CHAPTER 7: Superstructure

CONTENTS

FUNCTIONAL REQUIREMENTS

7.1 EXTERNAL MASONRY WALLS

Workmanship

i. All workmanship must be within the tolerances defined in Chapter 1 of this Manual.
ii. All work is to be carried out by a technically competent person in a workmanlike manner.
iii. Cavities should be clear from mortar droppings to prevent moisture ingress.
iv. Masonry walls should not be laid in extreme weather conditions.

Materials

i. All materials should be stored correctly in a manner that will not cause damage or deterioration of the product.
ii. All materials, products and building systems shall be appropriate and suitable for their intended purpose.
iii. Materials should be suitable for the relative exposure of the building in accordance with the relevant British Standard.
iv. The structure shall, unless specifically agreed otherwise with the Warranty provider, have a life of not less than 60 years. Individual components and assemblies, not integral to the structure, may have a lesser durability, but not in any circumstances less than 15 years.

Design

i. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
ii. Structural elements outside the parameters of regional Approved Documents must be supported by structural calculations provided by a suitably qualified expert.
iii. The design and construction of masonry walls must meet the relevant Building Regulations, British Standards, Eurocodes and other statutory requirements.

7.1.1 Protection

All new masonry work should be protected during construction by covering it to ensure that walls are not allowed to become saturated by rain water or 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.

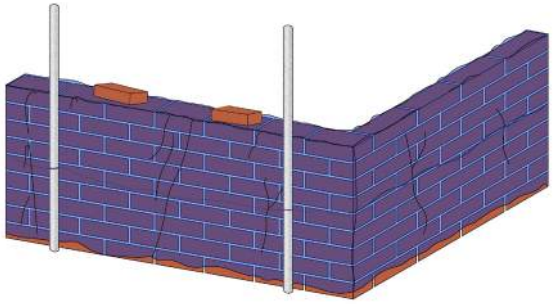

Figure 1: Protection of masonry

Stability during construction

Gable walls should be appropriately propped prior to the construction of any roof. When a floor or roof slab of a building is used for the temporary storage of building materials, the loading should not exceed the design loading for the element.

7.1.2 Brick and block suitability

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 guidance can be found in this Manual under Chapter 2 – Materials.

Non-rendered blockwork

All external blockwork should be rendered or otherwise finished with a cladding that is appropriately durable, unless the block manufacturer can provide third-party certification confirming that the blockwork can be left unfinished, or finished in an alternative way.

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 (see Chapter 2 – Materials).

7.1.3 Mortar

General

A mortar type above DPC should be chosen in accordance with the guidance given in Chapter 2 – Materials, 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. Mortar should be mixed by machine, or use ready mixed retarded mortars.

Mixing

Mortar should be carefully and consistently proportioned, and then thoroughly mixed using a mechanical mixer, except for very small quantities.

7.1.4 Adverse weather

Working in adverse weather

Precautions should be taken when necessary to maintain the temperature of bricks, blocks and mortar above 3°C. The use of anti-freeze as a frost resistant additive in mortar is not permitted. Further guidance can be found in Chapter 2 – Materials.

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 to assist with water retention. On no account should masonry units or completed work be saturated with water.

Dealing with areas of high exposure to frost and wind driven rain

Frost attack

Frost-resistant bricks should be used in areas that are prone to prolonged periods of frost.

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.

Wind-driven rain

To ascertain the risk relating to wind-driven rain, the following should be determined:

- The exposure to wind-driven rain, using Figure 2.
- 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.

