

SPECIFICATION AND DESIGN CONSIDERATIONS

Table 2. Codes, thicknesses and weights

BS EN 12588:2006 code no	Thickness mm	Weight kg/m ²	Colour code
3	1.32	14.97	Green
4	1.80	20.41	Blue
5	2.24	25.40	Red
6	2.65	30.05	Black
7	3.15	35.72	White
8	3.55	40.26	Orange

Although Rolled Lead Sheet to BS EN 12588 is available in 6 standard codes as shown above, there may be circumstances whereby thicker codes can be considered for use. These can help accommodate more extreme weather conditions and also allow drip centres to be increased. Detailing on the sizing and fixing of these heavier codes is not given in this manual but advice on their use is available from the LSA technical department. Please check availability, delivery and any special size limitations with the manufacturer before specifying.

Table 3. General guidance and recommendations for specifying thickness of lead sheet for various uses

When specifying thickness also make allowances for the anticipated life of the building concerned - The longer the life, the heavier the code.

Type of application	Sheltered to moderate exposure	Moderate to severe exposure	Listed or pre- 1919 buildings
	BS EN 12588 code no	BS EN 12588 code no	BS EN 12588 code no
Flat roofing	5 or 6	6 or 7	6, 7 or 8
Parapet, box and tapered valley gutters	5 or 6	6 or 7	6, 7 or 8
Pitched roofs	5 or 6	6 or 7	6, 7 or 8
Vertical cladding	4 or 5	5 or 6	6 or 7
Dormer cheeks	4 or 5	5 or 6	5, 6 or 7
Dormer roofs	4 or 5	5 or 6	6, 7 or 8
Chimney flashings: back gutters, front aprons	4 or 5	5 or 6	5 or 6
Lead slates	4 or 5	4 or 5	5 or 6
Hip and ridge flashings	4 or 5	5 or 6	6, 7 or 8
Pitched valley gutters	4 or 5	4 or 5	6 or 7
Weatherings to cornices, parapets walls and projections	4 or 5	5 or 6	6 or 7
Damp-proof courses (DPCs)	4 or 5	4 or 5	4 or 5
Apron and cover flashings	4 or 5	5 or 6	5, 6 or 7
Soakers	3	3	3 or 4

Note - Situations may arise whereby the thickness of lead sheet will need to be increased to cope with thermal movement, exposure and longevity. Please refer to the various Tables within this manual for further clarification.

SUBSTRATE DESIGN AND ROOF CONSTRUCTION

Leadsheet

General background

In handling technical enquiries over the years, it has become clear that the substrate design and roof construction can provide a number of issues for specifiers and installers to deal with. In order to provide greater clarity around this potentially tricky area we have improved the order and detailing of the different steps that should be taken as well as improving the quality of the drawings and tables to ensure the guidance is clearer.

Below are the key elements that should be adhered to when specifying or installing Rolled Lead Sheet to BSEN 12588

Substrates

Substrates or decking for lead coverings must provide a near continuous smooth surface that is strong enough to support the lead (and any superimposed loadings) and hold the fixings firmly and permanently.

Resistance to corrosion – Condensation

Condensation on the underside of lead sheet can cause corrosion. The amount of corrosion will depend on the frequency and duration of the condensation conditions and the temperature variations of the lead. In some cases, occasional small amounts of condensation will result only in a thin coating of white carbonate under the lead.

However, when large amounts of condensation occur frequently, a thick layer of corrosion can form and, in extreme condensation conditions, the corrosion can penetrate completely through the lead. To avoid the problem, all leadwork should be laid on constructions that conform to the current Building Regulations and the recommendations in BS 5250 and BS 6229. NB - BS6229 is due for revision

Although the ventilated cold roof is an acceptable method of construction, it will be suitable for lead roofing only if any warm air that percolates through the vapour check, thereby causing condensation in the insulation area, can be readily dissipated by adequate ventilation under the decking (Fig 1a). A cold roof is unlikely to be effective over highly heated or humid areas.

For most lead roofing and cladding on new buildings, the ventilated warm roof is recommended (Fig 1b). The ventilation above the insulation will disperse any moisture that may percolate through the vapour control layer. Although recommended, it is usually difficult to achieve a 100% effective vapour control layer, and without ventilation any moisture penetration could be trapped in the insulation area.

Without the ventilated air space this may cause condensation and corrosion problems, especially when the roof is subsequently heated by the sun. However, it is still of paramount importance, even with a ventilated warm roof, to ensure that the vapour control layer is as efficient as possible, with correctly sealed joints and abutments.

Another advantage of the ventilated warm roof is that the ventilation will gradually dissipate any water ingress that occurs during construction or that may subsequently penetrate through the lead covering due to mechanical damage, extremes of weather etc. This construction will also avert the possibility of thermal pumping, which may occur when a lead roof has been highly heated by the sun and is suddenly cooled by a shower of rain.

The ventilated warm roof does not, however, obviate the need for extreme care to keep the insulation and decking as dry as possible during construction before the underlay and lead are laid. It is also important to rectify any subsequent damage to the lead covering speedily so that water ingress is minimised.

Occasionally, there may be a risk of moisture collecting in the ventilation area due to 'clear night sky radiation' or leakage. To allow for this, a breather membrane is laid on the topside of the insulation. Any moisture that may collect on this membrane will be readily dispersed when normal weather conditions resume or when the cause of the leakage is rectified. When renewing existing leadwork, the underside of the old lead will give an indication as to whether or not there has been a condensation problem. If corrosion is minimal, the existing roof construction will usually be satisfactory for the new lead, provided that there is to be no change in the use or heating levels of the building.

Resistance to corrosion – Condensation (cont.)

However, where possible, an increase in roof ventilation should be considered. Frequently, the heating levels will have been increased in recent years, or are to be improved during the refurbishment of the building. In these cases, careful consideration will be necessary to evaluate the possibilities of condensation and whether increased ventilation or a new roof

design is required to avoid a problem in the future. In situations where there is significant corrosion under the old lead due to condensation, reference should be made to the British standards, and ventilation should be provided wherever possible.

Fig 1a. Ventilated cold roof

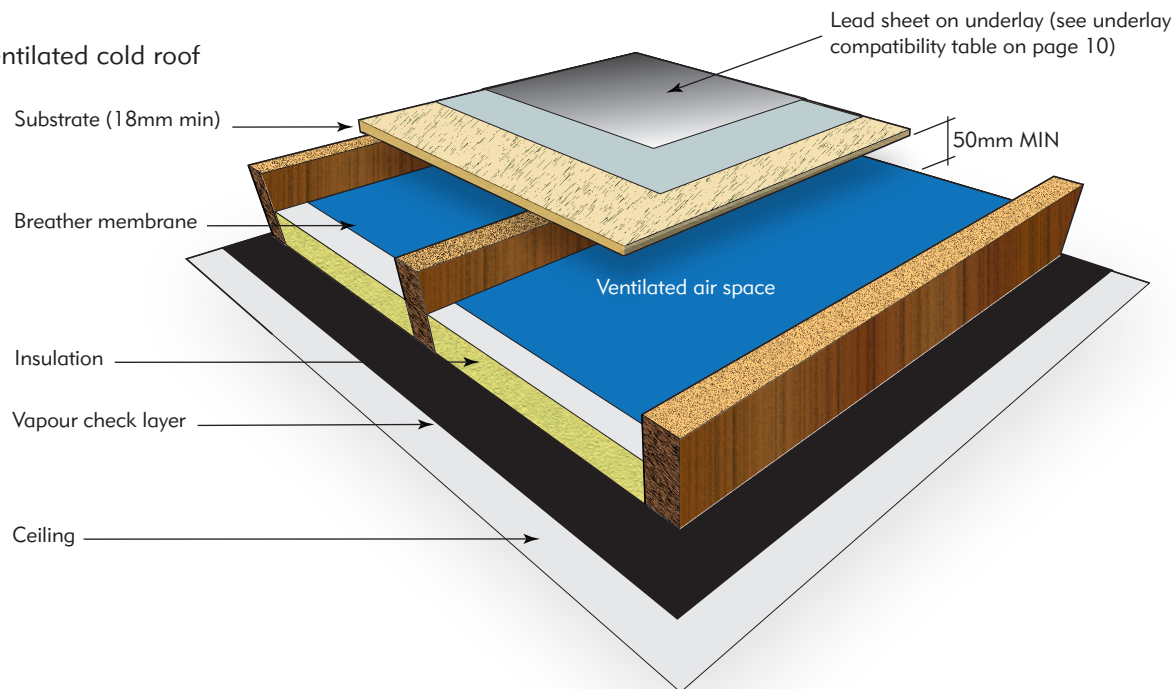
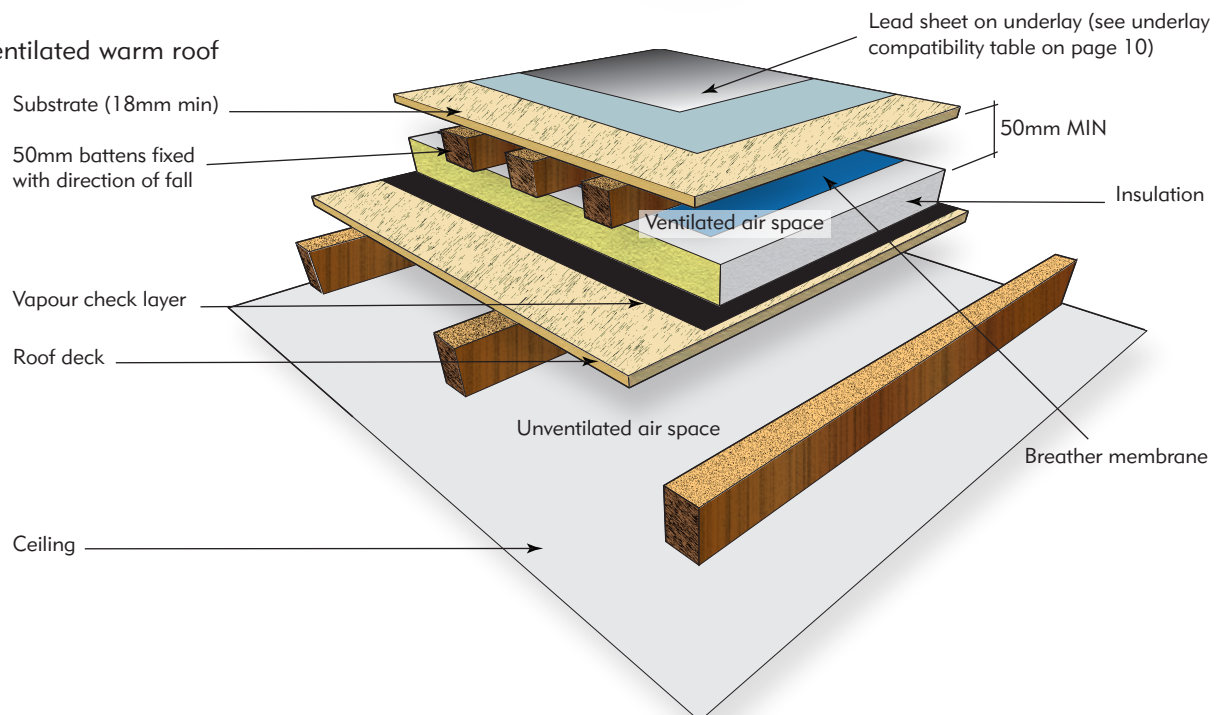
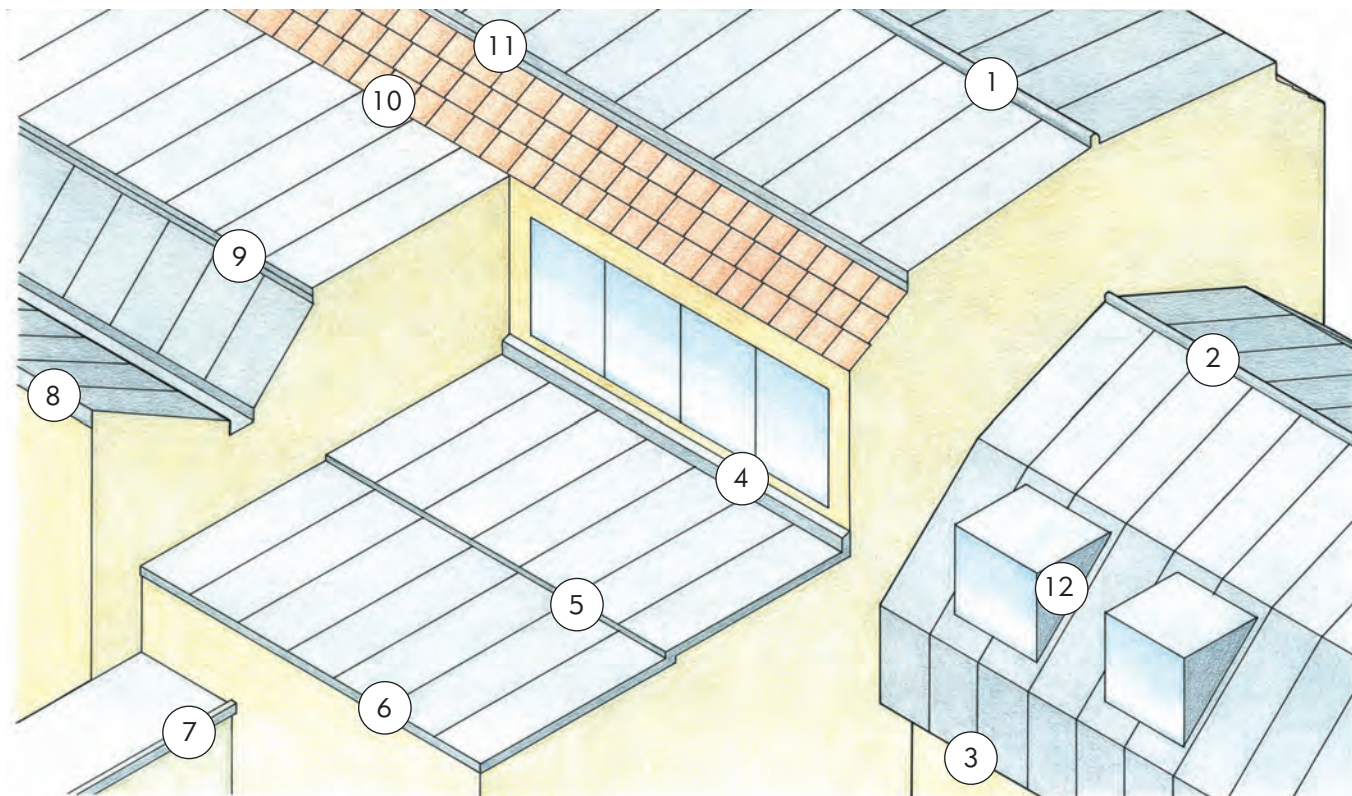


Fig 1b. Ventilated warm roof

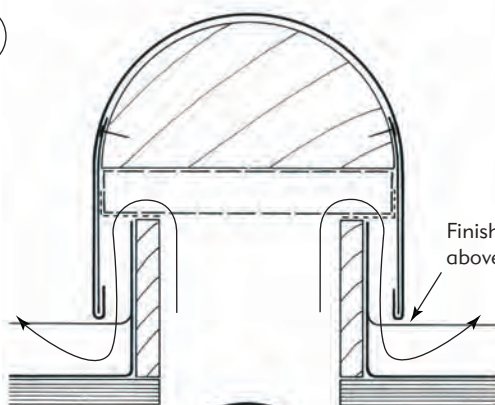


Ventilation details

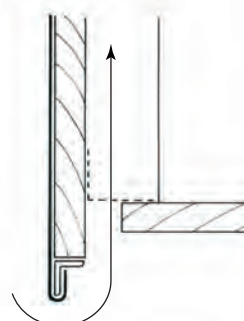
Key drawing and ventilation details



1

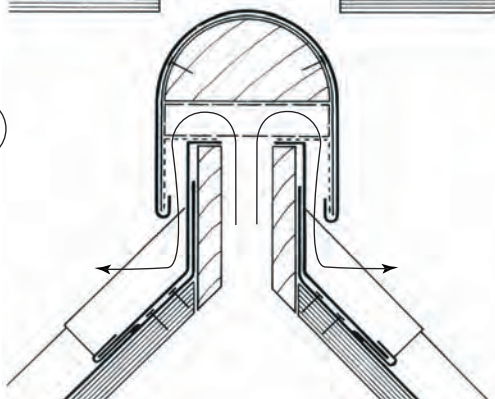


3

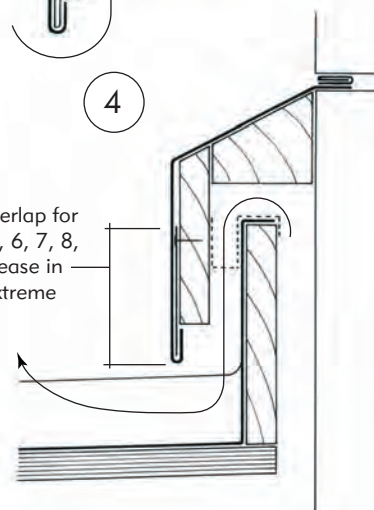


Finished 5mm max
above roll

2



4

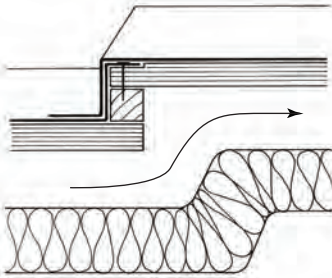


75mm min overlap for
details 1, 2, 4, 6, 7, 8,
9 and 11 Increase in
positions of extreme
exposure

The annotations indicate the figure numbers for which a method of providing ventilation is illustrated. There can be many variations of these details to suit particular aesthetic requirements. In some cases, the provision of external proprietary or site-made ventilators will be satisfactory, especially for situations where additional ventilation has to be provided in an existing roof. Although natural ventilation will be adequate for most circumstances, it may be necessary to use mechanical ventilation where the risk of condensation is very high (such as a lead roof over a swimming pool).

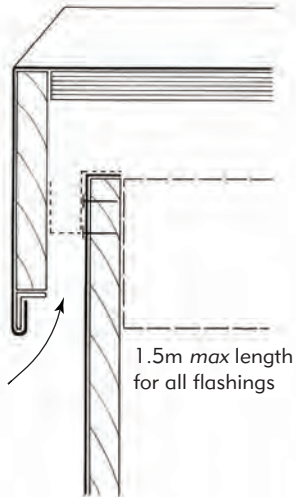
Ventilation details (cont.)

5

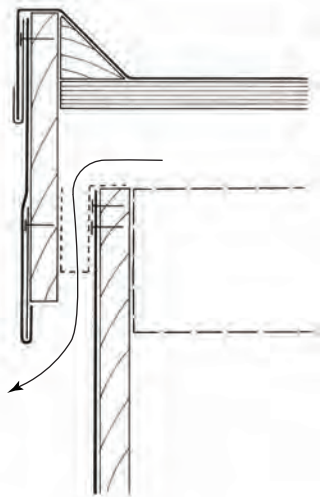


All leadwork to standard details

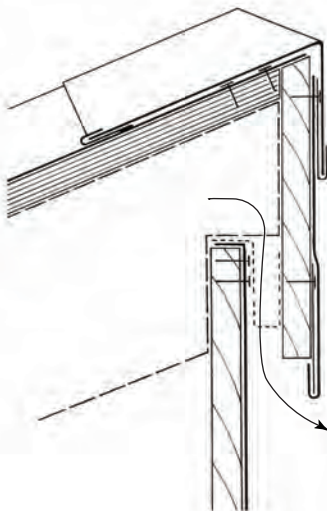
6



7

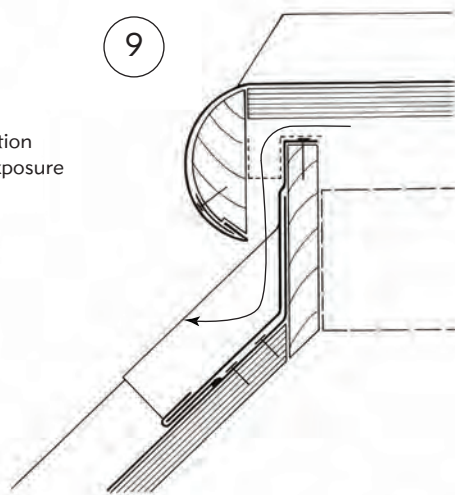


8

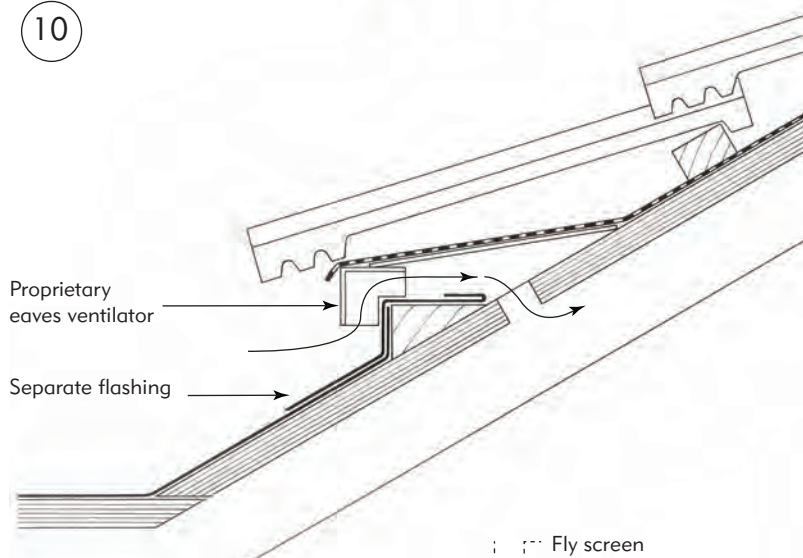


All free edges of ventilation details clipped to suit exposure

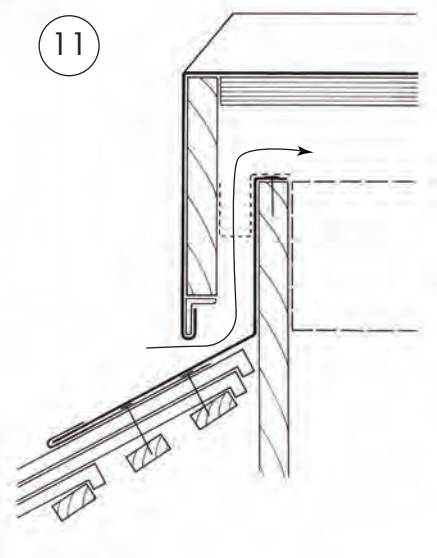
9



10



11



 Fly screen
 Ventilation gap - refer to British standards



12 Dormer cheek ventilation

Battens to form 25mm minimum ventilated air space

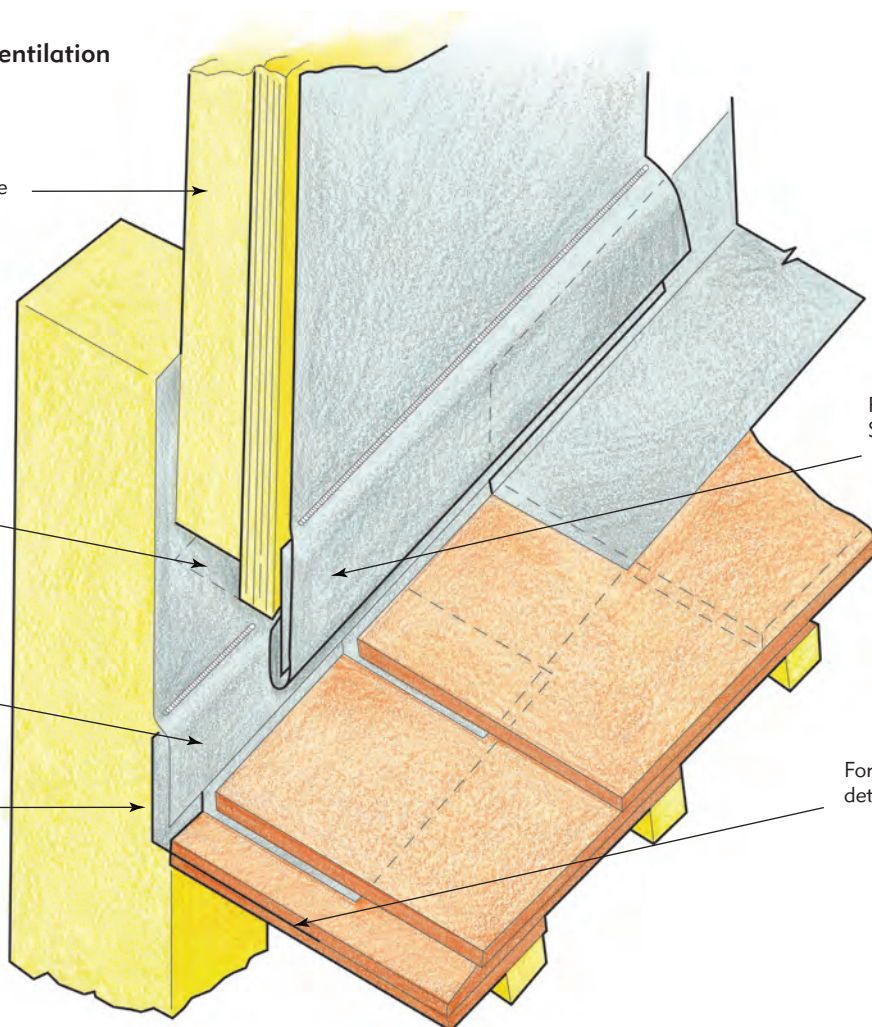
Fly screen protecting ventilated area

Seperate flashing where necessary

100mm upstand to soakers

For clipping information
See page 29 fig47

For information on soaker
detail see page 179 fig 285



Underlays

For roofing, cladding and weathering applications, an underlay is normally used to isolate the lead sheet from the substrate and allow the lead to expand and contract freely with changes in temperature. To increase the life and performance of the lead sheet, it is advisable to use an underlay in most applications.

The main requirements for underlays are that they should:

- a) Allow for thermal movement by reducing the amount of drag between the substrate and the lead sheet
- b) Help to protect the lead sheet against corrosive attack from stone, concrete or discharge from timber and roof condensation
- c) Provide an even surface and level out any imperfections that could damage the lead, such as nail heads, board edges and knots
- d) Fully support the lead sheet so that it cannot sag or be punctured
- e) **Reduce the risk of moisture being trapped between the lead and the substrate (see also 'Resistance to corrosion – Condensation', pages 4 - 5).**

The type of underlay material used should:

- f) Not be adversely affected by heat when in-situ welding takes place
- g) Be free of any substance that could be deleterious to lead sheet.

Types of underlay

Building paper

Building paper, conforming to BS 1521 Class A, may be used on smooth decking materials such as plywood, as long as the underside of the decking is ventilated. It is also a suitable underlay for smooth concrete, stone or screeded surfaces to prevent corrosive attack on the underside of the lead sheet caused by the release of free alkali from the drying cement.

General guidance and recommendations when specifying an underlay.

Substrates	Class A Building Paper to BS 1521	Geotextile Underlay (220-220g/m ²)
Exterior Quality Plywood	✓	
Penny Gap Soft Wood Timber Boarding	✓	✓
Penny Gap Oak Boarding	✓	
Stone	✓	
Concrete	✓	
Brick	✓	

Timber

The traditional substrate for lead coverings fixed in-situ is softwood boarding with an underlay. Either tongued-and-grooved or plain-edged boarding can be used. Gaps between the plain boards are acceptable in situations where slight condensation may occasionally form under the lead and where ventilation through the gaps is desirable. The gaps should not exceed 5mm for codes 5 and 6 or 10mm for codes 7 and 8. All timber should be well seasoned to give maximum resistance to warping. Where possible, boarding should be fixed in the direction of fall or diagonally (see also 'Timber', page 11). Exterior plywood or blockboard to BS EN 636-3 are also satisfactory timber substrates and the use of these materials has tended to supersede boarding, particularly on steeply pitched and vertical surfaces.

The minimum thickness for all timber substrates is 18mm. Nails used for fixing boarding and other timber members should be punched below the surface and all screws should be countersunk. Corners of external angles should be well rounded.

Concrete and masonry

Surfaces should have a smooth finish and an underlay is essential to isolate the lead from the concrete or masonry and provide a surface that allows the metal to move freely with temperature changes. Any fixing materials that are set into concrete or masonry should not be vulnerable to decay through retained moisture or condensation. Concrete should be reasonably dry before covering with lead sheet (see 'Masonry, concrete and mortars', page 11).

Thermal insulation materials

Lead is not normally fixed directly onto thermal insulation materials because of the need to provide ventilation. However, where direct fixing is required, it will be necessary to determine whether the fixings are strong enough to hold the lead permanently in position. In most cases, insert battens will be required to take the fixings; it is essential that the battens be secured to the substrate firmly and permanently.

Contact with other materials – Metals

For building applications, experience has shown that lead sheet can be used in contact with another metal, such as copper, zinc, iron, stainless steel or aluminium without risk of significant bi-metallic corrosion.

In some cases, this appears to contradict the electro-chemical series, which compares the potential rates at which metals corrode. However, this series was produced under ideal laboratory conditions with perfect electrical circuits. In practice, these conditions rarely – if ever – exist externally on a building, where the metals in contact are exposed to the atmosphere. For example, no problems arise in the traditional use of copper nails and clips as fixings for lead and there is wide experience of the satisfactory use of lead flashings with aluminium glazing bars.

There is, however, one important exception: when lead and aluminium are used together in a marine environment. The chemical reaction between the lead oxide on the surface of the lead and the sodium chloride in salt water creates a caustic run-off that can attack aluminium, whether there is electrical contact or not. As severe corrosion can also occur in crevices, the use of lead sheet in juxtaposition with aluminium in marine environments is not recommended.

