conditions to give an appearance of a traditional brick built chimney. Please note, the guidance within this section only covers traditional brick finishes and does not cover finishes such as render.

The following conditions must be met:
- They must have third party product conformity certificate to be acceptable for use.
- Where metal fixings are used within 5km of the coastal shoreline, they must be suitable for the location e.g. marine grade stainless steel.
- False chimney stacks must have a service life no less than 25 years as a non-structural component.
- The fixing/installation procedure must be followed as this forms the basis of the independent testing approval.

Chimney noggin support location

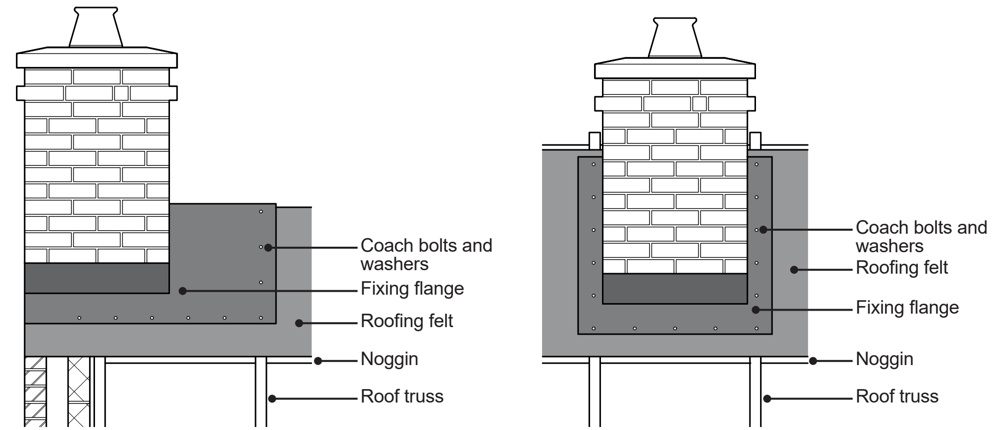


Additional roof felt location



Installation location

Traditional masonry gable end installation **Mono pitch installation**



For further guidance on roof structures and coverings, please refer to our section on ‘Roofs’

14. Driveways and Paving

Contents

Limitations of Functional Requirements

1. This guidance for drives and external pathways only applies to a drive and pathway that leads to the principal entrance to the visitable dwelling/building from the highway.
2. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
3. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced.
4. Timber used in paths must meet our requirements for decking and should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
5. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
6. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. External vehicular and pedestrian access routes to the principal entrance shall be designed and constructed so that they:
    a. Permit safe and convenient access from the highway;
    b. Are of sufficient width;
    c. Are durable;
    d. Reasonably level and consistent with adjacent features;
    e. Suitably drained to prevent water logging of the ground near the building.
2. Structural elements outside the parameters of Building Regulations must be supported by structural calculations provided by a suitably qualified expert.
3. Damp proofing works should prevent any external moisture passing into the internal environment of the building.

14. Driveways and Paving

14.1 Driveways and Paving

Limitations of the Technical Manual Functional Requirements

This guidance for drives and external pathways only applies to a drive and pathway that leads to the principal entrance to the visitable dwelling/building from the highway.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

- Details and specifications of the proposed layouts.
- Details indicating proposed drainage provision of those areas.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Preparation of ground

The area to be surfaced should be prepared by stripping away all vegetation and organic material. Land drainage should be considered for ground that is saturated.

Excavation trenches e.g. service trenches, should be backfilled with granular type material to the required level. The backfill should be compacted in layers no greater than 150mm, and the fill material should at least have the same bearing capacity as the adjacent ground.

Driveway construction

A suitable sub-base that is capable of supporting the finished surface material should be provided. Suitable sub-base material is considered as:

- Weak mix concrete ST1 (site mixed acceptable).
- Well graded crushed stone or recycled concrete (minimum aggregate size 75mm).

The minimum thickness of sub-bases are indicated in the below table.

Use of surface	Min sub-base thickness	Comments
Pathway	75mm	
Driveway (light duty)	100mm	Light domestic traffic
Driveway (medium duty)	150mm	Suitable for carrying small lorries e.g. refuse, vehicles, or fuel delivery

Crushed stone or recycled aggregate sub-bases should be well compacted to adequately support the pathway or drive (see the table below). Where the ground below the sub-base is weak or soft (typically <10% CBR), the sub-base should be designed by an Engineer.

Suitable compaction of sub-bases

Compactor type	Compactor size	Minimum number of passes	
		100mm sub-base	150mm sub-base
Vibrating plate	1400-1800kg/m² 1800-2000kg/m² >2000kg/m²	8 5 3	Unsuitable 8 6
Vibrator roller	700-1300kg/m width 1300-1800kg/m width 1800-2300kg/m width	16 6 4	Unsuitable 16 6
Engine driven vibro-tamper	<65kg 65-75kg >75kg	5 3 2	8 6 4

Minimum thickness of surfaces for drives and paths

Surface type	Material specifications	Minimum thickness (1)		British Standard
		Path	Drive	
Rolled asphalt	Coarse asphalt 10mm nominal size	60	60	BS 594
Macadam single course	40mm coated macadam	75	75	BS 4987
Macadam two course	Nominal 20mm coated base course	60	60	BS 4987
	Nominal 6mm wearing course	25	25	BS 4987
Block paving	Clay or calcium silicate	50	50	BS 6677
	Pre-cast concrete	60	60	BS 6717
Concrete	Designated mix	75	100(2)	
Pre-cast concrete paving	Dense concrete	50	n/a	BS 7263:1

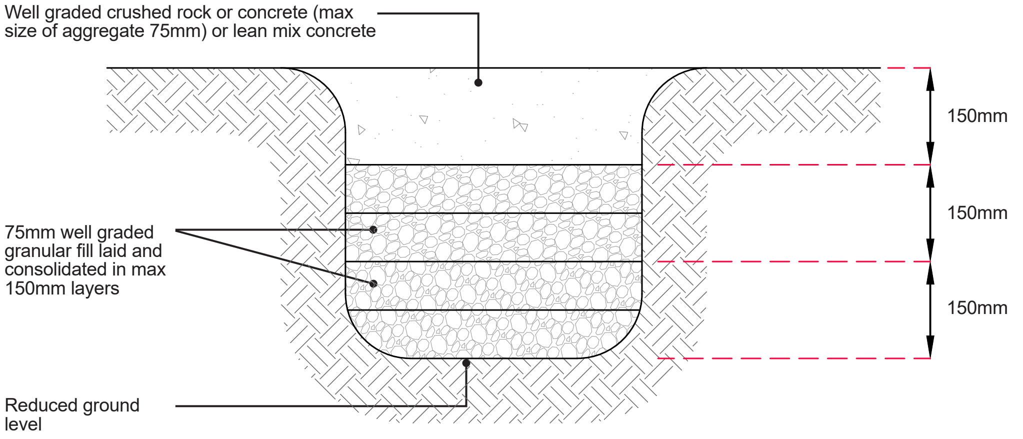
(1) Drive minimum thickness assumes standard loadings for a typical family car. Additional thicknesses are required where increased loads are applied e.g. LGV vehicles.
(2) Drives increased to 150mm on poor ground or clay.

Retaining walls

Retaining walls are outside the scope of this guidance, however where a retaining wall provides support to the structure or the primary entrance to the property they should be designed by an Engineer.

Gabions, timber structures and other types of flexible retaining walls should not be specified to provide support to homes, garages, roads, drives, car parking areas or drainage systems.

Backfilling of trenches

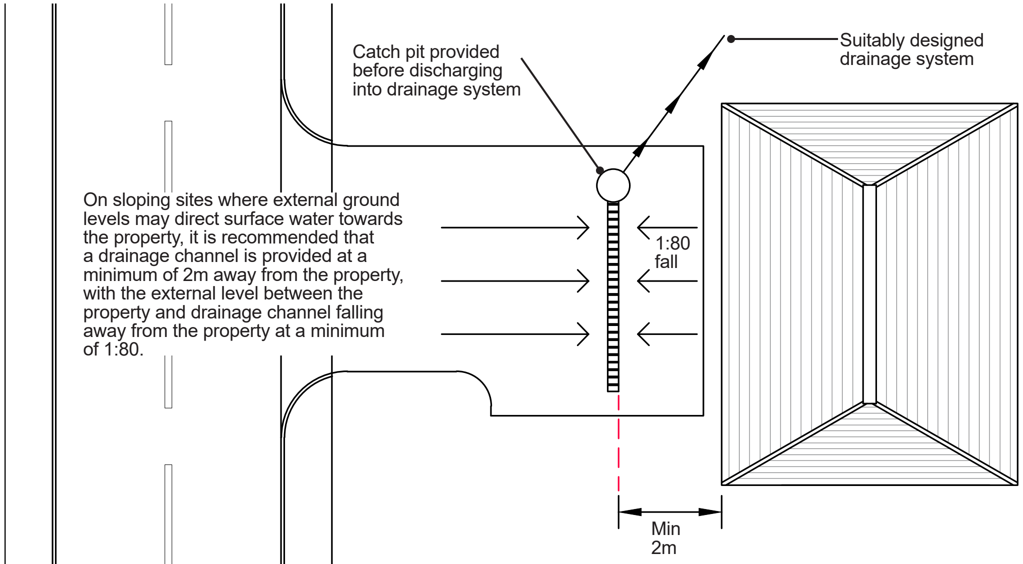


Sloping sites towards a property

All paving and drives, with the exception of the principle level access into the dwelling, should be laid at least 150mm below the damp proof course (DPC) of the dwelling.

Laying of paths and drives

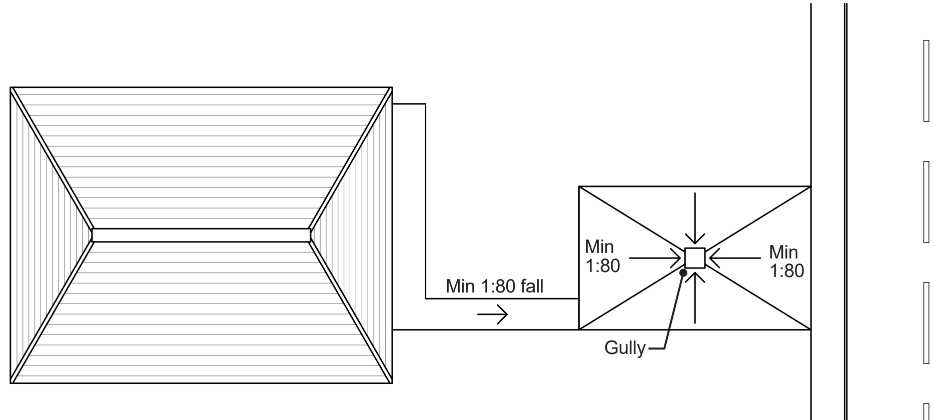
- Paths and driveways should be effectively drained to prevent ponding of water adjacent to the building.
- Paths and driveways should be laid to fall away from the building at a minimum of 1:80 and a maximum of 1:12.
- Rainwater should either discharge into a trapped gully or drain to garden land that is well drained.
- Gullies should be trapped when discharging to a soakaway or combined drainage system (the approval of the statutory sewerage undertaker may be required).



When a drainage channel is provided, it must be connected to the storm drainage system to prevent flooding occurring and water ingress into the building. An accessible silt trap should also be included to prevent excess debris entering the system.

Where slotted surface water drainage channels are proposed to be used near the building (e.g. in front of garage door openings) and the ground levels would otherwise cause water to concentrate towards the building wall and potentially flood the building; a gradient should be created for at least 2m away from the wall of the building to divert the water towards the slotted drain channel.

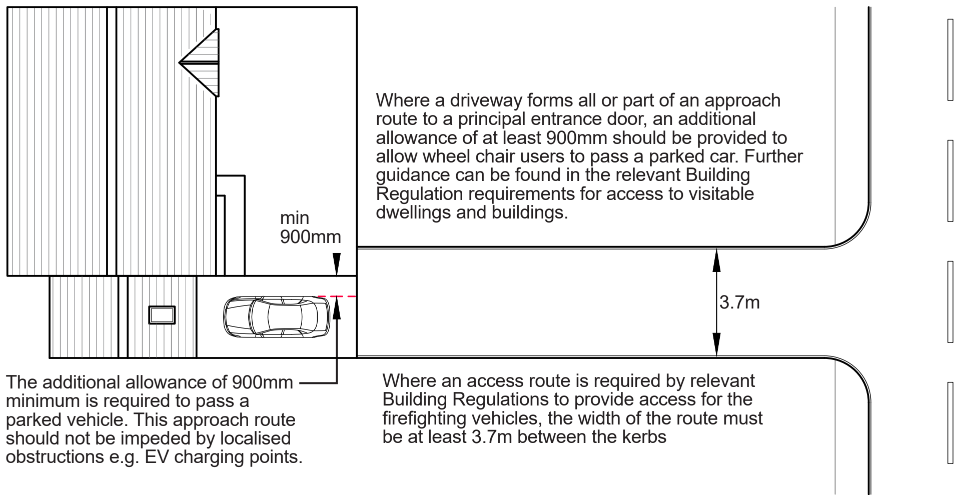
Drainage and gradients of access and paths

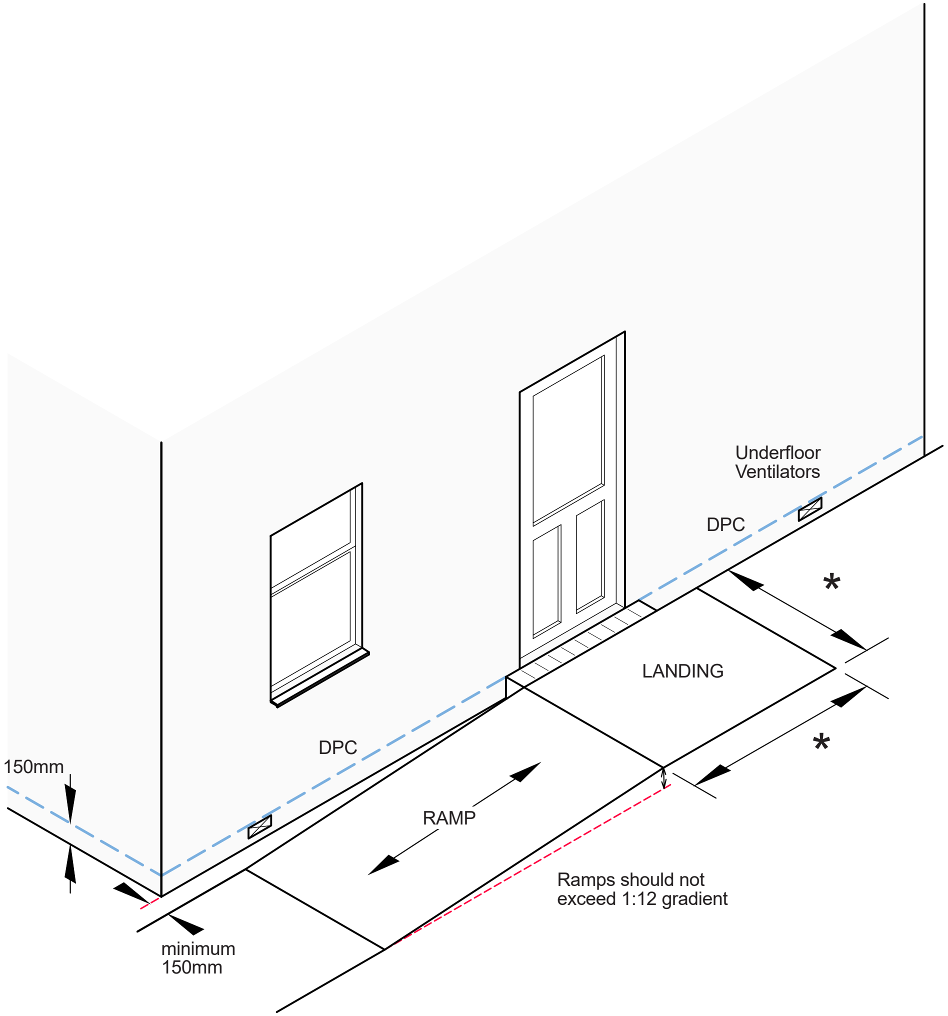


- Paving laid to falls away from building.
- Rainwater should not discharge onto a highway.
- All paving and drives, with the exception of the principle level access into the dwelling, should be laid at least 150mmbelow the damp proof course (DPC) of the dwelling.

Access requirements

The construction of the driveway must be suitable and durable enough to take additional loadings where required





A drainage channel (drained to a suitable outfall) should be provided to exposed level entrances

The construction of the access landings and ramps must not compromise the DPC in the walls

Landing should be laid to a 1:60 fall in a single direction away from door

*see Building Regulations for disabled ramp design and landing dimensions.

The construction of the access landings and ramps must not compromise the DPC in the walls. A recommended 150mm gap between the ramp and the external wall (as shown) should be provided.

* See relevant Building Regulations for disabled ramp design and landing dimensions. Ramps should not exceed 1:12 gradient. Where the outside ground levels slope towards the property, an effective gully system should be provided to prevent flooding e.g. in front of garage doors.

Where access requirements are required under relevant Building Regulations to the principal entrance of the visitable dwelling the ground surface of the defined approach route must be firm, even, smooth enough to be wheeled over, not covered by loose laid materials such as gravel and shingle and have a maximum cross-fall of 1:40.

Tolerances for surfacing of paths and drives

Drives and paths: standing water

Differences in the surface should not exceed +/-10mm from a 2m straight edge with equal offsets. Some fracturing or weathering may also appear if using natural stone due to the make-up of the material. This tolerance applies to principle pathways and driveways to the dwelling that are required to meet relevant Building Regulation standards for access to visitable dwellings and buildings.

Drainage system covers

Drainage system covers in hard standing areas should line up neatly with the adjacent ground.

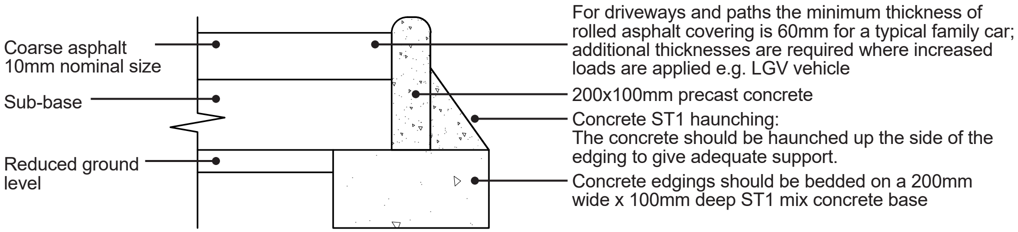
Further guidance can be found in the 'External Windows and Doors' section.

Edgings

Edgings are to be provided to paths and driveways to prevent movement or displacement. Edgings should be laid to ensure that there are no excessive gaps and laid with smooth alignment along the top of the edging.

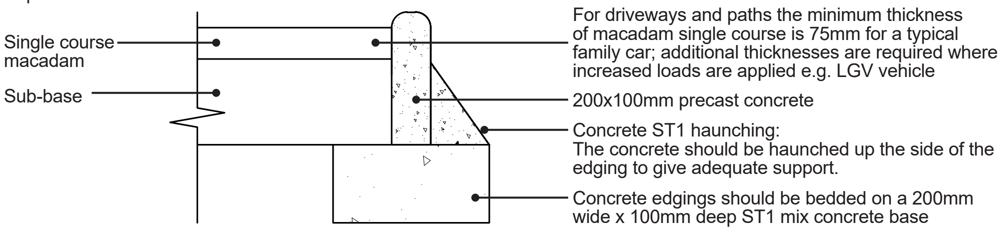
Asphalt

Ensure that sub-bases are dried and primed and that the surface is appropriately rolled with a vibratory roller to the required finish.



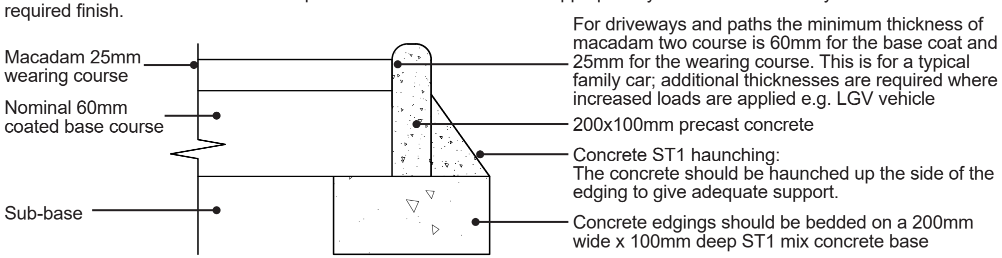
Single course macadam

Ensure that sub-bases are dried and primed and that the surface is appropriately rolled with a vibratory roller to the required finish.



Two course macadam

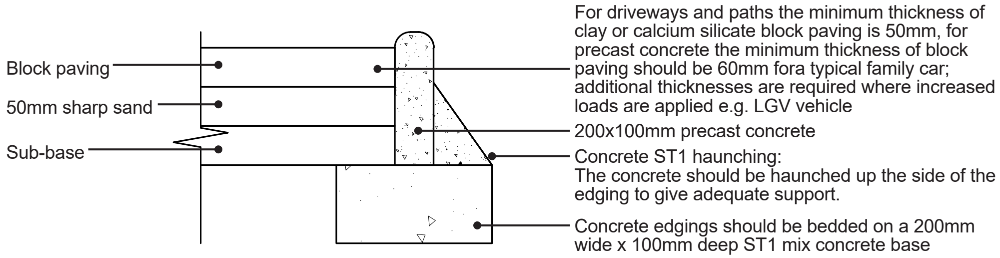
Ensure that sub-bases are dried and primed and that the surface is appropriately rolled with a vibratory roller to the required finish.



Block paving

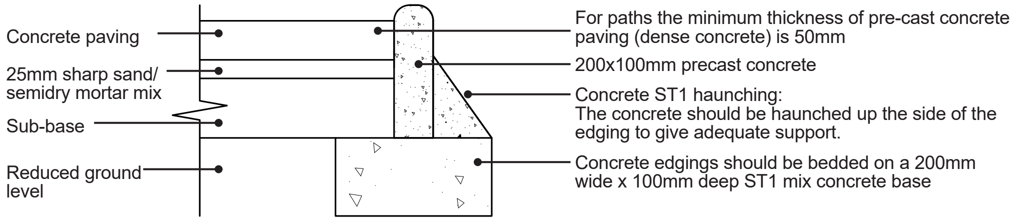
- Block paving should be laid on a minimum of 50mm sharp sand, and gaps between blocks should not exceed 5mm.
- All joints should be filled with kiln-dried sand or similar.
- Blocks should be cut using a block splitter and the finished path or driveway should be compacted with a plate vibrator.
- Care should be taken to ensure that the surface of the paving is not damaged or scuffed.

Porous block paving joints
Where paving is designed to allow ground water to drain through the joints, the gaps between blocks and the material within the joints should meet the initial design specification. The joint material should be sufficient to prevent blocking and prevent moss growth.



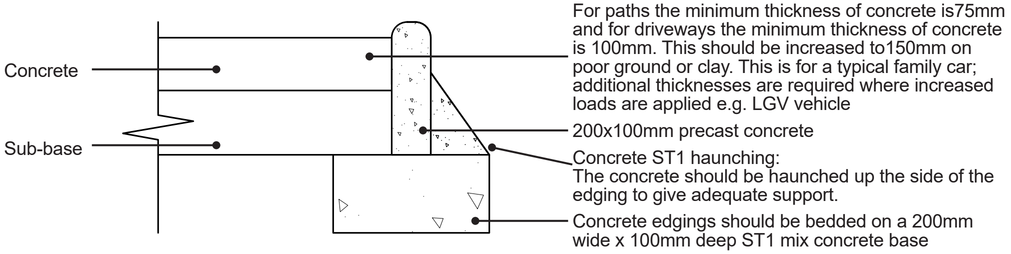
Concrete paving

- Paving slabs should be placed on a 25mm bed of sharp sand or semi-dry mortar mix (sand/cement mix ratio 3:1).
- Joints between slabs should be no greater than 4mm for straight edge paving slabs, and should be filled with kiln-dried sand.
- A neat consistent joint should be provided to rustic slabs.
- Slabs should be cut with a diamond blade cutter or similar to give a neat finish.

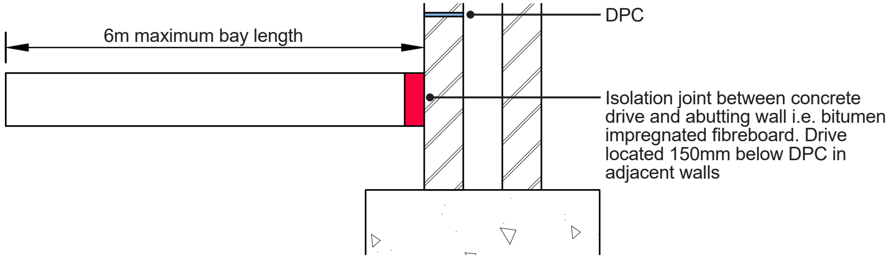


In-situ concrete

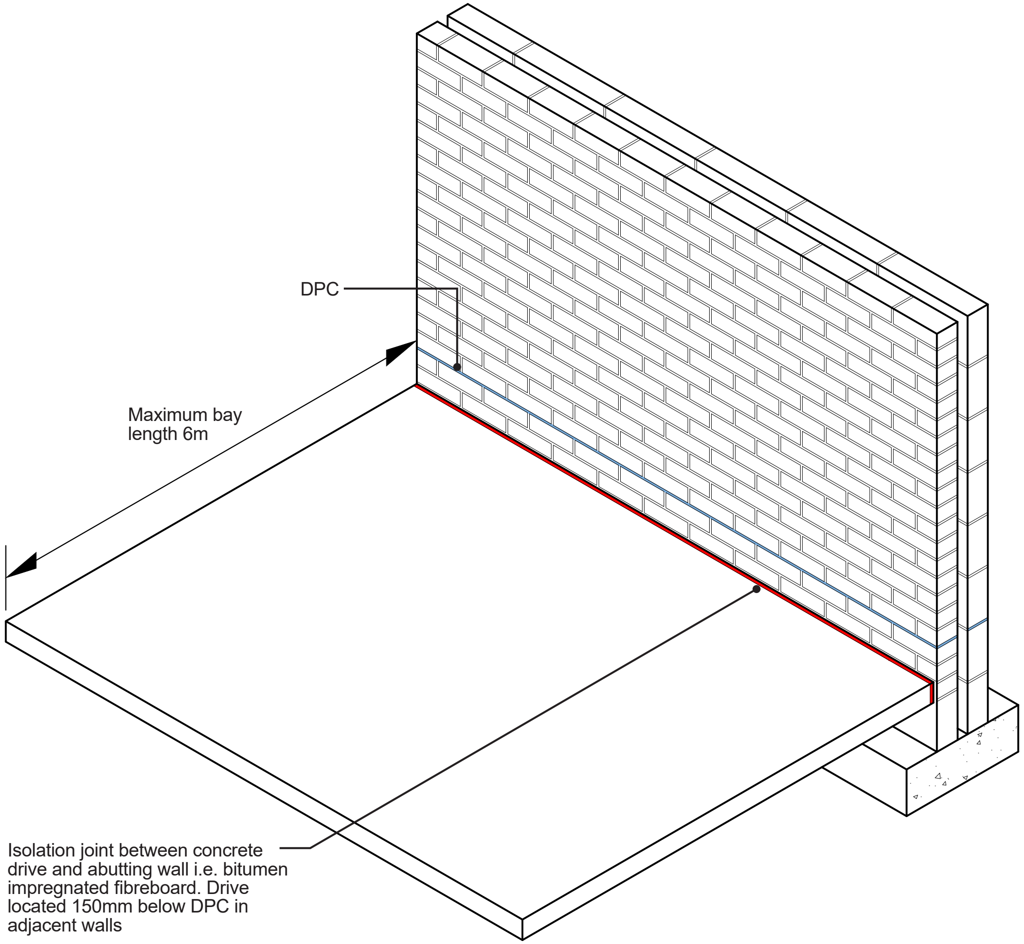
In-situ concrete should be laid in areas of 20m² maximum to allow for movement. Where abutting an adjacent structure, the concrete should be isolated using a flexible jointing material. Where the sub-base is well drained, it is recommended that the concrete is cast onto a damp proof membrane.



Typical cast in-situ drive or path abutting the dwelling



Isolation joint between in-situ concrete drive and abutting wall



Limitations of guidance

The following guidance is applicable to timber decking that forms part of the principle entrance to the property.

This guidance is limited to decking that is no more than 600mm above the adjacent ground level. For decked areas which are 600mm and greater above the external ground level the guidance within the 'Roof Terraces and Balconies' section should be followed.

Preparation of ground

The area to be surfaced should be prepared by stripping away all vegetation and organic material. Land drainage should be considered for ground that is saturated.

Timber decking

Only timber naturally resistant to decay, or which can be treated by an industrial process to give long-term protection from decay, shall be used.

Hardwoods: Only use species rated as durable or moderately durable.

Softwoods: Only use species/components with natural durability or which have been treated in accordance with BS EN 335 to a 'Use Class' standard appropriate to their use i.e. 'Use Class 4' treatment for posts and other structural components in direct ground or freshwater contact, or 'Use Class 3' treatment for all components out of direct ground contact subject to frequent wetting.

Please note:
- Whitewood should not be used for posts embedded in the ground or for other elements (joists) in the ground or other non-permeable surface e.g. concrete slab.
- All cross-cuts, notches or large boreholes shall be treated on site with a suitable preservative. For full guidance on wood preservation specification, contact the Wood Protection Association.

Timber grade (strength class): C16 minimum

The grade (strength class) of timber used for structural components such as posts, beams and joists shall be sufficient to cope with the loads placed upon it during its service life.

For decks below 600mm in height, the use of C16 timber is recommended.

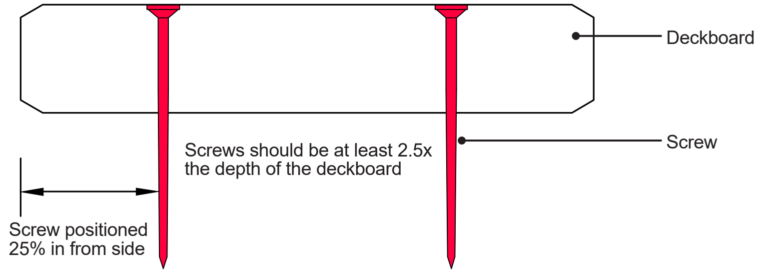
Posts can be made from laminated sections, solid timber or round poles, and should have a load-bearing capability/size/spacing appropriate to the scale and end use of the structure. For extended life, the surface mounting of posts on precast piers or metal shoes is recommended.

Note:
- Do not exceed the recommended load and span for each strength class; for detailed recommendations, refer to span tables in TDA/TRADA Timber Decking: The Professionals' Manual.
- Use 'noggins'/blocking to strengthen frames where appropriate to prevent flexing.
- Timber moisture content at installation should be 20% maximum.

To minimise the effects of shrinkage, e.g. cupping, cracking, warping, etc. install timber as close as possible to the equilibrium moisture content of the site. For outdoor wood, moisture content varies from 19% in winter to 13% in summer in the UK.
For best results, always install wood with moisture content lower than 20%. The stability of all wood used outdoors can be improved by the use of water-repellent treatments.

Board fixing

- Fixing points at board ends shall be no closer than 25 mm to the board end and should always be pre-drilled to prevent splitting.
- On grooved boards the fixing point should always be at the bottom of a groove, flush with the surface of the wood.
- Screw heads should be countersunk level with the surface of the board.
- Pre drilling pilot holes will prevent splitting. Always drill pilot holes 2mm oversized when fixing hardwood boards.
- All metal fixings shall be made from corrosion-resistant materials, such as stainless steel, hot dipped, galvanised or other specialist coating. Before use, verify with the manufacturer that the fixings you have chosen are suitable for use with treated timber.
- Aluminium fasteners should not be used with treated wood. Prevent galvanic corrosion by using the same type of metal for both fixings and connectors.
- Screws should be at least two-and-a-half times the thickness of the board being fixed.
- All joist bearing points shall be secured by two screws positioned at the quarter points of the board i.e. 25% in from the side.
- Take care using high-pressure nail guns as they can damage timber.



Board spacing

When laying timber decking boards:
- Allow for a 5mm minimum to 8mm maximum gap between board lengths.
- Where the board abuts a post, allow a 5mm gap.
- Where board ends meet, allow a 3mm gap.

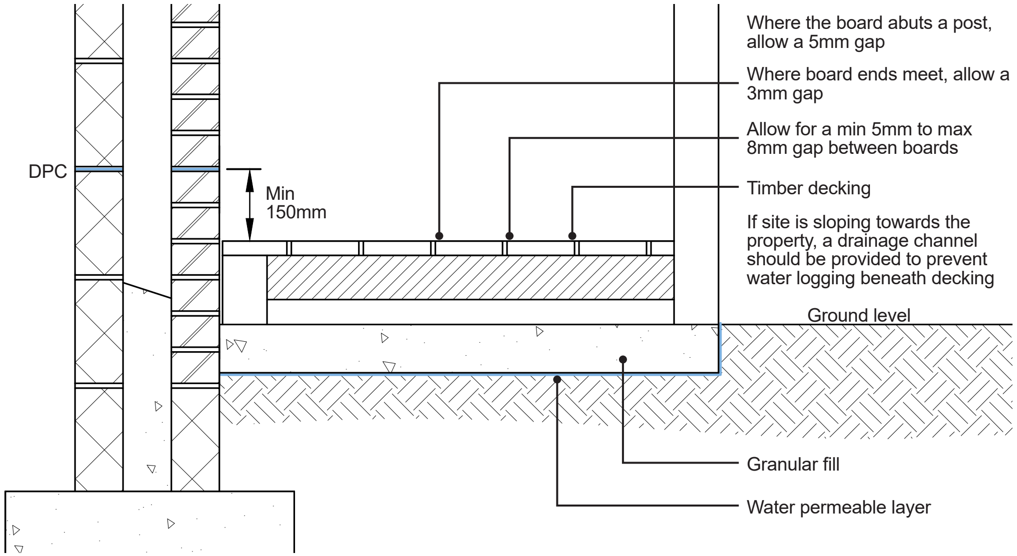
Fall

To aid drainage, build a gentle fall of 1:100 into the deck, away from any adjacent property. Grooved deck boards are designed to assist the drainage of surface water, so lay them in the direction of the fall.

Level threshold

For further guidance on the formation of level thresholds please see the 'External Windows and Doors' section.

Timber decking



Further specification references

- TDA/TRADA Timber Decking: The Professionals' Manual - second edition November 2006
- TDA Technical Bulletin TB 02: Statutory requirements
- TDA Technical Bulletin TB 04: Parapet design and construction
- TDA Technical Bulletin TB 08: Metal fixings
- TDA Code of Practice TDA/RD 08/01: Raised timber decks on new homes - desired service life 60 years
- Wood Protection Association: Timber Preservation Manual

British standards

The standards set out below all have a relevance to the creation of high-performance timber decks:

- BS EN 335-1 Use classes of wood and wood-based products against biological attack - Part 1: Classification of Use classes
- BS EN 335-2 Use classes of wood and wood-based products against biological attack - Part 2: Guide to the application of use classes to solid wood
- BS EN 335-3 Durability of wood and wood-based products - Definition of hazard classes of biological attack - Part 3: Application to wood-based panels
- BS EN 350-1 Durability of wood and wood-based products - Natural durability of solid wood - Part 1: Guide to the principles of testing and classification of the natural durability of wood
- BS EN 350-2 Durability of wood and wood-based products - Natural durability of solid wood - Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe
- BS EN 351-1 Durability of wood and wood-based products - Preservative-treated solid wood - Part 1: Classification of preservative penetration and retention
- BS EN 351-2 Durability of wood and wood-based products - Preservative-treated solid wood - Part 2: Guidance on sampling for the analysis of preservative-treated wood
- BS EN 460 Durability of wood and wood-based products - Natural durability of solid wood: Guide to the durability requirements for wood to be used in hazard classes
- BS EN 599-1 Durability of wood and wood-based products - Performance of wood preservatives as determined by biological tests - Part 1: Specification according to hazard class
- BS 8417 Preservation of timber - Recommendations. Guidance for specifiers on the treatment of timber drawing on relevant sections of BS EN standards
- BS 5756 Specification for visual strength grading of hardwood
- BS 6105 Specification for corrosion-resistant stainless steel fasteners
- BS 6399-1 Loading for buildings. Code of Practice for dead and imposed loads
- BS 7359 Nomenclature of commercial timbers, including sources of supply
- BS 5268-2 Structural use of timber. Code of Practice for permissible stress design, materials and workmanship
- BS 6180 Barriers in and about buildings - Code of Practice
- BS 6399-1 Loading for buildings. Code of Practice for dead and imposed loads

15. Heating Services

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. A commissioning certificate is required for any work completed by an approved installer.
2. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

Design

1. Heating services shall be designed, constructed and installed so that they:
    a. Are provided with evidence to demonstrate they meet the requirements of Building Regulations;
    b. Do not adversely affect the structural stability of the building;
    c. Prevent the entry of hazardous ground substances, external moisture or vermin;
    d. Are constructed using non-hazardous materials;
    e. Are durable and robust;
    f. Are safe and convenient in use;
    g. Are insulated to prevent unintended heat losses;
    h. Are capable of being adequately controlled.

15.
Heating Services

15.1
Associated Services for Space and Water Heating Systems

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Fully detailed drawings for the proposed system.
2. Full specification for the elements of the system(s), which shall include but not be limited to:
   a) Any space/hot water system serving appliances, and associated elements of plant employed for the delivery of space heat or hot water services.
   b) Water storage cisterns and cylinders.
   c) Heat emitters and any associated controls.
3. Commissioning certification.
4. Post installation/completion testing requirements.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Gas services supplied to the dwelling

Pipework serving up to and including the emergency control valve and meter should be installed in accordance with the requirements of the gas transporter, gas supplier and primary meter owner.

Electrical services supplied to the dwelling

Mains and services cable installations up to and including the meter should be in accordance with the requirements of the Utility provider.

Items to be taken into account include:

- Locations and fittings of pipes and cable service entries should be protected where passing through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage. Fire stopping may also be required. Services should not to be located in the cavity of an external wall, except for electricity meter tails.
- Services should only be buried in building fabric where permitted by relevant Codes of Practice.

Services entering into the building

Penetrations through the structural fabric into the building must not must not create a structural instability or diminish the durability of the surrounding building fabric.

Weather resistance

Penetrations through the external weather proof envelope must be appropriately sealed to ensure suitable weather resistance is achieved. Any fittings, components and/or sealants provided for this purpose must be installed in accordance with the manufacturer's recommendations.

Utility meters

External meter boxes should be of a type approved by the supply authority and located as close as practical to the main access point to the building.

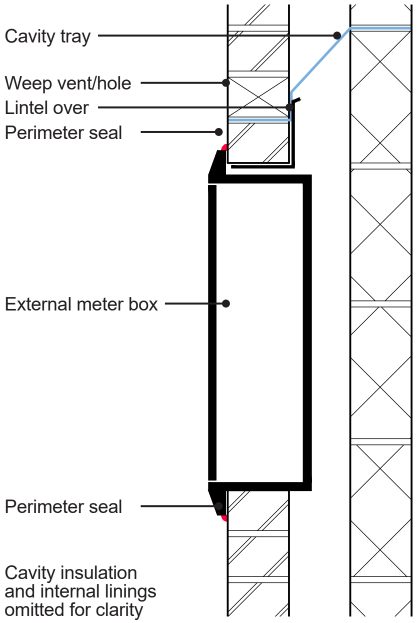
Domestic meters may be of the following type:

- Built-in to the outer leaf of the wall.
- Surface-mounted on an external wall.
- Semi-concealed: sunk into the ground adjacent to the outer wall.
- Individual, purpose-made compartments, in accordance with British Standards.

For further guidance, the respective Utility provider requirements should be followed in relation to type and acceptable installation of meter boxes e.g. installation height, external ductwork, fixing for connection purposes and they may recommend that reference is made to National Joint Utility Group Publications.

For Warranty purposes, any openings provided in walls for the installation of meters must be structurally sound, and their location must not create a structural instability where they are placed astride other structural openings e.g. doors and window openings. They must be provided with a lintel and increased wall tie frequency around the opening edges in line with the guidance in the 'External Walls' section.

The installation must also be suitably weatherproofed to prevent dampness entering the home by incorporating appropriate perimeter seals, a cavity tray and weep vents/holes above the opening.



Penetrations from gas pipework

Installation of pipework must comply with relevant Approved Codes of Practice and Industry standards, such as those published by the Institution of Gas Engineers and Managers (IGEM) or Gas Safe Register (GSR).

Note: Where gas pipework is to be installed in timber frame, allowance must be made for differential movement – see the 'External Walls – Timber Frame' section of this Technical Manual.

Penetrations from electrical cabling

Electrical services and installations must comply with the requirements of BS 7671 'Requirements for electrical installations' and comply with BS 6004 'Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting'.

Note: the passage of cabling under, against or within thermal insulation should be avoided, unless they have been appropriately sized and de-rated. Additionally, provision for separation should be made for any PVC covered cables to ensure they are not in contact with polystyrene insulation.

Materials

The recommendations of the water supplier with regard to materials and fittings used for water services should be followed. It may be necessary to fit aluminium protector rods in areas where the corrosion of copper cylinders occurs. These are to be fitted during manufacture, in accordance with the relevant British Standards.

Fire stopping

Where fire stopping is installed around services that penetrate fire-resisting floors, walls or partitions, all fire sealing and fire stopping materials used must be fully compatible with the pipes and/or cabling. Guidance on compatibility should be sourced from the manufacturers of interacting materials in the first instance.

Further general information on this can be found in the ‘Upper Floors’ and ‘Internal Walls’ guidance.

Installation of services

All items should be installed to ensure satisfactory operation.

Items to be taken into account include:

- Locations and fittings of pipes and cable service entries through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage.
- Fire stopping may also be required (see above).
- Services should not to be located in the cavity of an external wall, except for electricity meter tails.
- Only to be buried in screeds where permitted by relevant Codes of Practice.

For further guidance on electrical services, reference should be made to the ‘Electrical Services’ section.

Jointing of service supply pipes and fittings

Proprietary joints should be made strictly in accordance with the manufacturer’s instructions.

For metal pipes, only flux recommended by the pipe manufacturer should be used and all traces should be removed immediately after jointing. Flux containing lead are not acceptable.

Suitable clips or brackets are to be used to secure pipes and fittings. Fixings should be installed adequately and spaced to stop sagging but not restrict thermal movement.

Sufficient room should be allowed for thermal expansion and contraction to avoid damage and noise from pipe movement.