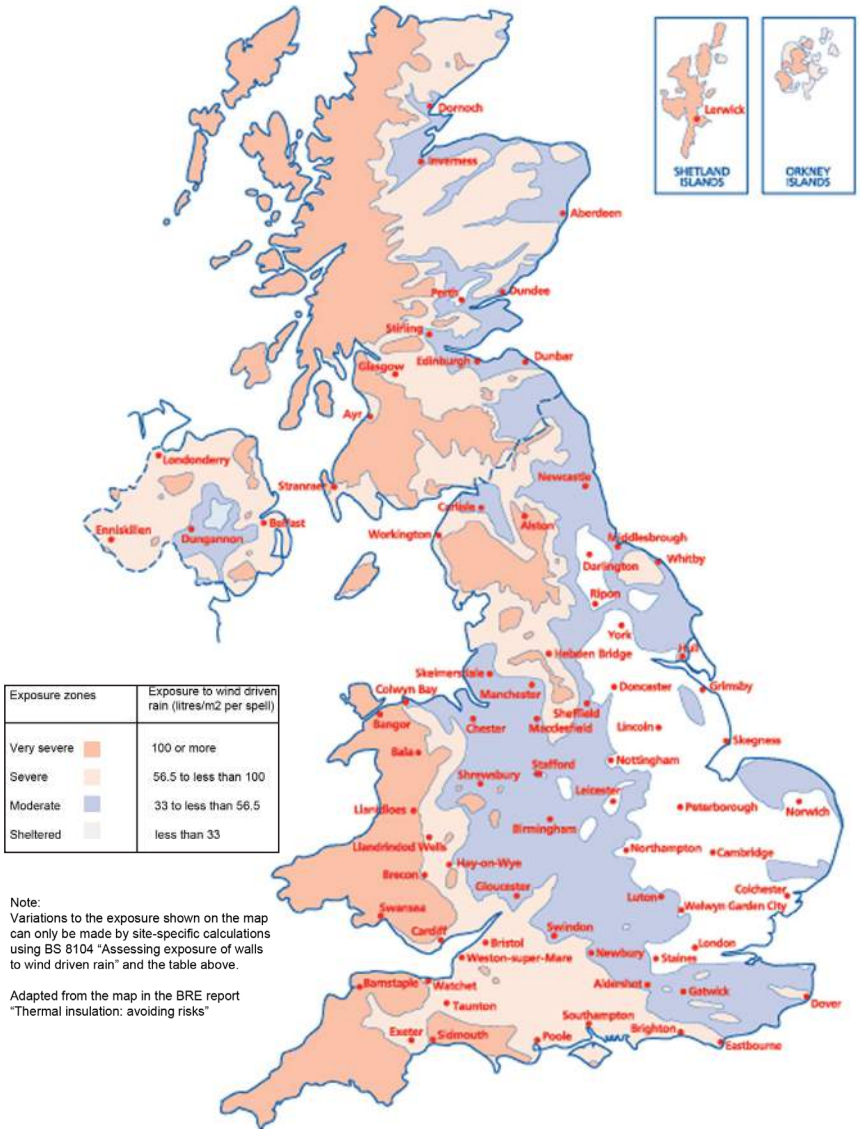

Figure 2: Map showing exposure to wind-driven rain categories

Exposure category	Suitable wall construction	Minimum insulation thickness (mm)		
		Built-in insulation	Retro-fill (other than UF foam)	UF foam
Very Severe	Any wall with impervious cladding	50	50	50
	Fair-faced masonry with impervious cladding to all walls above ground storey	100	100	N/A
	Any wall fully rendered (2)	75	75	N/A
	Fair-faced masonry (1)	N/A	N/A	N/A
Severe	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	N/A
Moderate	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	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 cavity insulation is not permitted.
- (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 dwellings is determined by its location on the map showing categories of exposure to wind driven rain.
- 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.

Table 1: Suitable cavity wall construction depending on exposure

7.1.5 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, in accordance with Chapter 7.1.8.
- The cavity can be fully insulated or partially insulated, depending on exposure to wind-driven rain. For partial fill insulation, a minimum clear cavity of 50mm should always be provided. Further information can be found in BS 8104.

7.1.6 Structural design of walls

A method of meeting the requirements of the warranty is to design and construct walls to the relevant Approved Document 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 a Chartered Structural Engineer can be used as a solution.

7.1.7 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:

- Restraint type joist hangers
- Lateral restraint straps
- Other forms of restraint proven by a Chartered Engineer

Restraint 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.
- Hangers are spaced at centres of floor joists included in the design.
- The hanger is suitable for the loadings and masonry strength.

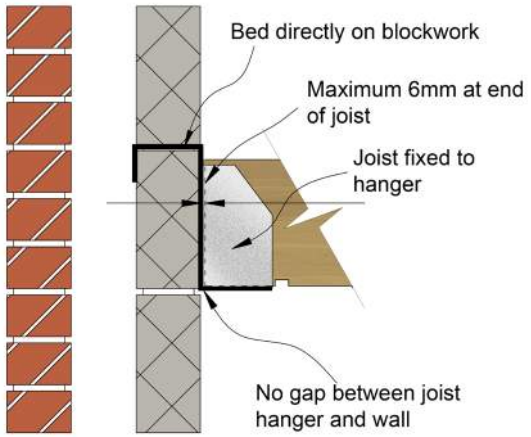

Figure 3: Typical restraint type joist hanger

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; the thermal insulation of the wall may be reduced unless similar units to the blocks are used.