LEAD SHEET ACCESSORIES

Patination of external leadwork

In rainy or damp conditions, new lead sheet will produce an initial, uneven white carbonate on the surface. This can be aesthetically unacceptable, particularly when in cladding applications. More importantly, the white carbonate can be washed off by rain, causing unsightly staining on materials below the leadwork.

To reduce the risk of staining, and also to provide a pleasing surface appearance, a coat of patination treatment should be applied to the leadwork as soon as practical after fixing. Preferably, the coating should be applied no later than the end of the day's work, as overnight rain can cause the white stain to develop.

To be effective, the manufacturer's instructions should be carefully followed. However, there are occasions when the patinated surface of new leadwork, particularly lead roofing, becomes scuffed by foot traffic during the laying of subsequent areas. In these situations, a second application may be necessary when all the areas and other adjacent builders' work have been completed.

It is important to apply a coating between the laps of roofing and cladding panels and underneath the lead for a minimum of 75mm of laps over tiles, slates or glass. Clips along the edges of laps and other free edges should be turned over on completion. This treatment does not serve as a protective coating to the lead sheet.



Clips

The thickness of clips will depend on the degree of exposure of the building (see also 'Fixings', pages 21-33). Except for sheltered locations, lead sheet is not recommended for clips that secure the free edges of lead flashings. This is because of its relatively low mechanical strength when compared with copper and, in particular, stainless steel. Where lead clips are employed in moderate and severe exposures, a low fixing point should be used (Fig 44, page 29), and the thickness of the lead should be increased by one or two codes.

Normally, 0.6mm-thick tinned copper sheet or 0.38mm stainless steel are used for clips. However, for high-exposure situations, a thicker sheet (0.7mm copper or 0.46mm stainless steel) should be used.

Clips should be not less than 50mm wide. They should be turned over the edge of the lead by at least 25mm except where they are tucked into a welted edge. Continuous clips should be not less than 75mm wide.

Lead

Clips should be not less than 50mm wide and the thickness of lead sheet used should be not less than the thickness of the flashing, roofing or cladding sheet.

Copper

Copper or tinned copper clips should be not less than 50mm wide and cut from copper sheet not less than 0.6mm thick, conforming to BS EN 1172. It should be soft temper in welts, seams and rolls, and quarter-hard temper elsewhere.

Stainless steel

Clips should be fully annealed stainless-steel strip, conforming to BS EN 10088. The strip should be at least 50mm wide and not less than 0.375mm thick. It may beterne-coated if exposed to view.

Nails

Nails should be large-headed copper or stainless steel, conforming to BS 1202 -1 and 2. The shanks should be annular ring, helical ring or serrated and not less than 20mm long. The shank diameter for heavy-duty applications should not be less than 3.35mm and for light-duty not less than 2.65mm.

Screws

Screws should be brass or stainless steel, complying with BS EN 14592 +A1:2012. They should be not less than 19mm long and 3.35mm in diameter.



Solder

Solder for making soldered fixing dots should be grade D or grade J, conforming to BS EN ISO 9453.

Battens

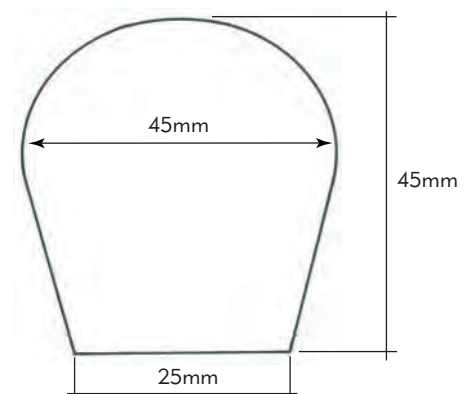
Where battens are used for fixing leadwork to concrete, brickwork or blockwork, they should be of treated softwood to protect them from rot, and should have the following minimum dimensions:

- a) across the fall – 75mm wide x 25mm thick
- b) with the fall – 50mm wide x 25mm thick

Wood rolls

Wood rolls should use treated softwood and be shaped as shown in Fig 2. The undercut to the base of the roll is designed to prevent wind uplift. The minimum dimensions are shown but larger rolls may be necessary for extra protection in areas of severe exposure. Large rolls, proportional to the size of the roof for visual effect, may also be used on hips and ridges.

Fig 2. Standard roll



HEALTH AND HYGIENE

The Control of Lead at Work Regulations and the supporting Approved Code of Practice address the precautions required to protect people who are exposed to lead arising from work activities.

In most cases, the use of lead sheet in building does not create a significant exposure to lead, although it is essential not to eat, drink or smoke in a place liable to be contaminated by lead and also to thoroughly wash hands, arms and face at the end of each working session.

When lead-welding is carried out for short periods of time in the open air, there is no significant hazard, but when stripping old lead sheet where the underside is heavily corroded, or when lead-welding in unventilated conditions, additional precautions must be observed.

Further information is contained in a booklet available from the LSA.

FIXINGS

All leadwork must be adequately fixed into position. Fixings for leadwork perform two functions: to hold the lead securely and permanently in position and to prevent lifting and distortion in high wind conditions. Fixings, particularly intermediate fixings, must not restrict free thermal movement of the lead as this could cause the sheet to buckle, which in turn will result in fatigue cracking.

Lead flashings to brick and masonry walls without DPCs – Wedging, fixing and pointing

A flashing will only perform its function of preventing water penetration at an abutment if it is correctly detailed and fixed where the lead turns into a chase (raggle).

Abutment flashings to brick, block and stonework without DPCs are usually fixed into joints by lead wedges (Fig 15). These are simply strips of lead sheet 20-25mm wide, folded several times to suit the thickness of the joint (Fig 16). The lead is turned into a joint or chase by not less than 25mm. The wedges are driven into the joints (with a hammer and plugging chisel) to hold the 25mm turn-in securely and at a depth sufficient for the pointing material to conceal the wedges. Spacing should not exceed 450mm.

With step flashings, one wedge, placed centrally, is sufficient for each step, except on low-pitched roofs, where the longer steps may require two wedges to ensure that both ends are firmly fixed.

Fig 15.

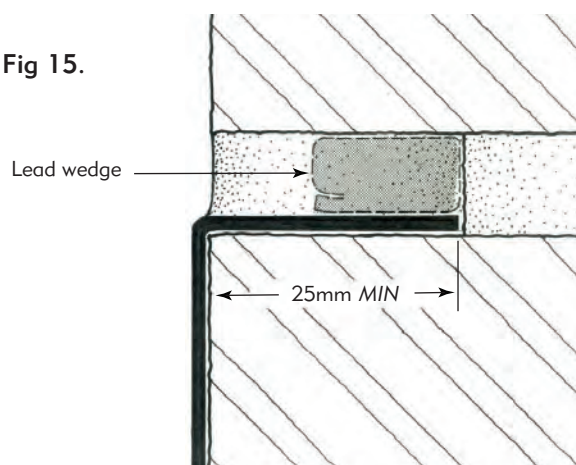
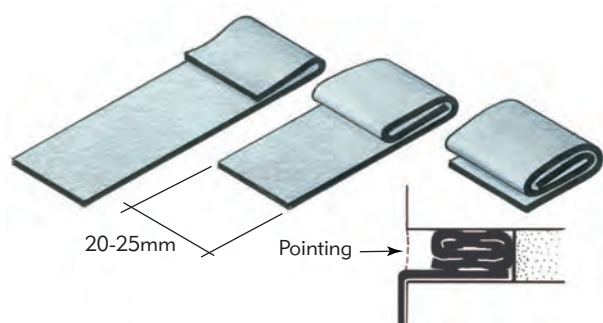


Fig 16. Wedges

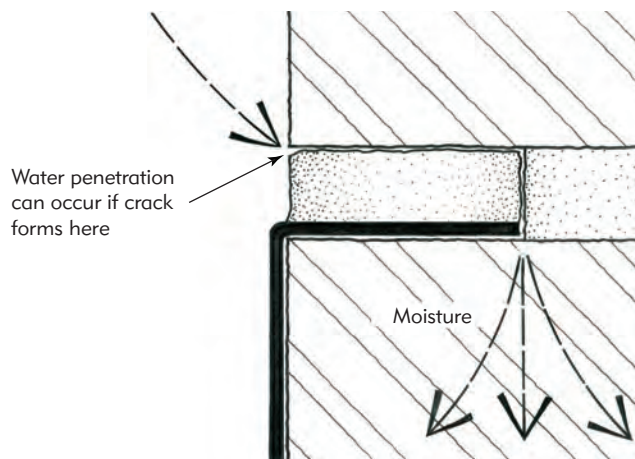


Lead flashings to brick and masonry walls without DPCs – Wedging, fixing and pointing (cont.)

The purpose of an abutment flashing is to weather the junction between the wall and an adjacent surface (such as the roof covering). It is not intended to prevent water penetration down through the wall. A DPC is fitted for this purpose.

Although the amount of water penetration is acceptable in many existing buildings where DPCs are not fitted, care should be taken when extending a property where a previously outside wall becomes internal once the extension is completed. Pointing an abutment flashing as shown in Figs 16 and 18 will not prevent water penetration as shown in Fig 19. The more exposed the wall, the greater the risk of dampness below the flashing. To avoid this problem, a DPC tray system is usually fitted together with the abutment flashing (see pages 48-55).

Fig 17.



Pointing materials

Although mortar pointing has often proved satisfactory, experience has shown that in positions exposed to direct sunlight, the different expansion coefficients of lead and mortar can cause cracks to occur. Rainwater can then penetrate to cause unacceptable dampness below (Fig 17).

In these situations, a mastic sealant has proved to be preferable to mortar for the pointing of joints up to about 18mm wide (Fig 18). Applied to properly prepared surfaces, the sealant will adhere to both the masonry and the lead and will be well able to accommodate the differences in expansion without cracking.

The pointing material should be compatible with both the lead sheet and the DPC material (see 'Sealants', page 11).

Fig 18.

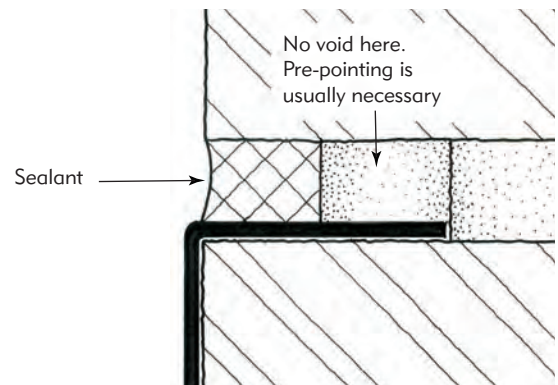
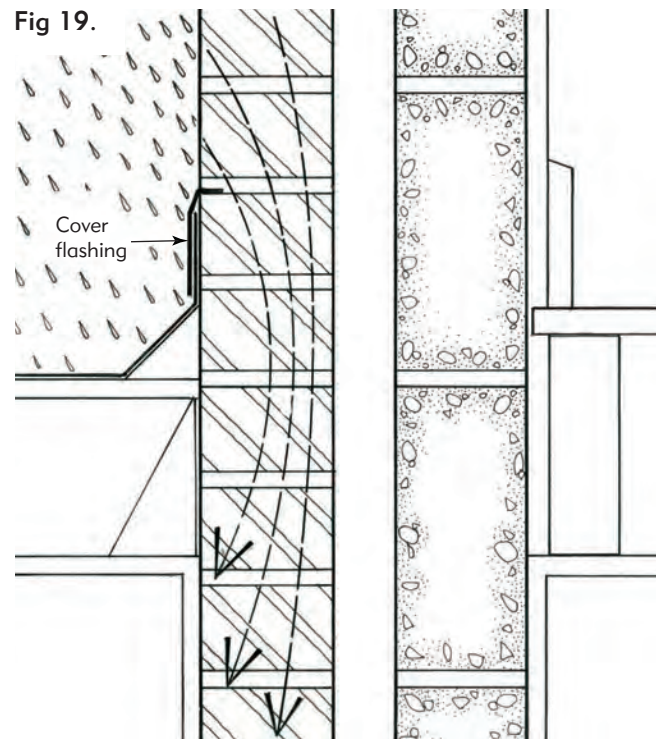


Fig 19.



Unless the flashings are pointed correctly, there will be a risk of water penetration where the lead turns into a wall. For mastic sealants, the manufacturer's instructions should be strictly followed.

The main factors that affect the performance of mortar pointing are:

1. Thorough cleaning out of joints
2. Thorough damping down of the masonry
3. Correct mortar specification
4. Thorough compaction of mortar into the joints – a pointing key or pointing iron to suit the width of the joint is recommended
5. Protection of newly placed pointing from direct sun or wind, or from frost.

Lead flashings to brick and masonry walls without DPCs – Wedging, fixing and pointing (cont.)

In some circumstances, it may be possible to fit both DPCs and flashings at the same time; here, the method shown in Fig 35 can be used. As the back edge of the lead is single-welted, it becomes anchored in the mortar and lead wedges are not necessary. In addition, experience has shown that if the DPC is well bedded, the joint between DPC and lead will be weather-tight.

This technique is also recommended where the height of masonry above the DPC is less than 600mm (Fig 36) and, due to the lack of a strong bond at the DPC line, there is a risk of the masonry lifting when wedging the flashings.

Fig 35.

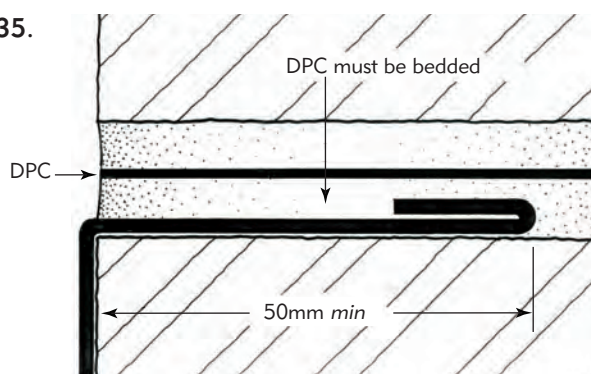
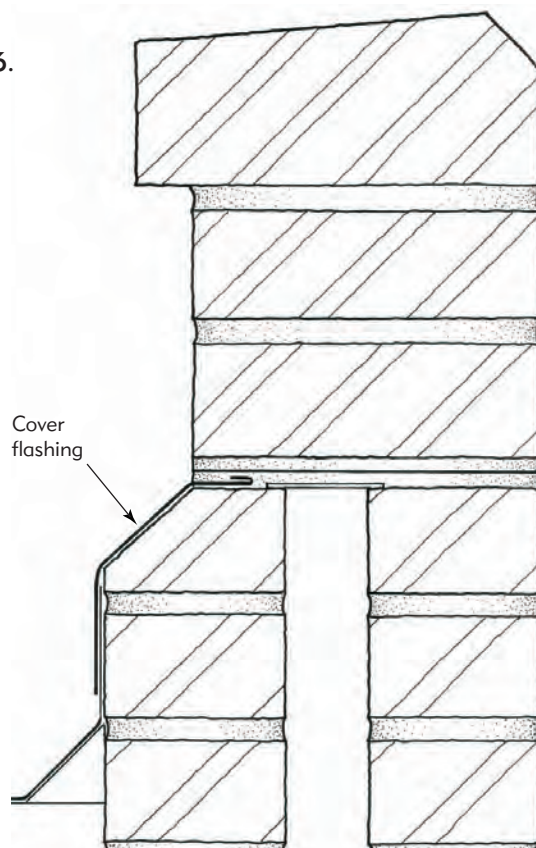


Fig 36.



Fixings to free edges of flashings

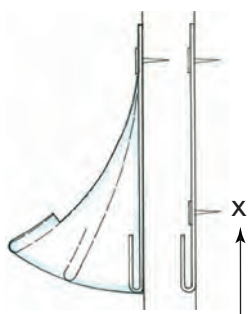
The free edge of a lead flashing must always be adequately clipped to prevent lifting and distortion in high wind conditions. Adequate clipping will depend on the location, orientation and exposure of the building: these will determine the material used for the clips, their spacing and, most importantly, the method of fixing.

For sheltered exposures, clips fixed at each lap and at about 500mm centres will be adequate. However, in more exposed situations, this method of fixing will not prevent wind uplift in storm conditions and additional

restraint will be needed. Clips should be spaced at between 300 and 500mm centres depending upon the exposure to wind lift. It should also be noted that ridge, hip and mansard flashings are particularly vulnerable to wind uplift.

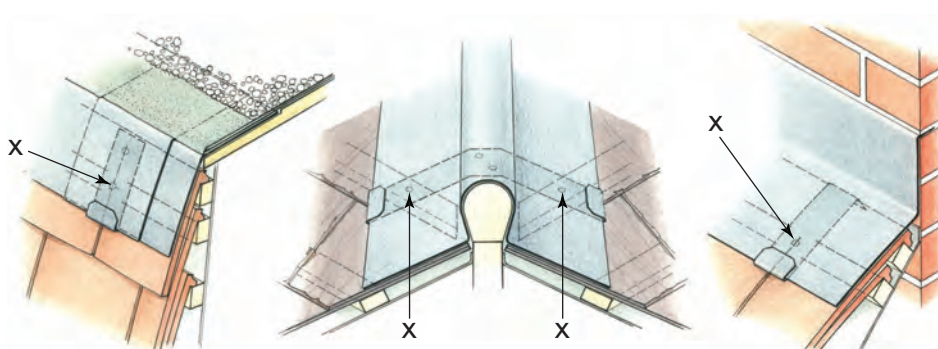
The important principle, 'The lower the fixing, the stronger the clip', is illustrated in Fig 37. Typical examples of extra fixings to clips are shown in Fig 38 – these are vital if clips are to provide effective resistance to wind uplift in storm conditions. For the specification of fixing clips, see page 12.

Fig 37. 'The lower the fixing, the stronger the clip'



X additional fixing positioned approximately 50-75mm from the free edge. An extra tile batten may have to be fitted.

Fig 38. Clips for moderate to severe exposures



X indicates additional fixings

Fixings on free edges of roofing, cladding and weatherings (cont.)

Fig 44. Lead-welded clip for moderate and severe exposure

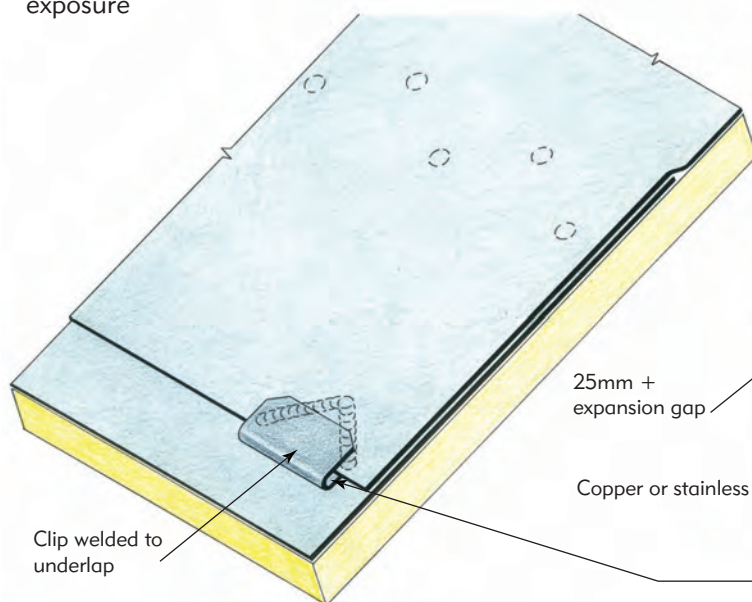
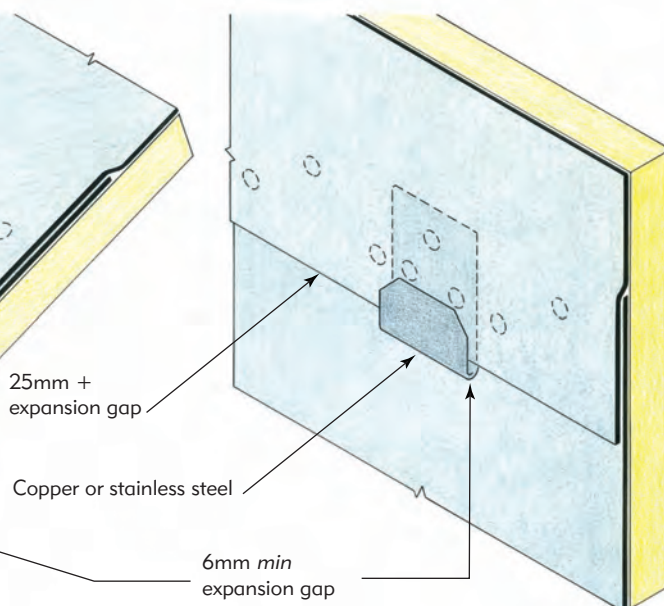


Fig 45. Clip for moderate and severe exposures



For short lap joints (such as on vertical cladding), the arrangement shown in Fig 45 would be adequate because the length of clip is much shorter than when used on a long lap joint (Fig 43). The fulcrum is relatively close to the free edge of the overlap and therefore this clip, or the alternative shown in Fig 44, would be satisfactory for most exposures.

Note the expansion gap at the bottom of all three clips. This is to allow the overlapping sheet to expand freely with changes in temperature. **Normally the gap is 6mm, but when fixing leadwork in winter conditions the gap should be not less than 8mm.**

In positions exposed to very high wind pressure or suction, a continuous clip is recommended (Figs 46 and 47c). This method of fixing can also be used where visible clips are aesthetically unacceptable.

Clips are required along the bottom edge of lead cladding. Fig 47 shows three examples and again, the material used and the spacing of the clips depends on the exposure of the building.

Fig 46. Clip for severe exposures 30° and above

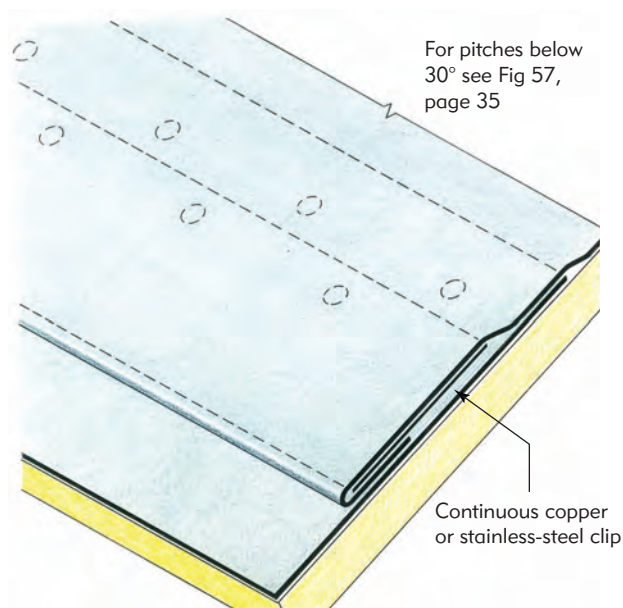
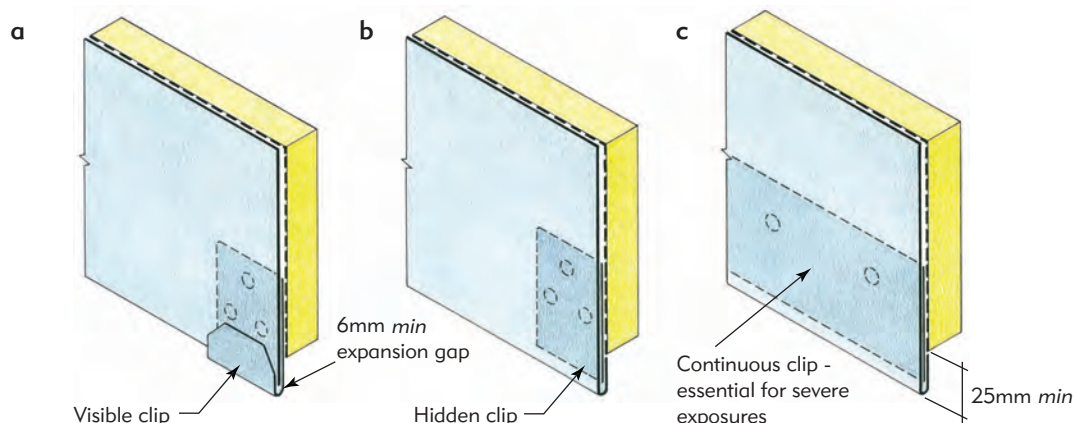


Fig 47. Clips on bottom edge



Head fixings to flashings and weatherings

Where flashings of up to 200mm girth are fixed at the head by nails or screws – for example, a mansard flashing (Figs 129-132, pages 66-67) – the fixings should be spaced about 150mm apart, not less than 25mm from the top edge.

Flashings that are deeper than 250mm will require head fixings, as for roofing and cladding. The head fixings should be overlapped with a separate cover flashing or the edge of a roof covering.

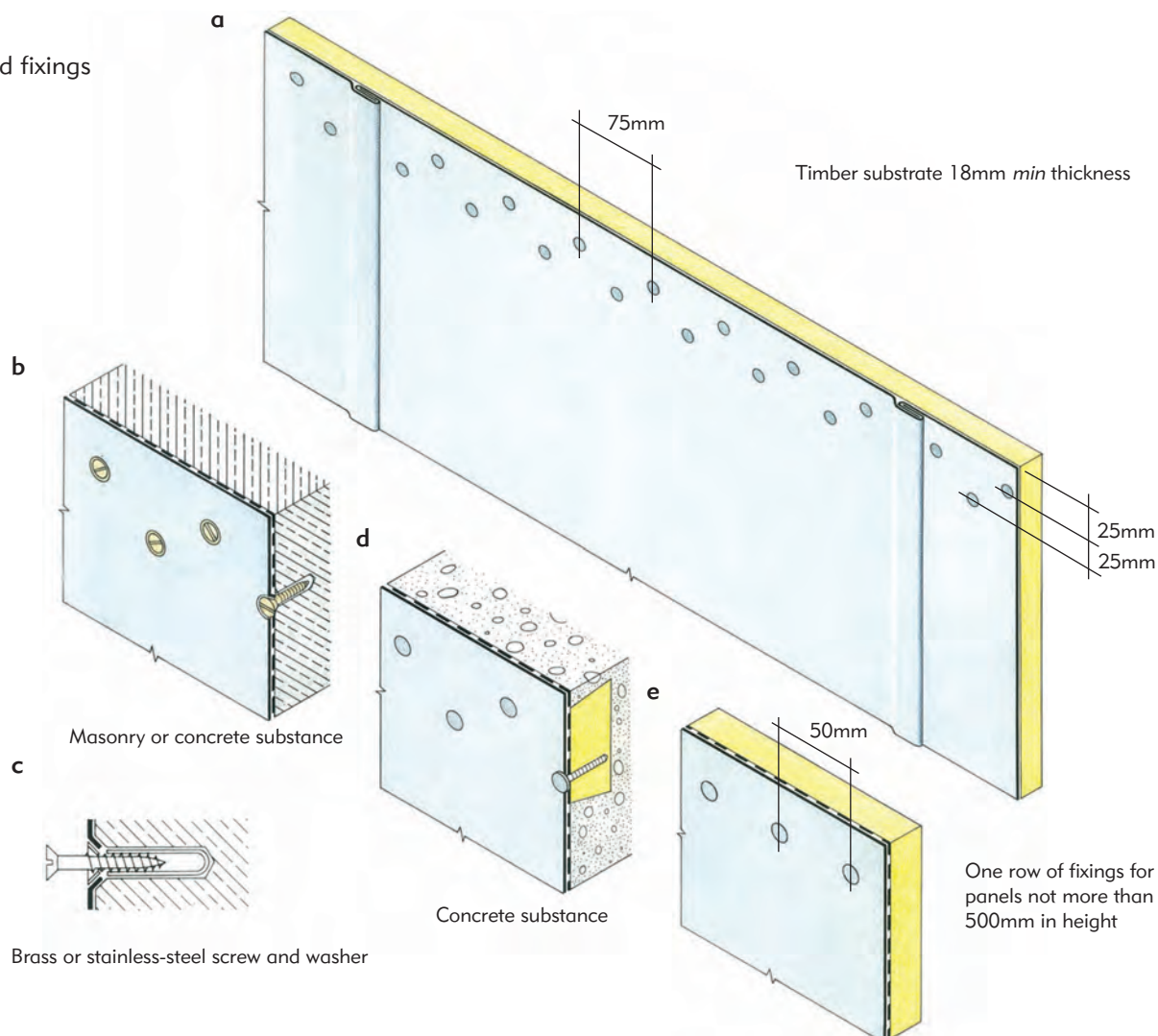
Head fixings to roofing and cladding

The usual method of securing the top of a panel of lead sheet to a timber substrate – for example, on pitched roofs, cladding and dormer cheeks – is with two rows of copper or stainless-steel nails at 75mm centres (Fig 50a). It is important to position the first row of nails 25mm from the top edge. A single row, spaced at 50mm centres, will be adequate when the piece of lead does not exceed 500mm in height (Fig 50e). When using codes 7 and 8 lead sheet on steeply pitched roofs (such as cathedrals), three rows of nails are recommended.



Where the substrate is concrete, preservative-impregnated timber battens can be inset to take the fixings (Fig 50d). However, in some areas the authorities may require the lead to be fixed directly to the concrete or masonry to give maximum fire-resistance. For direct fixing, brass or stainless-steel screws with washers are used at the same spacing as for nails (Fig 50b). The screws are fixed into plugs, which must be of a kind unaffected by moisture, such as polyamide or similar plastic (Fig 50c).