Gas pipework contained within ducts

Ducts that contain gas pipework must be ventilated to ensure that any minor leakage of gas can be cleared to prevent a build-up reaching dangerous levels. For guidance on ventilation requirements, the installer should refer to BS 6891 ‘Specification for the installation and maintenance of low pressure gas installation pipework of up to 35 mm on premises’. Note: Ventilation of the duct should not be solely relied upon for mitigation in a major gas leak caused by a larger failure in the pipework.

Where gas pipework is contained within a duct which cannot be ventilated to the recommendations of the above standard, the provision of proprietary containment pipework – such as products which have a secondary outer cover to contain any escaping gas from the primary outer cover – should only be accepted where:

- Each end terminates to a point of safe and ventilated dispersal.
- The proprietary product has recognised 3rd Party Accreditation certification or suitable testing to a recognised Approved Code of Practice or Standard.
- Its use within the installation complies with relevant Approved Codes of Practice and Industry standards, such as those published by the Institution of Gas Engineers and Managers (IGEM) or Gas Safe Register (GSR).

Chasing of masonry cavity walls

If chases in walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

Pipework in walls

If the services are hidden in walls, they need to be positioned so that any significant cracking of the surface cannot occur.

A metallic tape should be applied to the pipework where plastic pipework is hidden within or behind wall surfaces, which would otherwise not be located by a metal detector. Some adhesives for metallic tapes may not be compatible with the pipework it is being attached to. Please refer to the manufacturers recommendations to ensure compatibility.

Services within structural floors

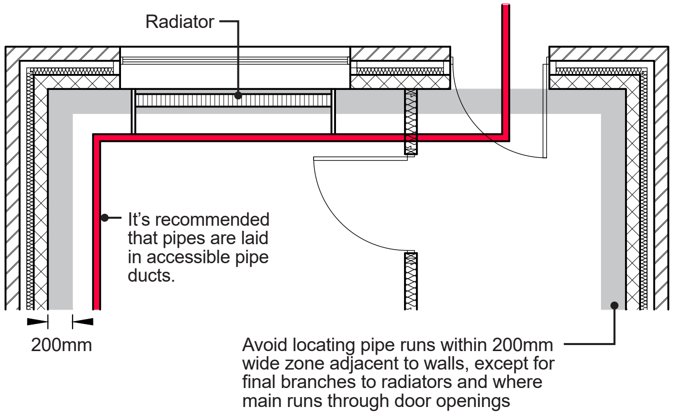
Services should not be incorporated within structural floors or structural screeds.

Pipework in non-structural floor screeds

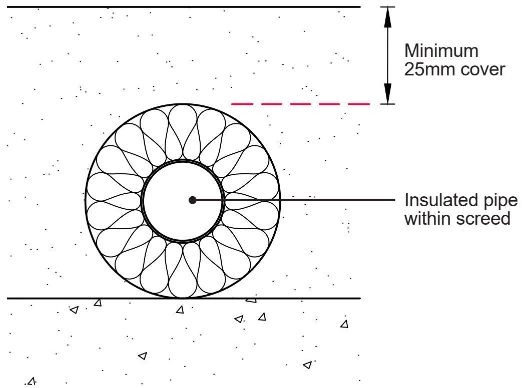
If the services are hidden in floors, they need to be positioned so that any significant cracking of the surface cannot occur. Where copper pipes are permitted in floor screeds, they should be:

- Sleeved or wrapped so that they can move freely along the length and at joints and bends.
- Jointed with capillary joints.

Recommended positioning of pipes in non-structural screeds



Recommended positioning of pipes in non-structural screeds



Screed cover should be a minimum 25mm over the pipe and insulating materials. The screed thickness should still be at least 25mm where pipes cross over.

Notches and drillings

Solid timber floor joists should not be excessively notched or drilled to allow the passage of services - further information can be found in the ‘Upper Floors’ section.

Services passing through ‘Engineered floor joists’ e.g. I-joists, open metal web joists, laminated beams, etc. must follow published guidance from the joist manufacturer.

Cutting or alteration of the flange of an engineered floor joist is strictly prohibited – where this occurs, the engineered joist must be replaced.

15. Heating Services

15.2 Conventional Space and Water Heating Systems

Space heating systems

Where space heating systems are provided, evidence will be required to demonstrate that it is compliant with the requirements of relevant Building Regulations and the guidance of relevant Approved Codes of Practice and industry standards to ensure safe operation.

Where appropriate, space heating systems should comply with the following:

- BS EN 12828 ‘Heating systems in buildings. Design for water-based heating systems’.
- BS 8303 ‘Installation of domestic heating and cooking appliances burning solid mineral fuels’.
- BS 5410 ‘Code of practice for oil firing’.
- BSRIA guide BG 4/2011 ‘Underfloor heating and cooling’.
- BS 5410 ‘Code of practice for oil firing’
- EN 14336 ‘Heating systems in buildings. Installation and commissioning of water based heating systems.’

Where space heating is delivered via a domestic wet central heating systems and incorporates a gas fired boiler, reference should be made to BS 6798 ‘Specification for selection, installation, inspection, commissioning, servicing and maintenance of gas-fired boilers of rated input not exceeding 70 kW net’.

Space heating delivered by electric boilers serving a wet central heating systems should reference manufacturer’s guidance for specification, installation, and commissioning.

Space heating appliances, including all components and controls, should be of a type approved by the relevant authority and their relevant equipment testing & approval schemes.

Performance of space heating systems

Any whole-house heating system should be designed to meet internal temperatures to the levels set out as per below. External temperature is to be -2°C.

Air change rates given below are default values derived from the guidance of BS EN 12831-1 ‘Energy performance of buildings - method for calculation of the design heat load. Space heating load’.

Location	Temperature	Air changes
Living room	21°C	1 per hour
Dining room	21°C	1 per hour
Kitchen	18°C	2 per hour
Bedrooms	18°C	1 per hour
Bed-sitting room	21°C	1 per hour
Bathrooms	22°C	2 per hour
Hall and landing	16°C	2 per hour
Separate WC	18°C	2 per hour

Note: Space heating systems using low or zero carbon technologies only, e.g. Air source heat pumps, should follow the guidance in the ‘Heating Services - Other Forms of Heating Systems Including Low and Zero Carbon Systems’ section. Any designs using differing data values or system specific guidance than those given above must be fully rationalised within supporting calculations.

Designs must also make allowance for influencing factors, such as:

- The number of air changes per hour from kitchens and bathrooms should account for any mechanical ventilation.
- The presence of open flued appliances affecting the rate of air change. Where this occurs, air change rates used for the design should be increased in accordance with BS EN 12831.
- Design temperatures should be verified by calculations and not by performance tests.
- The main living room should have a heating appliance or a heat output as part of a whole home heating system.

Design and installation of hot water services

Evidence shall be provided that the design and installation is compliant with the requirements of the relevant Building Regulations and the guidance of relevant Approved Codes of Practice and industry standards to ensure safe operation, and be adequate for the demand and consumption.

Where appropriate, systems delivering hot water services should comply with the following:

- BS EN 806 Parts 1-5 ‘Specifications for installations inside buildings conveying water for human consumption’.
- BS8558 ‘Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806’.

Storage vessels

Should be:

- Accessible for maintenance,
- Installed as per manufacturers recommendations,
- Insulated, and adequately supported.

Where an immersion heater is fitted, it should be:

- Appropriate for the type of water supplied to the building.
- Thermostatically controlled.
- Located so that it can be withdrawn for replacement.
- Fitted with an accessible on/off switch.

Protection against freezing

Cisterns, vent pipes and all water services in unheated spaces should be insulated against freezing as specified in the design.

Insulation is not to be placed below a cold water tank where it can benefit from heat from beneath. Tanks that are raised need to be insulated on all sides in an unheated roof space.

Fully insulated bends and junctions are required, especially near openings to the outside air, such as the eaves. If possible, water pipes should not be located within a loft space where they could be affected by cold ventilation air.

Provision for expansion

An expansion pipe is to be provided on vented systems for hot water.

Unvented hot water systems

Third-party accreditation is required where an unvented hot water system with a storage capacity greater than 15 litres is required by the design. Installation is to be completed by a competent person.

Draining down facility

Hot water installations require the capability to be drained down.

Controls – Space heating

Space heating and hot water service appliances should have controls as determined by the specialist heating design. Dependant on the chosen and specified system, such controls may include but are not limited to:

- Zone controls.
- Time and temperature controls.
- Boiler interlocks.
- Controls for space heating and controls for hot water.

Maintenance

All system installations must have safe access provided to all elements requiring routine inspection, periodic servicing/maintenance, repair and periodic functional checks in relation to performance inclusive of any switchgear, inverters, meters and controls in accordance with the manufacturer’s recommendations.

Testing and commissioning

All systems must be tested and commissioned in accordance with a commissioning schedule.

Evidence should be provided in the commissioning schedule for:

- Identification of the systems to be commissioned.
- Identification of commissioning activities for each area of the system and installation.
- A list of documentation requirements associated with the commissioning process.
- A list of documents which will be handed over at completion of testing and commissioning.

The testing and commissioning of the system must prove and demonstrate that the installation is in accordance with the certification requirements, the manufacturer’s recommendations and the design.

Upon completion, the installer must provide a certificate to confirm that the system has been installed, tested and commissioned in accordance with the above.

Completion of works

Upon completion of work, the installer must provide evidence of an information pack, which includes:

- User instructions for the systems installed.
- Contact details for the manufacturer and installer.
- All information in relation to the key components installed.
- Maintenance and servicing requirements.
- Any Warranties and/or guarantees relating to appliances and associated kit.

15.
Heating services

15.3
Other Forms of Heating Systems Including Low and Zero Carbon Systems

This section provides guidance on how low or zero carbon systems may be acceptable to meet the Functional Requirements of this Technical Manual, for:

- Air source heat pumps.
- Ground source heat pumps.
- Solar photovoltaics (PV).
- Solar thermal water heating.
- Wind turbines.
- Biomass boiler.

Alternative systems that follow the general principles of this sub section will be subject to specific agreement.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Fully detailed design and installation suite of documents for the proposed system, which shall include:
   a) A drawing package inclusive of schematics covering positions of appliances, plant, associated pipework and/or electrical cabling.
   b) Manufacturer specification for all appliances and elements of plant.
   c) A clear matrix document indicating interfacing systems and which manufacturer and/or installer is responsible for each system and the resultant interface(s).
   d) Fixing schedules.
   e) Specification for controls.
   f) Commissioning certification.
   g) Post installation/completion testing requirements.
   h) An operation and maintenance manual for each system and interfacing elements.
   i) SAP assessment documentation to demonstrate the Building Fabric performance for the building supports the inclusion of such heating systems.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Design and specification

All 'low or zero carbon technology systems' and products must have current certification confirming satisfactory assessment by an appropriate independent authority that is acceptable to our Warranty.

Systems and products assessed through the Microgeneration Certification Scheme (MCS) will be acceptable for Warranty purposes, subject to:

Any electricity generating technologies with a capacity of up to 50kW and heat generating technologies with a capacity of up to 45kW (including any method of attachment to the building) must:

- Hold certification with the 'Microgeneration Certification Scheme (MCS)', and,
- The installers must also be registered with the 'Microgeneration Certification Scheme (MCS)'.

Designs and location of components should take account of:

- Internal and external noise.
- Vibration.
- Penetrations through the weather proof fabric.
- Loading onto the structure, any system components requiring foundations or anchorage into structure must be designed by an Engineer.
- Positioning in relation to openings.
- Potential encroachment across defined access routes.

Designs should ideally be supplied from one manufacturer as a package and not as individual components or materials. However, where components from more than one manufacturer are used, they should be compatible to ensure the satisfactory design performance is achieved.

Note:

1. Where a Low or zero carbon technology system is installed as a **secondary** system i.e. to contribute towards the primary space and water heating system to the building, they should be designed so that the overall heating system meets the performance requirements within 'Heating Services – Conventional Space and Water Heating Systems'.
2. Where a low or zero carbon technology system provides the main **primary** space and water heating system: users must be aware how the system works differently to a conventional heating system and be clearly explained to them on handover, to ensure how to run the system efficiently.
3. Any assessment of the performance of a space heating system must avoid comparisons with conventional heating systems e.g. gas boilers. If a systems performance must be measured, it should be done so against a comparable system benchmark using the same technologies to avoid misconceptions that these systems are not being as responsive or are failing to meet the required performance levels.

Installation

All system installations must have current certification confirming satisfactory assessment by an appropriate independent authority.

All installations must:

- Be carried out by certified installers, trained to an acceptable level for the system(s) being installed. Installers certified in accordance with the MCS installer standards will generally be acceptable.
- Installation information issued by the system manufacturer and system designer must be followed.
- Be able to prove and demonstrate a clear Quality Assurance procedure for the installation.

Where installation involves more than one installer e.g. where 2 or more different systems interface, a clear statement must be provided to clearly communicate which installer is responsible for each system and all associated interfacing.

Installations or work to systems containing fluorinated gas must use operatives that are F-Gas qualified and all individual operatives must have a qualification as an individual from an accredited organisation e.g. City and Guilds, Building Engineering Services Association (BESA), LCL Awards, Construction Industry Training Board (CITB).

Typically this will occur on Air Source Heat Pumps that are part of 'split systems' e.g. smaller outdoor units plus an indoor unit and may also incorporate a hot water cylinder.

All electrical installations must:

- Comply with BS 7671 'Requirements for Electrical Installations'.
- Be in accordance with the 'Electrical Services' section of this Technical Manual.

Electrical systems and installations which generate electricity and are connected to the mains should automatically disconnect when there is a mains power failure. This is to avoid them from feeding the network or local distribution system during a planned or unscheduled loss of mains supply.

All pipework installations must:

- Comply with relevant codes and standards or be independently assessed for their intended use.
- Use materials suitable for the intended purpose and provide satisfactory performance for the life of the system. Any refrigerant pipework should be of refrigerant quality copper pipe, or other material as recommended by the manufacturer.

Where there is a risk of pipes freezing, they should be insulated. The insulation material must be:

- Inert, durable, and resistant to the effects of moisture.
- In-line with relevant codes and standards or be independently assessed for their intended use.
- Incorporate a vapour control layer to prevent ice build-up when employed on refrigerant pipework.

Any system components fixed to the building structure must:

- Be fully designed and assessed by an Engineer with regards to the buildings ability to accept the loadings and prevent detrimental effects arising from additional loading, movement or vibration.
- Be in accordance with the manufacturer's recommendations in relation to the type, size, number, position and fitting tolerance of fixings.
- Utilise fixings made from durable materials in accordance with recognised standards.
- Not adversely affect the weather resistance of the building.
- Fixings, supports, bracketry and mounting frames for components should be capable of taking designated loads in accordance with the manufacturer's recommendations.
- Have adequate protection against corrosion. Where two metals are to be joined, they should either be compatible or isolated, to prevent bimetallic corrosion. Aluminium and aluminium alloys should not come into contact with cementitious material.

Any system components penetrating through the building structure/fabric must:

- Be formed and detailed to provide adequate weather resistance.
- Be sealed to limit air leakage and prevent moisture from reaching the interior or any part of the structure that could be adversely affected by its presence.
- Must be weatherproofed using appropriate flashings and fixings where detailing requires e.g. solar photovoltaic panels and pitched roofing.
- Not include weatherproofing details that rely solely on sealant.
- Be robustly formed and sealed to inhibit the passage of fire and smoke where deemed required by relevant Building Regulations.

Maintenance

All system installations must have safe access provided to all elements requiring inspection, periodic servicing/maintenance, repair and periodic functional checks in relation to performance inclusive of any switchgear, inverters, meters and controls in accordance with the manufacturer's recommendations.

The electrical installation should be capable of being isolated from all other electrical sources when required, for maintenance or testing.

Testing and commissioning

The testing and commissioning of the system must prove and demonstrate that the installation is in accordance with the certification requirements, the manufacturer's recommendations and the design.

Upon completion, the installer must provide a certificate to confirm that the system has been installed, tested and commissioned in accordance with the above.

Completion of works

Upon completion of work, the installer must provide an information pack, which includes:

- A completed manufacturer's certificate from an acceptable independent assessment organisation, MCS or suitable alternative that is acceptable to our Warranty.
- User instructions for the systems installed.
- Contact details for the manufacturer and installer.
- All information in relation to the key components installed.
- Details of the fuel type and source.
- Maintenance and servicing requirements.
- Any Warranties and/or guarantees relating to appliances, items of plant and associated kit.

The information pack should clearly explain how to operate the system efficiently and provide a clear explanation on what to expect from the installed system. This is of particular importance for users whom are more accustomed to gas boiler systems and the differences they may experience in operation.

For clarity, these differences should identify if a system is likely to be not as responsive; radiators (if installed) feeling cooler to the touch albeit that rooms still reach the target temperature as designed and the differences in using an alternate means of control e.g. no provision of on/off timers to control space heating.

Heat pumps

A device which takes heat energy from a low temperature source and upgrades it to a higher temperature at which it can be usefully employed for heating and/or hot water. Heat pumps may utilise different heat sources:

- Ground Source, where heat energy is extracted from the ground (e.g. from boreholes, horizontal trenches or aquifers)
- Water Source, in which heat energy is extracted from water (e.g. lakes, ponds or rivers)
- Air Source, where heat energy is directly extracted from ambient air.

Equipment certification
On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 007 - MCS Product Certification Scheme Requirements: Heat Pumps (Single Heat Pumps up to 45KWth)
-

All installed equipment must carry the ‘MCS Certification Mark’.

Design, installation and commissioning
All work carried out shall be executed in accordance with the relevant MCS Microgeneration Installation Standards:

- MIS 3005 D & MIS 3005 I Requirements for MCS Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Microgeneration Heat Pump Systems, and,
- Provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Installations or work to systems containing fluorinated gas must use operatives that are F-Gas qualified and all individual operatives must have a qualification as an individual from an accredited organisation e.g. City and Guilds, Building Engineering Services Association (BESA), LCL Awards, Construction Industry Training Board (CITB).

Typically this will occur on Air Source Heat Pumps that are part of ‘split systems’ e.g. smaller outdoor units plus an indoor unit and may also incorporate a hot water cylinder.

General considerations
Radiators and pipework that are used with these systems are likely to be larger than that of traditional gas boilers.

As well as the size of pipework, pipe runs will need to follow the specific schematics issued by the designer of the system to ensure they deliver the flow rates expected. Changes of direction in pipework may give rise to a reduced flow rate where they do not follow the specific system schematics and specifications.

Oversizing components can result in significantly reduced efficiency and therefore any equipment that forms part of a designed system will have been calculated to ensure that it is not oversized for its space heating load. For this reason, substitution of the specified equipment within a designed system must be avoided.

Similarly, the location and positioning of equipment should be exactly as illustrated upon schematics, notably where air flow is key around installed equipment and is also essential in avoiding clashes with other elements. It is also paramount to ensure that positioning allows for periodic maintenance to be carried out by providing sufficient access to installed equipment.

Any assessment of the performance of a space heating system must avoid comparisons with conventional heating systems e.g. gas boilers. If a systems performance must be measured, it should be done so against a comparable system benchmark using the same technologies to avoid misconceptions that these systems are not being as responsive or are failing to meet the required performance levels.

Key points of note are that radiators, when installed as part of heat pump systems, will feel cooler to the touch. This should not be considered as a failure of the systems performance where the designed room temperature is ultimately achieved within the designated response time for the space to achieve its target temperature.

Heating systems that incorporate heat pumps will typically use different approaches to managing temperatures, with simple on/off timer control of conventional space heating being replaced with controls that are more suited to the system e.g. ‘setback’ temperature strategy. This is where a limiting temperature (a temperature that you never want the conditioned space to fall below) is set for the system and a target temperature is also set (the temperature for use of the space at chosen points in the day, as per the specific design).

Impact on the building structure
Underground systems must not undermine or otherwise impact on building foundations due to proximity or operation. Any system designs must be carried out alongside foundation designs and engage any relevant parties in the foundation design at an early stage.

A site specific calculation for assessment of loading will be required where equipment is mounted onto building fabric i.e. placed on a flat roof, or attached to an external wall. This is applicable even where an approved mounting system kit is utilised.

Weather resistance
Where equipment is attached to the building fabric it must be provided with detailing that does not allow rainwater to run back towards the building or create staining. Where employed, weather shielding attachments must direct water away from the structure. Where services or product attachment creates a penetration of the weatherproof envelope, all detailing must be weather tight and should not solely rely on the use of sealants.

Solar photovoltaics (PV)

Solar photovoltaic (PV) systems use module arrays to generate electricity from sunlight which are mounted on a roof(s) and/or walls using mounting systems.

Module types are:

- Monocrystalline or polycrystalline silicon PV modules.
- Amorphous thin film PV modules.
- Bespoke Building-integrated PV modules - PV glazing, PV façade units or PV shading units.
- Hybrid PV modules.

PVs are generally about 1m x 1.5m and are connected in series as an ‘array’ to achieve a desired energy output.

Equipment certification
On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 005 - MCS Product Certification Scheme Requirements: Solar PV Modules.
- MCS 012 – MCS Product Certification Scheme Requirements: Pitched Roof Installation Kits.
- MCS 017 – MCS Product Certification Scheme Requirements Bespoke Building Integrated PV Products.

All installed equipment must carry the ‘MCS Certification Mark’

Design, installation and commissioning
All work carried out shall be executed in accordance with the relevant guidance:

- MCS/ECA – Guide to the Installation of Photovoltaic Systems
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Panels and all associated components inclusive of fixings must meet the fire performance requirement of the relevant Building Regulations.

General considerations
The efficiency of PV is dependent on positioning and achieving the maximum exposure to sunlight of the panels. Factors that affect this are orientation and the angle of the roof on which they are fixed.

The ideal roof angle depends on the location of the home but generally 30° elevation is the optimum in the UK.

Durability
Where PV units form part of the weather proof envelope they must achieve the same service life as the roof covering (25 years).

Components must be checked they are suitable for durability where used in Coastal locations due to the aggressive conditions components will be exposed to.

Impact on the building structure
Structural assessment must be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from the PV modules, associated mounting systems, and any battery storage placements on or within the roof structure or associated voids.

Any assessment should also consider the potential loads created by wind and snow. For each site the imposed wind and snow loads should be derived using the procedures within Eurocode 1 (BS EN 1991-1). Wind loads vary considerably across the UK and are influenced by factors such as site altitude, building height and local topography.

Recognised test data commissioned for the specific purpose of determining the wind loads on such systems should be used to create any calculations.

Weather resistance
Where equipment is attached or mounted to the building fabric, it must be provided with detailing that does not allow rainwater to enter the building fabric via structural connections, cabling or pipework penetrations. All detailing must be weather tight and should not solely rely on the use of sealants.

Flat roof PV module arrays that are supported on a framework must incorporate suitable protection to the flat roof waterproofing and be designed alongside flat roof drainage provision. Support structure and any associated system i.e. ballasted bases must not create an imposition to the drainage of the flat roof or compromise the waterproof roof covering.

Solar thermal water heating

Solar thermal panels or solar collectors are devices that are mounted on to your roof to absorb the sun's heat and use it to heat up water, stored in a cylinder.

Equipment certification
On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 004 - MCS Product Certification Scheme Requirements: Solar Collectors
- MCS 012 – MCS Product Certification Scheme Requirements: Pitched Roof Installation Kits

Alternatively, solar collector equipment may be listed under the CEN Solar Keymark scheme.

All installed equipment must carry the 'MCS Certification Mark'.

Design, installation and commissioning
All work carried out shall be executed in accordance with the relevant guidance:

- MIS 3001 – Requirements for MCS Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Solar Heating Microgeneration Systems.
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Durability
Where Solar thermal water heating system units form part of the weather proof envelope they must achieve the same service life as the roof covering (25 years).

Components must be checked they are suitable for durability where used in Coastal locations due to the aggressive conditions components will be exposed too.

Impact on the building structure
Structural assessment must be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from Solar Heating equipment, associated mounting systems and the potential loads created by wind and snow. For each site the imposed wind and snow loads should be derived using the procedures within Eurocode 1 (BS EN 1991-1). Wind loads vary considerably across the UK and are influenced by factors such as site altitude, building height and local topography. Recognised test data commissioned for the specific purpose of determining the wind loads on such systems should be used to create any calculations.

Weather resistance
Where equipment is attached or mounted to the building fabric, it must be provided with detailing that does not allow rainwater to enter the building fabric via structural connections, cabling or pipework penetrations. All detailing must be weather tight and should not solely rely on the use of sealants.

Flat roof Solar Heating equipment arrays that are supported on a framework must incorporate suitable protection to the flat roof waterproofing and be designed alongside flat roof drainage provision. Support structure and any associated system i.e. ballasted bases must not create an imposition to the drainage of the flat roof.

Wind turbines

Wind turbines use propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity into battery storage.

Types may be:

- Roof mounted wind turbines.
- Pole-mounted wind turbines.
- Micro domestic turbine.

Equipment certification
On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 006 - MCS Product Certification Scheme Requirements: Small Wind Turbines (up to 50kW output).

Design, installation and commissioning
All work carried out shall be executed in accordance with the relevant guidance:

- MIS 3003 – Requirements for Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Micro and Small Wind Turbine Systems.
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Impact on the building structure
Structural assessment must be provided to prove and demonstrate the structures ability to accommodate the additional loads transmitted from the associated mounting systems. Where wind turbines are pole mounted to or through fabric, the rotational effects creating by pole mounted equipment should also be considered.

Any battery storage placements on or within the roof structure or associated voids should also be considered within any structural assessment.

Weather resistance
Where equipment is attached or mounted to the building fabric, it must be provided with detailing that does not allow rainwater to enter the building fabric via structural connections, cabling or pipework penetrations. All detailing must be weather tight and should not solely rely on the use of sealants.

Biomass systems

Biomass systems burn natural materials such as wood pellets, chips or logs to provide space heating and power to hot water services.

Equipment certification
On request, manufacturers of equipment shall be able to produce evidence of the operation of a documented quality control system that has been assessed and meets with the requirements of the Microgeneration Certification Scheme (MCS).

Assessment specific to equipment should be aligned with the relevant Microgeneration Certification Scheme:

- MCS 008 - MCS Product Certification Scheme Requirements: Biomass.

Design, installation and commissioning
All work carried out shall be executed in accordance with the relevant guidance:

- MIS 3004 – Requirements for Contractors undertaking the supply, design, installation, set to work, commissioning and handover of Biofuel Heating Systems.
- MCS Guidance Document – Percussive Events Guidance.
- And, provide evidence that the system will meet a level of performance required by the relevant Building Regulations.

Impact on the building structure
Structural assessment must be provided for the additional loads and any foundation requirements for the installation of heavy plant related to biomass equipment. For further guidance, please refer to the 'Foundations' section.

Weather resistance
Where equipment passes through building fabric, it must be provided with appropriate seals and weathering detailing that does not allow rainwater to enter the building fabric or act in a manner that is detrimental to the structural or weatherproofing of that element of fabric. Detailing should not solely rely on the use of sealants.

Relevant standards

- BS EN 12975-1 'Thermal solar systems and components. Solar collectors'.
- BS EN 12976-1 'Thermal solar systems and components. Factory made systems'.
- BS EN 61215 'Terrestrial photovoltaic (PV) modules - design qualification and type approval'.
- BS EN 14511 Parts 1-4 'Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling'.
- BS EN 61400-1'Wind turbines'.
- BS EN 61400-2'Wind turbines. Small wind turbines'.
- BS EN 14785 'Residential space heating appliances fired by wood pellets'.
- BS EN 12809 'Residential independent boilers fired by solid fuel'.
- BS EN 303-5 'Heating boilers for solid fuels, hand and automatically fired, nominal heat output of up to 300kW. Terminology, requirements, testing and marking'.

Microgeneration Certification Scheme (MCS)

All references to any Microgeneration Certification Scheme (MCS), and any associated guidance and/or literature produced by the MCS, is considered correct at the time of publishing.

As low and zero carbon technologies are a developing area of construction, users are advised to access and use the most up-to-date versions of this guidance when undertaking design, specification, installation and commissioning of any such systems. Please visit the Microgeneration Certification Scheme (MCS) website for further information.

It should also be noted that any other certification schemes or regulation bodies that are introduced in the future, and in addition to the Microgeneration Certification Scheme (MCS) may be acceptable for Warranty, but only when subject to agreement with the Warranty Provider or we introduce supplementary information.

16. Ventilation and Extraction

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. The occurrence of high indoor temperatures, and the measures to mitigate or control, are a health and welfare matter that is outside the scope of our Warranty that will need agreement with your Building Control provider.
4. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. A commissioning certificate is required for any work completed by an approved installer.
2. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

Design

1. Ventilation services shall be designed, constructed and installed so that they:
    a. Provide sufficient indoor air quality;
    b. Do not adversely affect the structural stability of the building;
    c. Are constructed using non-hazardous materials;
    d. Are durable and robust;
    e. Are safe and convenient in use;
    f. Are insulated to prevent unintended heat losses;
    g. Are capable of being adequately controlled.

16. Ventilation and Extraction

16.1 General Requirements

Provision of Information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site.

This should include a detailed ventilation strategy defining the approach being taken, which may include, but not be limited to:

1. Fully detailed ventilation drawings, schedules and specification for the proposed system that indicate type, location and associated flow rates for all contributing elements/devices.

Prior to commencement, the Warranty Surveyor at their discretion, may also request additional supporting information that demonstrates suitability for use of any materials or systems contained within the above.

At completion, the installing contractor will be required to provide a copy of the commissioning certificate for each element of mechanical ventilation/extraction for inclusion into the home owner's information pack, which should include the flow rate confirmation as per the designed strategy at point of completion.

Ventilation strategy

The arrangement of natural ventilation and mechanical ventilation, should be designed to facilitate the exchange of air at defined rates to and from the spaces contained within a building.

The ventilation strategy may rely on a combination of natural ventilation, mechanical ventilation and purge ventilation.

Natural ventilation provision
Natural ventilation relates to air change occurring through formed openings whose operation is not reliant on mechanically driven elements (e.g. doors, windows and manually operated trickle vents) that function without the use of mechanically driven elements.

Mechanical ventilation provision
This is purpose provided ventilation which is designed into the building to provide a quantifiable and controlled rate of ventilation e.g. mechanical background ventilators, intermittent extract fans, and continuous supply/recovery of air through mechanical systems (MEV and MVHR).

Purge ventilation provision
Purge ventilation relates to ventilation that provides a rapid delivery of fresh air to a space.

Natural ventilation systems

Where doors, windows and manually operated trickle vents are provided, they must be controllable and located to avoid undue draughts. They must also be designed to prevent moisture ingress from rainfall / snow.

They should be sized and operable in accordance with the relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

Mechanical ventilation systems

Where the designed ventilation strategy requires the inclusion of purpose provided ventilation, each element should be compliant with the respective part of relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

Mechanical background ventilators
Where mechanical background ventilators are provided, e.g. Humidistats etc., they must be controllable and located to avoid undue draughts. They should be adequately protected against adverse weather and moisture ingress.

Intermittent and continuous extract fan units
Intermittently operated and continuously operated extract fans provide extract ventilation to remove odours and excessive humidity. Where the designed ventilation strategy requires the inclusion of mechanical extraction, it should be provided at rates compliant with the relevant Building Regulations and the rates of ventilation should be consistent with the statutory guidance e.g. Approved Documents.

Continuous mechanical extract (MEV) systems and Continuous mechanical supply and extract systems with heat recovery (MVHR)
Where the designed ventilation strategy such a system, it should be designed and installed to be compliant with the relevant Building Regulations and the statutory guidance e.g. Approved Documents.

The system should be designed as a complete package, the performance of all materials and components should be considered to ensure compatibility and performance of the system.

The system should:

- Be designed to ensure that a satisfactory level of performance is achieved and in accordance with statutory guidance e.g. Approved Documents.
- Ensure even distribution of airflow taking account airflow resistance, including the bends and fittings.
- Have adequate fan capacity accounting for airflow resistance of the system.
- Airflow resistance should be calculated in accordance with BS EN 13141-2 and manufacturer's data.
- Have ductwork that is as direct as possible.
- Be installed in accordance with the design and manufacturers recommendations.

Mechanical extraction rates

Room	Intermittent extract	Continuous extract
Kitchen	30 l/s adjacent to hob or 60l/s elsewhere	13 l/s
Utility	30 l/s	8 l/s
Bath/shower room/*Designated Drying Area	15 l/s	8 l/s
Sanitary accommodation	6 l/s	6 l/s

Note: *Applicable only in Scotland

Purge ventilation

Purge ventilation should be provided in accordance with the relevant Building Regulations. Purge ventilation provision is required in each habitable room and should be capable of extracting a minimum of four air changes per hour (ach) per room directly to outside.

Allowance for air movement

Ventilation strategies that rely upon air transfer throughout the dwelling, may require an undercut to internal doors. Typically this is required to be of minimum area 7600mm² in all internal doors above the floor finish which is equivalent to an undercut of 10mm for a standard 760mm width door. In such instances, the air transfer provision must be unrestricted after floor finishes have been laid (e.g. carpets should not encroach).

Note: Where fire doors are installed, reference must be made to the fire door certification for the size of allowable gaps.

Background ventilators

Where manually operated trickle vents are installed in windows and doors, they must be correctly specified for the location and should be installed so as not cause potential damage to render finishes or restrict the ability to open the window/door. Windows with operating mechanisms that can be set in 'night vent' positions are not accepted as meeting this requirement.

Where background ventilation is provided, whether it is manually operated or mechanically delivered, it must be controllable and located to avoid undue draughts. It should be adequately protected against adverse weather and moisture ingress.

Fan units and associated plant/kit

Any fan units and/or associated plant/kit (e.g. extraction fan units, MEV/MVHR units) should be adequately fixed to a part of the building that can support the load and does not give rise to acoustic transfer as a result of their attachment and operation.

All elements should be fixed in accordance with the design and manufacturer's recommendations.

Controls

- Any manual boost controls should be provided locally to the areas being served.
- In kitchens, any automatic controls must provide sufficient flow during cooking with fossil fuels (e.g. gas) to avoid build-up of combustion products.
- Ensure the system always provides the design ventilation rates.

Access and operation

MEV systems must be installed so that:

- The fan units and controls are easily accessible.
- Identify maintenance and servicing requirements.
- Ducts and air valves should have either fitted filters or be accessible for cleaning.

Ductwork – interfacing with building fabric

The route of ductwork should take account of other building elements and where it passes through structural elements, it should not adversely affect the structural performance of the building. Where alterations to structural elements are required, this should only be carried out in accordance with the manufacturer's recommendations, or be designed by an Engineer.

Floor joists should not be excessively notched or drilled to accommodate ductwork. Further information can be found in the 'Upper Floors' section.

Detailing should allow for thermal expansion and contraction to avoid damage and noise from ductwork movement. This may result in sleeved approaches through structural elements to prevent damage and the avoidance of solidly embedding ducts with mortar.

The route of ductwork should not adversely affect the fire performance of the building fabric. Fire performance should be in accordance with Building Regulations and in accordance with the guidance of the relevant statutory guidance e.g. Approved Documents.

Issues that should be taken into account include:

- Passage through compartmentation and/or protected routes.
- The integrity of walls and floors.
- Additional requirements for flats and apartments with a floor above 4.5m.
- Impact of outlets and ducting on the building fabrics fire performance.
- The use of dampers and fire stopping to mitigate the risks.

Where proprietary fire stopping systems are used around services that penetrate fire-resisting floors, walls or partitions, they should be installed using the manufacturer's recommendations.

Further information can be found in the 'Upper Floors' and 'Internal Walls' guidance.

Ductwork installation – layout, runs and junctions

Ductwork systems should be designed by a specialist, and be installed in accordance with the manufacturer's guidance. The route of ductwork should not hinder the free flow of air or achievement of the required ventilation rates.

It is recommended that rigid ducts are used as far as practicable, and bends should generally be formed with proprietary rigid components.

Flexible ducting should only be used for final connections. Where utilised, installed ductwork lengths and sizing must be strictly in accordance with the design to avoid any loss or reduction in the designed ventilation rates. Installation should be straight and fully supported, without undulation or restrictions as result of compression or constriction.

Where flexible duct is used to form bends on an extract system, they should be restricted to a maximum of:

- Two for systems up to 30 l/s.
- One for extract rates higher than 30 l/s.

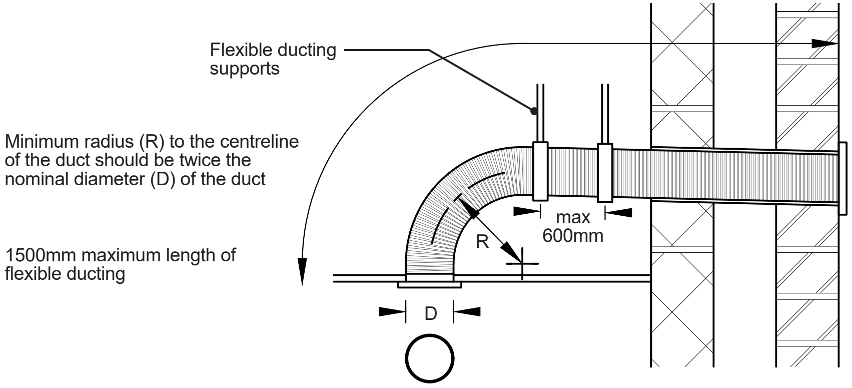
Ductwork should be securely fixed, and have adequate support throughout its length, with clips and supports for spaced at equal distances and in accordance with the ductwork manufacturer's recommendations.

All joints and connections should be mechanically fixed and sealed in accordance with ductwork manufacturer's guidance.

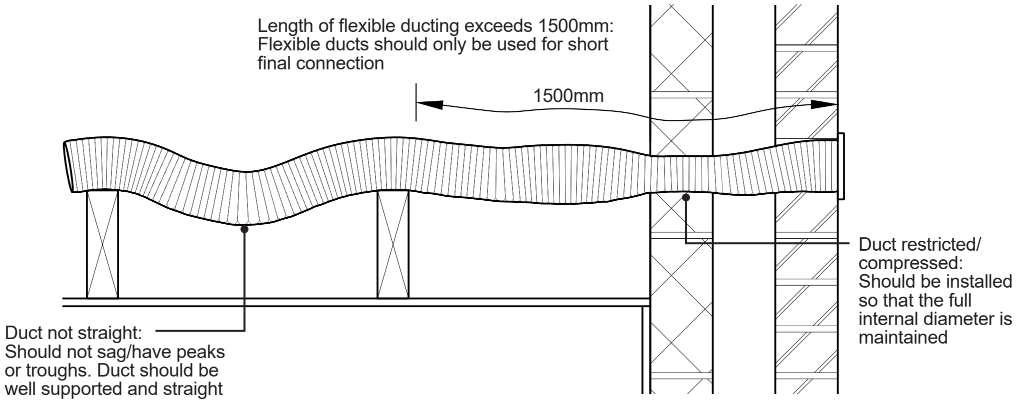
Ductwork should not be in direct contact with other surfaces, such as plasterboard ceilings, that may transfer noise to the home.

Where ductwork passes through an external wall, it should be positioned to slope slightly outwards to prevent water entering the building.

Correct duct installation



Incorrect duct installation



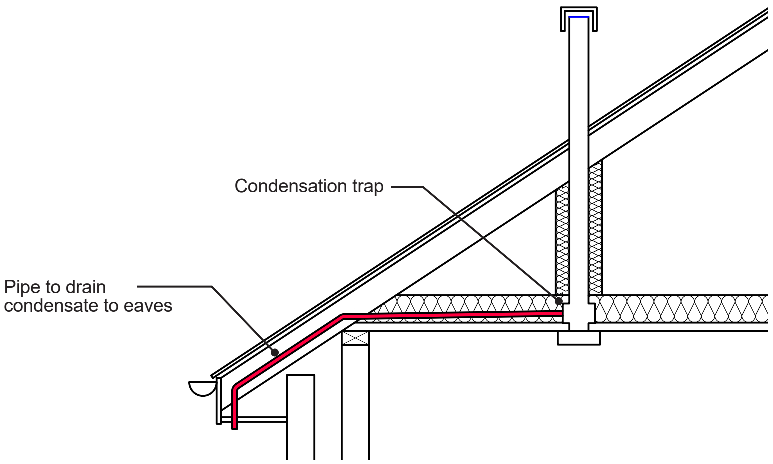
Ductwork - control of condensation

Where ductwork from extractor fans goes through unheated spaces such as roof voids, action should be taken to minimise the chance of condensation forming in the ducting and any consequential damage caused to finishes and the fan unit. To achieve this, ductwork should:

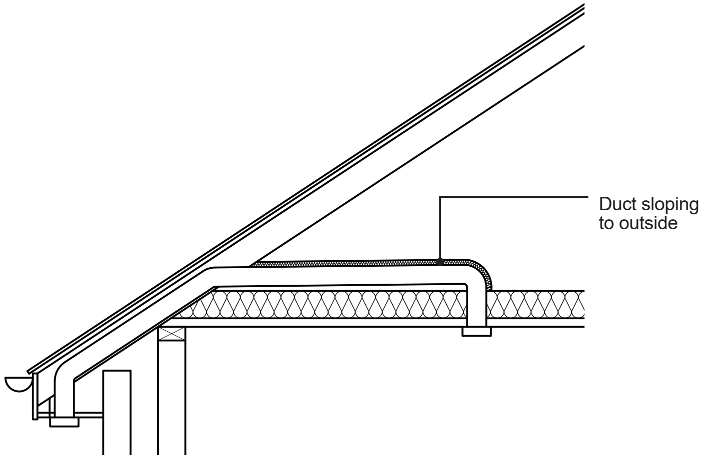
- Discharge to the outside air.
- Provide continuous insulation to the outside of the ductwork.
- Be laid to fall away from the fan.

The insulation type, thickness and thermal resistance should be included and documented within the any ventilation strategy and supporting designs. Alternatively, the ductwork can be fitted with a condensate trap that discharges to the outside or installing the duct to slope to the outside.

Insulating a vertical extract duct



Insulating a horizontal extract duct



Ductwork – termination to outside air

Ventilation systems should terminate freely to open air and terminals should not adversely affect the performance of the ventilation system by restriction or resistance of air flow.

Airflow resistance data for terminals should be supplied by the manufacturer via testing in accordance with BS EN 13141-2. Where terminals are located on external walls or pass through a roof structure, these should be adequately protected against adverse weather and moisture ingress.

Where used, extracted air must discharge directly to outside air and not terminate in a manner that may allow a return of the extracted air to an internal space e.g. extraction grilles in roof soffits directly above an opening window or within 500mm of a trickle vent.

Outlets should not discharge into courtyards, enclosures or architectural screens, and should be downwind of intakes where there is a prevailing wind direction.

Location of air inlets and exhausts

The location of MVHR inlets must be sited away from nearby pollution sources such as boiler flues, chimneys, ventilation extracts, SVPs etc. An MVHR specialist must provide a design proposal for the specific location to confirm the system will function correctly.