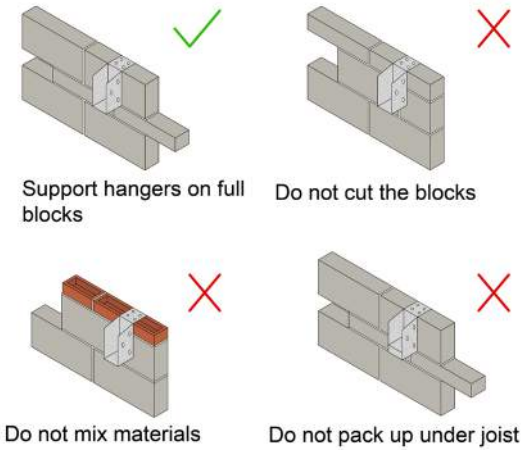

Figure 4: Correct use of hangers

Lateral restraint straps

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 2m centres (see Figures 5, 6 and 7). Straps need not be provided to floors at, or about, the same level on each side of a supported wall and at the following locations:

Timber floors in two storey dwellings where:

- Joists are at maximum 1.2m centres and have at least 90mm bearing on supported walls or 75mm.
- Bearing on a timber wall plate
- Carried by the supported wall by restraint type joist hangers as described in BS 5268: 7.1.
- Concrete floors with minimum 90mm bearing on supported wall.

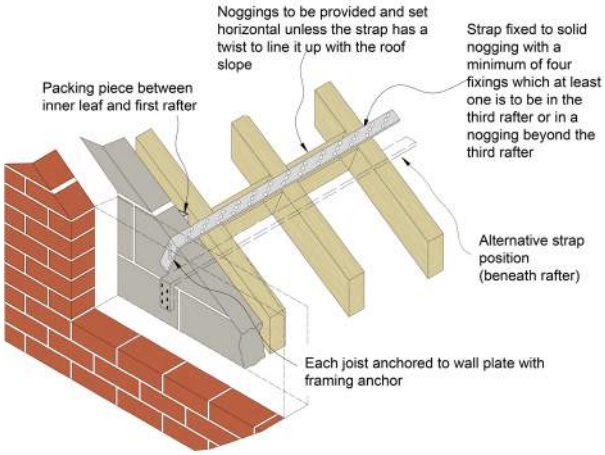

Figure 5: Lateral restraint strap to gable wall

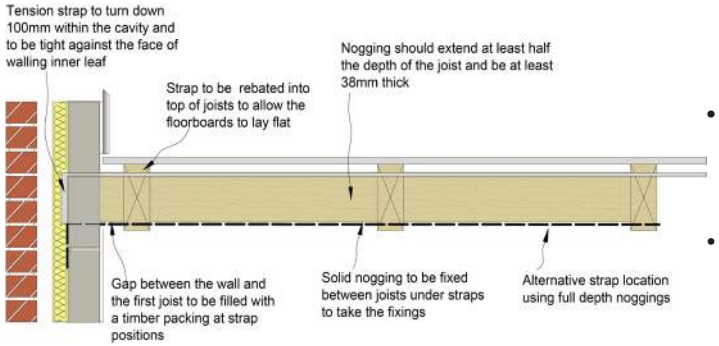

Figure 6: Lateral restraint to floors

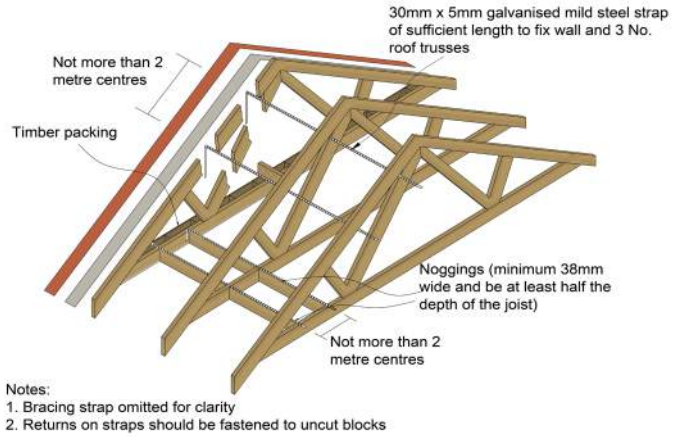

Figure 7: Lateral restraint to gable wall via roof trusses

7.1.8 Wall ties

Wall ties should meet the following provisions:

- Wall ties should be to BS EN 845-1 or have appropriate third-party certification.
- 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 on 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.