Fig 50. Head fixings



JOINTS

Joints for leadwork are designed to allow for thermal movement. The choice and spacing of joints can be related to the aesthetic requirements of a building, but in all cases a joint must be weather-tight in its selected position. To ensure freedom for thermal movement, it is important that joints are not formed too tightly.

Laps

Laps to abutment flashings, apron flashings, secret gutters and pitched valleys

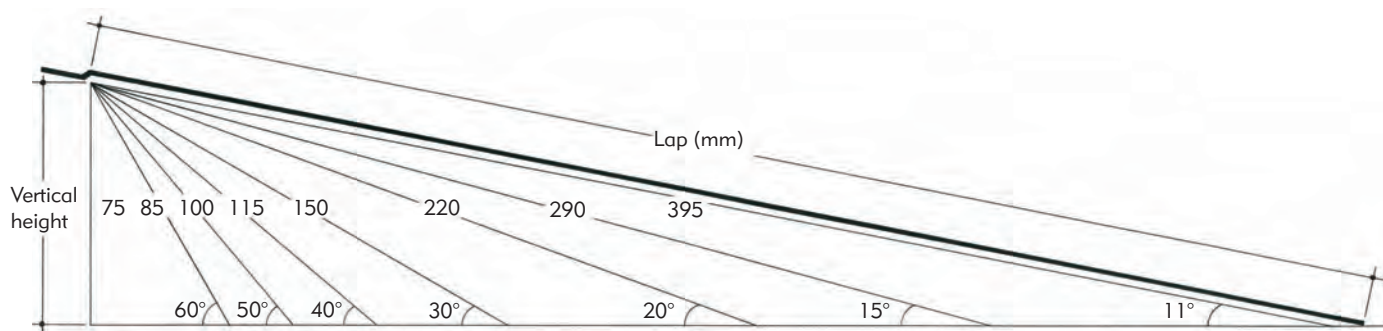
Joints between flashing pieces are usually laps. With abutment flashings, the side laps should be not less than 100mm, increasing to 150mm for locations that are exposed to high wind and rain. Flashings over 200mm in girth will require a side lap of at least 200mm, with the lap clipped as in Fig 42 (page 28).

Flashings at abutments over 250mm in depth should be done in two pieces with the lower section detailed with end-to-end welts as for cladding (Fig 253, page 158).

Each piece should be not longer than 1.5m. Flashings under the edges of felt and asphalt roofs should not be longer than 1m.

For secret gutters, step and cover flashings and pitched valley gutter linings, end-to-end laps should conform to a vertical weathering height of not less than 75mm (Figs 55-56). It should be noted that the pitch of a valley gutter is about 5° (average) less than the roof pitches on either side.

Fig 55. Lap diagram



Consider increasing vertical height to 100mm for severe exposures

Laps to pitched roofs and vertical cladding

This joint is used across the fall for all roofs over 10° and for vertical cladding. The minimum cover should be equivalent to a vertical height of 75mm (Fig 55). For example, a 20° pitched roof would require a lap of 220mm; a 30° pitch would require 150mm and vertical cladding 75mm. The effective lap length should be measured from the bottom row of fixings to reduce the risk of the fixings becoming wet where moisture is drawn into the lap by capillary attraction.

Although experience has shown that these lap requirements are satisfactory for most situations, it may be necessary to increase the vertical height to 100mm for severe exposures.

The head of the underlap should be fixed with two rows of copper or stainless-steel nails (Figs 50 and 56), and the edge of the overlap will require clipping to suit the exposure.

For severe exposures, or where the use of exposed clips is aesthetically unacceptable, the welted edge with continuous clip is recommended.

For pitches of 30° and above, the continuous clip detail shown in Fig 46 (page 29) would be suitable. However, with pitches below 30°, the copper or stainless-steel continuous clip would be too wide to prevent wind uplift. Although the clip could be nailed closer to the overlap, there would be a risk of water penetration through the nail fixings in storm conditions, and therefore a continuous lead clip should be used (Fig 57). Code 4 lead sheet is the minimum thickness to use for the clip, which should be welded to the underlap about 50mm from the lower edge of the overlap. Usually, lap joints are staggered from bay to bay to avoid over-complicated intersections with other joints.

Laps (cont.)

Fig 56. Lap

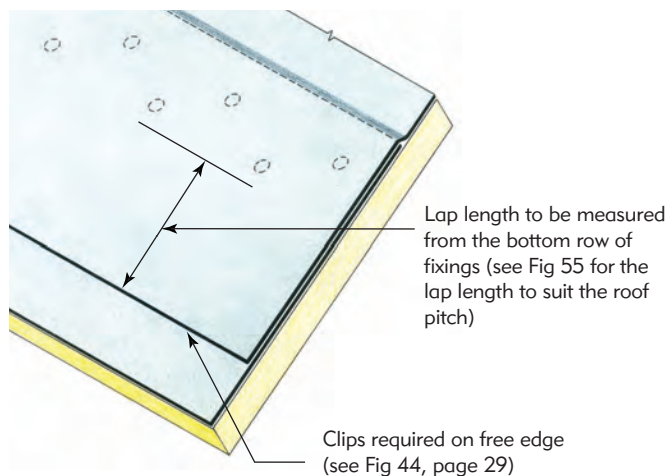
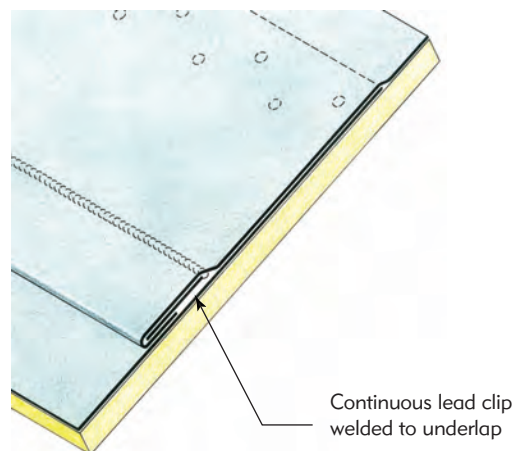


Fig 57. Lap with continuous lead-welded clip



Rolls

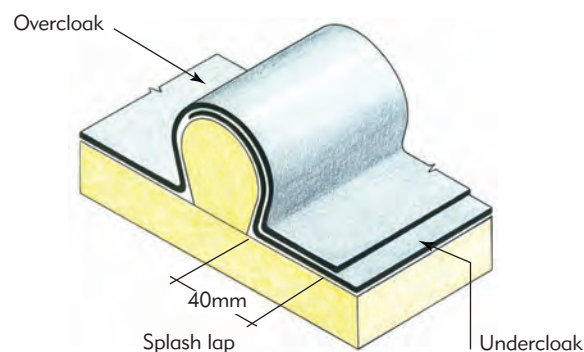
Wood-cored roll

This joint is suitable for flat roofing, pitched roofing and also lead cladding. Standard roll dimensions are shown in Fig 2 (page 13), but bigger rolls are sometimes used to give a bolder appearance. The undercut at the base of the roll is designed to resist wind uplift.

For flat and low-pitched roofing, the wood roll is the accepted joint since it is not easily damaged by foot traffic. The undercloak is turned over the top of the roll just beyond the crown and then nailed to the roll not more than one-third of the length of the bay, starting from the head. The overcloak is dressed fully over the roll and extended as a splash lap that serves to stiffen the free edge and keep it in position (Fig 58).

When using codes 7 and 8 for flat and low-pitched roofing in sheltered to moderate exposures, the traditional splash lap can be omitted and the overcloak finished about 5mm above the roof surface. However, in

Fig 58. Wood-cored roll



these cases it will be necessary to extend the undercloak at the roll end to achieve an adequate side lap (Figs 202-203, pages 118-119).

An alternative wood-cored roll (Fig 59), which is suitable for both roofing and cladding, is used when the splash lap is undesirable for aesthetic reasons. When using codes 4-6 lead sheet, the splash lap is omitted and the edge of the overcloak welted around copper clips fixed behind the undercloak at 450mm centres.

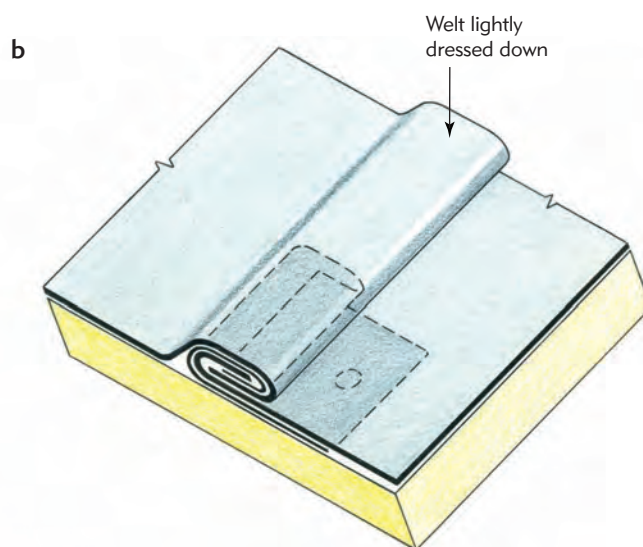
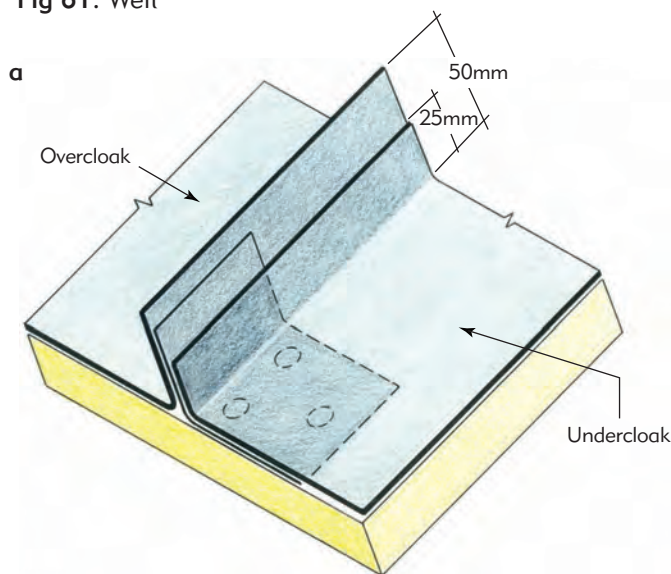
Owing to the difficulty in achieving a straight line along the welted edge on curved surfaces, this detail is not recommended for very curved roofs (such as semi-circular dormer tops).

With a 45mm roll, 75mm is added to the width of the bay for the undercloak and 175mm for the overcloak if there is a splash lap – or 135mm for the overcloak if the splash lap is omitted. These measurements will allow for trimming of the overcloak to achieve a clean line along the free edge.



Welt

Fig 61. Welt



This joint is suitable for steeply pitched roofs and wall cladding. It can also be used for small areas of more shallow-pitched coverings (such as curved dormer tops and door hoods) where there is no risk of the welt being submerged by the flow of rainwater in storms. Welts are commonly used for joining lengths of parapet capping, cornices and other weatherings. They are formed by turning up the underlap 25mm, and the overlap 50mm (Fig 61a), and then folding as shown in Fig 61b. Copper clips are incorporated in the welts at 450mm-maximum centres. To allow for thermal movement, it is important that the welt is only dressed down lightly.



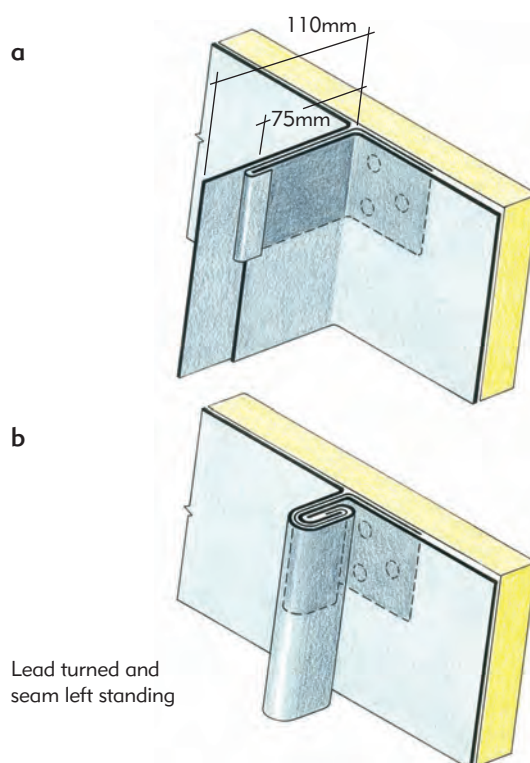
Fig 62. Standing seam

Standing seam

In general, this joint is only suitable on pitched roofs of 80° and above where it will not be vulnerable to mechanical damage. Its use is mainly for short areas of vertical cladding (such as fascias), where there are no angles and the boldness of the joint is preferred to the roll.

The standing seam is made similarly to the welt except that the upstands are taller (Fig 62a) and there is an extra fold to the finished seam, which is then left standing.

Upstand allowances are approximately as shown in Fig 62b, but these could be increased slightly to provide an even more prominent joint.

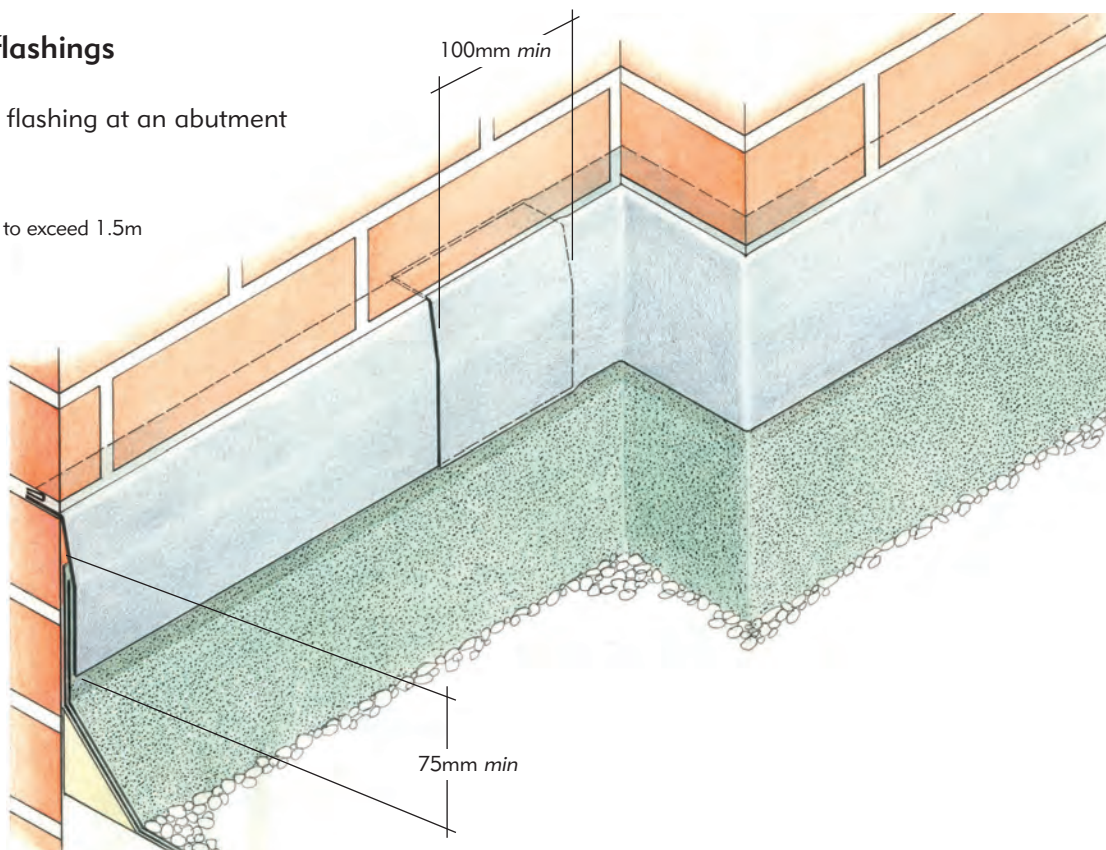


FLASHINGS

Abutment flashings

Fig 65. Cover flashing at an abutment

Note
No flashing piece to exceed 1.5m



All abutment flashings are designed to prevent rainwater from penetrating between the wall and the roof covering. However, they will not stop wind-driven rain that penetrates a wall from seeping down into the area below the roof surface. That is the function of a DPC (pages 48-55). However, the usual 25mm allowance that is turned into the mortar joint (or prepared groove) will divert water that runs down the wall surface safely out over the flashing and onto the roof.

Cover flashings to felt and asphalt upstands

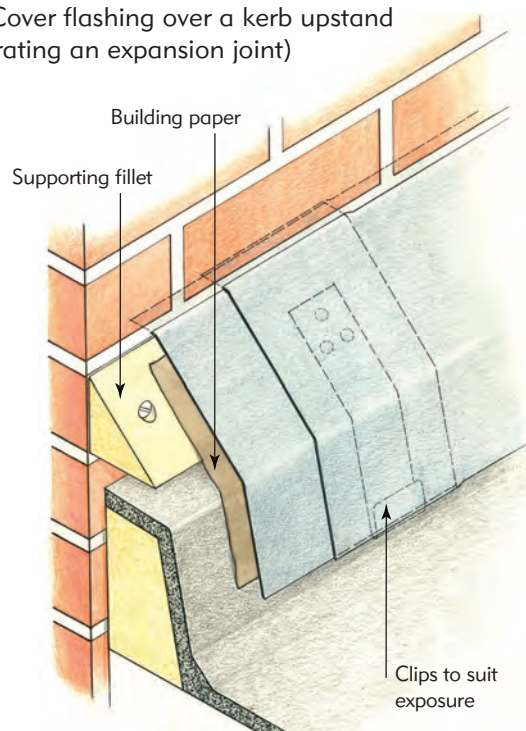
Cover flashings are simply strips of lead sheet with the top edge turned into a wall and wedged at about 450mm centres. The other edge covers over the upstand of the roofing material – bituminous felt or asphalt, for example – by not less than 75mm (Fig 65). End-to-end laps should be not less than 100mm, with clips spaced along the free edge to suit the exposure. The length of each cover flashing piece should not exceed 1.5m.

Where cover flashings are used to weather over a kerb upstand – often incorporating an expansion joint – it will be necessary to provide support for the lead to prevent sagging, which could result in water penetration through the lap joints. Fig 66 shows a practical detail where a timber-bridging fillet provides both support for the lead and fixing for the clips. It is important to fit a small gusset in any internal corners of the 25mm turn-in (Fig 78).

If there is a risk of adhesion between the asphalt or felt upstand and the lead, a building paper separator can be inserted.

Where no continuous mortar joint is available (for example, ashlar or rubble work), a chase is cut into the masonry to accommodate the 25mm turn-in (Figs 26-27, page 24).

Fig 66. Cover flashing over a kerb upstand (incorporating an expansion joint)



Abutment flashings (cont.)

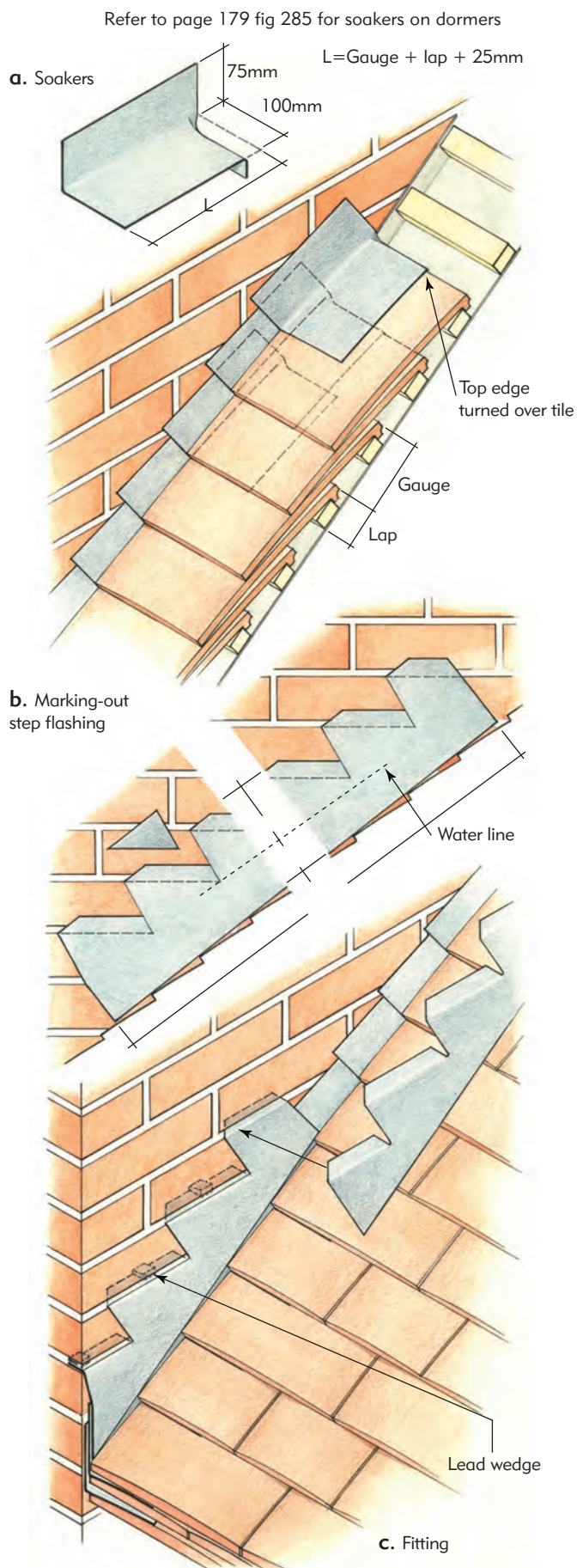
Soakers and step flashings to slates and tiles

Soakers are used where a slated or double-lap plain-tiled pitched roof abuts a wall. The length of a soaker equals the gauge (batten centres) plus the lap (the dimension by which the tile or slate overlaps the next but one below it). For example, the length of a soaker for a standard plain tile, laid to a gauge of 100mm and with a head lap of 65mm, would be $100 + 65 = 165\text{mm}$. For a slate laid to a gauge of 200mm and with a lap of 100mm, the length of its soaker would be $200 + 100 = 300\text{mm}$. An extra 25mm is added to this for turning down over the top of the tile or slate to prevent the soaker from slipping.

The width of a soaker should be a minimum of 175mm to allow for a 75mm upstand against the wall and 100mm under the tiles or slates. Soakers are usually made from code 3 lead sheet. Fig 67a shows soakers in position.

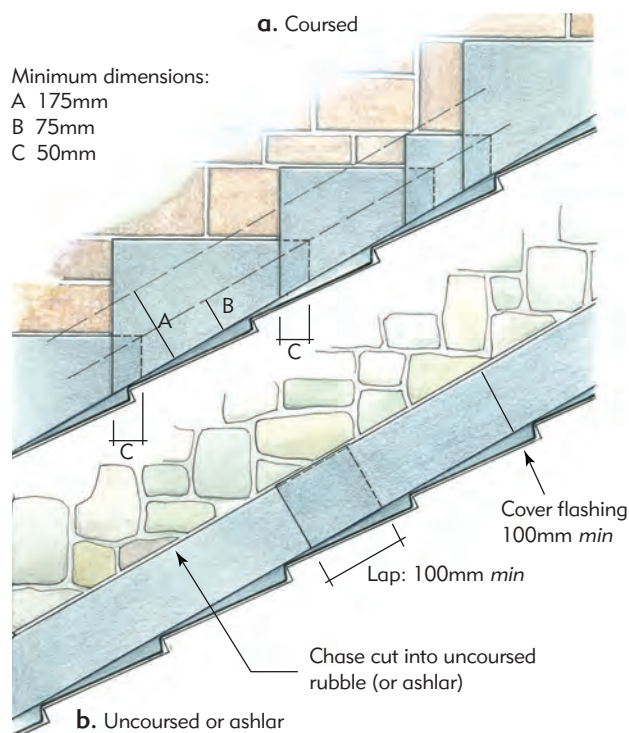
To make the abutment weather-tight, the upstand of the soakers is covered by a step flashing. A 150mm-wide piece of lead is held against the abutment and steps are marked, cut, and the turn-in of each step folded and then fitted, as shown in Fig 67b. The step flashing must cover over the soaker upstand by not less than 65mm. Each piece of step flashing should not exceed 1.5m in length and laps between pieces should not be less than 100mm. When fixing, use lead wedges to secure the steps (Fig 67c).

Fig 67. Abutment with soakers and step flashings



Abutment Flashings

Fig 70. Abutment flashings to stone walling



Secret gutter at abutment

When using a step and cover flashing over single-lap interlocking flat tiles or slates, there is a risk of water penetrating under the lead, especially on low pitches in exposed positions. An alternative method of weathering is to use a secret gutter with a step flashing (Fig 71).

The gutter should be about 75mm wide with a timber sole to fully support the lead linings. A gutter depth of 25mm will normally be adequate to cope with the flow of rainwater in storm conditions.

Factors that must be considered are the length of the abutment and the amount of rainwater that the gutter will receive from wind-driven rain across the roof and from the vertical surface above. Because the tiles are not bedded down the abutment, the edge of the roof covering should finish not more than 15mm from the wall.

For situations where the flow of rainwater is likely to surcharge a secret gutter, or if there is risk of blockage where leaves, pine needles and so on can fall or be blown on to the roof, a step and cover flashing with a secret gutter is recommended (Fig 72). In both cases the gutter lining pieces should not exceed 1.5m in length and be fixed securely at the head only. Laps between pieces should conform to Fig 55 (page 34). The top of the gutter upstand against the wall should be not less than 65mm above the surface of the tiles. The step flashing (or step and cover flashing) is then fixed as previously described.

Where the secret gutter discharges into an eaves gutter, it will be necessary to notch the fascia board to accept the gutter depth. However, where the high point in the eaves gutter is positioned at the abutment, this will not be practicable and inserting a timber-packing piece can raise the sole of the gutter. The lead lining should be splayed out to avoid the risk of an overflow at the side (Fig 73).

Fig 71. Abutment flashing with secret gutter

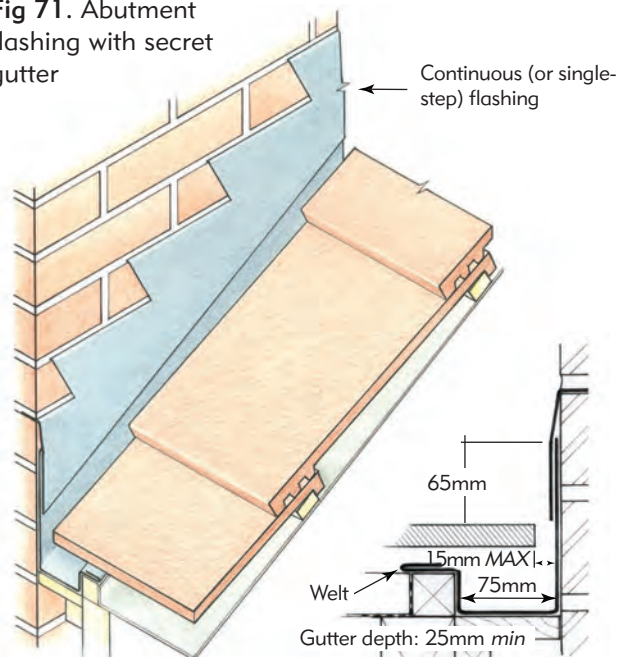


Fig 72. Abutment step and cover flashing with secret gutter

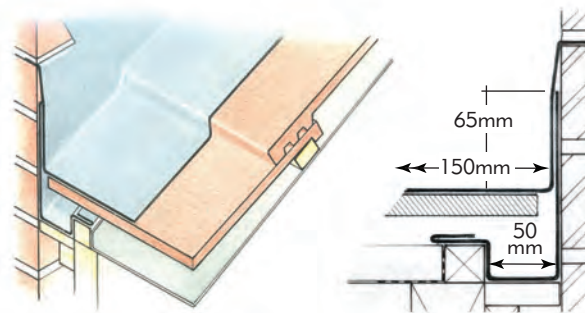
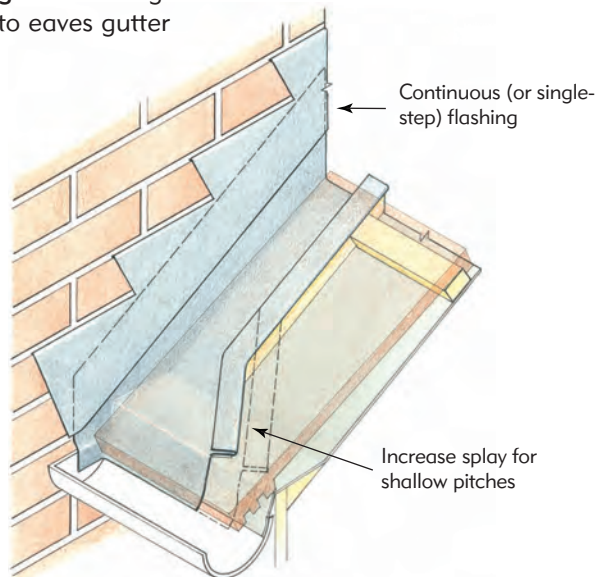


Fig 73. Secret gutter outlet into eaves gutter



Abutment flashings (cont.)