Addition provisions for timber frame

In addition to general provisions for the installation of ductwork, the following are of particular note where they interact with external wall in timber frame construction:

- The routing and termination of ductwork should not affect the fire resistance of the structure.
- Penetrations through the Air and Vapour Control Layers should be tight fitting to reduce air leakage and the passage of moisture vapour.
- Adequate allowance for differential movement to occur where the duct passes through any external leaf e.g. masonry.
- Ducts that pass through the external wall cavity and provide an opening should be enclosed with a cavity barrier and protected with a cavity tray.

Further information can be found in 'External Walls – Timber Frame'.

Commissioning

Air flow rates for all fans should be measured and recorded as part of the commissioning procedure.

The measured rates should be as per the design intention. Where the rates are lower than those designed, an adjustment should be made to correct the system and all air flows should then be re-tested.

At completion, the installing contractor will be required to provide a copy of the commissioning certificate for each element of mechanical ventilation/extraction for inclusion into the home owner's information pack, which should include the flow rate confirmation as per the designed strategy at point of completion.

17. Electrical Services

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. A commissioning certificate is required for any work completed by an approved installer.
2. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

Design

1. Electrical services shall be designed, constructed and installed so that they:
    a. Provide evidence to demonstrate the installation meets Building Regulations;
    b. Do not adversely affect the structural stability of the building;
    c. Prevent the entry of hazardous ground substances, external moisture or vermin;
    d. Are constructed using non-hazardous materials;
    e. Are durable and robust;
    f. Are safe and convenient in use.

17. Electrical Services

17.1
Mains

Provision of information

Design
A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

1. Schematic layout drawing identifying locations of all elements relating to the electrical system e.g. outlets, switches, distribution boards, and any associated equipment.
2. The location and type of ancillary components that are connected to the electrical system e.g. those used for fire safety, power points to ventilation systems and associated controls.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Installation
The installing contractor will be required to demonstrate, in a clearly understandable format, that the installation provides an adequate level of performance. As a means to demonstrate this, the installing contractor must:

1. Be registered with a Competent Person Scheme to prove and demonstrate that their work complies with the relevant Building Regulations.
2. Issue testing and commissioning certification for each installation at completion.

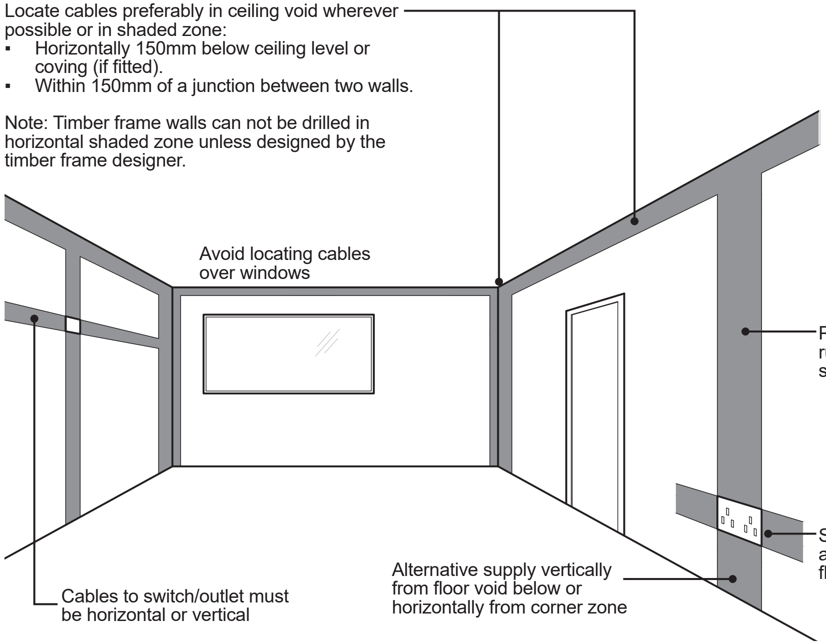
General provisions for installation

- All electrical installations should be in accordance with the relevant Building Regulations and BS 7671.
- A suitable electrical service of the appropriate size for normal domestic use shall be provided.
- PVC-covered cables should not be in contact with polystyrene insulation.
- Electrical cables should not be diagonal, and their locations should be in accordance with the image below and current relevant Building Regulations.
- Cables routed within the shaded zones must be in accordance with BS 7671 (see detail below).

Safety zones for electrical cables in walls

Locate cables preferably in ceiling void wherever possible or in shaded zone:
- Horizontally 150mm below ceiling level or coving (if fitted).
- Within 150mm of a junction between two walls.

Note: Timber frame walls can not be drilled in horizontal shaded zone unless designed by the timber frame designer.



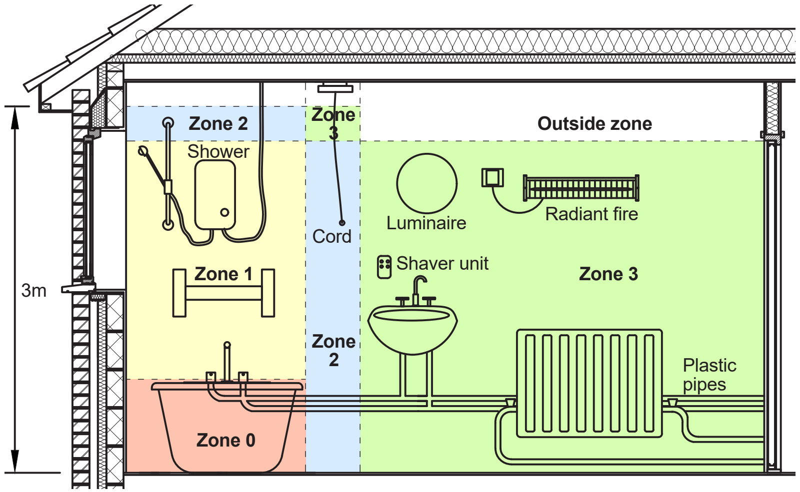
Supplementary earth bonding

For domestic situations, supplementary bonding is required in areas of increased risk, which are rooms containing a bath or shower. It is not required within kitchens, utility rooms or washrooms.

Supplementary bonding is not required to the pipes or metal fittings attached where plastic pipes are used within a bathroom or shower room. This also applies where short lengths of metal pipes connected to bathroom fittings are attached to plastic pipes.

Supplementary bonding is still required to electrical equipment such as electric showers or electric heaters. This type of bonding must also be connected to the protective conductor of all circuits supplying electrical equipment in the bathroom.

Supplementary bonding in a bathroom - plastic water supply pipe installation

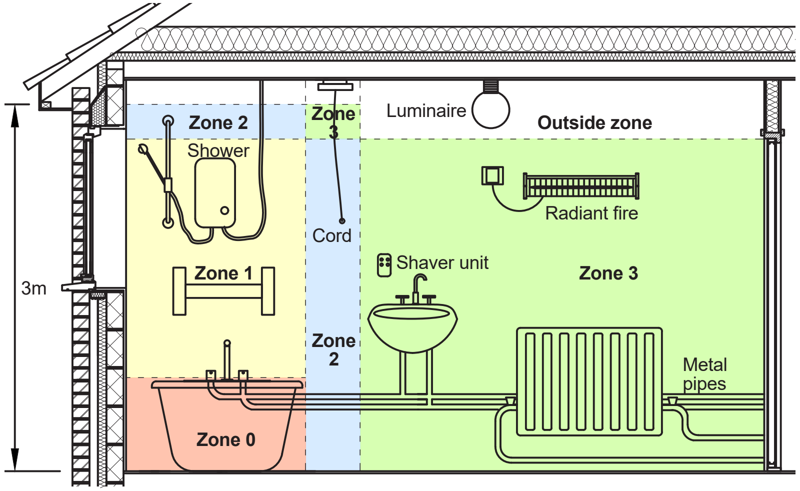


The protective conductors of all power and lighting points within the zones must be supplementary bonded. The bonding connection may be to an earth terminal of a switch or accessory supplying equipment.

Circuit protective conductors may be used as supplementary bonding conductors.

Supplementary bonding of short lengths of copper pipe installed where the pipes are visible is not necessary.

Supplementary bonding in a bathroom - metal water supply pipes



The protective conductors of all power and metal lighting points within the zones must be supplementary bonded to all conductive parts in the zones including metal waste, water and central heating pipes, metal baths, and shower basins.

Circuit protective conductors may be used as supplementary bonding conductors.

Metal baths not connected to a metal building structure do not require supplementary bonding if all metal pipes connected to them have been bonded.

Connection to pipes to be made with BS 951 clamps (complete with "Safety Electrical Connection" label).

Socket outlets

Socket outlets are to be conveniently positioned in close proximity to the TV aerial and telephone outlets, thus allowing for electrical equipment including TVs etc. Rooms should be provided with the following 13a outlets:

Room	Number of 13A Outlets	Comments
Kitchen/Utility	8	▪ Where separate kitchen and utilities are provided, each room should have at least 4 outlets. ▪ Where appliances are provided, three outlets should be available for general use.
Dining room	4	
Living/family room	8	Two outlets should be near the TV aerial outlet.
Main bedroom	6	
Other bedrooms	4	
Landing	2	
Hall	2	

Note: the above refers to individual socket outlets e.g. a double socket would count as 2 outlets.

Where open plan or mixed used spaces are provided, allowances applicable to each space in the above table should be combined and applied across the mixed use area. For example, a mixed use area incorporating living and dining areas would require 12 outlets in total. 4 outlets serving the dining room and 8 serving the living room, with at least 2 outlets being provided near to TV aerial outlets.

Cooking

Cooking appliances provided to the cooker space in a dwelling must be suitably switched and terminated with a minimum 30a electricity supply.

If a cooker panel is provided, it needs to be positioned to the side of the cooker space. A 13a socket outlet should be positioned at the cooker space where a gas supply is provided to the dwelling.

Co-axial cable

A concealed co-axial cable should be provided from the roof void to a terminal outlet within the main living room. Where the co-axial cable is not provided, a conduit and draw wire, or an alternative, should be provided. The provision of an aerial is not required.

Gas appliance

Where a gas appliance requires an electrical supply, a suitably fixed spur or socket outlet should be provided.

Light fittings

At least one fixed lighting outlet should be provided to all rooms. Areas greater than 25m² are to be provided with two fixed lighting outlets.

Halls, landings and staircases are to be provided with lighting outlets and two-way switches.

Down lighters and other flush-fitting attachments should not be installed through a ceiling if the ceiling is providing part of the required acoustic insulation or fire resistance to the property.

If down lighters are provided to ceilings below roof voids (excluding thatched roofs), precautions are to be taken to ensure that no fire risk is caused by the proximity of other materials.

Passive infrared (PIR) sensors are to be used in common and external areas.

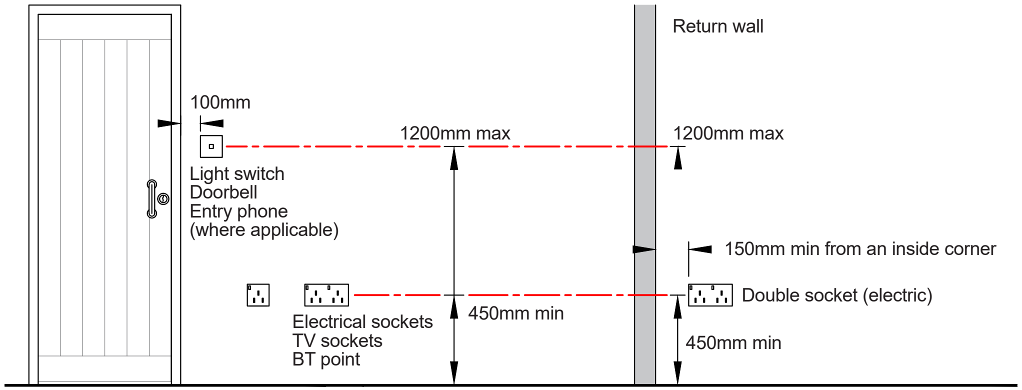
Positioning of sockets and switches

Sockets and switches should be positioned in accordance with the details on this page and the relevant Building Regulations.

For clarity, the maximum and minimum height dimensions illustrated are measured to their centre line from finished floor level. Consumer units should be mounted so that the switches are between 1350mm and 1450mm above finished floor level.

Distances from inside corners are shown as a minimum requirement for Warranty. It should be noted that an increased distance may need to be provided to comply with development specific requirements for access and use of the building to comply with relevant Building Regulations.

Heights of wiring accessories and setting out sockets in proximity to internal walls



Notching and drilling

Floor joists should not be excessively notched or drilled. Please refer to the 'Upper Floors' section for further guidance.

Concealed services

If the services are hidden in walls or floors, they need to be positioned so that any significant cracking of the surface cannot occur.

Services in framed walls

In addition to general provisions for the installation of services, the following are of particular note for timber frame construction external walls:

- The routing and termination of services should not affect the fire resistance of the structure.
- Electrical services are to be rated for their location with consideration for insulation.
- Service penetrations through the VCL should be tight fitting to reduce air leakage and the passage of moisture vapour.
- Avoid running electrical services in the external wall cavity, except for meter tails.
- Services should be protected with metal plates if they pass within 25mm from face of stud.
- Adequate allowance for differential movement to occur without causing damage should be provided for rigid services rising vertically through a building.
- Services that pass through the external wall cavity and provide an opening (such as meter boxes) should be enclosed with a cavity barrier and protected with a cavity tray.

Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

Chasing of masonry cavity walls

If chases in walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

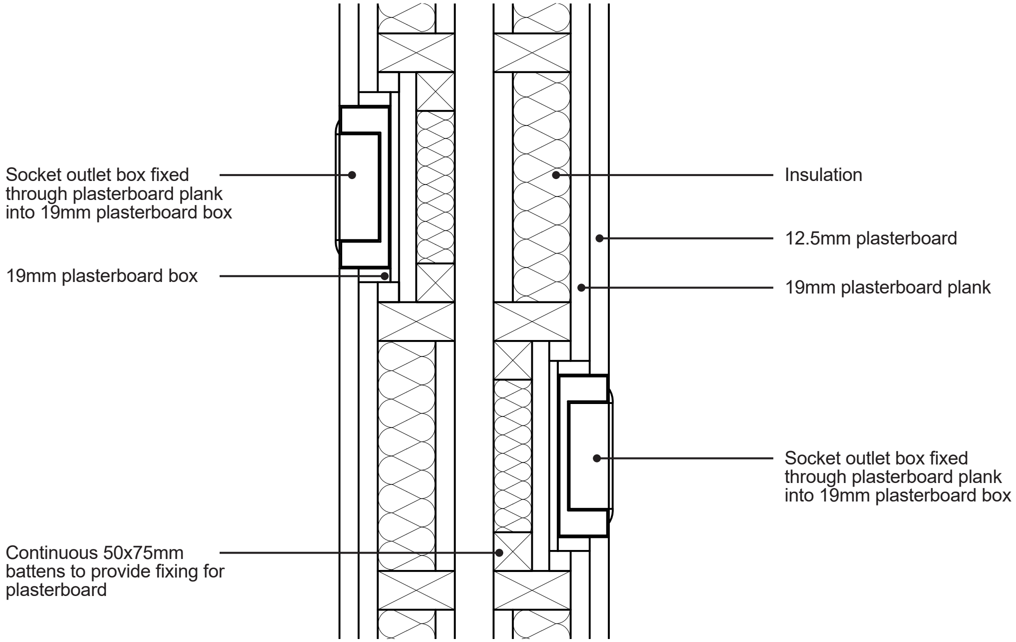
Fire stopping

Fire stopping is required around services that penetrate fire-resisting floors, walls or partitions.

If proprietary systems are used, they should be installed using the manufacturer's recommendations.

Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

Staggered services on party walls (section plan view)



Please note: The installation services within a party wall should not compromise the sound or fire resistance.

18. Cold Water Supply

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.

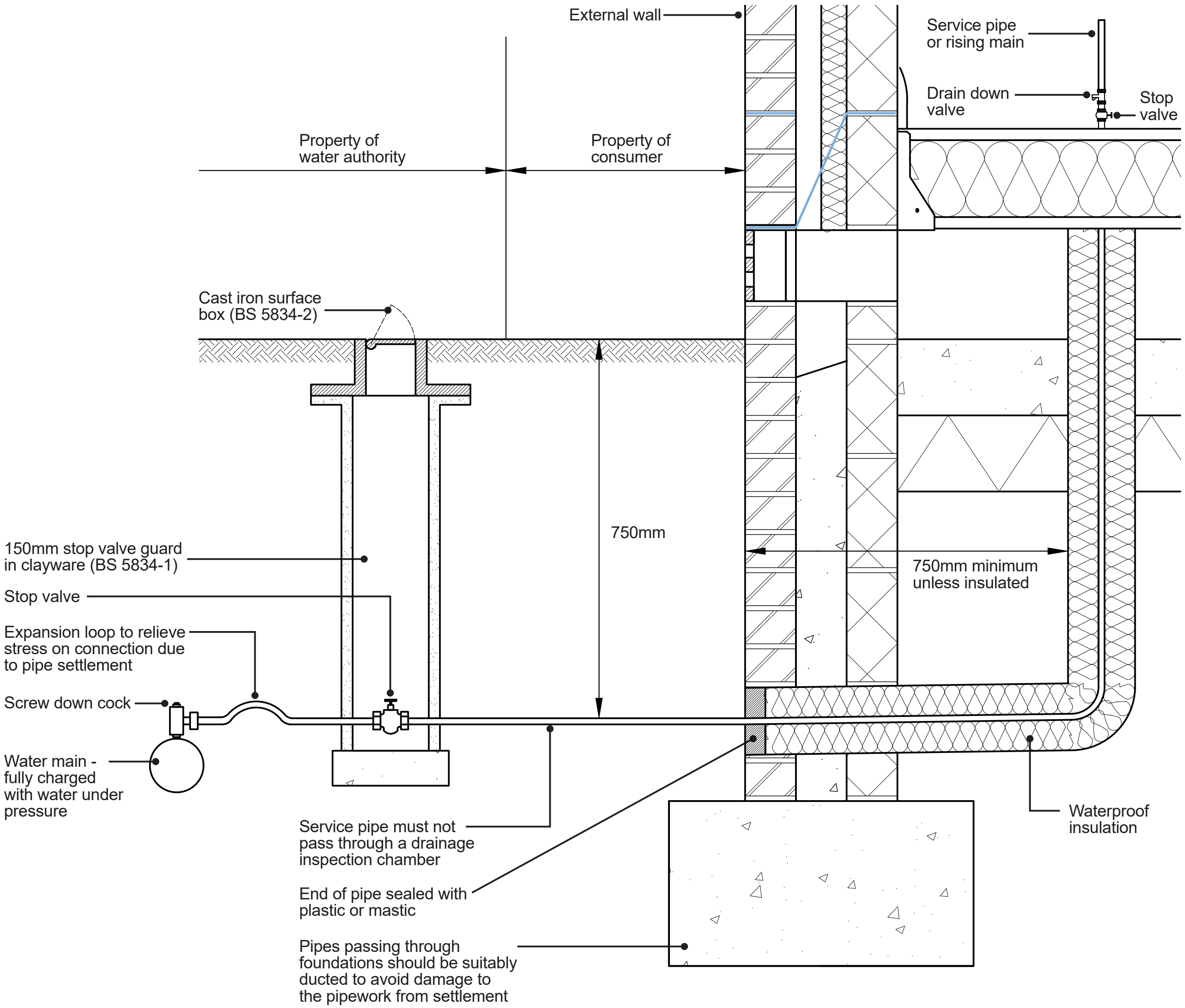
Design

1. Cold water supply to plumbing, boilers and heating appliances shall be designed, constructed and installed so that they:
   a. Provide evidence to demonstrate the installation meets Building Regulations;
   b. Do not adversely affect the structural stability of the building;
   c. Prevent the entry of hazardous ground substances, external moisture or vermin;
   d. Are constructed using non-hazardous materials;
   e. Are durable and robust;
   f. Are safe and convenient in use.
2. An adequate cold water service shall be provided which is:
   a. Suitable for normal domestic purposes;
   b. Protected against frost.

18. Cold Water Supply

18.1 Cold Water Supply to Plumbing, Boilers, and Appliances

Installation of incoming water services



Cold water services

Each building should have an adequate supply of cold water. The water supply should be fed from below ground and insulated to prevent freezing.

Cold water systems may have provision for storage or be directly connected to the main supply. Drinking water needs to be supplied directly from the main supply.

Cold water pipes and storage cisterns located in roof spaces and other unheated areas should be appropriately insulated to the relevant standards.

Cold water storage cisterns will require the capacity specified in the design. Suitable support should be given for the cistern filled with water.

To stop the cistern bottom being deformed, permanent support is to be given where necessary. Adequate materials for support platforms are:

- Softwood boarding.
- Marine plywood.
- Chipboard type P5.
- Oriented Strand Board type OSB3 to British Standards.

All water tanks should be accessible. Gangway boarding is required to each cistern opening from the roof space access. An area of 1m² of boarding is to be provided next to cisterns to permit routine maintenance.

Water storage cisterns should be protected from contamination by a rigid, close-fitting cover (which is not air tight) that excludes light and insects.

Holes should be formed with a cutter in the positions shown in the design.

Overflows in warning pipes should be no less than 19mm diameter and situated 25mm from the shut off water level in the cistern. The pipe may dip below the water level in accordance with water regulations. Alternatively, the pipe should terminate vertically downwards, or a tee should be fitted horizontally at the discharge end.

Draining down facility

Cold water installations require the capability to be drained down.

Use of materials

Materials that are safe and minimise the risk of corrosion are to be used for pipes and fittings for water services. The recommendations of the water supplier with regard to materials and fittings should be followed.

It may be necessary to fit aluminium protector rods in areas where the corrosion of copper cylinders occurs. These are to be fitted during manufacture, in accordance with the relevant British Standards.

Installation of building services

All items should be installed to ensure satisfactory operation.

Items to be taken into account include:

- Locations and fittings of pipes and cable service entries through the substructure.
- Services must be sleeved or ducted through structural elements (and not solidly embedded) to prevent damage. Fire stopping may also be required. Services should not to be located in the cavity of an external wall, except for electricity meter tails.
- Only to be buried in screeds where permitted by relevant Codes of Practice.

Where copper pipes are permitted in floor screeds, they should be:

- Sleeved or wrapped so that they can move freely along the length and at joints and bends.
- Jointed with capillary joints.

A metallic tape should be applied to the pipework where plastic pipework is hidden within or behind wall surfaces, which would otherwise not be located by a metal detector.

Jointing of pipes and fittings

Proprietary joints should be made strictly in accordance with the manufacturer's instructions.

Only fluxes recommended by the pipe manufacturer should be used, and all traces should be removed immediately after jointing. Fluxes containing lead are not acceptable.

Suitable clips or brackets are to be used to secure pipes. Fixings should be installed adequately and spaced to stop sagging but not restrict thermal movement. Where needed, pipes should have adequate falls.

Sufficient room should be allowed for thermal expansion and contraction to avoid damage and noise from pipe movement.

Notches and drillings

Floor joists should not be excessively notched or drilled. Please refer to the 'Upper Floors' section for further guidance.

Taps

Cold taps should be located to the right of the hot water tap.

Concealed services

If the services are hidden in walls or floors, they need to be positioned so that any significant cracking of the surface cannot occur.

Chasing of masonry cavity walls

If chases in masonry walls are necessary, their depth should not exceed:

- One-sixth the thickness of the single leaf for horizontal chases.
- One-third the thickness for vertical chases.

Hollow blocks should not be chased unless specifically permitted by the manufacturer.

Please refer to the 'Internal Walls' section for further guidance.

Services within or beneath floors

Protection through wrapping or ducting is necessary when pipes are situated under floor screeds. Thermal expansion allowances are to be made, especially at changes of direction.

The insulating material around the pipework needs to be a minimum of 25mm in thickness. The screed thickness should still be at least 25mm where pipes cross over.

Fire stopping

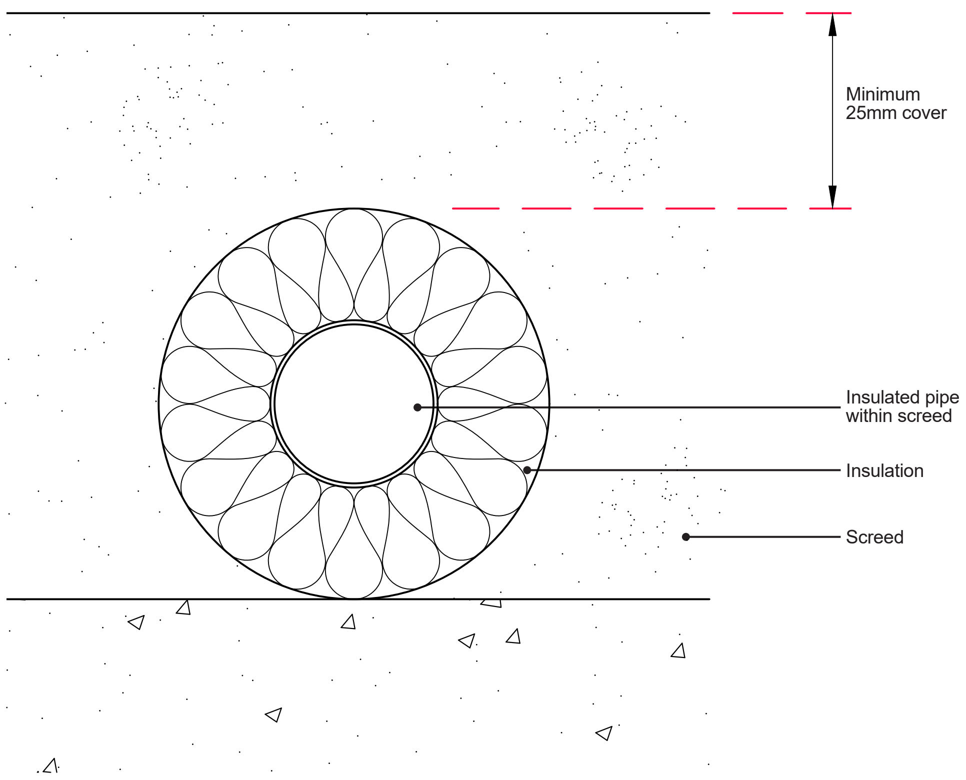
Fire stopping is required around services that penetrate fire-resisting floors, walls or partitions. If proprietary systems are used, they should be installed using the manufacturer's recommendations.

Please refer to the 'Internal Walls' and 'Upper Floors' sections for further guidance.

Supplementary bonding

Where required the pipework should be fitted with supplementary earth bonding.

Positioning of pipes in screeds



19. Garages

Contents

Limitations of Functional Requirements

1. These Functional Requirements are limited to non-habitable buildings constructed as detached or semi-detached / integral garages only.
2. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
3. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window / door or ‘decorative external cladding’ (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
7. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
8. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. Garages should be constructed to resist lateral and vertical loads adequately.
2. Foundations should be designed and constructed to suit local ground conditions and adequately support the weight of the structure and imposed loads.
3. Specialist works must be provided and supported by structural calculations completed by an Engineer where necessary.
4. Garages shall be designed and constructed so that they:
    a. Are structurally sound and do not impair the stability of adjacent structures;
    b. Have adequate provision for drainage of roof water.
5. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
6. Structural elements outside the parameters of Building Regulations must be supported by structural calculations provided by an Engineer.
7. Damp proofing works should prevent any external moisture passing into the internal environment of the habitable building.
8. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.
9. A floor between the dwelling area and an integral garage shall be designed and constructed so that they:
    a. Have adequate resistance to the spread of fire between garage, and dwelling area;
    b. Prevent undue heat losses from the dwelling area to unheated garage.

19.
Garages

19.1
Garages

Limitations

This section does not apply to a garage that:

- Is heated.
- Is used as a habitable space.
- Requires the walls to resist wind-driven rain.
- Is intended to have decorative finishes e.g. floor coverings or plastered walls.

Provision of information

A full set of design drawings and specifications shall be made available to the Warranty Provider and all other interested parties prior to the associated works starting on site. This may include:

- Evidence to show garages are:
  - Able to sustain and transmit all normal loads to the ground without affecting their own stability or that of the housing unit (or any adjacent buildings) by excessive deflection or deformation that would adversely affect the appearance, value and serviceability of the building or the housing unit.
  - They provide an acceptable and durable external surface and are not adversely affected by harmful or toxic materials in the atmosphere or from the ground.
  - They encourage the rapid discharge of moisture due to rain or snow from their surfaces to suitable gutters and down pipes, or to some other form of collection and discharge that prevents moisture from re-entering the garage, where it might have adverse effects.
  - In the event of fire, they resist fire spread to the housing unit and to adjacent buildings.
  - They are provided with sufficient locks or other devices to resist unauthorised entry.
  - Where additional services installations are installed within the garage but where they serve the main dwelling, (such as central heating boilers or electrical or plumbing installations), these must comply with the relevant additional guidance contained in this Manual.

The Warranty Surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

Services within a garage

Where services or appliances are sited within an uninhabitable garage space:

Water services

- The rising main should not be located within the garage.
- Any Water supply or outlet must have suitable provision for isolating and draining down.
- Pipes must have suitable protection against freezing.

Electricity

- All electric installations should comply with BS 7671.

Risk of fire or explosion

- Installation of boilers and heating appliances should be in accordance with relevant statuary regulations.

Foundations

Foundations should be constructed so that loads are adequately transferred. Please refer to the ‘Foundations’ section for further guidance.

Ground gases

Where the garage is attached / integral to a dwelling and, the Dwelling requires gas prevention measures to be provided, the ground floor and wall structures must be designed and constructed to ensure adequate protection against ground gases emanating from the ground below.

Contaminants should be identified within the Site Investigation Report (please refer to the ‘Ground Conditions’ section for further guidance), and recommendations provided within the site investigation report.

Garage floor

Ground bearing

- Floors should have a minimum concrete thickness of 100mm and bear onto a suitable sub-base.
- The concrete should be float finished (not tamped) and to at least a GEN3 grade, as the garage is not a habitable space some surface imperfections of the floor finish are acceptable.
- The effects of normal drying shrinkage of concrete floors could cause some small gaps around the perimeter at wall junctions.

Suspended beam and block

- Where beam and block floors are to be installed to areas with higher potential point loads such as garages, additional reinforcing of the screed will be required to distribute loads effectively.
- This reinforcing should be of at least an ‘A’ mesh quality, and the screed should be thick enough to give an appropriate depth of cover.

It is recommended that garage floors are laid to falls and where practical, a step be provided where the garage is integral to the house in manner that promotes dispersion of water to a suitable point away from the building. This may be in addition to the requirements of Building Regulations relating to garage floor requirements.

Please refer to the ‘Ground Floors’ section for further guidance.

Walls

As garage accommodation is not habitable, single leaf 100mm walls may be considered acceptable, providing that the following provisions are met:

- The height of wall does not exceed 2400mm from ground level. Where walls are constructed that exceed 2400mm in height e.g. Gable walls, the overall thickness must be increased to at least 190mm thick.
- Intermediate piers are provided. The piers should extend the full height of the wall.
- The piers should be built off a suitable foundation.
- The wall is adequately restrained at ceiling and verge level.
- The walls are capable of adequately transferring the roof loadings to the foundation.
- Walls are pointed both internally and externally.
- Walls should be provided with a suitable DPC located at least 150mm above ground level.
- Proprietary lintels should be provided over window/door openings.

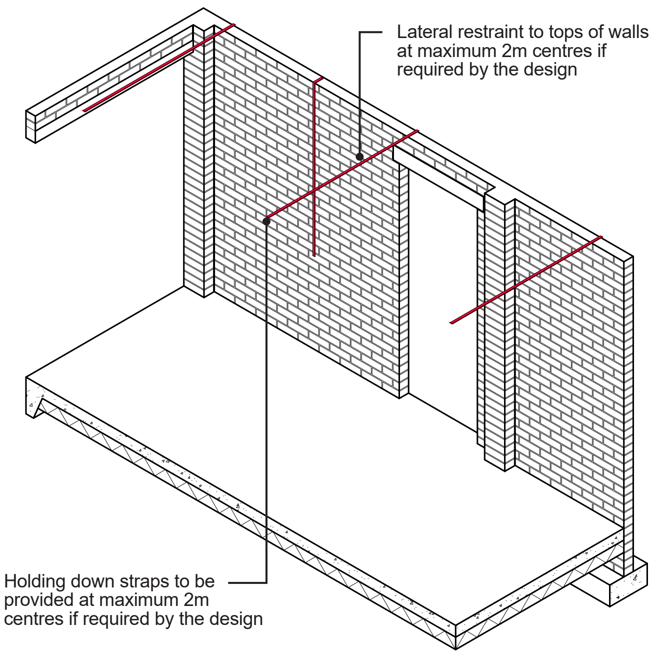
Roofs

Roofs should be weather tight. Flat roofs should have a minimum design fall of 1:40. Tiled roofs should be installed in accordance with the manufacturer’s instructions, including pitch, fixing and lap.

Roof structures should be durable enough to support roof loadings adequately. Timber trusses should be adequately braced and traditional cut roofs should have timber elements that meet relevant Building Regulations and supporting documents.

Please refer to the ‘Roofs’ section for further guidance.

Lateral restraint to 100mm thick walls with piers



GARAGES: Fire separation between garages on a boundary

Walls between garages

Where walls separate garages under two different ownerships or tenancies, the separating wall should be taken up to the underside of the roof and fire stopped.

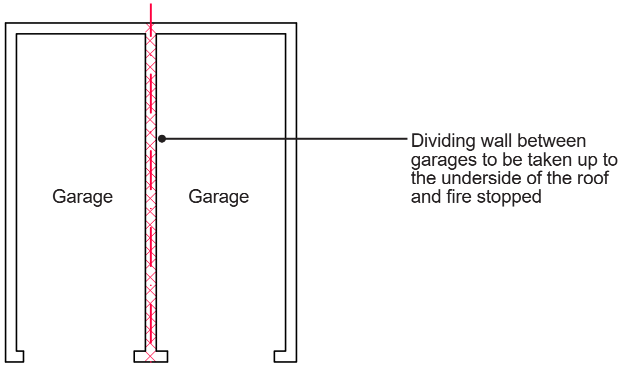
The following guidance is provided for typical examples of multiple ownership situations.

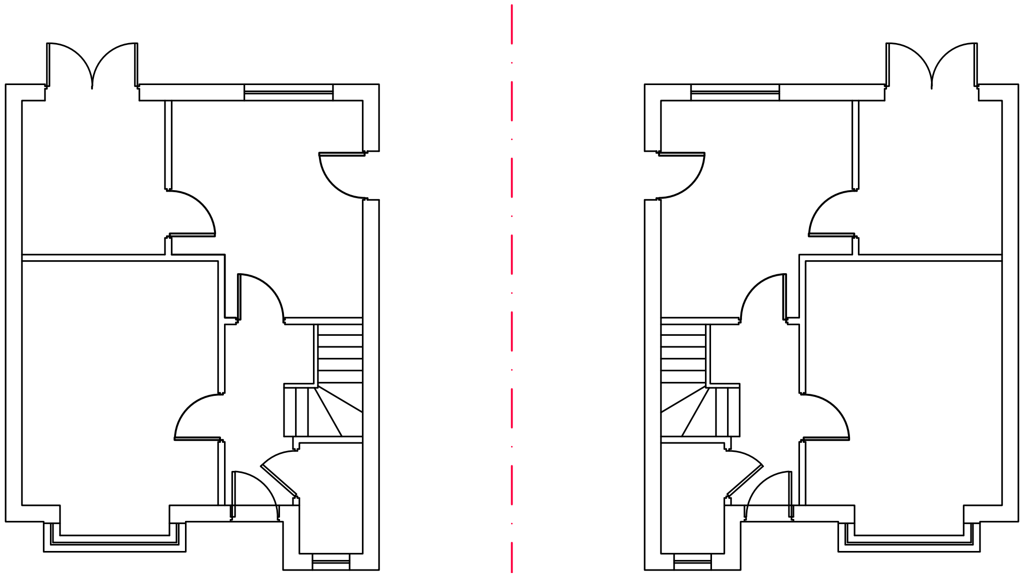
Note: The dividing walls should have the appropriate fire resistance in accordance with the relevant Building Regulations.

Example Plan 1: Linked detached garages

The dividing wall (also boundary) forms a compartment situation between two properties and must be taken up to the underside of the roof covering and fire stopped.

Note: red dashed line can be a site boundary position.

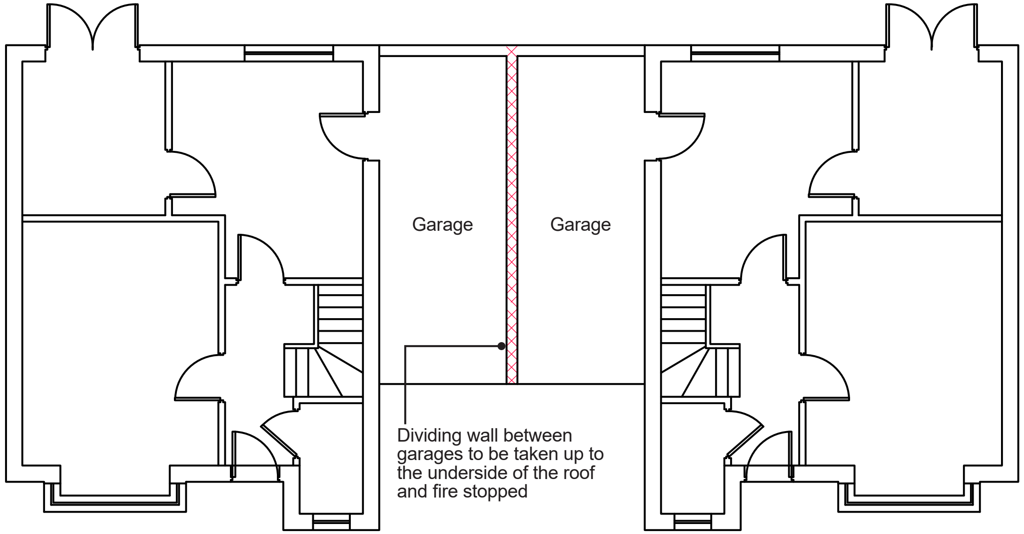




Detached garage away from dwelling

Example 2: Linked to dwelling and linked to another garage across boundary

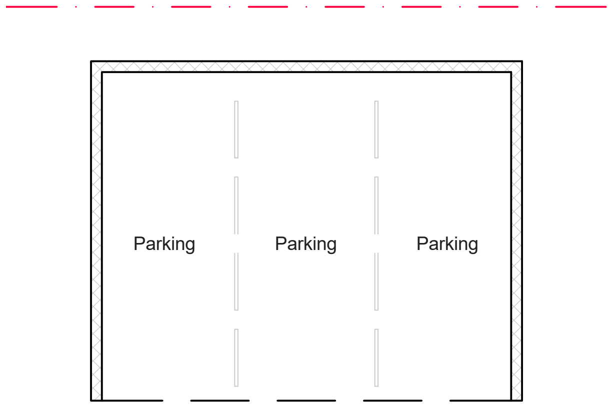
The dividing wall (on the boundary) forms a compartment situation between two properties and must be taken up to the underside of the roof covering and fire stopped.



Garages linking two properties

Example 3: Linked carport (open fronted - no dividing walls)/undercroft car parking area

Note: red dashed line can be a site boundary position.



i.e. Where an allotted car park space is provided and no legal boundary situation exists between bays.

In this situation, where no ownership boundary will exist and just allotted parking bays, no requirements for compartment walls will exist, therefore can remain open.

Linked carport/parking bay

Examples 1, 2 and 3 are for guidance purposes only in all situations compliance with the appropriate relevant Building Regulations should be achieved.

Fire stopping at roof level between party walls

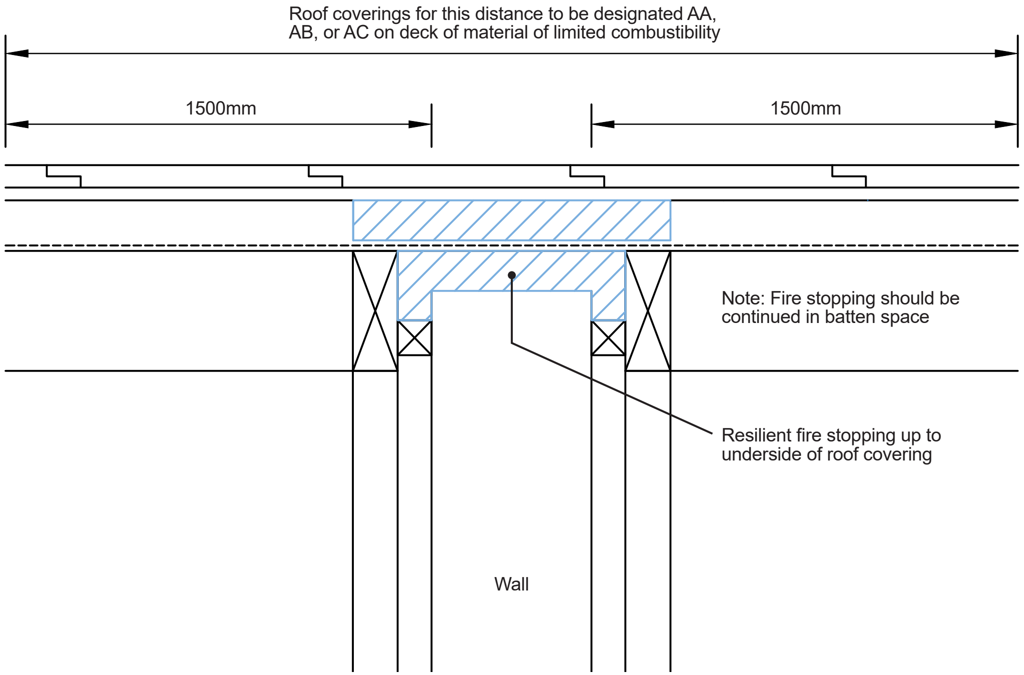
Compartmentation

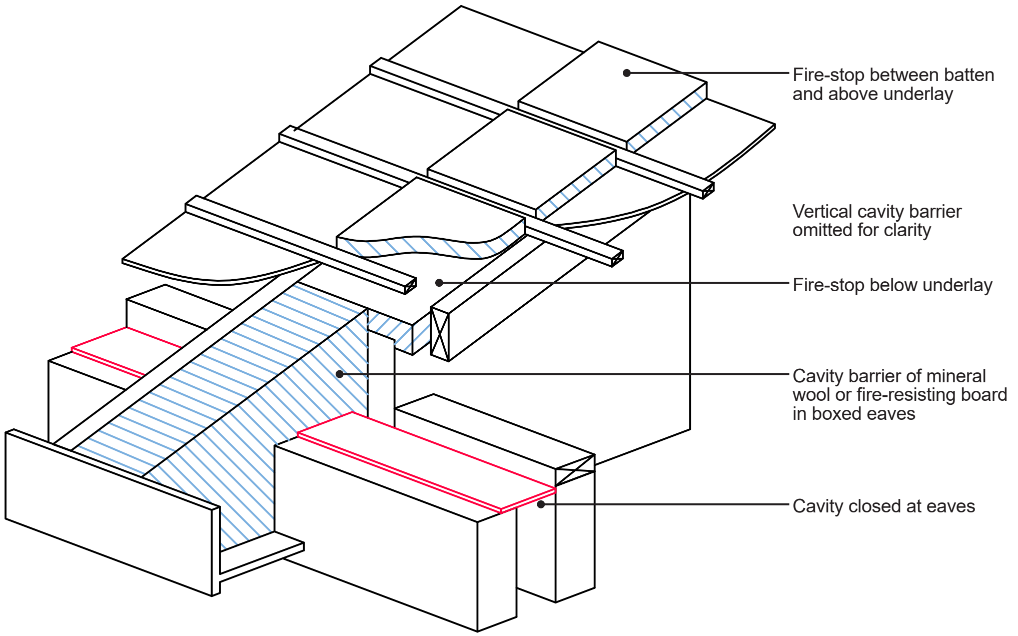
The spread of fire within a building can be restricted by sub-dividing it into compartments separated from one another by walls and/or floors of fire-resisting construction. The roof void, like most spaces within a building, can provide a route for the spread of fire and smoke. As an often-concealed space, it is particularly vital that fire-resistant cavity barriers are provided at the following points:

- At junctions of separating wall and external cavity wall.
- At junctions of compartment wall and compartment floor (not illustrated).
- At junctions of separating wall with roof, under roof tiles.
- Within boxed eaves at separating wall position.