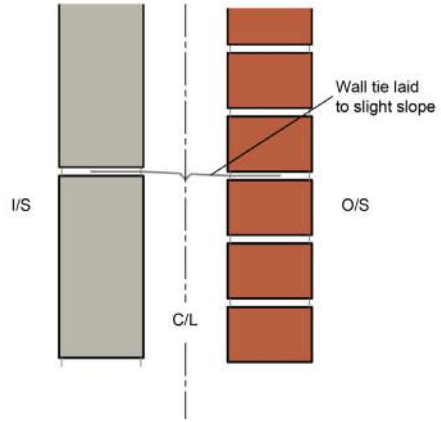

Figure 8: Wall tie provision

Stainless steel wall ties should always be used.

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.

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	750mm	450mm (increased to 300mm at reveals and movement joints)
Greater than 150mm	Wall tie specification and design to be provided by a Chartered Structural Engineer, or in accordance with appropriate third party certification. Design will be determined by location and site specific conditions.		

Table 2: Wall tie spacing

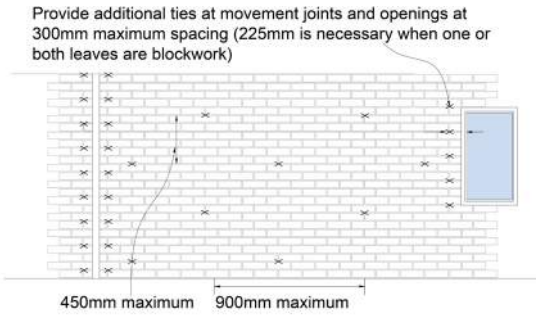

Figure 9: Provision of wall ties

Proprietary ties are to have appropriate third-party certification.

Wall ties are to have the correct thickness in accordance with BS 5628-2005.

Proprietary insulation retaining clips compatible with the tie should be used where the cavity is partially filled.

7.1.9 Bonding internal walls to external walls

Bonded walls in brickwork are comparatively easy to construct, but this can be more difficult with blockwork, so either:

- Tooth every alternative course (see Figure 10) or butt and tie (see Figure 11).
- Where blocks are of a different density, always use a butted joint; on 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.

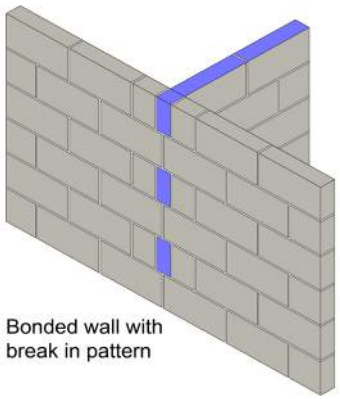

Figure 10: Block bonding internal masonry walls to inner leaf

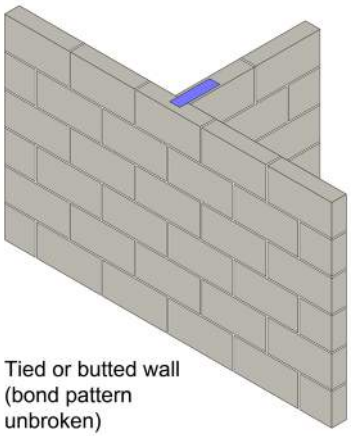

Figure 11: Bonding internal walls to inner leaf using ties

7.1.10 Corbelling

The extent of corbelling of masonry should not exceed that indicated in Figure 12 unless supported or reinforced. Reinforced corbels should be designed by a Chartered Structural Engineer.