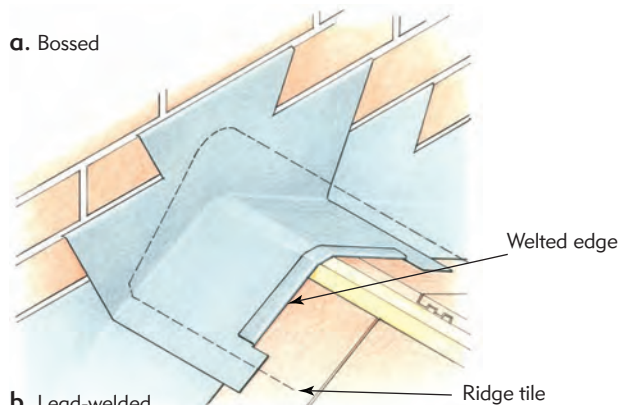
Saddle at abutment

The flashing for an abutment at a ridge is called a saddle. It can be formed either by bossing or lead-welding and is fitted before the ridge tiles (Fig 74a). The saddle should extend 150mm along the ridge and not less than 150mm down the roof on each side.

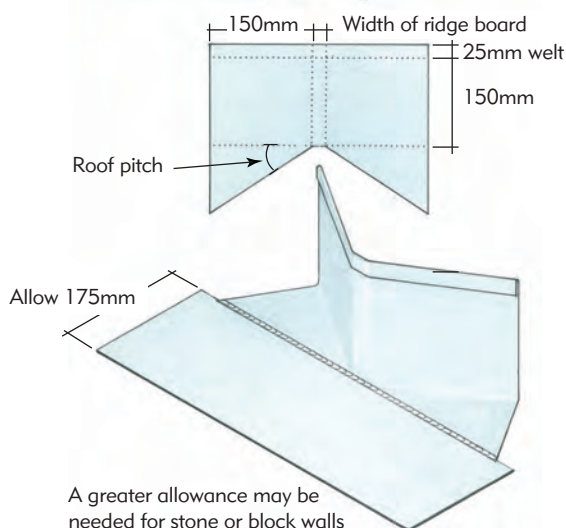
With shallow-pitched roofs, the saddle is usually bossed to shape on the bench, with the steps marked and cut in position as required for fixing to the wall. For steeper roofs, the alternative lead-welded method (Fig 74b) is generally more practical. In both cases, the edge under the ridge tile is welted to form a weather check.

Fig 74. Lead saddle at abutment

a. Bossed



b. Lead-welded



Apron flashings at abutments

Where a pitched roof abuts a wall, the upstand should be not less than 75mm, with the top edge turned 25mm into the joint and wedged at about 450mm centres (Fig 75). The maximum length for each piece is 1.5m, with laps of not less than 100mm. The apron should extend down the roof slope to provide at least 150mm over the tiles or slates, increasing to 200mm for low-pitched roofs or exposed positions. Clips will be needed along the front edge of the apron to suit the exposure to wind uplift. For most contoured tiles, the inherent malleability of lead sheet will allow the material to be bossed and dressed in-situ to fit snugly to the roofing.

Fig 75. Apron flashing at abutment with lean-to-roof

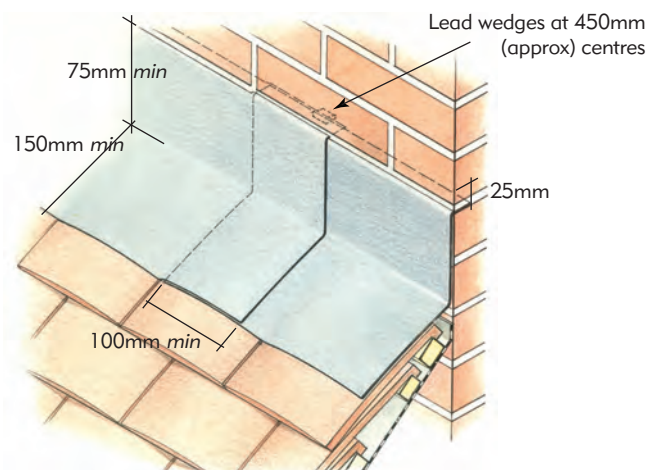


Fig 76. Apron flashing at abutment with sharp-edged interlocking tiles

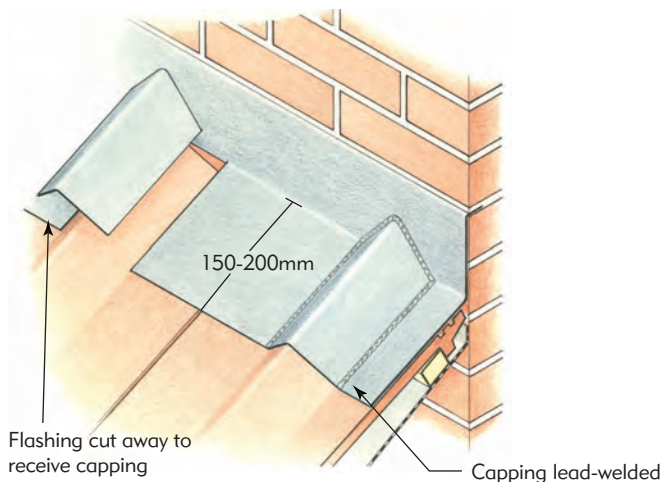
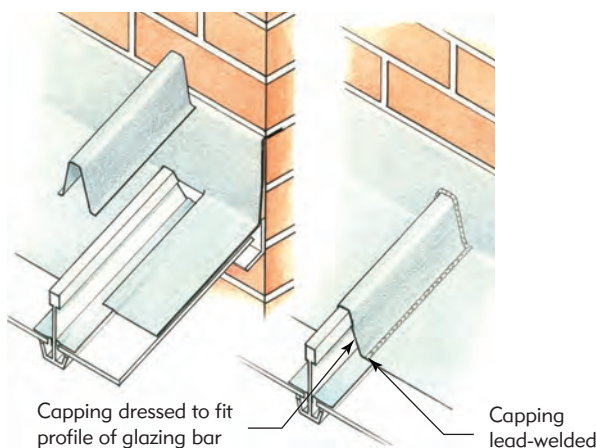


Fig 77. Apron flashing at abutment with high-profile patent glazing



However, where the tiles have sharp raised edges, or when flashing over deep patent glazing sections, the lead can be cut and welded as shown in Figs 76-77. This will avoid thinning and splitting when the lead is dressed down over the sharp edges. The capping pieces are lead-welded on the bench and the flashing lengths are then fitted over the projections and dressed to fit. Note that, in both cases, the lead is not cut away behind the raised tile profiles or glazing bars as this helps to hold the flashings in position.

Chimney flashings

Front apron – bossed

The piece of lead sheet for the front apron will be not less than 300mm wide – 150mm for the upstand against the chimney plus 150mm for the apron over the tiles. With low-pitched roofs, particularly in exposed situations, the cover over the tiles should be increased to 200mm.

The length of the piece will be the width of the chimney plus a minimum of 150mm on each side. Over deeply profiled tiles, this should be increased to 200mm on each side.

Shaping a front apron is done mainly on the bench. The piece of lead sheet is first folded along its length to the angle between chimney and roof. The corners are marked to the width of the chimney and each corner is then bossed as shown in Fig 80 – the arrows indicating the direction in which the lead is worked. The sheet is bent to form a 'wave' and then bossed towards the corner. The process is repeated many times and gradually the corner is formed without significant thinning of the lead.

Front apron – lead-welded

This work is set out and cut as shown in Fig 81, with the cut and fold lines conforming to the width of the chimney and the pitch of the roof. After folding as shown, the gussets are inserted with flat butted lead-welded seams.

The bossed or lead-welded apron is moved up to the chimney and the upstand is marked to suit the joint in the brickwork or stonework. This joint must be at least 75mm above the top surface of the tiles or slates. An extra allowance of 25mm is made for turning the lead into the mortar joint. The upstand is then cut, and the top edge folded and fixed into the joint with lead wedges (Fig 82). At this stage, the wedges should not be inserted too close to the corners, as this could impede the later fixing of the side flashings.

Fig 80. Front apron - bossed

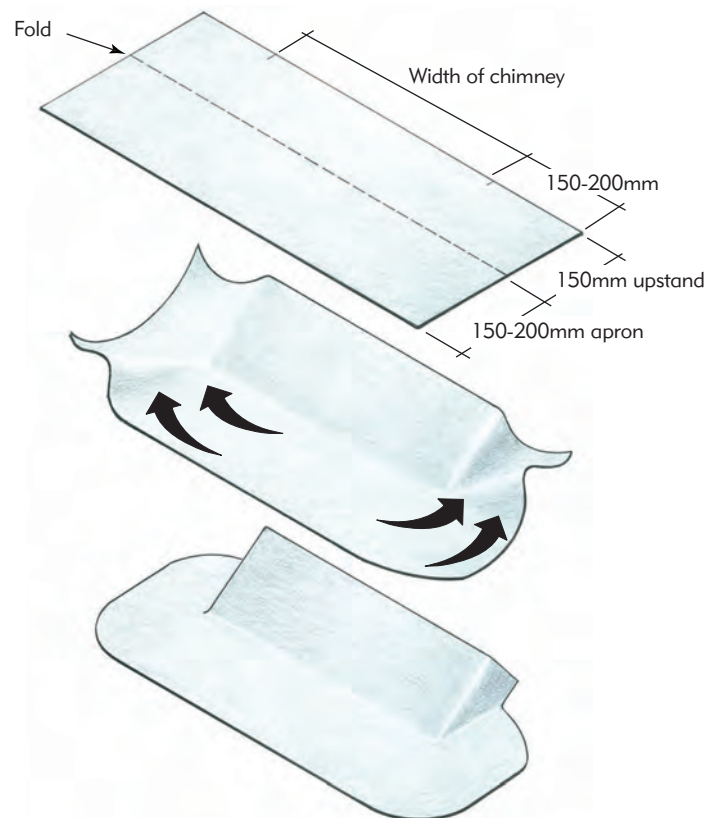


Fig 81. Front apron - lead-welded

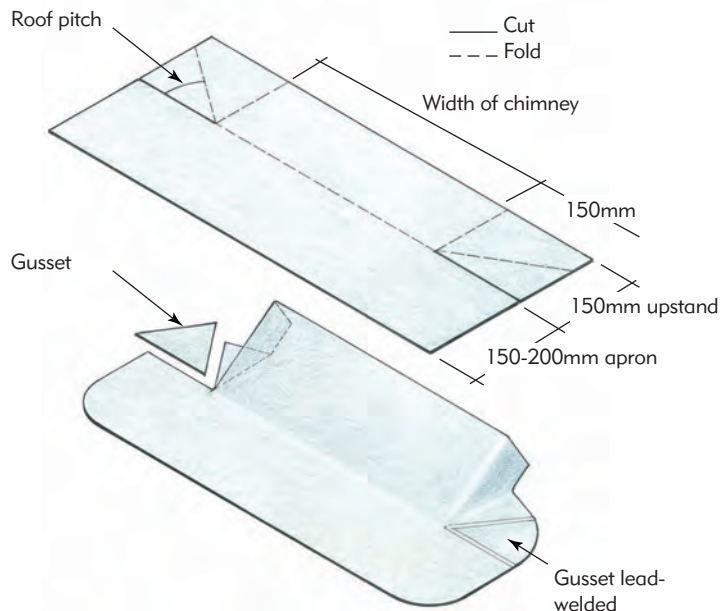
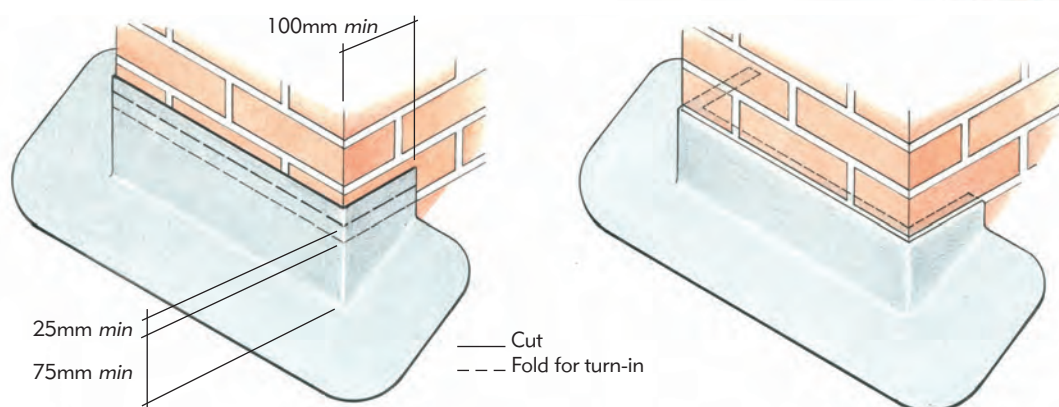


Fig 82. Front apron in position



Chimney flashings (cont.)

Side flashings

On roofs covered with slates or double-lap plain tiles, the side flashings are fitted over the upstand of soakers with the front end simply turned round the corner of the chimney and then fixed with lead wedges (Fig 83).

For single-lap tiles, side flashings can be either bossed or lead-welded.

Bossing the front corner of a side flashing is similar to forming a front apron and the arrows in Fig 84 show the direction of working. An alternative method, using lead-welding, is shown in Fig 85. In both cases, the upstand allowance is 150mm and the extension out over the tiles should be not less than 150mm, increasing to 200mm in exposed situations or over deeply profiled tiles.

Fig 86 shows a simpler, alternative side flashing for roof pitches above 20°. This involves neither bossing nor lead-welding. It is essential, however, to provide a lap of not less than 150mm between the side flashing and the return of the front apron.

Fig 83. Side flashing over soakers

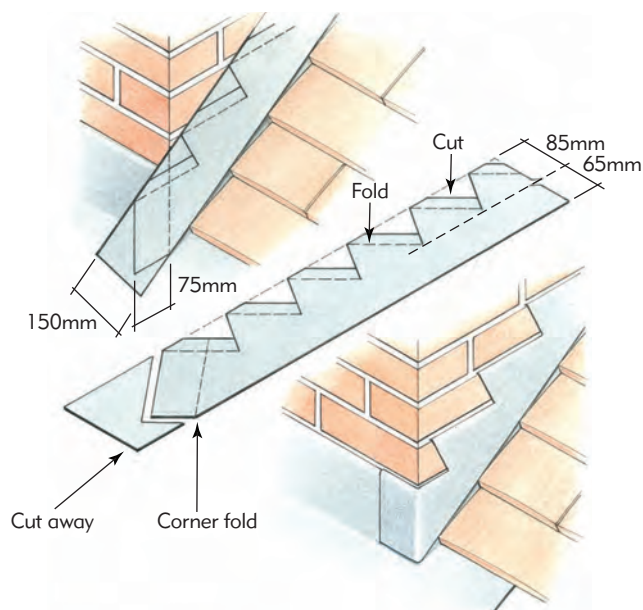


Fig 84. Side flashing – bossed

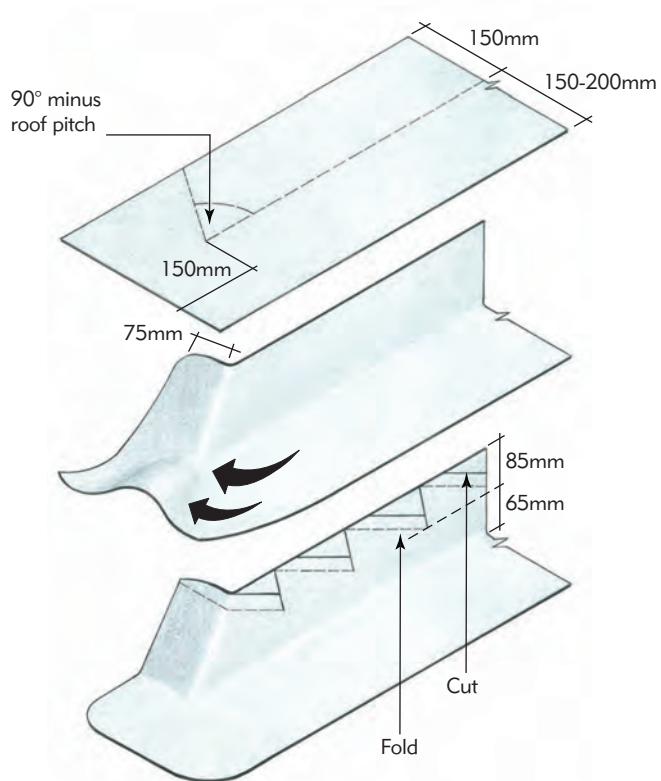


Fig 85. Side flashing – lead-welded

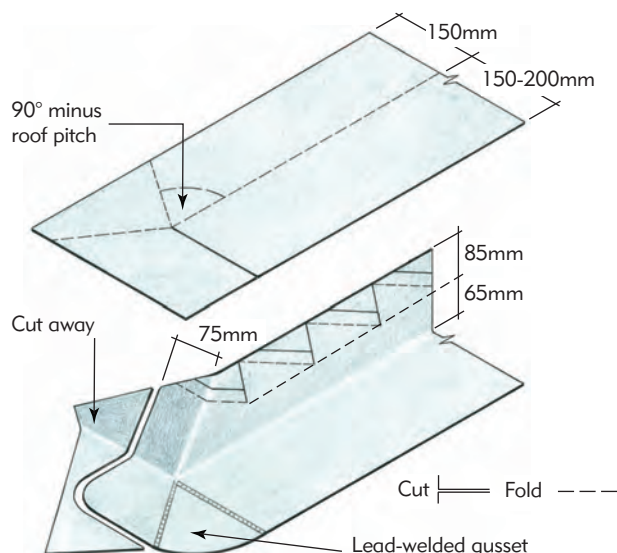
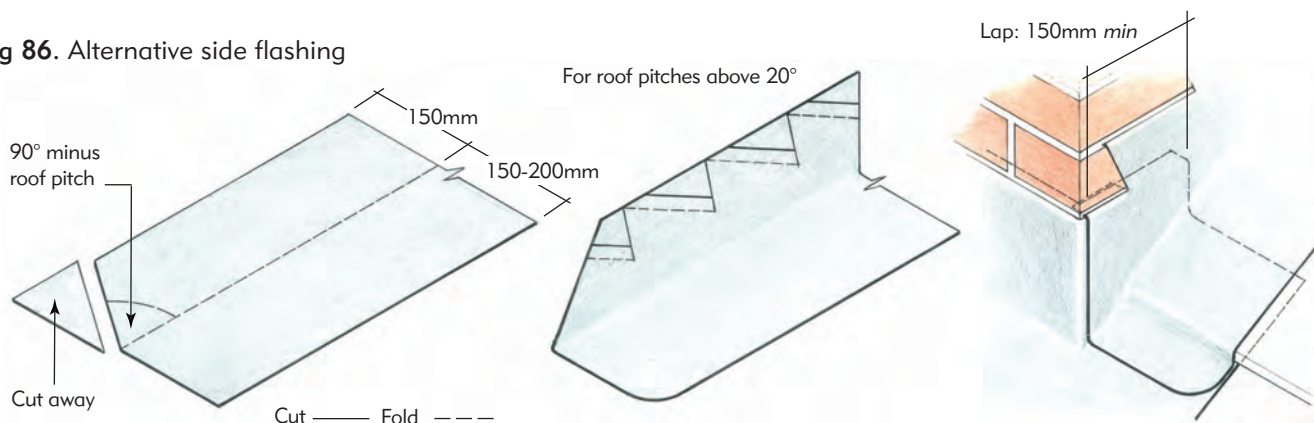


Fig 86. Alternative side flashing



Chimney flashing

Back gutter – bossed

To boss a back gutter involves considerably more work than bossing a front apron and code 5 lead sheet is the minimum thickness recommended for this application. A minimum of 100mm is allowed for the upstand against the chimney, about 150mm for the gutter sole and 225mm for the extension up the roof slope, making a total girth of about 500mm. The length of piece will be the width of the chimney plus an allowance of 225mm on each side for shaping the corners.

Forming the corners is done mainly on the bench and the arrows on Fig 87 show the direction of bossing. The lead is bent to form a 'wave' and then bossed towards the corner. This operation is repeated many times, shaping the lead into a corner as shown, without significant thinning of the sheet. Occasional dressing from below will prevent creasing near the corner. Final bossing of the corners is carried out in-situ so that the lead fits snugly over the tile profiles.

Back gutter – lead welded

Setting-out for a lead welded back gutter is shown in Fig 88. Although the width of the piece will be the same as for bossing, the length will vary. With slates or double-lap plain tiles, the allowance on each side of the chimney is 150mm, whereas a minimum of 200mm is required for single-lap tiles. The measurement A-B reflects the vertical dimension taken from sole of the gutter to the roof finish i.e. slates or tiles etc. After cutting, the back gutter is folded and the gussets inserted and lead-welded as shown. The shape of the gusset may vary according to preferred practice.

The final flashing on a chimney within the roof slope is the cover flashing over the back-gutter upstand (Fig 89). A minimum of 100mm each side is allowed for turning around each corner of the chimney and the bottom of the flashing is finished 5-10mm from the gutter sole. Lead wedges are used to secure the cover flashing into the mortar joints.

For chimneys on the ridge, saddle pieces are required as shown in Fig 74 and described on page 43.

Fig 90. Back gutter at an abutment

For internal corner detail, see Figs 192-193, pages 111-112

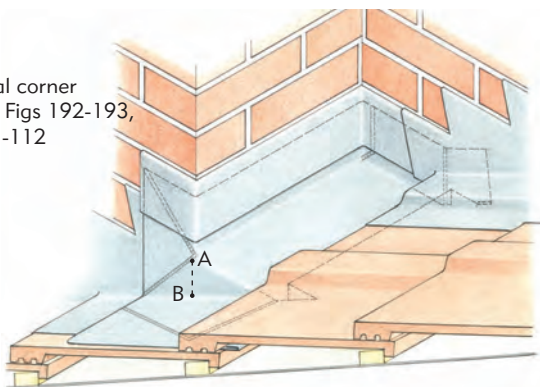


Fig 87. Back gutter - bossed

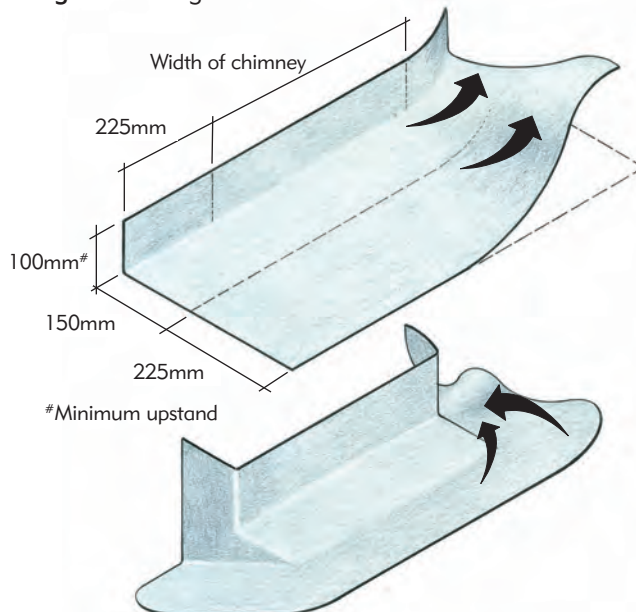


Fig 88. Back gutter - lead-welded

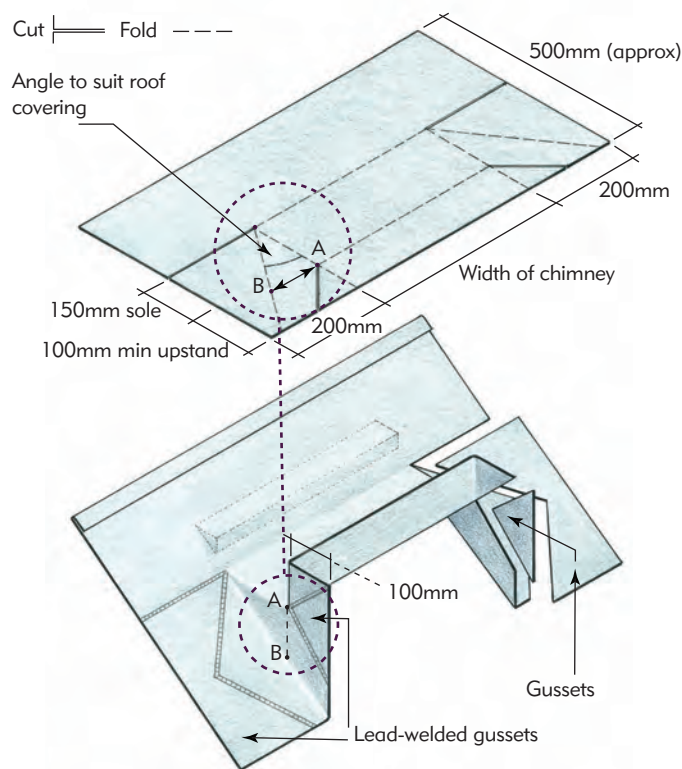
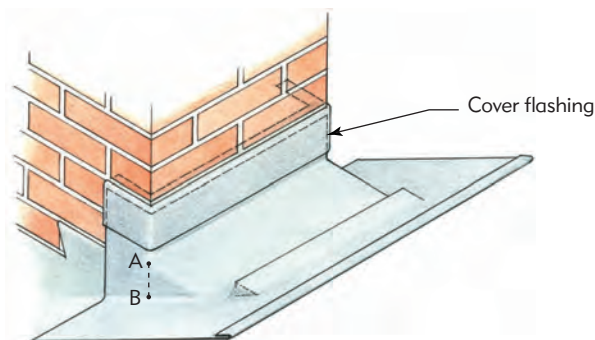


Fig 89. Back gutter in position



Chimney flashings and damp-proof courses (DPCs)

Chimney DPCs

The chimney flashings already shown in this section are designed and detailed to prevent penetration of water into the roof space at the junction between the tiles or slates and the chimney. They will not, however, check moisture that may penetrate into the chimney and seep down the brick or stonework into the area below the roof. This form of water penetration is prevented by the use of a DPC (Fig 91).

A chimney DPC is especially necessary where moisture penetration would be visually unacceptable, could damage the structure below, or both. This is most likely in exposed positions and on chimneys through low-pitched or flat roofs where the distance between the roof surface and ceiling is relatively small.

With some pitched roofs in moderate exposures, a degree of dampness in the chimney within the roof space may be acceptable. However, in exposed conditions or where low pitches reduce the surface-to-ceiling distance, or, again, where the roof space is habitable and visible, a chimney DPC tray is strongly recommended.

Fig 91. Chimney DPCs – degrees of effectiveness

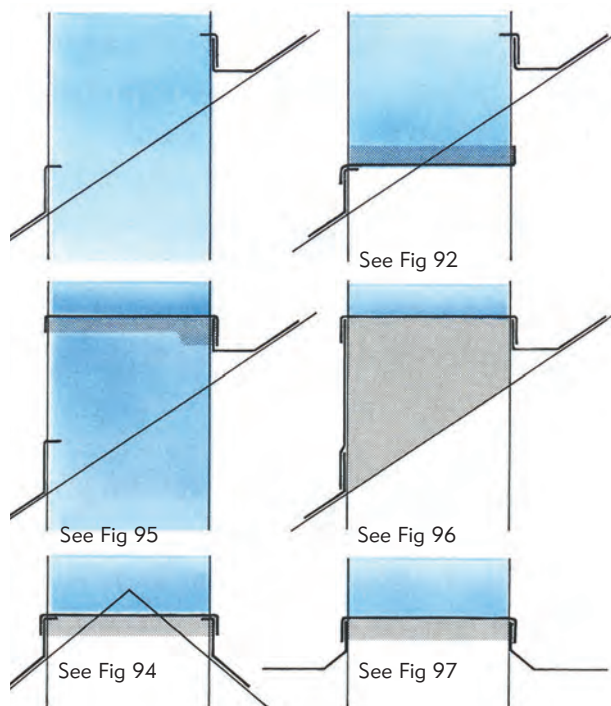
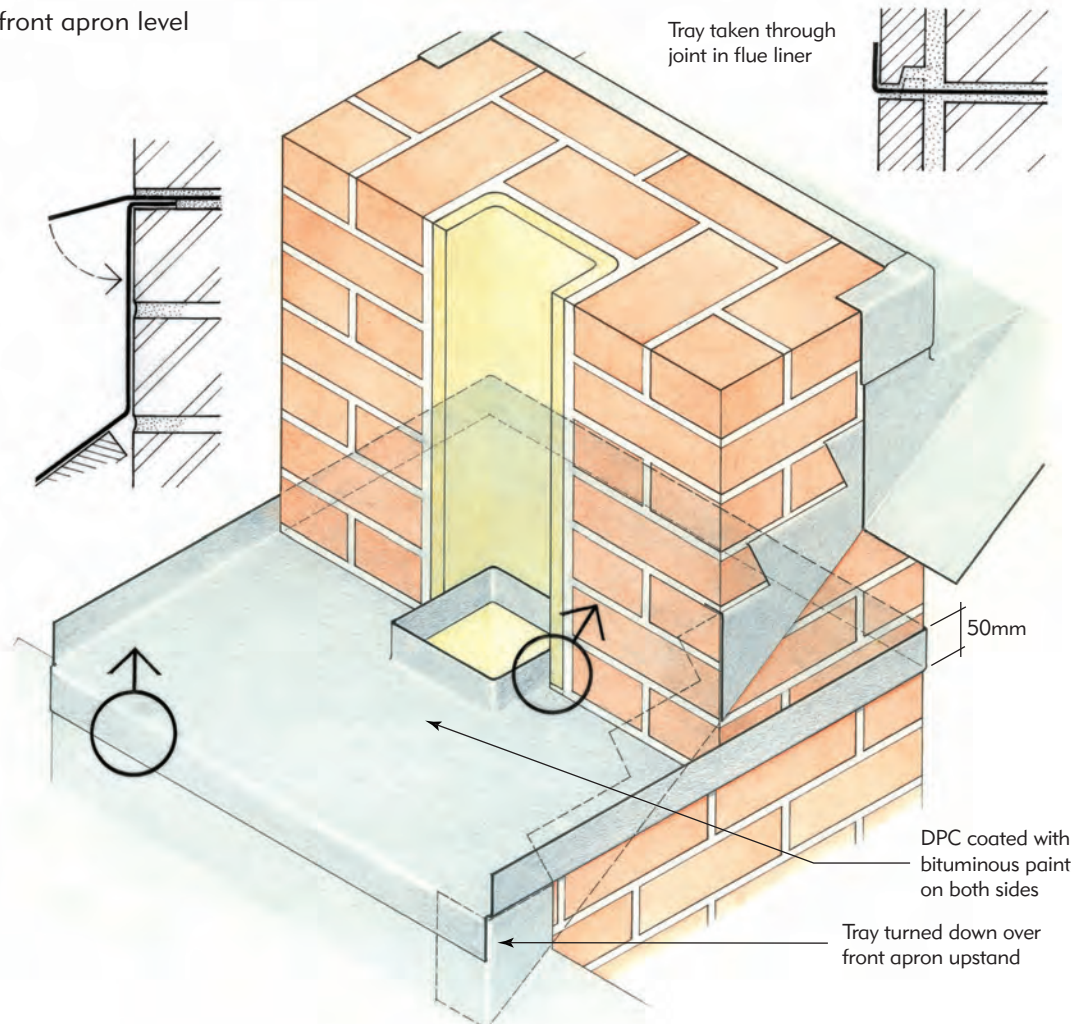


Fig 92. DPC at front apron level



Chimney flashings and DPCs (cont.)