Junctions of compartment walls with roof

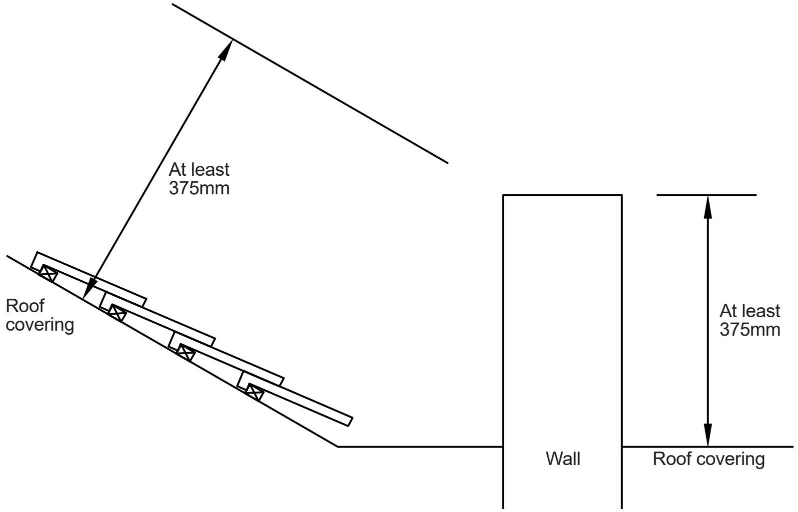
A compartment wall should be taken up to meet the underside of the roof covering or deck, with fire stopping, where necessary, at the wall/ roof junction to maintain the continuity of fire resistance. The compartment wall should also be continued across any eaves cavity. If a fire penetrates a roof near a compartment wall, there is a risk that it will spread over the roof to the adjoining compartment. To reduce this risk, a roof zone 1500mm wide on either side of the wall should have a covering of designation AA, AB or AC on a substrate or deck of a material of limited combustibility.





Fire stopping should be provided in accordance with the relevant Building Regulations

- Party/separating walls 25mm below the top of the rafter line and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent distortion of the roof tiles.
- The fire stopping should be continuous to eaves level and a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed.



20.
Tolerances

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works (not applicable to the ‘Ground Conditions’ guidance).
2. A more stringent tolerance may be stated within an existing National or European standard, however, for the purposes of coverage under the relevant Warranty Policy, where we have identified a tolerance requirement, this would be deemed suitable to meet our Functional Requirements (not applicable to the ‘Ground Conditions’, ‘Foundations’ and ‘Stairs’ guidance).
3. We only measure tolerances which are identified within this Technical Manual.

Workmanship

1. All workmanship must be within the tolerance requirements in this Section by a technically competent person in a workmanlike manner so that the required finishes are achieved.

Materials

1. All materials should be suitable for the relative exposure of the building.

Design

1. The design and specification shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.

20.
Tolerances

20.1
Tolerances

Introduction

- During construction, masonry units should be laid to ensure the wall will be adequately: plumb, straight on plan and straight in section.
- Tolerances and appearances should be considered for the entire wall not individual elements of the construction.
- Assessment should be made in daylight conditions, and from a minimum 10m distance from the element.
- Fair-faced masonry should be completed to a reasonable level, ensuring texture, finish and appearance are consistent.
- A reasonable appearance for single leaf 102.5mm brick walls should be to have one finished side only. A neat and tidy finish should be applied to the other side.
- Mortar blemishes can occur on individual masonry units.
- Efflorescence is naturally occurring in certain types of masonry. Its affects are not harmful and the residue will generally disappear of its own accord over time.
- Certain masonry products specified within the design have features and marks inherent to their fabrication.
- Minor shrinkage may occur within masonry components.
- For fair face natural and cast stonework, finishes should be reasonably uniform in colour and texture.
- Fungal growth, and colour variation may occur due to mitigating factors such as the orientation of the wall, shading, and even pollution.

Tolerances for external facing masonry

External facing masonry includes:

- Facing brickwork and blockwork.
- Natural stone.
- Cast rough faced masonry.

Location of measurement	Tolerance
Mortar bed joint	Level of bed joints should be +/- 8mm in any 5m length of wall. The thickness of a mortar bed should not vary from the average thickness of the next eight successive joints by +/- 1.5mm.
Mortar perpend joint	Centre lines of perpends should be with +/- 15mm of the centre line to the next 5 successive perpend joints.
Straightness in plan	The wall must be relatively straight in plan. A maximum of +/- 8mm deviation in any length of wall up to 5m.
Straightness in section*	The maximum deviation is +/- 8mm in any storey height, up to a maximum of 3m high.
Plumb in section	The maximum deviation from plumb in any storey height up to 3m, is a maximum of 8mm. Any walls over 3m in height should be a maximum of 8mm from plumb in any storey, and no more than 12mm in total.
Exterior window reveal	The maximum deviation is 4mm per 1m straight edge.
* The method of measurement for fair faced natural masonry and cast rough faced masonry is different to that of fair faced brickwork and blockwork. Please see the additional requirements for the measurement of fair faced natural masonry and cast rough faced masonry.	

Mortar bed joints

Masonry bed joints should be satisfactorily straight, with the line of level taken along the top side of the brick or block.

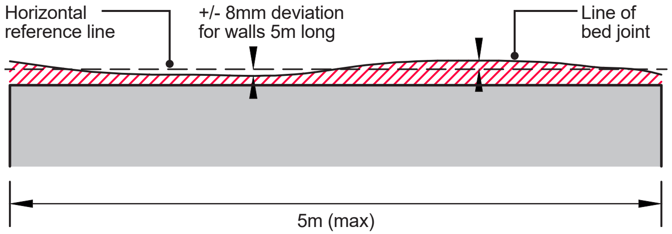
- Level of bed joints should be +/- 8mm in any 5m length of wall; and,
- The thickness of a mortar bed should not vary from the average thickness of the next eight successive joints by +/- 1.5mm.

Measure and add 8 successive bed joints and divide by 8 to determine the average size:

11+11+12+9+10+10+12+9 = 84

Divide 84 by 8 = 10.5mm

Therefore, the acceptable range of the bed joint below the 8 measured bed joints is 9-12mm



Mortar perpend joints

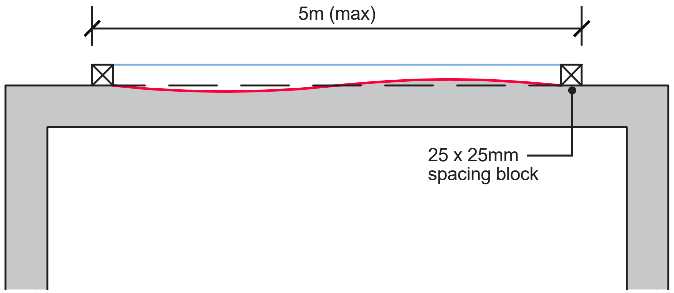
Vertical alignments of perpend joints should not deviate from the perpendicular to an extent which impairs the structural stability of the wall.

- Centre lines of perpends should be with +/- 15mm of the centre line to the next 5 successive perpend joints; and,
- Perpend joints within masonry panels between openings may be offset to accommodate setting-out. The perpend joints within the panel should not cumulatively displace more than the above tolerance.

Method of measurements for fair faced brickwork and blockwork

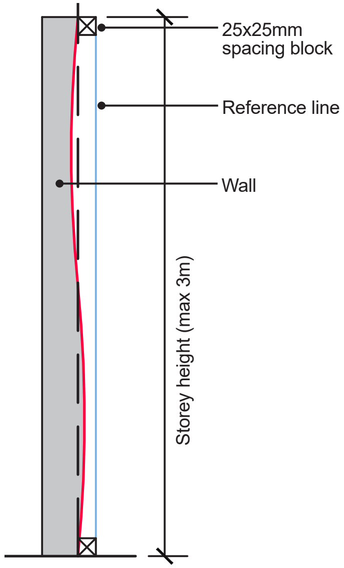
Method of measurement for straightness in plan

- The wall must be adequately straight in plan. A maximum of +/- 8mm deviation in any length of wall up to 5m.



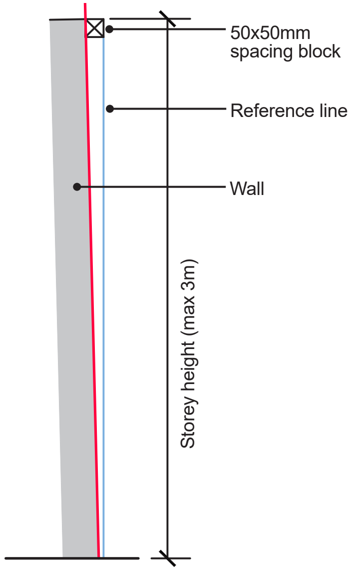
Method of measurement for straightness in section

- The maximum deviation is +/- 8mm in any storey height, up to a maximum of 3m high.



Method of measurement for plumb in section

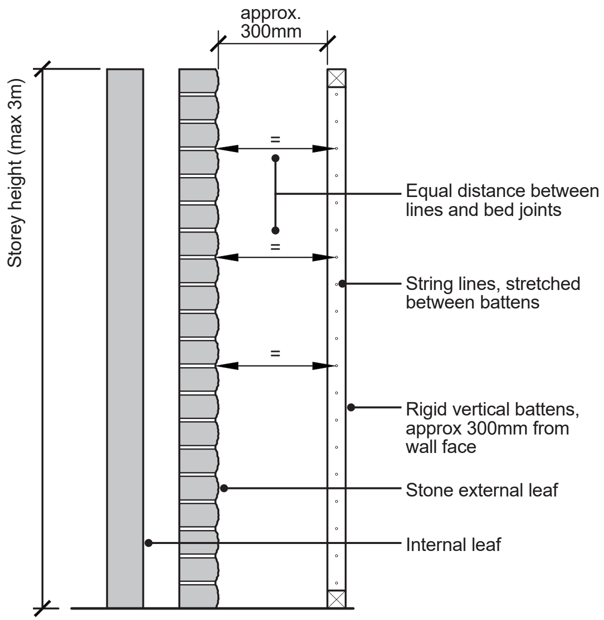
- The maximum deviation from plumb in any storey height up to 3m, is a maximum of 8mm.
- Any walls over 3m height should be a maximum of 8mm from plumb in any storey, and no more than 12mm in total.
- Using 50mm spacing blocks the line of the masonry face in plumb must be between 42mm and 58mm from the reference line.



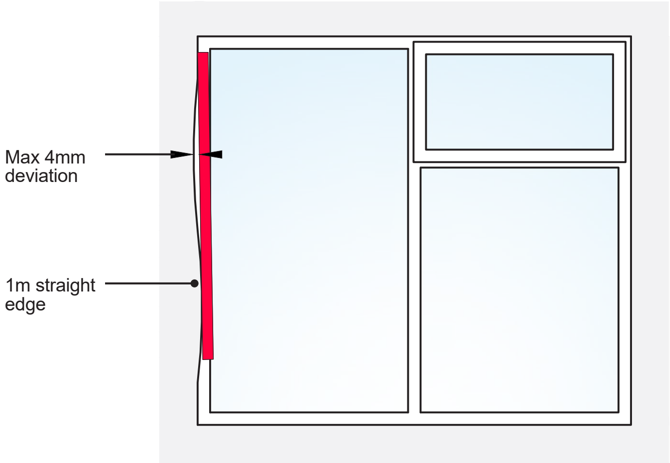
Additional requirements for the measurement of fair faced natural masonry and cast rough faced masonry

Rather than attempt to use the uneven face of the wall to determine tolerance, the finished face of the bed joint will provide the datum. This is based on the masonry units having a minimum 100mm mortar bed width, achieved at initial laying.
For the purpose of tolerance measurement, this cannot be raked or pointed to reinstate tolerance.

- Temporary but rigid battens at the building angles are to be erected approximately 300mm away from the wall face.
- Lines are to be stretched between the battens.
- There should be a constant distance maintained between the line and the bed joint subject to the permissible deviations.



Exterior window reveal



Render and cladding

Render

- Render should be applied to achieve a consistent texture, finish, and colour in line with the designers proposed specification. Some variations in colour appearance may occur due to variation in suction of the background surface to the render, along with orientation of the wall.
- Completed and set render should be free from crazing (crazing is defined within BS EN 13914-1 as being short, irregular and very fine cracks up to approximately 0.2mm in width). It is worth noting that some localised hairline cracking is likely to occur in traditional, and proprietary render systems. Limited cracking and crazing should not impair the performance of the home.
- Patching and other such repairs may be visible but they should be inconspicuous as possible in application.
- Where the render coat includes features such as bell-casts then tolerances are not applicable at these locations.
- The surface of the render should be within a maximum of +/- 4mm vertical and horizontal deviation when measured with a 5m straightedge.

Curtain Walling

Design should allow for the line, level, plumb and plane of the completed curtain wall to be within the acceptable tolerances of:

- Line: +/-2mm in any one storey height or structural bay width, and +/-5mm overall.
- Level: +/-2mm of horizontal in any one structural bay width, and +/-5mm overall.
- Plumb: +/-2mm of vertical in any one structural bay width, and +/-5mm overall.
- Plane: +/-2mm of the principle plane in any one storey height or structural bay width, and +/-5mm overall.

Rainscreen cladding systems

Design should allow for the line, level, plumb and plane of the completed rainscreen cladding systems to be within the acceptable tolerances of:

- Line: +/- 3mm in any one storey height or structural bay width.
- Level: +/- 3mm of horizontal in any one structural bay width.
- Plumb: +/-3 mm of vertical in any one structural bay width.
- Plane: +/- 3mm of the principle plane in any one storey height or structural bay width.

Tile Hanging

The uniform appearance is to be maintained for panels of tile hanging, especially at abutments. No significant variations in finish or colour should be present.

Timber cladding

Variations in colour to uncoated timbers exposed to weather conditions are to be expected, the rate and extent of which may vary.

Brick slip cladding

Tolerances for the finish of brick-slip cladding should meet the same as those listed for fair-faced masonry.

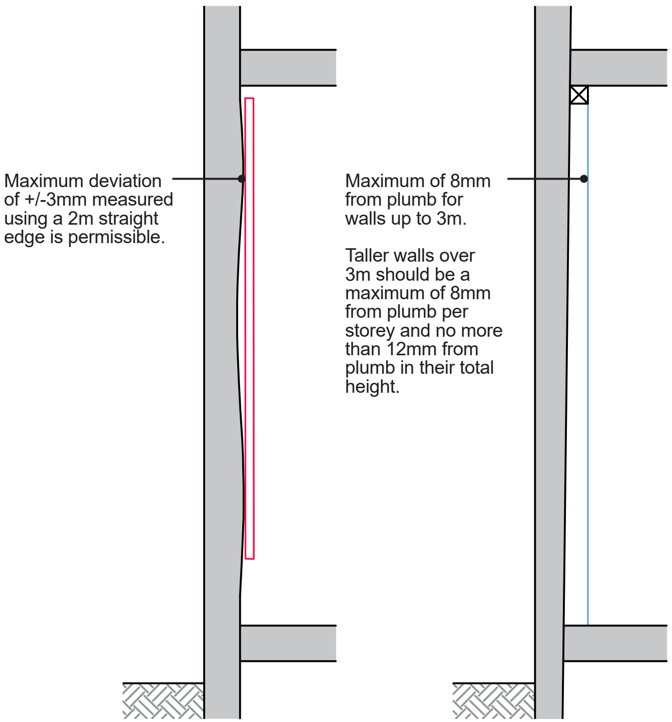
Cast and real stone

- Finishes should be reasonably uniform in colour and texture.
- Efflorescence, fungal growth, and colour variation may occur due to mitigating factors such as the orientation of the wall, shading, and even pollution.

Introduction

- The wall must be relatively flat. Maximum deviation of +/-3mm measured using a 2m straight edge is permissible.
- The wall must be relatively plumb. Maximum of 8mm from plumb for walls up to 3m. Taller walls over 3m should be a maximum of 8mm from plumb per storey and no more than 12mm from plumb in their total height.
- Allowances should be made for minor textural differences around switches and such fittings.
- Board joints should not be readily visible.
- Max +/- 3mm surface deviation when measured using a 450mm straight edge.
- Viewed from a distance of at least 2m in natural daylight (no artificial lighting to be used).
- Jointing tape should not be visible within the finished surface.
- Some cracking (up to 2mm wide) may occur at wall, floor and ceiling junctions, due to shrinkage and differential movement of materials.

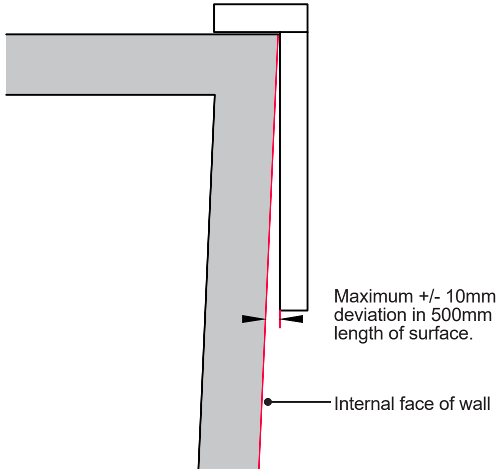
Flatness and plumb of internal walls



Outer corners to internal walls

Setting out of corners, duct casings (larger than 250mm), and associated framing should be:

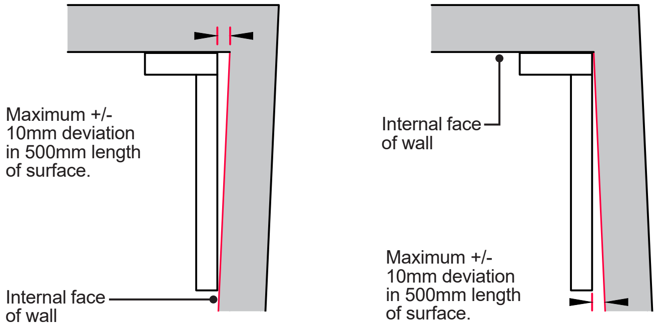
- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum +/- 10mm deviation in 500mm length of surface.



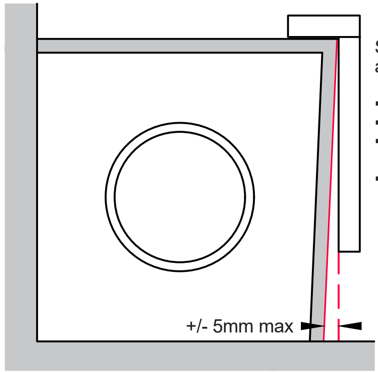
Internal corners of internal walls

Setting out of corners, duct casings, and associated framing should be:

- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum +/-10mm deviation in 500mm length of surface.



Service ducts (up to 250mm)



Setting out of corners, duct casings, and associated framing should be:

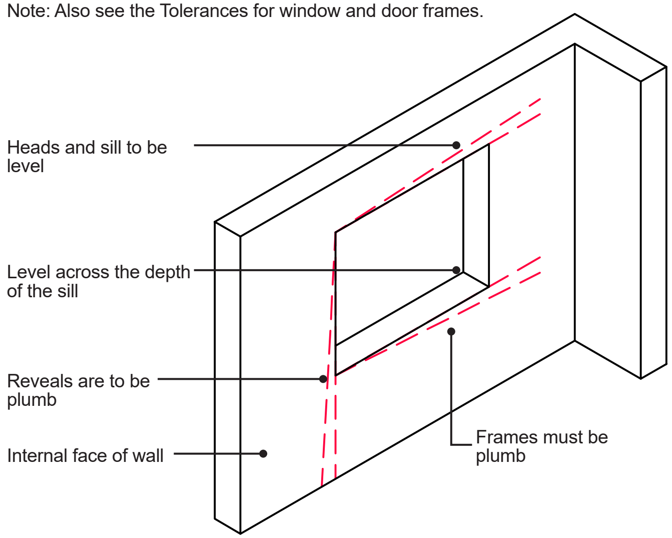
- Square.
- Neat and tidy.
- Provided with appropriate decorative finish to their surface.
- Maximum +/- 5mm deviation in 250mm length of surface relating to the boxing of the service duct (for lengths of wall over 250mm please refer to the requirement for 'Internal corners of internal walls).

Internal openings (for reveals) for windows and doors

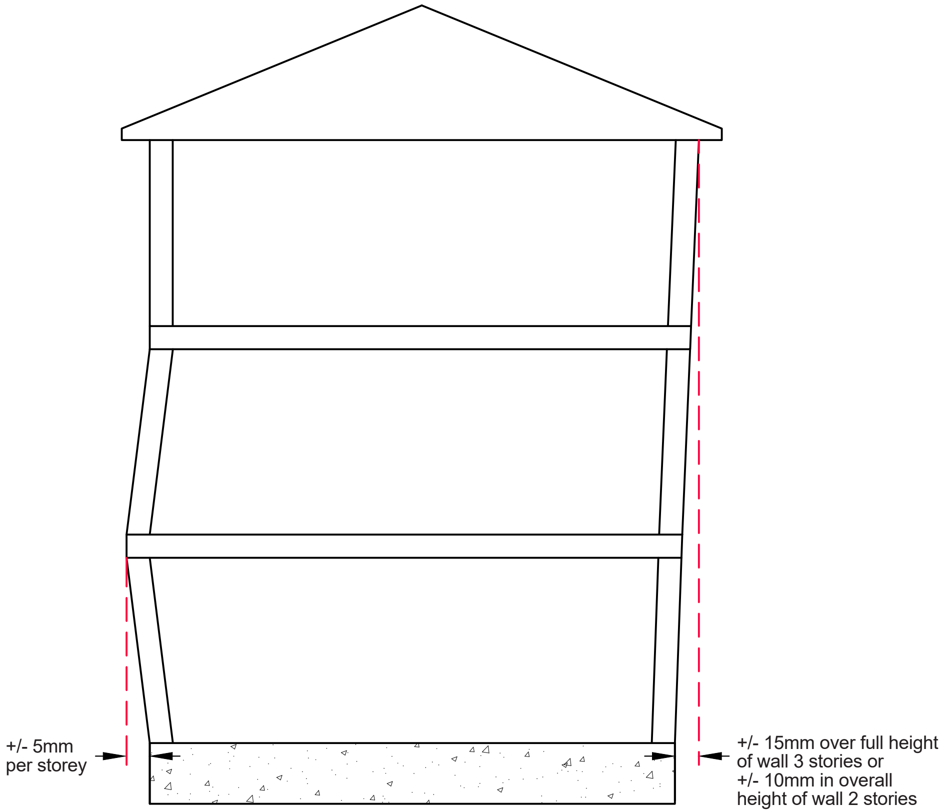
Internal openings must be:

- Flat along the length of sills and boards with maximum deviation of +/-3mm in every 2m.
- Heads and sill to be level, with a maximum deviations of 3mm out of level for openings up to 1.5m; where openings are longer than 1.5m then this deviation may be increased to maximum 5mm out of level.
- Reveals are to be plumb, with a maximum deviation of +/-3mm for openings up to 1.5m high; where reveals exceed 1.5m high then a maximum deviation of +/-5mm is permissible.
- Level within +/- 3mm across the depth of the sill, measured from the face of the frame (tiled sills may be intentionally laid to a fall to allow moisture run-off).
- Reveals are to be square with a maximum deviation of +/- 5mm for reveals up to 250mm deep (deeper reveals should refer to external corners).

Note: Also see the Tolerances for window and door frames.



Steel frame: wall panel erection tolerances



Site tolerances
It is essential that the accuracy of setting out foundations and ground beams are checked well in advance of materials being delivered to site.

For accurate erection of the frame the following tolerances are required at the level of the base of the wall frame:

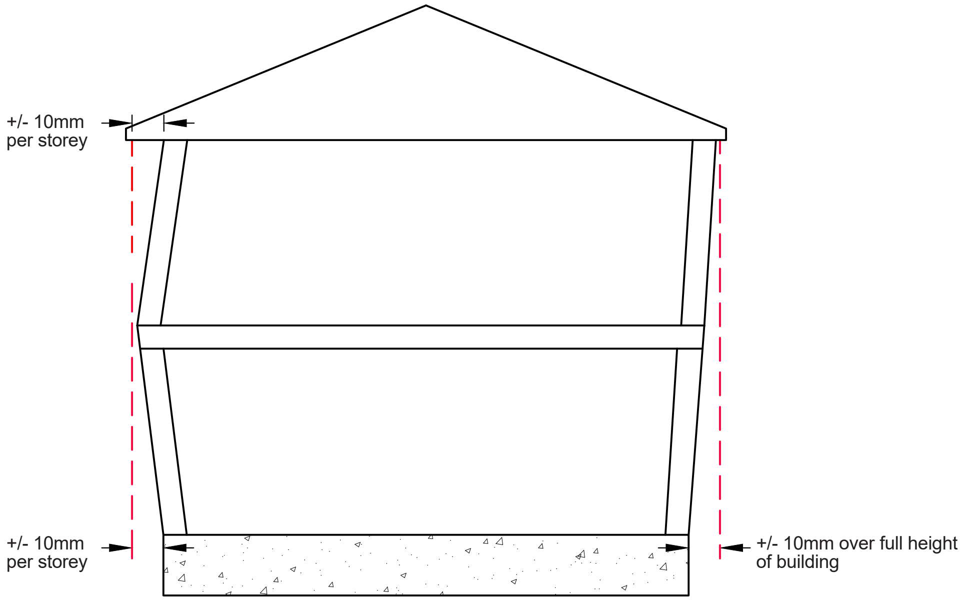
- Length of wall frame: +/-10mm in 10m.
- Line of wall frame: +/-5mm from outer face of plate.
- Level of base of wall frame: +/-5mm over complete wall line.

Metal stud framework
The wall panel usually consists of a head rail, base rail (sole plate) and possibly horizontal noggins at mid-height, together with vertical wall studs.

Vertical tolerances are:

- +/-15mm in overall height of wall 3 storey or;
- +/-10mm in overall height of wall 2 storey or;
- +/-5mm in storey height (approx. 2.5m).

Timber frame: wall panel erection tolerances



Manufacturing tolerances
The following are our manufacturing tolerances that timber frame manufacturers' must adhere to:

- Length: +/-3mm.
- Height: +/-2mm.
- Diagonals should be equal, acceptable deviation is +/-5mm.
- Opening dimensions: +5mm.

Sub structure
It is important that the tight tolerances for timber frame are understood, getting the location and level of the sub-structure correct is one of the most important parts of the build process. The sub-structure or upstands that support the timber frame should be set out to the dimensions noted on the timber frame drawings:

- Within +/-10mm in length, width and line.
- Diagonals should be within +/-5mm up to 10m, and +/-10mm more than 10m.
- Levelled to +/-5mm from datum.

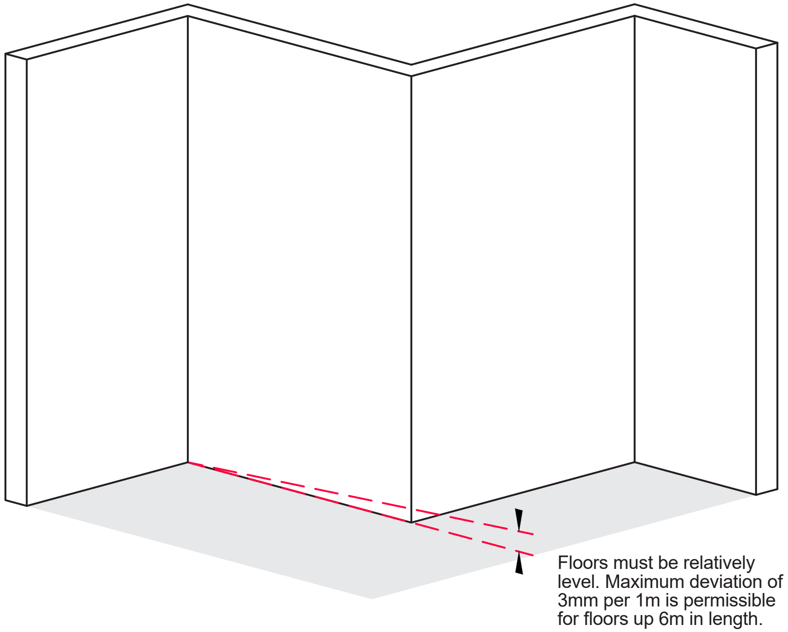
Location
Sole plates should:
- Be levelled to +/-5mm from datum.
- Not overhang or be set back from the substructure by more than 12mm on a 89mm sole plate and 20mm for a 140mm sole plate.
- Be set out within +/-10mm in length and in line within +/-5mm, as defined by the timber frame drawings.
- Diagonals should be within +/-5mm up to 10m, and +/-10mm for more than 10m.

Wall panel erection tolerances
Wall panels should be erected to the following tolerances:
- +/-10mm from plumb per storey height.
- +/-10mm from plumb over the full height of the building.
- +/-3mm from line of sole plate, with maximum +/-5mm deviation from drawing.
- +/-5mm from line at mid height of wall panel.
- Inside faces of adjacent wall panels should be flush.
- Adjacent wall panels should be tightly butted.
- The sole plate and base rail faces should be flush.

Floors

Floors levels
The effects of normal drying out / shrinkage of floors (timber and concrete) may result in minor differences in level and can result in squeaking of materials as they move against each other which might not be able to be eliminated entirely.

- The floor must be relatively flat. Maximum deviation of +/- 5mm is permissible using a 2m straight edge with equal offsets.
- Floors must be relatively level. Maximum deviation of 3mm per 1m is permissible for floors up 6m in length.
- Floors over 6m horizontal length are permitted to have a maximum deviation of 20mm across their length.



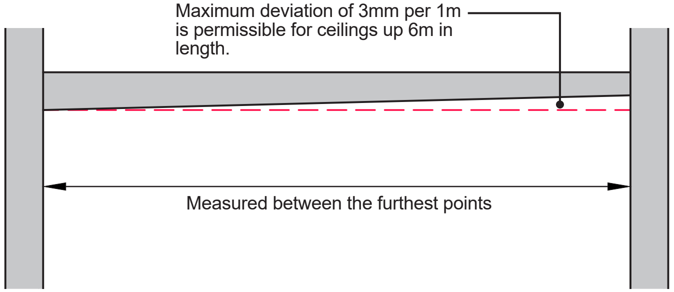
Floor deflection limits
The deflection limit must be 0.003 X the span with a maximum deflection of 14mm where strutting is provided and 12mm where strutting is not provided. This is based on the total and imposed loads for combined bending and shear.

The Engineer must ensure that the design of the floor construction does not deflect greater than the above tolerances, unless the relevant BS or EN design code requires the deflection to be smaller.

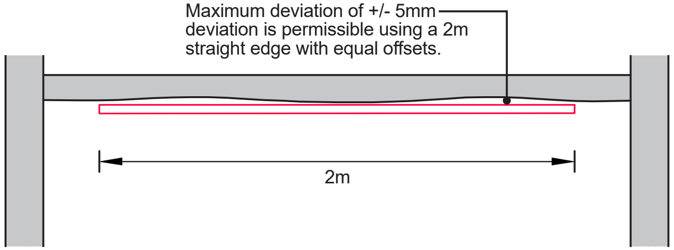
Internal ceilings

- The ceiling must be relatively flat. Maximum deviation of +/- 5mm is permissible using a 2m straight edge with equal offsets.
- Ceilings must be relatively level. Maximum deviation of 3mm per 1m is permissible for ceilings up 6m in length.
- Ceilings over 6m horizontal length are permitted to have a deviation of 20mm across their length.
- Some cracking (up to 2mm wide) may occur at wall, floor and ceiling junctions, due to shrinkage and differential movement of materials.

Level of ceiling



Flatness of ceiling



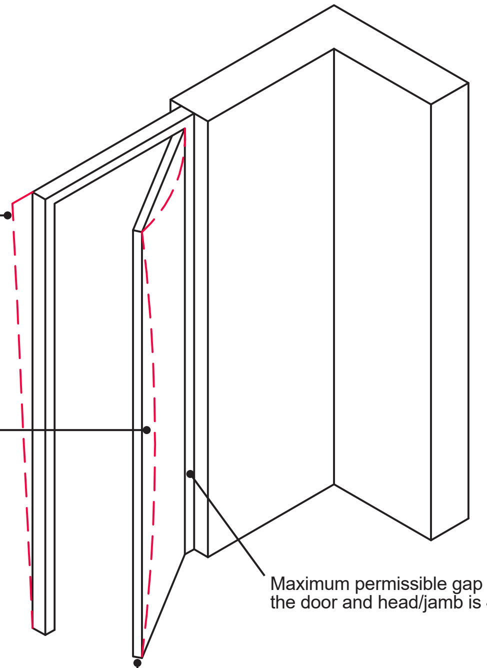
Doors

All doors should be installed in accordance with the manufacturers' guidance and recommendations. Door installations should adhere to Building Regulatory requirements for Fire & Ventilation.

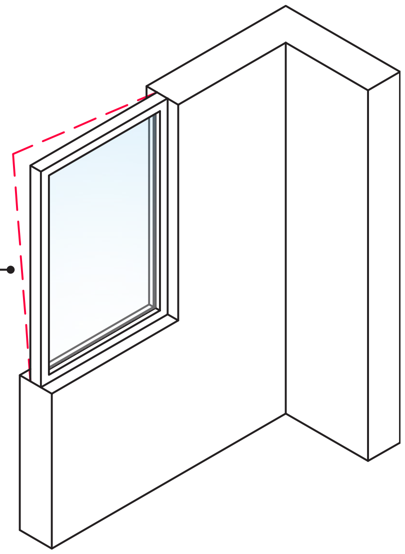
- Frames must be plumb within a maximum deviation of +/-5mm over the total height to the frame.
- Maximum permissible gap between the door and head/jamb is 4mm.
- Where double doors meet the gap at the stiles should be within 4mm.
- Distortion across the faces of the doors should be limited to 5mm in height and 3mm in width.
- Gaps to the underside of doors will need to take into consideration requirements of applicable Building Regulations. However, the maximum permissible should be between 10mm and 22mm.

Note: These dimensions are without prejudice to satisfactory performance in terms of weather tightness, exclusion of draughts and fire resistance where appropriate.

Door frames



Window frames



Glazing

Glass must meet the visual assessment criteria of CWCT Technical Note 35 (TN 35). The total number of faults permitted in a glass unit shall be the sum total of those permitted by the relevant BS EN Standard for each pane of glass incorporated into the unit concerned.

Acceptable faults include:

- Bubbles or blisters.
- Hairlines or blobs.
- Fine scratches not more than 25mm long.
- Minute particles.

When assessing the appearance of glass:

- The viewing distance used shall be the furthest stated in any of the BS EN Standards for the glass types incorporated in the glazed unit. In the event of doubt, the viewing distance shall be 2m (3m for toughened, laminated, or coated glass).
- The viewing shall commence at the viewing distance, and shall not be preceded by viewing at a closer distance.
- The viewing shall be undertaken in normal daylight conditions, without use of magnification.
- The above does not apply within 6mm of the edge of the pane, where minor scratching is acceptable.

Joint sealants

Sealants must be tool finished in order to:

- Remove any blisters and irregularities within the product.
- Achieve a compressed and smooth, neat finish within its surface.

Skirtings

- The gap between the floor (without coverings) and the bottom face of the skirting should not exceed 5mm at the time of completion. It should be noted that the gap may increase due to normal drying out, shrinkage, or deflection (particularly to timber floors).
- It is possible that there will be joints in skirtings on long walls. When viewed from a distance of 2m in daylight, joints will need to show a consistent appearance.
- It is anticipated that there will be some initial shrinkage of the skirting after occupation of the building.

Fitted furniture

- Fitted furniture with doors and drawers should be aligned vertically, horizontally and in plan.
- Factory finished components should not have conspicuous abrasions or scratches when viewed in daylight from a distance of 0.5m.
- Function as designed by the manufacturer.
- Adjacent doors and/or drawers with any gaps between them should be consistent.
- At the intersection of adjacent worktops, there should not be a visible change in level.

Painted and varnished surfaces

- All surfaces should be reasonably smooth as practicably possible when viewed in daylight from a 2 metre distance and not by shining any artificial light onto the surface.
- Significant nail holes, cracks and splits should not be seen and should be filled to reduce their visible appearance.
- Colour, texture and finish should be reasonably consistent and any joints are to be filled where necessary. Although it should be noted that some variations can occur.
- External finishes may dull over time depending on a number of factors.
- Some seeping of resin from knots is a natural occurrence that may cause paintwork discolouration both internally and externally.

Sanitary ware

Sanitary fittings should be free from conspicuous abrasions, scratches and chips when viewed from a distance of 0.5m in general daylight. Where sanitary ware is provided in windowless accommodation the items should be viewed in artificial lighting from the fixed wall or ceiling provisions (not from portable equipment).

Drives and paths

- Surface variation should not exceed +/-10mm from a 2m straight edge with equal offsets. However, it should be accepted that localised falls into gullies and channels are acceptable.
- Design and construction should be completed to minimise the potential for standing water. Sixty minutes after rainfall has ceased, areas of temporary standing water should be no deeper than 5mm, nor exceed $1m^2$ in area. Temporary standing water should not be present adjacent to entrance doors.
- Some fracturing or weathering may also appear if using natural stone due to the make-up of the material. This tolerance applies to principle pathways and driveways to the building that are required to meet the standards of Part M (Access to and use of buildings).

Drainage system covers

- Drainage system covers in hard standing areas should line up neatly with the adjacent ground.

Wall tiling

Courses should be straight and even to form a plane and regular surface, especially around fittings and fixtures.

- There should be no cut or unfinished tiles at exposed edges or external corners.
- Joints should be even and cut neatly.
- Spacing should be sufficient to allow for expansion.
- Up to sanitary fittings and fixings, the sealing method should be in accordance with the design and account for movement.
- Proprietary water-resistant grouting should be used in accordance with the manufacturer’s recommendations.
- Appropriately designed movement joints should be:
  - Built into tiling at centres at a maximum of 4.5m, vertically and horizontally.
  - Provided at vertical corners in large tiled areas.
  - Located at junctions where there are variations in surfaces or backgrounds.
  - 1-2mm where tiles are without spacer lugs.
- Grouting should be:
  - As specified in the design, including mix and colour.
  - Cement-based epoxy resin or a proprietary product.
  - Waterproof in and around shower enclosures and where tiling can be saturated.

Radiators and similar appliances

Appliances displayed in and about the home should be:

- Free from cracks, holes, and splits.
- Have any joints filled consistent to the main material.
- Reasonably uniform in colour, texture and finish.

External plastic and UPVC materials (other than windows and doors)

Materials such as fascias, soffits, meter boxes, etc. should be provided to meet the following:

- Be reasonably smooth in their finish. Free from nail holes, any cracks or splits.
- All joints to be sympathetically filled to replicate the main material.
- Be reasonably uniform in colour, texture, and finish.

Pitched roof coverings

Coverings should have an aesthetically suitable appearance.

Tiles and slates should:

- Be reasonably uniform, with a consistent texture and finish.
- Be selected from mixed packets to avoid excessive colour banding.

It should also be accepted that:

- Some minor blemishes can occur within the surfaces of the tile or slate.
- Variations in colour, texture, and finish can occur within tiles and slates, especially when natural quarried items.
- Efflorescence is to be expected.

Garages

Garages shall be constructed to achieve an acceptable appearance. The floors, walls, and roofs should be built to appropriate tolerances.

- Garages are not considered habitable spaces.
- Gaps up to 2mm wide may be experienced in unplastered blockwork. Caused by thermal movement and/or shrinkage.
- Garage floors may be installed with falls provided in order to either assist with drainage, or to satisfy the requirements of the Building Regulations.

A.
Appendix A

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window / door or ‘decorative external cladding’ (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.

Design

1. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.

A.
Appendix A

A.1
Finishes

Plastered finishes

Introduction
This section covers all plastered finishes to walls and ceilings. Plastered finishes should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

Substrate and background
Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Plaster proposed to be applied to backgrounds that are susceptible to thermal movement, such as lightweight concrete or aerated blockwork, may not be suitable and an independent dry lining or board on dabs system be adopted. Guidance on applications of plaster should be in accordance with the block manufacturer’s instructions.

Where the background has a mix of varying materials, e.g. blockwork and brickwork, expanded metal should be provided to prevent differential movement in the plaster finish.

Plaster mixes
Plaster mix ratios should be in accordance with manufacturer’s recommendations and be appropriate for the intended use.

Minimum plaster thickness
The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in the ‘Tolerances’ section, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the table below.

Thickness of plaster

Element	Minimum number of coats	Typical thickness
Walls - metal lath	3	13mm (nominal)
Blockwork	2	13mm (nominal)
Brickwork	2	13mm (nominal)
Walls - plasterboard	1	Skim to provide suitable and durable finish
Walls - concrete	1	Minimum thickness to provide suitable and durable finish
Ceiling - plasterboard	1	Skim to provide suitable and durable finish
Ceiling - concrete	2	10mm maximum

Tape and jointing

Where plasterboards to internal walls and ceilings are to be taped and jointed, and not plastered they must:

- Be durable enough to prevent surface cracking.
- Meet the required levels of fire and sound insulation in accordance with current Building Regulations (i.e. proven to achieve the standards without a plaster skim coat).
- Have all materials (such as tape, jointing compound etc.) that are specified, to be a part of the board manufacturer’s system or approved by the board manufacturer for use with their board.

Please note, tapered edge boards must be used for directly applied finishes where plasterboards are not to be plastered.

Painting and decorating

Timber
Painting or staining of external timber is required to provide protection and stability, even if the timber is preservative treated. Timber with moisture content greater than 18% is not suitable for painting or staining.