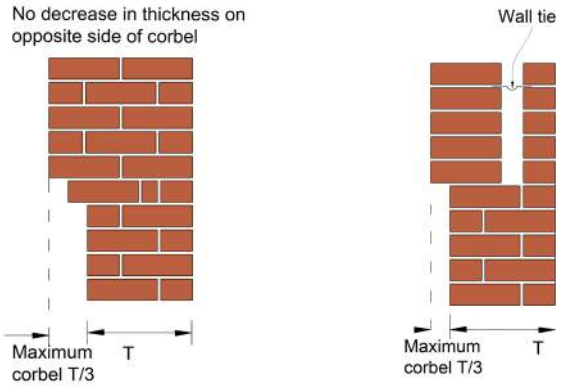

Figure 12: Typical corbelling arrangements

7.1.11 Allowing for movement

Vertical movement joints should be provided to the outer leaf of cavity walls as indicated in Table 3. The first joint from a return should be no more than half the dimension indicated in the table.

Where the finished ground level is 600mm or greater below the horizontal DPC, the movement joint should be continued within the external leaf of the substructure. The DPC should be lapped a minimum of 100mm to accommodate any movement.

Movement joints below the DPC should also be provided at major changes in foundation level and at changes in foundation design. Wall ties at a maximum of 300mm centres should be provided on each side of movement joints. 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.

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.

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.

Material	Normal spacing	Joint thickness
Clay brickwork	12m (spacing up to 15m may be possible if sufficient restraint is provided – consult Designer)	15mm
Calcium silicate and concrete brickwork	7.5m–9m	10mm
Concrete blockwork (used in outer leaf)	6m	10mm
Stone	12m	15mm
Note: It is not normally necessary to provide movement joints to the internal leaf of cavity walls but should be considered where rooms occur with unbroken lengths of wall in excess of 6m. 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.		

Table 3: Spacing of expansion joints

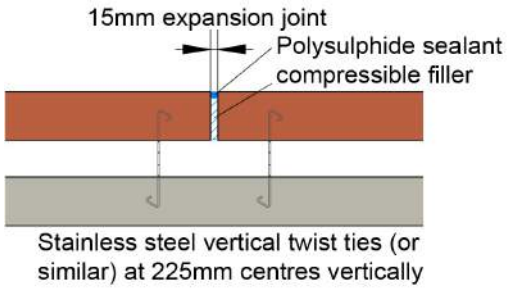

Figure 13: Typical expansion joint detail

7.1.12 Lintels

Bearing length

Use the correct length and width of lintel 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 to beams and lintels (see Figures 14 and 15). Lintels should be insulated to prevent excessive thermal bridging.

Do not:

- Support lintels and beams on short lengths of cut block and make-up pieces.
- Apply load to the lintels or beam before the masonry supporting has hardened.

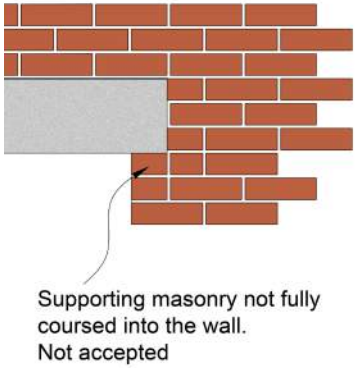

Figure 14: Incorrect method of brick bond around lintels

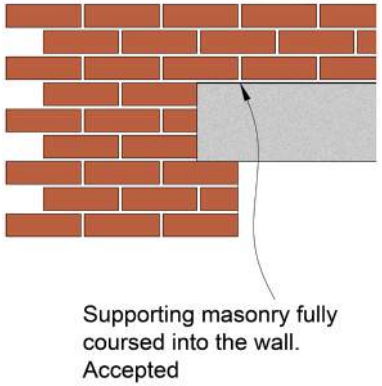

Figure 15: Correct method of brick bond around lintels

7.1.13 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 are to be provided:

- At all interruptions likely to direct rain water across the cavity, such as rectangular ducts, lintels and recessed meter boxes.
- Above cavity insulation that is not taken to the top of the wall, unless that area of wall is protected by impervious cladding.
- 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.
- Continuously above lintels where openings are separated by short piers.
- Above openings where the lintel supports a brick soldier course.

Cavity trays are to rise at least 150mm from the outer to the inner leaf, be self-supporting or fully supported and have joints lapped and sealed.