DPC at front apron level

A chimney DPC takes the form of a lead tray that is built horizontally into the stack. Where the chimney penetrates a pitched roof, the tray is usually fitted level with the top edge of the front apron (Fig 92). The sides and back (which are mainly in the roof space) are turned up against the stack and the front is turned down over the front apron. The tray will collect any water that penetrates downwards and drain it through weep holes in the vertical joints above the front apron. A joint in the flue lining should coincide with the level of the tray to allow a turn-up of at least 25mm inside the lining.

Moisture that collects in a flue can contain sulphuric acid and therefore the flue liners and also the brickwork or masonry above the tray should be bedded in sulphate-resisting mortar.

The practice of turning the tray up between the flue lining and the brickwork is not recommended. Site investigations have shown that in storm conditions, rainwater will penetrate the brickwork, percolate down against the flue liners and run between the lead upstand and liner to cause dampness in the area below. Sealing the joint with a mastic or similar material has not proved to be effective.

When fitting a chimney tray at front apron level, it is important to bed the tray and then immediately rake out the soft mortar from under the front to a depth of 25mm to facilitate the later fitting of the front apron. This will avoid the risk of damage to the tray that might occur if hardened mortar later has to be removed with a plugging chisel.

Fig 93 shows a similar DPC where the chimney is on an outside wall and Fig 94 where the stack is at the ridge.

To prevent corrosion of the lead and to avoid staining, both surfaces of all chimney DPCs should be coated with a bituminous paint.

DPC at back gutter level

An alternative position for a chimney tray is at back gutter level. Fig 95 shows a tray combined with a cover flashing over the back gutter. With this method, there is an area of exposed stack below the tray and it is therefore only suitable for sheltered exposures or where any dampness penetrating into the roof space would quickly dry out.

Even when a DPC tray is at front apron level, it must be appreciated that some of the damp area will still be below the roofline. Where the roof space forms part of the living or work area this will be unsightly – and often unacceptable. Fig 96 shows a combined DPC and flashing designed to overcome this problem. As a practical alternative to Figs 92 and 95, it is suitable for all applications and particularly recommended in conditions of extreme exposure. This DPC has a minimum allowance of 75mm all round for turning down over the flashing panels.

Fig 93. DPC at front apron level

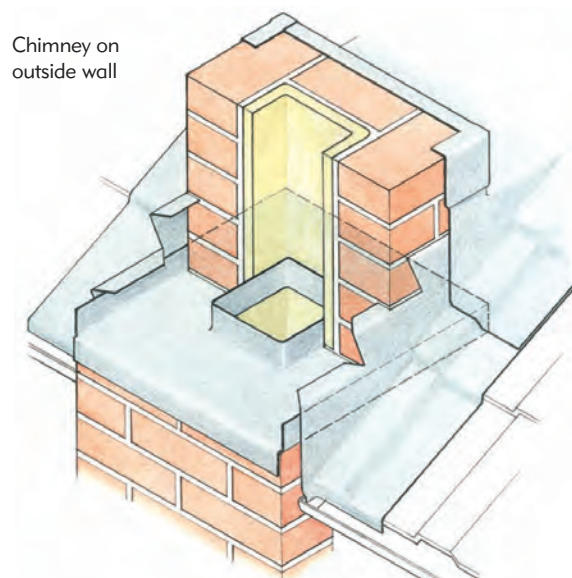


Fig 94. Chimney stack at ridge

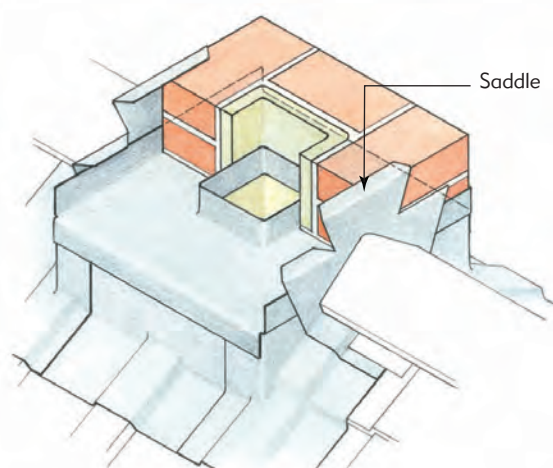
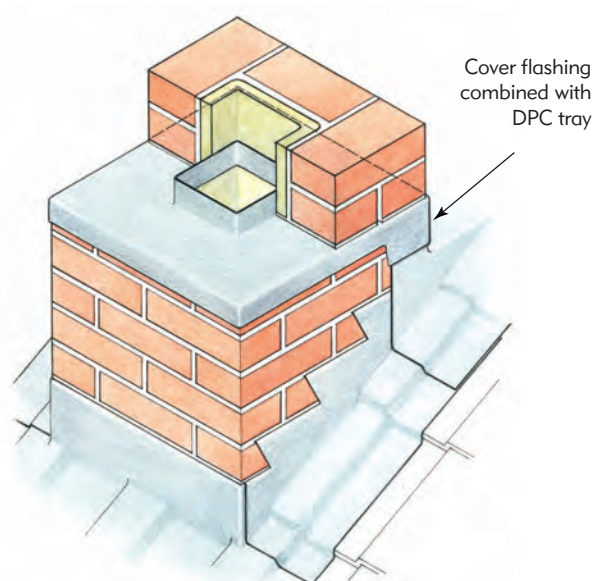


Fig 95. DPC at back gutter level



Chimney flashings and DPCs (cont.)

DPC at back gutter level (cont.)

After the roof has been tiled, the front and side flashing panels are fixed to the chimney at the top with one row of brass or stainless steel screws at 75mm centres. However, on steeply pitched roofs where the distance between the tray and the roof at the front of the chimney exceeds 500mm, these fixings should be increased to two rows (Fig 50, page 31).

For small and medium sized chimneys, a welted joint is only required at each front corner. For larger chimneys, additional welts or intermediate fixings will be necessary (Figs 49, 53 and 61, pages 30-37). If, with steeply pitched roofs, Fig 96 is not aesthetically acceptable, then the fitting of a DPC at both front apron and back gutter levels will minimise the risk of dampness below the roof line.

DPC to chimney on a flat roof

Where a stack penetrates a flat roof, the DPC is fitted as shown in Fig 97, with the sides of the tray turned down over the upstand of the roof covering. Weep holes can be provided on all sides of the chimney to allow water to drain more readily from the tray onto the roof.

From Fig 91 it can clearly be seen that, without an efficient chimney DPC, water can easily penetrate the areas below. With a flat roof, damp will become evident all the more quickly on the chimney surface below and also often on the ceiling, because the distance between roof and ceiling is relatively small.



Fig 96. Combined DPC and flashing

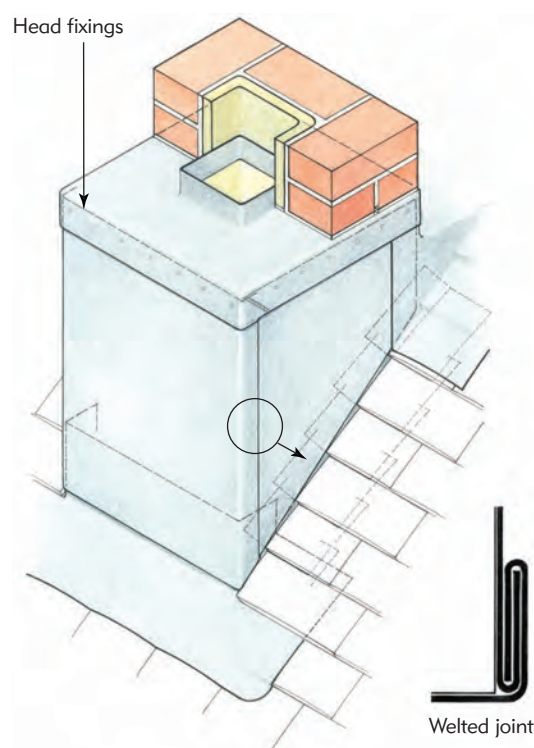
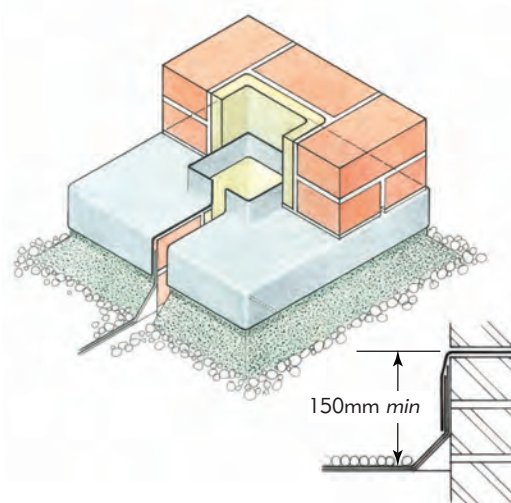


Fig 97. DPC to chimney through flat roof



Damp-proof courses (DPCs)

DPCs at abutments to cavity walls

As a material for DPCs, lead sheet provides a tough, impermeable membrane that is flexible and can be readily shaped. It has very good resistance to sliding when subjected to lateral thrust and will withstand moderate settlement of a building.

Lead sheet DPCs should be coated on both sides with bituminous paint to avoid the risk of corrosion by the free alkali in fresh Portland cement mortar (see page 11).

Code 4 lead sheet is the thickness usually specified for DPCs. However, where the cavity width exceeds 50mm, code 5 is recommended.

At an abutment to a wall of cavity construction, the outer skin becomes an internal wall below the roofline and a DPC is required to prevent dampness from penetrating into the area below.

Pitched valley gutters

The first consideration when constructing a lead-lined pitched valley gutter is the height of the lining boards relative to the tiling/slating battens. If the roof is close-boarded (known as 'sarking' in Scotland) or is to be counter-battened, the valley boards can be fixed to the top of the rafters. This will ensure that the top of the tilting fillet on each side of the gutter is approximately level with the tops of the battens (Fig 113a). If the roof is not boarded or counter-battened, the valley boards should be recessed so that their tops are level with those of the rafters.

However, when trussed rafters have been specified, it is not permissible to notch into these and recess the valley boards. In these cases, it will be necessary to provide noggins to support the valley boards; these are cut to fit flush between the rafters (Fig 113b). In addition, to ensure a smooth surface for the lead, a 4mm plywood sheet should be laid across the valley boards and rafters.

For most gutters, the valley boards should extend 225mm each side of the centre of the valley, with tilting fillets positioned 150mm each side of the centre. When the tiles or slates are laid, the distance between the edges should be not less than 125mm (Fig 114).

Although the traditional valley gutter width of 125mm has proved to be satisfactory for all normal areas of slated and tiled roofs, tests have shown that the gutter sizes need to be related to the roof pitch, design rainfall rate and the catchment area. In many cases, a gutter width of 100mm will be adequate, but to allow for all types of conditions, especially for very long valleys at low pitches, the gutter width should be designed using the recommendations in Table 4.

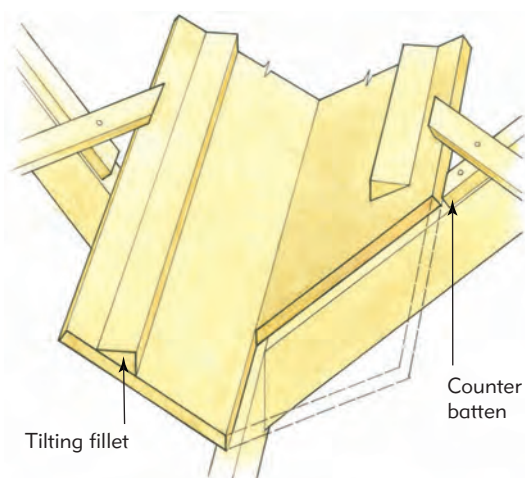
Methods of gutter construction may vary in different parts of the country, but the following recommendations are important in all areas:

1. Gutter lining boards should be not less than 18mm thick.
2. The tops of the tilting fillets should be approximately level with the top of the tiling/slating battens. The tilting fillet should maintain the line of slates or tiles and prevent chaffing of the lead sheet.
3. The cut edges of single-lap profiled tiles should be bedded on plain tile slips or an equivalent slip material to separate the mortar from the lead and to allow free thermal movement of the gutter linings.

Fig 113. Substrate construction

a Counter-battened or boarded roof

Felt omitted for clarity



b Boards flush with rafters and fixed on noggins

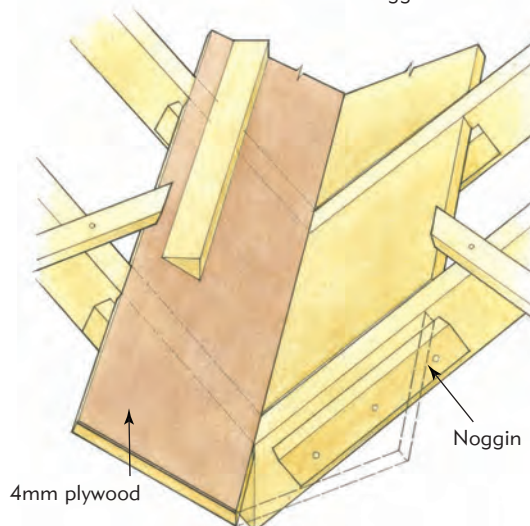
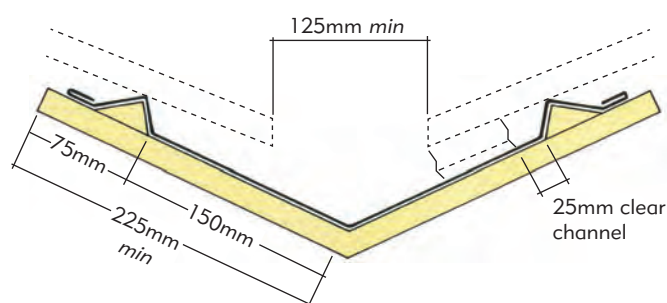


Fig 114. Key dimensions



4. Advice on the bedding of tiles or slates should be obtained from the manufacturer.
5. Where moss is likely to grow on adjacent roofs, a coat of bitumastic paint will provide some protection against corrosion. Alternatively, a thicker code of lead sheet should be used (see also pages 11 and 99).

Pitched valley gutters (cont.)

Table 4. Recommended widths of pitched valley gutters

Width of valley gutters (mm)

Roof Pitch	50 year Design rainfall rate 0.0625 l/s per m ² (225mm/h)	
	25m ² and less on plan	25 -100m ² on plan
15.5 - 17°	150	250
17.5 - 22°	125	200
22.5 - 29.5°	100	150
30 - 34.5°	100	125
35+°	100	100

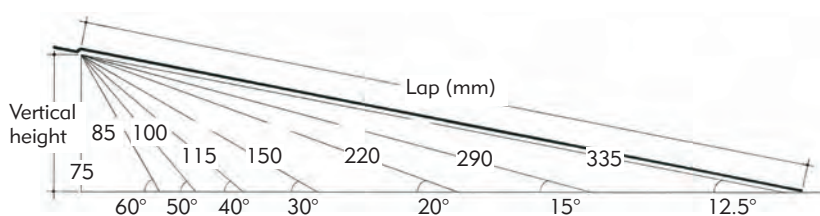
Table 4 shows the recommended width of valley gutters for a once in 50 year rain event. The rate should be compared with charts in the National Annex of BS EN 12056-3:2000 and BS EN 5534:2014

It should be noted that these recommended widths are based on:

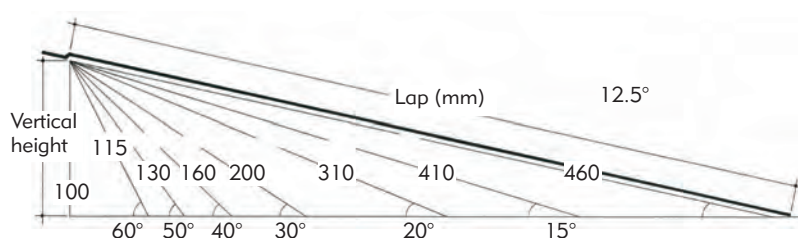
- Plan area, not actual area of the roof
- A maximum rafter length of 10m measured on plan.

Other factors that should be considered are:

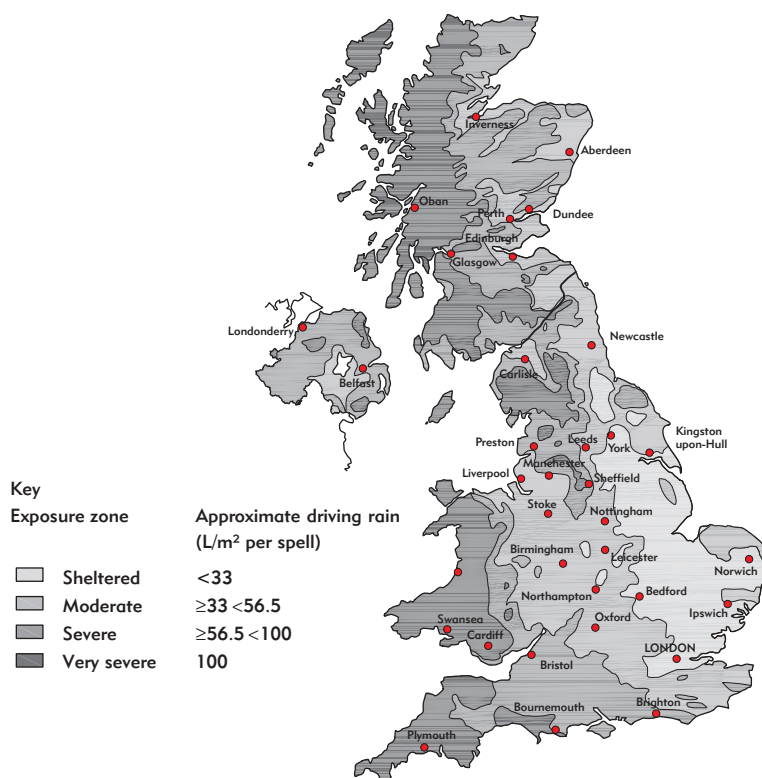
1. Where adjacent walls discharge on to the pitched roof, an allowance of 50% of plan area should be added to the roof area to allow for driving rain against the wall. For a more accurate calculation of expected discharge, refer to BS EN 12056-3:2000.



Laps for roofs in sheltered and moderate exposure locations



Laps for roofs in severe and very severe exposure locations



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2. Roof areas of different size on each side of the valley should be calculated to include the total plan area draining into the valley. If the plan areas differ by more than 10%, calculations will be required to determine the open valley width.
3. With different pitches on each side of the valley, use the lower pitch for calculation, provided that the difference is not greater than 5°, calculations will be required to determine open valley width.
4. Table 4 is for valleys where the plan angle between adjacent roof slopes is 90 degrees. Where the plan angle is less or more than 90 degrees, calculations will be required to determine the open valley width.
5. The type of roof material - for example, plain or contoured tiles - has no significant effect on the performance of the valley gutter
6. The design data applies to open valleys only. It does not apply to soakered, closed or mitred valleys, secret gutters or box gutters.



Pitched valley gutters (cont.)

Fig 115. Valleys with bedded tiles

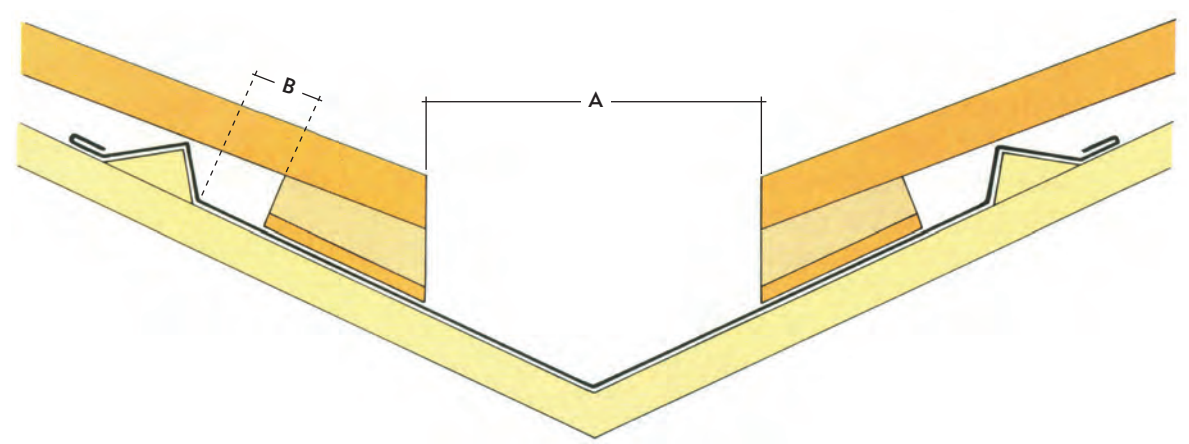


Table 5. Dimensions for pitched valleys with bedded tiles

A (mm)	B (mm)	Width of lead to line valley (mm approx)
100	25	500
125	25	525
150	25	550
200	25	600
250	25	650

Table 6. Dimensions for pitched valleys with unbedded tiles or slates

A (mm)	B (mm)	Width of lead to line valley (mm approx)
100	50	400
125	50	425
150	50	450
200	50	500
250	50	550

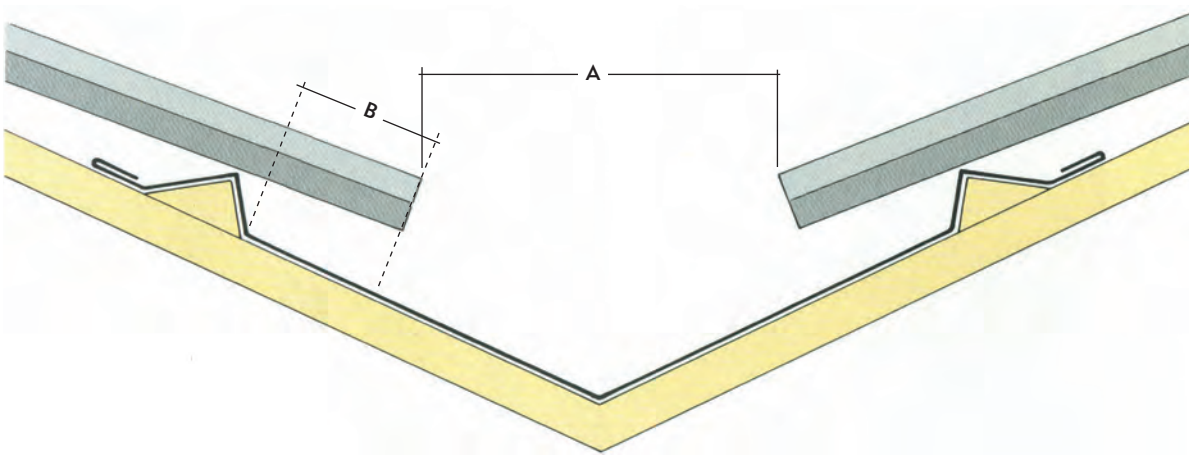
Fig 115 shows a cross-section of a valley gutter and Table 5 indicates the key dimensions for valleys with bedded tiles.

It is important to leave a clear 25mm channel behind the bedding to allow any water that may penetrate to run freely down to discharge into the eaves gutter.

For unbedded valleys, the cut edge of the tiles or slates extends not less than 50mm over the tilting fillets (Fig 116).

The key dimensions are shown in Table 6.

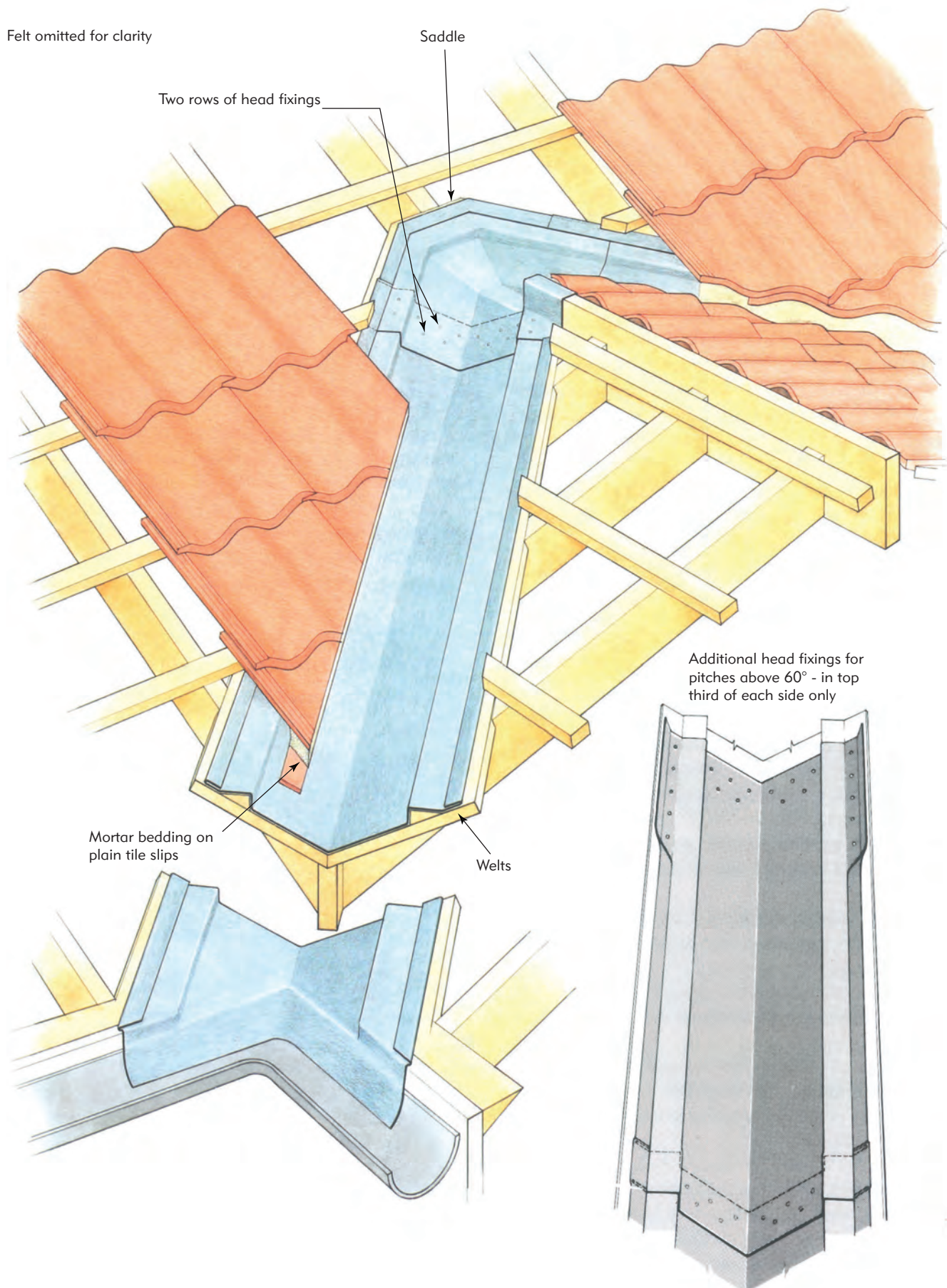
Fig 116. Valleys with unbedded tiles or slates



Pitched valley gutters (cont.)

Fig 117. Lead-lined pitched valley gutter and saddle

Felt omitted for clarity



Pitched valley gutters (cont.)

The lead linings are laid directly onto the valley boards. It is important that the bituminous sarking felt beneath the tiles is not carried into the sole of the gutter as an underlay to the lead because of the risk of the felt softening during the summer. This would cause the lead to stick to the substrate, restricting free movement of the lead linings, which could result in fatigue cracking.

Fig 117 shows a typical valley and saddle. Codes 4 and 5 lead sheet are the thicknesses most commonly used for gutter linings and the length of each piece should not exceed 1.5m. Where thicker sheet (such as code 7) is specified, and the raking edges of the roof covering are not bedded, lengths of up to 2m may be used.

Two rows of copper or stainless-steel nails across the top of each piece will provide adequate fixing and allow the individual pieces to expand and contract freely. On gutter pitches above 60°, additional fixings can be used at the sides in the top third only.

Laps between the pieces of lead sheet should conform to the lap diagrams on page 59. For example, for a sheltered to moderate exposure for a valley pitch of 30° you must allow 150mm from the bottom row of fixings to the edge of the lapped lead sheet and for a valley pitch of 12.5° you must allow 335mm from the bottom row of fixings to the edge of the lapped lead sheet. Please refer to page 35 Fig 56 for further clarification.