The paint and stain systems specified should be compatible with any timber preservatives and timber species used.

Where windows and doors are to be stained, proprietary sealants and beads should be used in glazing rebates in accordance with the manufacturer’s instructions as an alternative to linseed oil putty.

Staining
Timber should be stained in accordance with the manufacturer’s recommendations.

Painting
Painting of timber should consist of at least one primer coat, one undercoat and one finish coat, or alternatively in accordance with the manufacturer’s instructions.

Masonry and rendering
External brickwork and render should be dry before paint is applied, and paint systems for external brickwork or render should be applied in accordance with the manufacturer’s instructions.

Metal
Internal and external structural steel should be protected with at least two coats of zinc phosphate primer. A decorative paint finish may then be applied.

Internal and external steel that has been galvanised to a rate of at least 450g/m² is acceptable without further protection. Steel galvanised to a rate of less than 450g/m² should be protected with at least two coats of zinc phosphate primer and a suitable decorative finish, where required. This may need to be increased where a development is within a coastal location - see ‘Appendix B - Coastal Locations’.

Intumescent paint coverings must be applied in accordance with the manufacturer’s instructions.

Plaster and plasterboard
Plaster and plasterboard surfaces should be prepared and made ready for decorating in accordance with the manufacturer’s instructions.

External finishes in Coastal locations

Additional requirements may be necessary in coastal locations due to the aggressive environment effects on exposed finishes. Please see ‘Appendix B - Coastal Locations’ for further information if a project is within a coastal location.

Ceramic wall tiling

Tiles should be fit for purpose, have a suitable finish and be of an appropriate size and thickness.

The installation of the tiling should follow the guidance contained in BS 5385 - 3.

Background surfaces
Background surfaces should be adequate to support ceramic tiles, and as a minimum should:

- Be even, to adequately support the whole tile.
- Be strong and durable enough to support the tile.
- Have sufficient absorbency to ensure that adhesives will stick effectively or a suitable bonding agent applied.
- Be of the same construction type; where two construction types are present, e.g. blockwork and timber stud, light reinforcing should be provided over the junction between the two types.

In addition, where forming part of a framed wall to a shower enclosure, walk in shower or wet room:

- A moisture resisting plasterboard (or a third party product approved water resistant backer board) should be used for the area of the ‘shower enclosure’ wall that is to be tiled (up to a height of 1800mm above the floor level).
- The enclosure walls are required to be waterproof for a height of 150mm above the floor junction.

Walk in showers and wet rooms floors

The floor areas to a walk in shower or wet room (where the floor area is part of the shower floor) is required to be waterproof and drained, a timber floor deck substrate should not be used. The floor deck must be a water stable component with a third party product approval confirming its use for this situation.

- The fall to the wet room area floor must prevent ponding and should be between 1:80 to 1:100 to a drainage point.
- The floor drainage point must be maintainable and adequate in size to take the intended water flow from the shower head without flooding occurring.
- Due to the need for a fall in the finished surface to an outfall a suitable threshold may be necessary at the wet room door opening (which gives access to the rest of the accommodation).

Anhydrite screeds/calcium sulphate screeds

Anhydrite screeds/calcium sulphate screeds need to be left to dry to allow for hydration to take place to gain its strength. Finishes should not be installed until the screed has gone below 75% relative humidity. The drying times should be in accordance with the manufacturer’s guidance, testing will be required to confirm the screed has been suitably cured before any surface applied finishes are laid. If an OPC based adhesive or ceramic tile adhesive is to be used, then an acrylic or water dispersible epoxy penetrating sealer should be applied to seal the screed in 1 to 2 coats in accordance to the sealant manufactures instructions.

B.

Appendix B

Contents

Coastal location definition

For the purposes of this Technical Manual, this means any building works on:
- Any site within 500m of the shoreline;
- Other sites up to 5km inland from the shoreline;
- Sites located in 'tidal' estuarine areas where they are within 5km of the general UK coastal shoreline.

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. Materials, components and external surfaces should be suitable and appropriately durable for the aggressive environment that the building is located.
2. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
3. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
4. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
5. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/ door or 'decorative external cladding' (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
6. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.

Design

1. For shoreline, sea front developments and developments within 500m of the shoreline: The design team must provide specifications and detailing to demonstrate the durability, suitability and weather tightness of the construction for its location, with particular attention to the externally exposed structural frame, window and door openings, balcony/roof abutments (particularly at balcony window openings), exposed lintels, claddings and roof fixings. The choice of materials and coatings must be appropriate for the aggressive environment.
2. For developments that are between 500m to 5km from the coastal shoreline; The design team must provide evidence from manufacturers that the materials used which are externally exposed are appropriate for use in the construction in this environment.
3. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
4. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
5. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

B.
Appendix B

B.1
Coastal Locations

Developments within a coastal location

Coastal location definition
For the purposes of this Technical Manual, we are considering any building works on:

- The shoreline and sites within 500m of the shoreline.
- Other sites up to 5km inland from the shoreline.
- Sites located in ‘tidal’ estuarine areas where they are within 5km of the general UK coastal shoreline.

Shoreline means:

- The foreshore.
- Land adjacent to the foreshore including in particular any cliff, bank, barrier, dune beach or flat which is adjacent to the foreshore.

Developments within coastal locations
A coastal location is considered as having an aggressive environment particularly with regard to environmental corrosion conditions as well as other risks.

Key risks to construction in coastal locations

Coastal locations are at risk from a combination of one or more of the following:

Wind speed
Coastal regions particularly in the South West, West and North Western areas of the UK are at greater risk of exposure to higher wind speeds than inland areas. Gust wind speeds in combination with rain from offshore can create particular design issues for buildings sited in shoreline locations, particularly for cladding and roof coverings and their associated fixtures and fittings.

Aggressive environment
Materials and fixings need to be protected from the saline rich environment particular in wind driven rain. This can effect and reduce the durability (and life expectancy) of materials and finishes compared to those located inland and non coastal locations.

UV
Higher levels of UV are to be expected in coastal locations which have an impact on durability and longevity of finishes. This has the effect of reducing the durability of a material or finish and requiring maintenance at more frequent periods than would otherwise be expected inland.

Rain penetration
Walls, claddings, external openings including windows and doors, construction junctions and roofs exposed to the prevailing wind driven rain are vulnerable to rain penetration unless correctly designed and constructed for the conditions of the site and orientation of the elevations. The level of exposure to rain penetration in coastal locations should be determined by using the calculation method in BS 8104. This determines the wind blown rain category for a specific site.

It should be noted that not all coastal locations are classified in BS 8104 as severe or very severe. Nonetheless, a coastal and shoreline location is at much greater risk of exposure to higher wind speeds and driving rain than inland areas.

BS 8104 and the wind driven rain maps found in BR 262 must not be used as a means to solely identify exposure to all the environmental factors associated with a coastal location.

There are numerous publications providing good practice guidance on methods of preventing rain penetration to internal surfaces of buildings in very severe exposure locations e.g. BRE publication: Thermal insulation: avoiding risks.

Maintenance
It is the designer’s responsibility to ensure that exposed components forming part of the structure or waterproof envelope must perform to meet the Functional Requirements within this Technical Manual.

Certain materials and particularly the finishes may, due to the environment, require an on-going planned maintenance requirement in order to keep a satisfactory finish. In these circumstances it will be the building owner’s responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided. Typically dark coloured finishes will fade much sooner.

Debris build up, e.g. wind-blown sand, must be managed, particularly to balconies. These can lead to leaks and overflowing of blocked outlets which in turn cause damage to other parts of the structure and concentrate the potential for water ingress. Bi fold and patio type doors are known for the seals, mechanisms and drainage holes being affected by wind-blown sand if not regularly maintained.

Material Specification
A high number of failures of the building envelope in coastal environments are directly related to the incorrect specification of materials i.e. using materials that are not suited to the environment leading to premature failure or corrosion. This can include:

- Lack of adequate preparation and protective finishes to external window frames whether they be timber or metal. The coatings may have a shorter durability due to the high UV or saline environment.
- Exposed metal surfaces not provided with the correct protection or grade.

A defect due to the incorrect specification for the environment will manifest itself sooner and to a greater extent in a coastal location than one not in such a location.

Masonry walls

The guidance in BS EN 771 for masonry walls of bricks and/or blocks incorporating damp-proof courses and flashings may be adopted.

Masonry walls of natural stone or cast stone blocks should be constructed in accordance with the relevant recommendations of BS EN 771 and to suit the degree of exposure.

External masonry walls in severe and very severe categories of exposure will benefit from having additional protective features to avoid excessive wetting of the masonry. Features such as deep overhanging eaves, verges and projecting sills should be incorporated into the design.

The following architectural detailing should be avoided:

- Flush sills.
- Inadequate or non existent overhangs at verges.
- Large expanses of glazing or impermeable cladding with no effective means to shed run off water, clear of the masonry below.
- Areas of rendering abutting masonry with no effective seal at the junction to prevent water penetration to the rear of the render.

Insulated concrete formwork (ICF) structures

ICF structures rely on a suitable external cladding to provide the waterproof envelope. The external cladding, if masonry, should be constructed as described earlier in this guide. Direct render applications are not acceptable for Warranty purposes.

Rendering in coastal locations

External rendering to external masonry walls should conform to the relevant recommendations of BS EN 13914-1:2005, and follow the guidance in the 'External Walls - Render' of this Technical Manual. However, the following points should be followed when constructing a render cladding finish in a coastal location.

Render angle beads should be appropriate for the environment when installed. Non corrosive render beading e.g. PVC or marine grade stainless steel should be specified. Any other products used must have a current third party product approval stating they are suitable for the environmental conditions proposed.

Fixings to render angle beads must be suitable to prevent corrosion occurring.

The durability of the rendering will also be dependent upon the type of background, the type of rendering, mix proportions and the method of application.

The 'background' or substrate which is to support the render must be suitable for bonding the render and be dry in condition. Materials of differing densities should be avoided in the substrate, if this latter point cannot be avoided, the render manufacturer must provide a specification for the render application over these areas to avoid future cracking.

The choice of render and render carrier boards (if used) must be correctly specified for the location proposed.

Wherever possible, whatever the conditions of exposure, advantage should be taken of architectural features which protect the rendering. Such protective features become more important as conditions become more severe, adequate overhangs and drips will reduce the risk of frost damage.

Whilst traditional renders are applied in several layers and normally are 20 to 25mm thick to provide a cladding in a severe location, a detailed specification of a factory made render system from the render manufacturer will be required to justify it is suitable for the proposed conditions and the overall thickness.

Polymer modified, ready to use factory produced renders contain high quality raw materials and a range of admixtures (notably water repellents) which reinforce the waterproofing properties of the renders. The thickness of these renders may vary depending upon the particular application and guidance should be sought from the render manufacturer.

Note: adding additional water repellent which is not within the render manufacturer's specification into the mix on the worksite should not be carried out, it may even be harmful to pre-prepared render systems as it can lead to faults in the finish.

For more guidance for the suitability of Render construction, please see the guidance in the 'External Wall - Render' section of this Technical Manual.

External cladding systems including rain screens

The materials used within the construction should be capable of withstanding weathering, atmospheric pollution and potential chemical attack for the intended design life.

The system must have a current third party product approval confirming the specification is suitable for a coastal environment.

The supplier and designer should provide evidence to satisfy the following:

- Evidence of the minimum design life of the enclosure as a whole for the particular environment location (with maintenance considered to allow for components that may have a lessor design life but are expected to be periodically replaced).
- Confirmation of what routine maintenance, repair and replacement is likely during the design life and who will be responsible for this.
- Details to confirm that the potential for electrolytic corrosion will be avoided within the system.
- The surfaces of the cladding system should be capable of resisting the action of chemicals with which it is likely to come into contact during its design life.

Components should have a design life as stipulated in the Functional Requirements, see the service life table in 'Appendix C - Materials, Products, and Building Systems' for further information:

- Secondary framing and its fixings.
- Panels and their fixings.
- Thermal-insulating components and materials.
- Vapour barriers.
- Flashings.
- Window sub frames.
- Door frames.
- Fixed window frames.
- Opening windows.
- Doors.
- External shading devices.
- Window and door equipment.
- Glazing.
- Gaskets and compression seals.
- Sills and closure pieces.
- Inlet and extract grilles.

Components which are likely to have a shorter design life of only a few years and will need to be periodically replaced as part of a planned maintenance programme are:

- Gun and knife-applied sealants.
- Site-applied external finishes.

The cavity behind a rain screen is deemed to be a moist zone and materials selected must not corrode, deteriorate or affect the performance of the cavity barrier during its design life.

Corrosion protection

All external metals (included embedded fixings/wall ties etc, in external wall claddings) must have suitable corrosion protection for the intended environment. Further guidance can be found in 'Appendix C - Materials, Products, and Building Systems'.

Windows and doors

The choice of windows and doors must be supported by the manufacturer's certification to confirm they meet the design weather conditions and be classified and tested in accordance with the following weather performance standards:

- BS 6375-1 Weather tightness.
- Air permeability - BS EN 12207 - Classification & BS EN 1026 - Test method.
- Water resistance - BS EN 12208 - Classification & BS EN 1027 - Test method.
- Wind resistance - BS EN 12210 - Classification & BS EN 12211 - Test method.

Site testing for water penetration of the joints to windows and doors in accordance with the CWCT test methods is recommended to check the site workmanship of the building envelope as constructed. See CWCT Technical Note No. 41 for guidance on site hose testing.

In addition to the above, workmanship should follow the recommendations of BS 1186-2. The design and construction of factory assembled windows must meet BS 644. Non factory assembled units and 'bespoke' units are also expected to meet the same standard.

Window and door furniture and fittings must be resistant to the effects of the saline environment.

Where back ground ventilators (trickle vents) are installed, they must be correctly specified for the location and should be installed so as not cause potential damage to render finishes or restrict the ability to open the window/door.

Balconies

The following guidance is to be read in addition to the guidance found in the 'Roof Terraces and Balconies' section.

Balcony construction
The materials used in balcony construction must comply with the relevant Building Regulations.

An adequate step or raised threshold must be provided to avoid the risk of penetrating moisture created by the high wind driven rain. A minimum of 75mm upstand between the highest point of the balcony roof waterproof surface and the underside of the door sill should be provided, 150mm in all other situations.

In all locations:

- A flush fitting balcony floor finish abutting any door unit in the external wall of the dwelling must not occur as this could lead to a concentration of water against the window frame. A minimum gap of at least 10mm will be required which should be maintainable to ensure build up of any silt or other debris is avoided.
- Where a decorative walking surface deck is installed above; the balcony roof waterproof covering must be designed to fall away from any external doors opening into the building to prevent water pooling against the door units due to lack of fall.
- Drainage outlets must be easily accessible and maintainable even if decking/balcony floor finishes are applied.
- Fixings used in balcony decking or guarding must be appropriately specified to prevent adverse reaction with certain timbers.
- Regular maintenance of balcony floors will be required to avoid wind blown sand clogging up drainage outlets and balcony door seals and tracks.
- Balcony steelwork must be adequately protected against the potential for corrosion ('Appendix C - Materials, Products, and Building Systems').

C.

Appendix C

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.

Workmanship

1. All workmanship must be within the tolerance requirements set out in this Technical Manual.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
2. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
3. All load bearing structural elements providing support to the Home will have a service life of not less than 60 years, unless specifically agreed otherwise with us. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
4. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/ door or ‘decorative external cladding’ (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
5. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
6. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
7. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
8. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. All MMC systems must be designed and built using certified materials, have quality management systems in place for the manufacture of the system and have been accepted by our Warranty Innovations Department prior to an offer of Warranty is issued.
2. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
3. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
4. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
5. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.

C.
Appendix C

C.1
Materials, Products, and Building Systems

Timber storage

Timber should be stored correctly to ensure it does not deteriorate. It should be kept dry and covered in cold conditions to prevent surface freezing, and should be kept off the ground and spaced to allow air to move around freely. Timber should be kept flat to prevent warping or twisting.

Handling and transportation of roof trusses

When transporting and handling trussed rafters, sagging and flexing should be avoided at all times. Whether handling is manual or by using mechanical equipment, trusses should be moved in a vertical positions unless support can be provided to every joint.

Manual lifting of roof trusses

On long-span trusses, it may be necessary to employ additional labour at intermediate positions. If required, the truss may be inverted so that the apex hangs down. See-sawing the truss across walls and scaffolding must be avoided. Individual designs and site conditions may dictate different requirements in order to install trusses in their final position.

Mechanical lifting of roof trusses

Ideally, when using mechanical lifting, the trusses should be lifted in banded sets and lowered onto suitable supports. Lifting points should be rafter or ceiling intersections or node points. Lifting trusses singularly should be avoided a suitable spreader bar should be used to withstand the sling force.

Timber durability and preservative treatment

Timber and joinery used in the construction shall either have adequate natural durability or be preservative treated against fungal decay and insect attack with the preservative treatment being in accordance with BS 8417.

BS 8417 provides information to establish the appropriate type of treatment according to the particular element and conditions of use. Tables 1 to 3 of BS 8417 must be referred too to identify 'Use classes, 'Service Factor code' and durability class of wood for the desired service life.

It is important that any pre-treated timber be re-treated if it is cut to expose untreated end grain. The treatment should be coloured so it can be proven that the end grain has been treated.

Timber grading

Timber should be of the appropriate strength classification in order to meet its design intention. For timber that is to be used for structural purposes e.g. floor joists, rafters and ceiling joists, the minimum strength classification should be C16.

Preservative treatment

Preservative treatment of roof timbers is normally unnecessary, except where specifically required under relevant standards and Codes of Practice, and in the following circumstances:

- Roof timbers should be preservative treated where the insulation and ceiling line follow the roof pitch.
- Trussed rafter construction which is cut back at eaves or where the rafter 'feet' are trimmed to sit into the external walls. Preservative treatment will be required to the cut ends.
- The Approved Document of Regulation 7 of the Building Regulations for England requires that in certain geographical areas, all softwood roof timbers should be treated against attack by the House Longhorn Beetle.

The areas at risk are:

- The District of Bracknell Forest.
- The Borough of Elmbridge.
- The Borough of Guildford (other than the area of the former Borough of Guildford).
- The District of Hart (other than the area of the former Urban District of Fleet).
- The District of Runnymede.
- The Borough of Spelthorne.
- The Borough of Surrey Heath.
- In the Borough of Rushmoor, the area of the former district of Farnborough.
- The District of Waverley (other than the parishes of Godalming and Haslemere).
- In the Royal Borough of Windsor and Maidenhead, the parishes of Old Windsor, Sunningdale and Sunninghill.
- The Borough of Woking.

The timber should be impregnated with a preservative suitable for use in 'Use Class 1' in pitched roofs (Class 2 if in pitched roofs with high condensation risk) and 'Use Class 2 flat roofs', in accordance with BS 8417, for a 60 year anticipated service life. Cut ends must be liberally brushed or dipped with an end-grain preservative.

It is strongly recommended that, where punched metal fasteners are proposed to roof trusses, only micro-emulsion or organic solvent preservatives should be used for timber treatment, to limit the possibility of corrosion of the fasteners and so as not to adversely affect glued joints.

Natural durability recommendations for timber components (based on natural durability against fungi given in BS EN 350-2)

Component	Use Class (table 1 BS 8417)	Minimum durability class of wood for which heartwood can be used without treatment		Examples of service situations
		Desired service life* =		
		15 years	60 years	
Internal joinery	1	5	5	Internal joinery and timbers in upper/intermediate floors not built into solid walls
Roof timbers (dry)	1	5	5	Wood in pitched roofs except tiling battens and valley gutter members
Roof timbers (dry) (Longhorn beetle area)	1	3	3	As above
Roof timbers (risk of wetting)	2	4	2	Tiling battens, wood in pitched roofs with high condensation risk, flat roof timbers, ground floor joists
External walls/ground floor joists	2	4	2	Frame timbers in timber frame houses, ground floors joists
Sole plates above DPC	2	3	2	Sole plates
External Joinery (non-load-bearing coated) and cladding (coated)	3 coated	4	2	Coated cladding, soffits, fascias, windows and doors, valley gutter timbers
Fence rails, deck boards and joists, external joinery (non load-bearing uncoated) and cladding uncoated	3 uncoated	3	1	Uncoated cladding, decking timber that are not in contact with the ground
Deck posts	4	2	1	
Poles	4	2	1	
Sleepers	4	2	1	

* See service life table at the end of this section.

Above table is adapted from BSI Standards Publication BS8417:2011+A1:2014 Preservation of wood – Code of practice, Tables 1 & 3

Green and air dried/seasoned oak

For the purposes of this section there are three types of oak we are referring to:
- Green Oak- Recently felled oak with a moisture content typically between 60%-80%.
- Air dried (seasoned) Oak- Naturally stored oak with a natural seasoning process moisture content up to 30%.
- Certified Kiln Dried Oak- Processed seasoned timber with a moisture content of 12% or less.

Green Oak, air dried/seasoned oak is not acceptable for including in the external wall construction, frame, window/door construction, internal wall, or roof constructions, regardless of whether it forms part of the waterproof envelope or not, AND will not be acceptable for Warranty cover except where described below.

Green Oak or air dried oak will not be acceptable for projects requiring Warranty cover in the following situations:
- A structural element/component, either internally or externally of the property to be constructed, regardless of whether it forms part of the waterproof envelope or not.
- Windows and doors.

Air dried oak may only be acceptable in the following location:
- External cladding finish materials, subject to moisture content at the time of installation (max.16%) and a suitable second line of weather proof envelope defence provided behind the cladding to protect the structural substrate and internal linings.

Certified kiln dried Oak is not acceptable for use:
- As an external ‘structural’ element/component of the property to be constructed, regardless of whether it forms part of the waterproof envelope or not.

Certified kiln dried Oak with a certified maximum moisture content of 12% may only be acceptable for:
- Parts of the internal structure where any movement of the oak will not affect the waterproof envelope e.g. floor beams, floor joists, roof trusses and purlins; providing the Engineer proves that any shrinkage / twisting in the oak will be catered for and be isolated from the waterproof envelope.
- Windows and doors, see guidance in the ‘External Windows and Doors - Additional Requirements for External Timber Window and Door Frames’ section for manufacturing criteria/testing.

Please note: independent cladding/decorative cladding (i.e. Mock Tudor Cladding) which is not built into the wall should have a certified moisture content of 16% +/- 2%.

‘Green’ timber species used instead of oak

Where ‘green’ timber species are proposed, they should be specified based on the required service life as specified within this section.

Metal fixings

Metal components should be austenitic stainless steel, sherardized or galvanised where they are to be fixed or used adjacent to treated timber.

Standards referred to

- BS EN 1912 Structural timber-strength classes - Assignment of visual grade and species.
- BS EN 1995-1-1 Eurocode Design of timber structures.
- BS 8417 Preservative of wood - Code of Practice.
- BS EN 335 Durability of wood and wood based products.

Concrete

Cold weather working
To meet the Functional Requirements, the minimum working temperature should not fall below 2°C. It is important that during cold weather periods, regular temperature readings should be taken. Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure, and make the necessary allowances for sites that have a higher level of exposure.

Ready mixed concrete
It is a requirement of BS 8500 and BS EN 206-1 that the temperature of fresh concrete shall not be below 5°C at the time of delivery. Measures should also be put in place to ensure immature concrete is prevented from freezing before sufficient strength has been achieved.

Site mixed concrete
Site mixing is acceptable at low temperatures, provided:

- The minimum temperature is no less than 2°C.
- The concrete is appropriately protected during curing.
- Ground conditions are not frozen.

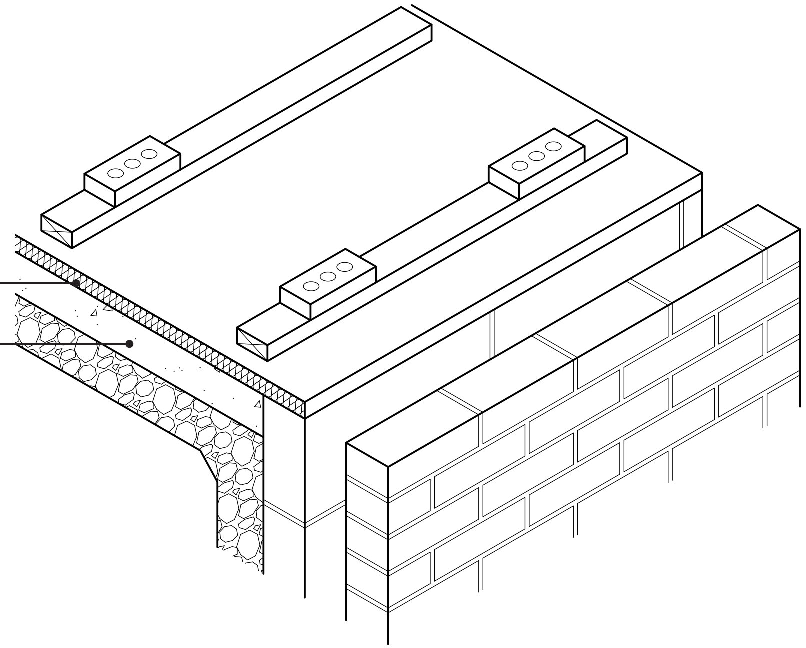
Concreting of foundations and oversite
Concrete should not be poured if the ground is frozen as frozen ground can change in stability and volume during thawing, and therefore may cause damage to the recently poured concrete.

During cold weather, it may be appropriate to cover the ground to prevent freezing and, in some extreme cases, heating of the ground may be required.

Other concreting
Concrete reinforcing and formwork should not be frozen and be free from snow and ice.

Curing of concrete
Concrete may take longer to cure in cold conditions, and an additional six days may be required in extreme cases. Concrete may be covered with a rigid insulation to prevent freezing during curing periods. This is particularly useful for oversized slabs. Concrete should not be poured if the ground is frozen, or if the temperature is less than 2°C.

Concrete curing in cold weather conditions



Concrete suitability

Concrete of the appropriate durability and strength should be used in all circumstances. The Table below gives details of the correct concrete for varying applications.

Please note: Non-cement based concrete products need prior approval by us.

Application	Ready mixed concrete	Site mixed concrete	Consistence class
Substructure Blinding (unreinforced) Backfilling	GEN1	N/A	S3
Substructure (unreinforced) Structural blinding Strip, trench, and mass filled foundations Concreting of cavity walls to ground level	GEN1	N/A	S3/S4[1]
Floor (unreinforced and unsuspended) with screed added or other floor finish Floor slab as finish (e.g. power float)	GEN1 GEN2	N/A N/A	S2 S2
Garage floors (unreinforced and unsuspended)	GEN3	N/A	S2
Reinforced slabs (buildings and garages suspended or unsuspended)	RC35	N/A	S2
Superstructure	As specified by an Engineer	N/A	As specified by an Engineer
External works: Pathways Bedding for paving slabs	 PAV1 GEN1	 ST5 ST1	 S2 S1

Note:
1. Consistence class S3 should be used for strip foundation concrete and consistence class S4 should be used for trench fill foundation concrete.

Concrete mixes

Site mixed concrete
Site mixed concrete should generally be avoided unless it is for non-structural applications e.g. backfilling or bedding of paving slabs etc. There may be exceptional circumstances where site mixing is unavoidable. Where this is the case, extra caution must be taken to ensure that the correct mix proportion is used; delivery notes should be provided if necessary, and a provision for testing may be required.

Ready mixed concrete
Concrete must be mixed using the correct proportions of cement, sand, aggregate and water. Ready mixed concrete should be delivered as close as possible to the site works and should be poured immediately to prevent settlement or separation of the mix. Ideally, ready mixed concrete should be poured within two hours of the initial mixing at the concrete plant.

Ready mixed concrete should only be sourced from a supplier who has a quality control system in place to ensure the correct standard of concrete is delivered. The quality control scheme should be either QSRMC (Quality Scheme for Ready Mixed Concrete) or a relevant British Standard Kite mark scheme.

It is important to pass all design specifications of the concrete to the ready mixed supplier to ensure that the delivered concrete meets the design intention.

Delivery notes should be kept and made available for inspection if required.

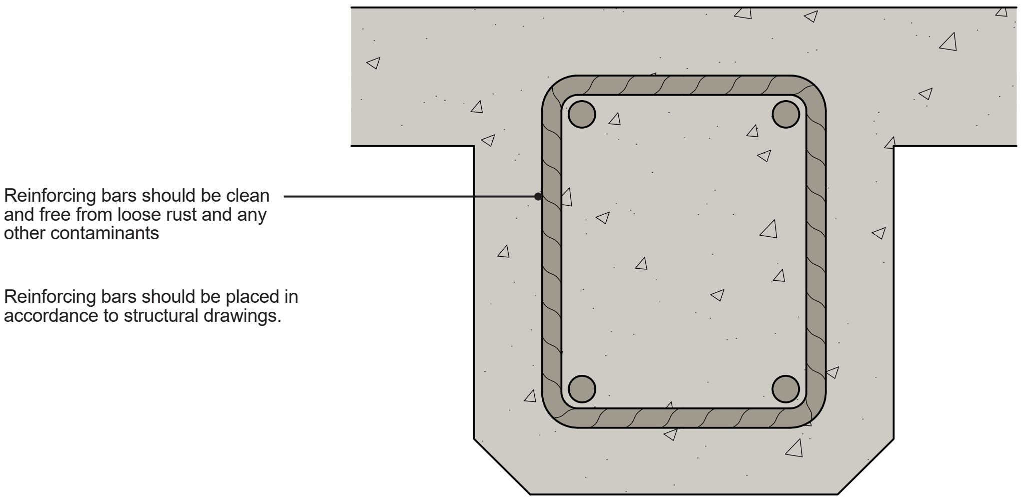
Additional water should not be added to the concrete on-site, nor should the ready mixed concrete be poured into water-filled trenches unless the concrete has been specifically designed for this purpose.

Reinforcing

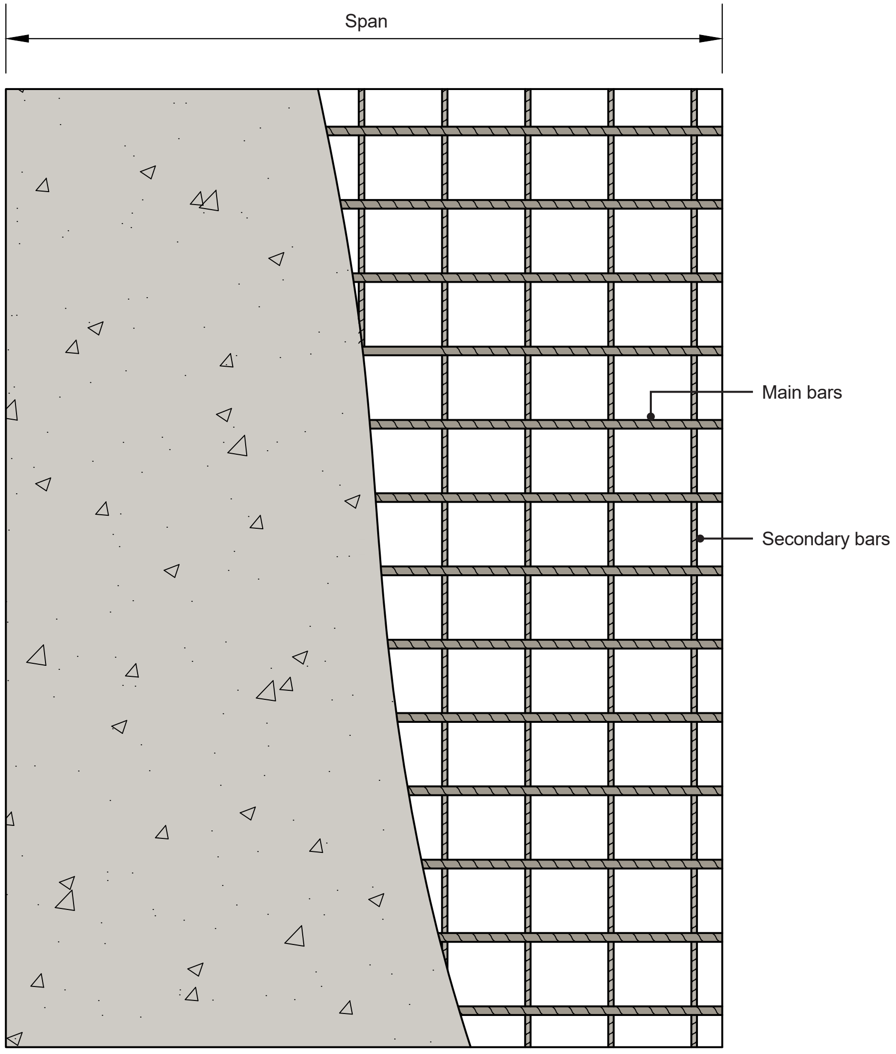
Reinforcing bars and mesh should be clean and free from loose rust and any other contaminants that may cause deterioration of the reinforcing material or the durability of the concrete.

Reinforcing bars and mesh should be placed in accordance with structural drawings; bars that are to be bent should be done so using the correct tools for the job.

Reinforcing bars in concrete beams



Position of bars on reinforced concrete slab



Reinforcing bars should be correctly positioned, ensuring there is appropriate concrete cover, and reinforcing mesh placed in the right direction (main bars parallel to span).

Reinforcing cover

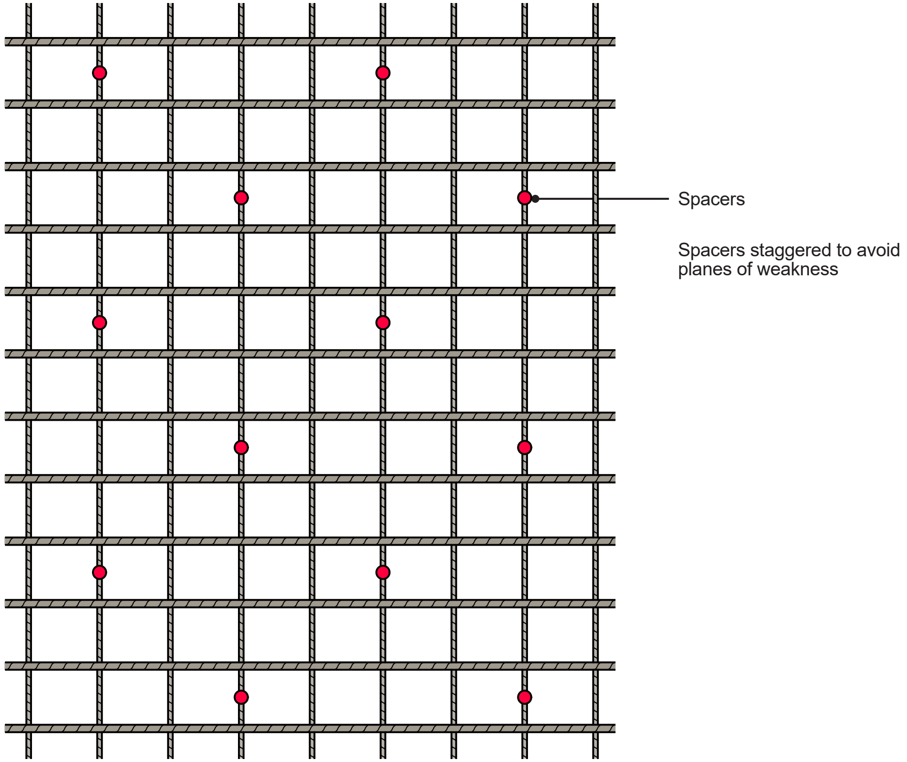
An appropriate level of concrete cover should be provided to the reinforcement; the cover thickness will depend on the exposure of the concrete and its application. Concrete cover should be specified by an Engineer, or alternatively by using the table below.

Minimum concrete reinforcing cover

Application (concrete position)	Minimum cover (mm)
Concrete in direct contact with the ground	75
All external applications e.g. shuttered walling	50
Floor slabs and other applications where concrete is cast onto a membrane	40
Concrete over blinding concrete	40
Internal conditions	25

Reinforcing should be supported by proprietary chairs or spacers, and can be made of concrete, plastic or steel. The thickness and depth of a concrete spacer should not exceed 50mm x 50mm. Spacers should be placed at a maximum of 1m centres, and when supporting mesh should be staggered.

Position of spacers



Admixtures

Admixtures should only be used if stipulated as part of the original design specification. If an admixture is to be proposed where it was not intended as part of the design, an Engineer must confirm that the admixture is appropriate and required.

It is important that the appropriate amount of admixture is applied to any mix. Any overdosing may cause concrete deterioration or poor workability.

Common admixtures

- Plasticisers - improve the workability of concrete, especially when pumped; they can also improve concrete adhesion, which is particularly enhanced when concrete is reinforced.
- Air entraining agents - increase the air void volume of concrete, which in turn produces a surface more resilient to cold weather, and is therefore ideally suited to outdoor conditions where cold weather exposure is high, such as pathways or roads.
- Accelerators - provide an improved curing time, but caution should be taken to allow for reasonable time to 'finish' the concrete.

Admixtures in cold weather
Admixtures may be used in cold weather, but usually will not assist in preventing concrete from freezing; therefore, they should not be relied upon to compensate for freezing conditions. The guidance for cold weather working should be followed in these circumstances.

Admixtures and reinforcing
Admixtures containing chloride will cause corrosion to occur, meaning they should not be used in concrete containing reinforcing.

Expansion/movement joints

Joints in concrete should be provided to prevent cracking caused by shrinkage; shrinkage will be less significant if the concrete is reinforced.

A larger number of expansion joints should be provided to concrete where weak spots may occur. This could include a narrowing width of floor slab for example.

Vibration and compaction of concrete

Reinforced concrete should be compacted using a vibrating poker, but care must be taken to ensure the concrete is not over-compacted and the concrete mix separated.

Curing of concrete

Concrete should be adequately cured before loads are applied. It is acceptable that masonry walls may be built up to damp proof course (DPC) on a foundation that is not fully cured; however, care must be taken to prevent any damage to the foundation. The concrete should be at least durable enough to carry the masonry.

The speed at which concrete mixes cure depends on the mix ratio and whether there are any additives within the concrete. Where curing time is critical, such as cast in-situ upper floors, curing times should be indicated as part of the design and formwork struck, as advised by an Engineer.

To prevent concrete curing too rapidly after initial drying, exposed concrete should be covered with hessian, polythene or sand. This prevents the surface drying too quickly and protects the concrete. This level of protection is particularly critical in hot or adverse weather conditions.

Standards referred to:

- BS 8110 Structural use of concrete.
- BS EN 1992-1-1 Design of concrete structures, general rules and rules for buildings (incorporating UK National Annex to Eurocode).
- BS 8500 Concrete - Complementary British Standard to BS EN 206-1.
- BS EN 206-1 Concrete. Specification, performance, production and conformity.
- BS EN 12620 Aggregates for concrete.
- BS EN 197 Cement. Conformity evaluation.

Cold weather working

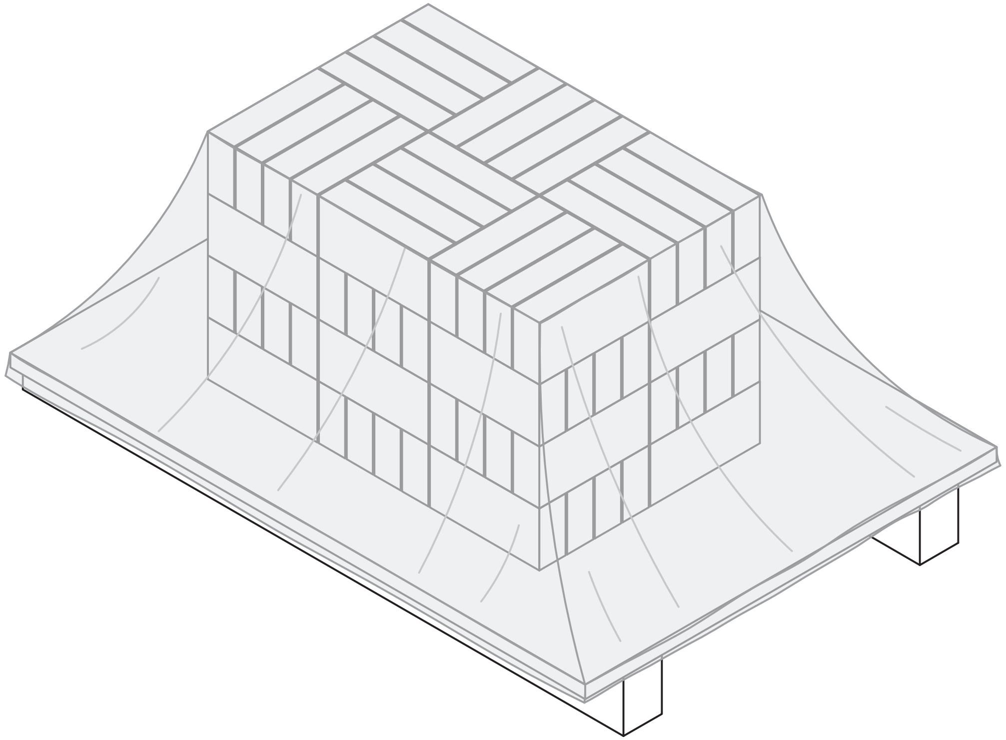
To meet the Functional Requirements of this Technical Manual, the minimum working temperatures should not fall below 2°C when working with masonry. It is important that during cold weather periods, regular temperature readings should be taken.

Thermometers should be placed away from direct sunlight, preferably in a shaded area. When assessing the temperature, it is also important to consider wind chill and weather exposure, and make necessary allowances for sites that have a higher level of exposure.

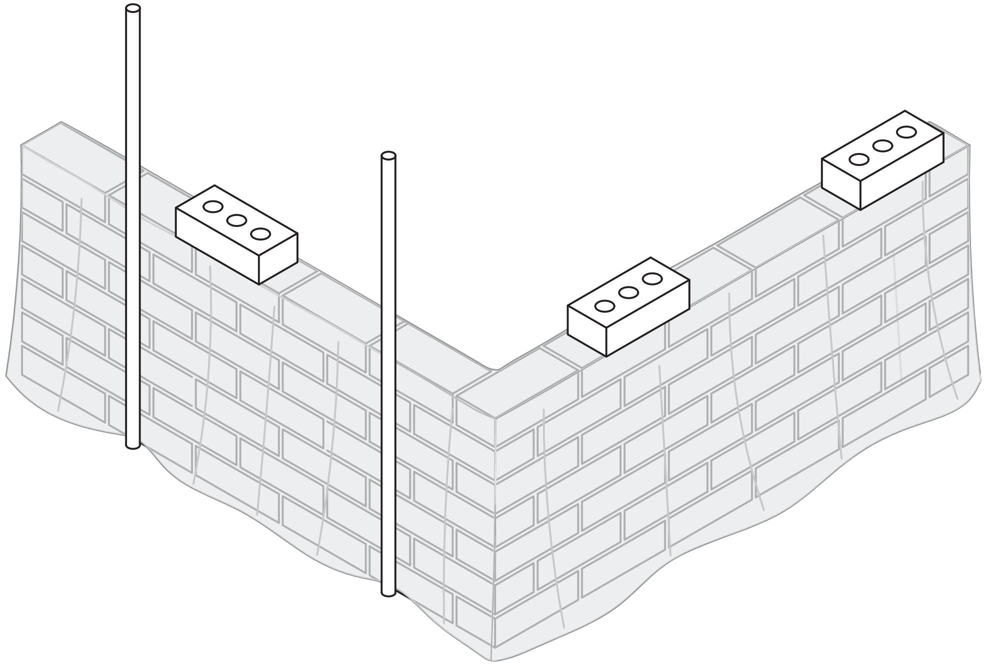
Protection of materials

Covers should be provided to protect materials from frost, snow and ice, particularly bricks, blocks, sand and cement. Frozen materials should never be used under any circumstances.