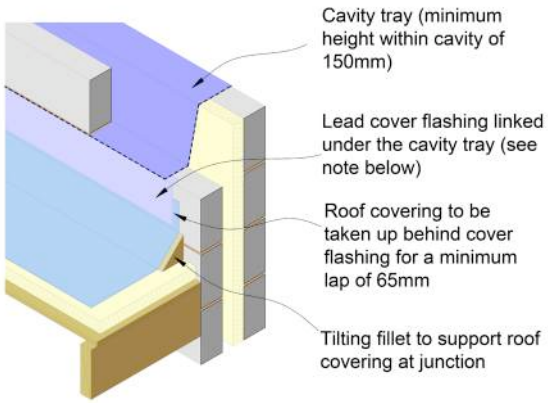

Figure 16: Cavity tray over a flat roof/wall abutment

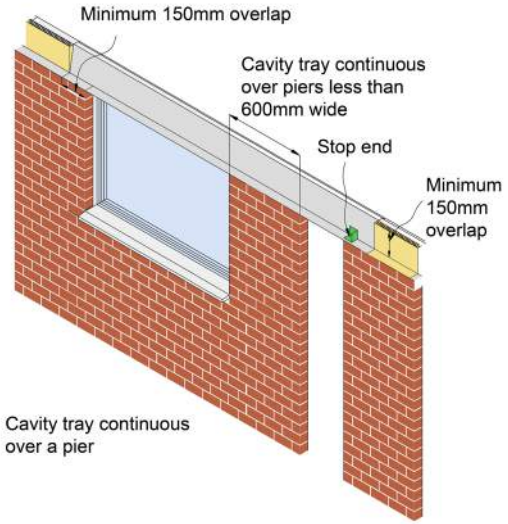

Figure 17: Continuous cavity tray over two openings and a small pier

7.1.14 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. Where the wall is externally rendered, the weep-holes are not deemed necessary for cavity wall construction.

Weep-holes in exposure zones 3 and 4 should be designed to prevent ingress of wind-driven rain (including ground level).

7.1.15 Stop-ends

Cavity trays should have water tight stop-ends to prevent water from running into the adjacent cavity. 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.

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 cavity insulation is employed.

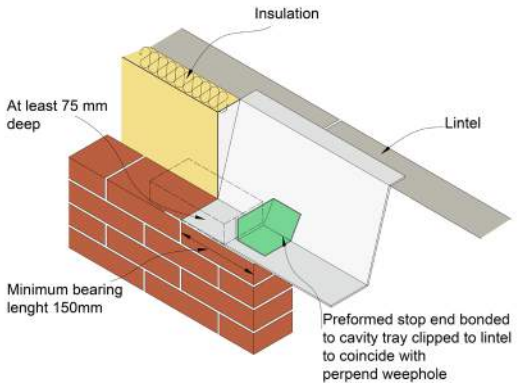

Figure 18: Stop-end to cavity tray

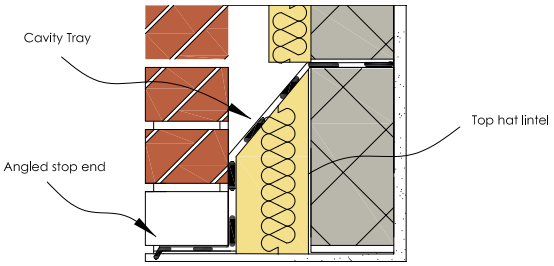

Figure 19: Stop-end in relation to cavity tray and lintel

7.1.16 Steps and staggers

Particular care is needed in adequately preventing the ingress of water in a terrace of dwellings with steps and staggers. A proprietary cavity tray system should be used, or alternatively, a suitable tanking system. Stepped cavity trays are required at all pitched (stepped) roof abutments with external cavity walls, e.g. attached garages or staggered terraces. The bottom (last) cavity tray must be supplied with two stop-ends and an

associated weep-hole, allowing all water to escape over the lower roof covering. For brickwork, blockwork and stonework, lead cover flashings should be linked into the cavity tray (lapped in below).

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.

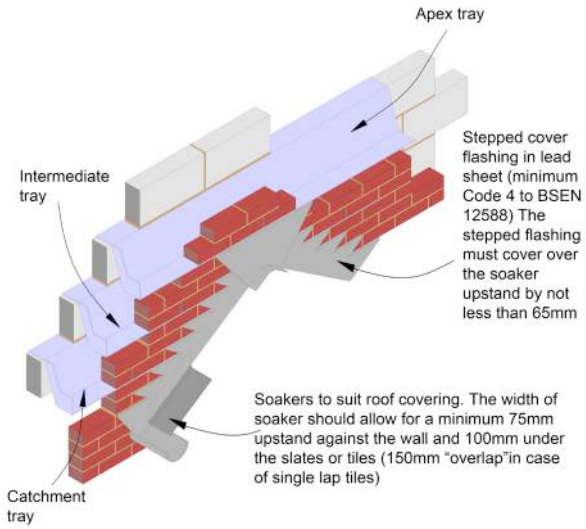

Figure 20: Stepped cavity at roof/wall abutments

7.1.17 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 manufacturer's 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, it is recommended that mortar joints to facing brickwork are not recessed.