Pitched valley soakers

Valley soakers (Fig 119) can only be used on roofs covered with double-lap plain tiles or slates and are an alternative to the gutter linings previously described. However, valley soakers are not recommended where the length of the valley exceeds 6m, or where a valley receives an additional volume of rainwater from a roof area above.

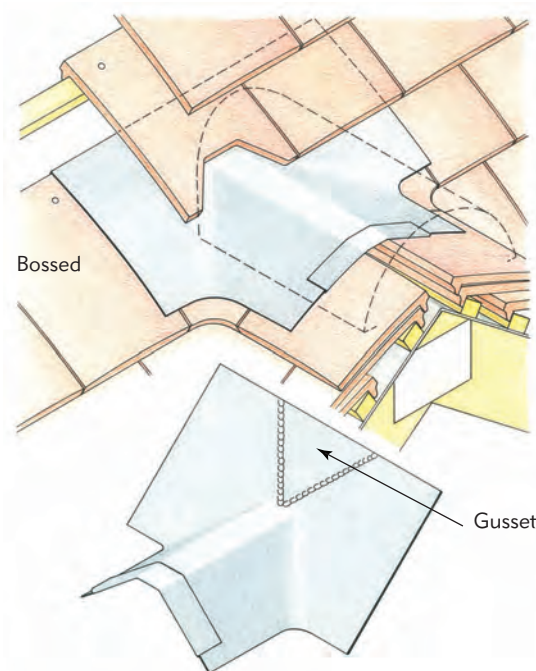
Code 3 is the normal thickness for valley soakers. The use of thicker sheet may cause unevenness in the tiling or slating, particularly where manufactured slates are used. However, with thicker, uneven, natural slates, code 4 lead sheet is preferable.

For pitches of 45° and over, the soakers are fitted one to each course of tiles or slates. At the intersection of the valley with a ridge, a lead saddle (Fig 118) is fitted.

The angle at each end of the soaker will vary with the pitch of the roof. A practical way to ascertain this angle is to offer up a piece of lead sheet when the first course of tiles or slates is laid, fold it around the valley and mark the cutting lines.

Once cut, this soaker can be used as a pattern for cutting the other soakers from a strip of lead sheet. The length

Fig 118. Lead saddle at intersection of plain tile roofs

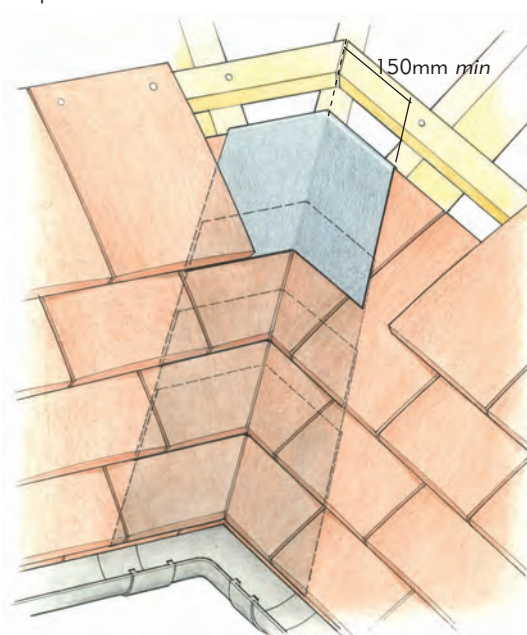


or, alternatively, lead-welded (for steep pitches)

A lead saddle is required where two lead-lined valleys meet. It should be large enough to give a lap of at least 150mm over the gutter lining on each side. A similar saddle is also used to weather the intersection where two tiled valleys meet (Fig 118). These can be either bossed to shape on the bench or fabricated using a lead-welded gusset, as shown.

Fig 119. Soakers to valley with mitred plain tiles

For pitches of 45° and over



Note: Not recommended for valleys over 6m long

of the valley soakers will also vary with the roof pitch and, again, this measurement can be obtained when the first course of tiles is laid.

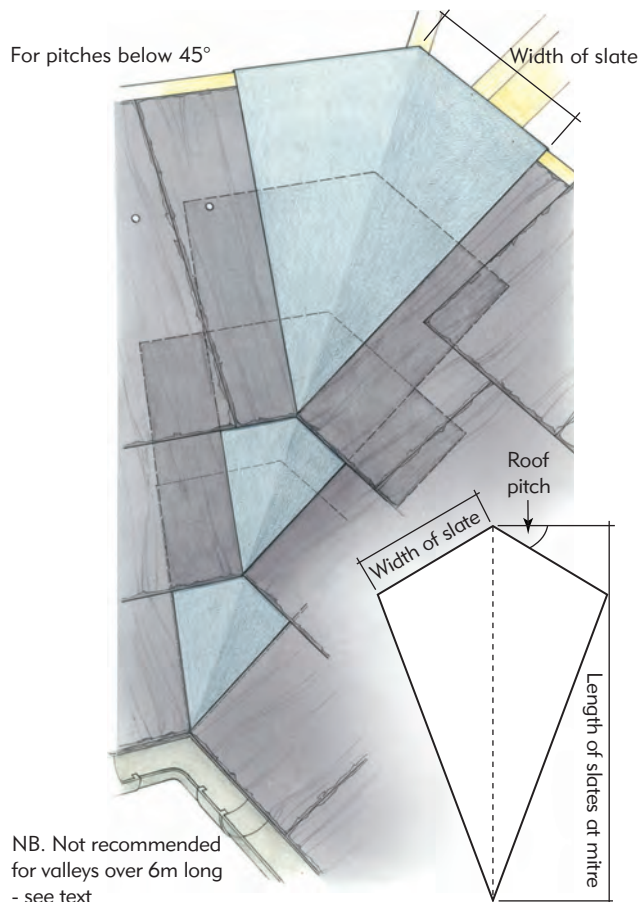
Pitched valley soakers (cont.)

Soakers should extend 150mm each side of the valley. No fixing is necessary as each soaker is held in position by turning the top edge over the tile, as shown in Fig 119.

For roof pitches of less than 45° the soakers described above will be inadequate because the 75-100mm laps between soakers will be vulnerable to water penetration in storm conditions. Fig 120 shows a method that is suitable for lower pitches where the exposed section of each soaker provides the extra lap required. The visible portions of the soakers provide a 'chevron' effect but this can be cut back providing that the lap conforms to the minimum requirements shown in Fig 55 (page 34).

Although 'chevron' soakers are suitable for roof pitches below 45°, they are not recommended for valleys that exceed 6m in length, particularly where slates are used on pitches below 35°. In storm conditions, the depth of rainwater at the lower end of a long gutter could result in water penetration. Therefore, for long gutters, a lead-lined valley (Fig 117) is recommended.

Fig 120. Valley soakers to slated roofs



Ridge and hip rolls

The use of lead-covered wood-cored rolls as a finish to ridges and hips are associated mainly with slated roofs. The base of the wood roll should be fixed a minimum of 5mm above the slates (Fig 121) so that the lead can be dressed to key neatly under the bulge of the roll.

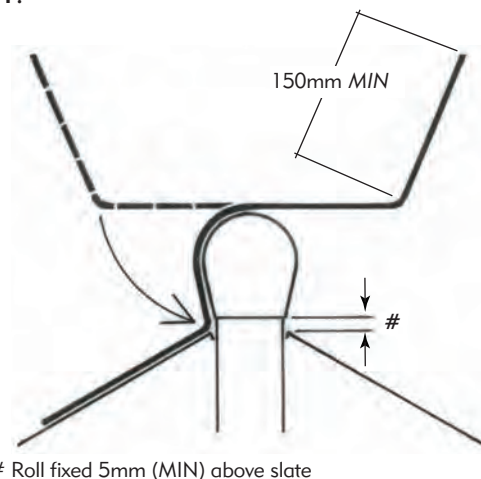
The minimum size and shape for wood rolls is shown in Fig 2 (page 13).

The width of each flashing piece will be the distance around the core roll plus 150mm on each side for covering over the slates. A practical method of fitting is to form the lead into a trough that is then placed over the roll and pressed down to fit snugly to the roll and slate surfaces. This method avoids excessive on-site dressing at the sides, which can result in thinning of the lead at the corners.

Code 4 lead sheet is the minimum thickness to use for this work, although code 5 is preferable. On historic buildings or situations of high wind exposure, codes 6 or 7 are often specified.

Code 4 ridge flashings should not exceed 1.5m in length, increasing to a maximum of 2m for code 5 or

Fig 121.



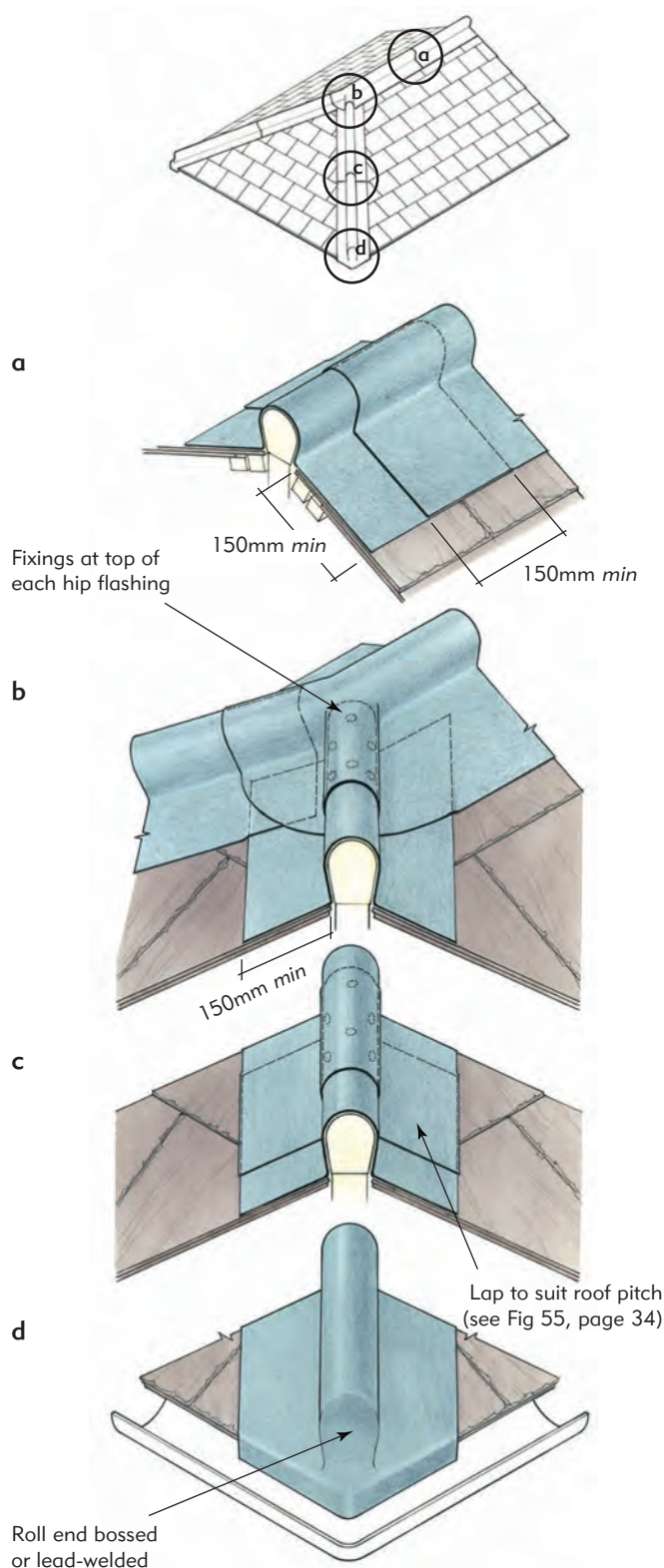
thicker. All hip flashings should be fixed in lengths not greater than 1.5m.

Lap joints between pieces should not be less than 150mm. For roof pitches below 30°, it may be necessary to increase the laps and also the cover over the slates to 200mm, particularly on buildings exposed to high wind and rain. Each 1.5m piece of hip flashing should be fixed to the wood roll with copper or stainless-steel nails as in Fig 122. Ridge flashings need not be nailed at the laps.

Ridge and hip rolls (cont.)

Although the undercut at the side of a wood roll is designed to stop the flashings from lifting, it will not prevent wind uplift along the free edges on each side of the roll. It is essential therefore, especially on buildings that are subject to high winds, to provide efficient clipping along the free edges of the lead. For spacing

Fig 122. Ridge and hip wood-cored rolls



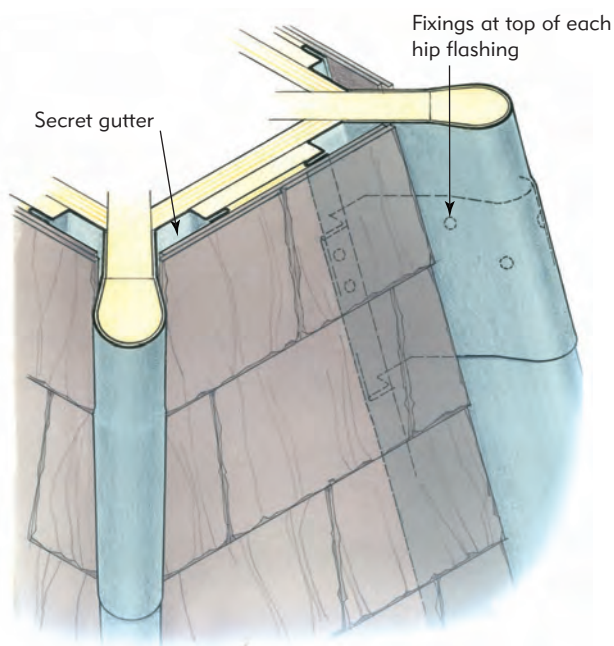
and fixing of clips, refer to 'Fixing clips', pages 26-28.

Junctions between ridge and hip flashings – and where the roll terminates at the hip end – can be formed either by bossing or lead-welding.

Where a ridge roll meets an abutment such as a chimney stack or a party wall, a saddle can be formed similar to Fig 74 (page 43).

An alternative hip weathering, using a wood roll and a secret gutter, is shown in Fig 123. This detail is particularly suitable for steeply pitched slated areas such as steeples, spires and multi-sided turrets. With flashings to steeply pitched hips, it is essential to provide adequate head fixing. Therefore, no fewer than eight nails are required to secure each 1.5m length. The tops of the lead-covered rolls can be weathered with an appropriate capping.

Fig 123. Wood-cored roll hips to spires



GUTTER LININGS

Dimensions and arrangement of joints

Lead-lined gutters are used where a lead-covered flat roof, or a tiled or slated roof, is designed with a parapet wall. They are also used where a flat or pitched roof abuts a vertical wall, where two pitched roofs are joined by a horizontal valley gutter, and between adjacent areas of lead roofing. To allow for thermal movement, lead gutter linings must always be divided into separate pieces (bays).

The size of a piece of gutter lining will depend on the thickness of lead sheet used. Table 8 shows the maximum length and girth for the five codes of lead sheet normally used for lining both box and tapered gutters.

Although code 4 is the minimum thickness for gutter linings, its use is recommended only for very short gutters, because the maximum drip spacing of 1.5m is usually uneconomical compared with using code 5 and drips at 2m centres.

If the length of a piece of lining is less than the recommended maximum, the girth can be increased so that the bay is about the same area. For example, it would be acceptable to use code 6 with a length of 1.6m and an overall girth of 1m. However, the length must not be increased beyond the maximum, even if the girth is less than that recommended, because this can cause a ridge to form across the bay which, in turn, will result in a fatigue crack.

To accommodate thermal movement, drips are used across the fall for both box and tapered gutter linings. Laps or welts are unsuitable because these joints will permit water penetration. Where a gutter lining exceeds the recommended girth, rolls are used (lengthwise) to divide the bays into two or more pieces. A transverse roll can also be used to join two or more bays at the high point in a gutter.

Provision of ventilation to the underside of the substrate supporting gutter linings may be necessary (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).



Drip heights

In the past, 40mm drips incorporating an anti-capillary groove were sometimes used in gutters. Experience has shown that these grooves gradually become ineffective owing to the collection of atmospheric dirt, which makes them vulnerable to water penetration in storm conditions. Therefore, the minimum height of a drip in a gutter should be 50mm for codes 4, 5 and 6 and 60mm for codes 7 and 8. However, where a roll abuts a drip, it is important that the finished height of the roll on the lower bay is not less than 5mm below the top edge of the drip. To achieve this when using a standard 45mm roll, the minimum drip heights should be as shown in Table 9. If larger rolls are used, the height of the drip should be increased to achieve the 5mm minimum between roll and drip heights.

Fig 170. Measurement of girth

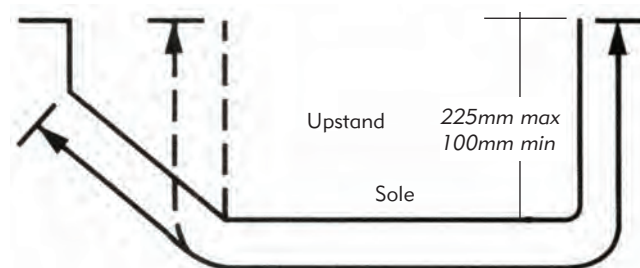


Table 8. Gutter dimensions

BS EN 12588 code no	Maximum length between drips (mm)	Maximum overall girth (see section above) (mm)
4	1500	750
5	2000	800
6	2250	850
7	2500	900
8	3000	1000

Table 9. Gutter drip heights

BS EN 12588 code no	Minimum drip height (mm)
4	55
5	55
6	55
7	60
8	60

Gutter linings (cont.)

Fall

The minimum fall between drips in all lead-lined gutters should be 1 in 80.

Drip design

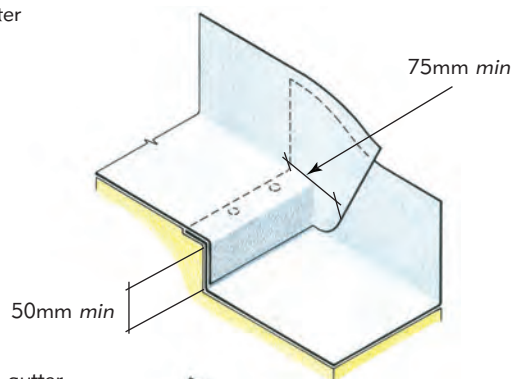
A drip with a splash lap (Figs 196 -198, pages 114 -115) is suitable for both flat roofing and gutter linings. The splash lap serves to stiffen the free edge of the overcloak, thereby making it less vulnerable to lifting in high winds. However, long experience has shown that atmospheric dirt, which tends to collect under the splash lap, slows the drainage of rainfall from under these laps, especially in gutters with minimum fall. In most gutters, there is no risk of the bays lifting, even in storms. Therefore the splash lap can be omitted, provided that the side lap is not reduced (Figs 171a and b). This drip detail is recommended for gutters situated in areas that receive heavy deposits of dust and where leaves and other debris can either fall or be blown onto a gutter area. Where a roll is used to divide a wide gutter, the roll to drip details shown on pages 125-126 can be modified.

Fig 172 shows both the drip and the rolls without splash laps. Although not essential, it is normal practice when omitting splash laps on the drips to omit them also on the rolls. When using codes 6, 7 and 8 lead sheet, the overcloak is finished about 5mm above the roof surface. For codes 4 and 5, the overcloak is welted around copper clips fixed behind the overcloak at 450mm-maximum centres.

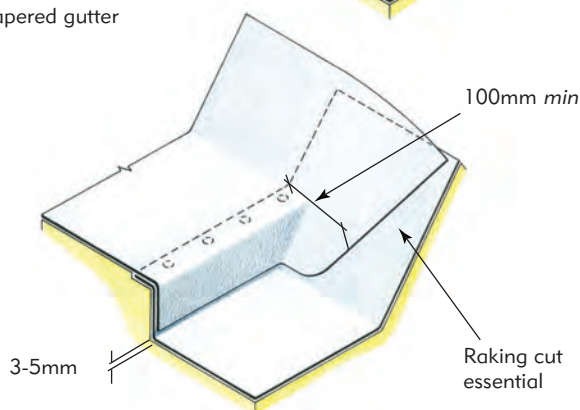
When splash laps are omitted on rolls, it is necessary to extend the undercloak at the roll end to achieve an adequate lap.

Fig 171. Drips without splash laps

a. Box gutter



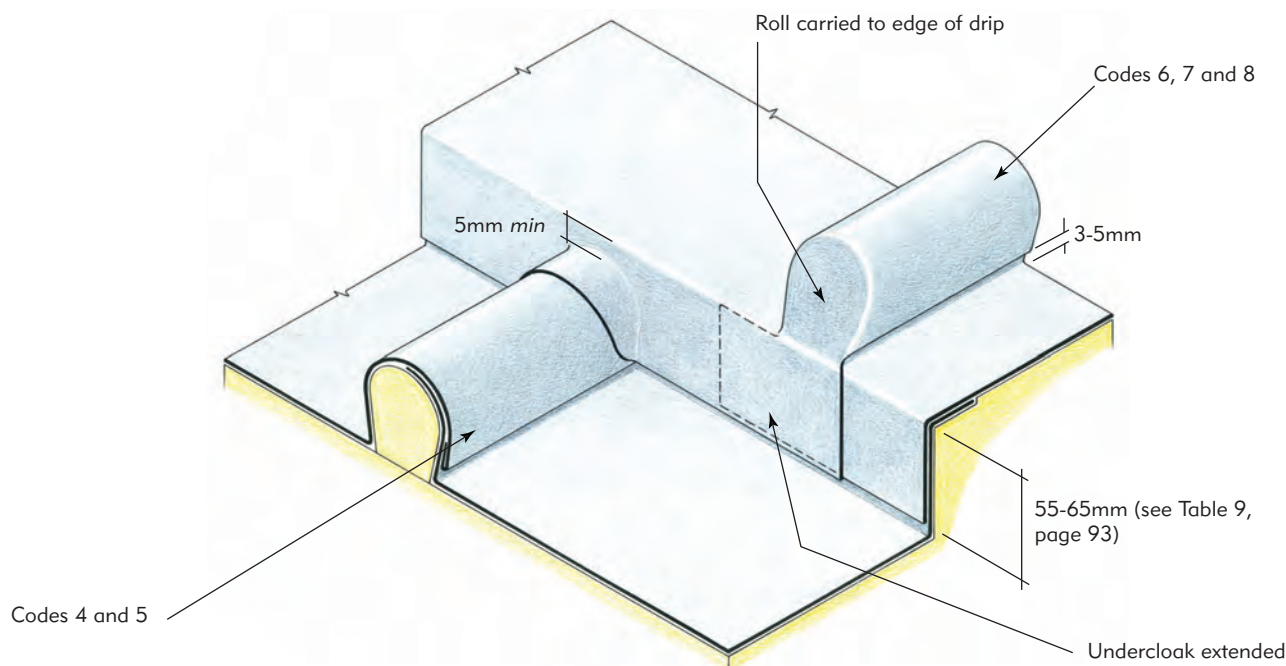
b. Tapered gutter



Drips without splash laps can be used in gutters up to and including 3°.

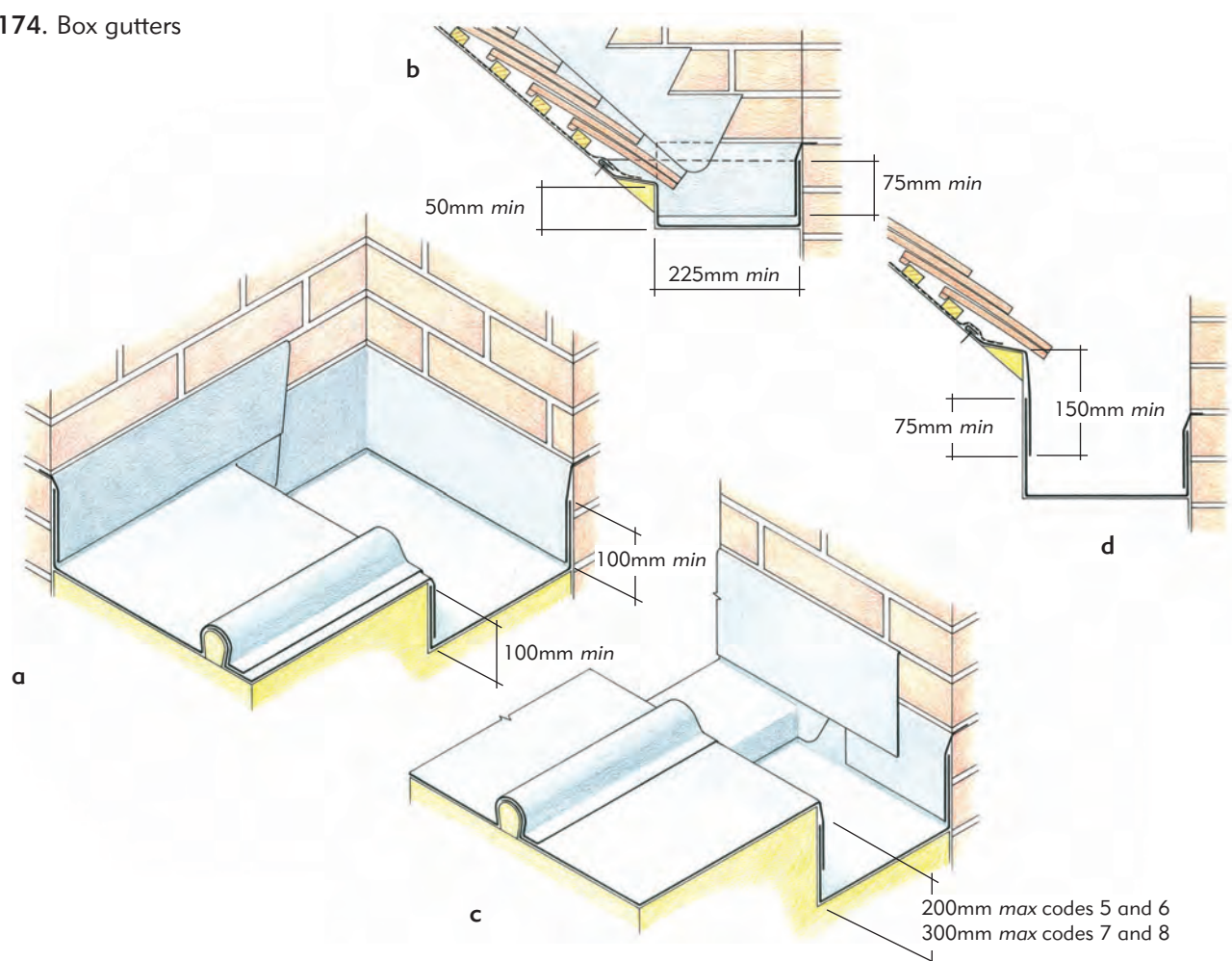
Again, it is important that the side laps are not reduced where the drip abuts a vertical wall or slope. In addition, the position of the roof must be carefully considered to ensure that the bays are not liable to be lifted in high wind or suction conditions. However, for gutters over 3° the extended splash lap will still be required to cover over the head fixings.

Fig 172. Roll/drip intersections for wide gutters



Gutter linings (cont.)

Fig 174. Box gutters



Box gutters

This type of gutter usually has parallel sides and should not be less than 225mm wide. When used with a lead-covered roof, the depth at the highest point in a gutter should not be less than 100mm (Fig 174a). However, when used with a tiled or slated roof, this depth can be reduced to 50mm because the gutter lining is carried up the roof slope under the tiles or slates to provide the total minimum depth of 100mm (Fig 174b). The minimum upstand against a parapet wall should be 100mm and this will not normally increase significantly at the drips because the cover flashings can be progressively stepped down.

On the roof side, the vertical face will increase at each drip and it is permissible to increase the gutter upstand to 200mm maximum for codes 5 and 6, or 300mm for codes 7 and 8 (Fig 174c). It is important that these taller upstands should not be nailed along the top edge, as this would restrict free thermal movement of the gutter linings.

The front of the roofing bays is normally turned down between 100mm and 150mm and the minimum lap over the gutter upstand is 75mm. With tiled or slated roofs, a separate flashing is used when the upstand on the roof side exceeds 100mm (Fig 174d).



Gutter linings (cont.)

Tapered gutters

A tapered gutter will occur where a pitched roof abuts a vertical wall or where a horizontal valley gutter joins two pitched roofs. With a tapered gutter, the pitched roof merges into the sole of the gutter without upstands. According to the fall of the gutter and the pitch of the roof, the gutter sole will increase in width at each drip. Therefore, the gutter is wider at its highest point than at its lowest (Fig 177a).

A tapered gutter should be at least 150mm wide at its lowest point. Since the gutter width increases at each drip, the upper part is often too wide to be lined with one piece of lead. In these cases, a roll is used to divide the wide section into two or more bays so that the maximum girth does not exceed the dimensions shown in Table 8 (page 93). The tilting fillet at the sides is fixed about 150mm up the roof slope and the gutter lining is then carried up and over this fillet with the edge single-welted (Fig 177b). Where a gutter abuts a wall at the top, the bays will be turned up and weathered with a cover flashing (Fig 177c).