Protection of blockwork



Protection of masonry walls



Protection of masonry

Any new walls or other masonry construction will require protection against frost where temperatures are expected to drop below 2°C. Ideally, all masonry should be protected with polythene or hessian. If temperatures are expected to fall to an extremely low level, insulation boards may be required, and heating may even be considered.

Finishes including rendering, plastering and screeds

Rendering should only be completed if the outside temperature is at least 2°C; there should be no frost within the construction that is to be rendered and, where possible, rendering should not take place where freezing weather conditions are anticipated prior to adequate curing.

No plastering or screeding should take place unless the building is free from frost. It is acceptable to use internal heating to warm the building effectively; however, it is important to ensure that heaters do not emit excessive vapour into the building. Adequate ventilation should be provided to allow moist air to escape. The building should be appropriately pre-heated before plastering, and continue to be heated whilst the plaster dries.

Masonry units

Masonry units should be of an appropriate durability to meet the design intention. The type of masonry unit to be used will affect the specification of the mortar. Masonry units with greater durability should be used where there is a higher potential for saturation or severe exposure to wind-driven rain. Refer to the masonry unit manufacturer when making this selection.

Due to difficulties in testing the durability of the exact batch proposed to be used, reclaimed bricks should not be used for Warranty purposes.

The following table is derived from PD 6697 - Durability of masonry in finished construction and provides guidance of the suitably of masonry in different areas of construction. This table should be read in conjunction with the following table ‘Classification of micro conditions of exposure of completed masonry which gives further guidance on the masonry condition or saturation.

Please note: Non-cement based concrete products need prior approval by us.

Durability of masonry in finished construction (derived from PD 6697 - 2019)

Masonry condition or situation (A)	Quality of masonry units and appropriate mortar designations				
	Clay units	**Calcium silicate units**	**Aggregate concrete bricks**	**Aggregate concrete, autoclaved aerated concrete blocks and manufactured stone units**	**Remarks**
(A) Work below or near external ground level					
A1 - Low risk of saturation without freezing MX2.1	P – F0 and S0 or U – F0, F1 or F2 and S0, S1 or S2 in M12, M6 or M4	Without or with freezing Compressive strength class 20 or above in M4 or M2 (see remarks)	Without or with freezing Mean compressive strength 16.5 N/mm² or above in M4	Without or with freezing a) of net density ≥ 1500 kg/m³; or b) made with dense aggregate conforming to BS EN 12620; or c) having a mean net compressive strength ≥ 7.3 N/mm²; or d) most types of autoclaved aerated unit (see remarks) or e) all types of manufactured stone units. All in M4 or M2 (see remarks)	Some types of autoclaved aerated concrete block may not be suitable. The manufacturer should be consulted. In sulfate bearing ground conditions, the recommendations in 6.2.9.4 (see PD 6697:2019) should be followed. Where designation M2 mortar is used it is essential to ensure that all masonry units, mortar and masonry under construction are protected fully from saturation and freezing. Some manufacturers of clay units do not recommend the use of their U -F1 units for work below or near external ground level.
A2 - High risk of saturation without freezing MX2.2	U – F1 or F2, and S1 or S2 in M12, M6 or M4 unless a manufacturer advises against the use of F1	Compressive strength class 20 or above in M6 or M4	Mean compressive strength 16.5 N/mm² or above in M6 or M4	As for A1 in M6 or M4	Masonry most vulnerable in situations A2 and A3 is located between 150 mm above and 150 mm below finished ground level. In this zone masonry will become wet and can remain wet for long periods, particularly in winter. Where S1 clay units in designation M6 mortar are used in A2 or A3 locations, the recommendations in 6.2.9.4 (see PD 6697:2019) should be followed. In conditions of highly mobile groundwater, consult the manufacturer on the selection of materials (see 6.2.8.1.10 to 6.2.8.1.14).
A3 - High or low risk of saturation with freezing MX3.1, MX3.2	U – F2 and S2 in M12 or M6 (see remarks)	Compressive strength class 20 or above in M6 or M4	Mean compressive strength 22 N/mm² or above in M6 or M4	As for A1 in M6	
(B) Masonry DPCs (masonry DPC’s are not acceptable for Warranty purposes)					
(C) Unrendered external walls (other than chimneys, cappings, copings, parapets, sills)					
C1 - Low risk of saturation MX3.1, MX4, MX5	U – F2 and S2 in M12, M6 or M4	Compressive strength class 20 or above in M4 or M2 (see remarks)	Mean compressive strength 7.3 N/mm² or above in M4	Any in M4 or M2 (see remarks)	To minimize the risk of saturation, walls should be protected by roof overhang and other projecting features. However, such details may not provide sufficient protection to walls in conditions of very severe driving rain (see 6.2.7.4 of PD 6697:2019). Certain architectural features, e.g. brick masonry below large glazed areas with flush sills, increase the risk of saturation (see 6.2.8.5 of PD 6697:2019).
C2 - High risk of saturation MX3.2, MX4, MX5	U – F2 and S2 in M12 or M6 (see remarks)	Compressive strength class 20 or above in M4	Mean compressive strength 18 N/mm² or above in M4	Any in M4	Where designation M2 mortar is used it is essential to ensure that all masonry units, mortar and masonry under construction are protected fully from saturation and freezing.
D) Rendered external walls (B) (other than chimneys, cappings, copings, parapets, sills)					
Rendered external walls. Any exposure condition.	U – F1 or F2 and S1 or S2 in M12, M6 or M4 (see remarks)	Compressive strength class 20 or above in M4 or M2 (see remarks)	Mean compressive strength 7.3 N/mm² or above in M4	Any in M4 or M2 (see remarks)	Rendered walls are usually suitable for most wind-driven rain conditions (see 6.2.7.4 of PD 6697:2019). Where S1 clay units are used, the recommendations in 6.2.9.4 (see PD6697:2019) should be followed for the jointing mortar and the base-coat of render. Clay units of F1/S1 designation are not recommended for the rendered outer leaf of a cavity wall with full fill insulation (see 6.2.7.4.2.9 of PD 6697:2019) For Warranty purposes render on an external leaf of clay bricks (F2, S1, or F1, S1 designation bricks BS EN771) in severe or very severe exposures is not permitted where the cavity is to be fully filled with insulation.

Masonry condition or situation [A]	Quality of masonry units and appropriate mortar designations				
	Clay units	**Calcium silicate units**	**Aggregate concrete bricks**	**Aggregate concrete, autoclaved aerated concrete blocks and manufactured stone units**	**Remarks**
(E) Internal walls and inner leaves of cavity walls					
Internal walls and inner leaves of cavity walls MX1	P – F0 and S0 or U – F0, F1 or F2 and S0, S1 or S2 in M12, M6, M4 or M2 (see remarks)	Compressive strength class 20 or above in M4 or M2 (see remarks)	Mean compressive strength 7.3 N/mm² or above in M4 (see remarks)	Any in M4 or M2 (see remarks)	Where designation M2 mortar is used it is essential to ensure that all masonry units, mortar and masonry under construction are protected fully from saturation and freezing
(F) Unrendered parapets (other than cappings and copings)					
F1 - Low risk of saturation with freezing, e.g. low parapets on some single storey buildings MX3.1, MX4	U – F2 and S2 in M12, M6 or M4	Compressive strength class 20 or above in M4	Mean compressive strength 22 N/mm² or above in M4	a) Of net density ≥ 1 500 kg/m³; or b) Made with dense aggregate conforming to BS EN 12620; or c) Having a mean net compressive strength ≥ 7.3 N/mm²; or d) Most types of autoclaved aerated unit (see remarks); or e) All types of manufactured stone unit f) All in M4	Most parapets are likely to be severely exposed irrespective of the climatic exposure of the building as a whole. Copings and DPCs should be provided wherever possible. Some types of autoclaved aerated concrete block may not be suitable. The manufacturer should be consulted.
F2 - High risk of saturation with freezing e.g. where a capping only is provided for the masonry MX3.2, MX4	U – F2 and S2 in M12 or M6 (see remarks)	Compressive strength class 20 or above in M4	Mean compressive strength 22 N/mm² or above in M4	As for F1 in M6	
G) Rendered parapets (other than cappings and copings)					
Rendered parapets MX3.1, MX3.2, MX4	U – F1 or F2 and S1 or S2 in M12, M6 or M4 (see remarks)	Compressive strength class 20 or above in M4	Mean compressive strength 7.3 N/mm² or above in M4	Any in M4	Single-leaf walls should be rendered only on one face. All parapets should be provided with a coping. Where S1 clay units are used, the recommendations in 6.2.8.4 (see PD6697:2019) should be followed.
(H) Chimneys					
H1 - Unrendered with low risk of saturation MX3.1, MX4, MX5	U – F2 and S2 in M12, M6 or M4 (see remarks)	Compressive strength class 20 or above in M4 (see remarks)	Mean compressive strength 12 N/mm² or above in M4 (see remarks)	Any in M4	Chimney stacks are normally the most exposed masonry on any building. Because of the possibility of sulfate attack from flue gases the recommendations in 6.2.9.4 (see PD6697:2019) should be followed.
					Brick masonry and tile cappings cannot be relied upon to keep out moisture. The provision of a coping is preferable.
H2 - Unrendered with high risk MX3.2, MX4, MX5	U – F2 and S2 in M12 or M6 (see remarks)	Compressive strength class 20 or above in M4 (see remarks)	Mean compressive strength 16.5 N/mm² or above in M4 (see remarks)	a) Of net density ≥ 1 500 kg/m³; or b) Made with dense aggregate conforming to BS EN 12620; or c) Having a mean net compressive strength ≥ 7.3 N/mm²; or d) Most types of autoclaved aerated unit (see remarks) or e) All types of manufactured stone unit	Some types of autoclaved aerated concrete block may not be suitable for use in situation H2. The manufacturer should be consulted.
H3 - Rendered MX3.1, MX3.2, MX4, MX5	U – F1 or F2 and S1 or S2 in M12, M6 or M4 (see remarks)	Compressive strength class 20 or above in M4 (see remarks)	Mean compressive strength 7.3 N/mm² or above in M4 (see remarks)	Any in M6	Where S1 clay units are used, see 6.2.8.4.
(I) Cappings, copings and sills					
Cappings, copings and sills MX3	U – F2 and S2 in M12	Compressive strength class 30 or above in M6	Mean compressive strength 33 N/mm² or above in M6	a) Of net density ≥ 1 500 kg/m³; or b) Made with dense aggregate conforming to BS EN 12620; or c) Having a mean net compressive strength ≥ 7.3 N/mm²; or d) All types of manufactured stone unit e) All in M6	Autoclaved aerated concrete blocks are not suitable for use in situation I. Where cappings or copings are used for chimney terminals, the recommendations in 6.2.8.4 (see PD6697:2019) should be followed. DPCs for cappings, copings and sills should be bedded in the same mortar as the masonry units.
(J) Freestanding boundary and screen walls (other than cappings and copings). (This section is not produced for Warranty purposes. For further information please see PD 6697-2019)					

Masonry condition or situation (A)	Quality of masonry units and appropriate mortar designations				
	Clay units	**Calcium silicate units**	**Aggregate concrete bricks**	**Aggregate concrete, autoclaved aerated concrete blocks and manufactured stone units**	**Remarks**
(K) Earth retaining walls (other than cappings and copings)					
K1 - With water-proofing on retaining face and coping MX3.1, MX3.2, MX4	U – F2 and S2 in M12 or M6. Refer to (B) for units from foundation to 150 mm above ground level.	Compressive strength class 20 or above in M6 or M4	Mean compressive strength 16.5 N/mm² or above in M6	a) of net density ≥ 1 500 kg/m³; or b) made with dense aggregate conforming to BS EN 12620; or c) having a mean net compressive strength ≥ 7.3 N/mm²; or d) most types of autoclaved aerated unit (see remarks); or e) all types of manufactured stone unit f) All in M4	Because of possible contamination from the ground and saturation by ground waters, in addition to subjection to severe climatic exposure, masonry in retaining walls is particularly prone to frost and sulfate attack. Careful choice of materials in relation to the methods for exclusion of water recommended in 6.2.8 (see PD6697:2019) is essential. It is strongly recommended that such walls be backfilled with freedraining materials. The provision of an effective coping with a DPC (see 6.2.8 of PD 6697:2019) and waterproofing of the retaining face of the wall (see 6.8.6 of PD 6697:2019) is desirable. Some types of autoclaved aerated concrete block are not suitable for use in situation K1; the manufacturer should be consulted.
K2 -With coping or capping but no water-proofing on retaining face MX3.1, MX3.2, MX4, MX5	Consult the manufacturer	Compressive strength class 30 or above in M6	Mean compressive strength 33 N/mm² or above in M12 or M6	As for K1 but in M12 or M6 (see remarks)	Some aggregate concrete blocks are not suitable for use in situation K2; the manufacturer should be consulted.
L) Drainage and sewage, e.g. inspection chambers, manholes					
L1 - Surface water MX3.1, MX3.2, MX5	Max. water absorption 7 % in M12 (in line with historic DPC and engineering brick categories) or F2 and S2 in M12 (see remarks)	Compressive strength class 20 or above in M6 or M4	Mean compressive strength 22 N/mm² or above in M4	a) Of net density ≥ 1 500 kg/m³; or b) Made with dense aggregate conforming to BS EN 12620; or c) Having a mean net compressive strength ≥ 7.3 N/mm²; or d) All types of manufactured stone unit in M4	If sulfate ground conditions exist, the recommendation in 6.2.8.4 (see PD6697:2019) should be followed. Some types of autoclaved aerated block are not suitable for use in situation L1; the manufacturer should be consulted."
L2 - Foul drainage (continuous contact with masonry) MX3.1, MX3.2, MX5	Max. water absorption 7 % in M12 (in line with historic DPC and engineering brick categories) or F2 and S2 in M12 (see remarks)	Compressive strength class 50 or above in M6 (see remarks)	Mean compressive strength 48 N/mm² or above with cement content ≥ 350 kg/m³ in M12 or M6	Not suitable	Some types of calcium silicate brick are not suitable for use in situations L2 or L3; the manufacturer should be consulted.
L3 - Foul drainage (occasional contact with masonry) MX3.1, MX3.2, MX5	Max. water absorption 7 % in M12 (in line with historic DPC and engineering brick categories) or F2 and S2 in M12 (see remarks)	Compressive strength class 20 or above in M6 or M4 (see remarks)	Mean compressive strength 48 N/mm² or above with cement content ≥ 350 kg/m³ in M12 or M6	Not suitable	

A) For the classification of micro conditions of exposure of completed masonry MX1, 2, 3, 4 and 5, see BS EN 1996-2:2006, Annex A, and NA to BS EN 1996-2:2006.

B) For Warranty purposes a specialist render system and mortar should be employed for parapets, chimneys, retaining walls and walls below DPC.

LD - Clay masonry units with a low gross density for use in protected masonry.

HD - Clay masonry unit for unprotected masonry as well as clay masonry unit with high gross dry density for use in protected masonry.

The table below should be read in conjunction with table above 'Durability of masonry in finished construction'. The table below provides further information on the environment in which the masonry maybe suitable.

Classification of micro conditions of exposure of completed masonry (reproduced from BS EN 1996-2:2006)

Class	Micro condition of masonry	Examples of masonry in this condition
MX1	**In a dry environment**	Interior of buildings for normal habitation and for offices, including the inner leaf of external cavity walls not likely to become damp. Rendered masonry in exterior walls, not exposed to moderate or severe driving rain, and isolated from damp in adjacent masonry or materials.
MX2	**Exposed to moisture or wetting**	
MX2.1	Exposed to moisture but not exposed to freeze/thaw cycling or external sources of significant levels of sulfates or aggressive chemicals.	Internal masonry exposed to high levels of water vapour, such as in a laundry. Masonry exterior walls sheltered by overhanging eaves or coping, not exposed to severe driving rain or frost. Masonry below frost zone in well drained non-aggressive soil.
MX2.2	Exposed to severe wetting but not exposed to freeze/thaw cycling or external sources of significant levels of sulfates or aggressive chemicals.	Masonry not exposed to frost or aggressive chemicals, located: in exterior walls with capping's or flush eaves; in parapets; in freestanding walls; in the ground; under water.
MX3	**Exposed to wetting plus freeze/thaw cycling**	
MX3.1	Exposed to moisture or wetting and freeze/thaw cycling but not exposed to external sources of significant levels of sulfates or aggressive chemicals.	Masonry as class MX2.1 exposed to freeze/thaw cycling
MX3.2	Exposed to severe wetting and freeze/thaw cycling but not exposed to external sources of significant levels of sulfates or aggressive chemicals.	Masonry as class MX2.2 exposed to freeze/thaw cycling.
MX4	**Exposed to saturated salt air seawater or de-icing salts**	Masonry in a coastal area. Masonry adjacent to roads that are salted during the winter
MX5	**In an aggressive chemical environment**	Masonry in contact with natural soils or filled ground or groundwater, where moisture and significant levels of sulfates are present. Masonry in contact with highly acidic soils, contaminated ground or groundwater. Masonry near industrial areas where aggressive chemicals are airborne.
Note: In deciding the exposure of masonry the effect of applied finishes and protective claddings should be taken into account.		

Acceptable assumed equivalent mixes for prescribed mortars (reproduced from BS EN 1996-1 UK National Annex to Euro Code 6: Design of Masonry Structures Table NA.2)

Compressive strength class a)	Prescribed mortars (proportion of materials by volume) (see note)				Mortar designation	Suitable for use in environmental condition
	Cement b): Lime : Sand with or without air entrainment	Cement b): Sand with or without air entrainment	Masonry cement c): Sand	Masonry cement d): Sand		
M12 M6 M4 M2	1: 0 to ¼: 3 1 : ½ : 4 to 4 ½ 1 : 1 : 5 to 6 1 : 2 : 8 to 9	1 : 3 1 : 3 to 4 1 : 5 to 6 1 : 7 to 8	Not suitable 1 : 2 ½ to 3 ½ 1 : 4 to 5 1 : 5 ½ to 6 ½	Not suitable 1 : 3 1 : 3 ½ to 4 1 : 4 ½	(i) (ii) (iii) (iv)	Severe (S) Severe (S) Moderate (M) Passive (P)

a) The number following the M is the compressive strength for the class at 28 days in N/mm².
b) Cement or combinations of cement in accordance with N.A>2.3.2, except masonry cements.
c) Masonry cement in accordance with N.A. 2.3.2 (inorganic filler other than lime).
d) Masonry cement in accordance with N.A. 2.3.2 (lime).

Note 1: When the sand portion is given as, for example, 5 to 6, the lower figure should be used with sands containing a higher proportion of fines whilst the higher figure should be used with sands containing a lower proportion of fines.

Note 2: For Class 2 of execution control site compressive strength testing is not required for these traditional mixes and checking of prescribed mortars should only be done by testing the proportions of the constituents

General requirements for mortar

Mortar in masonry shall be sufficiently durable to resist the relevant micro exposure conditions for the intended life of the building and shall not contain constituents which can have a detrimental effect on the properties or durability of the mortar or abutting materials. Acceptable masonry unit specifications and mortar can be selected from PD 6697:2019. It is strongly recommended that you check with the manufacturers for suitability in specific applications when making your selection.

Mortar should be designed to take account of any requirement for bed joint reinforcement.

Factory made mortars and pre-batched mortars shall be used:

- In accordance with the manufacturer’s instructions, including mixing time and type of mixer.
- Before the expiry of the workable life stated by the manufacturer.
- Taking account of weather conditions.

Site made mortar shall be:

- Ready for use when it is discharged from the mixer, and no subsequent additions of binders, aggregates, admixtures or water should be made.
- Be mixed so as to have a sufficient workability for it to fill the space into which it is placed, without segregation.
- Used before its working life has expired.
- Used taking account of weather conditions.

Specification of mortars for masonry

Mortar for masonry can be:

- General purpose or thin layer or lightweight.
- Factory made (pre-batched or pre-mixed) or semi-finished factory made (both to BSEN998-2) or site made (to BSEN1996-2).
- Designed (performance concept) or prescribed (recipe concept).

Designed masonry mortar has a composition and method of manufacture chosen by the producer in order to achieve specified properties.

Prescribed masonry mortar is made in predetermined proportions whose properties are assumed from the stated proportion of constituents.

Historically mortars were generally specified in terms of a prescription or recipe as, for example, in BS 5628. The updated British Standard for masonry mortar, BS EN 998-2, is a performance based standard.

Mortar should be specified, manufactured and installed in accordance with:

- BS EN 1996: Design of masonry structures.
- BS EN 998-2: Specification for mortar for masonry.
- PD 6678: Guide to the specification of masonry mortar.
- PD 6697: Recommendations for the design of masonry structures to BSEN1996-1-1 and BSEN1996-2.

Specification of factory-made or semi-finished factory-made to BS EN 998-2

For prescribed mortars:

- The prescribed mortar specification should be drafted so that the quality is controlled by stated compositional requirements.
- The compressive strength shall be declared using publicly available references establishing the relationship between same mix proportions of the same constituents and compressive strength. The proportion of the prescribed constituents required to provide the stated “M” values for prescribed masonry mortars are given in table NA.2 of the National Annex to BS EN 1996-1-1.
- The mix proportions by volume or by weight of all the constituents shall be declared by the manufacturer. The manufacturer shall verify the conformity of the mortar to the specification by referring to any production records and delivery documentation. CE marking/UKCA marking of prescribed factory made mortar signifies that the product conforms to the European Commission’s Construction Products Directive. Conformity is demonstrated by initial type testing and factory production control to BS EN 998-2.

For designed mortars:

- The compressive strength of masonry mortar shall be declared by the manufacturer. The manufacturer may declare the compressive strength class with the compressive strength designated by a ‘M’ followed by the compressive strength class in N/mm², which it exceeds.
- CE marking/UKCA marking of a designed factory made mortar signifies that the product conforms to the essential requirements of the European Commission’s Construction Products Directive (CPD). Producing designed factory made mortar in accordance with BS EN 998-2 ensures that the mortar conforms to the CPD and can therefore be CE marked/ UKCA marked .
- BS EN 998-2, Annex ZA specifies that if designed mortar carries the CE mark/UKCA mark, the factory production control system will have been certified by a notified body (third party certification body).

Specification of site-made mortar to BS EN 1996-2.

Prescribed and designed mortars:

- The design specification should state the required product performance characteristics and the means of their verification including the requirements for sampling and frequency of testing.
- Where the designer is satisfied that a prescriptive specification will provide the required performance, a detailed specification of the constituent materials, their proportions and the method of mixing may be given either on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use.
- When the mix prescription is not given in the design specification, the detailed specification of constituent materials, their proportions and the method of mixing should be selected on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use. When tests are required, they should be carried out in accordance with the design specification and BS EN 1015. When test results indicate that the mix prescription is not giving the required performance characteristics, the mix prescription should be amended and if it is part of the design specification any amendments should be agreed with the designer.
- Where designed mortars are manufactured on site, and not within a factory control system, the mortar specification should state how conformity is to be assessed. This can range from infrequent but regular testing of samples to visual inspection and random testing of samples with statistical analysis of results. The specification should describe the supervision, inspection and testing that is required in order to confirm that the mortar conforms to the specifiers chosen BS EN 998-2 requirements.

Testing and conformity evaluation

Conformity evaluation methods for both factory and site made masonry mortar can range from examination of production records to testing and comparison of the results with tabulated values for known compositions.

Standards referred to

- BS 6399 Loadings for buildings.
- BS 8103 Structural design of low rise buildings.
- BS 187 Specification for calcium silicate (sand lime and flint lime) bricks.
- BS 3921.
- BS 5628 Parts 1, 2 and 3 Code of Practice for use of masonry.
- BS EN 771-1.
- BS EN 998 Specification for mortar for masonry.
- BS EN 1996-1 Design of masonry structures.
- PD 6697:2019.

Corrosion protection and protective coatings

Corrosion protection to steelwork (including lintels)
All materials on buildings are subject to wear during use, this is caused by mechanical, chemical, electrochemical, thermal, microbiological and radiation related impacts. Mechanical reactions lead to wear, chemical and electrochemical reactions cause corrosion.

Corrosion is defined as the physical interaction between a metal and its environment which results in changes to the metals properties, and which may lead to significant functional impairment of the metal, the environment, or the technical system of which they form part of (BS EN ISO 8044).

Corrosion resistance is the ability of a metal to maintain its operational capability in a given corrosion system. When selecting suitable construction materials which are protected to resist corrosion during its service life, it is important to consider the building, its location, the surrounding environment, the atmosphere and climatic conditions.

There are several types of corrosion that must be considered to ensure that the material(s) selected will not corrode and lead to functional impairment:

- Uniform surface corrosion.
- Electrolytic corrosion.
- Crevice corrosion.
- Pitting corrosion.
- Stress corrosion.
- Contact corrosion.

Steel lintels in coastal locations

Steel lintels in coastal locations, used in both leaves of an external wall openings on projects within 500m of the shoreline, should be austenitic stainless steel and, in addition protected by a separate damp proof system/ cavity tray.

For sites between 500m and 5km of the shoreline, the lintel manufacturer should confirm their product is suitable for use in this environment– if not made from austenitic stainless steel and confirm will remain durable for 60 years. The durability of this element should not be reliant on maintenance

Protective coatings and finishes to metals

All metals must have a suitable protective coating to minimise or prevent corrosion during its life and be selected to comply with the appropriate standards and with the corrosion category described in the following table.

The classification of environmental corrosion conditions has been taken from BS EN ISO 9223 Table 4 and BS EN ISO 12944-4 Table 1. This provides a verbal description of the corrosion categories. Note: to determine the corrosion rates for aluminium, copper, steel and zinc, please refer to the standards listed.

Table 1: Hotrolled steelwork environment and protection categories

Area	Condition	Description	Environment Categories
External	Outside	All steelwork	C4 or C5 – Note 1
Building Envelope	Facade	All steelwork	C4 or C5 – Note 1
Building Envelope	Cavity zone: Very high corrosion risk - Coastal locations and areas within (500m) from the shoreline	All steelwork located within the cavity zone should be galvanised	C4 or C5 – Note 1
Building Envelope	Cavity zone: High corrosion risk - Coastal locations and areas located (1km to 0.5km) from the shoreline	All steelwork located within the cavity zone should be galvanised	C4 or C5 – Note 1
Building Envelope	Cavity zone: Reduced corrosion risk - Coastal locations and areas over (5km) from the shoreline	Steelwork protection category will depend on location within cavity	Note 2 and Note 3
Building Envelope	Basement and steelwork below ground level	Full or partial basement situation	C5 - Note 1 and 4
Internal	Sub-floor void	Steelwork not in contact with the ground	C3
Internal	Internal swimming pool	Steelwork located in areas that can be effected by chemicals	C4 - Note 1
Internal	Kitchen	Protected against condensation	C2
Internal	Bathrooms	Protected against condensation	C2
Internal	Roof voids	Unheated	C2

Table 1 notes:

Note 1: Material specification and corrosion protection plan should be provided by the Principal Designer to ensure that the steelwork has a 60 year life to first maintenance.

Note 2: Under normal conditions, where wall cavities remain dry, either by use of an impermeable outer skin or where there is (40mm or greater) physical separation of the steelwork from the brick outer skin – a corrosion environment category C2 or C3 may be used (depending on the external severity of the environment category and corrosivity rating in Tables 1 and 2 respectively).

Note 3: Steelwork located within the cavity (less than 40mm from the brick outer skin) will normally require a corrosion category C4 or C5 protection.

Note 4: Alternative steelwork protection methods including concrete encasement should be agreed prior to steelwork fabrication. Note: Post applied paint systems are NOT accepted as an alternative to Hot Dipped Galvanising.

Note 5: Additional paint coatings over galvanised steel, such as Intumescent paint, need to be correctly specified and applied to suit environment and fire rating.

Standards

- ISO 8044 - Corrosion of metals and alloys - Basic terms and definitions.
- ISO 9223 - Corrosion of metals and alloys - Corrosively of atmospheres - Classification.
- ISO 9224 - Corrosion of metals and alloys - Corrosively of atmospheres - Guiding values for the corrosively categories.
- ISO 12944-2: Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments.
- BRE Digest 301 - Corrosion of metals by wood.
- PD 6484 - Commentary on corrosion at bi-metallic contacts and its alleviation.

Note: The CWCT Technical Note 24 provides guidance on corrosion and corrosion protection to cladding.

Table 2: Steelwork corrosion rating and protection categories

Corrosivity Rating	Corrosion Protection	Protection Thickness	Number of coats	Comments:
C1 Interior Dry	High build zinc phosphate epoxy primer.	80 µm	1 or 2	
C2 Interior Rural Occasional Condensation	High build zinc phosphate epoxy prime	80 µm	1 or 2	
C3 Interior Urban Inland some air pollution located over (5km) from the shoreline.	High build zinc phosphate epoxy primer (80 µm) + high build epoxy (MIO, 120 µm)	200 µm	1 or 2	Steelwork protection category will depend on location within cavity
C4 Coastal locations and areas between (5km to 1km) from the shoreline.	Hot Dip Galvanise to BS EN ISO 1461	85 µm	1	All steelwork located within the cavity zone should be galvanised.
C5 High Humidity or Coastal with High Salinity within (500m) from the shoreline.	Hot Dip Galvanise to BS EN ISO 1461	140 µm	1	All steelwork located within the cavity zone should be galvanised
CX or C5 + Coastal Splash Zones	Specialist design including a site specific assessment required	As per the Engineers specifications	As per the Engineers specifications	Additional risks to consider in splash zones: Accelerated Low Water Corrosion. (ALWC)

Table 2 notes:

Surface preparation for all corrosion protection applications:
Thoroughly clean surfaces prior to abrasive blast cleaning in accordance with BS EN ISO 8501.

Application:
All protection coatings to be factory applied to manufacturers recommendations.

Treating damaged areas of protective coating:
Make good to appropriate Corrosivity Rating in accordance to manufacturers recommendations.

Connections:
All connections and fittings to the hotrolled steelwork will need to achieve 60 year life to first maintenance.

Additional guidance
Additional guidance on corrosivity categories (C1 to C5) and associated protective coatings can be found on the following website: www.steelconstruction.info

Galvanising protection recommendations can be found within The Galvanizers Association Handbook which includes UK map showing atmospheric corrosion rates of Hot Dip Galvanising.

Steelwork protection

For Warranty purposes:

- Exposed steel frame construction used on sites with an atmospheric corrosivity of C4 or C5 to BS EN ISO 12944, including sites within 500m from a coastal shoreline, should be galvanised to a rate of 710 g/m^2.
- Decorative finishes must be compatible with the protective coat specification. Refer to BS EN 12944 ‘paints and varnishes: corrosion protection of steel structures by protective paint systems’ and the manufacturers recommendations.
- Any section of previously galvanised or other protected steel which is then cut or drilled must be provided with appropriate remediation to the exposed parts of steel to ensure adequate corrosion protection is maintained.
- The designer should specify the protective coating system where any steelwork is to be welded.
- Surface preparation should be to BS EN 12944-4.
- The use of Intumescent paint for achieving fire protection should be compatible with any corrosion protective coating applied and the manufacturer’s guidance should be followed.

Fixings

Fixings that are exposed to weathering, moisture and corrosive environments or applications where concentrations of corrosive agents may accumulate should be made from high grade austenitic stainless steel (e.g. A4) or a protective coating suitable for the corrosion category described in the table above.

Roof fixings

In addition to the guidance found in the ‘Roofs’ section, the following is applicable:

- For clay, concrete and slate roofing a full roof fixing specification from the slate or tile manufacture must be provided and the exposure and orientation of the site taken into account.
- All fixings must be durable for the environment location.
- For metal cladding:
  - The designer must establish the environment’s corrosivity when specifying metal cladding for roofs in coastal locations as well as the potential for wind uplift and movement in a cladding system during severe wind conditions, particularly over party wall positions.
  - The designer should ensure capillary action at the overlapped joints is prevented which with high saline water could also cause pitting corrosion to take place, leading to the failure of the roof panels.

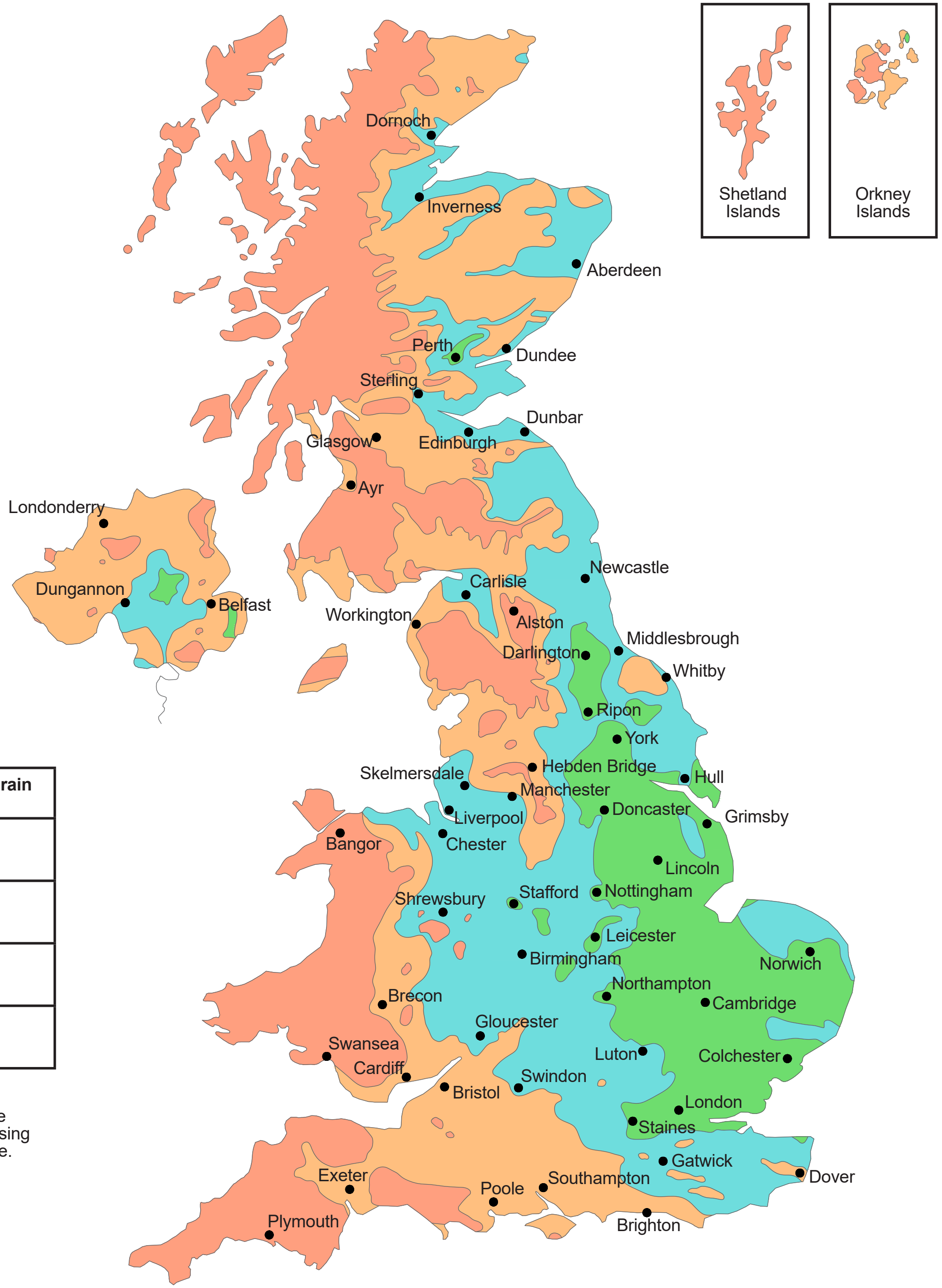
Durability of fixings

ISO 12944 also classifies three different durability ranges ‘low, medium & high’ for protective paint systems. Therefore, in severe and very severe environments, external paints and varnishes, and other protective coatings must be chosen to have a ‘high’ durability rating.

Whilst the durability range is not a ‘guarantee time’, consideration has to be made to the Functional Requirements of this Technical Manual (see the Service Life table at the end of this section).

Due to the environment, certain materials and particularly the finishes may require on-going maintenance in order to keep a satisfactory finish e.g. balcony timber decking. In these circumstances it will be the building owner’s responsibility to ensure that regular maintenance of exposed components and finishes is undertaken to ensure they perform correctly. Maintenance plans will need to be in place during the lifetime of the building to ensure premature failure of coatings or components is avoided.

Materials, products and building systems should be chosen to take into account wind driven rain exposure maps.



Exposure zones	Exposure to wind driven rain (litres/m² per spell)
Very severe	100 or more
Severe	56.5 to less than 100
Moderate	33 to less than 56.5
Sheltered	less than 33

Note:
Variations to the exposure shown on the map can only be made by site-specific calculations using BS 8104 “Assessing exposure of walls to wind driven rain” and the table above.

The following table provides an indication of the service life requirements expected. The list is not exhaustive and other elements not mentioned will need to be agreed with us prior to works starting on site.

Building element [1]	Service life requirement

Load bearing structural elements providing support [2]
 	
▪ Foundations
▪ Substructure load bearing walls
▪ Basement structural retaining walls
▪ Basement slabs
▪ Podium and transfer decks
▪ Ground floors (all construction types e.g. timber, steel, concrete etc.)
▪ Superstructure frame, i.e. RC columns and beams
▪ External loadbearing wall elements including:
  ▪ Both leaves of cavity masonry wall
  ▪ Timber frame panels (e.g. traditional stud, I-beam etc.)
  ▪ Light gauge steel frame
  ▪ External masonry leaf to framed structure
  ▪ Solid masonry walls
  ▪ MMC offsite manufactured wall panels (timber, steel, concrete etc.)
  ▪ Lintels, posts and beams
  ▪ Soleplates
  ▪ Heavy gauge steel frame
  ▪ Infill panels
▪ Internal walls (load bearing)
▪ Intermediate floors (all construction types)
▪ Masonry chimneys
▪ Roof structural members (timber, steel, concrete etc.) including:
  ▪ Ceiling joists
  ▪ Rafters
  ▪ Trusses
  ▪ Purlin
  ▪ Roof cassettes
  ▪ Flat roof joists/planks/RC units etc.
  ▪ Wall plates
  ▪ Tiling battens
  ▪ Flat roofing decking
▪ Exposed beams and posts providing a structural support e.g. porch posts, gallows brackets etc.
▪ Balcony / Terrace structural members (steel, timber or composite where above 600mm from ground level
 	
▪ Guarding (To balcony, terrace edges, stairs etc.)
	
	60 years
	60 years
	60 years
	60 years
	60 years
	60 years
	60 years
	60 years
	
	60 years
	60 years
	60 years
	60 years
	
	60 years
	
	60 years
	
	25 years

Curtain walling systems ▪ Primary components (i.e. those not easily replaced) ▪ Secondary components i.e. those that are easily replaced / accessible and do not require substantial dismantling of the system. (Repairs can be easily undertaken as part of planned maintenance programme in place during the service life of the cladding) Note: Will require Third party certification to verify which components achieve service life.	 60 years if structural and all primary components 25 years for secondary components
Factory made insulated chimneys ▪ Solid fuel or Oil e.g. twin wall internal / external stainless steel flues and chimneys.	 30 years operational life

Non loadbearing elements in the external wall and roof constructions that do not form part of the water proof envelope ▪ Thermal insulation	 25 years
External building elements not forming a structural function but part of the waterproof envelope [3] ▪ Roof tiles and metal roof cladding ▪ Flat roof coverings ▪ Offsite manufactures MMC elements such as false glass fibre chimney stacks, coping stones, window cills ▪ Breather membranes in vertical framed external walls and pitched roofs ▪ Coated timber window / doors including frames ▪ PVCU and metal window / doors including frames ▪ Other decorative claddings, fascia's etc. e.g. coated timber claddings, zinc ▪ Render finishes including render boards ▪ Uncoated timber cladding Will need planned maintenance, repair or replacement during this reduced period.	 25 years 25 years 25 years 25 years 15 years 15 years 15 years 15 years 15 years
Horizontal timber decking boards (structural walking surface, not supporting structure/joists) ▪ Up to 600mm above the ground ▪ Between 600mm and 2400mm above the ground ▪ Greater than 2400mm above the ground level Note: All structural elements of a balcony = 60 years Decking will need planned maintenance, repair or replacement during that reduced period. Does not take account of other legislative requirements e.g. fire resistance	 15 years 30 years 60 years 60 years

1. The list of elements in this column have been put together to help identify the service life requirements for typical components. It is not exhaustive and other elements not listed – please discuss with your Warranty Surveyor.
2. Fixings for load bearing structural elements require a service life to match the building element as specified in the above table.
3. Fixings for non-structural building elements (building elements only for waterproof envelope functions), should have a service life which matches non-structural building element.

C.
Appendix C

C.2
Suitability of Products and Systems

Suitability of products

It is important to ensure that products used in construction can be proven to satisfy the relevant functional requirements of this Technical Manual. The below factors must be taken into consideration as a minimum when selecting products:

1. Durability; including:
   a) Compatibility of materials (interactions between components, structural or otherwise).
   b) Longevity of materials (identifying it achieves a 60 year service life where used in the structure or lesser period where identified in the Service Life table contained within this section of the Manual).
   c) Maintenance requirements.
2. Structural integrity, including serviceability of product (where applicable).
3. Hygiene, Health & Environment including:
   a) Vapour permeability and moisture resistance.
   b) Water/weather tightness.
   c) Release of dangerous substances.
4. Demonstrable evidence of quality control in production.
5. Proof and demonstration of product suitability through supporting statements on scope, use and installation. This may be provided by the manufacturer or an independent approval body.
6. The use of approved of installers where specified by the manufacturer, Warranty provider or third party product approval certificates.