7.1.8 Parapets

The minimum thickness and maximum height of parapet walls should be in accordance with Figures 21 and 22. The materials used in the construction of parapet details should be suitable for the location and exposure. Where possible, the use of raking parapets should be avoided due to the need for high standards of detailing and the workmanship required to prevent the ingress of moisture. In very severe exposure zones, it is recommended that a parapet construction is avoided altogether.

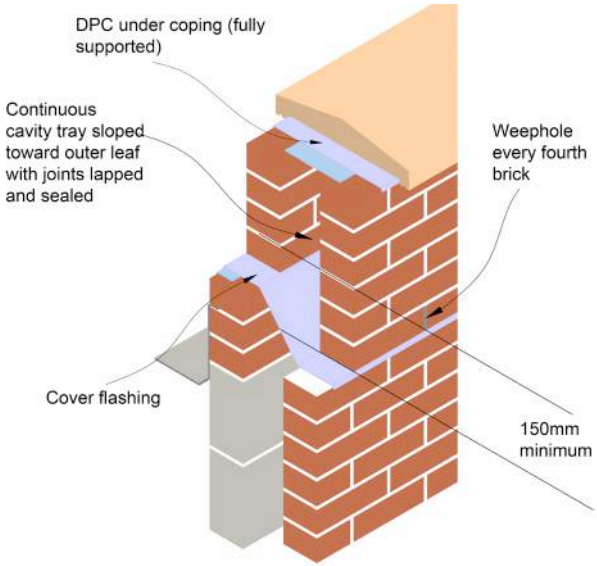

Figure 21: Parapet wall detail

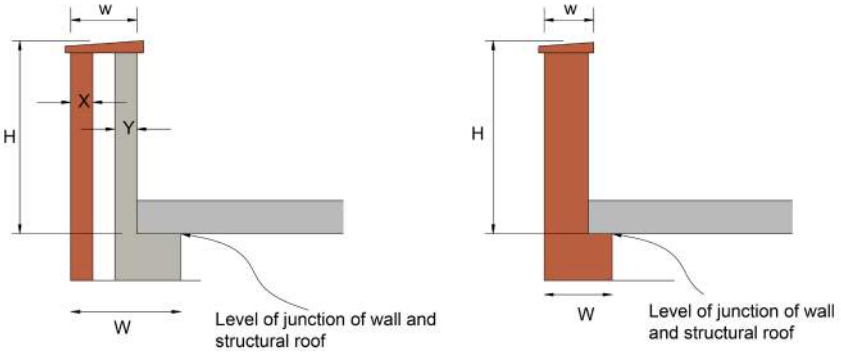

Figure 22: Maximum height of parapet walls (to be read in conjunction with Table 4)

Wall type	Thickness (mm)	Parapet height to be not morethan (mm)
Cavity wall	x + y equal or less than 200 x + y greater than 200 equal or less than 250	600 860
Solid wall	w = 150 w = 190 w = 215	600 760 860
Note: w should be less than W - as showed in Figure 22		