Fig 177. Tapered gutters

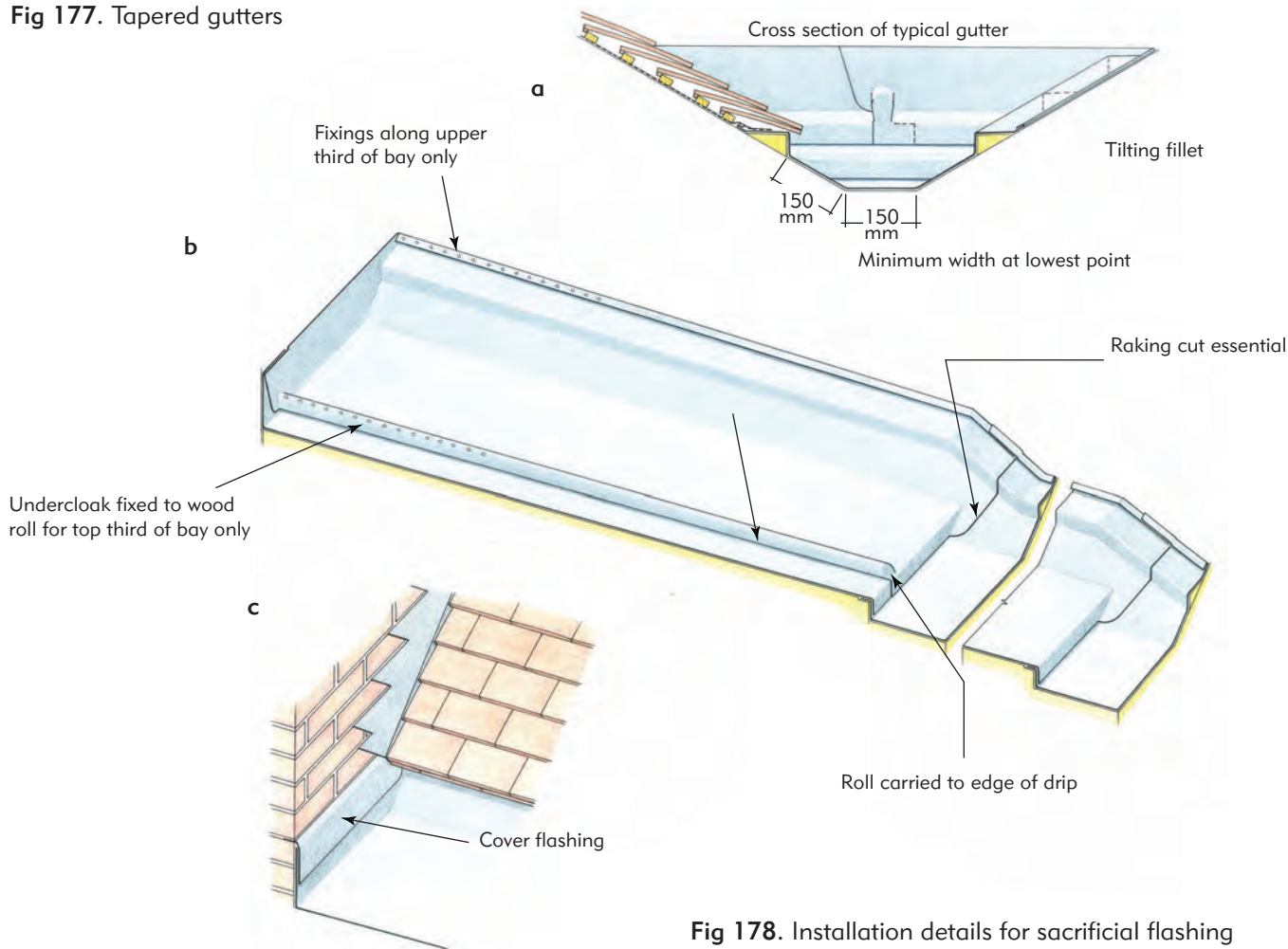
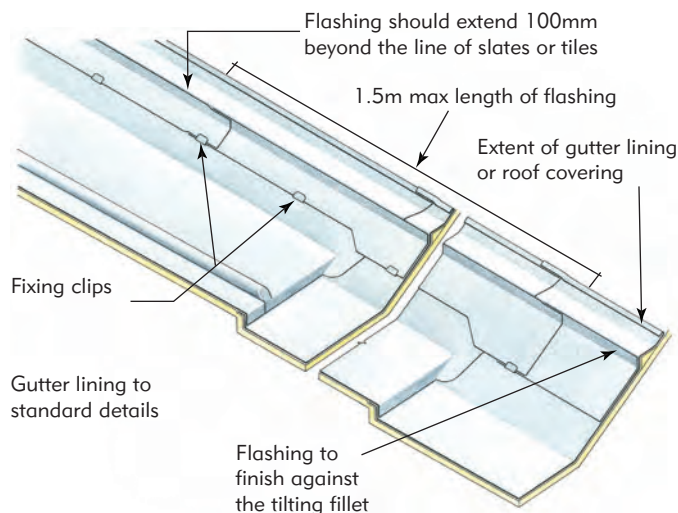


Fig 178. Installation details for sacrificial flashing

Sacrificial flashings

Where rainwater or dew runs down a lichen or moss-covered roof, the resulting acidic run-off will form narrow, clean-cut grooves or round spots in the lead sheet at the roof's drip-off points. Over many years, this can result in failure, and leakage will occur. To prevent this a sacrificial flashing at the drip-off points will need to be installed (Fig 178). The flashing can be made from a lighter code of lead sheet than that used for the roof or gutter. It should be tucked under the slates or tiles and clipped into position by means of lead clips welded to the surface of the lead roof or gutter. It must not be nailed into position, as it needs to be easily removable, without disturbance to the slates or tiles, when it comes to be replaced. This flashing can also be used to cover to the side lap where the distance up the slope exceeds 150mm.



ROOFING AND CLADDING

Flat roof coverings

Recommendations in this chapter are for roofs of pitch up to and including 10° . The general principles outlined apply to roofs of any size and to canopies, dormer and bay window tops, hoods etc, where the overall size is greater than can be covered in one piece. The maximum size of the separate bays or panels of lead sheet that are to form an area of roof covering, and hence the spacing of joints, will depend primarily on the thickness of lead to be used. Additional thickness may be required in positions that are very exposed and vulnerable to wind uplift, in areas subject to foot traffic (during maintenance, for example), and when bossing complicated intersections.

The minimum fall for a flat roof is 1 in 80. Joints in the direction of fall generally should be wood-cored rolls. Hollow rolls may be used where there is no risk of damage by foot traffic, but they are more suitable for pitched roofs where laps are used for the joints across the fall and where there are no complicated intersections. Drips should always be used for the joints across the fall.

Provision of ventilation to the underside of the substrate supporting flat roofs may be necessary (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).

Spacing of joints

According to the thickness of lead used, the maximum spacing of joints for flat and low-pitched roofs, up to and including 10° , are as shown in Table 10. This table shows a fundamental principle for all sheet leadwork – the thinner the lead, the smaller the piece. Situations sometimes occur where the length of a bay is less than the recommended maximum, and in these cases, the width may be increased so that the bay is about the same area. For example, Fig 188a shows the maximum bay size when using code 6 lead sheet. If the length is reduced to 1800mm, the girth can be increased to 840mm to provide a bay of about the same area (Fig 188b).

It is important to remember, however, that wood rolls are designed to prevent wind uplift as well as to allow for thermal movement. Therefore, in exposed positions the width of bays should not be increased as this could result in the lead lifting between the rolls during storm conditions. It is also very important that the length should never be increased beyond the maximum recommended for each code of lead, even if the width is less than that recommended. This can result in a ridge forming across the bay that, in turn, will result in a fatigue crack.

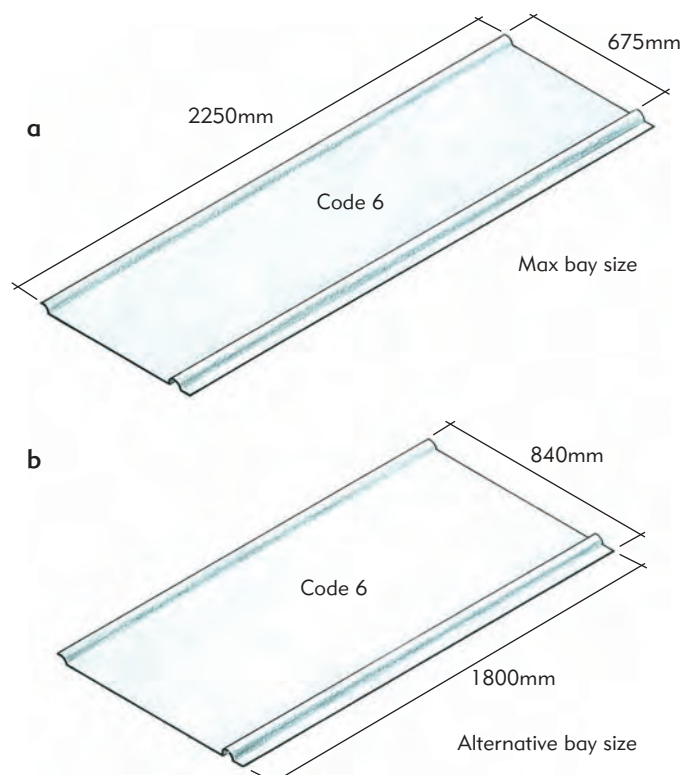


Table 10 Flat roofs - spacing of joints

BS EN 12588 code no	Maximum spacing of joints with the fall (mm)	Maximum distance between drips (mm)
4	500	1500
5	600	2000
6	675	2250
7	675	2500
8	750	3000

Dormer top bay sizing differs from above see pages 185-186

Fig 188. Sizing of bays



Flat roof coverings (cont.)

Methods of fixing

With roofs up to and including 3° , each bay of lead sheet is held in position by nailing the undercloak into a rebate in the drip at the top and nailing the undercloak to the wood roll at 150mm centres for the top third of its length (Fig 189a). This method of fixing will hold the bay firmly and permanently in position while still allowing the sheet to move freely when subjected to the changes in temperature.

At abutments, the top of the bay is turned up against the wall. The fixings, which should be spaced at 50mm centres in the top third of the roll, are sufficient to hold the bay in position (Fig 189b).

For roof pitches over 3° , however, experience has shown that these methods of fixing will not prevent the lead from moving downwards by gravity. Therefore, extra fixings will be required as shown in Fig 190. Two rows of fixings will be required, but it will not be necessary to nail the top third of the undercloak to the roll.

At drips on roofs over 3° , it is not necessary to turn the undercloak into a rebate at the top (Figs 215-216). The turn-up at abutments should be not less than 50mm. The splash laps or cover flashings at drips and abutments are extended to cover the copper nail fixings. As water will infiltrate the fixing area, it will be necessary to seal the nail heads by solder dabs or lead-welding.

Fig 189. Fixings – roofs up to and including 3°

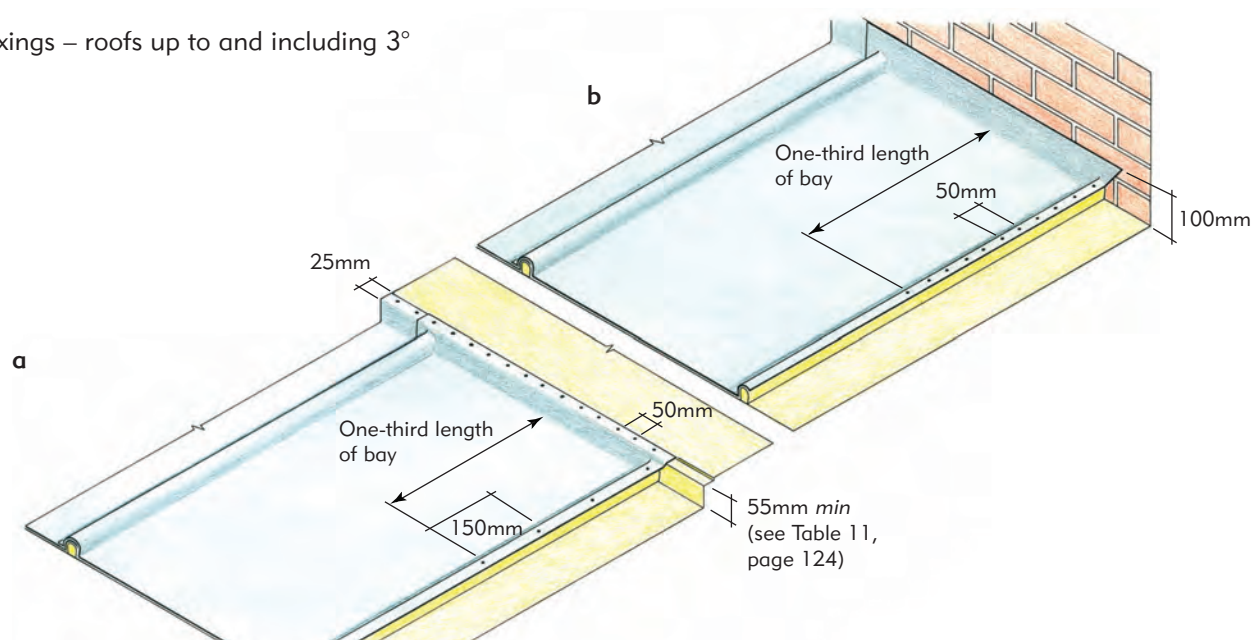
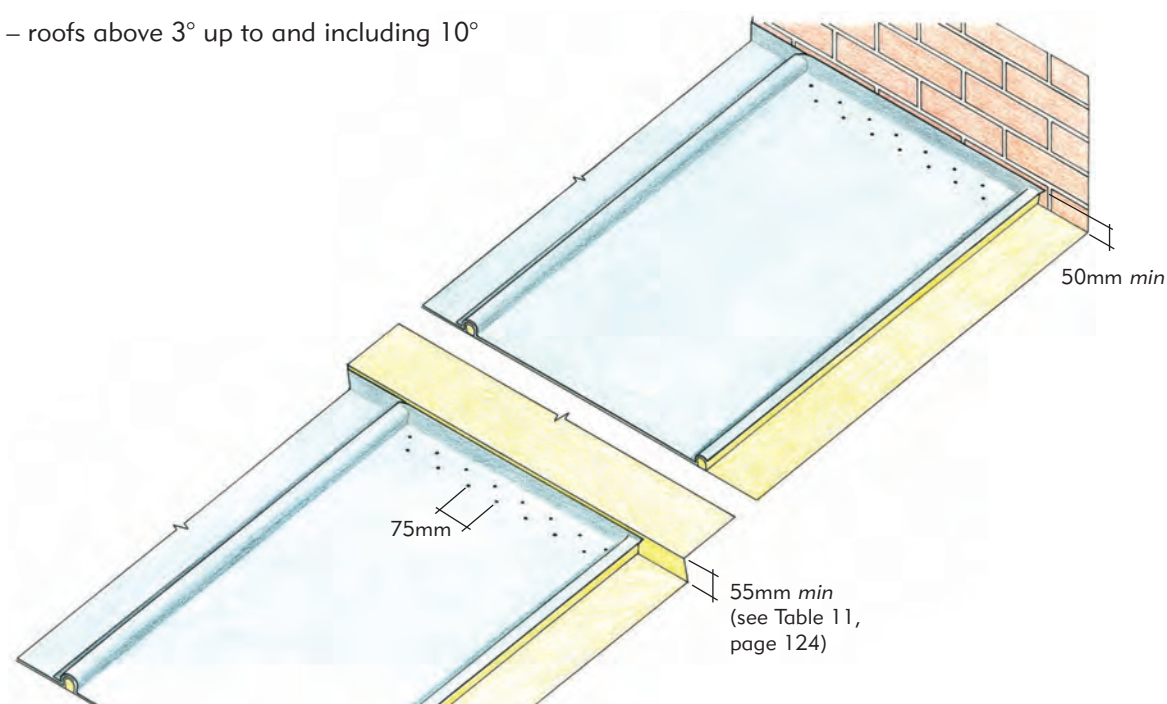


Fig 190. Fixings – roofs above 3° up to and including 10°



Pitched roof coverings

Recommendations in this chapter are for roof pitches above 10° up to and including 80°. As with flat roof coverings, the maximum size of the separate bays or panels of lead sheet that are to cover an area of roofing, and hence the spacing of joints, will depend primarily on the thickness of lead to be used. In severely exposed situations, additional thickness or a reduction in joint spacing may be required to avoid the risk of distortion and lifting during storms.

Joints in the direction of the fall are normally wood-cored rolls or hollow rolls. Welts can be used on pitched roofs, provided that there is no risk of them becoming submerged during heavy rain and wind. Although standing seams are only recommended for areas above 80°, they can be used on short lengths of pitched roofing between 45° and 80° where there are no angles down the roof slope and where there is no risk of mechanical damage. For aesthetic reasons, drips are used occasionally for the joints across the fall but, in general, the recommended joint is a lap.

Provision of ventilation to the underside of the substrate supporting pitched roofs may be necessary. (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).

Spacing of joints

According to the thickness of lead used, the maximum spacing of joints for pitched roofs up to 80° is as shown in Tables 12 and 13.

Except in sheltered positions, it is not recommended to increase the width of a bay when the length is less than shown in the table, especially when the roof pitch exceeds 25°. Indeed, for vulnerable areas in very exposed positions (for example, at corners and gable ends), it may be necessary to decrease the recommended maximum width between joints with the fall to avoid distortion and lifting of the lead.

Experience has proved that the maximum lengths shown will give a long maintenance-free life if fixed correctly. However, there will be occasions where an area of roofing receives additional reflected solar heat from an adjacent surface or is located in a sun trap with little air movement to cool the surface of the lead. In these situations, consideration should be given to reducing the maximum lengths shown in the table by 300mm.

Table 12. Roof slopes above 10° up to and including 60° – spacing of joints

BS EN 12588 code no	Maximum spacing of joints with the fall (mm)	Maximum distance between laps (mm)
4	500	1500
5	600	2000
6	675	2250
7	675	2400
8	750	2500

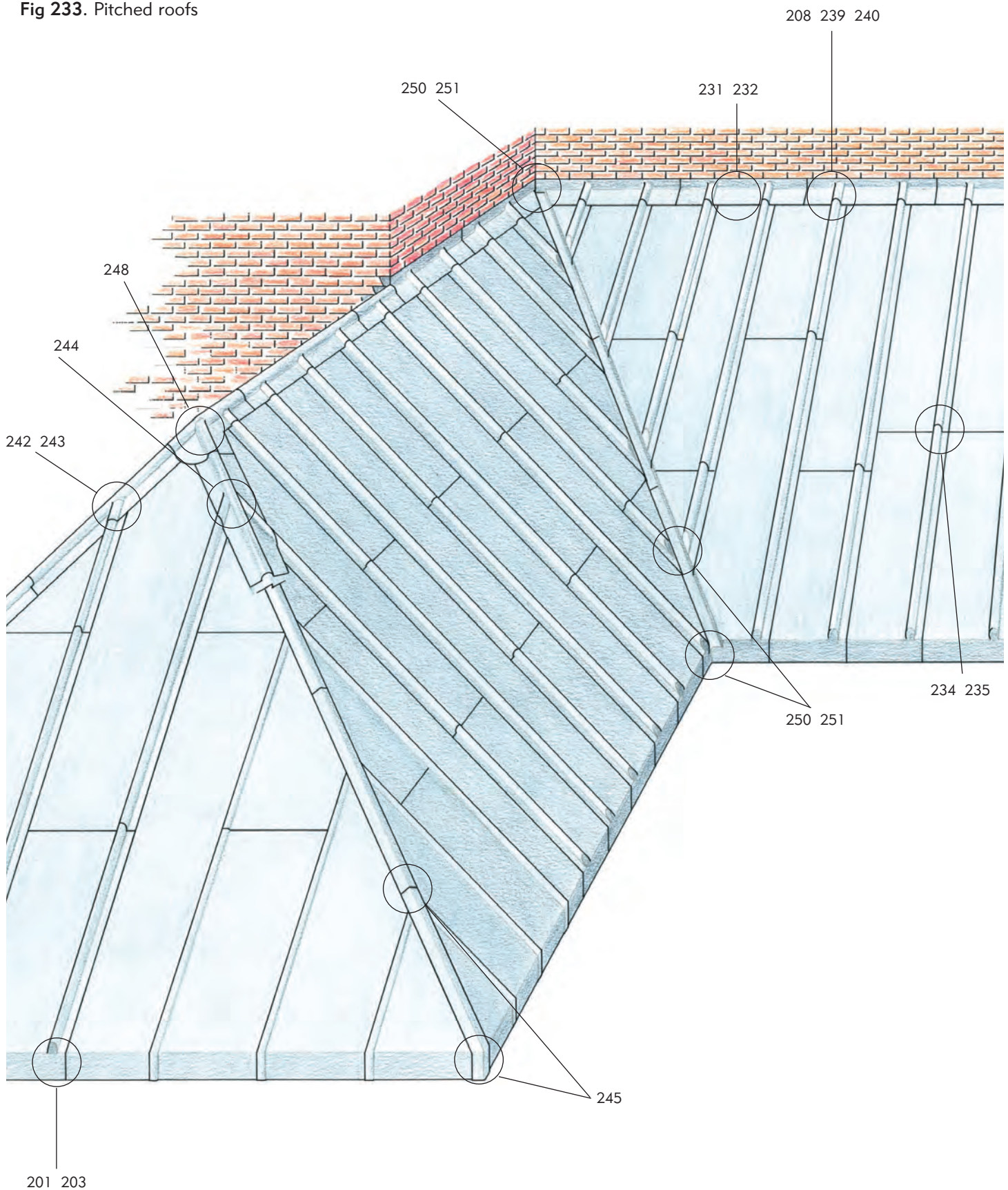
Table 13. Roof slopes above 60° up to and including 80° – spacing of joints

BS EN 12588 code no	Maximum spacing of joints with the fall (mm)	Maximum distance between laps (mm)
4	500	1500
5	600	2000
6	675	2250
7	675	2250
8	750	2250



Pitched roof coverings (cont.)

Fig 233. Pitched roofs



Pitched roof coverings (cont.)

Finishes at abutments

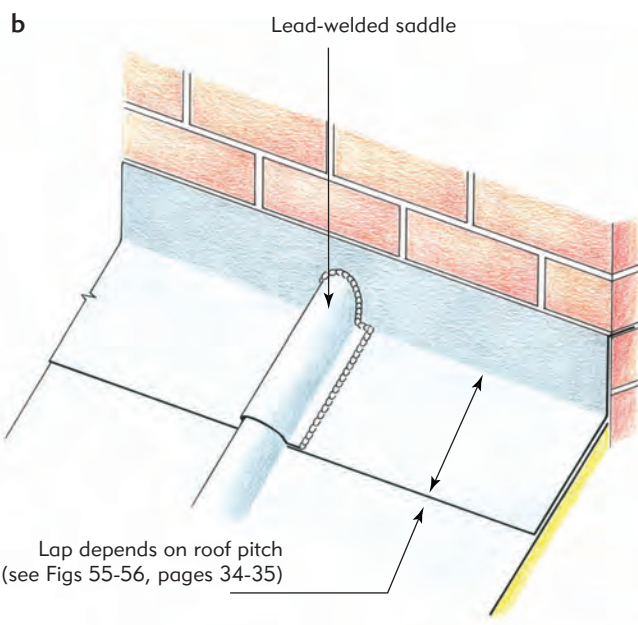
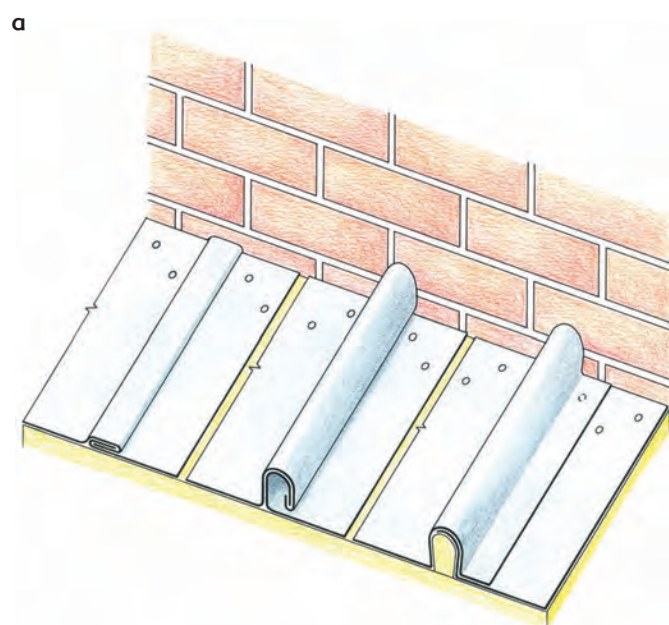
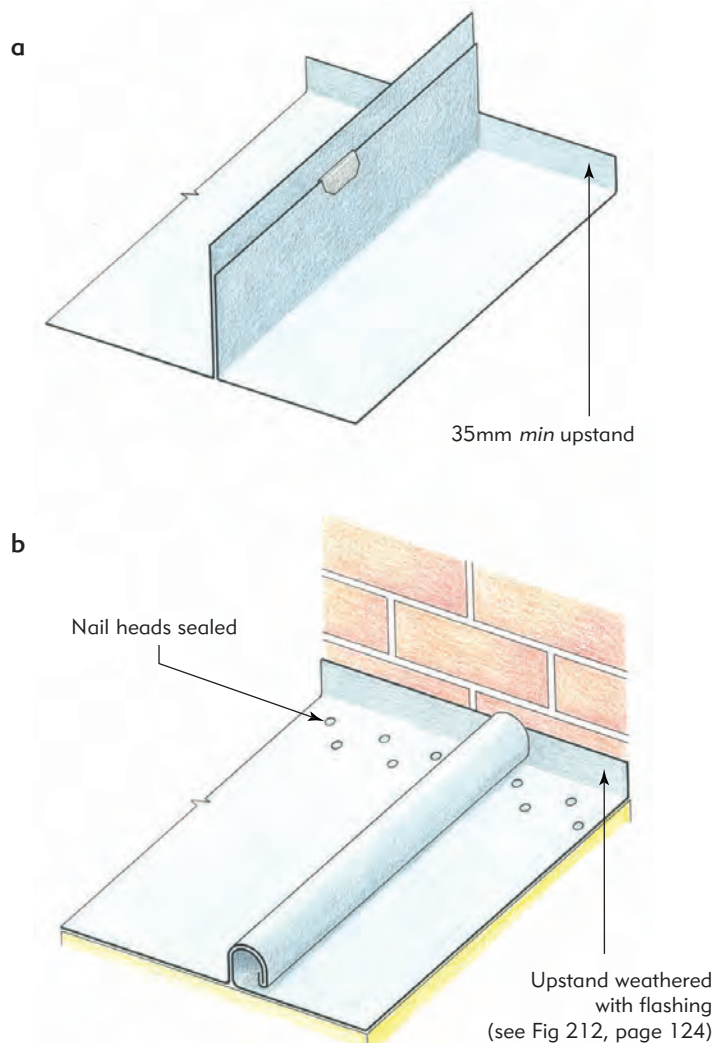
When using wood-cored rolls, the detail shown for a 3-10° abutment (Fig 208, page 122) would be suitable for roof pitches up to 30°. This detail can also be used where a hollow roll abuts a wall, but the upstand should be reduced to about 35mm to enable the roll to be turned neatly (Figs 239a and b). The upstands of both wood-cored and hollow rolls are made weather-tight with a cover flashing (Fig 212, page 124).

For roof pitches of 30° and above, it is more practical and economical to finish the bay as shown in Figs 240a and b. The lead is taken to the top of the roof slope, nailed, and then covered by a flashing. It is important that the lap between flashing and roofing bays is not less than recommended in Fig 55.



Fig 240. Abutment finishes (30° and above)

Fig 239. Hollow roll at abutment (10-30°)



Pitched roof coverings (cont.)

External and internal corners

These corners can be formed by bossing as shown for flat roof coverings in Figs 192 and 194 (pages 111-112). The work required in bossing is progressively less as the roof pitch increases.

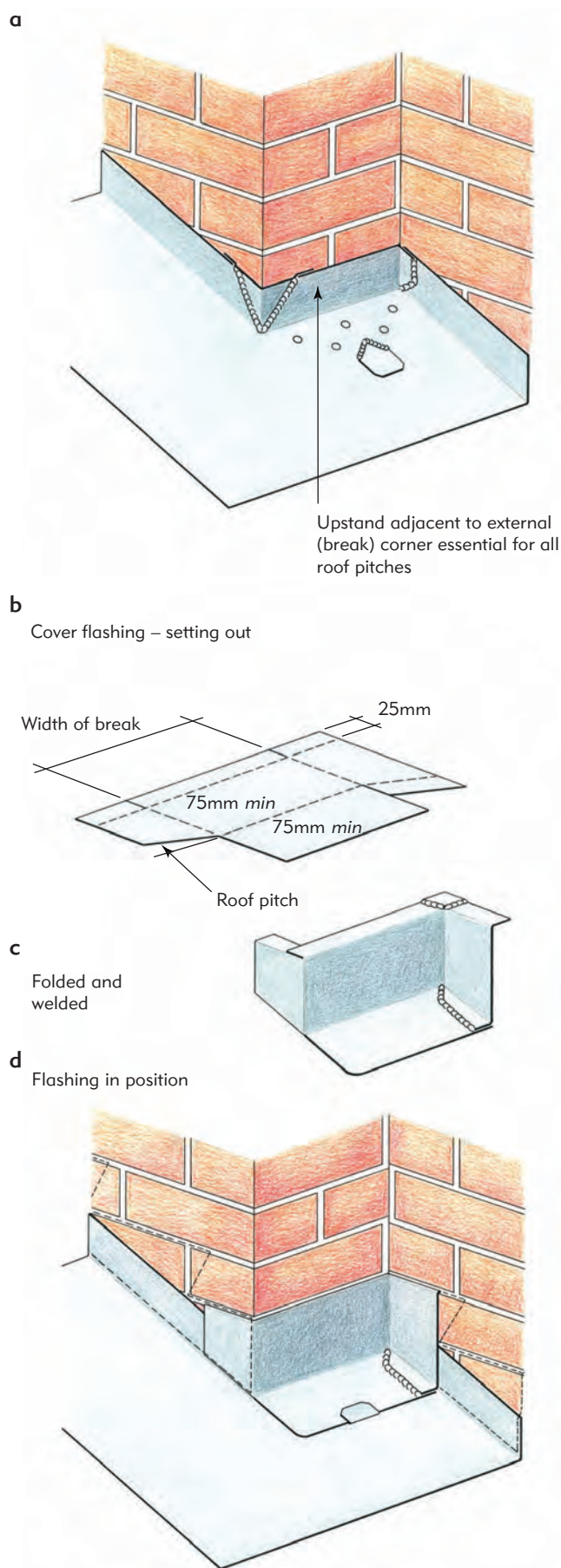
Both corners can also be formed using similar lead-welding methods (Figs 193 and 195), with the gusset required for the break corner decreasing in size as the roof pitch increases.