Products can be proven to satisfy the above requirements by[1]:
- Providing a valid full third party product approval from an independent approval body which is accepted by us. This could either be a UKAS, European equivalent product conformity accredited organisation or other body accepted by us, which looks at the product/system as a whole and reports on its suitability and scope of accepted use. Such third party approval can assist in demonstrating compliance with our Warranty, but, the Functional Requirements in the Technical Manual must also be complied with. There are also certain systems and products which whilst they may hold a third party approval, represent an enhanced Warranty risk and are not acceptable to us. If in doubt please contact our Technical team for further clarification [2], and/or,
- Providing evidence products meet the requirements of relevant British Standards, Codes of Practice or equivalent European Standards current at the time of application [3], and/or,
- Providing evidence of CE/UKCA marking where a corresponding European standard exists (CE marking is acceptable until 30th June 2025 for construction products to the GB market). This shall be supported by evidence of testing carried out on the product and a Declaration of Performance Certificate being provided[3].

Note 1:
- A combination of these methods may need to be provided to prove products satisfy our Functional Requirements.

Note 2:
- The third party product conformity certificate must be valid and current.
- We will require to assess the third party approval to determine if it provides sufficient information to confirm the product or system meets the requirements of this Technical Manual and that it is being used within the scope of that approval.
- Some of the above Warranty requirements are not always included in the third party product conformity certificate or do not take account of specific risk areas that our Warranty requires to be addressed.
- A product may not have been tested for the particular application on site. To avoid doubt, developers and Builders should seek clarification from the Warranty provider, that the third party accreditation for the product/system will be acceptable.
- Certain systems and products which hold third party certification may not be acceptable as they are considered an enhanced risk for Warranty cover purposes. Please refer to our Technical team for further clarification.

Note 3:
- Evidence a product meets a relevant British Standard, code of practice or equivalent European standard, or has evidence of CE/UKCA marking but not fully satisfy all of our 6 Warranty requirements as highlighted above and further information may be required.

Where no British or European standard exists for a product, it must have a valid full third party product approval from an independent approval body which is accepted by us. The third party product approval must satisfy all of the above requirements.

Product selection and Building Regulations
The designer should demonstrate the product meets the requirements of the Building Regulations to the satisfaction of the appointed Building Control Body. This may include, but is not limited to:

- Structure and movement characteristics
- Safety in case of fire
- Sound insulation
- Thermal performance
- Air tightness

The Warranty Surveyor, at their discretion may ask for evidence of the above in support of Warranty Provision.

European Technical Assessment (ETA)
Products or systems with an ETA certificate will need to be reviewed by our Technical Team as these do not always potentially cover all the factors that a full third party product conformity approval certificate may provide and aspects such as durability or the quality management systems that are in place may not be included.

In addition:

- Where bearing a CE marking/UKCA marking in accordance with the Construction Products Directive, this shall be supported by evidence of the testing carried out on the product.
- CE marking is acceptable until 30th June 2025 for construction products to the GB market.

Construction products that do not meet the Warranty requirements may not be acceptable for Warranty approval. It is advised that the design team must approach the Warranty provider early in the design stage to discuss the viability of the use of such a material, and determine what further independent third-party testing may be required in advance of the final design proposal.

Products that hold full third-party product conformity approval will still need to be structurally accepted on a site-by-site basis depending on the layout and loading of the component. Thermal properties and measures to prevent condensation will also require specific assessment depending on exposure, orientation etc.

CE / UKCA marking

The UKCA marking is a new GB product marking that is to be used for goods being placed on the market in England, Wales and Scotland and it applies to most goods previously subject to the CE marking.

For ‘construction products’, CE marked products will be accepted in UK until 30th June 2025.

All construction products in circulation in the England, Wales and Scotland markets must change their marking to UKCA mark by 1st July 2025.

There are separate requirements for the Northern Ireland market.

UK approved bodies

From 1st January 2021, UK notified bodies operating under the EU Construction Products Regulation and based in the UK were granted new UK ‘approved body’ status and listed in a new UK database.

Approved bodies are able to undertake conformity assessment activity for UK ‘designated standards’. Where an approved body has undertaken the assessment, the manufacturer (or their authorised representative) must affix the UK marking. Rules around affixing the new UK marking will be equivalent to current CE marking.

For the Northern Ireland market, UK ‘approved bodies’ will be designated by the United Kingdom Accreditation Service (UKAS) and be allowed to assess the performance of construction products to EU harmonised standards. This will enable economic operators to use the CE marking with the UK (NI) indication and place their product on the Northern Ireland market.

These bodies are be listed on the UK Market Conformity Assessment Body (‘UKMCAB’) database.

Proprietary products and systems in place of a traditional construction method

Where a proprietary product or system is proposed in place of a traditional construction method, the product or system must still meet the requirements of the relevant British Standard or have a full third party product approval certificate.

Minimum required supporting information for cavity trays and DPC's

Where flexible DPC materials are to be used as a cavity tray, they should:

- Have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012.
- Have third-party certification (BBA or similar UKAS accredited body) confirming their suitability for use as a cavity tray.
- Be supplemented by clear manufacturer's guidance in relation to installation.
- Where required, be subject to the assessment of an Engineer e.g. where used in parapet walls, retaining structures, etc.

The Declaration of Performance information should include reference to BS EN 14909:2012 and include one of the 'Product Designation Codes' given within that standard to enable clear determination of the material being used on site.

		Minimum required supporting information			
Position	**Installation type**	**BS EN 14909 Declaration of Performance**	**UKAS 3rd Party Accreditation**	**Manufacturers guidance**	**Engineers specification**
Base of a wall	Horizontal linear DPC	✓		✓	
Window reveal	Vertical linear DPC	✓		✓	
Accommodation of movement e.g. stone heads	Slip plane provision	✓			✓
Retaining structures	Horizontal linear DPC	✓	✓	✓	✓
Parapet walls	Horizontal linear DPC	✓	✓	✓	✓
Under coping stones	Horizontal linear DPC	✓	✓	✓	✓
Base of a wall	Cavity tray	✓	✓	✓	
Under a jointed stone sill	Cavity tray	✓	✓	✓	
Over an obstruction in the cavity or an opening	Cavity tray	✓	✓	✓	
Over a horizontal cavity fire barrier	Cavity tray	✓	✓	✓	
Over a brickwork support angle	Cavity tray	✓	✓	✓	✓
Roof abutments – flat and pitched	Cavity tray – horizontal/ stepping	✓	✓	✓	
Parapet walls	Cavity tray	✓	✓	✓	✓

Flexible DPC materials (e.g. polyethylene)

Where flexible DPC materials are to be used as a cavity tray, they should:

- Have supporting evidence in the form of a Declaration of Performance to BS EN 14909:2012.
- Have third-party certification (BBA or similar UKAS accredited body) confirming their suitability for use as a cavity tray.
- Be supplemented by clear manufacturer's guidance in relation to installation.

Modern methods of construction (MMC)

It is important to ensure that MMC, products or systems meet the same requirements as detailed in 'Suitability of 'products''.

Construction methods that cannot meet the requirements of this Technical Manual must be submitted for acceptance by the Warranty provider in advance of the Warranty application, at the design stage, well before commencement on-site.

MMC, products or systems that have third-party approval will still need to be structurally accepted on a site-by-site basis depending on the layout and loading of the component. Thermal properties and measures to prevent condensation will also require specific assessment depending on exposure, orientation etc.

Where the components of the Innovative MMC system cannot be inspected on site (e.g. closed panels or volumetric modules), the system should be subject to review by our Innovations Team.

Modern Methods of Construction (MMC) are pre manufactured/off-site produced systems and components which are used in the construction industry, particularly for housing, as they potentially represent savings in time and materials, and provide higher standards of quality than more conventional methods of construction.

Key points to note are:

- Off-site assembly means quick erection times on-site and a quick, weather tight construction achieved.
- The accurate setting out of foundations etc. needs to be managed and may require pre-levelling checks to be completed prior to delivery of MMC systems to site.
- MMC, particularly volumetric modular systems and large panel systems, will require advanced planning of the site for access, off-loading, installation and possibly storage of systems.
- The construction, design and layout of a typical system is planned in advance, so last-minute changes have to be avoided by good project management and what is known as a 'design freeze', imposed in advance of production commencing in the factory.
- The quality of the final product will rely on accurate assembly on-site by factory-trained or authorised Specialist Contractors.
- Where on site zip-up works are required, it is expected that these works will be undertaken by suitability trained staff and overseen by a supervisor directly employed by the system manufacturer as a minimum.
- MMC takes advantage of standardised construction, and may not be adaptable for complex architectural or planning design requirements. Additional testing may be necessary to ensure standards for durability and weather tightness can be achieved e.g. incorporating flat roof drainage outlets through closed panel parapet extensions.
- The key to good quality MMC system is protection of building elements in transit, storage and during erection until the building receives final weather protection. Water trapped in closed-panel systems could damage both structure and insulation, therefore Quality Assurance is crucial at every stage of the off-site manufactured construction process.

Types of modern methods of construction (MMC)

The definition of MMC spans a range of approaches from, off-site, near site and on site pre manufacturing, process improvements and technology applications.

Some typical examples of MMC are defined below:

- Category 1 – Pre-manufactured (3D primary structural system) – Volumetric.
- Category 2 – Pre-manufactured (2D primary structural system) – Panelised.
- Category 3 – Pre-manufactured non-systemised primary structure) – Pre-manufactured structural members.
- Innovative new components and systems new to the market that may or may not demonstrate compliance with a British or European standards.

The Modern Methods of Construction (MMC) categorisation as per Government definition framework.

Many MMC components are usually site-based assembled e.g. Insulated Concrete Formwork systems.

Volumetric - Pre manufactured 3D primary structural systems
Volumetric construction (also known as modular construction) involves the 'off-site' production of pre manufactured three-dimensional units. ISO 9001 accredited or equivalent quality controlled systems of production in the factory should be in place and expected.

Modules may be brought to site in a variety of different forms, ranging from a basic structural shell to one where all the internal and external finishes and services are already installed.

Volumetric construction can consist of timber frame (including engineered timber), light gauge steel, and concrete or composite constructions. External cladding may form part of the prefabricated system, with only localised on-site specialist sealing required.

Alternatively, traditional masonry cladding may need to be constructed; in this case, specific detailing for the support of claddings, cavity barriers and DPCs must be pre-agreed, Building Control compliant and checked by Site Managers.

Panelised- Pre manufactured 2D primary structural systems
Panelised systems are a systemised approach using flat panel units used for basic floor, wall, and roof structures (sometimes referred to as cassettes). These can comprise of varying materials and are produced in a factory environment. The panels are assembled on-site at the final workface to produce a final three-dimensional structure. The most common approach is to use open panels, or frames, which consist of a skeletal structure only e.g. stick frame, with services, insulation, external cladding and internal finishes being installed on site.

More complex panels can be produced, these are typically referred to as closed panels. Closed panels involve more factory based fabrication and can include lining materials and insulation. These may also include services, windows, doors, internal wall finishes, and external claddings.

Hybrid
Again off-site manufactured, this combines both panelised and volumetric approaches, and typically volumetric units.

Sub-assemblies and components
This category covers factory-built sub-assemblies or components in an otherwise traditionally built structural form, typically schemes incorporating the use of floor or roof cassettes, precast concrete foundation assemblies, preformed service installations (such as bathroom pods), and cladding systems etc.

Site-based systems
These are structural systems that fall outside the 'off-site manufactured' categories, such as Insulated Concrete Formwork (ICF). Only systems with independent third-party approval will meet the requirements of the Technical Manual. The acceptability of these systems relies heavily on the quality procedures in place for the installation of the system on-site, in accordance with third-party approval.

Innovative systems and products
These are 'Products and Systems' that are new to the market and do not demonstrate meeting the requirements of a relevant British or European standard and therefore not able to be CE/UKCA marked. These products and systems will need to be discussed with the Warranty provider at the earliest stage possible and before an offer of Warranty is given.

The Developer/Designer must provide evidence to confirm:

- Durability, Structural integrity, Water tightness, Sound Insulation, Thermal performance, Maintenance etc. of the product/system,
- The quality management systems in place for the construction/installation, and
- Evidence of a suitable third party product conformity certification (see notes in 'Suitability of products'),
- Have agreement with the Warranty provider before it is integrated into the building works.

Where the components of the system cannot be inspected on site such as all off-site manufactured systems category 1 and all closed panel, or complex category 2 systems, these will require to be submitted to our Warranty Innovations Team for review and acceptance.

Suitability of MMC systems

Building systems including 'off-site' manufactured systems should have independent third-party product approval, which must also recognise UK Building Regulation requirements. The Independent third party product/system approval must provide details of performance and testing carried out in the following areas to demonstrate acceptability to the Warranty provider:

- Structural integrity.
- Performance in fire situations.
- Resistance to water penetration (consider exposure rating of location), vapour permeability and dangerous substances.
- Safety in use.
- Acoustic characteristics.
- Thermal and movement characteristics.
- Compatibility of materials (interaction between components, structural or otherwise).
- Durability and longevity of materials (60 year service life where used in the structure or lesser period identified in the Service Life table in this section of the Technical Manual).
- Maintenance requirements and provisions.

Structural performance must be identified against appropriate BS EN standards. The developer must provide structural calculations for each project on a case-by-case basis, and the design shall allow for robustness to disproportionate collapse (where applicable).

Systems and components must be manufactured under a recognised quality management process. Systems and components might not have an overall full third-party product conformity approval but the individual components used must have the required full third party conformity certification. There must also be a current ISO 9001 Quality management system in place for the design, manufacture and erection of the system process (completed by a UKAS accredited organisation).

Where third-party product conformity certification is provided for a system or product, and the independent certification does not recognise our Warranty requirements, additional checks may be required to confirm the system is acceptable e.g. the need to provide a drained cavity behind some insulated cladding systems and to external cladding systems on timber and steel-framed systems. Supporting evidence of testing undertaken to prove the system may be asked for.

Durability and weather tightness are key aspects of the Warranty requirements, and the track record of the system will need to be established. Evidence of experience gained elsewhere, where environmental conditions may be significantly different, will need to be assessed, in comparison with conditions here in the UK.

Treatment of timber components will need to be assessed with regard to the species of timber used. The natural durability and the need for preservative treatment are dependent on the component's location in the construction and the Warranty requirement for durability. Treatment for insect attack in certain parts of the country will also be required. Certain European countries do not accept use of preservatives however for our Warranty requirements preservative treatment may be necessary unless evidence can be provided to demonstrate the timber species, heartwood used in the system is sufficiently durable without treatment for the position used in the building.

Detailing is critical in providing integrity to the building e.g. connections between a wall panel and a window unit. Supporting documentation must show the make-up of the tested system. When assessing projects, a particular design detail may not have been covered by the certification e.g. a balcony junction. This information must be made available at an early stage.

Certain components of a building have particular functions and may not be replaced by components that look similar but might structurally behave in a different manner. Similarly, a product with a third party assessment for a particular use may not be acceptable in a different form of construction.

The continuation of Quality Management Systems from manufacture to erection on-site must be demonstrated. The level of supervision of the systems on-site is critical to meet the Warranty requirements.

Structurally Insulated Panels (SIPs)

Structurally Insulated Panels (SIPs) are a form of composite panel. Only systems which hold full third party product conformity approval will meet the requirements of the Technical Manual. The third party accreditation must also cover how panels interconnect and not just cover a panel in isolation.

Where the SIP system is manufactured by a third party product approval certificate holder (the SIP Manufacturer) but is marketed under another name by 'another company': Where the openings are formed and erected by this 'another company' they must be authorised by the SIP Manufacturer/certificate holder to undertake such alterations, and the erection/installation of the panels.

Requirements for quality control systems (such as ISO9001) are the same as for open-panel systems.

Insulated concrete formwork (ICF)

Insulated concrete formwork (ICF) utilizes polystyrene (mainly) as a temporary formwork, with concrete poured into the formwork core at staged lifts to provide the structural 'wall' component to carry the loads of the building down to foundations, this can be both external and internal walls.

The insulation formwork (usually either expanded or extruded polystyrene (EPS or XPS)) is left in place after the concrete has cured to form a permanent integral part of the insulation of the building. An external weatherproof cladding system will be required as the ICF system alone is not proven to be resistant to weather.

For the purposes of this Technical Manual:

- The system proposed must have a current third party 'product approval'.
- ICF systems will be acceptable for a maximum of 3 storeys in height (including the ground floor level) and must be accompanied with a full Engineers design package. ICF systems may be accepted above the 3 storeys limit when third party independent Engineer is involved in pre-pour inspections and will provide final sign-off for the whole structure.
- Basements formed from ICF construction will not be acceptable. Alternative forms of Basement construction will be required and then only permitted if a CSSW qualified Waterproofing specialist takes responsibility for the design of the waterproofing to ensure the design meets the requirements of BS 8102. Further guidance can be found in the 'Basements' section of the Technical Manual.

Types of ICF structure

The formwork is usually one of the following four formats; Blocks, planks, panels, or composites with planks or panels where tie devices are used to secure the 'outer and inner' components together.

It is expected that all ICF type structures are to be erected by the ICF manufacturer's approved contractors that meet our Warranty conditions.

Weatherproof envelopes to ICF structures

Details of the type and construction of the external cladding system must be agreed with the Warranty Surveyor before installation:

- The provision for a horizontal damp proof course must be appropriate for the type of ICF system.
- The design must allow for effectively preventing water penetration at window/door openings. Using mastic as the only means of weather protection between the frame and the ICF will not suffice. The ICF manufacturer or the ICF association recommendations should be followed e.g. use of a compriband or similar third party product approved gasket DPC system around frame junctions. Particular attention should also be given to the joints between the windows and doors and the surrounding cladding system.
- The designer must provide details for prior approval of any lean-to/flat roof abutments, parapets or balcony constructions to determine how water penetration at these junctions to the inside of the building will be prevented.

Claddings for ICF structures

- The fixing specification for all cladding types for ICF structures must be specified by an Engineer.
- Masonry/stone cladding: a minimum 50mm cavity will be required and the wall tie fixings taken into the concrete core.
- All other claddings: a drained and vented 19mm minimum cavity will be required. If open boarding, additional weather protection to the ICF may be required e.g. a suitable breather membrane.

Installation of ICF systems

The ICF system must be installed by the ICF manufacturers recommended contractors. The height of lifts (stages of filling with concrete) must be properly controlled to avoid distortion to the formwork and honeycombing in the concrete core (due to incorrect placement). The installation of the formwork must ensure that after pouring the concrete core the requirements of the 'Tolerances' section of our Technical Manual will be met.

D.

Appendix D

Contents

Limitations of Functional Requirements

1. These Functional Requirements do not and will not apply to create any Policy liability for any post completion remedial works carried out by the Contractor or otherwise, nor to any materials used in those remedial works.
2. The guidance provided in this Section, is guidance that provides a suggested solution to meeting the Functional Requirements. If an alternative solution is selected, then this must still meet the Functional Requirements.
3. Means of escape, passive and active systems are not covered by the Warranty.

Workmanship

1. Any new work must meet the tolerance requirements detailed in the Technical Manual. Tolerances will not apply to existing finishes e.g. walls and floors that have not been upgraded or altered, or where the supporting elements will not allow for the tolerances to be met.
2. All work is to be carried out by a technically competent person in a workmanlike manner.
3. Concreting shall not take place during cold weather periods where the working temperature is below 2°C or where ground conditions are frozen.

Materials

1. All load bearing structural elements providing support to the Home regardless of whether it is a new or existing element, will have a service life of not less than 60 years, unless specifically agreed otherwise with us. An Engineer will need to explicitly confirm this in a written report. All other parts of the Home will have a lesser durability and need planned maintenance, repair or replacement during that reduced period.
2. Existing elements that are to be retained must provide a 'waterproof envelope' to the building and be structurally adequate.
3. All materials should be stored, installed and protected correctly in a manner that will not cause damage or deterioration of the product.
4. All materials, products and building systems shall be appropriately tested and approved for their intended purpose.
5. Whilst there is and can be no Policy responsibility and/or liability for any roof covering, window/door or 'decorative external cladding' (i.e. cladding which is decorative only and the substrate wall provides the main weather proof barrier) to achieve a performance service life of 60 years or less, such elements shall be designed and constructed so they have an intended service life of not less than where stipulated within this Manual.
6. Timber should be adequately treated or finished to resist insect attacks and be suitable for the position used within the structure. All timber treatment should be in accordance with relevant British Standards and Codes of Practice.
7. Timber used in the building to provide support to the structure must be appropriately seasoned to prevent excessive shrinkage and movement.
8. All materials should be suitable for the relative exposure of the building in accordance with the relevant British Standards.
9. Reclaimed materials may only be reused with the prior agreement with the Warranty Surveyor. Independent certification and/or testing of the suitability may be required.

Design

1. The design and specifications should give clear indication of the design intent and demonstrate a satisfactory level of performance with regards the renovation of components and the interaction of new elements.
2. Specialist reports* are required to confirm that existing elements will have an adequate level of:
    a. Structural stability; and
    b. Weather resistance of the existing 'waterproof envelope'.

    * As defined in the 'Materials' section of these Functional Requirements.
3. The following additional elements shall be supported by structural calculations designed by an Engineer:
    a. Structural elements outside the parameters of Building Regulations.
    b. Specialist structural works.
    c. Reinforced concrete elements.
    d. Precast structural elements.
    e. Any engineered beams/posts manufactured off-site.
4. Damp proofing works should prevent any external moisture passing into the internal environment of the building.
5. Projects consisting of non-standard/modern methods of construction must be supported with evidence of valid independent third party product conformity certification before an offer of Warranty is provided. These types of constructions must be declared before commencement.
6. Where existing drainage and plumbing systems are intended to be utilised as part of the work, the retained system must be adequate and be certified by an appropriate service expert.

7. In addition, for Appendix D.2: 'Conversions and Refurbishments - New Elements Connecting to Existing Structures':
    a. There should be a Party Wall Agreement in accordance with the Party Wall etc. Act (please note that this requirement will be relevant where the applicant is not the owner of the adjoining property).
    b. Evidence must be provided to demonstrate the separating wall between the new and existing building meets the relevant requirements of the relevant Building Regulations.
    c. All existing sub-structures and superstructures must be suitable to support any proposed increased loading resulting from the construction of the new building.
    d. The junction of the new walls to the existing walls must ensure that dampness cannot track back into the new or existing building.
    e. An effective damp proof course should be present in the existing wall, linked to the new damp proof course and damp proof membrane of the new building.
    f. At the junction of the existing and new structures, detailing should allow for differential movement without cracking. Any settlement should be limited to 2mm-3mm, which would not normally adversely affect the roof covering.

D.
Appendix D

D.1
Conversions and Refurbishments - Existing Elements

The guidance that follows is for buildings that do not have any Historic or Conservation Planning restrictions. It is expected that the building can be appropriately upgraded in accordance with current Building Regulations with respect to structure, fire, resistance to moisture, sound, ventilation, drainage, heat producing appliance, conservation of fuel and power, access and security.

The following building types will not be considered suitable for Warranty cover:

- Grade 1 listed buildings.
- Scheduled and ancient monuments.
- Cob construction.
- Through wall oak/timber frame.
- Wattle and daub.
- Former agricultural buildings of any nature, with the exception of farm houses/dwellings which have not been used in any way for livestock.
- Barns.

Conversions and refurbishments are projects that involve work on existing buildings, parts of existing buildings or any retained elements of an existing building. This could include the conversion of industrial or commercial buildings into housing, the conversion of an existing residential building into flats, an additional storey to an existing building, the refurbishment of an existing residential building, or a façade retention project.

The refurbishment assessment process

The Warranty includes cover for the retained structural elements and waterproof envelope of any existing building for the duration of the policy. Conversion or refurbishment schemes covered under the New Homes, Social Housing and Private Rental policies will be the subject of a Refurbishment Assessment by our Warranty Technical Services Surveyors. Ideally, this should occur before you start planning or building.

The Technical Services Surveyor always undertakes an initial site-based assessment of the existing fabric to ascertain in general terms if the proposal is capable of representing a standard risk to the Underwriter. If deemed acceptable, the development is then subject to a technical audit process during construction, and the following guidance is intended to assist all parties in ensuring the relevant requirements are met, as well as providing an element of consistency in approach.

Depending on the condition of the original building, expert surveys may be required for the different elements of the building, as described in the following guidance. If any of the surveys conclude that any of these elements are unable to achieve a residual service life less than that shown in our service life table within ‘Appendix C’, they should be systematically replaced or repaired.

The building elements considered likely to be acceptable for retention will be identified by the Technical Services Surveyor and be subject to non-negotiable, site-specific, technical conditions called refurbishment assessment design items that must be fully satisfied before the scheme can be recommended as a standard risk to the underwriter. There may be instances where additional investigations and/or information is required to address the design items in full. Failure to address the design items in full may result in the offer of Warranty being withdrawn.

All conversion schemes are different and there is no one set of technical conditions or list of information that can adequately demonstrate the validity of every scheme. The refurbishment assessment design items set out in detail the basis of the investigation or means of proving those building elements proposed for retention are suitable for Warranty and will satisfy the functional requirements.

Survey reports or design work commissioned before the refurbishment assessment may not meet the technical requirements of the Warranty and, therefore, may require additional investigation and/or amendments.

Existing buildings and structures can present particular problems both initially and during the construction phase. Therefore, it is essential that thorough and comprehensive survey work is undertaken prior to new works commencing to understand both the current condition of the structure and the impact any proposed works may have. Although initially this may be considered an unnecessary early expense, the savings in reconstruction costs can greatly outweigh the cost of the preparatory work.

Elements of the retained structure and proposed works should not be considered in isolation, as a solution for one problem may cause issues elsewhere. Past performance is no guarantee of ongoing adequate performance because different expectations and changing living conditions can impact on both the actual and perceived performance of a converted/refurbished structure.

It is not possible to cover every building type within this guidance, therefore, the guidance is general, and certainly will not apply in every scenario. It is strongly recommended that early discussions are held to determine the exact requirements and to enable a full review of the proposed strategy and development.

Where new work is proposed, it should follow the guidance for those elements in the applicable sections of this Technical Manual. Where new work is applied to, or meets, existing elements, consideration on how these areas interact must be made; for example, new cavity masonry construction that abuts an existing solid wall construction. If works have progressed to a stage beyond where it is not possible to survey the structure or that new works have been carried without inspection, it is highly likely that the scheme cannot be considered a standard risk and the offer of Warranty may be withdrawn.

Please note that the requirements of the technical audit are quite different from those undertaken to comply with Building Control and Planning legislation. If any such bodies have imposed restrictions on the areas above, we suggest you contact the Technical Services Department before undertaking any works. As a Warranty Provider we are not obliged to accept any limitations or restrictions placed on a conversion/refurbishment scheme by a third-party that may affect or conflict with our own requirements.

General guidance for retained elements

Damp Proof Course (DPC) and Damp Proof Membranes (DPM)

All masonry walls at ground floor level should have a functioning DPC. If it cannot be confirmed if there is a functioning DPC, or if there are signs of dampness at low level, a damp survey will be required to be undertaken by a member of the Property Care Association or RICS Chartered Building Surveyor with relevant knowledge and experience, in line with the principles contained within the Joint Position Statement (JSP2022) titled ‘Investigation of moisture and its effects on traditional buildings’.

Ground levels and ventilation should be checked before any remedial DPC treatments are considered. However, where remedial DPC treatments are required, these must be appropriate to the type of construction, independently tested/approved come with a 10 year insurance-backed guarantee. Remedial DPC treatments must be installed by a member of the Property Care Association and the guarantees must cover workmanship and materials. A copy of the guarantee is required for our records upon completion of any remedial treatment carried out.

All existing ground bearing slabs should have a functioning DPM. The construction of the floor shall be assessed as part of the damp survey and any remedial treatment required must be appropriate to the type of construction, independently tested/approved and provided with a 10 year insurance-backed guarantee. Remedial DPM treatments must be installed by a member of the Property Care Association and the guarantee must cover workmanship and materials. A copy of the guarantee should be provided for our records upon completion of any remedial treatment carried out.

Timber treatment against insect and fungal attack

If existing timbers are to be retained, a timber condition report is required to be produced by a member of the Property Care Association or RICS Chartered Building Surveyor with relevant knowledge and experience. All retained timbers will need to be assessed, logged and the remedial treatment noted. Any remedial treatments must come with a 10 year insurance-backed guarantee and be undertaken by a member of the Property Care Association, where guarantees must cover workmanship and materials. A copy of the guarantee is required for our records upon completion of any remedial treatment carried out.

Roof coverings

Pitched roof coverings shall be replaced unless it can be demonstrated that they are in good condition and have a residual service life of at least 25 years. Please refer to ‘Appendix D Conversions and Refurbishments – Existing Elements: Timber roofs, and windows and doors’ for further guidance.

Flat roof coverings shall be replaced unless it can be demonstrated the roof is less than 5 years old and has been installed in accordance with the functional requirements of the Technical Manual. Please refer to ‘Appendix D Conversions and Refurbishments – Existing Elements: Timber roofs, and windows and doors’ for further guidance.

Weather resistance of walls, including claddings, render, re-pointing, etc.

The existing walls of the building shall provide a weathertight barrier. The existing walls or cladding system will need to be assessed, to confirm that they are in good condition, suitable for the building’s exposure rating as detailed in BS 5628 and shall provide a weathertight envelope for the next 15 years.

External doors and windows

In general, all windows considered to be over the age of 15 years old will be required to be replaced. Typical exceptions may include existing windows that are subject to planning and conservation restrictions. If windows are to be retained, a condition survey and report will be required by an independent, qualified Surveyor or specialist to confirm a residual service life of 15 years. Consideration must be given to improving the thermal characteristics.

Where repairs to windows are required we will ask you to prepare a sample repair on site so our Risk management Surveyor can bench mark the required standard so that this can be replicated across the whole refurbishment site. Note: painting windows does not make them newly constructed.

Sound testing

Party walls and party floors should be sound tested in accordance with the Building Regulations to determine compliance. Access maybe required into adjacent buildings so that sound testing is completed. Test and Declare is not permitted unless the building is classed as a ‘historic building’ as defined by the Building Regulations and dispensations are placed on the requirements of the regulations by the Local Authority. Please note, the Robust Details scheme are only applicable to new build units and cannot be accepted on conversion project.

External and internal services

Any services to be retained should be suitably tested and reported by a specialist. The specialist should also confirm fire compartmentation requirements as necessary.

Foundations

All existing structures will be subject to a structural appraisal by a competent specialist i.e. Chartered Engineer, who has suitably experience in the conversion and refurbishment of buildings of the type involved and in particular, the ground conditions beneath the site. The Engineer will be asked to provide a report, based upon a fully intrusive survey, to confirm that the structure and its individual components are structurally sound and has, in their professional opinion, a residual service life of 60 years. A copy of the appraisal should be provided for our records.

This appraisal should address:

- Settlement.
- Heave.
- Foundation depth and type.
- Soil type.
- Basement walls and floors.
- Trees adjacent to buildings.
- Undermining due to new floor structures or building services.

When carrying out the appraisal, the Engineer should take into account any proposed increased loading on the structure and foundations, alterations to existing load paths and any alterations to the existing stability of the building.

Any areas of cracking or suspected movement are to be assessed and remedial measures provided by the Engineer that will confirm a 60 years residual service life will be achieved, once the remedial works have been satisfactorily completed. Furthermore, any additional loads must be catered for and consideration of the impact of any landscaping and drainage works is required.

Where the existing foundations are inadequate, and/or there is evidence of structural movement, and/or the proposals are to increase the load on the foundations, an Engineer should design a suitable solution, which should certify a residual service life of 60 years once the remedial works have been satisfactorily completed. This must be discussed with the Technical Services Surveyor prior to implementation. Proposals for underpinning should be prepared by an expert and be in accordance with BS 8004.

Where trees are within close proximity to an existing structure, the potential risk of movement must be fully assessed. A detailed analysis supported by comprehensive structural designs and calculations should be provided supported by soil samples to determine the plasticity of the ground and the extent of the root intrusion beneath or around the building.

Underpinning

Underpinning will only be considered where it is supported by a full structural design with calculations and that the superstructure is assessed for differential movement. Movement joints should be provided between existing and underpinned/ new foundations.

Basement structural waterproofing

Our standards to basement conversions are no different to our New Homes approach. If the intention is to use any space below ground level (fully or partially), then the design shall ensure there is adequate resistance to the passage of water/ moisture to the inside, following the guidance in BS 8102. Please refer to the ‘Basements’ section for further information for basement provision. You must appoint a CSSW specialist to design, inspect and certify the waterproofing.

Where a basement area on a converted or refurbished site is not habitable or used for plant storage, any damp/water ingress occurring is specifically excluded from the Policy as stated below.

Excluded is: water entry, dampness or condensation to the enclosing walls, floors and ceilings of any underground: car-parking and any associated underground refuse stores, cycle stores, plant rooms (that do not house items of plant that directly service the Home and for which the failure of such plant would prevent the normal use of the Home), lifts / escalators, associated access stairs and lobbies; where the structural integrity of the Home is not affected.

Drainage

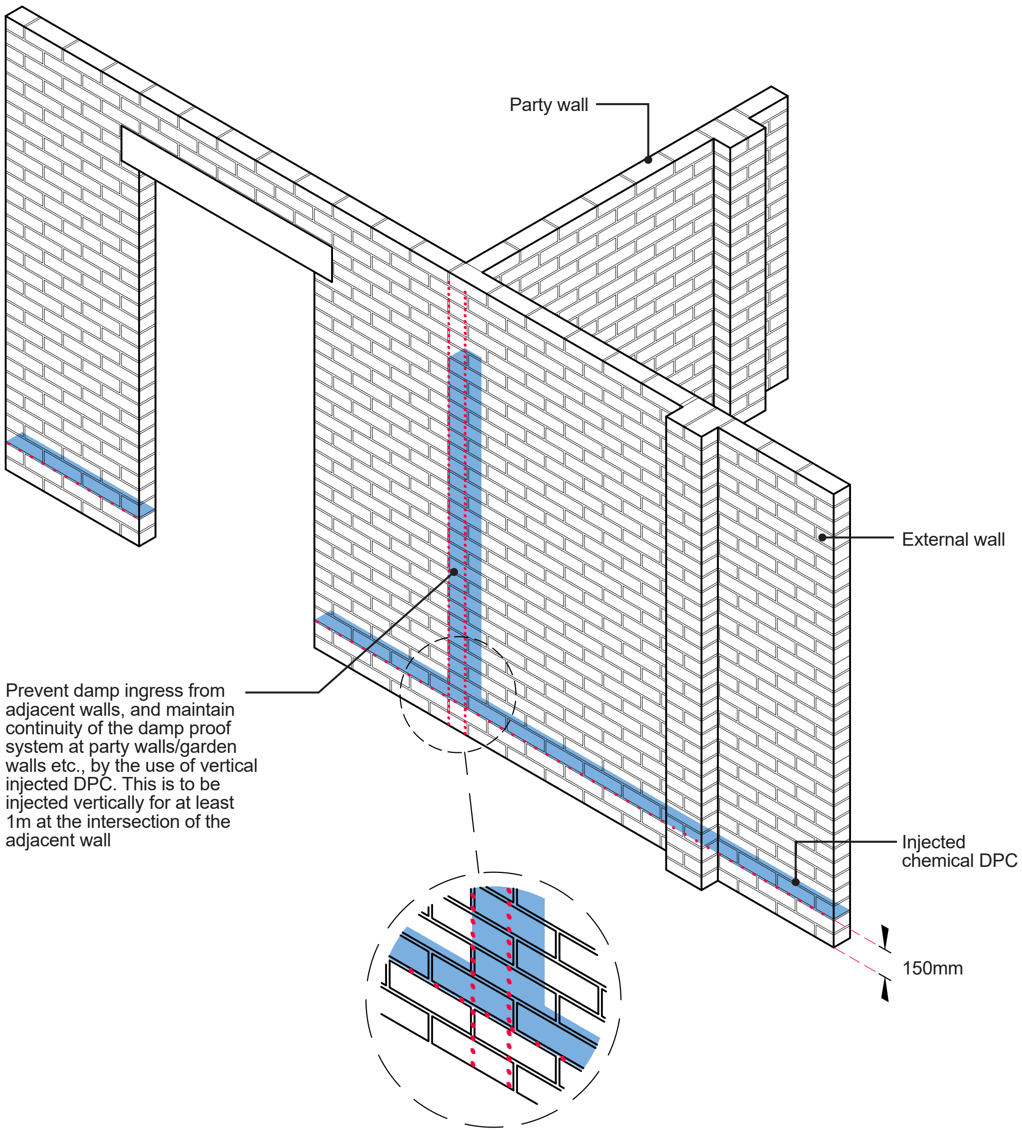
Drainage systems shall be replaced unless it can be demonstrated that the existing drainage system is fit for purpose, have suitable falls and the required rodding facilities.

Where private drains are retained, a CCTV survey should be undertaken to ensure the integrity and design of any retained system. Where the lengths of existing retained drainage do not have rodding access in accordance with current requirements, additional access points should be provided. Inspection chambers and manholes located within habitable parts of the building will not normally be acceptable. Existing septic tanks and cesspools should be replaced with a new sewerage treatment system.

Where some of the elements are new and replaced as part of the conversion/refurbishment, no report is necessary.

Above ground rainwater disposal
All rainwater goods must be suitably sized and meet the requirements of BS EN 12056:3. Where existing rainwater goods are to be retained including guttering, downpipes and specially formed channels, a condition report based upon an intrusive survey by a Chartered Building Surveyor or otherwise agreed specialist is required. The report must confirm that the rainwater goods (and ancillary products) are in good condition, fit for purpose i.e. capacity to meet the requirements of BS EN 12056:3 and have a residual service life of less than 15 years.

Typical chemically injected DPC



Damp proofing in walls

Where an existing DPC cannot be identified or is found to be defective, a remedial DPC should be provided; it should have a 10 year insurance-backed guarantee and be installed by a Property Care Association Member. A copy of the guarantees is required for our records upon completion of any remedial treatment carried out.

A suitable remedial DPC should be provided to existing walls, placed at least 150mm above external ground level to ensure that ground moisture does not enter the inside of the building. Consideration must be given to the height of the ground floor.

Some types of wall are not suitable for treatment by a remedial DPC system. These include:

- Walls of exceptional thickness i.e. greater than 600mm.
- Rubble-filled walls.
- Random flint/granite walls, or those of other similar impermeable materials.
- Mud walls (cob), wattle and daub.
- Rat trap bond.

Where it is not suitable to provide a remedial DPC, the wall should be assessed to demonstrate that it prevents rising dampness from entering into the building. The assessment should include the following:

- Damp Proof Survey from a member of the Property Care Association or RICS Chartered Surveyor to confirm that there is no evidence of rising damp and a copy of the report should be provided and retained for our records,
- Suitable detail of the ground floor construction and independent internal lining system that keeps the internal environment of the dwelling dry.

Advice should be sought from a member of the Property Care Association as to the suitability of their proposed products/system. Products used in chemically injected or membrane systems should always hold current independent third-party certification.

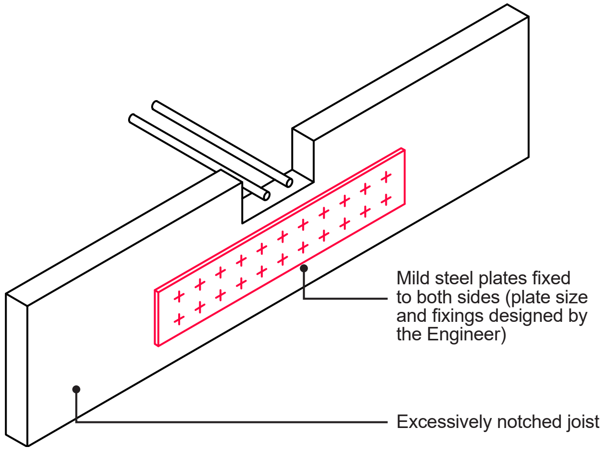
Condition and treatment of floor timbers

Where it is proposed to keep the existing ground floor, the existing floor boards/finish should be lifted to ascertain the condition of the timber joists/wall plates. A report compiled by an Engineer must be provided to confirm that the floor construction will be adequate to take the proposed loadings. A specialist timber report by a member of the Property Care Association or RICS Chartered Building Surveyor with relevant knowledge and experience will also be required to identify if the timbers are at risk, or are presently suffering from insect infestation and/or fungal attack and if so, what remedial treatment will be required. A copy of the report should be provided and retained for our records.

When deciding if an existing ground floor is adequate, there are a number of areas that should be addressed, including:

- An adequate DPC to walls/sleeper walls.
- All timbers must be free from rot and insect infestation.
- Adequate cross ventilation to the sub-floor (please note, many sub-floor voids will require cleaning out to achieve ventilation and reduce dampness).
- Adequate foundations supporting sleeper walls.
- Joists are of sufficient size and span.
- Are any load-bearing internal walls built off floor joists?
- Have joists been weakened by excessive notching or drilling?
- Adequate trimming to hearths.
- Adequate strutting of joists.

Strengthening an excessively notched joist



Timber condition survey

It is a requirement of our Warranty that an intrusive timber survey is undertaken to demonstrate the overall condition of timber members that are proposed to be retained. The survey should be completed by a member of the Property Care Association or a RICS Chartered Building Surveyor with relevant knowledge and experience and should include the following:

- An intrusive investigation to identify the overall condition of the timber.
- Deep probe moisture readings where timber is embedded, to confirm that the timber remains durable at bearings.
- Causation and remediation of timber defects.

It is essential that the type of fungal attack is correctly identified, as treatment methods vary for dry rot and wet rot.

The cause of both fungal and insect attack is elevated moisture levels, which may be caused by the following:

- Rain penetration.
- Condensation.
- Hygroscopic salts.
- Defective rainwater goods and roofs.
- Bridging of existing DPCs, or no DPC.
- Defective renders.
- Leaking drains and internal plumbing.
- Incorrect external levels.

Areas that have not been inspected should be clearly identified to enable a subsequent inspection to be carried out when the structure has been fully exposed. This could include rafter feet and wall plates that are particularly prone to rot.

Fungal attack is controlled by two sets of measures, primary and secondary.

Primary measures
These consist of locating and eliminating sources of dampness and promoting the rapid drying out of the structure. Where the timber becomes wet and remains wet, e.g. the moisture content exceeds 20%, then it is likely to decay. By eliminating the source of dampness and the drying of timbers to below 20%, the fungus will normally stop growing and will eventually die.

Secondary measures
These consist of determining the full extent of the outbreak and a combination of:

Removing all decayed timbers.
- Treating of walls that contain fungi (only applicable to dry rot).
- Treating of sound timbers with preservative on a localised basis where required.
- Using preservative-treated replacement timbers (pre-treated).
- Introducing support measures, such as isolating timbers from walls and the provision of ventilation between timbers and the walls.

Dry rot commonly occurs when timber is in contact with damp brickwork and where ventilation and heating are inadequate. Therefore, particular attention should be paid to cellars, basements and sub-floors, and also behind panelling.

Where buildings are considered to be historically significant, and there may be limitations placed upon what remedial treatments can be used, we advise that the services of an building conservation consultancy is used, who have the requisite experience in dealing with the conversion and refurbishment of historic buildings. The appointed consultant should be approved by our Technical Surveying department.

These expert consultants must be retained until the end of the project to verify that the works that they have recommended have been carried out to their satisfaction. Commencement and completion reports will be required and retained on our systems.