Table 4: Parapet walls/height ratios

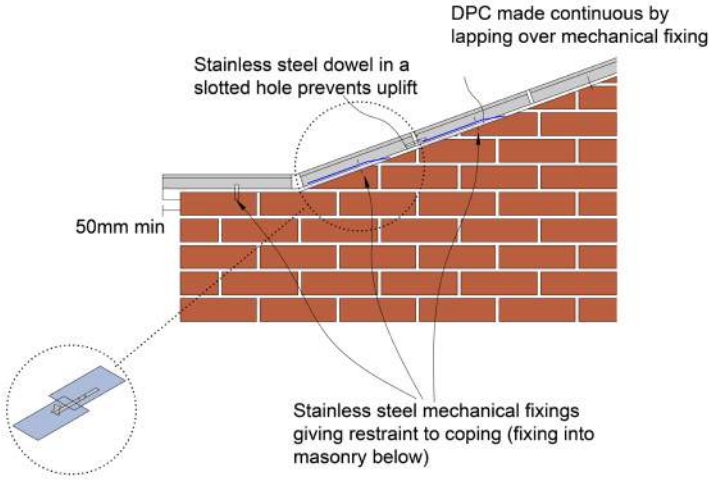

Figure 23: Fixing of copings to sloping parapets

7.1.19 Natural stone

General

The following additional guidance for natural stone shall be used in conjunction with any other information in this Manual. When selecting stone for cavity wall house building, it is important to consider the exposure rating for the area.

It is not recommended to use a soft, porous-type stone in a 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.

It is advisable to use a stone that has been quarried within a reasonable location 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 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.

Walls constructed with a cavity are essential where the location is likely to be of moderate exposure or worse. A sawn bed of 100mm minimum thickness is to be used as the outer leaf of a cavity wall, although 150mm is recommended. Where dressed stone is used and the bed falls below 90mm due to the irregularities of the stone, the stone should be backed with either a brick or 50mm minimum thickness block wall to maintain the 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.

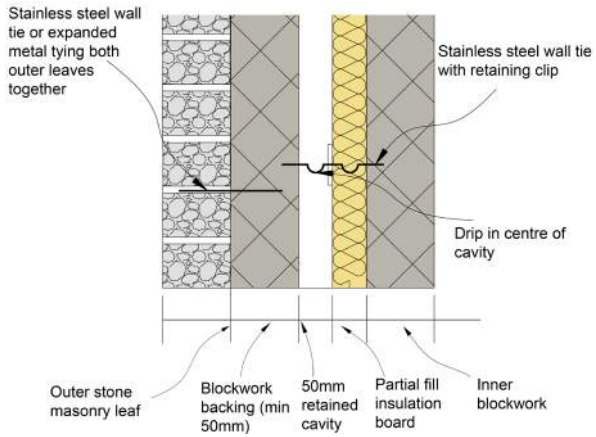

Figure 24: Masonry cavity wall with stone outer leaf

Mortar

The mortar for use with stone should comply with the relevant British Standards for sand, lime and cement, as set out in BS 5390.

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

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.

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.

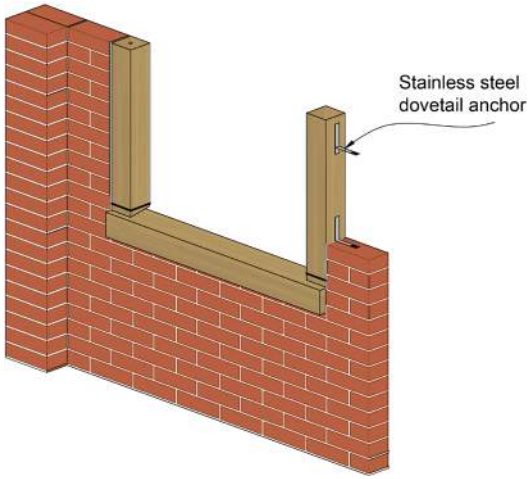

Figure 25: Stone jamb and mullion, fixing to walls

Cavity trays

In addition to the previous guidance for cavity trays, 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.

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.

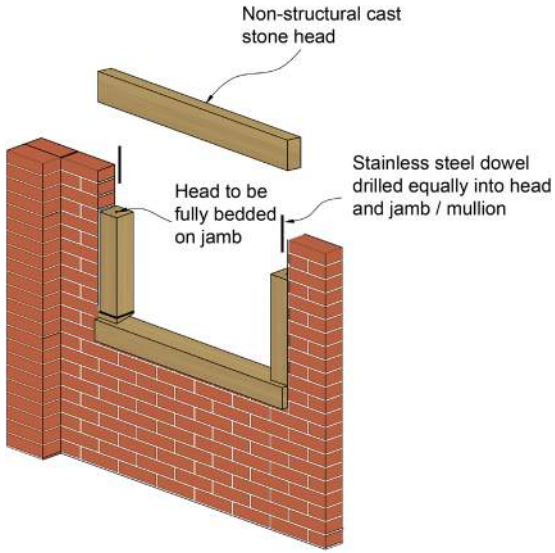

Figure 26: Joining stone jambs to sills and head