Fig 241a shows a position where an external and internal corner occur in the same roofing bay. Irrespective of the roof pitch, it is essential in these situations to provide an upstand above the nail fixings. When the distance between the corners is wider, as shown in the key drawing Fig 233 (page 143-144), rolls should be positioned between the two corners. In these situations, the upstand can be omitted on all bays, except the bay with the break corner, when the roof pitch is over 30°. The cover flashing is set out as in Fig 241b, then cut, and formed (Fig 241c). Fig 241d shows the finished corner.

Eaves-to-wall abutments

These abutments occur where a wall continues past or stops at the eaves. Methods of bossing and lead-welding the corners are shown for flat roof coverings in Figs 199 and 200 (page 116), and these details can be modified slightly to suit pitched roof coverings.

Fig 241. Corners



Pitched roof coverings (cont.)

Hips

Fig 242. Wood-cored roll abutting hip

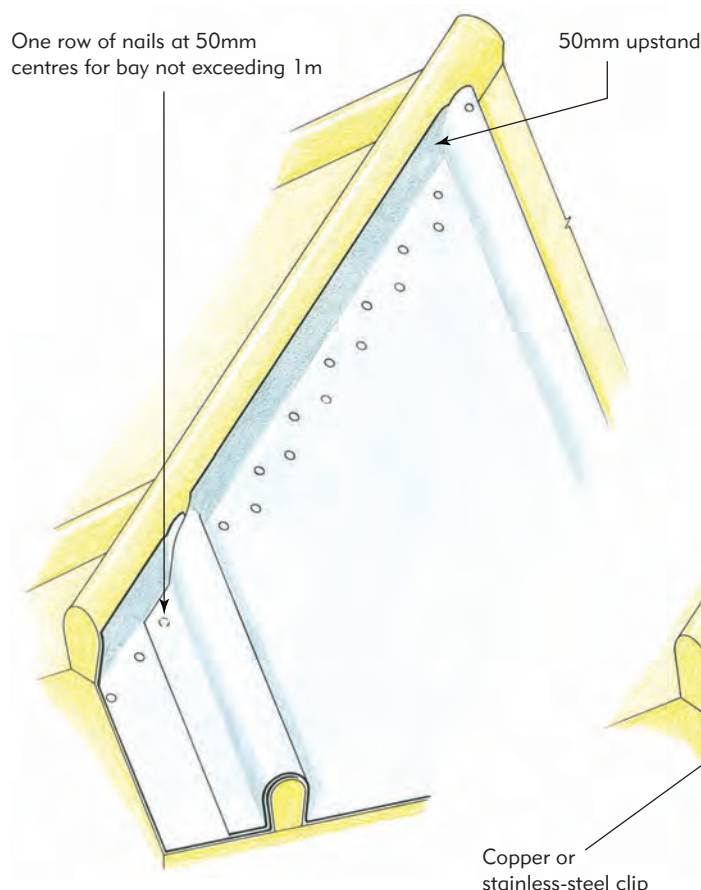
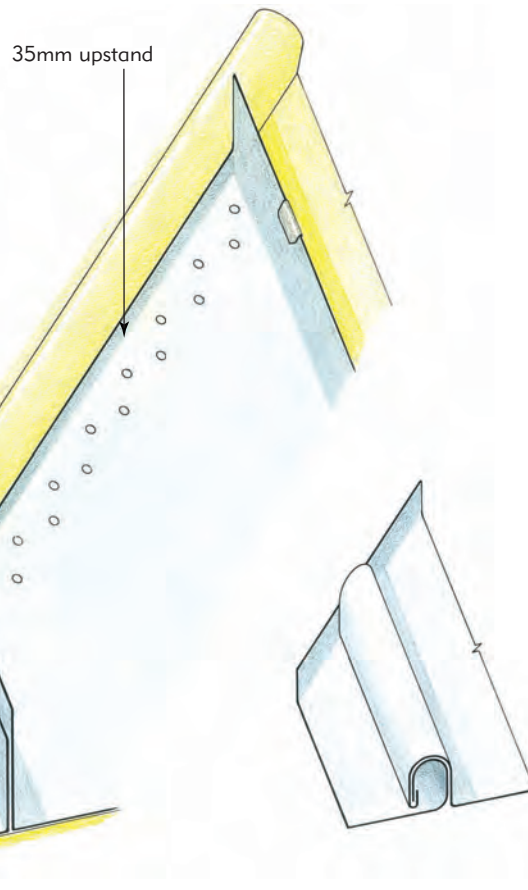


Fig 243. Hollow roll abutting hip

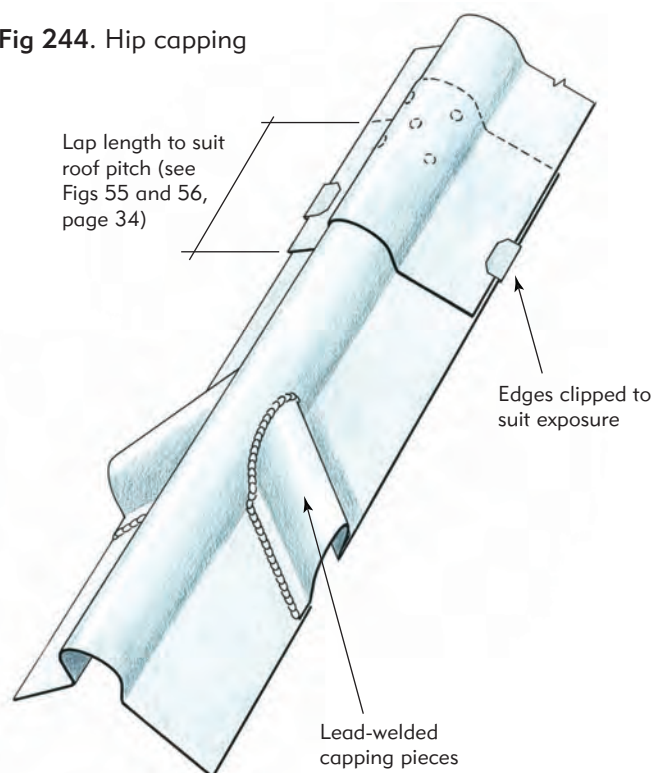


Where roofing bays abut a hip roll, detailing is similar to an abutment at a wall. When wood-cored rolls are used, the top of the bay is turned up about 50mm (Fig 242), and for hollow rolls about 35mm (Fig 243). The bays are fixed with two rows of nails at 75mm centres, or one row at 50mm centres if the longest side of the bay does not exceed 1m.

Capping pieces are used to cover the hip roll, with the extension on each side not less than 75mm (Fig 244). When the pitch of the hip is below 30°, it will be necessary to seal the nail heads by solder dabs or lead-welding. Alternatively, the extension on each side of the roll can be increased so that rainwater does not infiltrate the fixing area.

Where the hip is above 30°, the upstand against the hip roll can be omitted, provided that the capping piece covers the top of the roofing bays to conform to the lap requirements of Fig 55. However, since hips and ridges are vulnerable areas, the upstand should be omitted only on buildings in sheltered to moderate exposures.

Fig 244. Hip capping



Pitched roof coverings (cont.)

Ridges

Where pitched roofing bays about a ridge, the methods of detailing and fixing are similar to abutments at hips and walls. Although not essential, a large roll (king roll) is normally used along the ridge. The top of the bays are turned up against this roll and fixed as shown in Fig 246. Capping pieces are fitted over the ridge roll, with an extension of not less than 75mm on each side to cover the sealed nail fixings.

For aesthetic reasons, the extension on each side of the ridge roll is often longer (100-150mm) and in these cases, it may not be necessary to seal the nail heads. However, in storm conditions, rainwater can infiltrate the fixing area on pitches below 20°, even with extended laps, making **it essential to seal the nail heads with solder dabs or lead-welding**.

When the roof pitch is above 30°, the upstand against the ridge roll can be omitted if the capping covers the top of the roofing bays to provide a 75mm-minimum vertical cover (Fig 247). However, since ridges are the most vulnerable areas on a building, the upstand should be omitted only in sheltered to moderate exposures.



Fig 246. Ridge (above 10°)

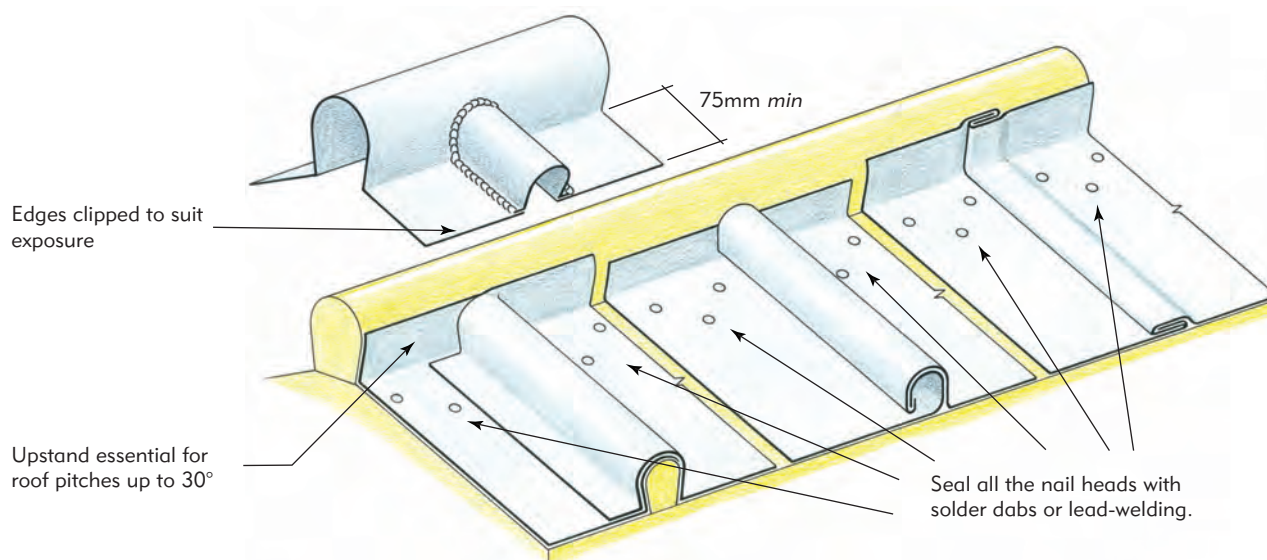
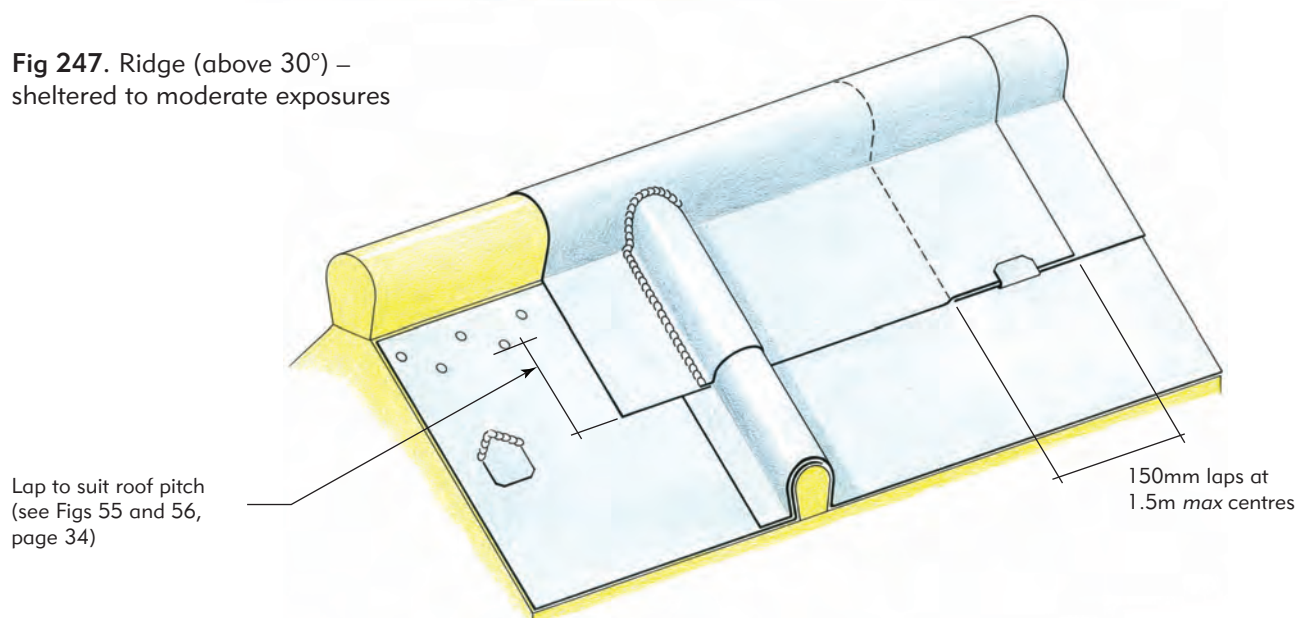


Fig 247. Ridge (above 30°) – sheltered to moderate exposures



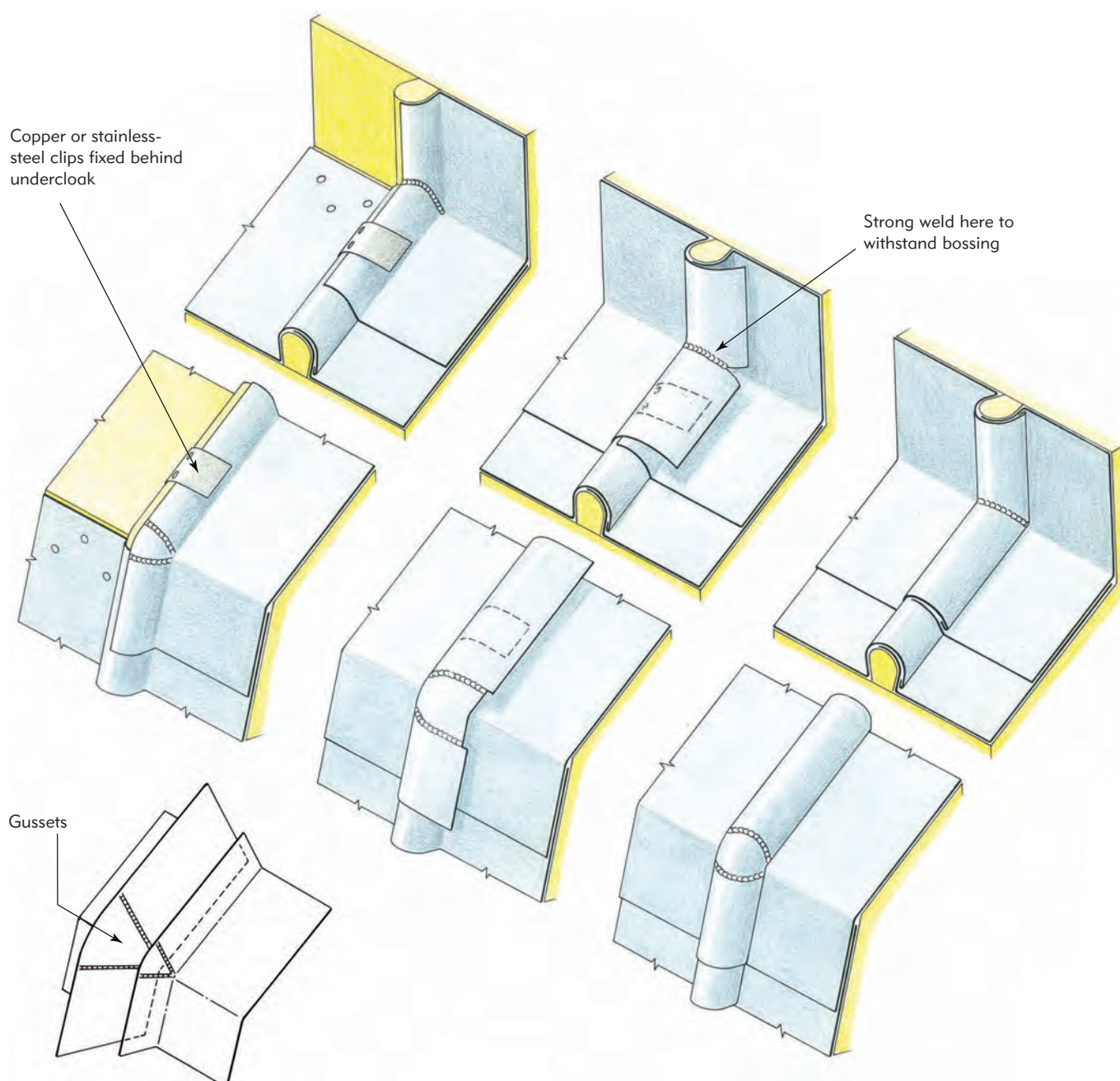
Pitched roof coverings (cont.)

Changes in pitch of wood-cored roll

Pitched roofs with wood-cored rolls are often designed with changes in pitch. Usually, a lap joint is positioned near the change in pitch – Fig 252 shows an example of an external and an internal angle. The roll can be detailed with a splash lap on the overcloak or with a welted overcloak, as shown. It is possible to boss the angles but usually it is more practical to form them by lead-welding. To make the external corner, the undercloak and overcloak are cut and bent to the required angle, and gussets are inserted by welding on the bench.

With the work in position, the undercloak can be readily dressed to fit the roll. The overcloak is then turned, with some bossing at the angle, to fit the roll and engage the clips. For the internal corner, the lead is cut and folded and the angles welded on the bench before placing the bays in position. It is important that a strong weld is made on the overcloak because this has to withstand the bossing required to achieve a close fit to the roll at the angle.

Fig 252. Wood rolls – changes in pitch



Lead sheet cladding

Recommendations in this chapter are for steep mansard slopes over 80° and vertical walls. The vertical joints are usually wood-cored rolls or welts and, occasionally, hollow rolls. Standing seams can be used where there is no risk of mechanical damage (for example, when using ladders during routine maintenance or window cleaning). Standing seams are used mainly on short areas of vertical cladding where there are no angles. Laps are used for the horizontal joints.

Provision of ventilation behind the substrate supporting vertical cladding may be necessary (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).

Spacing of joints

The maximum spacing of joints for cladding work is shown in Table 14. Normally, spacing of the vertical joints should not be increased when the distance between the laps is less than that recommended in the table. In very exposed positions, such as corners and gable ends, it may be necessary to decrease the spacing of the vertical joints or, alternatively, to introduce intermediate fixings into the vulnerable areas (Figs 53 and 54, page 33).

Fig 253a shows the maximum size for panels of codes 4 and 5 lead sheet. In most cases, intermediate fixings will not be required. However, there will be situations, particularly when using codes 4 and 5 for fascia cladding or preformed lead-faced panels, where the spacing of vertical joints can be wider than shown in Table 14. A wider joint spacing may be required to allow the vertical joints to line up with window mullions above or below the cladding or, perhaps, to suit the module of a building. Fig 253b shows examples of alternative joint spacing for panels of codes 4 and 5, which are the thicknesses used most often for this work. Where more than one intermediate fixing is used in a panel, it will be necessary to detail the fixings to allow for thermal movement (Fig 54).

Methods of fixing

For normal cladding, the individual panels of lead are secured at the head with two rows of fixings, or three rows when using codes 7 and 8 lead sheet. When wood-cored rolls are used for the vertical joints, additional nails are fixed into the top third of the undercloak. Experience has shown that these fixings will hold the lead firmly and permanently in position. Even with vertical work, the lead will not creep if the maximum distance between laps shown in Table 14 is not exceeded. However, the panels will expand and contract when subjected to changes in temperature. Therefore, it is important that retaining clips on the lap joints are turned to allow for at least 6mm of movement.

Table 14. Cladding – spacing of joints

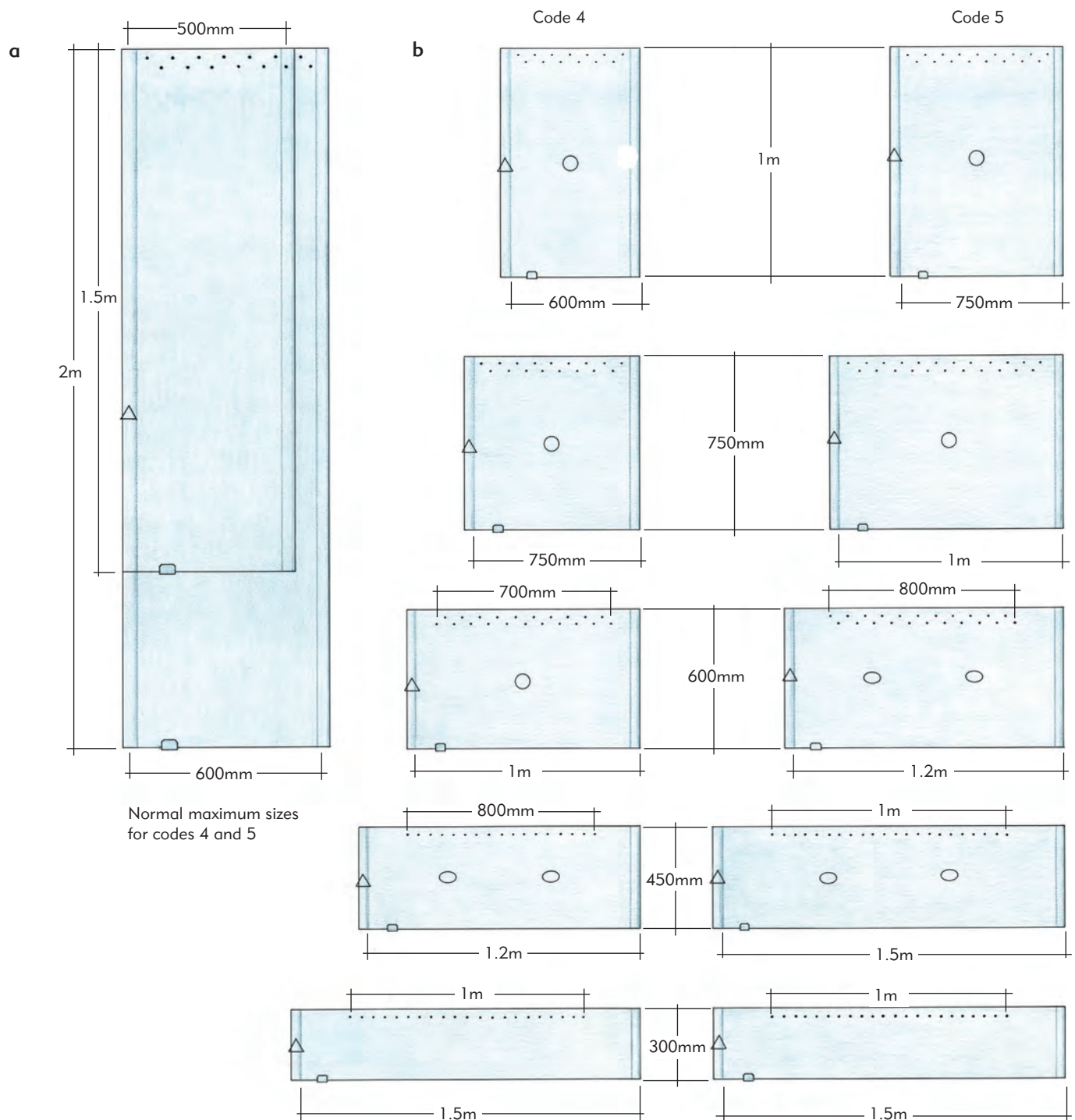
BS EN 12588 code no	Maximum spacing of vertical joints (mm)	Maximum distance between laps (mm)
4	500	1500
5	600	2000
6	600	2000
7	650	2250
8	700	2250





Lead sheet cladding (cont.)

Fig 253. Sizing and fixing of panels



•• Head fixings (see Fig 50, page 31)

△ Clips in welts, rolls or standing seams (see Figs 49, page 30, and Figs 59-62, pages 36-37)

□ Fixings on free edges (see Figs 43-47, pages 28-29)

○ Intermediate fixings (see Figs 51-52, page 32)

○ Intermediate fixings (see Fig 54, page 33)

Dormer windows (cont.)

Side flashings

For roofs covered with single-lap tiles, the flashing lengths should not exceed 1.5m. Laps between pieces, and where the flashing laps the return of the sill weathering (Fig 285a), should conform to the requirements of the lap chart (Fig 55, page 34). The upstand against the dormer cheek should be not less than 100mm. Each flashing piece is held in position by nailing the top third of the upstand to the cheek.

Where the roof is covered with double-lap plain tiles or slates, soakers are used with upstands not less than 100mm (Fig 285b). For lead-covered roofs, the narrow bay on each side of the dormer is turned up against the cheek (Fig 301, page 187).

Fig 284. Sill weathering in position

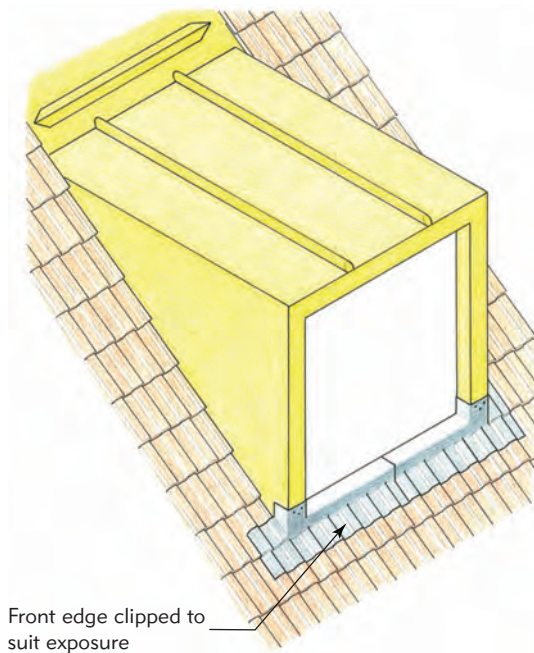
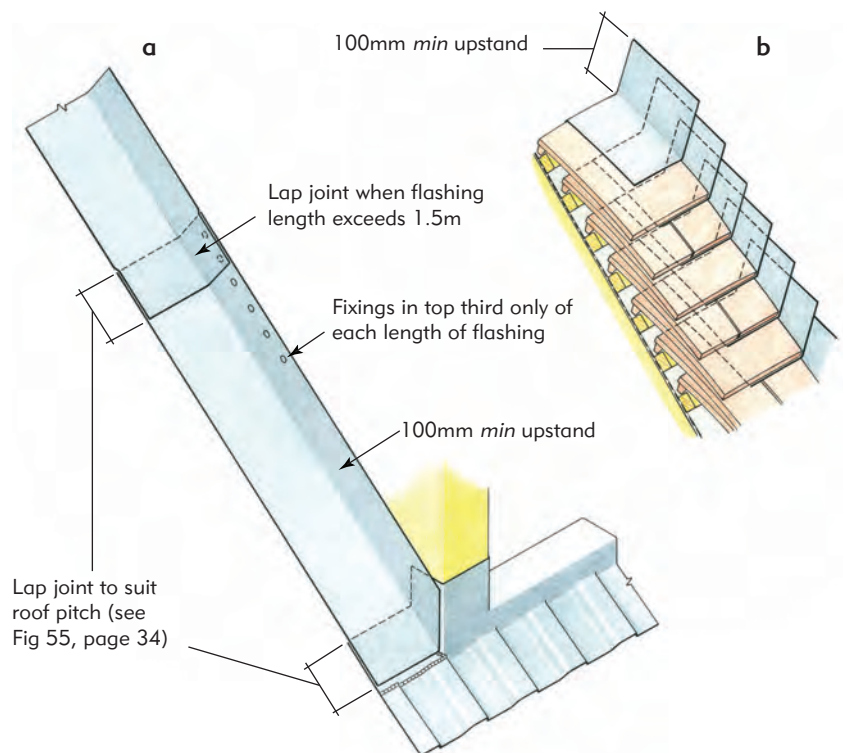


Fig 285. Side flashings



Domes, turrets and spires

The principles for the covering of large domes, turrets and spires are similar to those for lead coverings for pitched roofing (pages 141-156). Individual pieces of lead sheet must be sized in relation to the thickness specified and held in position by adequate head fixings. Free edges must be clipped to suit the exposure of the building and when intermediate fixings are necessary, they should be positioned so that free thermal movement of the lead is not impeded.

The same principles also apply to the weathering of small domes, turrets and spires. However, with these smaller areas, all of the pieces of lead taper towards the top and extra care is required to ensure that adequate head fixing is provided.

Fig 322 shows examples of small domes, turrets and spires. Joints between the panels of lead can be wood-cored or hollow rolls. Hollow rolls are particularly suitable for deeply concave or convex surfaces. Welts can also be used where the pitch of the contoured surface and exposure of the building will not result in the welts becoming submerged by the flow of rainwater during storm conditions.

Provision of ventilation to the underside of the substrate supporting these roofs may be necessary (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).



Example of Herringbone detailing

Fig 322. Domes, turrets and spires