Where any remedial timber treatment is proposed, it shall be carried out by a registered member of the Property Care Association in accordance with their Code of Practice for Remedial Treatment and associated technical leaflets. A 10 year insurance-backed Warranty shall also be provided. A copy of the report and the 10 year insurance-backed Guarantee shall be provided and retained for our records.

Ventilation to floor voids

Existing timber floors are required to be cross ventilated, this is often an issue where the existing building is to be split up into various building compartments. In such cases a ventilation strategy should be considered.

Options for cross ventilation could include:

- Air bricks.
- Vertical stack pipes that provide ventilation to the floor.
- Mechanical ventilation systems.

In all cases consideration should be given to the passage of fire and sound.

The void beneath the timber floor must be clear to allow a free flow of air beneath the joists and floor structure.

Where the ground levels have previously been raised as a result of landscaping or access routes, ventilation points or airbricks can be obstructed or blocked which may prevent effective cross ventilation to the sub floor void. In such instances, changes to external ground levels must be made.

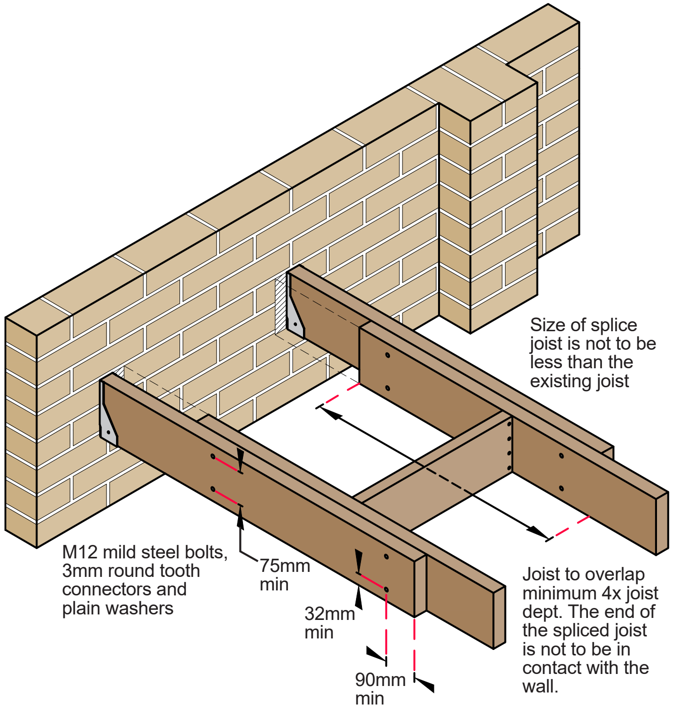
Existing solid floors

Only existing concrete floors are considered suitable for refurbishment, any stone, earth or tiled floors should be removed and replaced with a new concrete floor, Existing stone or tiled floor coverings may be used as a decorative finish.

Existing concrete floors will be required to meet the following requirements:

- That the floor has a suitable damp proof membrane. This has to be confirmed by a survey undertaken by a member of the Property Care Association. Where this cannot be confirmed a new DPM should be installed. A liquid applied membrane to the surface of the concrete would be suitable in most cases subject to the liquid membrane having appropriate third party certification. Note: Where existing slabs are cut for new drainage runs/service voids, it is not considered acceptable to carry out repairs to the existing DPM. A new DPM has to be installed.
- That the floor is free of any structural distress or movement. Where there are signs of movement, the floor should be replaced unless it can be proved by an Engineer that the floor is suitable for carrying imposed loads and supporting its own weight without any further movement or cracking.

Typical example of repairs to floor joists



Structural repairs

Prior to undertaking structural repairs, the root cause of the structural defect must be remedied by underpinning, the addition of adequate lateral restraint, buttressing, etc. Strengthening works to the structure may also be necessary to accommodate increased or modified loads.

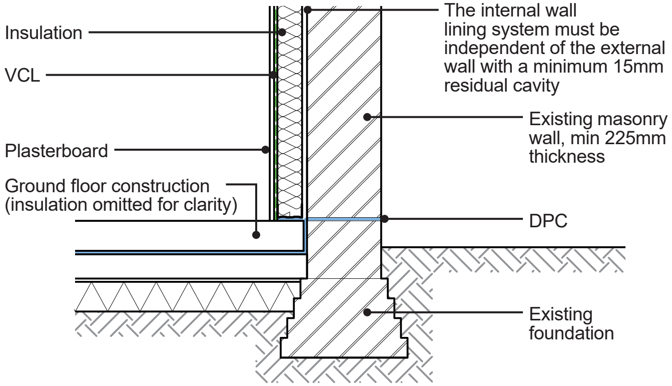
All assessment and design of remedial works must be carried out by an Engineer and upon completion certified that the remediated structure will have a 60 year residual service life.

External walls

Solid walls
To provide an acceptable level of protection against the ingress of rainwater, any retained solid masonry external walls should either:

- Be fully lined internally with an independent timber or metal stud wall.
- Be clad externally with a rainscreen or other protective measure.
- Comply with the requirements of BS 5628 (as outlined below).
- An independent lining system should also be provided where party walls between buildings, project above adjacent roof coverings (thus becoming external walls).

Typical independent internal lining



Where damage has occurred to walls, the cause needs to be investigated.

Likely reasons for the damage include:

- Ground movement - foundation failure, settlement, subsidence, chemical attack.
- Thermal movement - thermal expansion due to temperature changes.
- Roof spread - pitched roofs not properly tied, spreading at eaves.
- External and internal walls not bonded together.
- Wall tie corrosion.
- Inadequate lintels over openings.
- Sulphate attack - water-soluble sulphates attack cement-based mortar, normally in a wet environment, i.e. below ground level and parapet walls.
- Frost attack.
- Bonding timbers present and subject to rot and shrinkage.
- Ineffective or no lateral support at floor and roof level.
- Moisture ingress.

Weather resistance of walls and cladding

Existing solid brick or stone walls are unlikely to be acceptable as weather-resisting, although consideration of the exposure category of the building and porosity of the masonry will be given, i.e. do existing non-gypsum-based internal linings allow for greater insulation and evaporation than gypsum plasters alone?

It is anticipated that in all buildings, at least one of the additional treatments noted below will be required, and this must include appropriate insulation.

However, all solid masonry wall situations may require a Specialist's report to identify the extent of any necessary remedial treatment. A copy of the report shall be provided and retained for our records.

External treatments

Existing claddings can be retained if it can be shown by a suitably qualified expert that:
- The system maintains the integrity of the building.
- It is adequately fixed and the expected life span of the fixings, where appropriate, is in excess of 15 years.
- The cladding material is free from any defects.
- Adequate provision for movement has been allowed.

A copy of the expert report shall be provided and retained for our records.

If the above situations cannot be satisfied, a new external cladding or render system is required.

Internal treatments

An alternative to preventing moisture penetration by using externally applied claddings and renders is to adopt internally applied methods.

Systems are available that are installed on the inside of existing walls to prevent moisture penetration reaching the internal accommodation. These include:

- Independent metal or timber framed systems: these should not be fixed to the existing masonry walls, but fixed at the 'head and base' to avoid direct contact. Ventilation should be provided to avoid a build-up of condensation between the masonry and the inner lining system.
- New internal walls: these would normally be formed in blockwork, must be adequately founded and, where necessary, tied to the retained and new elements of structure.

Control of damp penetration

Measures should be taken to ensure that thermal insulation in cavities does not encourage the passage of moisture to the inside of the building.

Thermal insulation of walls and claddings

Various methods exist to upgrade the thermal insulation of existing walls and floors. Regardless of the methods adopted, it is essential that risks associated with increased thermal insulation are minimised, including:
- Surface condensation caused by improvements to draught proofing of the building measures.
- Interstitial condensation caused by moisture-laden air passing from the dwelling to within the fabric of the structure and condensing on cooler surfaces.
- Increased risk of damp penetration caused by the filling of cavities with insulation.
- Maintaining the robustness of the external and internal wall surfaces by the provision of adequate mechanical protection over insulation materials, e.g. externally applied insulation systems with render coat mechanical protection.
- Avoidance of cold bridges around openings and where structural elements extend through the thickness of the building envelope.
- Repeating thermal bridging must be considered, e.g. internal metal-framed walls should be used in conjunction with thermally insulated plaster board.

Render and plaster application finishes

Plaster for conversions/refurbishment
Where the condition and bond of the existing plaster can be shown to be adequate, it can remain, with the exception of the following:
- Where rising damp is present.
- Where a chemical DPC is to be installed.
- At the junction of external walls and party walls to see if they are properly bonded.
- Above openings to examine the make-up and condition of lintels.
- Where there is a possibility that bond timbers may have decayed.
- Where the wall is solid and the plaster is gypsum-based.

Where a chemically injected DPC is installed, it is necessary to remove the plaster one meter above the DPC level or 600mm above any apparent salt line/dampness, whichever is higher. Re-plastering work should be delayed as long as possible in order to encourage rapid evaporation of residual moisture, and the building should be well ventilated during the drying period.

Plastering work must comply with an independent third-party certification and the chemical DPC must meet the manufacturer's recommendations. Recommended plasters usually incorporate adhesives to increase resistance to the passage of hygroscopic salts from the wall into the plaster. The adhesives should not, however, act as a vapour barrier. Gypsum plaster should not be used in conjunction with chemically injected DPC.

The plaster should not bridge the DPC or be in contact with the ground floor slab.

Final redecoration should not be carried out until residual moisture has disappeared. Matt emulsion paint is recommended for use during this period.

Internally drilled holes concealed by skirting boards, etc. should not be plugged. Other visible holes and external holes should be plugged.

Rendering for conversion/refurbishment

Where the condition and bond of the existing render can be shown to be adequate, it can remain, subject to the following exceptions:
- If the render bridges the DPC.
- Above door and window openings where it is necessary to examine the type and condition of the lintels.
- Where there are signs of structural movement in the building, and further investigation is required.

If the existing render finish is to be retained, this will be subject to a condition survey from an independent RICS Chartered Building Surveyor or other recognised specialist consultant. This report must state that in their professional opinion, the render is adequately bonded to the substrate and is likely to have a residual service life in excess of 15 years.

Where over rendering is proposed, the bond of the existing render must be assessed and details will be required on how the new and the old render are to be adequately bonded together. Therefore, a condition report will be required on the existing render as detailed above. A specialist render consultant must be employed to specify the new render make-up and demonstrate how the new and the old render are to be bonded together. Please note all new render works must be in accordance with the 'External Walls - Render' section of this Technical Manual.

Cracking in masonry walls

Minor cracking can be defined as cracking that occurs in the mortar joints and which does not extend through the masonry components. Providing that the crack is no wider than 4mm, and there has been no lateral displacement of the wall, the wall can be re-pointed.

Major cracking affects the structural integrity of the wall, and investigation should be undertaken by an Engineer to find the cause of the problem. Once any specified remedial works are carried out, the appointed Engineer should confirm that the structure has a 60 year residual service life.

Walls out of plumb/bulging

Where walls are more than 25mm out of plumb or bulge more than 10mm within a storey height, an Engineer should comment on the stability. The wall may need to be rebuilt or strengthening works undertaken.

Where it is intended to provide buttressing walls to support out of plumb and/or bulging walls, they should be designed by an Engineer. Once any specified remedial works are carried out the appointed Engineer should confirm that the structure has a 60 year residual service life.

In raised tie roofs (where no ceiling ties are provided at eaves level), lateral spread of the brickwork just below eaves level may have occurred because the roof has deflected. In such cases, it is necessary to prop the roof and rebuild the affected part of the wall.

Bonding timbers

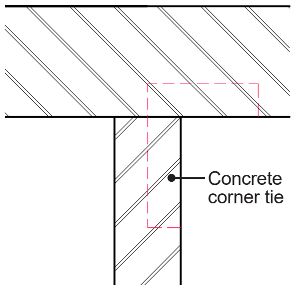
These are common in Georgian buildings, and were laid in the internal skin of the wall to reinforce it and to provide fixings for panelling, etc. With the low compressive strength of lime mortar and general timber decay, the bond timber compresses under load. As the timber is on the inner skin, the compression causes bulging outwards, which may be apparent on the external face. Normally, bond timbers should be exposed during the conversion and removed in short lengths, and replaced with bonded masonry.

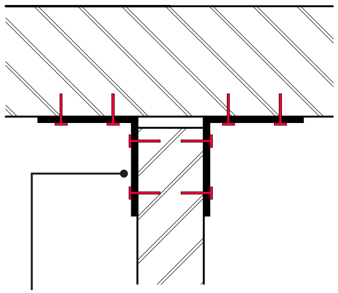
External and internal walls not bonded together

A common defect in properties up to the 1920s is the lack of bonding/tie of party walls to the external wall.

Different bricks and bricklayers were often used, with the poorer quality materials and labour being used on the party walls. This junction should be exposed when undertaking a conversion and if the bond is inadequate, a suitable stitching detail incorporated. A design by an Engineer may be required supported by confirmation the remedial works have a residual service life of 60 years.

Typical examples of rectifying unbonded walls





30mm x 5mm galvanised strap at 600mm centres mechanically fixed or resin grouted to the wall.

Arches and lintels

The existing timber lintels can be retained if they support the structural walls and it can be shown that the lintel is adequate for its purpose, i.e. there is no sign of any structural movement, loads will not be increased and the timbers are free from rot and insect infestation.

In order to ensure that any timber lintels are free from rot, all lintels should be exposed at both ends and on the inner (hidden) face of the timber embedded in the wall for openings in external walls.
Where movement or decay has occurred and the timber lintel is inadequate, the lintel should be replaced with either a concrete or steel lintel.

Where cracking has occurred in masonry arches, it will be necessary to rebuild the arched construction. In cases where failure has occurred due to the low pitch of the arch, it may be necessary to incorporate a lintel.

Alterations to existing openings

Where existing openings are to be filled with masonry, the new work should be adequately bonded to the existing and the weather resistance of the wall maintained. However, if the opening then becomes part of a party wall it should comply with the requirements for sound insulation.

Cavity Walls

Wall tie corrosion
Cavity walls have been constructed since 1850, but it was not until 1920 that this form of construction was widely adopted. It is important when undertaking a conversion to confirm the construction of the external wall. In cases where headers are incorporated into the bond of the external brickwork, an investigation of the wall construction must be undertaken to clarify the actual wall make up and the Technical Services Surveyor advised of the findings. Many properties in the Victorian period were built with either a 215mm outer leaf and cavity behind, or a 215mm inner leaf, cavity and a half brick outer leaf with snapped headers.

Initial evidence of cavity wall failure can include cracking of bed joints in mortar (typically every sixth course). This is due to the expansion of the wall ties as they corrode.

Bulging of the external leaf could also indicate that the ties have failed.

Where there is wall tie corrosion or inadequate ties, or where wall ties have corroded to an extent serious enough to threaten the stability of the wall or building, an Engineer should be appointed to determine the necessary remedial works and state that the structure following the remedial works has a residual service life of 60 years.

Insulation to cavity walls
Most cavity walls constructed after 1985 should already be insulated, however where a cavity wall is required to be thermally upgraded, it should be lined internally. The retrofitting of cavity wall insulation is not acceptable as the overall condition of the cavity is not known. If blown insulation is already present within an existing cavity, additional measures to provide continuous thermal protection to all external walls will be required. This may be in the form of an independent insulated lining internally or external wall insulation. Furthermore, the condition of cavity wall ties should be checked for corrosion and suitability for retention.

Timber framed walls

Timber framed elements must be structurally durable and free from rot.

The timber frame must be assessed as part of any timber survey as described earlier in this guidance. Particular attention should be given to sole plates and timber framed elements that are close to the ground.

Curtain walling

Curtain walling must be assessed by a cladding and façade specialist to determine the following:

- The structural durability of the façade.
- The adequacy of the façade in forming a suitable waterproof envelope.
- The fire performance of the façade, particularly with respect to external fire spread and ensuring cavity barriers are correctly installed in line with current Building Regulations.

No fines construction and other non-traditional methods

It is essential that any “no fines” construction is correctly assessed and tested to determine the durability and integrity of the structure by an Engineer to determine the structure will have a residual service life of 60 years.

Existing masonry

Where a wall is adequately founded or supported on a beam that shows no signs of distress, it can remain providing there is no increase in load onto the wall. Any increase in load should be justified by calculation by an Engineer. New masonry supported on existing timber beams should be avoided.

In older properties, it is possible that flitch beams and bressummers may be supporting masonry walls, and these should be examined by an Engineer to ascertain their capability to carry the load.

Existing studwork

Many properties built before 1880 have trussed internal partitions, usually located approximately halfway back in the depth of the property. Often, these walls are load-bearing, continue up through the building and carry floor and roof loads onto the foundations.

If a timber partition is load-bearing, providing it is adequate, the loads are not being increased and the timber is free from rot and insect infestation, it can remain. Where there are defects i.e. the floor sags on the line of the partition and there is distortion of door heads, then additional strengthening works should be undertaken.

New door openings cut into an existing trussed partition should be overseen by an Engineer, as this can adversely affect the triangulation of the truss.

Timber floors

Existing timber floor joists can be retained within the building, providing they are adequate for their purpose. The following points should be considered:

- Joists are of sufficient size for the span.
- Load on the floor is not being increased.
- Joists have not been weakened by excessive notching and/or drilling.
- All timbers are subject to an intrusive survey, confirming the ends of joists are free from rot.
- All timbers to be treated for insect infestation and wood rot.
- No masonry walls are built off timber joists.
- Appropriate strutting is provided.

Filler joist floors

Many buildings of the late Victorian and Edwardian periods were built with floors constructed of clinker concrete supported by embedded iron or steel joists. The concrete produced with clinker aggregate was porous, and therefore provided poor corrosive protection to the metal.

When considering a conversion in a building with filler joist floors, it is important to first investigate whether the floors have been subject to damp conditions and whether any significant corrosion has taken place.

Particular attention should also be paid to ensuring that the floor remains dry during the conversion, and this could include providing a temporary covering if removal of the existing roof is necessary.

Rooms containing areas of high humidity use or potential areas where water spillage can occur, e.g. wet rooms, bathrooms, en-suites kitchens, utility rooms should not be constructed over such filler joist floors.

General provisions for concrete and steel framed buildings

Where the scheme involves converting a concrete or steel-framed building into dwellings or other uses, the following guidance is given.

An appraisal of the existing building should be carried out by an Engineer, taking into account the proposals for the change of use.

This will include:

- Condition of the structural frame, including joints.
- Proposals to increase loadings on the structure and foundations.
- Alterations to existing load paths.
- Alterations to stability systems.
- Changes in environmental exposure.
- Recommendations to cover additional reports and testing by specialists.

The floor loads on the building may decrease, as they could be converted for domestic use only where previously they were, for example offices.

A statement from the Engineer confirming, where appropriate, that the existing foundation design is acceptable for the new loads subject to the building showing no signs of distress, i.e. movement, cracking etc. will be acceptable in such circumstances.

Where the intention is to increase the load on the existing structure e.g. by the introduction of an additional floor, then structural calculations should be provided to prove the adequacy of the building and foundations.

In all cases, the Engineer should confirm the building structure will achieve a 60 years residual service life once the remedial works have been satisfactorily completed.

Concrete-framed buildings

Where the building is of concrete construction, a structural appraisal by an Engineer is required. The survey and report is to be based on the recommendations made by ‘TR54 - Diagnosis of determination of concrete structure - The Concrete Society’ and ‘IStructE guide for assessing concrete structures’. It is recommended that the Engineer comments on the following:

- Has overall loading assessment been undertaken?
- Assessment of existing foundations is essential.
- The assessment needs to consider disproportionate collapse.
- Additional testing is required for carbonation, chloride attack, presence of High Alumina Cements and Alkali Silica reaction. The Engineer to provide the Warranty Provider with outline testing proposal for our review.
- Require confirmation of a residual service life of 60 years.

Steel-framed buildings

In addition to any structural reports, a visual inspection of the steel frame should be carried out to assess the extent of any corrosion of the framework.

Where corrosion is present, accurate measurements can be made using an ultrasonic gauge. Data collected can used to compare the thickness of steel sections against the original steelwork drawings, British Standards and the Historical Structural Steelwork Handbook to ascertain if the structural frame is adequate for the proposed loads.

Where steelwork has corroded, further analysis must be sought to determine if any expansion of the frame will/has occurred. In such scenarios, cathodic protection may need to be considered which will required to be carried out by a suitably qualified expert confirming that a 60 year residual service life will be achievable once the works have been completed.

Steelwork generally

Exterior steelwork should be inspected; where corrosion is visible, the steel can be grit blasted, cleaned and re-coated.

Perimeter steelwork in direct contact with the outer leaf of the building can be prone to corrosion, particularly in older properties. A sign indicating that this has happened is the displacement of the external masonry due to the expansion of the steelwork caused by corrosion. During the conversion process, the appropriate repairs/replacement should be carried out.

For interior steelwork, the risk corrosion of unprotected steelwork within the interior of a building is low, with only superficial rusting. Providing that a visual inspection confirms this, and the environment intends to remain dry, no further treatment of the steel will be required. Where the proposals involve the steelwork in a ‘wet’ environment, such as kitchens and bathrooms, it should be adequately protected.

Bimetallic corrosion

This should be considered in the existing and proposed structure.

Bimetallic corrosion occurs where two different metals are in electrical contact and are bridged by water or water containing other chemicals to form an electrolyte. A current passes through the solution from the base metal to the noble metal and, as a consequence, the noble metal remains protected and the base metal suffers increased corrosion.

Where there is a possibility of this occurring, or if it has already occurred, advice should be taken from a specialist on how to deal with it.

Cast iron, wrought iron and mild steel structures

Many older buildings that are converted into dwellings or other uses, e.g. warehouses, cotton mills etc. were built using cast iron, wrought iron or mild steel.

When the intention is to keep the existing structural elements, an appraisal of the existing building is necessary.

In addition to this, the Engineer should comment on the following:

- Determine the age of the building and the materials used.
- Assess how its construction has fared.
- Justify the loadings by calculation.
- Identify areas where additional testing and/or opening up is necessary.

If the proposed loads remain unchanged or are reduced, as will probably be the case, and it can be shown that the existing structure has not suffered any deterioration due to corrosion or deflection of structural members etc. the building may only require localised structural alterations.

Where the intention is to increase loads, carry out major structural alterations or the existing building is under-designed, an Engineer should comment on this and provide calculations to justify the proposals.

Surveying roof timbers

All roof timbers shall be subject to an intrusive timber survey, undertaken by a member of the Property Care Association or RICS Chartered Building Surveyor with relevant knowledge and experience and provide a report detailing any necessary treatment to be carried out. Particular attention should be given to rafter feet, wall plates and valley timbers, as these often show signs of rot.

Roof structure

It is essential that the roof structure has adequate strength, stiffness and dimensional accuracy appropriate for the new roof covering. All strengthening work should be designed by an Engineer to prove that after the work has been completed, the roof structure will have a residual service life of 60 years.

Where recovering of existing roofs occurs: Approved Document A Section 4, deals with the requirements for checking the structural integrity of the roof and supporting structure when considering the re-roofing of buildings.

Common problems encountered include:

- Excessive spans of rafters, purlins, binder and ceiling joists.
- Inadequate ties between rafters and ceiling ties.
- Insufficient number of collar ties at purlin level.
- Decay of rafter feet and valley beams.
- Settlement of purlin supports.
- Lateral spread of raised-tie roofs.

Roof coverings

Traditional slate and tiled roofs
Roofs should generally be re-covered in accordance with the ‘Roofs’ section of this Technical Manual. Where roofs are to be re-covered, it is required that existing gable walls are appropriately supported during the construction works and lateral restraint straps are fitted to any gable walls.

There may be exceptional circumstances where an existing tiled roof covering can be retained; however the following requirements would apply namely:

- That the tiled roof shows no sign of deterioration that suggests that the roof covering has passed its useful life.
- That the roof has a suitable roofing membrane/roofing felt beneath the tiles which is functioning correctly and not damaged.
- That ridges and hips are well bedded and mortar has not eroded. Please note, it may be reasonable in some circumstances that ridges and hips are re-fitted, mechanical fixing should also be provided in such circumstances.
- That timber battens and fixings are in good condition and fit for purpose.
- That existing flashings and weatherings are assessed, particular attention should be given to valleys and parapets, if there is any doubt of the condition of any weatherings, they should be replaced.

Please note:

1. A report should be provided on the condition of the tiles and stating that they have a residual service life of at least 25 years. The report should be provided by a suitably qualified expert.
2. Fibre cement tiles/slates are not be acceptable for retention.
3. Adequate provision for ventilation to the roof voids should be considered in accordance with BS 5250.
4. The requirements for resisting fire spread in the relevant Building Regulations must be considered e.g. how will fire stopping at heads of party walls etc. be achieved?
5. Wet bedded hips and ridges must be demonstrated to be adequately fixed or if found to be poorly bedded then they should be stripped and mechanically fixed (or if subject to listed restriction then they should be re-bedded in accordance with BS 5534.
6. All parapet capping/copings should be removed, new DPCs provided and re-fixed with mechanical fixings. Inside face of parapets to be waterproofed, lined lapped under DPC etc.

Continuous membrane roofs, and roof terraces and balconies
Membrane roofs, roof terraces and balconies should be re-covered in accordance with the ‘Roofs’ and ‘Roof Terraces and Balconies’ sections within this Technical Manual unless the following provisions can be met:

1. That the existing membrane is less than five years old, it is tested for water ingress and a condition report is provided to confirm a remaining residual service life of at least 25 years will be achieved (testing guidance requirements can be found in the ‘Roofs’ and ‘Roof Terraces and Balconies’ sections of this Technical Manual).
2. There are no signs of excessive ponding.
3. The roof has a fall, adequate upstands and suitable drainage outlets.
4. That roof terraces and balconies are fitted with overflows.
5. That any thermal upgrade via inverted insulation does not compromise roof drainage or upstands.

Where ever practicably possible, a cold deck roof should be converted into warm deck roof if feasible. If this cannot be achieved due to design limitations e.g. upstand heights, ventilation provision, etc. we may consider the retention of a cold deck roof on a site by site basis.

If a cold flat roof is to be retained, it must meet the requirements of BS 6229. Provision must be made for adequate cross ventilation and a condensation risk analysis must be undertaken to assess the risk of interstitial condensation occurring.

Rainwater goods

All rainwater goods must be suitably sized and meet the requirements of BS EN 12056:3. Where existing rainwater goods are to be retained, a condition report based upon an intrusive survey by a Chartered Building Surveyor or otherwise agreed specialist is required. The report must confirm that the rainwater goods (and ancillary products) are in good condition, fit for purpose i.e. capacity to meet the requirements of BS EN 12056:3 and have a residual service life no less than 15 years.

Windows and doors

Where windows and doors are replaced, this should be in accordance with the ‘External Windows and Doors’ section of this Technical Manual.

Any retained windows and doors must meet the following provisions:

- Should be no more than 15 years old.
- Be in good condition and free from any damage, rot or decay.
- Be able to perform as part of the waterproof envelope.
- Provide adequate ventilation where the building ventilation system relies on purge ventilation.
- That window mechanisms and catches operate correctly.

Where timber windows and doors are retained, care should be taken in ensuring the following elements are able to perform as required in maintaining the integrity of the waterproof envelope. Please note the below list is not an exhaustive list of issues but forms the basis of an initial assessment:

- Failing and weak framing joints.
- Failure of butted and pinned joints.
- Provision of projecting profiles for opening casements.
- Lack of drainage to insulated glazing units.
- Failing glazing beads.
- Failing draft seals.
- Distortions and twists in opening elements.

The Technical Services Surveyor reserves the right to accept or reject the retention of existing windows as part of their Refurbishment Assessment.

D.
Appendix D

D.2
Conversions and Refurbishments - New Elements Connecting to Existing Structures

Introduction

Where new developments are attached to existing buildings, and the existing elements that form part of the new structure must meet the Functional Requirements of the Warranty. The details below give some guidance on the minimum information and standards required to meet the Functional Requirements.

Party wall agreement

It is highly likely that improvements to an existing wall are necessary to meet the requirements of the Warranty. This may include underpinning, injected DPC and internal linings.

Where a wall is shared by two or more owners, the requirements of the Party Wall etc. Act may apply. This is separate legislation with different requirements to the Building Regulations or Warranty requirement. Further guidance on the Party Wall etc. Act can be found on the Planning Portal website www.planningportal.gov.uk

Separating walls

The separating wall between the new and existing building must meet the relevant requirements of the relevant Building Regulations.

Confirmation should be provided where the existing wall is to be upgraded to meet current relevant Building Regulations, particularly in meeting the relevant sound insulation and fire separation requirements. The structural integrity of the existing wall and its resistance to ground moisture should also meet current standards.

Existing foundations

The existing foundations and wall structure must be suitable to support any proposed increased loading resulting from the construction of the new building.

Foundations to the existing wall should be exposed and assessed for suitability to support additional loadings. It is important to protect existing foundations at all times, and care must be taken not to 'undermine' existing foundations when clearing the site or reducing levels.

Where existing foundations require underpinning, a design by an Engineer should be provided and approved by the Warranty Surveyor prior to work commencing on-site.

The existing wall should also be appraised by an Engineer to determine whether it is structurally stable and suitable to support additional loadings.

New wall junctions

The junction of the new walls to the existing walls must ensure that dampness cannot track back into the new building or existing building. The detailing of this junction is critical to ensure that moisture ingress does not occur between the new and existing walls. Typical acceptable details are shown to the right.

Damp proof course (DPC)

An effective DPC should be present in the existing wall, linked to the new DPC and Damp Proof Membrane (DPM) of the new building. Acceptable existing DPCs are considered as:

- A continuous felt or proprietary DPC material.
- A chemically injected DPC supported by an insurance-backed guarantee.
- A slate DPC is considered acceptable if the existing wall incorporates an independent wall lining system to the inner face of the new building.

The new DPC should lap the existing DPC by at least 100mm.

Existing and new structure junctions

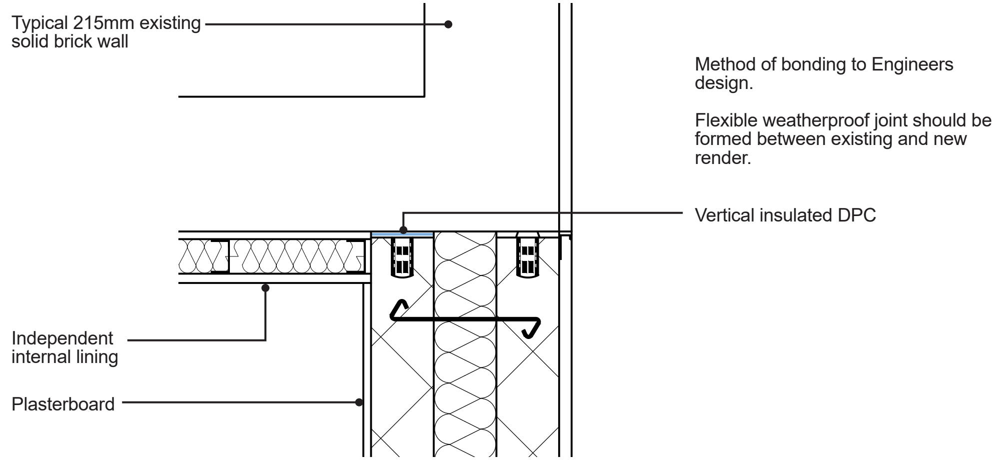
At the junction of the existing and new structures, detailing should allow for differential movement without cracking. Any settlement should be limited to 2mm-3mm, which would not normally adversely affect the roof covering.

Typical details of bonding new walls to existing are indicated to the below.

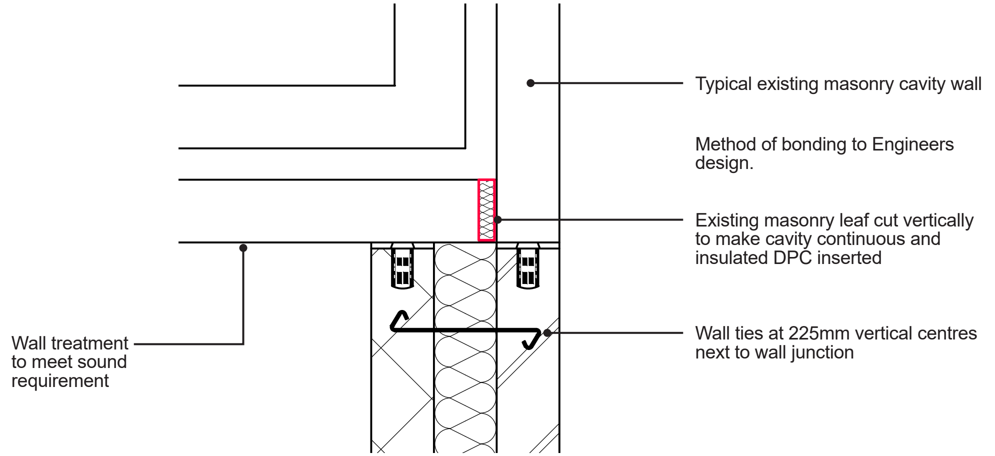
In order to prevent excessive differential movement, the new building should have the same foundation type as the existing building. Where the foundation types are different, e.g. new building pile and beam, existing building traditional strip foundation, the new building should be completely independent of the existing building.

The foundation design should be confirmed by an engineer and a copy of the report provided to the Warranty Surveyor before construction works commence.

Bonding new walls to existing solid masonry walls



Bonding new walls to existing masonry cavity walls



D.
Appendix D

D.3
Conversions and Refurbishments - Buildings with Historic Significance

Introduction

The guidance that follows is for buildings that have Historic or Conservation Planning restrictions, where due to such restrictions it is not possible or feasible to upgrade the building.

The guidance in this section is applicable to those elements that cannot be improved or altered, in all cases there are some types of construction that will not be suitable for Warranty cover these are as follows:

- Grade 1 listed buildings.
- Scheduled and ancient monuments.
- Former agricultural buildings of any nature, with the exception of the farmhouse.
- Barns.
- Cob construction.
- Through wall oak/timber frame.
- Wattle and daub.

Conversions and refurbishments are projects that involve work to existing buildings or parts of existing buildings. This could include the conversion of industrial or commercial buildings into housing; the conversion of an existing residential building into flats; an additional storey to an existing building; the refurbishment of an existing residential building; or a façade retention project.

The Warranty includes cover for the retained structural elements and waterproof envelope of any existing building for the duration of the policy. Conversion or refurbishment schemes covered under the New Homes, Social Housing and Private Rental policies will be the subject of a Refurbishment Assessment by our Warranty Technical Services Surveyors. Ideally, this should occur before you start planning or building.

The Technical Services Surveyor will always undertake an initial assessment of the existing fabric to ascertain in general terms if the proposal is capable of representing a standard risk to the Underwriter. If deemed acceptable, the development is then subject to a technical audit process during construction, and the following guidance is intended to assist all parties in ensuring the relevant requirements are met, as well as providing an element of consistency in approach.

Depending on the condition of the original building; an Engineer's survey may be required for the different elements of the building as described in the following guidance. If the survey concludes that any of these elements are unable to achieve a residual service life to that stipulated in the service life table in 'Appendix C', they should be systematically replaced or repaired.

Existing buildings and structures can present particular problems both initially and during the construction phase. Therefore, it is essential that thorough and comprehensive survey work is undertaken prior to new works commencing to understand both the current condition of any structure and the impact any proposed works may have. Although initially this may be considered an unnecessary early expense, the savings in reconstruction costs can greatly outweigh the cost of the preparatory work.

Elements of the retained structure and proposed works should not be considered in isolation, as a solution for one problem may cause issues elsewhere. Past performance is no guarantee of ongoing adequate performance because different expectations and changing living conditions can impact on both the actual and perceived performance of a converted/refurbished structure.

It is not possible to cover every building type within this guidance. The guidance is general and certainly will not apply in every scenario. It is strongly recommended that early discussions are held to determine the exact requirements and to enable a full review of the proposed strategy and development.

Where new work is proposed, it should follow the guidance for those elements in the various sections earlier in this Technical Manual. Where new work is applied to, or meets, existing elements, consideration on how these areas will interact must be made; for example, new cavity masonry that abuts an existing solid wall construction. If works have progress to a stage beyond where it is not possible to survey the structure or that new works have been carried without inspection, it is highly likely that the scheme cannot be considered a standard risk and the offer of Warranty may be withdrawn.

Please note that the requirements of the technical audit are quite different from those undertaken to comply with Building Control and Planning legislation. If any such bodies have imposed restrictions on the areas above, we suggest that you contact the Technical Services Department before undertaking any works. As a warranty provider we are not obliged to accept any limitations or restrictions placed on a conversion/refurbishment scheme by a third-party that may affect or conflict with our own requirements.

Retained elements, foundations and load-bearing structures (including floors, walls and roofs)

Planning restrictions
Where building renovation or thermal upgrade is limited by planning restrictions, a copy of the planning permission and supporting conditions must be provided.

The guidance in 'Appendix D – Conversions and Refurbishments - Existing elements' equally applies to the following elements:

- The structure.
- Damp Proof Course's (DPC) and Damp Proof Membranes (DPM).
- Timber treatment against insect and fungal attack.
- Roof coverings.
- Weather resistance of walls, including claddings, render, re-pointing, etc.
- External doors and windows.
- Sound testing.
- Foundation.

Drainage
The guidance in 'Appendix D – Conversions and Refurbishments - Existing elements' equally applies to this section.

Drainage systems shall be replaced unless it can be demonstrated that the existing drainage system is fit for purpose, have suitable falls and the required rodding facilities.

Where private drains are retained, a CCTV survey should be undertaken to ensure the integrity and design of any retained system. Where the lengths of existing retained drainage do not have rodding access in accordance with current requirements, additional access points should be provided. Inspection chambers and manholes located within habitable parts of the building will not normally be acceptable. Existing septic tanks and cesspools should be replaced with a new sewerage treatment system.

Where some of the elements are new and replaced as part of the conversion/refurbishment, no report is necessary.

Above Ground Rainwater Disposal
All rainwater goods, must be suitably sized and meet the requirements of BS EN 12056:3. Where existing rainwater goods are to be retained including guttering, downpipes and specially formed channels, a condition report based upon an intrusive survey by a Chartered Building Surveyor or otherwise agreed specialist is required. The report must confirm that the rainwater goods (and ancillary products) are in good condition, fit for purpose i.e. capacity to meet the requirements of BS EN 12056:3.

Basement structural waterproofing

Please refer to 'Appendix D - Conversions and Refurbishments - Existing Elements', and also the 'Basements' section in the main body of this Technical Manual for further guidance.

Where a basement area on a converted or refurbished site is not habitable, any damp/water ingress occurring is specifically excluded from the Policy.

Excluded is; water entry, dampness or condensation to the enclosing walls, floors and ceilings of any underground: car-parking and any associated underground refuse stores, cycle stores, plant rooms (that do not house items of plant that directly service the building and for which the failure of such plant would prevent the normal use of the Home), lifts/escalators, associated access stairs and lobbies; where a continuous structure entails the conversion, refurbishment or renovation of an existing building(s) and where the structural integrity of the building is not affected.

Damp proofing of walls

For details of remedial DPCs please refer to 'Appendix D - Conversions and Refurbishments - Existing Elements' which applies to damp proofing.

Where planning restricts the inclusion of an independent lining system and where it is not feasible to insert a chemical injection DPC, A full assessment must be completed by Chartered Building Surveyor who has proven experience in historic and listed buildings (RICS Accredited Building Conservation Surveyor or equivalent). The assessment must identify the risk of rising damp and propose solutions where applicable.

Condition and treatment of floor timbers

The guidance in 'Appendix D - Conversions and Refurbishments - Existing Elements' applies also to this section.

Structural repairs

Prior to undertaking structural repairs, it is essential that the root cause of the structural defect has been remedied by underpinning, addition of adequate lateral restraint, buttressing etc. Strengthening works to the structure may also be necessary to accommodate increased or modified loads.

Solid walls

Where external solid walls cannot be upgraded in accordance with the guidance in 'Appendix D - Conversions and Refurbishments - Existing Elements', and where the existing thickness of the external wall does not meet the required exposure rating in BS 5628, a full survey of the wall will be required by a Chartered Building Surveyor with proven experience in Historic and Listed Buildings (RICS Accredited Building Conservation Surveyor or equivalent). The report should not only identify the potential issues or defects but also provide solutions to ensure that the external walls remain durable.

The specialist historic building Surveyor services must be retained until the end of the project and verify that the works that they have recommended have been carried out to their satisfaction. The report should include the following information:

- Overall condition of the exiting external walls.
- The quality of existing mortar.
- The quality of existing masonry with respect to the durability of bricks/stone/render.
- Potential high risk areas or areas of concern where there is potential for future water ingress with particular attention focused towards the following:
  a) Parapets.
  b) Roof/wall abutments.
  c) Penetrations and openings.
  d) Stone feature-work.
  e) Window and door reveals.
  f) Rainwater outlets and rainwater pipes.

The following information should accompany the building survey:

- A scope of works clearly identifying any remedial measures.
- Details of any ongoing maintenance requirements for the walls.
- Confirmation of the level of supervision during the remediation process.

It should be noted that although the external walls may be proven as acceptable without independent internal lining systems, particular attention should be given to window and door reveals and it is likely that in all cases an independent lining will be necessary to window heads, sills and reveals. Consideration can be given where the reveals are already lined such as oak panelling adjacent to existing sash windows providing that the lining is free from dampness and decay and is considered in the above report requirements.

Windows and doors

Where existing windows and doors have to be retained due to planning and conservation restrictions but do not meet the guidance in 'Appendix D - Conversions and Refurbishments - Existing Elements', the following information must be provided to determine adequacy of performance:

- A full survey of the windows and doors by a suitable specialist to determine the current condition and the windows and doors ability to be resistant against water ingress for 15 years.
- Where windows are to be repaired, a full repair schedule must be provided detailing the extent of the repairs. A completion report from the suitable specialists shall be provided, confirming the repairs are adequate and that the windows now have a residual service life of not less than 15 years.
- Full details of the window repair specialist must be provided. The repair specialist must demonstrate that they have suitable experience for the specialist repairs of windows and doors.
- Where the window and door system includes feature stone mullions, full details prior to any repairs being carried must be provided to confirm that the mullions are resistant to moisture and will have durability against water ingress for at least 15 years.

Other construction elements

The guidance in 'Appendix D - Conversions and Refurbishments - Existing Elements' equally apply to the following elements:

- Internal walls.
- Timber floors above ground level.
- Other framed buildings.
- Filler joist floors.
- Surveying roof timbers.
- Roof structure.
- Traditional slate and tiled roof coverings.
- Continuous membrane roofs, roof terraces and balconies.

ON YOUR SITE, BY YOUR SIDE

2 Shore Lines Building, Shore Road, Birkenhead, Wirral, CH41 1AU
T 0800 107 8446 | E info@premierguarantee.co.uk | **premierguarantee.com**